National Curriculum for
CHEMISTRY
Grades XI – XII
2006
National Curriculum for

CHEMISTRY

Grades XI – XII

2006

GOVERNMENT OF PAKISTAN
MINISTRY OF EDUCATION
ISLAMABAD
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2. Aims and Objectives</td>
<td>2</td>
</tr>
<tr>
<td>3. Standards and Benchmarks</td>
<td>4</td>
</tr>
<tr>
<td>4. XI-Contents</td>
<td>9</td>
</tr>
<tr>
<td>5. XII-Contents</td>
<td>15</td>
</tr>
<tr>
<td>6. XI-Learning Outcomes</td>
<td>25</td>
</tr>
<tr>
<td>7. XII-Learning Outcomes</td>
<td>49</td>
</tr>
<tr>
<td>8. XI-XII Practicals</td>
<td>74</td>
</tr>
<tr>
<td>9. XI-XII Chemicals</td>
<td>82</td>
</tr>
<tr>
<td>10. XI-XII Equipment / Apparatus</td>
<td>84</td>
</tr>
<tr>
<td>11. Chapter-Wise Time Allocation</td>
<td>86</td>
</tr>
<tr>
<td>12. Instructions in the Class Room</td>
<td>87</td>
</tr>
<tr>
<td>13. Teaching Learning Program</td>
<td>88</td>
</tr>
<tr>
<td>14. Assessment and Evaluation</td>
<td>90</td>
</tr>
<tr>
<td>15. General Instructions to Authors</td>
<td>94</td>
</tr>
<tr>
<td>16. Electronic Instructional Material</td>
<td>95</td>
</tr>
<tr>
<td>17. Chapter Organizing System</td>
<td>96</td>
</tr>
<tr>
<td>18. Salient Features of the Curriculum</td>
<td>98</td>
</tr>
<tr>
<td>19. Glossary of Terms</td>
<td>101</td>
</tr>
<tr>
<td>20. Curriculum Development Team</td>
<td>103</td>
</tr>
</tbody>
</table>
Chapter 1  Stoichiometry

Introduction
1.1 Mole and Avogadro’s Number
1.2 Mole Calculations
1.3 Percentage Composition
1.4 Excess and Limiting Reagents
1.5 Theoretical Yield and Actual Yield as percentage

Chapter 2  Atomic Structure

Introduction
2.1 Discharge Tube Experiments
2.2 Application of Bohr’s Model
   2.2.1 Derivation of Radius, Energy, Frequency, Wave Length, Wave Number
   2.2.2 Spectrum of Hydrogen Atom
   2.2.3 Defects of Bohr’s Theory
2.3 Planck’s Quantum Theory
   2.3.1 Postulates With Derivation of $E = h\nu$
2.4 X-Rays
   2.4.1 Production, Properties and Uses
   2.4.2 Types
   2.4.3 X-rays and Atomic Number
   2.4.4 Moseley’s Experiment
   2.4.5 Moseley’s Law
2.5 Quantum Numbers and Orbitals
   2.5.1 Principle Quantum Number
   2.5.2 Azimuthal Quantum Number
   2.5.3 Magnetic Quantum Number
   2.5.4 Spin Quantum Number
   2.5.5 Shapes of s, p and d Orbitals
2.6 Electronic Configuration
   2.6.1 Aufbau Principle
   2.6.2 Pauli’s Exclusion Principle
   2.6.3 Hund’s Rule
   2.6.4 Electronic Configurations

Chapter 3  Theories of Covalent Bonding and Shapes of molecules

Introduction
3.1 Shapes of molecules
   3.1.1 VSEPR
   3.1.2 Resonance
3.2 Theories of covalent bonding
   3.2.1 VBT and hybridization
   3.2.2 MOT
3.3 Bond Characteristics
   3.3.1 Bond Energy
   3.3.2 Bond Length
   3.3.3 Ionic Character
   3.3.4 Dipole Moment

3.4 Effect of Bonding on Physical and Chemical Properties
   3.4.1 Solubility of Ionic and Covalent Compounds
   3.4.2 Reactions of Ionic and Covalent Compounds
   3.4.3 Directional and Non Directional Nature of Ionic and Covalent Bonds

Chapter 4 States of Matter I: Gases

Introduction

4.1 Kinetic Molecular Theory of Gases
   4.1.1 Postulates of Kinetic Molecular Theory
   4.1.2 Pressure and Its Units

4.2 Absolute Temperature Scale on the Basis of Charles Law
   4.2.1 Brief recall of Boyle's and Charles' Law
   4.2.2 Graphical Explanation of Absolute Zero

4.3 Avogadro's Law

4.4 Ideal Gas Equation
   4.4.1 Derivation
   4.4.2 Gas Constant and its Units

4.5 Deviation From Ideal Gas Behavior
   4.5.1 Graphical Explanation
   4.5.2 Causes for Deviation

4.6 Van der Waals Equation
   4.6.1 Volume Correction
   4.6.2 Pressure Correction

4.7 Dalton's Law of Partial Pressure

4.8 Graham's Law of Diffusion and Effusion

4.9 Liquefaction of Gases
   4.9.1 Joule-Thomson Effect
   4.9.2 Linde's Method of Liquefaction of Gases

4.10 Fourth State of Matter: Plasma

Chapter 5 States of Matter II: Liquids

Introduction

5.1 Kinetic Molecular Interpretation of Liquids
   5.1.1 Simple properties of Liquids Describing Diffusion, Compression, Expansion, Motion of Molecules, Kinetic Energy

5.2 Intermolecular Forces (Vander Waals Forces)
   5.2.1 Dipole-Dipole interaction
   5.2.2 Hydrogen Bonding
   5.2.3 London Forces
5.3 Energetics of Phase Changes
5.3.1 Molar Heat of Fusion, Molar Heat of Vaporization, Molar Heat of Sublimation
5.3.2 Energy Changes and Intermolecular Attractions
5.3.3 Change of State and Dynamic Equilibrium

5.4 Liquid Crystals
5.4.1 Brief Description
5.4.2 Uses from Daily Life

Chapter 6 States of Matter III: Solids

Introduction
6.1 Kinetic Molecular Interpretation of Solids
6.1.1 Simple Properties of Solids Describing Vibration of Molecules, Intermolecular Forces, Kinetic Energy

6.2 Types of Solids
6.2.1 Amorphous
6.2.2 Crystalline

6.3 Properties of Crystalline Solids
6.3.1 Symmetry
6.3.2 Geometrical Shape
6.3.3 Melting Point
6.3.4 Cleavage Plane
6.3.5 Habit of Crystal
6.3.6 Crystal Growth
6.3.7 Anisotropy
6.3.8 Isomorphism
6.3.9 Polymorphism
6.3.10 Allotropy
6.3.11 Transition Temperature

6.4 Crystal Lattice
6.4.1 Unit Cell
6.4.2 NaCl Crystal
6.4.3 Lattice Energy

6.5 Types of Crystalline Solids
6.5.1 Ionic Solids
6.5.2 Covalent Solids
6.5.3 Metallic Solids
6.5.4 Molecular Solids

Chapter 7 Chemical Equilibrium

Introduction
7.1 Reversible Reactions and Dynamic Equilibrium
7.1.1 Concept and Explanation
7.1.2 Law of Mass Action and Expression for Equilibrium Constant
7.1.3 Relationship between $K_c$, $K_p$, $K_a$, $K_w$
7.1.4 Importance of $K$ and Reaction Quotient
7.2 Factors Affecting Equilibrium (Le-Chatelier’s Principle)
  7.2.1 Effect of Change in Concentration
  7.2.2 Effect of Change in Pressure or Volume
  7.2.3 Effect of Change in Temperature

7.3 Industrial Application of Le-Chatelier’s Principle (Haber’s Process)

7.4 Solubility Product and Precipitation Reactions

7.5 Common Ion Effect

Chapter 8 Acids, Bases and Salts

Introduction
8.1 Acidic, Basic and Amphoteric Substances
8.2 Bronsted-Lowery Definitions of Acids and Bases
  8.2.1 Proton Donors and Acceptors
  8.2.2 Relative Strength of Acids and Bases
8.3 Conjugate Acid-Base Pairs
8.4 Expressing the Strength of Acids and Bases
  8.4.1 Ionization Equation of Water
  8.4.2 pH, pOH and pKw
  8.4.3 Acid Ionization Constant, Ka and pKa
  8.4.4 Leveling Effect
  8.4.5 Base Ionization Constant, Kb and pKb
  8.4.6 Relationship of Ka and Kb
8.5 Lewis Definitions of Acids and Bases
8.6 Buffer Solutions and their Applications
8.7 Salt Hydrolysis

Chapter 9 Chemical Kinetics

Introduction
9.1 Chemical Kinetics
9.2 Rates of Reactions
  9.2.1 Rate law or Rate Expression
  9.2.2 Elementary and overall Rate Constant and Units
  9.2.3 Order of Reaction and its Determination
  9.2.4 Factors Affecting Rate of Reaction
9.3 Collision Theory, Transition State and Activation Energy
9.4 Catalysis
  9.4.1 Characteristics of Catalysts
  9.4.2 Homogeneous Catalysis
  9.4.3 Heterogeneous Catalysis
  9.4.4 Enzyme Catalysis

Chapter 10 Solutions and Colloids

Introduction
10.1 General Properties of Solutions
  10.1.1 Solution, Suspension and Colloids
  10.1.2 Hydrophilic and Hydrophobic Molecules
  10.1.3 The Nature of Solutions in Liquid Phase
  10.1.4 The Effect of Temperature and Pressure on Solubility
10.2 **Concentration Units**
10.2.1 Percent
10.2.2 Molarity
10.2.3 Molality
10.2.4 Mole fraction
10.2.5 Parts per million, billion, and trillion

10.3 **Raoult's Law**
10.3.1 Non-Volatile Non- Electrolyte Solutes in Volatile solvents
10.3.2 When both Components are Volatile

10.4 **Colligative Properties of dilute Solutions**
10.4.1 Vapour Pressure Lowering
10.4.2 Boiling Point Elevation and Freezing Point Depression
10.4.3 Molar Mass Determination by Vapor Pressure Lowering, Boiling Point Elevation and Freezing Point Depression
10.4.4 Osmotic Pressure and Reverse Osmosis

10.5 **Colloids**
10.5.1 Properties of Colloids
10.5.2 Types of Colloids

### Chapter 11 Thermochemistry

**Introduction**
11.1 Energy in Chemical Reactions
11.2 Thermodynamics
11.3 Internal Energy
11.4 First Law of Thermodynamics
11.5 Standard State and Standard Enthalpy Changes
11.6 Heat Capacity
11.7 Calorimeter
11.8 Hess's Law: Enthalpy Change Calculations
11.9 Born Haber Cycle

### Chapter 12 Electrochemistry

**Introduction**
12.1 Oxidation-Reduction Concepts
12.1.1 Oxidation and Reduction
12.1.2 Oxidation Numbers
12.1.3 Recognizing Oxidation Reduction Reactions
12.1.4 Balancing Oxidation Reduction Equations by Oxidation Number Method
12.1.5 Balancing Oxidation Reduction Equations by the Half Reaction Method
12.1.6 Chemistry of Some Important Oxidizing and Reducing Agents
12.2 Electrode, Electrode Potential and Electrochemical Series
12.3 Types of Electrochemical Cells
12.3.1 Electrolytic Cells
12.3.2 Electrolysis of Aqueous NaCl
12.3.3 Voltaic Cells
   12.3.3.1 Standard State Cell Potential for Voltaic Cell
12.3.3.2 Standard State Reduction Half Cell Potential
12.3.3.3 Standard State Cell Potentials and Spontaneous Reaction

12.3.4 Batteries
   12.3.4.1 Primary Batteries
   12.3.4.2 Secondary Batteries
   12.3.4.3 Fuel Cells

12.3.5 Corrosion and its Prevention
Chapter 13  s- and p - Block Elements

Introduction
13.1  Period 3 (Na to Ar)
  13.1.1 Physical and Atomic Properties of the Elements
    13.1.1.1 Electronic Structure
    13.1.1.2 Trends in Atomic Radius
    13.1.1.3 Trends in First Ionization Energy
    13.1.1.4 Trends in Electronegativity
    13.1.1.5 Trends in Electrical Conductivity
    13.1.1.6 Trends in Melting and Boiling Points
  13.1.2 Reactions of the Period 3 Elements with Water, Oxygen and Chlorine
  13.1.3 Physical Properties of the Oxides
    13.1.3.1 Structure
    13.1.3.2 Melting and Boiling Points
    13.1.3.3 Electrical Conductivity
  13.1.4 Acid-Base Behavior of the Oxides
    13.1.4.1 Trends in Acid Base Behavior
    13.1.4.2 Reactions of Oxides with Water, Acids and Bases
  13.1.5 Chlorides of the Period 3 Elements
    13.1.5.1 Structure
    13.1.5.2 Melting and Boiling Points
    13.1.5.3 Electrical Conductivity
    13.1.5.4 Solubility in Water
  13.1.6 Hydroxides of the Period 3 Elements
    13.1.6.1 Sodium and Magnesium Hydroxides
    13.1.6.2 Aluminum Hydroxide
    13.1.6.3 Other Hydroxides

13.2  Group 1-Elements
  13.2.1 Atomic and Physical Properties
    13.2.1.1 Trends in Atomic Radius
    13.2.1.2 Trends in First Ionization Energy
    13.2.1.3 Trends in Electronegativity
    13.2.1.4 Trends in Melting and Boiling Points
    13.2.1.5 Trends in Density
  13.2.2 Trends in Reactivity with Water
  13.2.3 Reactions with Oxygen
    13.2.3.1 Reactions with Air or Oxygen and the formation of Normal Oxides, Peroxides, Super Oxides and their Stability
    13.2.3.2 Reactions of Oxides with Water and Dilute Acids
  13.2.4 Reactions with Chlorine
  13.2.5 Effect of Heat on Nitrates, Carbonates and Hydrogen-Carbonates explaining the Trend in Terms of the Polarizing Ability of the Positive Ion
  13.2.6 Flame Tests : Origin of Flame Colors
13.3 Group 2- Elements
13.3.1 Atomic and Physical Properties
   13.3.1.1 Trends in Atomic Radius
   13.3.1.2 Trends in First Ionization Energy
   13.3.1.3 Trends in Electronegativity
   13.3.1.4 Trends in Melting and Boiling Points
13.3.2 Trends in Reactivity with Water
13.3.3 Reactions with Oxygen and Nitrogen
   13.3.3.1 Simple Oxides
   13.3.3.2 Formation of Peroxides on Heating with Oxygen
   13.3.3.3 Formation of Nitrides on Heating in Air
13.3.4 Trends in Solubility of the Hydroxides, Sulphates and Carbonates
13.3.5 Trends in Thermal Stability of the Nitrates and Carbonates
13.3.6 How Beryllium Differs from other Members of its Group?
   13.3.6.1 Why is Beryllium Chloride Covalent and not Ionic?
   13.3.6.2 Amphoteric Beryllium Hydroxide

13.4 Group 4 –Elements
13.4.1 Physical Properties : Melting and Boiling Points
13.4.2 The Trend from Non-Metal to Metal
13.4.3 Oxidation State
13.4.4 Possible Oxidation States
   13.4.4.1 Inert Pair Effect in Formation of Ionic Bonds
   13.4.4.2 Inert Pair Effect and the Formation of Covalent Bonds
13.4.5 Chlorides of Carbon, Silicon and Lead
   13.4.5.1 Structures and Stability
   13.4.5.2 Reactions with Water
13.4.6 Oxides
   13.4.6.1 Structure of Carbon Dioxide and Silicon Dioxide
   13.4.6.2 Acid Base Behavior of Group IV Oxides

