National Curriculum for

CHEMISTRY

Grades XI – XII

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GOVERNMENT OF PAKISTAN
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CONTENTS

INTRODUCTION

The Chemistry Curriculum for grades IX through XII builds on the vertical progression of the K – VIII Science Curriculum. It now offers a relatively in-depth study of Chemistry as a major, independent science. It focuses on content, process skills, problem-solving, inquiry, and critical and analytical thinking skills.

This Chemistry Curriculum offers a radical shift from the traditional curriculum. The aim of this curriculum is to produce students who will be capable of doing independent thinking, asking questions, and looking for answers on their own.

Chemistry forms the base of all sciences. Chemistry impacts our lives in many ways. Medicines, industry, plastics, fuels, building materials, fertilizers, technology, all have some connection with chemistry. With this plethora of impacts on human life, teaching and learning of Chemistry must be taken seriously.

It is a given that not all of our students will become scientists or technologists. But these two fields of study affect our everyday lives. Many decisions that we are called upon to make as citizens of this "global village" involve science and technology. In some intricate way science, technology, and society are interwoven into the fabric of life. Even in the workplace much of what we do today depends on science and technology. Life in the present and also in the future will require individuals that are comfortable and competent in a complex, scientific and technological world society. It should thus be clear that schools have a massive responsibility to prepare scientifically literate students. The key is to prepare children with life-long learning skills to help them get a good grasp of the new knowledge that they will need to survive.

After completing this Chemistry Curriculum, students will be:

- knowledgeable about the key concepts and theories of Chemistry;
- able to think scientifically and use Chemistry content knowledge to make decisions about real-life problems;
- able to construct new knowledge through reading, discussions, and research;
- familiar with the natural world and respectful of its unity, diversity, fragility, and interconnectedness;
- able to make wise judgments on statements and debates that claim to have a science base.

If the above must happen in reality, education will need to:

- Focus on understanding, not syllabus coverage;
- Promote learning that is relevant and thus useful;
- Emphasize scientific literacy for ALL students;
- Promote interdisciplinary learning ----- make the connections; build the bridges.

This document is based on three rather broad categories of activities that connect all scientifically literate people:

- Knowing and Using science knowledge (learning science)
- Constructing new science knowledge (doing science)
- Reflecting on science knowledge (thinking science)

AIMS and OBJECTIVES

AIMS:

This two-year study of Chemistry aims to develop in all students:

- a scientific understanding of the physical world.
- cognitive, affective, and psychomotor abilities appropriate to the acquisition and use of chemical knowledge, understanding, attitude, and skills.
- an appreciation for the products and influences of science and technology, balanced by a concern for their appropriate application.
- an understanding of the nature and limitations of scientific activity.
- an ability to apply the understanding of Chemistry to relevant problems (including those from everyday real-life) and to approach those problems in rational ways.
- respect for evidence, rationality and intellectual honesty.
- the capacities to express themselves coherently and logically, both orally and in writing, and to use appropriate modes of communication characteristic of scientific work.
- the ability to work effectively with others.

OBJECTIVES:

A statement of objectives relevant to each of the general aims is listed below. The sequence is in no particular order.

Understanding the physical world:

Students should understand the scientific concepts inherent in the theme for each chapter and be able to:

- state, exemplify, and interpret the concepts.
- use appropriately, fundamental terms and Classification related to the concepts.
- cite, explain or interpret, scientific evidence in support of the concepts.

Using appropriate cognitive, affective and psychomotor abilities*:*

Students should show ability to:

- formulate questions that can be investigated by gathering first or second-hand data.
- find relevant published background information.
- formulate hypotheses and make predictions from them.
- plan an investigation and carry out the planned procedure.
- use appropriate and relevant motor skills in carrying out investigations.
- observe phenomena and describe, measure and record these as data.
- classify, collate and display data.
- construct and/or interpret visual representations of phenomena and relationships (diagrams, graphs, flowcharts, physical models).
- analyze data and draw conclusions.
- evaluate investigative procedures and the conclusions drawn from such investigations.

Understanding the nature and limitations of scientific activity:

For each facet of scientific activity selected for study, students should:

- describe and exemplify it.
- use appropriately any fundamental terms and classification related to it.
- recognize that the problem-solving nature of science has limitations.
- acknowledge that people engaged in science, a particularly human enterprise, have the characteristics of people in general.

