National Curriculum for

CHEMISTRY

Grades IX – X

2006

GOVERNMENT OF PAKISTAN
MINISTRY OF EDUCATION
ISLAMABAD

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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 IX-X

1. Classify common objects and substances according to observable attributes or properties.

2. Describe and compare objects in terms of mass, volume, density, and other physical and chemical characteristics.

3. Explain when size, mass, density, area, volume or temperature are appropriate to describe the properties of an object or substance.

4. Classification substances as elements, compounds, or mixtures and justify Gradeifications in terms of atoms and molecules.

5. Describe the arrangement and motion of molecules in solids, liquids, and gases.

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 IX-X

1. Describe common physical changes in matter: evaporation, condensation, sublimation, dissolution, thermal expansion and contraction.

2. Describe common chemical changes in terms of properties of reactants and products.

3. Explain physical changes in terms of the arrangement and motion of atoms and molecules.

4. Describe common energy transformations in everyday and industrial situations.

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 IX-X

1. Generate scientific questions about the world based on observation.
2. Develop solutions to problems through reasoning, observation, and investigations.
3. Design and conduct scientific investigations.
4. Use tools and equipment appropriate to scientific investigations.
5. Use metric measurement devices to provide consistency in an investigation.
6. Use sources of information in support of scientific investigations.
7. Write and follow procedures in the form of step-by-step instructions, formulas, flow diagrams, and sketches.

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 IX-X

1. Evaluate the strengths and weaknesses of claims, arguments, or data.
2. Describe limitations in personal knowledge.
3. Show how common themes of science, mathematics, and technology apply in real-world contexts.
4. Describe the advantages and risks of new technologies.
5. Develop an awareness of and sensitivity to the natural world.
6. Recognize the contributions made in science by cultures and individuals of diverse backgrounds.

GRADES IX-X CONTENTS

Chapter 1 **Fundamentals of Chemistry**

Introduction

1.1 Branches of Chemistry
Physical Chemistry, Organic Chemistry, Inorganic Chemistry, Biochemistry, Industrial Chemistry, Nuclear Chemistry, Environmental Chemistry, Analytical Chemistry

1.2 Basic Definitions
1.2.1 Elements, Compounds and Mixtures
1.2.2 Atomic Number, Mass Number
1.2.3 Relative Atomic Mass and Atomic Mass Unit
1.2.4 Empirical Formula, Molecular Formula
1.2.5 Molecular Mass and Formula Mass

1.3 Chemical Species
1.3.1 Ions (Cations, Anions), Molecular Ions and Free Radicals.
1.3.2 Types of Molecules (Monatomic, Polyatomic, Homoatomic, Heteroatomic)

1.4 Avogadro's Number and Mole
1.4.1 Avogadro's Number
1.4.2 Mole
1.4.3 Gram Atomic Mass, Gram Molecular and Gram Formula Mass

1.5 Chemical Calculations
1.5.1 Mole-Mass Calculations
1.5.2 Mole-Particle Calculations

Chapter 2 **Structure of Atoms**

Introduction

2.1 Theories and Experiments Related To Atomic Structure
2.1.1 Rutherford's Atomic Model (Experiment and Postulates)
2.1.2 Bohr's Atomic Theory (Postulates)

2.2 Electronic Configuration
2.2.1 Concepts of S and P Sub-Shells
2.2.2 Electronic Configurations of First 18 Elements

2.3 Isotopes
2.3.1 Definition
2.3.2 Examples (H, C, Cl, U)
2.3.3 Uses

Chapter 3 **Periodic Table and Periodicity of Properties**

Introduction

3.1 Periodic Table
3.1.1 Periods
3.1.2 Groups

3.2 Periodicity of Properties
- 3.2.1 Atomic Size
- 3.2.2 Ionization Energy
- 3.2.3 Electron Affinity
- 3.2.4 Shielding Effect
- 3.2.5 Electronegativity

Chapter 4 Structure of Molecules

Introduction

4.1 Why do Atoms Form Chemical Bonds?

4.2 Chemical Bonds

4.3 Types of Bonds
- 4.3.1 Ionic Bonds
- 4.3.2 Covalent Bonds
- 4.3.3 Dative Covalent Bonds
- 4.3.4 Polar and Non-Polar Bonds
- 4.3.5 Metallic Bonds

4.4 Intermolecular Forces
- 4.4.1 Dipole-Dipole Interactions
- 4.4.2 Hydrogen Bonding

4.5 Nature of Bonding and Properties
- 4.5.1 Ionic Compounds
- 4.5.2 Covalent Compounds
- 4.5.3 Polar and Non-Polar Compounds
- 4.5.4 Metals

Chapter 5 Physical States of Matter

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Gaseous State

5.1 Typical Properties
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5.2 Laws Related To Gases
- 5.2.1 Boyle's Law
- 5.2.2 Charles's Law

Liquid State

5.3 Typical Properties
(Evaporation, Vapour Pressure, Boiling Point, Freezing Point, Diffusion, Mobility, Density and Factors affecting them.)

Solid State

5.4 Typical Properties
(Melting Point, Rigidity, Density)

5.5 Types of Solids
- 5.5.1 Amorphous
- 5.5.2 Crystalline State

5.6 Allotropy

Chapter 6 Solutions

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6.2 Saturated, Unsaturated, Supersaturated Solutions and Dilution of Solution

6.3 Types of Solution

6.3.1 Solution of Gases (Gases in Gases, Gases In Liquids, Gases in Solids)

6.3.2 Solution of Liquids (Liquids in Gases, Liquids in Liquids, Liquids in Solids)

6.3.3 Solutions of Solids (Solids in Gases, Solids in Liquids, Solids in Solids)

6.4 Concentration Units

6.4.1 Percentage

6.4.2 Molarity

6.4.3 Problems Involving the Molarity of a Solution

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6.5.2 Effect of Temperature on Solubility

6.6 Comparison of Solutions, Suspension and Colloids

6.6.1 Solutions

6.6.2 Colloids

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7.2 Oxidation States and Rules for Assigning Oxidation States

7.3 Oxidizing and Reducing Agents

7.4 Oxidation - Reduction Reactions

7.5 Electrochemical Cells

7.5.1 Concept of Electrolytes

7.5.2 Electrolytic Cells

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7.6.1 Manufacture of Sodium Metal from Fused NaCl

