

# NORTH EAST NATIONAL BOARD OF SCHOOL EDUCATION

## Senior Secondary Curriculum in Chemistry

### RATIONALE

According to present scheme of school education at Senior Secondary stage, chemistry emerges out as a separate discipline. It is this stage where major emphasis is to be laid on providing suitable conceptual foundation.

The present chemistry course has been developed basically around the themes: Why to chemical reactions occur? What is the quantitative relationship among reacting constituents in a chemical reaction? How far and how fast will a chemical reaction proceed under a given set of conditions? Can we predict whether a chemical reaction will occur or not? What is the relation between the structure of a chemical substance and its functions/properties? In what way is a chemical reaction relevant for getting new types of substances and materials for daily life and chemical industries?

In the present course, there is no compartmentalization like physical, inorganic and organic chemistry. However basic chemical concepts considered necessary in the study of descriptive chemistry (inorganic and organic) are provided in the beginning of the course and an effort has been made to provide a disciplinary structure to chemistry and, therefore, a logical sequencing of concepts is provided. Applications of chemistry in daily life have been interwoven with the conceptual themes in such a way that learners can appreciate the importance of the study of chemistry relevant to daily life and in the economic development of the country. Some interdisciplinary aspects have also been provided to make the course more meaningful and functional.

### OBJECTIVES OF THE COURSE

At the end of the course, it is expected that a learner will be able to:

- Understand the principles, theories and laws of chemistry responsible for various chemical processes/reactions,
- Realize the role of chemistry in production of many elements (metals/non-metals) and compounds useful in industries and daily life.
- Appreciate the chemical nature of inorganic and organic substances around him/her,
- Choose various vocational, professional and applied course of his/her choice based on knowledge of chemistry gained.

Apart from this, the present course also aims at developing the following in the learner:

- Perform chemical calculations to know about the chemical reactions and chemical compounds,

- Explain chemical reactions, concepts and phenomenon,
- Develop awareness about uses and abuses of chemical substances,
- Develop skills like arranging/setting apparatus, handling apparatus and chemicals properly, and
- Analyse and synthesise simple compounds.



## SPECIAL FEATURES OF THE COURSE

The course also provides optional modules 'mostly of applied nature' out of which a student can choose one module according to his/her choice of career. Thus, there are seven course modules and five optional modules. A student appearing for senior secondary examination is expected to offer all the seven core modules, one module out of five optional modules, and practicals. All the core and optional modules are listed below:

### CORE MODUELS

S.No.	Module Study	Marks	
		Alloted	Hours
1.	Atoms, Molecules and Stoichiometry	7	14
2.	States of Matter	7	18
3.	Chemical Energetics	8	23
4.	Chemical Dynamics	7	19
5.	Structure of Atoms and Chemical Bonding	11	33
6.	Elements and Their compounds	15	48
7.	Chemistry of Organic Compounds	15	48

### OPTIONAL MODULES

1.	Agricultural Chemistry	10	37
2.	Bio-Chemistry		
3.	Environmental Chemistry		
	Total	80	240

A detailed curriculum is given for your ready reference

### CORE MODULES

#### MOUDLE 1 : ATOMS, MOLECULES AND STOICHIMOMETRY

##### Unit 1 Measurements in Chemistry

- A simple idea of basic SI units

- Derived SI unit
- Numerical Problems

### **Unit 2 Mole Concept**

- Counting and weighting of atoms and molecules
- Avogadro constant
- Molar quantities
- Numerical problems

### **Unit 3 Chemical Stoichiometry**

- Empirical and molecular formulae
- Chemical formula and percentage composition (chemical formula from percentage composition and vice versa)
- Mass relationship in chemical reactions (mole ratio from a balanced chemical equation, mole calculation)
- Limiting reagent concept and percentage yield.
- Numerical problems

