

# CHEMISTRY

Teaching Hours: 75  
Full Marks: 50(35+15)  
Pass Marks: 20(14+6)

## I. Introduction

This course in chemistry is designed to provide students with sufficient understanding and knowledge of the fundamental Chemistry contents as per equivalent to Higher Secondary Level. The practical component of this course is designed to supplement learning through the application of learned theory. The nature of the course is both theoretical and practical.

## II. General Objectives

On completion of this course, the students will be able to:

- a. acquaint with principles of Chemistry and their applications to become confident citizens in a technological world.
- b. handle the laboratories instrument, equipment and chemical introduced in the curriculum.

## III. Specific Objectives

On completion of this course the students will be able to:

- state and explain the behavior of gases at different temperature and pressure
- state and explain types and properties of crystal
- state and explain modern concept of atomic structure and chemical bonds
- balance redox reaction
- give ideas of chemical equilibrium and electrochemistry
- explain occurrences, preparations, properties and uses of hydrogen, ozone, water, ammonia, nitric acid, boron, silicon, phosphorous, sulphuric acid, halogens and noble gases
- explain the details about metallurgy of sodium, copper, zinc and iron
- explain the properties and uses of compounds of sodium, copper, zinc and iron
- describe sources of hydrocarbons
- discuss the preparation and properties of alkanes, haloalkanes, haloarenes, alcohol, aldehydes and ketones, carboxylic acids and amines
- justify the importance of chemistry in the service of mankind

## IV. Course Contents

### Group A: General and Physical Chemistry 30 hrs

#### Unit 1: States of matter 5 hrs

##### Gaseous state

- Applications Graham's Law of diffusion
- Dalton's law of partial pressure and its mathematical derivation.
- Kinetic molecular model of gases, its postulates and the explanation of Boyle's law and Charles' law from it (no derivation)
- Deviation from ideal behavior and causes of deviation.
- Ideal gases and real gases

##### Solid state

Classification of Crystalline solids on the basis of the nature of bonding

- [a] Ionic crystals
- [b] Covalent Crystals
- [c] Molecular Crystals
- [d] Metallic Crystals

#### Unit 2: Atomic Structure & Chemical Bonding 8 hrs

##### Atomic Structure

- Bohr model of atom and explanation of Hydrogen spectra
- Quantum mechanical model of atom (elementary ideas)
- de-Broglie equation
- Heisenberg's uncertainty principle
- Shapes of s & p orbitals
- Quantum numbers
- Pauli Exclusion principle
- Hund's rule of maximum multiplicity
- Isobars, Isotones, Isolectronic species

##### Chemical Bonding

- VSEPR theory & Shapes of molecules
- Hybridization ( $sp, sp^2, sp^3$ )
- Sigma & pi-bonds
- Some special types of bonds e.g. metallic bond, hydrogen bonds, Van der Waal's bonds
- Concepts of resonance as delocalized bonding (examples of ozone and benzene)
- Dipole moment

#### Unit 3: Atomic weight, molecular weight, oxidation reduction and volumetric analysis 8 hrs

- Oxidation & Reduction, balancing redox reaction by oxidation no method & ion-electron method.
- Redox titration, titration curves & selection of acid and base indicators.
- Determination of atomic weight by Dulong & Petit's law.
- Determination of mol wt. by Victor Mayer's method.

## **Unit 4: Ionic equilibrium and electrochemistry** **9 hrs**

### Ionic Equilibrium

- Ostwald dilution law, strength of acids & bases in term of  $K_a$ ,  $K_b$ , solubility product, relation between solubility and solubility product, common ion effect.

### Electrochemistry

- Electrolyte conduction, equivalent and molar conductivities
- Variation of molar conductivity with concentration
- Electrode potential and the use of electrode potential to predict a chemical reaction and EMF of a galvanic cell (electro chemical cell)
- Standard electrode potential
- Electrolysis & criteria for product formation.

## **Group B: Inorganic Chemistry** **20 hrs**

### **Unit 1: Non Metal** **14 hrs**

#### Hydrogen

- Position of hydrogen in periodic table. Different forms of hydrogen (Atomic, nascent, ortho and para hydrogen and isotopes of hydrogen) application of hydrogen.

#### Ozone

- Occurrence, preparation, structure and uses. Ozone layer and hole in ozone layer.

#### Water

- Structure of water and solvent property.
- Heavy water.

#### Ammonia

- Haber's process of manufacturing ammonia and uses.

#### Nitric acid

- Manufacture (principle with diagrammatic sketch)
- Properties and uses.

