Chemistry

Grade: XI

Teaching Hours : 150T + 50P **Full Marks : 100(75 t + 24P)**

Pass Marks : 27T + 10P

I. Introduction

Chemistry is concerned with the physical and chemical characteristics of substances, the nature of matter and the study of chemical reactions. Chemistry, thus, is a powerful process of uncovering and extending our understanding of various chemical phenomena. The power resides in the combination of concepts and experiments involving careful observation and quantitative measurements under controlled conditions. The resulting concepts suggest further experiments and investigations as a result; there will be a modification of the existing concept leading to a creativity of thought. This creativity involves the recognition of a problem; formulation of ideas to solve the problem and ultimately refinement of the original ideas. The present curriculum aims to foster this uniqueness among students by enabling them to study both theoretical and practical aspects of chemistry.

This course is theory-cum-practical. It is intended to consolidate learning in chemistry achieved in the secondary school. Furthermore, it intends to provide a concrete knowledge and appropriate skills for those students, continuing further studies in chemistry and the students not studying the subject beyond this stage. The course seeks to maintain a balance between useful facts, concepts and theories which will facilitate understanding of the properties of substances, reactions and processes. Emphasis is enforced to stimulate, create and sustain students' interest in chemistry.

Chemistry being and experimental science, laboratory is an essential component of its syllabus. The course intends to make students aware of the importance of scientific method for accurate experimental work and develop the abilities to interpret, organize and evaluate data in order to make decisions and solve problems.

II. General Objectives

The general objectives of this course are to:

1. Apply appropriate chemical principles, concepts, theories, definitions, laws, models and patterns to interpret, draw conclusion, make generalization, and predictions from chemical facts, observations and experimental data;
2. Select appropriate facts to illustrate a given principle, concept, theory, model and pattern;
3. Present chemical ideas in a clear and logical form; and
4. Select and organize data and perform calculations in which guidance in the method is not supplied.

III. Specific Objectives

After studying the course, the student shall be able to:

1. State and apply fundamental facts and principles of chemistry dealing with the
   a. Methods of preparation: general, laboratory and industrial process of the matters,
   b. Physical and chemical properties,
   c. Important applications.
2. Perform chemical calculations;
3. Identify the mineral resources of Nepal;
4. Understand chemical patterns and principles;
5. Apply knowledge and understanding of chemistry in familiar and unfamiliar;
6. Make accurate observations and measurements, being aware of possible sources of error;
7. Record the results of experiments accurately and clearly; draw conclusion and make generalization from experiment; and
8. Appreciate the scientific, social, economic, environmental and technological contributions and applications of chemistry.

General & Physical Chemistry (Section A)

Unit 1: Language of Chemistry (Review Lecturers) - 3 teaching hours

1. Chemical equations, their significance and limitations
2. Balancing chemical equations by:
   a. Hit and trial method b. Partial equation method
3. Types of chemical reaction

Unit 2: Chemical Arithmetic -17 teaching hours

2.1 Dalton's atomic theory and Laws of Stoichiometry:

1. Postulates of Dalton's atomic theory
2. Law of conservation of mass
3. Law of constant proportions
4. Law of multiple proportions
5. Law of reciprocal proportions
6. Law of gaseous volumes
7. Chemical calculations based on stoichiometry

2.2 Atomic Mass and Molecular Mass:

Definition of atomic mass and molecular man

1. Mole Concept
2. Mole in terms of mass, volume number and ions
3. Calculation based on mole concept

2.3 Empirical, Molecular Formula and Limiting Reactants:

1. Percentage compositions
2. Derivation of empirical and molecular formula from percentage composition
3. Chemical calculation based on following chemical equation
   - Limiting reactants
   - Mass-mass relationship
   - Volume-volume relationship

   (Solving reacted numerical problems)

2.4 Avogadro's Hypothesis and Its Applications:

1. Development of Avogadro's hypothesis
2. Definition of Avogadro's hypothesis
3. Application of Avogadro's hypothesis
   a. Deduction of atomicity of elementary gas
   b. Deduction of relationship between molecular mass and vapor density
   c. Deduction of molar volume of gases
   d. Deduction of molecular formula from its volumetric composition