## **MODULE 2 : STATES OF MATTER**

### **Unit 1 Behaviour of Gases**

- The gaseous state
- Boyle's Law
- Charles' law-kelvin Temperature Scale
- Avogadro's principle
- Dalton's law of partial pressures
- Ideal gas equation
- The kinetic molecular theory of gases
- Graham's law of diffusion
- Real gases-deviations from ideal gas behaviour.
- Liquifaction of gases
- Numerical problems

### **Unit 2 Liquids and Solids**

- The liquid state
- The solid state

### Unit 3 Solutions

- Solution, solute and solvent
- Concentration of solutions, - molarity molality, normality, mole fraction and mass percentage
- Types of solutions
- Raoult's law
- Ideal and non-ideal solutions
- Colligate properties of solutions simple numerical problems.
- Simple numerical problems

### Unit 4 The Colloidal Solution

- True solution, colloidal solution and a suspension
- Classification of colloids
- Preparation of colloidal solutions
- Properties of colloidal solutions
- Properties of colloidal solutions
- Applications of colloids

## MODULS 3 : CHEMICAL ENERGETICS

### Unit 1 Some Basic Concepts of Thermodynamics and Thermochemistry

- System : Isolated, closed and open system
- Processes; isothermal, adiabatic, reversible and irreversible
- Standard state of a substance
- Exothermic and endothermic reactions
- Thermochemical equations
- Concept of internal energy and enthalpy change, relationship between  $rH$  and  $rE$ , first law of thermodynamics
- Standard enthalpy of reactions
- Enthalpy changes during a reaction: enthalpy of formation, enthalpy of combustion, enthalpy of neutralization
- Hess's law and its applications
- Bond enthalpy
- Numerical Problems

## Unit 2 Spontaneity of Chemical Reactions

- Concept of entropy, entropy change in a system and spontaneity
- Relationship between  $G, H$  and  $S$
- Free energy change and spontaneity of a Chemical reaction
- Standard free energy of formation
- Free energy change and chemical equilibrium
- Numerical problems

## MODULE 4 : CHEMICAL DYNAMICS

### Unit 1 Chemical Equilibrium

- Reversible reactions
- Types of equilibrium system
- Equilibria in homogeneous and heterogeneous systems
- Law of chemical equilibrium
- Relationship between  $K_c$  and  $K_p$
- Factors affecting equilibrium – Le Chatelier's Principle
- Numerical problems.

### Unit 2 electrochemistry

- Electrolysis
- Electrical conductivity of electrolytic solutions
- Electrochemical cells
- Standard electrode potential
- Electrochemical series and its applications
- Effect of concentration on electrode potentials by Nernst equation
- Relationship between emf and free energy
- Numerical problems

### Unit 3 Rates of Chemical Reactions

- Rate of a Reaction
- Expressions for reactions rates
- Factors affecting rate of reaction
- Rate law
- Order of a reaction
- First order reaction
- Half life period
- Effect of temperature on reaction rate
- Catalysis
- Numerical problems

## Unit 4 Ionic Equilibria

- Acid-base equilibrium
- Ionisation constant of weak acids and bases
- Ionization of water
- pH value
- buffer solutions
- solubility equilibrium, solubility product and its applications
- numerical problems

## MODULES 5 : STRUCTURE OF AN ATOM AND CHEMICAL BONDING

### Unit 1 Atomic Structure

- Fundamental particles of an atom
- Scattering of particles-Rutherford's experiment
- Discovery of neutron
- Discharge of electricity through gases
- Rutherford's nuclear model
- Electromagnetic radiation
- Visible spectrum
- Line spectra of H-atom; Bohr model (no derivation)
- Wave-particle duality
- The uncertainty principle
- The wave mechanical model-orbitals (probability picture may be emphasized), quantum number and Pauli's exclusion principle
- Aufbau Principle-electronic configuration of atoms.
- Hund's rule

### Unit 2 Period Table and Variation in Atomic Properties

- Early attempts of classification
- Long form of periodic table
- Variation in atomic properties

### Unit 3 The Chemical Bond -I

- Why do atoms combine (potential energy diagram)
- Formation of ionic bonds, characteristics of covalent compounds, partial ionic character of covalent bonds, coordinate covalent bond.