13.5 Group 7-Elements: Halogenes
13.5.1 Atomic and Physical Properties
   13.5.1.1 Trends in Atomic Radius
   13.5.1.2 Trends in Electronegativity
   13.5.1.3 Trends in Electron Affinity
   13.5.1.4 Trends in Melting and Boiling Points
   13.5.1.5 Bond Enthalpies
      13.5.1.5.1 Bond Enthalpies in Halogenes
      13.5.1.5.2 Bond Enthalpies in Hydrogen Halides
13.5.2 Strength of Halogenes as Oxidizing Agents : F>Cl>Br>I
13.5.3 The Acidity of Hydrogen Halides
13.5.4 Halide Ions as Reducing Agents and Trends in Reducing Ability of Halide Ions
Chapter 14  d and f - Block Elements: Transition Elements

Introduction
14.1 General Features
14.1.1 General Features of Transition Elements
14.1.2 Electronic Structure
14.1.3 Binding Energy
14.1.4 Variable Oxidation States
14.1.5 Catalytic Activity
14.1.6 Magnetic Behaviour
14.1.7 Alloy formation
14.2 Coordination Compounds
14.2.1 Complex Ion
14.2.2 Nomenclature of Coordination compounds
14.2.3 Shapes of Complex Ions with Coordination number 2, 4 and 6
14.2.4 Colour of Complexes

14.3 Chemistry of Some important Transition Elements
14.3.1 Vanadium
14.3.1.1 Oxidation States
14.3.1.2 As Catalyst in Contact Process
14.3.2 Chromium
14.3.2.1 Oxidation States
14.3.2.2 Chromate – Dichromate Equilibrium
14.3.2.3 Reduction of Chromate VI Ions with Zn and an Acid
14.3.2.4 Potassium Dichromate as an Oxidizing Agent in Organic Chemistry
14.3.2.5 Potassium Dichromate as an Oxidizing Agent in Titrations
14.3.3 Manganese
14.3.3.1 Oxidation States
14.3.3.2 Potassium Manganate VII as an Oxidizing Agent in Organic Chemistry
14.3.3.3 Potassium Manganate VII as an Oxidizing Agent in Titrations
14.3.4 Iron
14.3.4.1 Oxidation States
14.3.4.2 Iron as Catalyst in Haber’s Process
14.3.4.3 Iron as Catalyst in Reaction between Persulphate and Iodide Ions
14.3.4.4 Reactions of Hexaaquairon(II) and Hexaaquairon(III) with Water and Ammonia
14.3.4.5 Reactions of Iron (II) and (III) Ions with Carbonate, and Thiocyanate Ions
14.3.5 Copper
14.3.5.1 Oxidation States
14.3.5.2 The Reaction of Hexaaquacopper(II) Ions with Hydroxide Ions, Ammonia, and Carbonate Ions
Chapter 15  Organic Compounds
   Introduction
   15.1 Sources
      15.1.1 Fossil Remains: Coal, Petroleum, Natural Gas
      15.1.2 Plants and Natural Products Chemistry
      15.1.3 Partial and Total Synthesis
      15.1.4 Products of Biotechnology
   15.2 Coal as a Source of Organic Compounds
      15.2.1 Destructive Distillation of Coal
      15.2.2 Conversion of Coal to Petroleum
   15.3 Characteristics of Organic Compounds
   15.4 Uses of Organic Compounds
   15.5 New Allotrope of Carbon: Bucky Ball
   15.6 Functional Groups and Homologous Series
   15.7 Detection of Elements in Organic Compounds

Chapter 16  Hydrocarbons
   Introduction
   16.1 Types of Hydrocarbons
   16.2 Alkanes and Cycloalkanes
      16.2.1 Nomenclature
      16.2.2 Physical Properties
      16.2.3 Structure
      16.2.4 Relative Stability
      16.2.5 Reactivity
   16.3 Radical Substitution Reactions
      16.3.1 Overview
      16.3.2 Reaction Mechanism
   16.4 Oxidation of Organic compounds
   16.5 Alkenes
      16.5.1 Nomenclature
      16.5.2 Relative Stability
      16.5.3 Structure
      16.5.4 Preparation of Alkenes
         16.5.4.1 Dehydration of Alcohols
         16.5.4.2 Dehydrohalogenation of Alkyl Halides
      16.5.5 Reactivity
      16.5.6 Reactions
         16.5.6.1 Hydrogenation
         16.5.6.2 Hydrohalogenation
         16.5.6.3 Hydration
         16.5.6.4 Halogenation
         16.5.6.5 Halohydration
         16.5.6.6 Epoxidation
         16.5.6.7 Ozonolysis
         16.5.6.8 Polymerization
      16.5.7 Conjugation
16.6 Isomerism
16.6.1 Chiral Centre
16.6.2 Carbon-Based Chiral Centers
16.6.3 Optical Activity
16.6.4 Optical Isomers
16.6.5 Stereoisomerism
16.6.6 Structural Isomerism

16.7 Alkynes
16.7.1 Nomenclature
16.7.2 Relative Stability
16.7.3 Structure
16.7.4 Physical Properties
16.7.5 Preparation of Alkynes by Elimination Reactions
16.7.6 Reactivity
16.7.7 Acidity of Terminal Alkynes
16.7.8 Addition Reactions of Alkynes
   16.7.8.1 Hydrogenation
   16.7.8.2 Dissolving Metal reduction
   16.7.8.3 Hydrohalogenation
   16.7.8.4 Hydration
   16.7.8.5 Bromination
   16.7.8.6 Ozonolysis

16.8 Benzene and Substituted Benzenes
16.8.1 Nomenclature
16.8.2 Physical Properties
16.8.3 Structure Molecular Orbital Aspects
16.8.4 Resonance, Resonance Energy and Stabilization
16.8.5 Reactivity And Reactions
   16.8.5.1 Addition Reaction
   16.8.5.2 Electrophilic Aromatic Substitution Reactions
      16.8.5.2.1 General Introduction
      16.8.5.2.2 Nitration
      16.8.5.2.3 Sulfonation
      16.8.5.2.4 Halogenation
      16.8.5.2.5 Friedel-Crafts Alkylation
      16.8.5.2.6 Friedel-Crafts Acylation
      16.8.5.2.7 Substituent Effects - (Table of Substituent Effects)
      16.8.5.2.8 Making Polysubstituted Benzenes

Chapter 17 Alkyl Halides and Amines

Introduction
17.1 Alkyl halides
   17.1.1 Nomenclature
   17.1.2 Physical Properties
   17.1.3 Structure
   17.1.4 Preparations of Alkyl Halides
      17.1.4.1 Reaction of Alcohols with Hydrogen Halides
17.1.4.2 Reaction Of Alcohols with other Halogenating Agents (SOCl₂, PX₃)
17.1.4.3 Radical Halogenation of Alkanes
17.1.5 Reactivity
17.1.6 Nucleophilic Substitution Reactions
  17.1.6.1 General Introduction
  17.1.6.2 Important Concepts
    17.1.6.2.1 Carbocations and Their Stability
    17.1.6.2.2 Nucleophile and Base
    17.1.6.2.3 Substrate and Leaving Group
  17.1.6.3 S₉¹ Mechanism
  17.1.6.4 S₉² Mechanism
17.1.7 1, 2 Elimination Reactions
  17.1.7.1 Overview
  17.1.7.2 E₁ Mechanism
  17.1.7.3 E₂ Mechanism
17.1.8 Substitution versus Elimination

17.2 Organometallic Compounds (Grignard’s Reagents)
  17.2.1 Preparation of Grignard’s Reagents
  17.2.2 Reactivity
  17.2.3 Reactions of Grignard’s Reagents
    17.2.3.1 with Aldehydes and Ketones
    17.2.3.2 with Esters
    17.2.3.3 with CO₂

17.3 Amines
  17.3.1 Nomenclature
  17.3.2 Physical Properties
  17.3.3 Structure
  17.3.4 Basicity
  17.3.5 Preparation of Amines
    17.3.5.1 Alkylation of Ammonia by Alkyl Halides
    17.3.5.2 Reductions of Nitrogen Containing Functional Groups
      17.3.5.2.1 Nitriles
      17.3.5.2.2 Nitro
      17.3.5.2.3 Amides
  17.3.6 Reactivity
  17.6.7 Reactions of Amines
    17.6.7.1 Overview
    17.6.7.2 Alkylation of Amines By Alkyl Halides
    17.6.7.3 Reaction of Amines with Aldehydes and Ketones
    17.6.7.4 Preparation of Amides
    17.6.7.5 Preparation of Diazonium Salts

Chapter 18 Alcohols, Phenols and Ethers

Introduction
18.1 Alcohols
  18.1.1 Nomenclature
  18.1.2 Physical Properties
  18.1.3 Structure
18.1.4 Acidity
18.1.5 Preparations of Alcohols
  18.1.5.1 Hydration of Alkenes (review)
  18.1.5.2 Hydrolysis of Alkyl Halides (review)
  18.1.5.3 Reaction of RMgX With Aldehydes And Ketones (review)
  18.1.5.4 Reduction of Aldehydes and Ketones
  18.1.5.5 Reaction of RMgX with Esters (review)
  18.1.5.6 Reduction of Carboxylic Acids and Esters
18.1.6 Reactivity
18.1.7 Reactions of Alcohols
  18.1.7.1 Reaction with HX to give Alkyl Halides (review)
  18.1.7.2 Reaction with SOCl₂, PX₃ to give Alkyl Halides (review)
  18.1.7.3 Acid Catalyzed Dehydration (review)
  18.1.7.4 Preparation of Esters
  18.1.7.5 Oxidation
  18.1.7.6 Cleavage of 1,2-diols
18.1.8 The Sulfur Analogues (Thiols, RSH)

18.2 Phenols
  18.2.1 Nomenclature
  18.2.2 Structure
  18.2.3 Physical Properties
  18.2.4 Acidity
  18.2.5 Preparation of Phenols from
    18.2.5.1 Benzene Sulfonic Acid
    18.2.5.2 Chlorobenzene
    18.2.5.3 Acidic Oxidation of Cumene
    18.2.5.4 Hydrolysis of Diazonium Salts
  18.2.6 Reactivity
  18.2.7 Reactions of Phenols
    18.2.7.1 Electrophilic Aromatic Substitutions (review)
    18.2.7.2 Reaction with Sodium Metal
    18.2.7.3 Oxidation
  18.2.8 Difference between Alcohol and Phenol

18.3 Ethers
  18.3.1 Nomenclature
  18.3.2 Preparation
  18.3.3 Physical properties
  18.3.4 Chemical reactivity

Chapter 19  Carbonyl Compounds 1:

Aldehydes and Ketones

Introduction

  19.1 Nomenclature
  19.2 Physical Properties
  19.3 Structure
  19.4 Preparations of Aldehydes and Ketones
    19.4.1 Ozonolysis of Alkenes (review)
19.4.2 Hydration of Alkynes (review)
19.4.3 Oxidation of Alcohols (review)
19.4.4 Friedel-Crafts Acylation of Aromatics (review)

19.5 Reactivity

19.6 Reactions of Aldehydes and Ketones
19.6.1 Nucleophilic Addition Reactions (Acid and Base Catalyzed)
19.6.2 Relative Reactivity
19.6.3 Reduction of Aldehydes and Ketones
   19.6.3.1 To Hydrocarbons
   19.6.3.2 Using Hydrides to Give Alcohols
   19.6.3.3 Using Carbon Nucleophiles
   19.6.3.4 Using Nitrogen Nucleophiles
   19.6.3.5 Using Oxygen Nucleophiles
19.6.4 Oxidation Reactions

Chapter 20 Carbonyl Compounds 2:

Carboxylic Acids and Functional Derivatives

Introduction
20.1 Nomenclature
20.2 Physical Properties
20.3 Structure
20.4 Acidity
20.5 Preparations of Carboxylic Acids
   20.5.1 Carbonation of Grignard's Reagent (review)
   20.5.2 Hydrolysis of Nitriles
   20.5.3 Oxidation of Primary Alcohols (review)
   20.5.4 Oxidation of Aldehydes (review)
   20.5.5 Oxidation of Alkyl benzenes (review)

20.6 Reactivity
20.7 Reactions of Carboxylic Acids
   20.7.1 Conversion to Carboxylic Acid Derivatives
      20.7.1.1 Acyl Halides
      20.7.1.2 Acid Anhydrides
      20.7.1.3 Esters
      20.7.1.4 Amides
   20.7.2 Summary of Reactions that Interconvert Carboxylic Acids Derivatives
   20.7.3 Reduction to Alcohols
   20.7.4 Decarboxylation Reactions
   20.7.5 Reactions of Carboxylic Acid Derivatives
      20.7.5.1 Reactions of Acyl Halides, Friedel-Crafts Acylation (review)
      20.7.5.2 Reactions of Acid Anhydrides, Hydrolysis
      20.7.5.3 Reactions of Esters, Hydrolysis, Reduction, and with Grignard's Reagent
      20.7.5.4 Reactions of Amides, Hydrolysis and Reduction
      20.7.5.5 Reactions of Nitriles, Hydrolysis, Reduction, and reactions with Grignard's Reagent
Chapter 21  Biochemistry

Introduction
21.1 Carbohydrates
  21.1.1 Classification
  21.1.2 Functions
  21.1.3 Nutritional Importance
21.2 Proteins
  21.2.1 Classification
  21.2.2 Structure
  21.2.3 Properties
  21.2.4 Importance of Proteins
21.3 Enzymes
  21.3.1 Role of Enzyme as a Biocatalyst
  21.3.2 Factors Affecting Enzyme activity
  21.3.3 Industrial Application of Enzyme
21.4 Lipids
  21.4.1 Classification
  21.4.2 Structure
  21.4.3 Properties of Lipids
  21.4.4 Nutritional and Biological Importance of lipids
21.5 Nucleic Acids
  21.5.1 Structural Components of DNA and RNA
  21.5.2 Nucleic Acid Polymers
  21.5.3 Storage of Genetic Information
21.6 Minerals of Biological Significance
  21.6.1 Sources of Important Minerals
  21.6.2 Biological Significance of Iron Calcium Phosphorous and Zinc

Chapter 22  Industrial Chemistry

Introduction
22.1 Introduction to the Chemical Process Industry and Raw Materials used
22.2 Safety Considerations in Process Industries
22.3 Dyes
22.4 Pesticides
22.5 Petrochemicals
22.6 Synthetic Polymers (PVC and Nylon)
22.7 Cosmetics: Lipsticks, Nail Varnish and Remover, hair Dyes
22.8 Adhesives
Chapter 23  Environmental Chemistry

Introduction

23.1 Chemistry of the Troposphere
   23.1.1 Chemical Reactions in the Atmosphere
   23.1.2 CO\textsubscript{x}, NO\textsubscript{x}, VOCs, SO\textsubscript{x}, O\textsubscript{3}
   23.1.3 Automobile, Pollutants and the Catalytic Converter
   23.1.4 Industrial Smog
   23.1.5 Photochemical Smog
   23.1.6 Global Warming and Climate Change
   23.1.7 Acid Rain

23.2 Chemistry of the Stratosphere: Production and Destruction of Ozone

23.3 Water Pollution and Water Treatment
   23.3.1 Types of Water Pollutants
      23.3.1.1 Suspended Solids and Sediments
      23.3.1.2 Dissolved Solids
      23.3.1.3 Thermal Pollution
   23.3.2 Waste water treatment

23.4 Green Chemistry

Chapter 24  Analytical Chemistry

Introduction

24.1 Classical Method of Analysis:
   Combustion Analysis and determination of Molecular Formula

24.2 Modern Methods of Analysis
   24.2.1 Spectroscopy
   24.2.2 Spectroscopic Methods
      24.2.2.1 Infra Red (IR)
      24.2.2.2 Ultra-Violet / Visible (UV-VIS)
      24.2.2.3 Nuclear Magnetic Resonance (NMR)
      24.2.2.4 Atomic Emission and Absorption
      24.2.2.5 Mass Spectrometry (MS)
XI- LEARNING OUTCOMES

Chapter 1  Stoichiometry

Introduction

Major Concepts

1.1 Mole and Avogadro’s number
1.2 Mole Calculations
1.3 Percentage Composition
1.4 Excess and Limiting Reagents
1.5 Theoretical Yield and Actual Yield as Percentage