   (Solving related numerical problems)

2.5 Equivalent Masse:

1. Concept of equivalent mass
2. Equivalent weight of elements, and compounds (Salt, acid, base, oxidizing agents, reducing agents)
3. Gram equivalent weight (GEW)
4. Relation between equivalent weight, valency and atomic weight
5. Determination of equivalent weight of metal by
   a. Hydrogen displacement method
   b. Oxide formation method

   (Solving related numerical problems)

Unit 3: State of Matter -14 teaching hours

3.1 Gaseous State

1. Boyle's law
2. Charle's law and Kelvin scale of temperature
3. Application of Charle's law and Boyle's law
4. Combined gas law, ideal gas equation and universal gas constant
5. Dalton's law of partial pressure
6. Mathematical derivation of Dalton's law and their applications
7. Graham's law of diffusion and its applications
8. Kinetic model of gas and its postulates
9. Ideal and real gases
10. Deviation of gas from ideal behavior

(Solving related numerical problems)

3.2 Liquid State:

1. Physical properties of liquid:

a. Evaporation and condensation
b. Vapor pressure of liquid and boiling
c. Surface tension
d. Viscosity

2. Solution and solubility:
   a. Equilibrium in saturated solution
   b. Solubility and solubility curve and its applications.

   (Solving related numerical problems)

3.3 Solid State:

1. Crystalline and amorphous solids
2. Water of crystallization
3. Efflorescence
4. Deliquesces
5. Hygroscopic
6. Seven types of crystal system
7. Simple cubic, face centered and body centered

Unit 4: Atomic Structure -10 teaching hours

1. Discovery of fundamental particles of atom (electron, proton and neutron)
2. Concept of atomic number, mass number, fractional atomic mass, isotopes, isobars
3. Rutherford's α ray scattering experiment and nuclear model of atom; limitation
4. Bohr's model of atom and explanation of hydrogen spectra
5. Limitation of Bohr's model of atom
6. Elementary idea of quantum mechanical model
   a. Dual nature of electron (de-Broglie equation)
   b. Heisenberg's uncertainty principle
   c. Probability concept
7. Shape of atomic orbital (s and p orbitals only)
8. Quantum numbers
9. Pauli's exclusion principle
10. Hund's rule of maximum multiplicity
11. Aufbau principle and Bohr Bury rule
12. Electronic configuration of the atoms and ions(Z=1 to 30)

Unit 5: Nuclear Chemistry -3 teaching hours

1. Concept radioactivity
2. Radioactive rays (alpha ray, beta ray and gamma ray)
3. Meaning of natural and artificial radioactivity)
4. Nuclear reactions, Nuclear energy (fission and fusion)
5. Nuclear isotopes and uses

Unit 6: Electronic Theory of Valency and Bonding -8 teaching hours

1. Basic assumption of electronic theory of valency
2. Octet rule
3. Ionic bonds, ionic compounds and characteristics of ionic compounds. Lewis symbol to represent the formation of ionic compounds
4. Covalent bonds, covalent compounds and characteristics of covalent compounds –Lewis structure of some typical covalent compounds
5. Co-ordinate covalent bonds. Lewis structures of some typical co-ordinate co-valent compounds
6. Exception of the octet rule
7. Partial ionic characters of covalent compounds. Non-polar and polar covalent molecules
8. Dipole moments and its application
9. Some special types of bonds: hydrogen bond and its types, metallic bond, vander Waal's bond. Resonance and resonance hybrid structures of O_3, SO_3, SO_2, CO_3^{-2}, SO_4^{-2}, PO_4^{-2}, NO_3^-
10. Classification of crystalline solids
    a. Ionic solid
    b. Covalent solid
    c. Molecular solid
    d. Metallic solid