Appreciating influences of science and technology:

Students should:

- recognize that the technology resulting from scientific activity influences the quality of life and economic development through or by improvements in medical / health care, nutrition, and agricultural techniques.
- explain that these influences may be the result of unforeseen consequences, rapid exploitation, or rapid cultural changes.
- realize that advances in technology require judicious applications.

Respecting evidence, rationality and intellectual honesty:

Students should:

- display respect for evidence, rationality and intellectual honesty given the number of emotive issues in the area of Chemistry.

Showing capacities to communicate:

Students should:

- comprehend the intention of a scientific communication, the relationship among its parts and its relationship to what they already know.
- select and use the relevant parts of a communication.
- translate information from communications in particular modes(spoken, written, tables, graphs, flowcharts, diagrams) to other modes.
- structure information using appropriate modes to communicate it.

Working with others:

Students should actively participate in group work and:

- share the responsibility for achieving the group task.
- show concern for the fullest possible involvement of each group member.

STANDARDS AND BENCHMARKS

In the 21st century, students will remain the most important natural resource to ensuring the continual improvement and ultimate progress of humankind. It is critical that all involved in education prepare students to meet the challenges of a constantly changing global society. It is time to call for a raising in the expectations of student learning.

Preparing students for success in the new millennium and beyond calls for increasing rigor and relevance in the curriculum. In adult roles, individuals are expected to work with others in a team setting, have an acquired knowledge base, be able to extend and refine knowledge, be able to construct new knowledge and applications and have a habit of self-assessing their assimilation of each dimension in their everyday decision making process.

This curriculum document is built upon Standards, Benchmarks, and Learning Outcomes for the benefit of student growth and progress.

STANDARDS are what students should know and be able to do. Standards are broad descriptions of the knowledge and skills students should acquire in a subject area. The knowledge includes the important and enduring ideas, concepts, issues, and information. The skills include the ways of thinking; working, communication, reasoning, and investigating that characterize a subject area. Standards may emphasize interdisciplinary themes as well as concepts in the core academic subjects.

Standards are based on:

- **Higher Order Thinking:** instruction involves students in manipulating information and ideas by synthesizing, generalizing, explaining or arriving at conclusions that produce new meaning and understanding for them.

- **Deep Knowledge:** instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understanding.

- **Substantive Conversation:** Students engage in extended conversational exchanges with the teacher and / or peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.

- **Connections to the World Beyond the Grade room:** Students make connections between substantive knowledge and either public problems or personal experiences.

BENCHMARKS indicate what students should know and be able to do at various developmental levels. Our benchmarks are split into 5 developmental levels:

- Kindergarten to grade III
- Grades IV-V
- Grades VI-VIII
- Grades IX-X
- Grades XI-XII

LEARNING OUTCOMES indicate what students should know and be able to do for each topic in any subject area at the appropriate developmental level. The Learning Outcomes sum up the total expectations from the student. Within this document, the Learning Outcomes are presented fewer than three subheadings:

- Understanding
- Skills including laboratory work
- Science, Technology and Society connections

The Standards and the accompanying Benchmarks will assist in the development of comprehensive curriculum, foster diversity in establishing high quality Learning Outcomes, and provide an accountability tool to individuals involved in the education marketplace. These provide a common denominator to determine how well students are performing and will assure that all students are measured on the same knowledge and skills using the same method of assessment.

STANDARDS

1. Using Scientific Knowledge

Students well-versed in the study of the sciences are better able to understand and appreciate the world around them and are also better able to make calculated decisions and take informed actions. Activities that require scientific thought include the *description* and *explanation* of real-world objects, systems, or events; the *prediction* of future events or observation; and the *design* of systems or courses of action that help individuals adapt to and modify (for better) the world around them.

In the physical sciences, particularly Chemistry, the specification of real-world contacts often focuses on *phenomena*, such as a variety of physical, chemical, and nuclear changes in matter.

Standard 1.1

Students will understand the processes of scientific investigation. They will be able to identify problems, design and conduct experiments, and communicate their findings using a variety of traditional and conventional tools including technology.

Standard 1.2

Students will describe and explain common properties, forms, and interactions between matter and energy; their transformations and applications in biological, chemical and physical systems.