Conceptual Linkages

This unit is built on

• Atomic Mass Unit (Grade IX-X)
• Relative Atomic Mass and Relative Molecular Mass (Grade IX-X)
• Chemical Species (Grade IX-X)
• Mole Concept (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Interpret a balanced chemical equation in terms of interacting moles, representative particles, masses and volumes of gases (at STP). (Analyzing)
- Construct mole ratios from balanced equations for use as conversion factors in stoichiometric problems. (Applying)
- Perform stoichiometric calculations with balanced equations using moles, representative particles, masses and volumes of gases (at STP). (Analyzing)
- Identify the limiting reagent in a reaction. (Analyzing)
- Knowing the limiting reagent in a reaction, calculate the maximum amount of product(s) produced and the amount of any unreacted excess reagent. (Analyzing)
- Given information from which any two of the following may be determined, calculate the third: theoretical yield, actual yield, percentage yield. (Understanding)
- Calculate the theoretical yield and the percent yield when given the balanced equation, the amounts of reactants and the actual yield. (Applying)
SKILLS:
Students will be able to:
- Use the volume (22.4 L) of one mole of a gas at STP to work mole-volume problems (Analyzing)
- Calculate the gram molecular mass of a gas from density measurements of gases at STP (Analyzing)
- Use the mole to convert among measurements of mass, volume and number of particles (Analyzing)
- Find out the limiting reactant in a chemical reaction and do the related calculations. (Applying)
- Perform calculations based on moles, mass, volume and number of particles. (Understanding)

SOCIETY, TECHNOLOGY AND SCIENCE:
Students will be able to:
- Understand that Chemistry is a quantitative Science (understanding)
Chapter 2        Atomic Structure

Introduction

Major Concepts

2.1  Discharge Tube Experiments
2.2  Application of Bohr's Model
2.3  Planck's Quantum Theory
2.4  X-Rays
2.5  Quantum Numbers and Orbitals
2.6  Electronic Configurations

Conceptual Linkages

This unit is built on

- Rutherford’s Atomic Model (Grade IX-X)
- Bohr’s Atomic Theory (Grade IX-X)
- Isotopes (Grade IX-X)
- Concept of s and p Subshells (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Summarize Bohr’s atomic theory (Applying)
- Use Bohr’s model for calculating radii of orbits. (Understanding)
- Use Bohr's atomic model for calculating energy of electron in a given orbit of hydrogen atom.
- Relate energy equation (for electron) to frequency, wave length and wave number of radiation emitted or absorbed by electron.
- Explain production, properties, types and uses of X-rays. (Understanding)
- Define photon as a unit of radiation energy. (Remembering)
- Describe the concept of orbitals. (Understanding)
- Explain the significance of quantized energies of electrons. (Applying)
- Distinguish among principal energy levels, energy sub levels, and atomic orbitals. (Understanding)
- Describe the general shapes of s, p, and d orbitals. (Understanding)
- Relate the discrete-line spectrum of hydrogen to energy levels of electrons in the hydrogen atom. (Applying)
- Describe the hydrogen atom using the Quantum Theory. (Understanding)
- Use the Aufbau Principle, the Pauli Exclusion Principle, and Hund’s Rule to write the electronic configuration of the elements. (Applying)
- Describe the orbitals of hydrogen atom in order of increasing energy. (Understanding)
- Explain the sequence of filling of electrons in many electron atoms. (Applying)
- Write electron configuration of atoms. (Applying)
**SKILLS:**

Students will be able to:
- Calculate the frequency given the wavelength or wave number. (Applying)
- Calculate the energy of a photon associated with a given wavelength or frequency of radiation. (Applying)
- Calculate energy differences between different energy levels of the hydrogen atom. (Analyzing)

**SOCIETY, TECHNOLOGY AND SCIENCE:**

Students will be able to:
- Describe how making models helps better understand atoms and molecules. (Applying)
- Explain firework displays
Chapter 3  Theories of Covalent Bonding and Shapes of Molecules

Introduction

Major Concepts

3.1 Shapes of Molecules
3.2 Theories of Covalent Bonding
3.3 Bond Characteristics
3.4 Effects of Bonding on Physical and Chemical Properties

Conceptual Linkages

This unit is built on

- Why do Atoms form Bonds?  (Grade IX-X)
- Types of Bonds  (Grade IX-X)
- Intermolecular Forces  (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Use VSEPR and VBT theories to describe the shapes of simple covalent molecules. (Applying)
- Describe the features of sigma and pi bonds. (Understanding)
- Describe the shapes of simple molecules using orbital hybridization. (Applying)
- Determine the shapes of some molecules from the number of bonded pairs and lone pairs of electrons around the central atom. (Analyzing)
- Define bond energies and explain how they can be used to compare bond strengths of different chemical bonds. (Analyzing)
- Predict the molecular polarity from the shapes of molecules. (Applying)
- Describe how knowledge of molecular polarity can be used to explain some physical and chemical properties of molecules. (Analyzing)
- Describe the change in bond lengths of hetero-nuclear molecules due to difference in Electronegativity values of bonded atoms. (Understanding)
- Describe the difference among molecular, network and metallic solids. (Understanding)
- Explain what is meant by the term ionic character of a covalent bond. (Understanding)

SKILLS:

Students will be able to:

- Use ball and stick models to represent different molecular shapes.
- Guess the physical state of molecule form its structure
SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Explain how hydrogen bonds and covalent disulphide bridges are responsible for straight and curly hair. (Applying)
Chapter 4  States of Matter I: Gases

Introduction
Major Concepts

- 4.1 Kinetic Molecular Theory of Gases
- 4.2 Absolute Temperature Scale on the Basis of Charles Law
- 4.3 Avogadro’s Law
- 4.4 Ideal Gas Equation
- 4.5 Deviation from Ideal Gas Behavior
- 4.6 Van der Waals Equation
- 4.7 Dalton’s Law of Partial Pressure
- 4.8 Graham’s Law of Diffusion and Effusion
- 4.9 Liquefaction of Gases
- 4.10 Fourth State of Matter: Plasma

Conceptual Linkages
This unit is built on
- Physical Properties of Gases due to Intermolecular Forces (Grade IX-X)
- Boyle’s Law (Grade IX-X)
- Charles’ Law (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- List the postulates of Kinetic Molecular Theory. (Remembering)
- Describe the motion of particles of a gas according to Kinetic Theory. (Applying)
- State the values of standard temperature and pressure (STP). (Remembering)
- Relate temperature to the average kinetic energy of the particles in a substance. (Applying)
- Use Kinetic Theory to explain gas pressure. (Applying)
- Describe the effect of change in pressure on the volume of gas. (Applying)
- Describe the effect of change in temperature on the volume of gas. (Applying)
- Explain the significance of absolute zero, giving its value in degree Celsius and Kelvin. (Understanding)
- State and explain the significance of Avogadro’s Law. (Understanding)
- Derive Ideal Gas Equation using Boyle's, Charles' and Avogadro’s law. (Understanding)
- Explain the significance and different units of ideal gas constant. (Understanding)
- Distinguish between real and ideal gases. (Understanding)
- Explain why real gases deviate from the gas laws. (Analyzing)
- Define and describe the properties of Plasma.(Applying)
UNDERSTANDING:

Students will be able to:
- Derive new form of Gas Equation with volume and pressure corrections for real gases. (Understanding)
- State and use Graham’s Law of Diffusion. (Understanding)
- State and use Dalton’s Law of Partial Pressures. (Understanding)
- Describe some of the implications of the Kinetic Molecular Theory, such as the velocity of molecules and Graham’s Law. (Applying)
- Explain Lind’s method for the liquefaction of gases. (Understanding)
- Define pressure and give its various units. (Remembering)
- Define and explain plasma formation. (Understanding)

SKILLS:

Students will be able to:
- Interconvert pressure in pascals, kilopascals, atmospheres and bar. (Applying)
- Calculate the partial pressure of a gas collected over water. (Applying)
- Calculate the new volume of a gas when the pressure of the gas changes. (Applying)
- Use the combined gas law in calculations. (Applying)
- Determine the molar volume of the gas under various conditions. (Applying)
- Apply the ideal gas laws to calculate the pressure or the volume of a gas. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Predict the effect of heating gases to extremely high temperatures. (Applying)
- Predict how pressure affects scuba divers at varying depths. (Analyzing)
- Explain the need to liquefy gases for different purposes. (Analyzing)
- Provide examples of uses of liquefied gases in the community. (Applying)
Chapter 5  States of Matter II: Liquids

Introduction

Major Concepts

5.1 Kinetic Molecular Interpretation of Liquids
5.2 Intermolecular Forces (Van der Walls forces)
5.3 Physical Properties of Liquids
5.4 Energetics of Phase Changes
5.5 Liquid Crystals

Conceptual Linkages

This unit is built on

• Physical Properties of Liquids due to Intermolecular Forces  (Grade IX-X)
• Effects of Temperature and Pressure on Vapor Pressure   (Grade IX-X)
• Effects of Temperature and Pressure on Boiling Point    (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Describe simple properties of liquids e.g., diffusion, compression, expansion, motion of molecules, spaces between them, intermolecular forces and kinetic energy based on Kinetic Molecular Theory. (Understanding)
- Explain applications of dipole-dipole forces, hydrogen bonding and London forces. (Applying)
- Explain physical properties of liquids such as evaporation, vapour pressure, boiling point, viscosity and surface tension. (Understanding)
- Use the concept of Hydrogen bonding to explain the following properties of water: high surface tension, high specific heat, low vapor pressure, high heat of vaporization, and high boiling point. And anomalous behaviour of water when its density shows maximum at 4 degree centigrade(Applying)
- Define molar heat of fusion and molar heat of vaporization. (Remembering)
- Describe how heat of fusion and heat of vaporization affect the particles that make up matter. (Understanding)
- Relate energy changes with changes in intermolecular forces. (Applying)
- Define dynamic equilibrium between two physical states. (Remembering)
- Describe liquid crystals and give their uses in daily life. (Applying)
- Differentiate liquid crystals from pure liquids and crystalline solids. (Applying)
**SKILLS:**

Students will be able to:
- Identify types of intermolecular attractions between the molecules of a liquid from a given list of liquids based on its molecular structures. (Applying)
- Compare and explain the volatility of different liquids at same temperature based on intermolecular forces. (Analyzing)

**SOCIETY, TECHNOLOGY AND SCIENCE:**

Students will be able to:
- Provide examples of liquid crystals used in objects like digital wrist watches and calculators. (Applying)
Chapter 6  States of Matter III: Solids

Introduction

Major Concepts

6.1. Kinetic Molecular Interpretation of Solids
6.2. Types of Solids
6.3. Properties of Crystalline Solids
6.4. Crystal Lattice
6.5. Types of Crystalline Solids

Conceptual Linkages

This unit is built on

- Physical Properties of Solids (Grade IX-X)
- Amorphous Solids (Grade IX-X)
- Crystalline Solids (Grade IX-X)
- Allotropic Solids (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Describe simple properties of solids e.g., diffusion, compression, expansion, motion of molecules, spaces between them, intermolecular forces and kinetic energy based on kinetic molecular theory. (Understanding)
- Differentiate between amorphous and crystalline solids. (Understanding)
- Describe properties of crystalline solids like geometrical shape, melting point, cleavage planes, habit of a crystal, crystal growth, anisotropy, symmetry, isomorphism, polymorphism, allotropy and transition temperature. (Understanding)
- Use oxygen and sulphur to define allotropes. (Understanding)
- Explain the significance of the unit cell to the shape of the crystal using NaCl as an example. (Applying)
- Name three types of packing arrangements and draw or construct models of them. (Applying)
- Name three factors that affect the shape of an ionic crystal. (Understanding)
- Define lattice energy. (Remembering)
- Differentiate between ionic, covalent, molecular and metallic crystalline solids. (Applying)
- Explain the low density and high heat of fusion of ice. (Understanding)
- Define and explain molecular and metallic solids. (Understanding)
### SKILLS:

Students will be able to:
- List some common amorphous solids encountered in daily life. (Applying)
- Explain why a compound like CaCl\(_2\) will fluctuate in mass from day to day because of humidity. (Applying)
- Purify saline water by repeated freezing. (Applying)

### SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- List examples of crystalline and amorphous solids in their community and relate these to their specific uses. (Analyzing)
Chapter 7  Chemical Equilibrium

Introduction

Major concepts
7.1 Reversible Reactions and Dynamic Equilibrium
7.2 Factors Affecting Equilibrium (Le-Chatelier’s Principle).
7.3 Industrial Application of Le-Chatelier’s Principle (Haber’s Process)
7.4 Solubility Product and Precipitation Reactions
7.5 Common Ion Effect

Conceptual Linkages
This unit is built on
- Reversible Reactions and Dynamic Equilibrium (Grade IX-X)
- Equilibrium Constant and its Derivation (Grade IX-X)
- Law of Mass Action (Grade IX-X)
- Equilibrium Calculations (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:
- Define chemical equilibrium in terms of a reversible reaction. (Remembering)
- Write both forward and reverse reactions and describe the macroscopic characteristics of each. (Understanding)
- State the necessary conditions for equilibrium and the ways that equilibrium can be recognized. (Understanding)
- Describe the microscopic events that occur when a chemical system is in equilibrium. (Understanding)
- Write the equilibrium expression for a given chemical reaction. (Understanding)
- Relate the equilibrium expression in terms of concentration, partial pressure, number of moles and mole fraction.
- Write expression for reaction quotient.
- Determine if the equilibrium constant will increase or decrease when temperature is changed, given the equation for the reaction. (Applying)
- Propose microscopic events that account for observed macroscopic changes that take place during a shift in equilibrium. (Applying)
- Determine if the reactants or products are favored in a chemical reaction, given the equilibrium constant. (Analyzing)
- State Le Chatelier’s Principle and be able to apply it to systems in equilibrium with changes in concentration, pressure, temperature, or the addition of catalyst. (Applying)
- Explain industrial applications of Le Chatelier’s Principle using Haber’s process as an example. (Analyzing)
- Define and explain solubility product. (Understanding)
- Define and explain common ion effect giving suitable examples. (Applying)
**SKILLS:**

Students will be able to:
- Calculate the equilibrium constant for a reaction given the equilibrium concentrations of reactants and products. (Applying)
- Calculate the concentration specified, given the equilibrium constant and appropriate information about the equilibrium concentrations. (Applying)

**SOCIETY, TECHNOLOGY AND SCIENCE:**

Students will be able to:
- Relate the role of chemical equilibrium in industries that focus on high yields. (Applying)
Chapter 8  Acids, Bases and Salts

Introduction  
Major Concepts

8.1 Acidic, basic and Amphoteric substances
8.2 Bronsted-Lowery Definitions of Acids and Bases
8.3 Conjugate Acid-Base Pairs
8.4 Expressing the Strength of Acids and Bases
8.5 Lewis Definitions of Acids and Bases
8.6 Buffer Solutions and their applications
8.7 Salt Hydrolysis

Conceptual Linkages
- This unit is built on Concepts of Acids and Bases (Grade IX-X)
- pH and pOH (Grade IX-X)
- Salts (Grade IX-X)
- Buffers (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:
- Define Bronsted and Lowery concepts for acids and bases (Remembering)
- Define salts, conjugate acids and conjugate bases. (Remembering)
- Identify conjugate acid-base pairs of Bronsted-Lowery acid and base (Analyzing)
- Explain ionization constant of water and calculate pH and pOH in aqueous medium using given Kw values. (Applying)
- Use the extent of ionization and the acid dissociation constant, Ka, to distinguish between strong and weak acids. (Applying)
- Use the extent of ionization and the base dissociation constant, Kb, to distinguish between strong and weak bases. (Applying)
- Define a buffer, and show with equations how a buffer system works. (Applying)
- Make a buffered solution and explain how such a solution maintains a constant pH, even with the addition of small amounts of strong acid or strong base. (Understanding)
- Use the concept of hydrolysis to explain why aqueous solutions of some salts are acidic or basic. (Applying)
- Use concept of hydrolysis to explain why the solution of a salt is not necessarily neutral. (Understanding)
- Define and explain leveling effect. (Understanding)
**SKILLS:**

Students will be able to:

- Calculate the fourth parameter when given three of four parameters—molarity of base, volume of base, molality of acid, volume of acid—used in a titration experiment, assuming a strong acid and strong base reaction. (Analyzing)
- Calculate the $[\text{H}_3\text{O}^+]$, given the $K_a$ and molar concentration of weak acid. (Applying)
- Calculate concentrations of ions of slightly soluble salts. (Applying)
- Calculate $K_a$ for the system, given the equilibrium concentrations of a weak acid and the $[\text{H}_3\text{O}^+]$ in the solution. (Applying)
- Perform acid-base titrations to calculate molality and strength of given sample solutions. (Applying)

**SOCIETY, TECHNOLOGY AND SCIENCE:**

Students will be able to:

- Link preservatives in food products and allergic reactions in people. (Analyzing)
- Explain why essential elements like iodine are added to table salt for better human health. (Analyzing)
- Explain gastric acidity and use of anti-acid drugs. (Analyzing)
- Explain curdling of milk with lemon juice. (Analyzing)
Chapter 9  Chemical Kinetics

Introduction

Major Concepts

9.1 Chemical Kinetics  
9.2 Rates of Reactions  
9.3 Collision Theory, Transition State and Activation Energy  
9.4 Catalysis

Conceptual Linkages

This unit is built on

- Rate of Reaction  
  (Grade IX-X)  
- Law of Mass Action  
  (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Define chemical kinetics. (Remembering)
- Explain and use the terms rate of reaction, rate equation, order of reaction, rate constant and rate determining step. (Understanding)
- Explain qualitatively factors affecting rate of reaction. (Applying)
- Given the order with respect to each reactant, write the rate law for the reaction. (Applying)
- Explain what is meant by the terms activation energy and activated complex. (Understanding)
- Relate the ideas of activation energy and the activated complex to the rate of a reaction. (Applying)
- Use the collision theory to explain how the rate of a chemical reaction is influenced by the temperature, concentration, size of molecules and. (Applying)
- Given a potential energy diagram for a reaction, discuss the reaction mechanism for the reaction. (Applying)
- Explain effects of concentration, temperature and surface area on reaction rates. (Applying)
- Explain the significance of the rate-determining step on the overall rate of a multi-step reaction. (Analyzing)
- Describe the role of the rate constant in the theoretical determination of reaction rate. (Analyzing)
- Describe that increase in collision energy by increasing the temperature can improve the collision frequency. (Applying)
- Define terms catalyst, catalysis, homogeneous catalysis and heterogeneous catalysis. (Understanding)
- Explain that a catalyst provides a reaction pathway that has low activation energy. (Applying)
- Describe enzymes as biological catalysts. (Understanding)
- Explain why powdered zinc reacts faster. (Analyzing)
**SKILLS:**

Students will be able to:
- Draw energy diagrams that represent the activation energy and show the effect of a catalyst. (Understanding)
- Calculate initial rate using concentration data. (Applying)
- Deduce the order of a reaction using the method of initial rates. (Analyzing)

**SOCIETY, TECHNOLOGY AND SCIENCE:**

Students will be able to:
- Describe how enzymes can be effective in removing stains from fabrics. (Applying)
- Understand that Chemistry deals with the transformation of matter
Chapter 10 Solutions and Colloids

Introduction

Major Concepts

10.1 General Properties of Solutions
10.2 Concentration Units
10.3 Raoult’s Law
10.4 Colligative Properties of Non-Electrolyte in Solutions
10.5 Colloids

Conceptual Linkages

This unit is built on

- Types of Solutions (Grade IX-X)
- Molarity (Grade IX-X)
- Solubility (Grade IX-X)
- Suspensions and Colloids (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- List the characteristics of colloids and suspensions that distinguish them from solutions. (Applying)
- Define hydrophilic and hydrophobic molecules. (Remembering)
- Explain the nature of solutions in liquid phase giving examples of completely miscible, partially miscible and immiscible liquid-liquid solutions. (Applying)
- Explain the effect of temperature on solubility and interpret the solubility graph. (Analyzing)
- Express solution concentration in terms of mass percent, molality, molarity, parts per million, billion and trillion and mole fraction. (Remembering)
- Define the terms colligative. (Remembering)
- Describe on a particle basis why a solution has a lower vapor pressure than the pure solvent. (Applying)
- Explain on a particle basis how the addition of a solute to a pure solvent causes an elevation of the boiling point and depression of the freezing point of the resultant solution. (Applying)
- Describe the role of solvation in the dissolving process. (Understanding)
- Define the term water of hydration. (Remembering)
- Explain concept of solubility and how it applies to solution saturation. (Applying)
- Distinguish between the solvation of ionic species and molecular substances. (Understanding)
UNDERSTANDING:

Students will be able to:
- List three factors that accelerate the dissolution process. (Understanding)
- Define heat of solution and apply this concept to the hydration of ammonium nitrate crystals. (Applying)
- Explain how solute particles may alter the colligative properties. (Applying)
- Explain osmotic pressure, reverse osmosis, and give their daily life applications. (Applying)
- Describe types of colloids and their properties. (Applying)
- List some colligative properties of liquids. (Understanding)

SKILLS:

Students will be able to:
- Perform calculations involving percent (volume/volume) and percent (mass/volume) solutions. (Applying)
- Calculate the molality of a solution. (Applying)
- Calculate the freezing point depression and the boiling point elevation of aqueous solutions. (Applying)
- Calculate molar mass of a substance using ebullioscopic and cryoscopic methods. (Applying)
- Calculate the percent of water in a given hydrate. (Applying)
- Explain the phenomenon freezing in a mixture of ice and salt. (Understanding)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Describe the effect of pressure on gas solubility and the effervescence observed when a bottle of carbonated drink is uncapped. (Applying)
Chapter 11  Thermochemistry

Introduction

Major Concepts

11.1 Energy in Chemical Reactions
11.2 Thermodynamics
11.3 Internal Energy
11.4 First Law of Thermodynamics
11.5 Standard State and Standard Enthalpy Changes
11.6 Heat Capacity
11.7 Calorimetry
11.8 Hess’s Law
11.9 Born Haber Cycle

Conceptual Linkages

This unit is built on

- Exothermic and Endothermic Reactions (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Define thermodynamics. (Remembering)
- Classify reactions as exothermic or endothermic. (Understanding)
- Define the terms system, surrounding, boundary, state function, heat, heat capacity, internal energy, work done and enthalpy of a substance. (Remembering)
- Name and define the units of thermal energy. (Remembering)
- Relate a change in enthalpy to the heat of reaction or heat of combustion of a reaction. (Applying)
- Relate change in internal energy of a system with thermal energy at constant temperature and constant pressure. (Applying)
- Define bond dissociation energy. (Remembering)
- Use the experimental data to calculate the heat of reaction using a calorimeter. (Applying)
- Specify conditions for the standard heat of reaction. (Applying)
- Apply Hess’s Law to construct simple energy cycles. (Applying)
- Describe how heat of combustion can be used to estimate the energy available from foods. (Analyzing)
- Explain reaction pathway diagram in terms of enthalpy changes of the reaction. (Born Haber’s Cycle) (Applying)
SKILLS:

Students will be able to:
- Use standard heats of formation to calculate the enthalpy change of a reaction. (Applying)
- Determine the heat of a reaction which is experimentally inaccessible from the heats of a set of reactions which are experimentally measurable. (Applying)
- Perform calculations involving energy cycles related to Hess’s Law. (Applying)
- Calculate lattice energy and enthalpy of formation of NaCl and MgO from given set of appropriate data. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Use of cold and hot pouches for cooling and heating. (Applying)
- Understand that transformation of matter is accompanied with changes in energy
Chapter 12  Electrochemistry

Introduction

Major Concepts

12.1 Oxidation-Reduction Concepts
12.2 Electrode, Electrode Potential and Electrochemical Series
12.3 Types of Electrochemical Cells

Conceptual Linkages

This unit is built on

- Redox Reactions (Grade IX-X)
- Rules for Assigning Oxidation States (Grade IX-X)
- Electrochemical Cells (Grade IX-X)
- Electrochemical Industries (Grade IX-X)
- Corrosion and Its Prevention (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Give the characteristics of a Redox reaction. (Understanding)
- Determine the oxidation number of an atom of any element in a pure substance. (Applying)
- Define oxidation and reduction in terms of a change in oxidation number. (Applying)
- Use the oxidation-number change method to identify atoms being oxidized or reduced in redox reactions. (Applying)
- Use the oxidation-number change method to balance redox equations. (Applying)
- Balance redox reactions that take place in acid solutions. (Applying)
- Break a redox reaction into oxidation and reduction half reactions. (Applying)
- When given an unbalanced redox equation, use the half reaction method to balance the equation. (Applying)
- Define cathode, anode, electrode potential and S.H.E. (Standard Hydrogen Electrode). (Remembering)
- Identify the substance oxidized and the substance reduced in a dry cell. (Applying)
- Use the activity series of metals to predict the products of single replacement reactions. (Analysis)
- Define cell potential, and describe how it is determined. (Understanding)
- Describe the reaction that occurs when a lead storage battery is recharged. (Applying)
- Explain how a fuel cell produces electrical energy. (Applying)
- Define the standard electrode potential of an electrode. (Remembering)
UNDERSTANDING:

Students will be able to:
- Distinguish between electrical terms such as coulomb, ampere, and volt. (Understanding)
- State and explain Faraday’s laws. (Understanding)
- Describe how a dry cell supplies electricity. (Understanding)
- Explain how a lead storage battery produces electricity. (Understanding)
- Define corrosion and describe simple methods like electroplating and galvanizing for its prevention. (Applying)

SKILLS:

Students will be able to:
- Use standard electrode potentials to calculate the standard emf of cell (Applying)
- Predict the feasibility of an electrochemical reaction from emf data. (Analyzing)
- Calculate the amount of substance reduced when a quantity of another substance is oxidized in an electrochemical cell. (Applying)
- Calculate the cell potential for an electrochemical cell under standard conditions. (Applying)
- Deduce the direction of flow of electrons in an electrochemical cell. (Analyzing)
- Calculate the quantity of charge passed in an electrochemical cell during electrolysis. (Applying)
- Calculate the mass or volume of substance liberated during electrolysis. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Explain how paints can protect metal surfaces from corrosion and other harmful agents. (Applying)
- Provide examples of applications of oxidation-reduction reactions in daily life. (Applying)
- Identify solar cells as the source of energy in future (Applying)
- Explain how batteries work. (Applying)
- Explain many reactions as the result of electron transfer
Chapter 13  s- and p - Block Elements

Introduction

Major Concepts

13.1 Period 3 (Na To Ar)
13.2 Group 1
13.3 Group 2
13.4 Group 4
13.5 Group 7 (Halogens)

Conceptual Linkages

This unit is built on

- Periodic Table (Grade IX-X)
- Periodicity of Properties (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Recognize the demarcation of the Periodic Table into s block, p block, d block, and f block. (Understanding)
- Describe how physical properties like atomic radius, ionization energy, electronegativity, electrical conductivity and melting and boiling points of elements change within a group and within a period in the Periodic Table. (Analyzing)
- Describe reactions of period 3 elements with water, oxygen and chlorine. (Applying)
- Describe physical properties and acid-base behavior of oxides, chlorides and hydroxides of period 3 elements. (Applying)
- Describe reactions of oxides and chlorides of period 3 elements with water. (Applying)
- Explain the trends in physical properties and oxidation states in groups I, II, IV and VII of the Periodic Table. (Analyzing)
- Describe reactions of Group I elements with water, oxygen and chlorine. (Applying)
- Explain effect of heat on nitrates, carbonates and hydrogen carbonates of Group I elements. (Applying)
- Describe reactions of Group II elements with water, oxygen and nitrogen. (Applying)
- Discuss the trend in solubility of the hydroxides, sulphates and carbonates of Group II elements. (Analyzing)
- Discuss the trends in thermal stability of the nitrates and carbonates of Group II elements. (Analyzing)
- Differentiate beryllium from other members of its group. (Analyzing)
### UNDERSTANDING:

Students will be able to:
- Describe reactions of Group IV elements with water. (Applying)
- Discuss the chlorides and oxides of group IV elements. (Applying)
- Explain the relative behaviour of halogens as oxidizing agents and reducing agents. (Applying)
- Compare the acidity of hydrogen halides. (Analyzing)
- Distinguish between an oxide and a peroxide. (Understanding)
- Write representative equations for the formation of oxides and sulphides. (Applying)
- Compare the outermost s and p orbital system of an element with its chemical properties. (Analyzing)

### SKILLS:

Students will be able to:
- Perform flame tests and explain the appearance of colors in the flame. (Analyzing)
- Analyze acidic and basic ions using various tests. (Analyzing)

### SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Describe how the food and beverage industry uses steel, tin, aluminum and glass for canning purposes. (Analyzing)
- Explain how certain elements are mined and extracted from the earth. (Applying)
- Relate the properties of the halogens to their important commercial uses. (Applying)
- Explain that iodine deficiency leads to goiter. (Understanding)
- Explain the applications of bleaching powder. (Understanding)
- Explain fluoride toxicity and deficiency. (Understanding)
Chapter 14  
**d and f - Block Elements (Transition Elements)**

**Introduction**

**Major Concepts**

14.1 Transition Elements  
14.2 Coordination Compounds  
14.3 The Chemistry of Some Specific Transition Metals

**Conceptual Linkages**

This unit is built on:

- Periodic Table  
- Periodicity of Properties  
- Metals and Metalloids

(Grade IX-X)

**LEARNING OUTCOMES**

**UNDERSTANDING:**

Students will be able to:

- Describe electronic structures of elements and ions of d-block elements. (Applying)
- Explain why the electronic configuration for chromium and copper differ from those assigned using the Aufbau principle. (Analyzing)
- Describe important reactions and uses of Vanadium, Chromium, Manganese, Iron and Copper. (Applying)
- Explain shapes, origin of colors and nomenclature of coordination compounds. (Applying)
- Relate the coordination number of ions to the crystal structure of the compound of which they are a part. (Applying)
- Define an alloy and describe some properties of an alloy that are different from the metals that compose it. (Analyzing)
- Describe the reactions of potassium dichromate with oxalic acid and Mohr’s salt. (Understanding)
- Describe the reactions of potassium manganate VII with ferrous sulphate, oxalic acid and Mohr’s salt. (Understanding)

**SKILLS:**

Students will be able to:

- Calculate concentration of iron (II) ions in solution by titration with KMnO₄. (Applying)
- Explain the reaction of hexaaquacopper (II) ions with iodide and determine the concentration of copper (II) ions in the solution. (Analyzing)
SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Compare properties of Brass, Bronze and their constituent elements. (Applying)
- Identify that certain transition metal compounds are used in paints
  (understanding)
Chapter 15  Organic Compounds

Introduction
Major Concepts
15.1 Sources
   15.1.1 Fossil remains: Coal, Petroleum, and Natural Gas
   15.1.2 Plants and Natural Products
   15.1.3 Partial and Total Synthesis
   15.1.4 Biotechnology
15.2 Coal as a source of Organic Compounds
   15.2.1 Destructive Distillation of Coal
   15.2.2 Conversion of Coal to Petroleum
15.3 Characteristics of Organic Compounds
15.4 Uses of Organic Compounds
15.5 New Allotrope of Carbon: Bucky Ball
15.6 Functional Groups and Homologous Series
15.7 Detection of Elements in Organic Compounds

Conceptual Linkages
This unit is built on
- Definition of Organic Chemistry (Grade IX-X)
- Sources and Uses of Organic Compounds (Grade IX-X)
- Functional Groups (Grade IX-X)
- Homologous Series (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:
Students will be able to:
- Define organic chemistry and organic compounds. (Remembering)
- Explain why there is such a diversity and magnitude of organic compounds. (Analyzing)
- Classify organic compounds on structural basis. (Analyzing)
- Explain the use of coal as a source of both aliphatic and aromatic hydrocarbons. (Understanding)
- Explain the use of plants as a source of organic compounds. (Understanding)
- Explain that organic compounds are also synthesized in the lab. (Understanding)
- Define functional groups and homologous series. (Remembering)