Unit 7: Periodic Classification of Elements -6 teaching hours

1. Introduction
2. Mendeleev's periodic law and periodic table
3. Anamolies Mendeleev's periodic table
4. Modern periodic law, and periodic table
5. Advantages of modern Periodic table
6. Division of elements into s, p, d and f blocks
7. Periodicity of physical properties: valency, atomic radii, ionic radii ionization energy, electron affinity and electronegativity (general trends only)

Unit 8: Oxidation and Reduction -6 teaching hours

1. Classical concept of oxidation and reduction
2. Electronic interpretation of oxidation and reduction
3. Oxidation number and rules for the assignment of oxidation number
4. Differentiate between oxidation number and valency
5. Oxidizing and reducing agent
6. Redox reaction
7. Balancing redox reactions by
8. Oxidation number method
9. Ion-electron method

Unit 9: Equilibrium

1. Introduction
2. Equilibrium
3. Chemical equilibrium
   a. Reversible and irreversible reactions
   b. Dynamic nature of chemical equilibrium and its characteristics
   c. Law of mass action
   d. Equilibrium constant (Kc) and its characteristics
   e. Homogenous and heterogeneous
   f. Relation between Kp and Kc (derivation)
   g. Le-chatelier's principle and its application

   (No numerical is required)

Inorganic Chemistry

Section B

Unit 10: Non-Metals I

10.1 Hydrogen:

1. Position in periodic table
2. Atomic hydrogen, Nascent hydrogen
3. Isotopes of hydrogen
4. Ortho and Para hydrogen
5. Applications

10.2 Oxygen:

1. Position in periodic table
2. Types of oxides
3. Uses of oxygen

10.3 Ozone:

1. Occurrence
2. Preparation from oxygen
3. Structure of ozone
4. Important properties of ozone
5. Ozone layer and ozone hole
6. Uses of ozone

10.4 Water

1. Structure
2. Solvent property of water

3. Heavy water and uses
4. Uses

10.5 Nitrogen and Its Compounds

1. Position of nitrogen in Periodic table
2. Uses of nitrogen
3. Types of nitrogen oxides (nake and Lewis structure)
4. Ammonia
   - Manufacture by Haber's synthesis method
   - Physical properties, chemical properties and uses
5. Oxyacid of nitrogen (type)
6. Technical production and nitric acid by Ostwald method
   - Properties of nitric acid and uses
   - Test of nitrate ion

Unit 11: Non-Metals II

11.1 Halogens: (Chlorine, Bromine and Iodine)

1. Position in periodic table
2. Comparative study on: preparation, properties and uses
3. Manufacture of bromine from carnallite process and manufacture of iodine form
   a. Sea weeds (principle only) b. caliche (Principle only)
4. Uses of halogens
5. Comparative study on; preparation, properties and uses of haloacids (HCI, HBr and HI)

11.2 Carbon:

1. Position in periodic table
2. Allotropes of carbon including fullerenes
3. Laboratory preparation, properties and uses of carbon monoxides

11.3 Phosphorous:

1. Occurrence, position in periodic table
2. Allotropes of phosphorous and uses of phosphorous
3. Preparation, properties and uses of phosphine
4. Oxides and oxyacids of phosphorous (structure and uses)
5. Preparation, properties and uses of orthophospheric acid

11.4 Sulphur:

Position in periodic table and allotropes

1. Hydrogen Sulphide: (Laboratory methods and Kipp's apparatus), properties and uses of
2. Sulphurdioxide: Laboratory preparation, preparation and uses
3. Sulphuric acid: Manufacture by contact process, properties and uses
4. Sodiumthiosulphate (hypo): formula and uses

11.5 Boron and Silicon

1. Occurrences, position in periodic table
2. Properties and uses
3. Formula and uses of burax, boric acid, Silicate and Silica

11.6 Noble gas: Position in periodic table, occurrence and uses

11.7 Environmental Pollution:

- Air pollution, photochemical song
- Acid rain, water pollution
- Greenhouse effect

Unit 12: Metal and Metallurgical Principles

1. Characteristics of metals, non-metals and metalloids
2. Minerals and ores
3. Important minerals deposit in Nepal
4. Different process involved in metallurgical process
5. Concentration
6. Calcination and roasting
7. Smelting
8. Carbon reduction process

9. Thermite process
10. Electrochemical reduction
11. Refining of metals: poling, electro-refinement etc

Unit 13: Alkali and Alkaline Earth Metals

1. Periodic discussion and general characteristics.
2. Sodium: Occurrence, Extraction from Downs process; properties and uses.
3. Sodium hydroxide: Manufacture, properties and uses.
4. Sodium carbonate: Manufacture, properties and uses.