2. Constructing New Scientific Knowledge

Students well-versed in the study of the sciences are users of the same knowledge. They possess the ability to *ask* questions about the world and can *develop solutions* to problems that they encounter or questions they ask by using scientific knowledge and techniques. In the process of finding solutions, the scientifically literate students may use their own knowledge and reasoning abilities, seek out additional knowledge from other sources, and engage in empirical investigations of the real world. These students can also learn by interpreting texts, graphs, tables, pictures, or other representations of scientific data and knowledge. Finally, such students can remember key points and use sources of information to *reconstruct* previously learned knowledge, rather than try to remember every detail of what they study.

Standard 2.1

Students will display a sense of curiosity and wonder about the natural world and demonstrate an increasing awareness that this has lead to new developments in science and technology. They will learn from books and other sources of information and reconstruct previously learned knowledge.

3. Reflecting on Scientific Knowledge

Students well-versed in the study of the sciences are also able to "step back" and analyze or reflect on their own knowledge. One such type of analysis is the *justification* of personal knowledge or beliefs using either theoretically or empirically based arguments. These students can also *show an appreciation* for scientific knowledge and the patterns it reveals in the world. They are also able to take a *historical and cultural perspective* on concepts and theories or to discuss institutional relationships among *science, technology, and society*. Finally, these students can *describe the limitations* of their own knowledge and scientific knowledge in general.

Standard 3.1

Students will demonstrate an understanding of the impact of science and technology on society and use science and technology to identify problems and creatively address them in their personal, social and professional lives. They will explain how scientists decide what constitutes scientific knowledge; how science is related to other ways of knowing; and how people have contributed to and influenced developments in science.

BENCHMARKS

Standard 1.1 Students will display a sense of curiosity and wonder about the natural world and demonstrate an increasing awareness that this has lead to new developments in science and technology. They will learn from books and other sources of information and reconstruct previously learned knowledge.

Benchmarks XI-XII

1. Describe various properties of materials that make them suitable and useful for differing jobs.
2. Analyze properties of common household and agricultural materials in terms of risk and benefit balance.
3. Classify elements based on their properties into common families.
4. Explain how elements differ in terms of the structural parts and electrical charges of atoms.
5. Analyze the motion of molecules in the various states of matter including plasma.

Standard 1.2 Students will describe and explain common properties, forms, and interactions between matter and energy; their transformations and applications in biological, chemical and physical systems.

Benchmarks XI-XII

1. Explain chemical changes in terms of the breaking of bonds and the rearrangement of atoms to form new substances.
2. Explain how and why mass is conserved in chemical changes.
3. Contrast the different types of chemical reactions in inorganic and organic chemistry.
4. Describe energy transformations involved in physical and chemical changes, and contrast their relative magnitudes.
5. Explain changes in matter and energy involving heat transfer.

Standard 2.1 Students will display a sense of curiosity and wonder about the natural world and demonstrate an increasing awareness that this has lead to new developments in science and technology. They will learn from books and other sources of information and reconstruct previously learned knowledge.

Benchmarks XI-XII

1. Ask questions that can be answered empirically.
2. Develop solutions to problems through reasoning, observation, and investigations.
3. Design and conduct scientific investigations.
4. Recognize and explain the limitations of measuring devices.
5. Gather and synthesize information from books and other sources of information.
6. Discuss topics in groups by making clear presentations, restating or summarizing what others have said, asking for clarification or elaboration, and defending a position.

Standard 3.1 Students will demonstrate an understanding of the impact of science and technology on society and use science and technology to identify problems and creatively address them in their personal, social and professional lives. They will explain how scientists decide what constitutes scientific knowledge; how science is related to other ways of knowing; and how people have contributed to and influenced developments in science.

Benchmarks XI-XII

1. Justify plans or explanations on a theoretical or empirical basis.
2. Describe some general limitations of scientific knowledge.
3. Show how common themes of science, mathematics, and technology apply in real-world contexts.
4. Discuss the historical development of key scientific concepts and principles.
5. Explain the social and economic advantages and risks of new technology.
6. Develop an awareness of and sensitivity to the natural world.
7. Describe the historical, political, and social factors affecting developments in science.