SKILLS:
Students will be able to:
- Make distinction among different organic compounds on the basis of their formula. (Analyzing)
SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Realize that many organic compounds are obtained from plants and animals. (Understanding)
- Understand that organic compounds are partially or totally synthesized in the lab. (Understanding)
- List many medicines are obtained from plants. (Remember)
Chapter 16     Hydrocarbons

Introduction
Major Concepts
16.1 Hydrocarbons
16.2 Alkanes and Cycloalkanes
16.3 Radical Substitution Reactions
16.4 Oxidation of Organic Compounds
16.5 Alkenes
16.6 Isomerism
16.7 Alkynes
16.8 Addition Reactions of Alkynes
16.9 Benzenes and Substituted Benzenes

Conceptual Linkages
This unit is built on
- Introduction to Alkane and Alkyl Radicals (Grade IX-X)
- Alkenes and Alkynes (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:
- Classify hydrocarbons as aliphatic and aromatic. (Understanding)
- Describe nomenclature of alkanes and cycloalkanes. (Understanding)
- Explain the shapes of alkanes and cycloalkanes exemplified by ethane and cyclopropane. (Applying)
- Explain unreactive nature of alkanes towards polar reagents. (Applying)
- Define homolytic and heterolytic fission, free radical initiation, propagation and termination. (Remembering)
- Describe the mechanism of free radical substitution in alkanes exemplified by methane and ethane. (Understanding)
- Identify organic redox reactions. (Understanding)
- Explain what is meant by a chiral centre and show that such a centre gives rise to optical isomerism. (Understanding)
- Identify chiral centers in given structural formula of a molecule. (Analyzing)
- Explain the nomenclature of alkenes. (Understanding)
- Explain shape of ethene molecule in terms of sigma and pi C-C bonds. (Understanding)
- Describe the structure and reactivity of alkenes as exemplified by ethene. (Applying)
- Define and explain with suitable examples the terms isomerism, stereoisomerism and structural isomerism. (Remembering)
### UNDERSTANDING:

Students will be able to:

- Explain dehydration of alcohols and dehydrohalogenation of RX for the preparation of ethene. (Understanding)
- Describe the chemistry of alkenes by the following reactions of ethene:
  - Hydrogenation, dehydrohalogenation, hydration, halogenation, halohydration, epoxidation, ozonolysis, polymerization. (Understanding)
  - Explain the concept of conjugation in alkenes having alternate double bonds. (Understanding)
- Use the IUPAC naming system for alkenes. (Applying)
- Define resonance, resonance energy and relative stability. (Understanding)
- Compare the reactivity of benzene with alkanes and alkenes. (Applying)
- Describe what is meant by the term delocalized electrons in the context of the benzene ring. (Understanding)
- Describe addition reactions of benzene and methyl benzene. (Applying)
- Describe the mechanism of electrophilic substitution in benzene. (Understanding)
- Discuss chemistry of benzene and methyl benzene by nitration, sulphonation, halogenation, Friedal Craft’s alkylation and acylation. (Applying)
- Apply the knowledge of positions of substituents in the electrophilic substitution of benzene. (Applying)
- Use the IUPAC naming system for alkynes. (Applying)
- Compare the reactivity of alkynes with alkanes, alkenes and arenes. (Analyzing)
- Discuss the shape of alkynes in terms of sigma and pi C-C bonds. (Applying)
- Draw different possible ring structures of benzene (Kekule structures). (Understanding)
- Draw straight chain structures of alkanes, alkenes and alkynes up to 10 carbon atoms. (Understanding)

### SKILLS:

Students will be able to:

- Draw different possible ring structures of benzene (Kekule structures). (Understanding)
- Draw straight chain structures of alkanes, alkenes and alkynes up to 10 carbon atoms. (Understanding)
SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Identify and link uses of various hydrocarbons used in daily life. (understanding)
- Identify various hydrocarbons which will be important as fuels for the future energy needs of Pakistan (understanding)
Chapter 17  Alkyl Halides and Amines

Introduction

Major Concepts
17.1 Alkyl Halides
17.2 Organometallic Compounds (Grignard's Reagents)
17.3 Amines

Conceptual Linkages
This unit is built on
• Functional Groups (Grade IX-X)
• Amino Acids (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:
Students will be able to:
• Name alkyl halides using IUPAC system. (Applying)
• Discuss the structure and reactivity of RX. (Applying)
• Describe the preparation of RX by the reaction of alcohols with HX, SOCl₂ and PX₃ and by radical halogenation of alkanes. (Applying)
• Describe the mechanism and types of nucleophilic substitution reactions. (Understanding)
• Describe the mechanism and types of elimination reactions. (Understanding)
• Describe the preparation and reactivity of Grignard’s Reagents. (Applying)
• Discuss chemistry of Grignard’s reagent by the addition of aldehydes, ketones, esters and carbon dioxide. (Understanding)
• Discuss nomenclature, structure and basicity of amines. (Applying)
• Describe the preparation of amines by alkylation of ammonia to RX and reduction of nitriles, nitro and amide functional groups. (Applying)
• Discuss reactivity of amines. (Applying)
• Describe chemistry of amines by alkylation of amines with RX, reactions with aldehydes, ketones, preparation of amides and diazonium salts.
• Describe isomerism in alkyl halides and amines. (Understanding)
SKILLS:

Students will be able to:
- Identify amines in the laboratory by carrying out appropriate tests. (Applying)
- Perform tests to detect nitrogen in organic compounds. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Identify organometallic compounds in medicines. (Applying)
- Compare haemoglobin and chlorophyll. (Understanding)
- Recognize alkyl halides as precursors of many organic compounds. (Applying)
Chapter 18  Alcohols, Phenols and Ethers

Introduction

Major Concepts
18.1 Alcohols
18.2 Phenols
18.3 Ethers

Conceptual Linkages
This unit is built on
- Functional Groups (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:
- Explain nomenclature, structure and acidity of alcohols as exemplified by ethanol. (Understanding)
- Describe the preparation of alcohols by reduction of aldehydes, ketones, carboxylic acids and esters. (Applying)
- Explain reactivity of alcohols. (Understanding)
- Describe the chemistry of alcohols by preparation of ethers and esters, oxidative cleavage of 1, 2-diols. (Applying)
- Discuss thiols (RSH). (Understanding)
- Explain the nomenclature, structure and acidity of phenols. (Applying)
- Describe the preparation of phenol from benzene sulphonic acid, chlorobenzene, acidic oxidation of cumene and hydrolysis of diazonium salts. (Applying)
- Discuss the reactivity of phenol and their chemistry by electrophilic aromatic substitution, reaction with Na metal and oxidation. (Applying)
- Differentiate between alcohol and phenol. (Understanding)
- Describe isomerism in alcohols and phenols. (Understanding)
- Identify ethers from their formula. (Understanding)

SKILLS:

Students will be able to:
- Identify alcohols using appropriate laboratory tests. (Applying)
- Identify phenols using appropriate laboratory tests. (Applying)
- Determine boiling points of alcohols and phenols in laboratory. (Applying)
**SOCIETY, TECHNOLOGY AND SCIENCE:**

Students will be able to:
- Explain the role of disinfectants in hygiene. (Analyzing)
- Differentiate between disinfectants and antiseptics. (Understanding)
- Recognize that ethers are used in anesthesia
Chapter 19  Carbonyl Compounds I: Aldehydes and Ketones

Introduction
Major Concepts
19.1 Nomenclature
19.2 Physical Properties
19.3 Structure
19.4 Preparations of Aldehydes and Ketones
19.5 Reactivity
19.6 Reactions of Aldehydes and Ketones

Conceptual Linkages
This unit is built on
- Functional Groups (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:
- Explain nomenclature and structure of aldehydes and ketones. (Applying)
- Discuss the preparation of aldehydes and ketones by ozonolysis of alkenes, hydration of alkynes, oxidation of alcohols and Friedel Craft’s acylation of aromatics. (Applying)
- Describe reactivity of aldehydes and ketones and their comparison. (Analyzing)
- Describe acid and base catalysed nucleophilic addition reactions of aldehydes and ketones. (Applying)
- Discuss the chemistry of aldehydes and ketones by their reduction to hydrocarbons, alcohols, by using carbon nucleophiles, nitrogen nucleophiles and oxygen nucleophiles. (Applying)
- Describe oxidation reactions of aldehydes and ketones. (Applying)
- Describe isomerism in aldehydes and ketones. (Understanding)
### SKILLS:

Students will be able to:
- Identify aldehydes in the laboratory tests. (Applying)
- Identify ketones using appropriate laboratory tests. (Applying)
- Determine melting or boiling points of aldehydes and ketones in laboratory. (Applying)

### SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Explain how oxidation and reduction alters the structure of organic compounds. (Understanding)
- Explain the need to limit exposure to formaldehyde vapors as used in adhesives, varnishes, paints, foam insulation and permanent press clothing. (Applying)
- Describe glucose and fructose as examples of aldehydes and ketones (Understanding)
Chapter 20   Carbonyl Compounds 2: Carboxylic Acids and Functional Derivatives

Introduction

Major Concepts
20.1 Nomenclature
20.2 Physical Properties
20.3 Structure
20.4 Acidity
20.5 Preparations of Carboxylic Acids
20.6 Reactivity
20.7 Reactions of Carboxylic Acids

Conceptual Linkages
This unit is built on
- Functional Groups (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:
Students will be able to:
- Describe preparation of carboxylic acids by carbonation of Grignard's Reagent, hydrolysis of nitriles, oxidation of primary alcohols, oxidation of aldehydes and oxidation of alkyl benzenes. (Applying)
- Discuss reactivity of carboxylic acids. (Applying)
- Describe the chemistry of carboxylic acids by conversion to carboxylic acid derivatives: acyl halides, acid anhydrides, esters, amides and reactions involving interconversion of these. (Analyzing)
- Describe reactions of carboxylic acid derivatives. (Applying)
- Describe isomerism in carboxylic acids. (Understanding)

SKILLS:
Students will be able to:
- Identify carboxylic acids in the laboratory (Applying)
- Determine melting or boiling points of carboxylic acids in laboratory. (Applying)
SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- List carboxylic acids present in fruits, vegetables and other natural products. (Applying)
- Link different carboxylic acids with their characteristic taste. (Applying)
- Recognize carboxylic acids used as preservatives in food and food products. (Applying)
Chapter 21  Biochemistry

Introduction

Major Concepts
21.1 Carbohydrates
21.2 Proteins
21.3 Enzyme
21.4 Lipids
21.5 Nucleic acids
21.6 Minerals of Biological Significance

Conceptual Linkages
This unit is built
• Carbohydrates (Grade IX-X)
• Proteins (Grade IX-X)
• Lipids (Grade IX-X)
• Nucleic Acids (Grade IX-X)

LEARNING OUTCOMES

Understanding
Students will be able to
- Explain the basis of classification and structure-Function relationship of Carbohydrates (understanding)
- Explain the role of various Carbohydrates in health and diseases (Understanding)
- Identify the nutritional importance and their role as energy storage (Applying)
- Explain the basis of classification and structure-function relationship of proteins (Understanding)
- Describe the role of various proteins in maintaining body functions and their nutritional importance (Applying)
- Describe the role of enzyme as biocatalyst and relate this role to various functions such as digestion of food (Applying)
- Identify factors that affect enzyme activity such as effect of temperature and pH.
- Explain the role of inhibitors of enzyme catalyzed reactions (Understanding)
- Describe the basis of classification and structure-Function relationship of Lipids (Applying)
- Identify the nutritional and Biological importance of lipids (Applying)
- Identify the structural components of DNA and RNA (Applying)
- Recognize the structural differences between DNA polymer (double strand) and RNA (single strand).
- Relate DNA sequences to its function as storage of genetic information (Applying)
- Relate RNA sequence (transcript) to its role in transfer of information to protein (Translation) (Applying)
- Identify the sources of minerals such as Iron, Calcium, Phosphorous and Zinc (Applying)
- Describe the role of Iron, Calcium, Phosphorous and Zinc in nutrition. (Applying)
SKILLS:
Students will be able to:
- Identify Calcium as a requirement for coagulation (Applying)
- Identify how milk proteins can be precipitated by lowering the pH using lemon juice (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:
Students will be able to:
- Explain why animals and humans have large glycogen deposits for sustainable muscular activities. Hibernating animals (polar bear, reptiles and amphibians) accumulate fat to meet energy resources during hibernation (Understanding)
- Identify complex Carbohydrates which provide lubrication to elbow and Knee.
- Describe fibrous proteins from hair and silk (Applying)
- Explain how Cholesterol and amino acid serve as hormones (Understanding)
- Identify insulin as a protein hormone whose deficiency leads to diabetes mellitus (Applying)
- Explain the role of minerals in structure and function (Understanding)
Chapter 22  Industrial Chemistry

Introduction

Major Concepts
22.1 Introduction: Introduction to Chemical Process Industry and Raw Materials used
22.2 Safety Considerations in Process Industries
22.3 Dyes
22.4 Pesticides
22.5 Petrochemicals
22.6 Synthetic Polymers (PVC and Nylon)
22.7 Cosmetics: Lipstick, Nail Varnish and Remover, Hair Dyes

Conceptual Linkages
This unit is built on
- Basic Metallurgical Operations  (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:
- Discuss the importance of the chemical industries in the economy of Pakistan. (Analyzing)
- Describe the raw materials available in Pakistan for various chemical industries. (Applying)
- Describe the chemical processes of addition and condensation polymerization. (Understanding)
- Interpret difference between petrochemical and chemicals derived from them. (Understanding)
- Describe the fractional distillation and refining of Petroleum (Understanding)
- List the various raw materials for Petrochemical industry. (Analyzing)
- Identify the important fractions. (Analyzing)
- Describe the basic building block processes in Petrochemical technology. (Understanding)
- Describe the Petrochemical process technology. (Understanding)
- List some major petrochemicals. (Applying)
- Discuss types and applications of hair dyes. (Applying)
- Describe the formation and uses of PVC and Nylon. (Applying)
- Describe preparation and applications of various cosmetics like nail varnish, nail polish remover and lipsticks. (Understanding)
- Describe types and applications of synthetic adhesives. (Understanding)

SKILLS:

Students will be able to:
- List the safety measures and precautions in process industries. (Analyzing)
- List various petrochemicals and their functions. (Applying)
SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:
- Identify risks associated with the manufacturing of chemicals. (Evaluating)
- Trace the development and uses of different synthetic fibers. (Applying)
Chapter 23  Environmental Chemistry

Introduction

Major Concepts
23.1 Chemistry of the Troposphere
23.2 Chemistry of the Stratosphere
23.3 Water Pollution and Water Treatment
23.4 Green Chemistry

Conceptual Linkages
This unit is built on
- Composition of Atmosphere (Grade IX-X)
- Layers of Atmosphere (Grade IX-X)
- Air Pollutants (Grade IX-X)
- Ozone (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:
- Recognize various chemical reactions occurring in the atmosphere. (Understanding)
- Recognize that the release of COx, SOx, NOx, VOCs are associated with the combustion of hydrocarbon based fuels. (Applying)
- Outline problems associated with release of pollutants including acid rain and the formation by free radical reactions of hazardous inorganic and organic compounds e.g., PAN. (Analyzing)
- Describe causes and impacts of urban smog. (Analyzing)
- Explain greenhouse effect and global warming as resulting in climate change. (Analyzing)
- Explain the build up to and recognize the adverse effects of ozone in the troposphere. (Applying)
- Describe the role of CFCs in destroying ozone in the stratosphere. (Applying)
- Describe the role of ozone in the stratosphere in reducing the intensity of harmful UV radiation reaching the earth. (Understanding)
- List possible alternatives to the use of CFCs. (Applying)
- Recognize and describe various water pollutants. (Applying)
- Explain the various parameters of water analysis. (Applying)
- List some major products of the petrochemicals industry, together with their uses. (Applying)

SKILLS:

Students will be able to:
- Estimate chloride ions in tap water using titration technique. (Applying)
SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Describe how properties of gases promote greenhouse effect. (Analyzing)
- Make connections between Halons and CFCs and their effects on ozone depletion. (Analyzing)
- Predict effects of radiation pollution. (Applying)
- Explain the need to work in a well-ventilated area when working with toxic solvents as used in adhesives. (Applying)
- Describe how rain water seepage through hazardous wastes dumpsites can dissolve and reach drinking water supplies. (Applying)
- Describe three ways in which water is purified naturally. (Applying)
- Explain how photochemical reactions contribute to air pollution. (Applying)
- Identify ways in which air pollution resulting from auto exhausts can be alleviated. (Applying)
- Recognize the use of catalytic converters in reducing pollutant emissions from petrol driven cars. (Analyzing)
- Differentiate between ozone at the earth’s surface and ozone formation and depletion in the atmosphere. (Applying)
- Realize that dumping waste water from household and industry without treatment to the rivers and creeks is dangerous for the environment. (Understanding)
Chapter 24     Analytical Chemistry

Introduction

Major Concepts
24.1 Classical Method of Analysis
24.2 Modern Methods

Conceptual Linkages
This unit is built on
- Structure of atoms and molecules (Grade IX-X)

LEARNING OUTCOMES

UNDERSTANDING:
Students will be able to:
- Compare the classical method of analysis with modern methods. (Understanding)
- Discuss the procedure of combustion analysis. (Understanding)
- Define spectroscopy and discuss its applications in analytical Chemistry (Applying)
- State the regions of electromagnetic spectrum used in IR and UV/vis spectroscopy (Applying)
- Explain the origin of IR absorption of simple molecules. (Analyzing)
- Determine structures of phenol, toluene, acetone and ethanol from its IR spectrum. (Analyzing)
- Predict whether a given molecule will absorb in the UV/visible region. (Analyzing)
- Predict the color of a transition metal complex from its UV/visible spectrum. (Analyzing)
- Outline in simple terms the principles of proton NMR spectroscopy. (Applying)
- Explain how chemical environment of a Proton affects the magnetic field it experiences and hence the absorption of energy at resonance frequency. (Applying)
- Describe standard scales used in proton NMR. (Applying)
- Explain instrumentation and working of MS. (Applying)
- Outline the use of MS in determination of relative isotopic masses and isotopic abundance. (Applying)
- Define and explain atomic emission and atomic absorption spectrum. (Understanding)

SKILLS:
Students will be able to:
- Calculate the average atomic mass of an element from isotopic data. (Applying)
- Calculate percentage of C, H and O from given data and determine empirical and molecular formula. (Applying)
**SOCIETY, TECHNOLOGY AND SCIENCE:**

Students will be able to:
- Describe how mass spectrometer is used to determine the relative masses of atoms and the abundances of isotopes. (Applying)
- Explain how different instruments help in the study of chemistry. (Analyzing)
- Explain how forensic chemists use the MS to identify small amounts of unknown material. (Applying)
- Explain temperature variations within parts of a flame. (Applying)
- Explain why forensic chemists must have strong problem-solving skills and a broad background in analytical chemistry. (Applying)
- Recognize the link between chemical instrumentation and technology. (Analyzing)
- Make connections between chromatography and MS as used in the analysis of small amounts of unknown materials. (Applying)
# XI-XII Practicals

<table>
<thead>
<tr>
<th>PRACTICALS</th>
<th>EQUIPMENT</th>
<th>CHEMICALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>XI-Practicals</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chapter 1:</strong> Introduction to Stoichiometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Estimate the Amount of $\text{Ba}^{+2}$ in the Given Solution of $\text{BaCl}_2$ Gravimetrically.</td>
<td>analytical balance, oven, funnel, wash bottle, Whatman filter paper #42, glass rod, beakers, desiccators, pipette, burner, matches, safety goggles</td>
<td>distilled water, potassium chromate solution, barium chloride solution -</td>
</tr>
<tr>
<td><strong>Chapter 2:</strong> Atomic Structure</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chapter 3:</strong> Theories of Covalent Bonding: Theories and Shapes of molecules</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chapter 4:</strong> States of Matter I: Gases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Demonstrate that Gases spread by diffusion to Areas of lower Concentration.</td>
<td>glass tube 40cm long and 1cm internal diameter, ring stand, clamp, clamp holder, cotton balls, forceps, dropper, rubber stoppers, safety goggles</td>
<td>concentrated $\text{NH}_3$ solution, concentrated $\text{HCl}$</td>
</tr>
<tr>
<td><strong>Chapter 5:</strong> States of Matter II: Liquids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Separate the Given Mixture of Inks by Paper Chromatography.</td>
<td>Whatman filter paper #1, glass cylinder with a glass support, rubber bung, lead pencil</td>
<td>Water – alcohol mixture, mixture of inks.</td>
</tr>
</tbody>
</table>
2. Separate the Following Ions from a given Mixture of their Salts (Ni^{2+}, Co^{2+}, Cu^{2+}) by Paper Chromatography.

   - Whatman filter paper # 1, glass cylinder with a glass support, rubber bung, lead pencil
   - 1% solutions of the chlorides of Ni, Co, Cu^{2+}, spraying solution (0.1% rubeanic acid in ethyl alcohol), solvent mixture (acetone, distilled water and concentrated HCl mixed in ratio 43:3:4)

3. Separate Lead and Cadmium in a mixture solution by Paper Chromatography.

   - Whatman filter paper # 1, glass cylinder with a glass support, rubber bung, lead pencil
   - Sample reagent (mixture of solutions of PbCl_2 and CdCl_2), solvent mixture (n-butanol + 3M HNO_3), spraying agent (H_2S gas)

4. Prove that the Loss of Thermal Energy When a Liquid Evaporates Will Lower the Temperature of the Liquid.

Chapter 6:
States of Matter III:
Solids

- Crystallize Benzoic Acid from water.

   - China dish, burner, tripod stand, wire gauze, matches, beakers, funnel, filter paper, stirrer, safety goggles
   - Distilled water and benzoic acid

Chapter 7:
Chemical Equilibrium

1. Purify a Given Sample of Sodium Chloride by Passing HCl Gas. (Application of common ion effect)

   - Beaker 500ml, funnel, round-bottom flask, glass tubing, wire gauze, thistle funnel, burner, stirrer, graduated flask and physical balance
   - Distilled water, common salt, concentrated H_2SO_4

2. Demonstrate a Shift in the Equilibrium Point of a Reaction by Changing Concentration. (Le Chatelier’s Principle)

   - 3 beakers of 150mL, 4 beakers of 50mL, safety goggles
   - 0.1M K_2CrO_4, 0.1M K_2Cr_2O_7, 1M HCl, 1M NaOH, 0.1M Ba(NO_3)_2
Chapter 8: Acids, Bases and Salts

1. Determine the Exact Molarity of the Given Solution of $\text{H}_2\text{SO}_4$ and the Volume of this Acid Required to Prepare 500 ml of 0.02 M Acid by Volumetric Method.

   - burette, pipette, funnel, conical flask, beakers, iron stand
   - phenolphthalein, 0.1M NaOH, 0.2M H$_2$SO$_4$, distilled water

2. Determine the Percentage of NaOH in the Given Solution by Volumetric Method.

   - burette, pipette, funnel, conical flask, beakers, iron stand
   - phenolphthalein, 0.1M NaOH, 0.1M HCl, distilled water, solution containing 8gms of a mixture of NaCl and NaOH

3. The given solution contains 6gms of Na$_2$CO$_3$ dissolved per dm$^3$. Determine the Percentage Purity of the Sample Solution by Volumetric Method.

   - burette, pipette, funnel, conical flask, beakers, iron stand
   - methyl orange, 0.1M Na$_2$CO$_3$, 0.1M HCl, distilled water, solution of 6gms of Na$_2$CO$_3$ in 1 liter

4. Determine the Value of X by Volumetric Method in the Given Sample of 6.3g of (COOH)$_2$. XH$_2$O Dissolved per dm$^3$.

   - burette, pipette, funnel, conical flask, beakers, iron stand
   - phenolphthalein, 0.1M NaOH, 0.1 (COOH)$_2$.2H$_2$O, Distilled water

5. Determine the Solubility of Oxalic Acid at Room Temperature Volumetrically.

   - burette, pipette, funnel, conical flask, beakers, iron stand
   - Phenolphthalein, 0.1M NaOH, 0.1 (COOH) 2.2H$_2$O, Distilled water.
### Chapter 9: Chemical Kinetics

1. Show that the Addition of a Catalyst Increases the Rate of Reaction.

   - 500 ml flask, spatula, tray, safety goggles
   - 10% H₂O₂, 0.1gm MnO₂, distilled water

### Chapter 10: Solution and Colloids

- None
- None
- None

### Chapter 11: Thermochemistry

1. Determine the Heat of Neutralization of NaOH and HCl.

   - Calorimeter with stirrer, thermometer, balance
   - 1M NaOH, 1M HCl, distilled water

### Chapter 12: Electrochemistry

1. Standardize the Given Solution of KMnO₄ and Calculate the Volume of KMnO₄ Required for Preparing 1 dm³ of 0.01M KMnO₄ Solution Volumetrically.

   - Burette, pipette, funnel, conical flask, beakers, iron stand, test tube
   - 0.1M FeSO₄ solution, 0.02M KMnO₄ solution, dilute H₂SO₄, distilled water

2. Determine the Amount of Iron in the Given Sample Volumetrically.

   - Burette, pipette, funnel, conical flask, beakers, iron stand, test tube
   - 0.05M FeSO₄ solution, 0.01M KMnO₄ solution, dilute H₂SO₄, distilled water

3. Determine the Percentage Composition Volumetrically of a Solution Mixture of K₂C₂O₄ and K₂SO₄.

   - Burette, pipette, funnel, conical flask, beakers, iron stand, test tube
   - Solution mixture of K₂C₂O₄ and K₂SO₄, 0.01M KMnO₄ solution, dilute H₂SO₄, distilled water
4. Determine the Solubility of Mohr’s Salt at Room Temperature Volumetrically.

XII-Practicals
Chapter 13:
s- and p- Block Elements

1. Prepare Potassium Xanthate
   - beakers, funnel, filter paper, measuring cylinder, safety goggles
   - potassium hydroxide, alcohol, carbon disulphide, ether (for washing of crystals), distilled water, copper sulphate solution

2. Detect the Following Cations:
   - NH$_4^+$, Mg$^{2+}$, Al$^{3+}$, Ca$^{2+}$, Cr$^{3+}$, Mn$^{2+}$, Fe$^{2+}$, Fe$^{3+}$, Cu$^{2+}$, Zn$^{2+}$, Ba$^{2+}$, Pb$^{2+}$
   - Detect the Following Anions:
     - CO$_3^{2-}$, NO$_3^-$, NO$_2^-$, SO$_4^{2-}$, SO$_3^{2-}$, Cl$^-$, Br$^-$, I$^-$, CrO$_4^{2-}$
   - Perform Tests for the Following Gases:
     - NH$_3$, CO$_2$, Cl$_2$, H$_2$, O$_2$, SO$_2$

Chapter 14:
d-f- Block Elements

1. Prepare Nickel Dimethyl Glyoxime.
   - test tubes, test tube holder, test tube rack, measuring cylinder, Bunsen burner, safety goggles, filter paper, funnel, dimethyl glyoxime solution, nickel salt solution, distilled water and NH$_4$OH
Chapter 15: Organic Compounds

None

Chapter 16: Hydrocarbons

1. Prepare Ethylene from Ethylene Bromide
   - test tubes, test tube holder, test tube rack, delivery tube, measuring cylinder, Bunsen burner, safety goggles
   - pieces of zinc metal, alcohol, ethylene bromide

Chapter 17: Alkyl Halides and Amines

1. Prepare Azo dye from Amine.
   - test tubes, test tube rack, test tube holder, measuring cylinder, balance, filter paper, funnel
   - amine, phenol, hydrochloric acid, ice, sodium nitrite, alcohol, distilled water

2. Identify the Amine Functional Group.
   - test tubes, test tube rack, test tube holder, measuring cylinder, balance, filter paper, funnel
   - Hinsberg test: benzenesulfonyl chloride, sodium hydroxide, HCI

Chapter 18: Alcohols, Phenols and Ethers

1. Prepare Iodoform.
   - test tubes, test tube holder, test tube rack, Bunsen burner, safety goggles
   - alcohol, sodium hydroxide, water, solution of iodine in potassium iodide

2. Identify the Phenol Functional Group.
   - test tubes, test tube holder, test tube rack, measuring cylinder, safety goggles
   - Litmus solution, Ferric Chloride solution

Chapter 19: Carbonyl Compounds I: Aldehydes and Ketones

1. Prepare Glucosazone.
   - beakers, test tubes, measuring cylinders, balance, Bunsen burner, match box, funnel, filter papers
   - glucose solution, 2,4-dinitrophenyl hydrazine solution, distilled water

2. Identify the Aldehyde and Ketone Functional Group
   - beakers, test tubes, measuring cylinders, Bunsen burner, match box, funnel, filter papers
   - Fehling’s solution, Tollens’s reagent, Benedict solution
Groups.

Chapter 20: Carbonyl Compounds II Carboxylic Acids and Functional derivatives

1. Prepare Benzoinilide from Benzoic Acid.
   - beakers, test tubes, measuring cylinders, Bunsen burner, match box, funnel, filter paper
   - benzoic acid, phosphorous pentachloride, ice, alcohol, distilled water

2. Identify the Carboxylic Acid Functional Group.
   - test tubes, beakers, balance, measuring cylinders, funnel, filter paper
   - Dilute sodium hydroxide, saturated potassium bi carbonate

Chapter 21 Biochemistry

1. Detect glucose as Reducing sugar in urine sample of diabetic patient
   - test tubes, beakers, conical flask, pipette,
   - Benedict Reagent, Fehling’s Solution

2. Detect Protein Urea denaturation
   - test tubes, beakers, conical flask, pipette,
   - Urea, egg white

3. Observe the digestion of starch with salivary amylase.
   - test tubes, beakers, conical flask, pipette, slides
   - Freshly prepared starch solution, iodine solution

4. Detect the presence of different lipid components in an oil sample by TLC
   - beakers, pipette, slides
   - Benzene, alcohol, Silica gel Chromatographic Grade

5. Determine the Iodine number of an oil
   - test tubes, beakers, conical flask, pipette, beakers
   - iodine solution, oil

Chapter 22: Industrial Chemistry

None None None
### Chapter 23: Environmental Chemistry

| None | None | None |

### Chapter 24: Analytical Chemistry

| 1 | Taking Infra Red, Ultra Violet/visible and Mass Spectra | Subject to the availability of the instruments | As required for the experiment |
### XI-XII Chemicals