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7.7.1 Rusting of Iron

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8.1.2 Comparison of Reactivity of Alkali and Alkaline Earth Metals

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10.1.2 Bronsted Concept of Acids, and Bases

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10.3.2 Types of

10.3.3 Uses of some Salts

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12.2.1.2 Dehydrohalogenation of Alkyl Halides

12.2.2 Important Reactions

12.2.2.1 Addition of Halogens

12.2.2.2 Addition of Hydrogen Halides

12.2.2.3 Oxidation With $KMnO_4$

12.3 Alkynes

12.3.1 Preparation

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12.3.1.2 Dehalogenation of Tetrahalides

12.3.2 Important Reactions

12.3.2.1 Addition of Halogens

12.3.2.2 Oxidation With $KMnO_4$

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Introduction

13.1 Carbohydrates

13.1.1 Monosaccharides

13.1.2 Oligosaccharides

13.1.3 Polysaccharides

13.1.4 Sources and Uses

13.2 Proteins

13.2.1 Amino Acids as Building Blocks of Proteins

13.2.2 Sources and Uses

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13.4 Vitamins

13.4.1 Types of Vitamins

13.4.2 Importance of Vitamins

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14.2.1 Troposphere

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15.2 Soft and Hard Water

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16.2.3 Flow Sheet Diagram

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16.3.1 Raw Materials

16.3.2 Reaction

16.3.3 Flow Sheet Diagram

16.4 Petroleum Industry

16.4.1 Petroleum

16.4.2 Origin of Petroleum

16.4.3 Mining of Petroleum

16.4.4 Important Fractions of Petroleum

GRADES IX-X LEARNING OUTCOMES

Chapter 1 Fundamentals of Chemistry

Introduction
Major Concepts
1.1 Branches of Chemistry
1.2 Basic Definitions
1.3 Chemical Species
1.4 Avogadro's Number and Mole
1.5 Chemical Calculations

Conceptual Linkages
This unit is built on

- Definitions of Atoms and Molecules (Grade VI)
- Symbols, Chemical Formula (Grade VI)
- Atomic Number, Mass Number (Grade VII)

This unit leads to

- Stoichiometry (Grade XI)
- Balancing of Redox Chemical Equations (Grade XI & XII)

LEARNING OUTCOMES

UNDERSTANDING:
Students will be able to:

- Identify and provide examples of different branches of chemistry. (Applying)
- Differentiate between branches of chemistry. (Understanding)
- Distinguish between matter and a substance. (Analyzing)
- Define ions, molecular ions, formula units and free radicals. (Remembering)
- Define atomic number, atomic mass, atomic mass unit. (Remembering)
- Differentiate among elements, compounds and mixtures. (Remembering)
- Define relative atomic mass based on C-12 scale. (Remembering)
- Differentiate between empirical and molecular formula (Understanding)
- Distinguish between atoms and ions. (Analyzing)
- Differentiate between molecules and molecular ions. (Analyzing)
- Distinguish between ion and free radical. (Analyzing)
- Classify the chemical species from given examples. (Understanding)
- Identify the representative particles of elements and compounds. (Remembering)
- Relate gram atomic mass, gram molecular mass and gram formula mass to mole. (Applying)
- Describe how Avogadro's number is related to a mole of any substance. (Understanding)
- Distinguish among the terms gram atomic mass, gram molecular mass and gram formula mass. (Analyzing)
- Change atomic mass, molecular mass and formula mass into gram atomic mass, gram molecular mass and gram formula mass. (Applying)

SKILLS:

Students will be able to:

- Calculate the number of representative particles in a given number of moles of any substance. (Applying)
- Calculate the number of moles in a given number of representative particles of any substance. (Applying)
- Calculate the mass of one mole of any substance. (Applying)
- Calculate the mass of a given number of moles of a substance. (Applying)
- Calculate the number of moles in a given mass of a substance. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Appreciate the molecularity of the physical world. (Understanding)
- Know about the debate going on for centuries about the corpuscular nature of matter.(Knowledge)
- Explain how science developed through observations and experiments rather than by speculation alone. (Analyzing)
- Explain how works of scientists help to change existing theories of the time. (Analyzing)
- Explain the size of the mole by creating an analogy. (Creating)
- Explain how the works of different scientists at the same time handicap or promote the growth of science. (Analyzing)

Chapter 2 Structure of Atoms

Introductions

Major Concepts

2.1 Theories and Experiments Related to Atomic Structure
2.2 Isotopes
2.3 Electronic Configuration

Conceptual Linkages

This unit is built on

- Structure of Atom (Grade VII)
- Introduction to Sub-Atomic Particles (Grade VII)

This unit leads to

- Derivation of Radius of Orbit (Grade XI & XII)
- Derivation of Energy of Electron (Grade XI & XII)
- Spectrum of Hydrogen (Grade XI & XII)
- Series of Spectrum (Grade XI & XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Describe the contributions that Rutherford made to the development of the atomic theory. (Applying)
- Explain how Bohr's atomic theory differed from its. (Analyzing)
- Describe the structure of an atom including the location of the proton, electron and neutron. (Understanding)
- Define isotopes. (Remembering)
- Compare isotopes of an atom. (Analyzing)
- Discuss properties of the isotopes of H, C, Cl, U (Understanding)
- Draw the structure of different isotopes from mass number and atomic number. (Applying)
- State the importance and uses of isotopes in various fields of life. (Remembering)
- Describe the presence of sub shells in a shell. (Understanding)
- Distinguish between shells and sub shells. (Understanding)
- Write the electronic configurations of the first 18 elements in the Periodic Table. (Remembering)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Describe how interpretations of experimental results of other scientists help scientists formulate new explanations and theories. (Applying)
- Show how testing prevailing theories brings about changes in them. (Analyzing)
- Describe the importance and uses of isotopes in various fields of life. (Analysis)

Chapter 3 Periodic Table and Periodicity of Properties

Introduction

Major Concepts

3.1 Periodic Table
3.2 Periodic Properties

Conceptual Linkages

This unit is built on

- Elements (Grade VI)
- Formula and Equations (Grade VII)
- Changes in Matter (Grade VIII)