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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 S_N1 Mechanism
17.1.6.4 S_N2 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 CO_2

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 $SOCl_2$, PX_3 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 COx, NO_X, VOCs, SO_X , O_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)
- Fine 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 $[H_3O^+]$, given the Ka and molar concentration of weak acid. (Applying)
- Calculate concentrations of ions of slightly soluble salts. (Applying)
- Calculate Ka for the system, given the equilibrium concentrations of a weak acid and the $[H_3O^+]$ 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. (Applying)
- 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. (Remernbering)
- 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. (Understanding)
- 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 reaction 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

XII-LEARNING OUTCOMES

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 (Grade IX-X)
- Periodicity of Properties (Grade IX-X)
- 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.
- 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 $KMnO_4$. (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 unreative 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, hydrohalogenation, 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)
- Explain the shape of benzene molecule (molecular orbital aspect). (Understanding)
- 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)
- Describe the preparation of alkynes using elimination reactions. (Applying)
- Describe acidity of alkynes. (Understanding)
- Discuss chemistry of alkynes by hydrogenation, hydrohalogenation, hydration, bromination, ozonolysis, and reaction with metals. (Understanding)
- Describe and differentiate between substitution and addition reactions. (Understanding)
- Explain isomerism in alkanes, alkenes, alkynes and substituted benzene. (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, $SOCl_2$ and PX_3 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 Friedal 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 inter-conversion 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.
- 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

PRACTICALS	EQUIPMENT	CHEMICALS
XI-Practicals		
Chapter 1: Introduction to Stoichiometry		
1. Estimate the Amount of Ba^{+2} in the Given Solution of $BaCl_2$ Gravimetrically.	analytical balance, oven, funnel, wash bottle, Whatman filter paper # 42, glass rod, beakers, desiccators, pipette, burner, matches, safety goggles	distilled water, potassium chromate solution, barium chloride solution -
Chapter 2: Atomic Structure		
None	None	None
Chapter 3: Theories of Covalent Bonding: Theories and Shapes of molecules		
None	None	None
Chapter 4: States of Matter I: Gases		
2. Demonstrate that Gases spread by diffusion to Areas of lower Concentration.	glass tube 40cm long and 1cm in internal diameter, ring stand, clamp, clamp holder, cotton balls, forceps, dropper, rubber stoppers, safety goggles	concentrated NH_3 solution, concentrated HCl
Chapter 5: States of Matter II: Liquids		
1. Separate the Given Mixture of Inks by Paper Chromatography.	Whatman filter paper # 1, glass cylinder with a glass support, rubber bung, lead pencil	Water – alcohol mixture, mixture of inks.

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.	beaker, thermometer, safety goggles	acetone

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 H_2SO_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_2SO_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_2CO_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_2CO_3, 0.1M HCl, Distilled water, solution of 6 gms of Na_2CO_3 in 1 liter
4. Determine the Value of X by Volumetric Method in the Given Sample of 6.3g of $(COOH)_2$. XH_2O Dissolved per dm^3.	burette, pipette, funnel, conical flask, beakers, iron stand	phenolphthalein, 0.1M NaOH, 0.1 $(COOH)_2.2H_2O$, 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) $2.2H_2O$, 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% H_2O_2, 0.1gm MnO_2, 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 $KMnO_4$ and Calculate the Volume of $KMnO_4$ Required for Preparing 1 dm^3 of 0.01M $KMnO_4$ Solution Volumetrically.	burette, pipette, funnel, conical flask, beakers, iron stand, test tube	0.1M $FeSO_4$ solution, 0.02M $KMnO_4$ solution, dilute H_2SO_4, 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 $FeSO_4$ solution, 0.01M $KMnO_4$ solution, dilute H_2SO_4, distilled water
3. Determine the Percentage Composition Volumetrically of a Solution Mixture of $K_2C_2O_4$ and K_2SO_4.	burette, pipette, funnel, conical flask, beakers, iron stand, test tube	solution mixture of $K_2C_2O_4$ and K_2SO_4, 0.01M $KMnO_4$ solution, dilute H_2SO_4, distilled water

4. Determine the Solubility of Mohr's Salt at Room Temperature Volumetrically.	burette, pipette, funnel, conical flask, beakers, iron stand, test tube	0.05M Mohr's salt solution, 0.01M $KMnO_4$ solution, dilute H_2SO_4, distilled water

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.	test tubes, test tube holder, test tube rack, delivery tube, measuring cylinder, match box, wooden splint, Bunsen burner, safety goggles, glass rod, filter paper, litmus paper	sodium hydroxide, ammonium hydroxide, dilute acids, barium, lead, silver salt solutions, Al foil, lime water and other necessary chemical solutions for the identification of these ions and gases

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_4OH

Chapter 15: Organic Compounds		
None		
Chapter 16: Hydrocarbons	None	None
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, HCl
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	beakers, test tubes, measuring cylinders, Bunsen burner, match box, funnel, filter papers	Fehling's solution, Tollen's reagent, Benedict solution

Groups.