13.1 Alkaline Earth Metals:

1. Periodic discussion and general characteristics
2. Preparation, properties and uses of:
    a. Quick lime
    b. Plaster of Paris
    c. Bleaching Powder
    d. Magnesia
    e. Epsom salt.

Organic Chemistry

Section C

Unit 14: Introduction to Organic Chemistry

14.1 Fundamental Principles:

1. Definition of organic chemistry and organic compounds
2. Origin of organic compounds (vital force theory)
3. Reasons for the separate study of organic compounds
4. Tetra covalency and catenation property of carbon
5. Classification of organic compounds
6. Functional groups and homologous series
7. Meaning of empirical formula, molecular formula, structural formula and contracted formula
8. Qualitative analysis of organic compounds. (detection of N, S and halogens by Lassaegne's test)

14.2 Nomenclature of Organic Compounds:

1. Common names
2. IUPAC system and IUPAC rules of naming hydrocarbons, alcohols, ethers, aldehydes, ketones carboxylic acid, amines, ester, acid derivative halogen derivatives, nitriles etc.)

14.3 Structure Isomerism in Organic Compounds:

1. Definition of structure isomerism
2. Types of structure isomerism: chain isomerism, position, isomerism, functional isomerism and mesmerism

14.4 Preliminary Idea of Reaction Mechanism

1. Concept of hemolytic and heterolytic fission
2. Electrophile, nucleophiles and free-radicals
3. Inductive effect, +I and –I effecy

Unit 15: Hydrocarbons

15.1 Sources:

Origin of coal and petroleum, hydrocarbon from petroleum cracking and reforming, aliphatic and aromatic hydrocarbon form coal, quality of gasoline, octane member and gasoline additive.

15.2 Alkanes (Saturated Hydrocarbons):

1. General Methods of preparation:
    - Decarboxylation
    - Catalytic hydrogenation
    - Reduction of halo alkane
    - Kolbe's electrolysis method
    - Using Grigrand's reagent
    - Wurtz reaction
    - From aldelydes and ketones

2. Physical properties
3. Chemical properties: Substitutions reaction, oxidation, pyrolysis or cracking aromatization

15.3 Alkenes:

1. General methods of preparation
   - Dehydration of alcohol
   - Dehydrohalohentaion
   - Catalytic hydrogenation of alkene
   - Kolbe's electrolysis
2. Laboratory preparation of alkene
3. Chemical properties of alkene: Addition reaction (H_2, X_2, HX, H_2O, O_3, H_2SO_4)
4. Oxidation with alkaline $KMnO_4$ (Baeyer's reaction)
5. Polymerization
6. Test of ethane and uses

15.4 Alkynes:

Ethyne

1. Preparation form i. carbon and hydrogen ii. Kolbes electrolysis iii. 1, 2 dibromoethane
2. Lab preparation of ethyne
3. Physical properties
4. Chemical properties: Addition (H_2, X_2, HX, H_2O, O_3), Acidic nature (action with ammonical $AgNO_3$ and ammonical Cu_2Cl_2), Oxidation with alkaline $KMnO_4$, Polymerization uses of ethyne

Practical

Full Marks : 25 **Pass Marks : 10**

Students are required to secure the pass marks in the practical paper separately. The following is the list of experiments. The students are required to perform in the practical classes in Grade XI.