This unit leads to

- s, p and d Block Elements (Grade XI)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Distinguish between a period and a group in the periodic table. (Understanding)
- State the periodic law. (Remembering)
- Classify the elements (into two categories: groups and periods) according to the configuration of their outer most electrons. (Analyzing)
- Determine the demarcation of the periodic table into an s block and p block. (Remembering)
- Explain the shape of the periodic table. (Analyzing)
- Determine the location of families on the Periodic Table. (Understanding)
- Recognize the similarity in the chemical and physical properties of elements in the same family of elements. (Understanding)
- Identify the relationship between electron configuration and the position of an element on the periodic table. (Analyzing)
- Explain how shielding effect influences periodic trends. (Applying)
- Describe how electronegativities change within a group and within a period in the periodic table. (Analyzing)

SKILLS:

Students will be able to:

- Describe how the atomic radii vary within a group and within a period of the periodic table. (Analyzing)
- Describe how the ionization energies vary within a group and within a period of the periodic table. (Analyzing)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain how scientists can build on one another's works. (Applying)

Chapter 4 Structure of Molecules

Introduction

Major Concepts

4.1 Why do Atoms React?
4.2 Chemical Bonds
4.3 Types of Bonds
4.4 Intermolecular Forces
4.5 Nature of bonding and properties

Conceptual Linkages

This unit is built on

- Valency of Elements (Grade VII)
- Electronic Configuration Based on Shells (Grade VII)
- Number of Electrons in Valance Shell (Grade VII)

This unit is leads to

- Theories of Bonding (Grade XI & XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Find the number of valence electrons in an atom using the Periodic Table. (Applying)
- Describe the importance of noble gas electronic configurations. (Understanding)
- State the octet and duplet rules. (Remembering)
- Explain how elements attain stability. (Understanding)
- Describe the ways in which bonds may be formed. (Remembering)
- State the importance of noble gas electronic configurations in the formation of ion. (Applying)
- Describe the formation of cations from an atom of a metallic element. (Applying)
- Describe the formation of anions from an atom of a non-metallic element. (Applying)
- Describe the characteristics of an ionic bond. (Understanding)
- Recognize a compound as having ionic bonds. (Analyzing)
- Identity characteristics of ionic compounds. (Understanding)
- Describe the formation of a covalent bond between two non metallic elements. (Understanding)
- Describe with examples single, double and triple covalent bonds. (Understanding)
- Draw electron cross and dot structures for simple covalent molecules containing single, double and triple covalent bonds. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain the need for different synthetic adhesives like glues and epoxy resins (Analyzing)
- Explain how aircrafts, cars, trucks and boats are partially held together with epoxy adhesives. (Analyzing)

Chapter 5 Physical States of Matter

Introduction

Major Concepts

Gaseous

5.1 Typical properties
5.2 Laws related to gases

Liquid state

5.3 Typical Properties

Solid state

5.4 Typical Properties
5.5 Types of solids

Conceptual Linkages

This unit is built on

- States of Matter (Grade IV)

This unit leads to

- Laws and Principles Obeyed by
- Different States of Matter (Grade XI & XII)

LEARNING OUTCOMES

Understanding

- Effect on the pressure of a gas by a change in the **a.** volume **b.** temperature. (Understanding)
- Compare the physical states of matter with regard to intermolecular forces present between them. (Analyzing)
- Account for pressure-volume changes in a gas using Boyle's Law. (Analyzing)
- Account for temperature-volume changes in a gas using Charles's Law. (Analyzing)
- Explain the properties of gases (diffusion, effusion and pressure). (Understanding)
- Summarize the properties of liquids like evaporation, vapor pressure, boiling point (Understanding)
- Explain the effect of temperature and external pressure on vapor pressure and boiling point. (Understanding)
- Describe physical properties of solids (melting and boiling points). (Understanding)
- Differentiate between amorphous and crystalline solids. (Analyzing)
- Explain the allotropic forms of solids.(Understanding)

SKILLS:

Students will be able to:

- Determine melting point of organic solids. (Applying)
- Determine boiling point of organic liquids. (Applying)
- Carry out sublimation. (Applying)
- Carry out distillation process. (Applying)

Society, Technology, And Science

- Explain how instrumentation changes as science progresses. (Understanding)
- Explain how curing with salts helps preserve meat. (Understanding)
- Explain how scientists use the power of reasoning to explain their observations. (Understanding)

Chapter 6 Solutions

Introduction

Major Concepts

6.1 Solution, aqueous solution, solute, and solvent
6.2 Saturated, unsaturated, supersaturated solutions and dilution of solution
6.3 Types of solution
6.4 Concentration Units
6.5 Comparison of Solutions, Suspension, and Colloids

Conceptual Linkages

This unit is based on

- Solutions and its Components (Grade VI)
- Properties of Solutions (Grade VI)
- Dilute and Concentrated Solutions (Grade VI)
- Solutions and Suspensions (Grade VI)
- Daily Life Uses of Solutions (Grade VI)

This unit leads to

- Colligative Properties of Solutions (Grade XI & XII)
- Colloids (Grade XI & XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Define the terms: solution, aqueous solution, solute and solvent and give an example of each. (Remembering)
- Explain the difference between saturated, unsaturated and supersaturated solutions. (Analyzing)
- Explain the formation of solutions (mixing gases into gases, gases into liquids, gases into solids) and give an example of each. (Understanding)
- Explain the formation of solutions (mixing liquids into gases, liquids into liquids, liquids into solids) and give an example of each. (Understanding)
- Explain the formation of solutions (mixing solids into gases, solids into liquids, solids into solids) and give an example of each. (Understanding)
- Explain what is meant by the concentration of a solution. (Understanding)
- Define Molarity. (Remembering)
- Define percentage solution. (Remembering)
- Solve problems involving the Molarity of a solution. (Applying)
- Describe how to prepare a solution of given Molarity. (Applying)
- Describe how to prepare dilute solutions from concentrated solutions of known Molarity. (Applying)
- Convert between the Molarity of a solution and its concentration in g/dm^3. (Applying)
- Use the rule that “like dissolves like” to predict the solubility of one substance in another. (Understanding)

- Define colloids and suspensions. (Remembering)
- Differentiate between solutions, suspension and colloids (Analyzing)

SKILLS:

Students will be able to:

- Prepare solutions of different strength. (Applying)
- Carry out dilution of solutions. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Relate solutions to different products in their community. (Analyzing)

Chapter7 Electrochemistry

Introduction

Major Concepts

7.1 Oxidation and reduction
7.2 Oxidation States and Rules for Assigning Oxidation States
7.3 Oxidizing and Reducing Agents
7.4 Oxidation- Reduction Reactions
7.5 Electrochemical Cells
7.6 Electrochemical Industries
7.7 Corrosion and its Prevention