Chapter 20: Carbonyl Compounds II Carboxylic Acids and Functional derivatives

1. Prepare Benzanilide 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)

Chemicals	Quantities
Acetone	5L
Ammonium hydroxide	5L
Aluminum foil	5 Rolls
Aniline	2.5L
$Ba(NO_3)_2$ solution 0.1M	2.5L
Barium Chromate Solution	2.5L
Benedict's Reagent	2.5L
Benzoic acid	500gms
Bromine water	5L
Carbon disulphide	2.5L
Common Salt	5Kg
$(COOH)_2.2H_2O$ solution 0.1M	2.5L
Copper sulphate solution	2.5L
Dimethyl glyoxime solution	2L
2,4-dinitrophenyl hydrazine solution	2L
Distilled water	20L
Ether	5L
Ethyl Alcohol	2.5L
Ethylene bromide	2L
Fehling's Reagent	2L
Ferric Chloride solution	2L
$FeSO_4$ solution 0.05M	2L
$FeSO_4$ solution 0.1M	2L
Glucose	2Kg
HCl solution 0.1M	5L
HCl solution 1M	5L
HCl Concentrated	2.5L
H_2O_2 solution 10%	2L
H_2SO_4 Dilute	5L
H_2SO_4 solution 0.2M	2.5L
H_2SO_4 Concentrated	5L
Ink mixture	500mL
Iodine solution in potassium iodide	10L
Iron Sulfide	1Kg
K_2CrO_4 solution 0.1M	2.5L
$K_2Cr_2O_7$ solution 0.1M	5L
$KMnO_4$ solution 0.01M	5L
$KMnO_4$ solution 0.02M	5L
Lime water	2L
Magnesium turnings	1Kg
Methyl orange	100gm
MnO_2	250gm
Mohr's salt solution 0.05M	5L
Na_2CO_3 solution 0.1M	5L
NaOH solution 0.1M	5L

NaOH solution 1M	5L
NH_3 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:	
Ni, Co,NH_4^+, Mg^{2+}, Al^{3+}, Ca^{2+}, Cr^{3+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Cu^{2+}, Zn^{2+}, Ba^{2+}, Pb^{2+}.	1Kg each
Salts of the following anions:	1Kg each
CO_3^{2-}, NO_3^-, NO_2^-, SO_4^{2-}, SO_3^{2-}, Cl^-, Br^-, I^-, CrO_4^{2-}.	500gm
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 H_2S)	2L
Starch	1Kg
Tollen's reagent	2L
Zinc turnings	1 Kg

XI-XII Equipment/Apparatus

(For Group of 20 Students)

Analytical balance (Digital)	05
Beakers 50mL	25
Beakers 100mL	25
Beakers 150mL	25
Burette 50mL	25
Bunsen burner	25
Calorimeter	25
China dish	25
Clamp	25
Clamp holder	25
Conical flask	25
Cotton bundles	02
Delivery tube	25
Desiccators	10
Dropper	50
Filter paper	05 Packets
Forceps	25
Funnel	25
Glass rod	25
Glass tubing	5m
Glass tube 40cm long and 1cm in diameter	25
Graduated flask	25
Iron stand	25
Kipps Apparatus	05
Litmus paper (Red)	05 Packets
Litmus paper (Blue)	05 Packets
Matches Box	10
Measuring flask 100mL	10
Measuring flask 500mL	10
Measuring cylinder 5mL	10
Measuring cylinder 10mL	10
Measuring cylinder 100mL	10
Oven	4
Pipette 10mL	25
Pipette 25mL	25
Pipette filler	25
Rubber bung	25
Ring stand	25
Round bottom flask 250mL	25
Rubber stoppers	25
Safety goggles	20
Soap	12 Bars
Spatula	25
Stirrer	25
Test tube	200
Test tube holder	40

Test tube rack	40
Thermometer	25
Thistle funnel	25
Tray	25
Tripod stand	25
Wash bottle	25
Whatman filters paper No. 42	05 Packets
Whatman filter paper No. 1	05 Packets
Wire gauze	25
Wooden splint	05 Packets