**(For Group of 20 Students)**

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>5L</td>
</tr>
<tr>
<td>Ammonium hydroxide</td>
<td>5L</td>
</tr>
<tr>
<td>Aluminum foil</td>
<td>5 Rolls</td>
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<tr>
<td>Aniline</td>
<td>2.5L</td>
</tr>
<tr>
<td>Ba(NO₃)₂ solution 0.1M</td>
<td>2.5L</td>
</tr>
<tr>
<td>Barium Chromate Solution</td>
<td>2.5L</td>
</tr>
<tr>
<td>Benedict’s Reagent</td>
<td>2.5L</td>
</tr>
<tr>
<td>Benzoic acid</td>
<td>500gms</td>
</tr>
<tr>
<td>Bromine water</td>
<td>5L</td>
</tr>
<tr>
<td>Carbon disulphide</td>
<td>2.5L</td>
</tr>
<tr>
<td>Common Salt</td>
<td>5Kg</td>
</tr>
<tr>
<td>(COOH)₂.2H₂O solution 0.1M</td>
<td>2.5L</td>
</tr>
<tr>
<td>Copper sulphate solution</td>
<td>2.5L</td>
</tr>
<tr>
<td>Dimethyl glyoxime solution</td>
<td>2L</td>
</tr>
<tr>
<td>2,4-dinitrophenyl hydrazine solution</td>
<td>2L</td>
</tr>
<tr>
<td>Distilled water</td>
<td>20L</td>
</tr>
<tr>
<td>Ether</td>
<td>5L</td>
</tr>
<tr>
<td>Ethyl Alcohol</td>
<td>2.5L</td>
</tr>
<tr>
<td>Ethylene bromide</td>
<td>2L</td>
</tr>
<tr>
<td>Fehling’s Reagent</td>
<td>2L</td>
</tr>
<tr>
<td>Ferric Chloride solution</td>
<td>2L</td>
</tr>
<tr>
<td>FeSO₄ solution 0.05M</td>
<td>2L</td>
</tr>
<tr>
<td>FeSO₄ solution 0.1M</td>
<td>2L</td>
</tr>
<tr>
<td>Glucose</td>
<td>2Kg</td>
</tr>
<tr>
<td>HCl solution 0.1M</td>
<td>5L</td>
</tr>
<tr>
<td>HCl solution 1M</td>
<td>5L</td>
</tr>
<tr>
<td>HCl Concentrated</td>
<td>2.5L</td>
</tr>
<tr>
<td>H₂O₂ solution 10%</td>
<td>2L</td>
</tr>
<tr>
<td>H₂SO₄ Dilute</td>
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</tr>
<tr>
<td>H₂SO₄ solution 0.2M</td>
<td>2.5L</td>
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<tr>
<td>H₂SO₄ Concentrated</td>
<td>5L</td>
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<tr>
<td>Ink mixture</td>
<td>500mL</td>
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<tr>
<td>Iodine solution in potassium iodide</td>
<td>10L</td>
</tr>
<tr>
<td>Iron Sulfide</td>
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<tr>
<td>K₂CrO₄ solution 0.1M</td>
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<tr>
<td>K₂Cr₂O₇ solution 0.1M</td>
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</tr>
<tr>
<td>KMnO₄ solution 0.01M</td>
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</tr>
<tr>
<td>KMnO₄ solution 0.02M</td>
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</tr>
<tr>
<td>Lime water</td>
<td>2L</td>
</tr>
<tr>
<td>Magnesium turnings</td>
<td>1Kg</td>
</tr>
<tr>
<td>Methyl orange</td>
<td>100gm</td>
</tr>
<tr>
<td>MnO₂</td>
<td>250gm</td>
</tr>
<tr>
<td>Mohr’s salt solution 0.05M</td>
<td>5L</td>
</tr>
<tr>
<td>Na₂CO₃ solution 0.1M</td>
<td>5L</td>
</tr>
<tr>
<td>NaOH solution 0.1M</td>
<td>5L</td>
</tr>
</tbody>
</table>
NaOH solution 1M  5L  
NH₃ solution concentrated  5L  
Phenol  2.5L  
Phenolphthalein  100gm  
Phosphorous pentachloride  1Kg  
Potassium hydroxide  2Kg  
Potassium iodide  2Kg  
Potassium oxalate  1Kg  
Potassium sulphate  1Kg  
Lead Nitrate  500gm  
Cadmium Nitrate  500gm  
Salts of the following cations:  1Kg each  
Ni, Co,NH₄⁺, Mg²⁺, Al³⁺, Ca²⁺, Cr³⁺, Mn²⁺, Fe²⁺, Fe³⁺, Cu²⁺, Zn²⁺, Ba²⁺, Pb²⁺  
Salts of the following anions:  500gm  
CO₃²⁻, NO₃⁻, NO₂⁻, SO₄²⁻, SO₃²⁻, Cl⁻, Br⁻, I⁻, CrO₄²⁻  
Silver nitrate  500mg  
Sodium nitrite  1Kg  
Solvent mixture (Acetone, Distilled Water and Concentrated HCl mixed in ratio 43:3:4)  2L  
Solvent mixture (n-butanol + 3M HCl)  2L  
Spraying Agent (A Concentrated solution of H₂S)  2L  
Starch  1Kg  
Tollen’s reagent  2L  
Zinc turnings  1 Kg
### XI-XII Equipment/Apparatus

*(For Group of 20 Students)*

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical balance (Digital)</td>
<td>05</td>
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<tr>
<td>Beakers 50mL</td>
<td>25</td>
</tr>
<tr>
<td>Beakers 100mL</td>
<td>25</td>
</tr>
<tr>
<td>Beakers 150mL</td>
<td>25</td>
</tr>
<tr>
<td>Burette 50mL</td>
<td>25</td>
</tr>
<tr>
<td>Bunsen burner</td>
<td>25</td>
</tr>
<tr>
<td>Calorimeter</td>
<td>25</td>
</tr>
<tr>
<td>China dish</td>
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</tr>
<tr>
<td>Clamp</td>
<td>25</td>
</tr>
<tr>
<td>Clamp holder</td>
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</tr>
<tr>
<td>Conical flask</td>
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<tr>
<td>Cotton bundles</td>
<td>02</td>
</tr>
<tr>
<td>Delivery tube</td>
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<tr>
<td>Desiccators</td>
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</tr>
<tr>
<td>Dropper</td>
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</tr>
<tr>
<td>Filter paper</td>
<td>05 Packets</td>
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<tr>
<td>Forceps</td>
<td>25</td>
</tr>
<tr>
<td>Funnel</td>
<td>25</td>
</tr>
<tr>
<td>Glass rod</td>
<td>25</td>
</tr>
<tr>
<td>Glass tubing</td>
<td>5m</td>
</tr>
<tr>
<td>Glass tube 40cm long and 1cm in diameter</td>
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</tr>
<tr>
<td>Graduated flask</td>
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</tr>
<tr>
<td>Iron stand</td>
<td>25</td>
</tr>
<tr>
<td>Kipps Apparatus</td>
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</tr>
<tr>
<td>Litmus paper (Red)</td>
<td>05 Packets</td>
</tr>
<tr>
<td>Litmus paper (Blue)</td>
<td>05 Packets</td>
</tr>
<tr>
<td>Matches Box</td>
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</tr>
<tr>
<td>Measuring flask 100mL</td>
<td>10</td>
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<tr>
<td>Measuring flask 500mL</td>
<td>10</td>
</tr>
<tr>
<td>Measuring cylinder 5mL</td>
<td>10</td>
</tr>
<tr>
<td>Measuring cylinder 10mL</td>
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</tr>
<tr>
<td>Measuring cylinder 100mL</td>
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</tr>
<tr>
<td>Oven</td>
<td>4</td>
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<tr>
<td>Pipette 10mL</td>
<td>25</td>
</tr>
<tr>
<td>Pipette 25mL</td>
<td>25</td>
</tr>
<tr>
<td>Pipette filler</td>
<td>25</td>
</tr>
<tr>
<td>Rubber bung</td>
<td>25</td>
</tr>
<tr>
<td>Ring stand</td>
<td>25</td>
</tr>
<tr>
<td>Round bottom flask 250mL</td>
<td>25</td>
</tr>
<tr>
<td>Rubber stoppers</td>
<td>25</td>
</tr>
<tr>
<td>Safety goggles</td>
<td>20</td>
</tr>
<tr>
<td>Soap</td>
<td>12 Bars</td>
</tr>
<tr>
<td>Spatula</td>
<td>25</td>
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<tr>
<td>Stirrer</td>
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<tr>
<td>Test tube</td>
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<td>Test tube holder</td>
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<tr>
<td>Item</td>
<td>Quantity</td>
</tr>
<tr>
<td>-------------------------------------</td>
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<tr>
<td>Test tube rack</td>
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<tr>
<td>Thermometer</td>
<td>25</td>
</tr>
<tr>
<td>Thistle funnel</td>
<td>25</td>
</tr>
<tr>
<td>Tray</td>
<td>25</td>
</tr>
<tr>
<td>Tripod stand</td>
<td>25</td>
</tr>
<tr>
<td>Wash bottle</td>
<td>25</td>
</tr>
<tr>
<td>Whatman filters paper No. 42</td>
<td>05 Packets</td>
</tr>
<tr>
<td>Whatman filter paper No. 1</td>
<td>05 Packets</td>
</tr>
<tr>
<td>Wire gauze</td>
<td>25</td>
</tr>
<tr>
<td>Wooden splint</td>
<td>05 Packets</td>
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### Class- XI

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Teaching</th>
<th>Assessment</th>
<th>Weightage %</th>
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<tr>
<td>Chapter 1: Stoichiometry</td>
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<tr>
<td>Chapter 2: Atomic Structure</td>
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</tr>
<tr>
<td>Chapter 3: Theories of Covalent Bonding and Shapes of Molecules</td>
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<tr>
<td>Chapter 4: State of Matter I</td>
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<td>Chapter 5: State of Matter II: Liquids</td>
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<td>Chapter 6: States of Matter III: Solids</td>
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<td>Chapter 7: Chemical Equilibrium</td>
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<td>Chapter 8: Acids, Bases and Salts</td>
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<tr>
<td>Chapter 9: Chemical Kinetics</td>
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<td>5</td>
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<tr>
<td>Chapter 10: Solutions and Colloids</td>
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<td>1</td>
<td>9</td>
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<td>Chapter 11: Thermochemistry</td>
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<td>8</td>
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<tr>
<td>Chapter 12: Oxidation, Reduction and Electrochemistry</td>
<td>10</td>
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<td>Total:</td>
<td>122</td>
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</table>

### Class XII

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Teaching</th>
<th>Assessment</th>
<th>Weightage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 13: s and p Block Elements</td>
<td>25</td>
<td>3</td>
<td>22</td>
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<tr>
<td>Chapter 14: d- Block Elements</td>
<td>9</td>
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<tr>
<td>Chapter 15: Organic Compounds</td>
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<td>Chapter 16: Hydrocarbons</td>
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<td>Chapter 17: Alkyl Halides and Amines</td>
<td>11</td>
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</tr>
<tr>
<td>Total:</td>
<td>122</td>
<td>17</td>
<td>100</td>
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</tbody>
</table>
INSTRUCTIONS IN THE CLASS ROOM

Educationists have realized that the quality of education cannot be better than the quality of teaching. How to teach well requires on the part of the teachers the following to note:

1. Thorough grinding and mastery of the subject matter which he/she teaches.
2. Scholarly attitude towards teaching/learning in the class and on the campus of the school i.e. thoughtfully reflective personality.
3. Highly polished communication skills in writing, speaking, and listening.
4. Respectful of the methods of science and mindful of the nature of scientific knowledge
5. Practicing believer in the core values of science such as:
   Longing to know, questioning everything, collecting data and looking for meaning in them, demand for verification, respect for logic, consideration of the premise and paradigm, consideration of the consequences.
6. Letting students express their understanding i.e. their version of what was taught in the class and why.
7. Giving more time to what students think and less time to what teachers think
8. Realizing that students construct their own knowledge and that this construction is greatly influenced by what the student already knows i.e. his/her prior knowledge. This implies that no student comes to the class room with empty head and that no information can be transferred intact from the head of the teacher to the head of the student.
9. There are various theories and models available which deal with understanding the process of learning. Teacher must base his practice of teaching on some theory and be able to explain or try to explain what works in the class room and why.
10. Teacher should realize that teaching is not just drilling information into the head of students nor is it just muddling through to teach as he was taught. It is a form of scholarship in which teachers are involved in action research. They look for new examples and non-examples. They sequence information in different ways and look for the best sequence. They diagnose the learning difficulties of students by looking into their prior knowledge where they search for misconceptions and knowledge gaps. They focus on the learning styles of individual students and recognize slow and fast learners.
11. Students watch their teachers and notice so many things about them and they talk about what they like or do not like. Teaching is close to show business and we can borrow much from the people in the show business.
TEACHING-LEARNING PROGRAM

The topics, or objectives within topics, can be taught in any order in keeping with the needs of teachers and students.

It will be clear that achievement of the educational objectives requires thoughtfully designed teaching situations. It is assumed that students will achieve the educational objectives by way of ongoing interplay between theoretical information and practical experience; it therefore follows that the teaching approaches and materials used should:

- represent chemistry as part of the process of scientific inquiry (rather than a rhetoric of conclusions)
- use inquiry-based teaching strategies where possible.
- be student-centered, assisting students to derive their own concepts from evidence and providing practical opportunities to develop individual reasoning abilities and motor skills
- exemplify the concept from local scenario.
- when beginning a new area of study, provide very direct, concrete experience – through classroom, laboratory and field work – or the next best substitute when direct experience is not feasible.
- provide rewarding opportunities to apply scientific understanding and ways of thinking to problems, especially everyday ones.
- provide opportunities refine ideas through dialogue with others, and work with them in ways like to foster cooperative abilities.
- provide opportunities to develop skills of written and oral communications.
- use testing as a diagnostic as well as an achievement tool.

Teachers’ Training and Refresher Courses:

Effective and meaningful chemistry education can only be guaranteed if the teacher, the key pivot of change, is developed enough in contents as well as methodology. In-service trainings may help the teachers to become familiar with a variety of strategies for successful delivery of the curriculum.

The curriculum development and revision is a continuous process in all stages of education so is the process of updating the teacher education programs at pre-service as well as at in-service stages. If the teacher is not fully equipped and trained to handle the new curricula, the curriculum transaction would not be appropriate and consequently, the learning will be inadequate. Teachers’ training needs the following actions:

1. Pre-service teacher training institutions are strengthened and their curricula be revised to meet the demands of fast changing and developing world.

2. In-service training should cover contents and methodologies. Content upgrading in chemistry is an urgent need for effective teaching. Emphasis should specifically be laid on learner-centered and activity based approaches. Laboratory practices, classroom demonstrations, active participation by the students, and field interactions should
become major components of in-service training programs. Workshops seminars and extension lectures should be organized more frequently and regularly and particularly in summer vacation.

3. Well-equipped resource centers should be established at the training institutions for a ready help to the needy teachers.
The purpose of assessment is to find out whether students have acquired the kind of skills, knowledge, and understanding that we set as goals for our courses. This purpose is achieved traditionally by conducting an examination at the end of the session called summative assessment. In this form of assessment, teachers require students to express their understanding of what teachers taught them and the performance of students is measured as grade points. This is a convenient form of assessment because it is easy to carry out and it does not consume much time.

However, this form of assessment is a single snapshot at the end of the session and does not provide opportunity either to the student or to the teacher to interact formatively through out the session as the student strives to develop his understanding of the content and purpose of the course.

This vacuum can be filled by using **FORMATIVE ASSESSMENT**, which is an ongoing process through out the session and uses Test – Feedback – Adjust cycle repeatedly to improve students' performance and efficiency in learning.

**Guidelines for appropriate Assessment**

**Assessment Procedures**

1. In addition to the end of the session exam, the practice of formative assessment should be used through out the session.

2. Tasks in the Formative mode of assessment should include
   - Homework
   - Lab report writing
   - Quizzes
   - Frequent written tests
   - Group discussion
   - Oral Presentation

3. Feedback on students' work in the above tasks should be provided to the students.

4. Question setting should be specifically directed to finding out the following Skills, Knowledge and Understanding according to the Bloom’s Taxonomy as given below

   **a. recall and retrieve** information related to the contents of the course.
   Leading words for setting questions:
   - list, define, identify, label, tabulate, name, who, when, where and so on.

   **b. comprehend** the information i.e. do they know what it means.
   Leading words for setting questions:
   - interpret, predict, distinguish, differentiate, estimate, discuss etc.

   **c. apply** their knowledge i.e. do they know what is it good for.
   Leading words for setting questions:
   - demonstrate, show, solve, classify, illustrate, modify, change, discover etc.
d. **analyze and synthesize** information i.e. taking things apart and putting together.

Leading words for setting questions:
- **Analyze**: analyze, separate, explain, arrange, compare, infer
- **Synthesize**: combine, integrate, rearrange, create, formulate, design etc

e. **Evaluate information** i.e. weighing available options leading words for setting questions:
- decide, measure, recommend, select, conclude, compare, summarize etc.