Conceptual Linkages

This unit is built on

- Balancing of Chemical Equations (Grade VIII)

This unit leads to

- Electrochemical Cells (Grade XI & XII)
- Balancing of Redox Reactions (Grade XI & XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Define oxidation and reduction in terms of loss or gain of oxygen or hydrogen. (Understanding)
- Define oxidation and reduction in terms of loss or gain of electrons. (Understanding)
- Identify the oxidizing and reducing agents in a redox reaction. (Analyzing)
- Define oxidizing and reducing agents in a redox reaction. (Understanding)
- Define oxidation state. (Remembering)
- State the common rules used for assigning oxidation numbers to free elements, ions (simple and complex), molecules, atoms.(Remembering)
- Determine the oxidation number of an atom of any element in a compound. (Applying)
- Describe the nature of electrochemical processes. (Understanding)
- Sketch an electrolytic cell, label the cathode and the anode. (Understanding)
- Identify the direction of movement of cations and anions towards respective electrodes. (Understanding)
- List the possible uses of an electrolytic cell. (Understanding)
- Sketch a Danniell cell, labeling the cathode, the anode, and the direction of flow of the electrons. (Understanding)
- Describe how a battery produces electrical energy. (Understanding)

UNDERSTANDING:

Students will be able to:

- Identify the half-cell in which oxidation occurs and the half-cell in which reduction occurs given a voltaic cell. (Applying)
- Distinguish between electrolytic and voltaic cells. (Analyzing)
- Describe the methods of preparation of alkali metals. (Understanding)
- Describe the manufacture of sodium metal from fused NaCl. (Understanding)
- Identify the formation of by products in the manufacture of sodium metal from fused NaCl. (Remembering)
- Describe the method of recovering metal from its ore. (Understanding)
- Explain electrolytic refining of copper. (Understanding)
- Define corrosion. (Remembering)
- Describe rusting of iron as an example of corrosion. (Understanding)
- Summarize the methods used to prevent corrosion. (Understanding)
- Explain electroplating of metals on steel (using examples of zinc, Tin and chromium plating). (Understanding)

SKILLS:

Students will be able to:

- Determine which solutions conduct electricity given a set of different solutions. (Analyzing)
- Perform metal displacement reactions in aqueous medium. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Compare the effects of Al_2O_3 and Fe_2O_3 formation on their parent metals and cite examples from daily life. (Analyzing)
- Explain how the food and beverage industries deal with corrosion. (Understanding)
- Explain how chemistry interacts with photography. (Applying)
- Explain how decorative and practical objects containing silver can differ significantly in their properties and durability depending on whether they are solid silver, thickly plated with silver or thinly plated with silver. (Understanding)

Chapter 8 Chemical Reactivity

Introduction

Major concepts

8.1 Metals
8.2 Non-Metals

Conceptual Linkages

This unit is built on

- Elements, Compounds and Mixtures (Grade VI)

This unit leads to

- Metals, Non-metals and Metalloids (Grade XI)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Show how cations and anions are related to the terms metals and non-metals. (Applying)
- Explain why alkali metals are not found in the Free State in nature. (Analyzing)
- Identify elements as an alkali metal or an alkaline earth metal. (Applying)
- Explain the differences in ionization energies of alkali and alkaline earth metals. (Understanding)
- Describe the position of sodium in Periodic Table, its simple properties and uses. (Understanding)
- Describe the position of calcium and magnesium in Periodic Table, their simple properties and uses. (Understanding)
- Differentiate between soft and hard metals (Iron and Sodium). (Analyzing)
- Describe the inertness of noble metals. (Understanding)
- Identify the commercial value of Silver, Gold and Platinum. (Analyzing)
- Compile some important reactions of halogens. (Applying)
- Name some elements, which are found in uncombined state in nature. (Understanding)

SKILLS:

Students will be able to:

- Qualitatively analyze cations (NH_4^+, Ca^{+2}, Mg^{+2}, Ba^{+2}, Zn^{+2}) and anions (CO_3^{-2}, SO_4^{-2}, Cl^-, I^-, NO_2^-). (Analyzing)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain the uses of noble metals for jewelry and coins.

Chapter 9 Chemical Equilibrium

Introduction

Major Concepts

9.1 Reversible Reactions and Dynamic Equilibrium
9.2 Law of mass action and Derivation of the expression for the equilibrium constant
9.3 Equilibrium Constant and its units
9.4 Importance of Equilibrium Constant

Conceptual Linkages

This unit is built on

- Types of Chemical Reactions (Grade VIII)

This unit leads to

- Reversible Reactions and Dynamic Equilibrium (Grade XII)
- Le-Chatelier's Principle (Grade XII)
- Limitations on the Use of Equilibrium Constants (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Define chemical equilibrium in terms of a reversible reaction. (Understanding)
- Write both the forward and the reverse reactions and describe the macroscopic characteristics of each. (Applying)
- Define Law of mass action (Understanding)
- Derive an expression for the equilibrium constant and its units(Applying)
- State the necessary conditions for equilibrium and the ways that equilibrium can be recognized. (Understanding)
- Write the equilibrium constant expression of a reaction.

SKILLS:

Students will be able to:

- Write the equilibrium expression for a given chemical reaction. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain how components of the atmosphere can be used successfully in producing important chemicals. (Applying)

Chapter 10 Acids, Bases and Salts

Introduction

Major Concepts

10.1 Concepts of Acids, Bases
10.2 pH Scale
10.3 Salts

Conceptual Linkages

This unit is built on

- Solutions (Grade VI)
- Acids, Bases and Salts (Grade VIII)

This unit leads to

- Conjugate Acids and Bases (Grade XII)
- Strength of Acids and Bases (Grade XII)
- Common Ion Effect (Grade XII)
- Buffer Solutions (Grade XII)
- Salt of Hydrolysis (Grade XII)
- Polyprotic Acids (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Define and give examples of Arrhenius acids and bases. (Understanding)
- Use the Bronsted-Lowry theory to classify substances as acids or bases, or as proton donors or proton acceptors. (Applying)
- Classify substances as Lewis acids or bases. (Analyzing)
- Write the equation for the self-ionization of water. (Remembering)
- Given the hydrogen ion or hydroxide ion concentration, classify a solution as neutral, acidic, or basic. (Applying)
- Complete and balance a neutralization reaction. (Applying)