CHAPTER WISE TIME ALLOCATION

Class- XI

Chapter	Teaching	Assessment	Weightage %
Chapter 1: Stoichiometry	10	1	8
Chapter 2: Atomic Structure	10	1	8
Chapter 3:Theories of Covalent Bonding and Shapes of Molecules	12	1	11
Chapter 4:State of Matter I	14	1	12
Chapter 5:State of Matter II: Liquids	9	1	11
Chapter 6:States of Matter III: Solids	10	1	7
Chapter 7:Chemical Equilibrium	8	1	7
Chapter 8:Acids, Bases and Salts	8	1	6
Chapter 9:Chemical Kinetics	8	1	5
Chapter 10:Solutions and Colloids	12	1	9
Chapter 11:Thermochemistry	11	1	8
Chapter 12:Oxidation, Reduction and Electrochemistry	10	1	8
Total:	122	12	100

Class XII

Chapter 13: s and p Block Elements	25	3	22
Chapter 14:d- Block Elements	9	1	6
Chapter 15:Organic Compounds	3	1	3
Chapter 16:Hydrocarbons	18	2	14
Chapter 17:Alkyl Halides and Amines	11	1	8
Chapter 18:Alcohols and Phenols	9	1	8
Chapter 19:Aldehydes and Ketones	4	1	4
Chapter 20:Carboxylic Acids	7	1	6
Chapter 21:Biochemistry	6	1	6
Chapter 22: Industrial Chemistry	8	1	6
Chapter 23: Environmental Chemistry	9	1	6
Chapter 24: Analytical Chemistry	13	3	11
Total:	122	17	100

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.

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.

ASSESSMENT AND EVALUATION IN CHEMISTRY

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 snap shot 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;

Learning Domains for Measurement	Weightage In Evaluation
• Knowledge, Comprehension, Analysis, Evaluation, Synthesis, Application:	85%
• Skills of Communication, Initiating and Planning, Designing Experiments and Interpreting Data:	05%
• Manipulative skills (Performing Lab Work)	10%

Weightage in Evaluation:

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

Class- XI

Chapter	Weightage %
Chapter 1: Stoichiometry	8
Chapter 2: Atomic Structure	8
Chapter 3:Theories of Covalent Bonding and Shapes of Molecules	11
Chapter 4:State of Matter I	12
Chapter 5:State of Matter II: Liquids	11
Chapter 6:States of Matter III: Solids	7
Chapter 7:Chemical Equilibrium	7
Chapter 8:Acids, Bases and Salts	6
Chapter 9:Chemical Kinetics	5
Chapter 10:Solutions and Colloids	9
Chapter 11:Thermochemistry	8
Chapter 12:Oxidation, Reduction and Electrochemistry	8
Total:	**100**

Class XII

Chapter 13: s and p Block Elements	22
Chapter 14:d- Block Elements	6
Chapter 15:Organic Compounds	3
Chapter 16:Hydrocarbons	12
Chapter 17:Alkyl Halides and Amines	8
Chapter 18:Alcohols and Phenols	9
Chapter 19:Aldehydes and Ketones	4
Chapter 20:Carboxylic Acids	6
Chapter 21:Biochemistry	6
Chapter 22: Industrial Chemistry	6
Chapter 23: Environmental Chemistry	6
Chapter 24: Analytical Chemistry	12
Total:	**100**

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 under standing 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:

More Emphasis should be on;	Less Emphasis should be on;
• Assessing what I most highly valued	• Assessing what is easily measured
• Assessing rich, well-structured knowledge	• Assessing discrete knowledge
• Assessing scientific understanding and reasoning	• Assessing scientific knowledge
• Assessing to learn what students do understand	• Assessing to learn what students do not know
• Assessing achievement and opportunity to learn	• Assessing to learn what students do not know
• Students engaged in ongoing assessment of their work and that of others	• Assessing only achievement
• Teachers involved in the development of external assessments	• Development of external assessments by experts alone

- Assessment pattern is subject to the requirement, policies, and procedures of the Examination Boards.

- Question paper should be based on the curriculum not on a particular textbook.

- Questions involving unfamiliar contexts or daily-life experiences may be set to asses 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.

- In general, SI units and terminology should be used.

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, straight forward, 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 every day 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:

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

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)

Tit Bits:

STS Connection

Subheading # 1.1.1

Subheading # 1.1.2

Critical Thinking

Practical Activity:

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.

GLOSSARY OF TERMS USED IN LEARNING OUTCOMES/ASSESSMENT

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

what-so- ever 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.

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