#### Boron

- Borax and boric acid (structure and uses only)

#### Silicon

- Silica (different forms, structure and uses only) and Silicates (introduction only), Silica glass (types of glasses only)

#### Phosphorous

- Orthophosphoric acid, Lewis structure and uses. Phosphate fertilizer.
- Sulphuric Acid
- Manufacture of sulphuric acid (flow sheet diagram and principle of contact process) properties and uses.
- Sodium thiosulphate (Hypo)

#### Halogens

- Manufacture of bromine from carnallite, and iodine from caliche.
- Preparation of HCl, HBr & HI their properties and uses.

#### Noble gases

- Occurrence, properties and uses of noble gases.

## **Unit 2 : Metals**

**6 hrs.**

### Metallurgy

- General principles of extraction of metals from their ores.

### Alkali and alkaline earth metals

- Sodium (Extraction by Down's process), properties & uses, sodium hydroxide: Technical production by Kellner-Solvay's process, properties and uses, sodium carbonate: Technical productions by Solvay ammonia soda process (principle and diagrammatic sketch only), properties and uses.
- Preparation, properties and uses of quick lime.

### Heavy Metals

- Copper : Extraction (principle only), properties and uses, compounds of copper (CuO, Cu<sub>2</sub>O, CuSO<sub>4</sub>·5H<sub>2</sub>O)
- Zinc : Extraction (principle only), properties and uses, compounds of zinc (white vitriol and zinc white)

### Galvanization.

- Iron: Extraction (principle only), Manufacture of steel (Bessemer & open hearth processes), Heat treatment of steel, stainless steel compounds of iron (green vitriol, ferric chloride and Mohr's salt).

## **Group C: Organic Chemistry**

**20 hrs**

### **Unit 1: Hydrocarbons**

**3 hrs**

- Sources of hydrocarbons: Coal oil as sources of hydrocarbons, hydrocarbons from petroleum, cracking and reforming, quality of gasoline, octane number, gasoline additives.
- Alkanes : Preparations of ethane from dehydrohalogenation of haloalkane, dehalogenation of dihaloalkane, Kolbe's electrolysis

### **Unit 2: Haloalkane and haloarenes**

**2 hrs**

- Haloarenes: Preparation of mono-halobenzene from benzene and benzene diazonium chloride, reactivity of haloarene, preparation, structure and uses of DDT, BHC.  
Grignard reagent.

### **Unit 3: Alcohol, aldehydes and Ketones**

**2 hrs**

- Preparation of alcohol from haloalkane, aldehydes and ketones (using Grignard reagent) industrial preparation from Oxo-process.
- Preparation of aldehydes from carboxylic acid and acid chloride, Properties of aldehydes and ketones : Aldol condensation, DNP-test, Distinction between Aldehydes and ketones by Tollen's reagent and Fehling's solutions.

### **Unit 4: Carboxylic acids and derivatives**

**2 hrs**

- Preparation from Grignard reagent and alkyl nitriles
- Lab preparation of formic acid from oxalic acid.
- Preparation and chemical properties of , acid anhydride, ester, amide, acid halide

**Unit 5: Amines****5 hrs**

- Classification of amines, Preparation from alkyl halides, nitro alkanes, nitriles, amides, Physical properties, Chemical properties: basic character, reaction with nitrous acid, Separation of primary, secondary and tertiary amines by Hoffmann's method.

**Unit 6: Chemistry in the service of mankind****6 hrs**

- Polymers: Definition: natural and synthetic polymer, preparation of synthetic polymer, PVC, polythene, nylon-66, dacron, teflon, terylene and their uses, Bakelite, Dyes: Definition, natural and synthetic dyes, azodye. Fertilizers: Definition, types of fertilizers, fertilizers as pollutant. Dyes: Definition, natural and synthetic dyes, azodye. Fertilizers: Definition, types of fertilizers, fertilizers as pollutant.

**V. Evaluation Scheme (Theory)**

Topics	Group	Teaching Load in Hrs.	Questions	Marks	Remarks
General & Physical	A	30	4	3X5=15	Selecting 3 questions out of 4
Inorganic	B	20	3	2X5=10	Selecting 2 questions out of 3
Organic	C	20	3	2X5=10	Selecting 2 questions out of 3

Theory: 35

Practical: 15

(including Viva-voce 3 marks)

**VI. Instructional materials**

- Charts of periodic tables
- Model of atomic structures
- Flow sheet chart of atomic structure, hydrogen spectrum, gas preparation
- Manufacture of acids, metallurgy of Na, Fe, Zn
- OHP
- Multi-media
- Graphs of periodic properties of elements

**VII. Chemistry Practical**

1. To prepare pure copper Sulphate ( $\text{CuSO}_4$ ) from the mixture of  $\text{CuSO}_4$  and  $\text{NaCl}$ .
2. To prepare pure  $\text{CaSO}_4$  from the mixture of  $\text{CaCO}_3$  & Sand.
3. To study the rate of flow of liquid through ostwald's Viscometer and determine the relative viscosity of unknown liquid.
4. To determine relative surface tension of liquid by capillary method.
5. To prepare N/10 Primary Standard solution of Sodium Carbonate and Oxalic acid
6. To determine the strength of bench acid/alkali by dilution method.