A. Experiments based on laboratory techniques:

1. To separate the insoluble component in pure and dry state from the given mixture of soluble and insoluble solids. (NaCl and sand)
2. To separate volatile component form the given mixture of volatile and non-volatile (demonstration of sublimation process)
3. To separate a mixture of two soluble solids by fractional crystallization (KNO_3+NaCl)
4. To prepare a saturated solution of impure salt and obtain the pure crystal of the same salt by crystallization
5. To separate the component of a mixture of two insoluble solids (The being soluble in dil acids)
6. To obtain pure water from given sample of water (Distillation).

B. Experiment to study the different reactions (Neutralization, Precipitation, Redox reaction, electrolysis) :

1. To perform precipitation reaction of $BaCl_2$ and H_2SO_4 and obtain solid $BaSO_4$;
2. To neutralize sodium hydroxide with hydrochloric acid solution and recover the crystal of sodium chloride.
3. To test the ferrous ions in the given aqueous solution and oxidise it to ferric ion (Ferrous → Ferric system)
4. Redox Reaction
5. To study the process of electrolysis and electroplating

C. Experiments on quantitative analysis:

1. To determine the equivalent weight or weight of metal by hydrogen displacement method;
2. To determine the solubility of the given soluble solid at laboratory temperature;
3. To determine the relative surface tension of unknown liquid by drop count method; and
4. To study the rate of flow of liquid through Ostwald's viscometer and determine the relative viscosity of unknown liquid.

D. Experiments on preparation of gas and study properties:

1. To prepare and collect hydrogen gas and study the following properties;
   a. Solubility with water, color, odor;
   b. Litmus test;
   c. Burning match stick test; and
   d. Reducing properties of nascent hydrogen.
2. To prepare and collect ammonia gas and investigate the following properties:
   a. Solubility with water/ color/ odor;
   b. Litmus test;
   c. Action with copper sulphate solution; and
   d. Action with mercurous nitrate paper.

3. To prepare carbondioxide gas and investigate the following properties:
    a. Solubility, color, odor;
    b. Litmus paper test
    c. Lime water test; and
    d. Action with burning magnesium ribbon.
4. To study the properties of hydrogen sulphide (Physical, analytical and reducing) ;
5. To study the following properties of Sulphuric Acid:
    a. Solubility with water;
    b. Litmus paper test;
    c. Precipitating reaction; and
    d. Dehydrating reaction.

E. Experiments on qualitative analysis:

7. To detect the basic radical of the given salt by dry way and the acid radical by dry and wet ways.

Basic Radicals: Zn^{++}, Al^{+++}, NH_4^+, Ca^{++}, Na^+

Acid Radicals: CO_3^{--}, SO_4^{--}, NO_3^-, Br^-, I^-, Cl^-

Note: Experiments from 1 to 19 requires one practical period of each experiment and the experiment no 20 requires four practical periods. (Two theory periods will be equivalent to one practical period)

Evaluation Scheme

The chemistry theory paper (XI) will consist of three types of questions:

(a) Very short-answer questions (weightage of 2 marks of each);
(b) Short-answer questions (weightage of 5 marks of each); and
(c) Long-answer questions (weightage of 10 marks of each).

According to manner of questions groups are divided into group 'A', group 'B' and Group 'C'.

1. Group 'A' will consist of 22 very short questions, out of which, examinees are required to answer only 15 questions.
2. Group 'B' will consist of 7 short questions, out of which, examinees are required to answer 5 questions.
3. Group 'C' will consist of 4 questions, out of which, examinees are required to answer 2 questions.

The weightage of content distribution for the three of questions from different sections of the curriculum will be as follows:

	Units	Teaching Hours	V.S.Q.	S.Q.	L.Q.
	1	3	X		
	2	17	2		
	3	14	2		
	4	10	2		
	5	3	1		
	6	8	2		
	7	6	1		
	8	6	1		
	9	5	1		
	10	12	2		
	11	23	2		
	12	6	1		
	13	10	1		
	14	16	2		
	15	11	2		
	15	**150**	**22**	**7**	**4**

Reference Books:

Acharya, Suk Dev, et.al. Fundamentals of Chemistry-XI, Bhundipuran Prakashan, KTM.