SKILLS:

Students will be able to:

- Use litmus paper, pH paper and other indicators for measuring pH of solutions. (Applying)
- Perform acid base titrations and related calculations. (Analyzing)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Identify areas of work for analytical chemists. (Understanding)
- Explain why the quantity of preservatives in food is restricted by government regulations. (Applying)
- Explain pH-dependent foods. (Applying)
- Explain process of etching in art and industry. (Applying)
- Explain the reactions between industrial pollutants and atmospheric water leading to formation of acids. (Applying)
- Describe harmful effects of acid rain. (Analyzing)
- Explain stomach acidity. (Applying)

Chapter 11 Organic Chemistry

Introduction

Major Concepts

11.1 Organic Compounds
11.2 Sources of Organic Compounds
11.3 Uses of Organic Compounds
11.4 Alkanes and Alkyl Radicals
11.5 Functional Groups

Conceptual Linkages

This unit is built on

- Hydrocarbons (Grade VIII)

This unit leads to

- Organic Compounds (Grade XII)
- Analytical Chemistry (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Recognize structural, condensed, and molecular formulas of the straight chain hydrocarbons up to ten carbon atoms. (Understanding)
- Identify some general characteristics of organic compounds. (Remembering)
- Explain the diversity and magnitude of organic compounds. (Understanding)
- List some sources of organic compound (Applying)
- List the uses of organic compounds (remembering)
- Recognize and identify a molecule's functional groups.(Understanding)
- Distinguish between saturated and unsaturated hydrocarbons. (Understanding)
- Name the alkanes up to decane. (Remembering)
- Convert alkanes into alkyl radicals. (Applying)
- Differentiate between alkanes and alkyl radicals. (Analyzing)
- Define functional group. (Remembering)
- Differentiate between different organic compounds on the basis of their functional groups. (Analyzing)
- Classify organic compounds into straight chain, branched chain and cyclic compounds. (Understanding)

SKILLS:

Students will be able to:

- Identify carboxylic acids, phenols, amines, aldehydes and ketones in terms of functional groups in the lab. (Analyzing)
- Distinguish between saturated and unsaturated compounds using iodine, bromine and potassium permanganate solutions. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Show how pharmaceutical chemists work towards the partial and total synthesis of effective new drugs. (Understanding)
- Explain how substances produced by plants and animals can also be produced in the lab. (Applying)

Chapter 12 Hydrocarbons

Introduction

Major Concepts

12.1 Alkanes
12.2 Alkenes
12.3 Alkynes

This unit leads to

- Introduction to Organic Chemistry (Grade XII)
- Isomerism (Grade XII)
- Hydrocarbons: Their Types, Properties and Reactions (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Explain why a systematic method of naming chemical compounds is necessary. (Analyzing)
- Characterize a hydrocarbon. (Understanding)
- Draw electron cross and dot structures of simple alkanes. (Applying)
- Write a chemical equation to show the preparation of alkanes from hydrogenation of alkenes and alkynes and reduction of alkyl halides.(Remembering)
- Draw structural formulas of alkanes, alkenes and alkynes up to 5 carbon atoms. (Understanding)
- Write a chemical equation to show the preparation of alkenes from dehydration of alcohols and dehydrohalogenation of alkyl halides. (Remembering)
- Write a chemical equation to show the preparation of alkynes from Dehalogenation of 1,2- dihalides and tetrahalides. (Remembering)
- Write chemical equations showing halogenation for alkanes, alkenes and alkynes. (Remembering)
- Write chemical equations showing reaction of $KMnO_4$ with, alkenes and alkynes. (Remembering)

SKILLS:

Students will be able to:

- Determine the boiling point of alcohol. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain hydrocarbons as fuel. (Applying)
- Explain Hydrocarbons as feed stock in industry. (Applying)

Chapter 13 Biochemistry

Introduction

Major Concepts

13.1 Carbohydrates
13.2 Proteins
13.3 Lipids
13.4 Nucleic acids
13.5 Vitamins

This unit leads to

- Aldehydes and Ketones (Grade XII)
- Amines (Grade XII)
- Carboxylic Acids (Grade XII)
- Esters (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Distinguish between mono-, di- and trisaccharides. (Understanding)
- Describe the bonding in a protein molecule. (Understanding)
- Explain the sources and uses of carbohydrates, proteins, and lipids. (Understanding)
- Differentiate between fats and oil. (Applying)
- Describe the importance of nucleic acids. (Understanding)
- Define and explain vitamins and their importance. (Understanding)

SKILLS:

Students will be able to:

- Check the relative solubility in water of starch and sugar. (Applying)
- Observe and explain the denaturing of proteins. (Analyzing)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain why agricultural and nutritional sciences are vital.. (Analyzing)
- Explain the use of natural products in the preparation of flavors, fragrances, resins and pharmaceuticals. (Applying)
- List and describe the commercial uses of enzymes. (Applying)
- Explain hydrogenation of vegetable oil. (Understanding)
- Explain the use of dextrose in drips. (Understanding)

Chapter 14 Environmental Chemistry I: Atmosphere

Introduction

Major Concepts

14.1 Composition of Atmosphere
14.2 Layers of Atmosphere
14.3 Air Pollutants
14.4 Acid rain and its effects
14.5 Ozone depletion and its effects

Conceptual Linkages

This unit is built on

- Mixtures (Grade VI)

This unit leads to

- Chemical Reactions in the Atmosphere (Grade XII)
- Oxides of Carbon, Nitrogen, sulfur Ozone and Volatile Organic Compounds. (Grade XII)
- Catalytic Destruction of Ozone (Grade XII)
- Depletion of the Protective Ozone Layer in the Stratosphere (Grade XII)
- Global Warming and Climate Change (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Define atmosphere. (Remembering)
- Explain composition of atmosphere. (Understanding)
- Differentiate between stratosphere and troposphere. (Analyzing)
- Summarize the components of stratosphere and troposphere. (Understanding)
- Describe major air pollutants. (Understanding)
- Describe sources and effects of air pollutants. (Understanding)
- Explain ozone formation. (Understanding)
- Describe acid rain and its effects (Understanding)
- Describe ozone depletion and its effects. (Understanding)
- Describe global warming. (Understanding)

SKILLS:

Students will be able to:

- Perform filtration experiments in the lab on different water samples having suspended impurities. (Analyzing)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain how incineration of waste material contributes to the problem of air pollution. (Analyzing)
- Debate whether the government should do more to control air pollution resulting from auto exhaust. (Analyzing)

Chapter 15 Environmental Chemistry II: Water

Introduction

Major Concepts

15.1 Properties of Water
15.2 Water as Solvent
15.3 Soft and Hard Water
15.4 Types of Hardness of Water
15.5 Methods of Removing Hardness
15.6 Disadvantages of Water Hardness
15.7 Water Pollution
15.8 Water borne diseases

Conceptual Linkages

This unit is built on

- Water as a universal solvent (Grade VI)

This unit leads to

- Water Quality (Grade XII)
- Waste Water Treatment (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Describe the occurrence of water and its importance in the environment including industry. (Analyzing)
- Review our dependence on water and the importance of maintaining its quality. (Analyzing)
- Describe the composition and properties of water. (Understanding)
- Differentiate among soft, temporary and permanent hard water. (Analyzing)
- Describe methods for eliminating temporary and permanent hardness of water. (Applying)
- Identify water pollutants. (Analyzing)
- Describe industrial wastes and household wastes as water pollutants. (Understanding)
- Describe the effects of these pollutants on life. (Understanding)
- Describe the various types of water borne diseases. (Understanding)

SKILLS:

Students will be able to:

- Test water quality by checking its color, odor, hardness and conductivity. (Applying)
- Determine boiling point of water. (Applying)
- Perform distillation of impure water samples. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Explain how hard water hampers the cleansing action of soap. (Understanding)
- Explain how and why water treatment is essential for water to be drinkable. (Applying)
- Compare modern water treatment and sewage treatment centers and processes. (Applying)
- Explain how chemistry helps maintain a clean swimming pool. (Applying)

Chapter 16 Chemical Industries

Introduction
Major Concepts
16.1 Basic Metallurgical Operations
16.2 Solvay Process
16.3 Urea
16.4 Petroleum Industry

Conceptual Linkages
This unit is built on

- Some Useful Products (Grade VIII)

This unit leads to

- Industrial Chemistry (Grade XII)

LEARNING OUTCOMES

UNDERSTANDING:

Students will be able to:

- Describe some metallurgical operations. (Applying)
- Make a list of raw materials for Solvay process. (Applying)
- Outline the basic reactions of Solvay process. (Analyzing)
- Develop a flow sheet diagram of Solvay process. (Creating)
- Describe the composition of urea. (Understanding)
- Develop a flow sheet diagram for the manufacture of urea. (Creating)
- List the uses of urea. (Remembering)
- Define petroleum (Remembering)
- Describe the formation of petroleum and natural gas. (Understanding)
- Describe the composition of petroleum. (Remembering)
- Describe briefly the fractional distillation of petroleum. (Applying)

SOCIETY, TECHNOLOGY AND SCIENCE:

Students will be able to:

- Relate the study of chemistry to careers in industry. (Understanding)
- Describe the link between chemistry, business and communication skills in order to promote chemical sales. (Applying)
- Describe how different types of fire (wood, oil, electric) require different chemistry to put them out. (Applying)
- Explain how technology impacts the production of common chemicals. (Applying)
- Debate the use of synthetic fertilizers versus organic / natural fertilizers. (Analysis)

LIST OF PRACTICALS

PRACTICALS	EQUIPMENT	CHEMICALS
Chapter 1: Fundamentals of Chemistry		
1. Separate the given mixture by physical method.	glass plate, spatula, ,magnet, test tube, beaker, gas burner, matches, safety goggles	iron filings, sand or any other soluble mix
Chapter 2: Structure of Atoms		
None	None	None
Chapter 3: Periodic table and periodicity of properties	None	None
Chapter 4: Structure of molecules		
None	None	None
Chapter 5: Physical States of Matter		
1. Determine the Melting Point of Naphthalene.	beaker, thermometer, Bunsen burner, tripod stand, wire gauze, glass stirrer, capillary tube and iron stand	water and naphthalene
2. Determine the Melting Point of Biphenyl.	beaker, thermometer, Bunsen burner, tripod stand, wire gauze, glass stirrer, capillary tube and iron stand	water and biphenyl
3. Determine the Boiling Point of Acetone.	beaker, thermometer, Bunsen burner, tripod stand, wire gauze, glass stirrer, fusion tube, iron stand and capillary tube	water and acetone
4. Determine the Boiling Point of Benzene.		water and benzene

5. Determine the Boiling Point of Ethyl Alcohol.	beaker, thermometer, Bunsen burner, tripod stand, wire gauze, glass stirrer, fusion tube, iron stand and capillary tube	water and ethyl alcohol
6. Separate naphthalene from the given mixture of sand and naphthalene by sublimation.	beaker, thermometer, Bunsen burner, tripod stand, wire gauze, glass stirrer, fusion tube, iron stand and capillary tube	mixture of sand naphthalene
7. Separate the given mixture of alcohol and water by distillation.	china dish or watch glass, tripod stand, funnel, burner, sand bath and cotton	mixture of water and alcohol
8. Demonstrate that a chemical reaction releases energy in the form of heat.	round bottom distillation flask, thermometer, corks, water condenser, receiving flask, burner, iron stand, tripod stand, wire gauze, filter paper and funnel	Anhydrous copper sulphate, distilled water
9. Demonstrate sublimation using solid Ammonium Chloride	test tubes, test tube racks, thermometer, safety goggles test tubes, test tube holder, gas burner, matches, safety goggles	Ammonium chloride

Chapter 6:
Solutions

1. Prepare 100 cm^3 of 0.1M NaOH solution.	beaker, stirrer, volumetric flask and physical balance	distilled water and solid sodium hydroxide
2. Prepare 100 cm^3 of 0.1M Na_2CO_3 solution.	beaker, stirrer, volumetric flask and physical balance	distilled water and solid sodium carbonate
3. Prepare 250 cm^3 of 0.1M HCl solution.	beaker, stirrer, volumetric flask and physical balance	distilled water and concentrated hydrochloric acid
4. Prepare 250 cm^3 of 0.1M of oxalic acid solution.	beaker, stirrer, volumetric flask and physical balance	distilled water and oxalic acid
5. Prepare 100 cm^3 of 0.1M NaOH solution from the given 1M solution.	beaker, stirrer, volumetric flask and measuring cylinder	distilled water and 1M NaOH solution