7. To determine the strength of approximate N/10  $\text{KMnO}_4$  solution with the help of standard oxalic acid.
8. To perform salt test of basic radicals by dry and wet ways ( $\text{Pb}^{+2}$ ,  $\text{Cu}^{+2}$ ,  $\text{Fe}^{+3}$ ,  $\text{Al}^{+3}$ ,  $\text{Zn}^{+2}$ ,  $\text{Co}^{+2}$ ,  $\text{Ni}^{+2}$ ,  $\text{Ca}^{+2}$ ,  $\text{Mg}^{+2}$ ,  $\text{Na}^+$ ,  $\text{NH}_4^+$ )
9. To perform the complete salt analysis of the given salts (at least four salts)
10. Differentiate between saturated and unsaturated hydrocarbons.
11. Identify carbonyl compounds and distinguish between aldehyde and ketone.
12. To study the properties of fats, oils and protein.
13. To determine the melting point of given organic compound.
14. To study  $\text{P}^{\text{H}}$  of natural water supplied.
15. To study electrolysis and electroplating.

(At least 10 of the above experiments must be performed)

### VIII. Prescribed textbook(s)

To be written (Textbooks will be prepared by the HSEB)

### IX. Reference books

1. Sthapit, M.K & Pradhananga R R, Foundation of Chemistry vol I, II & III, Taleju Prakashan, 2005.
2. Palak, K.R, Fundamentals of Chemistry, Pairabi Prakashan, 2062 B.S.
3. Gewali, M.B, Wagley, P., Tiwari R., Acharya S., Buddha Academic Publishers & Distributors Pvt. Ltd, 2006.
4. Chaulagain M.R, B.C.Tej Bahadur, +2 Chemistry vol 1 & Vol 2, Bhrikuti Academic Publications, 2058 B.S.
5. Mishra, P., A text book of Physical Chemistry, Bhrikuti Academic Publications, 2001 B.S.
6. Sthapit, M.K., Elementary Practical Chemistry, Taleju Prakashan 2006.
7. Palak, K.R. Higher Secondary Practical Chemistry, 2006.
8. Sthapit, M.K., Tuladhar, C.B. Elementary Qualitative Analysis, Taleju Prakashan 2005.
9. Palak, K.R., Concept of Higher Secondary Chemistry, Ratna Pustak Bhandar, 2003.
10. Palak, K.R., Higher Secondary Practical Chemistry, Ratna Pustak Bhandar, 2006.

**CHEMISTRY**  
**(Model Questions)**

Full Marks 35  
Pass Marks 14  
Time: 90 Minutes

**Specimen questions**

Attempt any three questions from group A and any two questions from each of group B and C. Each question carries 5 marks.

**Group A**

1. Give the main postulates of kinetic theory of gases? On the basis of this theory how one can explain Boyle's law qualitatively?
2. Explain the origin of Balmer series of line spectra of hydrogen atom.  
Hydrogen atom contains only one electron but line spectra of hydrogen consist of a large number of lines, how it can be accounted?
3. Balance the following reactions by O.N. method of ion-electron method  
(i)  $\text{MnO}_4^- + \text{H}^+ + \text{H} \rightarrow \text{Mn}^{++} + \text{H}_2\text{O}$
4.  $\text{Zn} + \text{HNO}_3 \rightarrow \text{Zn}(\text{NO}_3)_2 + \text{N}_2\text{O} + \text{H}_2\text{O}$
5. Represent graphically the variation of molar conductivity of strong electrolyte and weak electrolyte with concentration. Why molar conductivity of strong and weak electrolytes vary differently with dilution.

**Group B**

6. Why water is called universal solvent? Explain the solvent property of water with examples.
7. How sodium metal is extracted from sodium chloride by Down's Process?
8. What is steel? Describe the open-hearth process for the manufacture of steel.

**Group C**

8. Give the principle of Kolbe's electrolytic method for the preparation of ethane. Write the structure and uses of DDT.
10. How would you separate primary, secondary and tertiary amines?
11. (a) What are polymers? Give the names of any two synthetic polymers.  
(b) What is an azo-dye? Give two examples.

The End