5. Assessment should measure the capacity of students for critical judgment.
6. Assessment should focus on learning potentials for future learning at their own.
7. The question paper should cover the entire syllabus.
8. There should be no choice in the paper.
9. The paper should include Essay type questions, Short questions and MCQS.
10. Assessment should not judge weaknesses only but it must also focus on students’ strength and capabilities.
11. The assessment should be able to measure the initiative and drive of the students.
12. The teacher must make sure that the student during assessment feels comfortable and relaxed rather than tense and anxious.
13. Assessment language should be simple, clear, and unambiguous.

**Formative Assessment**

The formative assessment should be a part of the classroom learning. Following may be the devices on which the said objectives can be achieved:
- Lab completion
- Objective enhancement-worksheets, quizzes, and tests
- Observation
- Review questions
- Classroom discussions
- Oral presentation

The formative assessment should be cumulative and comprehensive and cover all objectives as per curriculum. Grading of students should be done through the use of assessment instruments that cover the expectations as defined by the objectives of the curriculum.

**Evaluation Strategy:**

An external examination is recommended at the end of the course. This evaluation should measure all the domains of learning and through it, the attainment of the objectives can be measured. The Weightage of the different domains of learning is given below;

<table>
<thead>
<tr>
<th>Learning Domains for Measurement</th>
<th>Weightage In Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge, Comprehension, Analysis, Evaluation, Synthesis, Application:</td>
<td>85%</td>
</tr>
<tr>
<td>Skills of Communication, Initiating and Planning, Designing Experiments and Interpreting Data:</td>
<td>05%</td>
</tr>
<tr>
<td>Manipulative skills (Performing Lab Work)</td>
<td>10%</td>
</tr>
</tbody>
</table>
Weightage in Evaluation:

For the final evaluation of the learning outcomes, following Weightage is recommended for the contents of XI and XII

Class- XI

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Weightage</th>
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<tbody>
<tr>
<td>Chapter 1: Stoichiometry</td>
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</tr>
<tr>
<td>Chapter 2: Atomic Structure</td>
<td>8</td>
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<tr>
<td>Chapter 3: Theories of Covalent Bonding and Shapes of Molecules</td>
<td>11</td>
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<tr>
<td>Chapter 4: State of Matter I</td>
<td>12</td>
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<tr>
<td>Chapter 5: State of Matter II: Liquids</td>
<td>11</td>
</tr>
<tr>
<td>Chapter 6: States of Matter III: Solids</td>
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<tr>
<td>Chapter 7: Chemical Equilibrium</td>
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<tr>
<td>Chapter 8: Acids, Bases and Salts</td>
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<tr>
<td>Chapter 9: Chemical Kinetics</td>
<td>5</td>
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<tr>
<td>Chapter 10: Solutions and Colloids</td>
<td>9</td>
</tr>
<tr>
<td>Chapter 11: Thermochemistry</td>
<td>8</td>
</tr>
<tr>
<td>Chapter 12: Oxidation, Reduction and Electrochemistry</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
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Class XII

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</tr>
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<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
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</tbody>
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Weighing of Assessment Objectives

**Theory assessment:** The theory examination is suggested to consist of a wide variety of questions. The assessment should be designed to examine the candidate’s understanding of the whole syllabus and should test the following range of abilities.

| Knowledge and understanding (recall 30%) | 60% |
| Higher abilities (handling information, application, and problem solving etc.) | 40% |

**Practical Assessment**

This is designed to test Experimental skills and investigations.

**Suggestions for Structuring Assessment and evaluation Tools:**

<table>
<thead>
<tr>
<th>More Emphasis should be on;</th>
<th>Less Emphasis should be on;</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Assessing what I most highly valued</td>
<td>• Assessing what is easily measured</td>
</tr>
<tr>
<td>• Assessing rich, well-structured knowledge</td>
<td>• Assessing discrete knowledge</td>
</tr>
<tr>
<td>• Assessing scientific understanding and reasoning</td>
<td>• Assessing scientific knowledge</td>
</tr>
<tr>
<td>• Assessing to learn what students do understand</td>
<td>• Assessing to learn what students do not know</td>
</tr>
<tr>
<td>• Assessing achievement and opportunity to learn</td>
<td>• Assessing to learn what students do not know</td>
</tr>
<tr>
<td>• Students engaged in ongoing assessment of their work and that of others</td>
<td>• Assessing only achievement</td>
</tr>
<tr>
<td>• Teachers involved in the development of external assessments</td>
<td>• Development of external assessments by experts alone</td>
</tr>
<tr>
<td>• Assessment pattern is subject to the requirement, policies, and procedures of the Examination Boards.</td>
<td></td>
</tr>
<tr>
<td>• Question paper should be based on the curriculum not on a particular textbook.</td>
<td></td>
</tr>
<tr>
<td>• Questions involving unfamiliar contexts or daily-life experiences may be set to assess candidates' problem-solving and higher-order processing skills. In answering such questions, sufficient information be given for candidates to understand the situation or context. Candidates are expected to apply their knowledge and skills included in the syllabus to solve the problems.</td>
<td></td>
</tr>
<tr>
<td>• In general, SI units and terminology should be used.</td>
<td></td>
</tr>
</tbody>
</table>
GENERAL INSTRUCTIONS TO AUTHORS

The National Curricula should be a reflection of our national needs and aspirations. This requirement can be met only if the textbooks are written in accordance with this curriculum. This curriculum meets not only the general aims and objectives but also fulfills the specific requirements of the individual subjects. Keeping these points in view the authors should observe the following points, while writing the textbooks.

1. The authors should adhere to the learning outcomes of each concept or chapter as mentioned with the contents in the curricula.
2. The continuity of the concepts with the earlier classes, their integration and logical development should be ensured.
3. Horizontal and vertical overlapping of the concepts should be avoided.
4. The textbook should be informative and interactive with questions to be put at suitable intervals to provoke the students to think.
5. The details of the treatment of the concept should be properly classified into headings and subheadings.
6. The language used should be simple, clear, straightforward, unambiguous and easily comprehensible by the students of the particular level.
7. Simple questions may be asked within the chapter, which requires students to recall, think, and apply what they have just learnt as well as to reinforce the learning of the concepts and principle.
8. The new advancements and development in the subjects should be incorporated where appropriate.
9. The examples and applications should be from everyday life and be supportive of our cultural values.
10. SI units should be used throughout the text and the numerical values used for various constants should be same.
11. Photographs and illustrations should be clear, labeled and supportive of the text. Tables, flow charts and graphs may be given wherever needed.
12. Key points at the end of each chapter should provide a summary of the important concepts and principles discussed in the chapter.
13. Review questions should be given at the end of each chapter requiring students to recall, think and apply what they have learnt in this chapter. This should start from simple questions increasing the complexity gradually and should test knowledge, understanding and skills of the students. The last few questions should encourage the student to apply the concepts studied in this chapter.
14. Each chapter should be accompanied with its precise and coherent summary to be given at the end of this chapter.
15. Solved numerical examples within the chapter and review questions at the end of the chapter should be based on variety of situations and should be related to local environment and culture.
Electronic instructional material is gaining popularity in the developed world. Educational technology providers are successfully marketing courseware with instructional management, assessment, individualized learning paths and professional development. Growing numbers of teachers have convenient and immediate access to entire libraries of instructional video correlated to curriculum. As far the educational scenario in Pakistan and other developing countries is concerned, lack of resources (particularly in schools) would hold back the evolution of electronic publishing in place of or along with printing.

It may be considered that a good ratio of the students of intermediate classes has access to computer technologies. They should be given chances of self learning (rather exploring the knowledge) and it can be made true by converting the data of the IX-X and XI-XII textbooks into electronic formats e.g. CD-ROMs. The CD-ROMs should be made available at the retail outlets.

In Chemistry, reactions and flow sheet diagrams are more important to convey the desired learning. Printed textbooks cannot tackle the diagrams that need 3-dimensional view for their understanding. Diagrams, photographs and animations should be published in electronic format i.e. CD-ROM that can be made an accessory item with the printed textbook. Such a CD should also have installed software for students’ assessment and evaluation in the form of tests, quizzes and games.
Chapter Organizing system – It should be taken into account that a consistent numbering system leads the students through each chapter at a glance in the beginning to conceptual heading throughout and finally to the summary of key concepts at the end. Each chapter should be organized in the following pattern:

**CHAPTER NAME**

**Outline:**

**Major Concepts:**

- 1.1:-------------
- 1.2:-------------
- 1.3:-------------

**Introduction**

**1.1 MAJOR CONCEPT**

(Depth of the topic should be kept with the teaching periods advised in the curriculum)

**Subheading # 1.1.1**

**Tit Bits:**

**STS**

**Connection**
EXERCISE:
The exercise should include;
- Multiple Choice Questions
- Short Questions
- Extensive Questions

(Questions should be made that can check learning outcomes in all the domains i.e. knowledge, comprehension, application, evaluation, synthesis and connection with technology and society.)
SALIENT FEATURES OF THE CURRICULUM

The curriculum is fully in harmony with the National Priorities and will provide an important momentum for achieving our vision for students.

Configuration with the Restructured Schemes of Studies:

The Ministry of Education went through an arduous exercise for restructuring the National Schemes of Studies. The Curriculum Development Team; while designing the curriculum, selecting the syllabi contents, carving the learning outcomes (including practical skills) and suggesting the timeframes and evaluation strategies for the contents, maintained a concrete configuration with the restructured Scheme of Study.

The Focused Areas:

It has been focused that the curriculum provides to the students:

- Challenges and Enjoyment
- Breadth
- Progression
- Depth
- Personalization and Choice
- Coherence
- Relevance

Reduction in Load:

Since it was important that the quality of Chemistry education at the secondary level was not compromised in any way, the reduction in load from the syllabus required a very careful selection of topics to be taught. The Team chose to leave topics out if:

- The question about why the student needs to study the topic at the particular stage could not be answered;
- The topic had no direct relevance to the student i.e. was not contextual;
- The content was repetitive across stages with no change in expected understanding, and
- Any topic was in isolation with no evident horizontal or vertical linkages.

The need for a network of ideas and cross-linking between the areas being identified was deemed very important. While deciding on the chapters/topics and the depth of each topic for the secondary level, a holistic view of the syllabus across all stages from the primary to the higher secondary and beyond was taken. Reducing the use of too many technical terms and avoiding very large numbers of examples will also help to make the content a little lighter. The importance of careful selection of illustrations and their use to make the concepts more explicit was stressed; in Chemistry, the quality of illustrations can make or mar any attempt at good textbooks/teaching.
The curriculum also takes up issues pertaining to environment, health and other ethical issues that arise with any interference of human beings in the natural processes, which have great relevance from the societal point of view.

**Reasoning vs. Comprehension:**

In secondary and higher secondary classes, abstraction and quantitative reasoning come to occupy a more central place than in the primary and elementary classes. We have to avoid the attempt to be comprehensive. A topic can be made comprehensive in two ways;

1. Adding many more concepts than can be comfortably learnt in the given time frame
2. Enumeration of things or types of things, even where there is no strong conceptual basis for classification

In the present revision, no attempt is made to be comprehensive. Unnecessary enumeration is avoided. The process by which factual knowledge can be acquired is more important than the facts themselves.

At this stage the disciplines of physics, biology and chemistry are beginning to emerge. The students should be exposed to experiences as well as modes of reasoning that are typical of these subjects. This stage also sees a certain consolidation of knowledge within themes. As a result, a theme may get a lot of space in one class (e.g. organization of life in Class IX) while being absent from the higher classes.

**Strengths**

The New Chemistry Curriculum;

- has a concrete structure, and well sequenced yet offers flexibility and maintains the momentum over all years of high school chemistry.
- highlights the degree of students expectations by laying out baseline levels of achievement at the end of grade X and XII respectively. These expectations are reflected within the Standards and Benchmarks as well as the Aims and Objects sections of the document.
- emphasizes Higher Order Thinking through the four year period. Students are encouraged to think at higher levels for themselves, becoming independent of the teacher-----a life-long learning skill.
- focuses on all the cognitive levels of the Revised Bloom’s Taxonomy. There is a conscious effort to shift from simply knowing, remembering, and understanding to the more complex applying analyzing, evaluating, and creating skills required for success in this 21st century world.
- makes positive connections among the contents taught, skills acquired, and a variety of real-life situational applications. The abstract begins to be more meaningful and students realize the “why” in their learning requirements.
- bridges the gaps between content knowledge and practical laboratory experiences by tying the two together. All laboratory activities are now connected to their respective topics and where there are none, it clearly states so.
- does away with overlapping topics among the three branches of sciences---Chemistry, Biology and Physics. Such topics appear only once in the most relevant branch of science.
- connects every topic to some previous learning experience and to future in-depth study of the same. Horizontal (within the year) and vertical (from year to year) progressions are highlighted through linkages for every topic. This makes it very clear as to where a topic is coming from and where it will heading.
- has done away with redundant and repetitive topics and this made room to accommodate more current and contemporary Chemistry topics that affect the lives of students today and will do so in their future as well.
- provides flexibility to the teachers in terms of teaching time and preparation.
- allows students to experience the learning of science by doing science and not just listening to science.
- focuses on providing “thinking”----creative, critical, and analytical----opportunities to students and teachers.
- provides a chance to honestly compare the document with any similar document from around the globe.
- provides opportunities to explore Chemistry and discover the wonder of science for oneself.
This glossary is intended to ensure that terms commonly used in the context of learning outcomes and assessment are appropriately interpreted so that no confusion whatsoever arises in their use.

These words are listed below along with their contextual meaning.

We urge the users of these terms to strictly follow this glossary and associate meanings to the key words as given in this glossary.

1. Define (the term(s))… is intended literally. Only a formal statement or equivalent paraphrase, such as the defining equation with symbols identified, being required.

2. What is meant by … normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

3. Explain may imply reasoning or some reference to theory, depending on the context.

4. State implies a concise answer with little or no supporting argument, e.g. a numerical answer that can be obtained ‘by inspection’.

5. List requires a number of points with no elaboration. Where a given number of points are specified, this should not be exceeded.

6. Describe requires candidates to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. The amount of description intended should be interpreted in the light of the indicated mark value.

7. Discuss requires candidates to give a critical account of the points involved in the topic.

8. Deduce/Predict implies that candidates are not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question.

9. Suggest is used in two main contexts. It may either imply that there is no unique answer or that candidates are expected to apply their general knowledge to a ‘novel’ situation, one that formally may not be ‘in the syllabi’.
10. **Calculate** is used when a numerical answer is required. In general, working should be shown.

11. **Measure** implies that the quantity concerned can be directly obtained from a suitable measuring instrument, e.g. Mass using a balance.

12. **Determine** often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula e.g. relative molecular mass or ideal gas equation.

13. **Show** is used where a candidate is expected to derive a given result. It is important that the terms being used by candidates are stated explicitly and that all stages in the derivation are stated clearly.

14. **Estimate** implies a reasoned order of magnitude statement or calculation of the quantity concerned. Candidates should make such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

15. **Sketch**, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct. However, candidates should be aware that, depending on the context, some quantitative aspects may be looked for, e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value. On a sketch graph it is essential that candidates clearly indicate what is being plotted on each axis.

16. **Sketch**, when applied to diagrams, implies that a simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

17. **Compare** requires candidates to provide both similarities and differences between things or concepts.

Acknowledgement: Extracted from Chemistry A/AS Level 2007 of Cambridge University, England
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<table>
<thead>
<tr>
<th>Names of Teachers Who Contributed</th>
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<tbody>
<tr>
<td>Mr. Shaukat Ali</td>
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<tr>
<td>Mr. Faiz-ur-Rehman</td>
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<tr>
<td>Mohammad Afzal</td>
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<td>Mr. Muhammad Aslam</td>
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<td>Mr. Zafar Iqbal Bhatti</td>
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<td>Mrs. Farhat Zaheer</td>
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<td>Mrs. Naheed Mehmood</td>
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<td>Mr. Mohammad Arif</td>
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<td>Ms. Nabila Iftikhar</td>
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<td>Mr. Naveed Ahmad</td>
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<td>Mr. Anwar ul Haque</td>
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<td>Mr. Peter John</td>
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<td>Mr. Naeem Asadullah</td>
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<td>Ms. Naheed Rehman</td>
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<td>Ms. Shenaz Rashid</td>
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