6. Prepare 100 cm^3 of 0.01M Na_2CO_3 solution from the given 0.1M solution.	beaker, stirrer, volumetric flask and graduated cylinder	distilled water and 0.1M Na_2CO_3 solution
7. Prepare 100 cm^3 of 0.01M HCl solution from the given 0.1M solution.	beaker, stirrer, volumetric flask and measuring cylinder	distilled water and 1M HCl solution
8. Prepare 100 cm^3 of 0.01M oxalic acid solution from the given 0.1M solution.	beaker, stirrer, volumetric flask and measuring cylinder	distilled water and 0.1M oxalic acid solution
9. Prepare pure copper sulphate crystals from the given impure sample.	beakers, funnel, filter paper, stirrer, china dish, burner	impure copper sulphate and distilled water
10. Demonstrate that miscible liquids dissolve in each other and immiscible liquids do not.	8 small beakers, organic waste bottle, safety goggles	water, oil, ethanol,
11. Demonstrate that temperature affects solubility.	test tubes, burner, matches, test tube holder, test tube rack, stirring rod, safety goggles	sucrose, water

PRACTICALS	EQUIPMENT	CHEMICALS
Chapter 7: Electrochemistry		
1. Demonstrate the conductivity of different given solutions.	Dry battery cell with holder with two electrodes, beakers, stirrer test tube holder	distilled water, sugar, NaCl, vinegar, HCl, NaOH
2. Demonstrate a metal displacement reaction in aqueous medium.	copper wire, bulb with bulb holder test tube,	copper sulphate and iron strip or nail
Chapter 8: Chemical Reactivity		
1. Demonstrate that two elements combine to form a binary compound.	test tube, test tube holder, burner	Iron and sulfur
2. Demonstrate that compounds can be products of a decomposition reaction.	test tubes, one holed stopper with glass tube and rubber tubing attached, mortar and pestle, gas burner, matches, test tube holders, safety goggles	calcium carbonate, lime water (solution of calcium hydroxide)
3. Demonstrate that an element and a compound can react to form a different element and a different compound.	beakers, safety goggles	copper chloride, small piece of aluminium foil or copper sulphate and iron strip
4. Demonstrate that some chemical reactions absorb energy.	test tube, stirring rod	water, ammonium chloride, cold packs (ammonium nitrate and water)
Chapter 9: Chemical Equilibrium		
None	None	None
Chapter 10: Acids, Bases and Salts		
1. Identify sodium, calcium, strontium, barium, copper, potassium radicals by flame test.	platinum wire, watch glass, burner, matches	salt of each of sodium, calcium, strontium, barium, copper, potassium, concentrated HCl

2. Standardize the given NaOH solution volumetrically.	pipette, burette, funnel, conical flask, beaker	standard solution of HCl, solution of NaOH, phenolphthalein
3. Standardize the given HCl solution volumetrically.	pipette, burette, funnel, conical flask, beaker	standard solution of NaOH, solution of HCl, phenolphthalein
4. Determine the exact molarity of the Na_2CO_3 solution volumetrically.	pipette, burette, funnel, conical flask, beaker	standard solution of HCl, solution of Na_2CO_3, methyl orange
5. Determine the exact molarity of a solution of oxalic acid volumetrically.	pipette, burette, funnel, conical flask, beaker	standard solution of NaOH, solution of oxalic acid, phenolphthalein
6. Demonstrate that some natural substances are weak acids.	dropper, knife, test tubes, 2 test tube racks, beaker, gas burner, wire gauze, matches, dropper, safety goggles	citrus fruits, pH paper
7. Classify substances as acidic, basic or neutral	six 100-cm^3 beakers, red and blue litmus papers, safety goggles	red and blue litmus paper, 0.1% bromthymol blue, 0.1m solutions of various acids(hydrochloric, nitric, sulphuric, and acetic acids), bases (sodium carbonate, hydroxides of sodium, potassium, calcium and magnesium) and neutral substances (methanol, ethanol, sodium chloride and water)

Chapter 11:
Organic Chemistry

1. Identify aldehydes using Fehling's test and Tollen's test.	test tubes, test tube holder, test tube rack, burner, water bath, matches, dropper, safety goggles	Fehling's solution, Tollen's reagent, glucose solution, distilled water
2. Identify ketones using 2, 4-dinitrophenyl hydrazine test.	test tubes, test tube holder, test tube rack, burner, matches, dropper, safety goggles	fructose solution, 2,4-dinitrophenyl hydrazine solution, distilled water

3. Identify carboxylic acids using sodium carbonate test.	test tubes, test tube holder, test tube rack, burner, matches, dropper, safety goggles	acetic acid solution, solid sodium carbonate, distilled water
4. Identify phenol using Ferric Chloride test.	test tubes, test tube holder, test tube rack, burner, matches, dropper, safety goggles	phenol solution, freshly prepared ferric chloride solution, distilled water
Chapter 12: Hydrocarbons		
1. Identify saturated and unsaturated organic compounds by $KMnO_4$ test.	test tubes, test tube holder, test tube rack, dropper	cinnamic acid solution, $KMnO_4$ solution, distilled water
Chapter 13: Biochemistry		
1. Demonstrate that sugar decomposes into elements or other compounds.	China dish, burner, tripod stand, wire gauze, matches, spatula, safety goggles	sugar
Chapter 14: Atmosphere		
None	None	None
Chapter 15: Water		
1. Demonstrate the softening of water by removal of calcium ions from hard water.	2 test tubes and stoppers, beaker	distilled water, small bar of soap, sodium sulphate solution, calcium sulphate solution and sodium bicarbonate solution
Chapter 16: Chemical Industries		
None	None	None

LIST OF CHEMICALS

(Based on 20 students)

CHEMICALS	QUANTITY
Acetic acid	02 litre
Aluminium Foil	250 g
Ammonium Chloride	01 kg
Ammonium Nitrate	01 kg
Barium Chloride or any salt of Barium	01 kg
Bromothymol Blue	20 g
Calcium Carbonate	01 kg
Calcium Chloride or any salt of Ca	500 g
Calcium Hydroxides	500 g
Cinnamic Acid	100 g
Concentrated Hydrochloric Acid	01 litre
Copper Chloride or any salt of Cu	100 g
2,4-Dinitrophenyl Hydrazine	05 g
Distilled Water	50 litre
Ethanol	01 litre
Fehling's Solution	500 cm^3
Ferric Chloride	250 g
Fructose	250 g
Glucose	250 g
Iodine	100 g
Lime water	02 litre
Litmus solution	01 litre
Magnesium Hydroxides	500 g
Methanol	01 litre
Methyl Orange	10 g
Nitric acid	01 litre
Oil	01 kg
Oxalic Acid	250 g
Phenol Solution	01 litre
Phenolphthalein	10 g
Potassium Chloride or any salt of K	50 g
Potassium Hydroxides	500 g
Potassium Permanganate	500 g
Powdered Zinc	250 g
Silver Nitrate	25 g
Soap	05 bars

Sodium Bicarbonate	250 g
Sodium Carbonate	500 g
Sodium Chloride	2 kg
Sodium Hydroxide	500 g
Sodium Metal	100 g
Sodium Sulphate	500 g
Sulphuric Acid	1 litre
Strontium Chloride or any salt of Strontium	100 g
Sugar	500 g
Tollen's Reagent	500 cm^3
Vinegar	1 litre

LIST OF Equipment/Apparatus

(Based on 20 students)

Battery cells with two Electrodes	20
Beakers 50 cm^3	50
Beakers 100 cm^3	100
Beakers 250 cm^3	100
Beakers 500 cm^3	100
Blue Litmus Paper	01 packet
Bunsen Burners	20
Burettes	50
Capillary Tubes	Pack of 100
China Dishes	50
Conical Flasks (250 cm^3)	50
Corks	24 each of four different sizes
Cotton	01 roll
Delivery Tubes	30
Droppers	30
Filter Papers	01 packet
Forceps	20
Funnels	20
Fusion tubes	100
Glass Plates	20
Glass Stirrers	20
Graduated Cylinders 50 cm^3	20
Graduated Cylinders 100 cm^3	20
Graduated Flasks 100 cm^3	20
Graduated flasks 250 cm^3	20
Graduated flasks 1000 cm^3	10
Iron Stands (complete with heavy base)	20
Knives	10
Magnets	20
Match Boxes	20
Organic Waste Cans	20
Physical Balances	20
pH paper (1to 14)	10 packets

Pipettes (10 cm^3)	20
Platinum Wires	20
Red Litmus Paper	01 packet
Round Bottom Distillation Flasks	20
Rubber Tubing	25 m
Sand Baths	20
Spatulas (stainless steel)	20
Test Tube Holders	20
Test Tube Racks	20
Test Tubes	200
Thermometers (110ºC)	20
Tripod Stands	20
Watch Glasses	20
Water Condensers	20
Wire Gauzes	20

CHAPTER WISE TIME ALLOCATION

IX-X

Chapter	Teaching (periods)	Assessment (periods)	Weightage %
Chapter 1: Fundamentals of Chemistry	12	3	5
Chapter 2: Structure of Atoms	16	3	5
Chapter 3: Periodic Table and Periodicity of Properties	12	2	5
Chapter 4: Structure of Molecules	16	4	8
Chapter 5: Physical states of matter	10	3	5
Chapter 6: Solutions	16	2	7
Chapter 7: Electrochemistry	18	3	9
Chapter 8: Chemical Reactivity	7	2	4
Chapter 9: Chemical Equilibrium	8	3	5
Chapter 10: Acid, Bases, and Salts	16	3	7
Chapter 11: Organic Chemistry	10	3	5
Chapter 12: Hydrocarbons	8	2	5
Chapter 13: Biochemistry	15	3	6
Chapter 14: Environmental Chemistry-I The Atmosphere	10	2	7
Chapter 15: Environmental Chemistry-II Water	10	2	8
Chapter 16: Chemical Industries	13	3	9
Grand Total:	197	43	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 mastery of the subject matter which he/she teaches.
2. Scholarly attitude towards teaching/learning in the class and on the campus of the school i.e. thoughtfully reflective personality.
3. Highly polished communication skills in writing, speaking, and listening.
4. Respectful of the methods of science and mindful of the nature of scientific knowledge
5. Practicing believer in the core values of science such as:
   Longing to know, questioning everything, collecting data and looking for meaning in them, demand for verification, respect for logic, consideration of the premise and paradigm, consideration of the consequences.
6. Letting students express their understanding i.e. their version of what was taught in the class and why.
7. Giving more time to what students think and less time to what teachers think
8. Realizing that students construct their own knowledge and that this construction is greatly influenced by what the student already knows i.e. his/her prior knowledge. This implies that no student comes to the class room with empty head and that no information can be transferred intact from the head of the teacher to the head of the student.
9. There are various theories and models available which deal with understanding the process of learning. Teacher must base his practice of teaching on some theory and be able to explain or try to explain what works in the class room and why.
10. Teacher should realize that teaching is not just drilling information into the head of students nor is it just muddling through to teach as he was taught. It is a form of scholarship in which teachers are involved in action research. They look for new examples and non-examples. They sequence information in different ways and look for the best sequence. They diagnose the learning difficulties of students by looking into their prior knowledge where they search for misconceptions and knowledge gaps. They focus on the learning styles of individual students and recognize slow and fast learners.
11. Students watch their teachers and notice so many things about them and they talk about what they like or do not like. Teaching is close to show business and we can borrow much from the people in the show business.

TEACHING-LEARNING PROGRAM:

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

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

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

Teachers' Training and Refresher Courses:

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

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

1. Pre-service teacher training institutions are strengthened and their curricula be revised to met 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.

Draw back

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
   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 MCQ's.
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 IX and X

Chapter	Weightage %
Chapter 1: Fundamental of Chemistry	5
Chapter 2: Structure Atomic	5
Chapter 3: Periodic Table and Periodicity of Properties	5
Chapter 4: Structure of Molecules	8
Chapter 5: Physical states of matter	5
Chapter 6: Solutions	7
Chapter 7: Electrochemistry	9
Chapter 8: Chemical Reactivity	4
Chapter 9: Chemical Equilibrium	5
Chapter 10: Acid, Bases, and Salts	7
Chapter 11: Organic Chemistry	5
Chapter 12: Hydrocarbons	5
Chapter 13: Biochemistry	6
Chapter 14: Environmental Chemistry 1- The Atmosphere	7
Chapter 15: Environmental Chemistry 2 – Water	8
Chapter 16: Chemical Industries	9
Grand 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 graph 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 increasing1 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. Similarly, a student can get comprehensive learning of a life phenomenon through animations. 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 schemes 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 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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