### Unit 3 The Chemical Bond – II

- Shapes of molecules. An introduction to VSEPR theory (upto 6 electron pairs only)
- Hybridization of atomic orbitals, hybrid orbitals (sp, sp<sup>2</sup>, sp<sup>3</sup>)
- Multiple covalent bonds

## **MODULE 6 : ELEMENTS AND THEIR COMPOUNDS**

### **Unit 1 general characteristics of Main Group Elements**

Variation in properties among s and p block elements with respect to (i) size (ii) ionization energies (iii) electron affinities (iv) electronegativity (v) metallic behaviour, variation in the nature of their (i) hydrides (ii) oxides and halides, diagonal relationship between elements (Li and Mg only)

### **Unit 2 General Characteristics of Transition Elements**

Electronic configuration, properties of d-block elements (first series only) in terms of their (i) variable oxidation states, (ii) magnetic properties (iii) colour of their ions and compounds (iv) complex formation and (v) catalytic properties.

### **Unit 3 Main-Group Elements and Their Compounds – 1**

- Hydrogen
- Alkali and alkaline earth metals
- Boron and aluminium
- Carbon and silicon

### **Unit 4 Main-Group Elements and Their Compounds – II**

- Nitrogen and phosphorus
- Oxygen and sulphur
- Halogens and noble gases

### **Unit 5 Chemistry of some Important Compounds of Transition Elements**

Preparation, properties and application of some important compounds:  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$ ,  $\text{K}_4\text{Fe}_2(\text{CN})_6$ ,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  Calamine.

### **Unit 6 General Metallurgical Principles**

- Occurrence of metals
- Important ores of some common elements: Na, Al, Sn, Pb, Ti, Fe, Cu, Ag and Zn
- General principles involved in the isolation of metals from their ores and refining (taking examples from these metals)

## **MODULE 7: CHEMISTRY OF ORGANIC COMPOUNDS Unit 1 General**

### **Principles, Classification and Nomenclature**

- Classification
- Type of bond fission : Homolytic, Heterolytic
- Inductive effect,
- Types of reactions: substitution and addition (electrophilic and nucleophilic),



- elimination and rearrangement
- Functional groups : definition and types
  - IUPAC nomenclature of monofunctional organic compounds
  - Isomerism

### **Unit 2 Hydrocarbons**

- Definition and types of hydrocarbons
- IUPAC nomenclature

### **Unit 3 Preparation and Properties of Hydrocarbons – II**

- Preparation of hydrocarbons
- Physical properties of hydrocarbons

### **Unit 4 Preparation and Properties of Hydrocarbons – II**

- Chemical properties of hydrocarbons (addition, substitution, oxidation) **Unit 5**

### **Compounds of Carbon Containing halogens (Haloalkanes and haloarenes)**

- IUPAC Nomenclature of halogen compounds
- Preparation of haloalkanes and haloarenes
- Physical and chemical properties

### **Unit 6 compounds of Carbon Containing Oxygen**

- Different types of oxygen containing compounds ( alcohols, ethers, aldehydes, ketones, acids, esters)
- IUPAC nomenclature of oxygen containing compounds
- Preparation and properties of alcohols, phenols, aldehydes, ketones and acids.

### **Unit 7 Compounds of Carbon Containing Nitrogen**

- Types of compounds-amides, amines, nitro compounds
- IUPAC nomenclature of amides, amines and nitro compounds
- Preparation and properties of primary aromatic and aliphatic amines.

## **OPTIONAL MODULES**

### **MODULE 1 : AGRICULTURAL CHEMISTRY**

#### **UNIT 1 soil and Plant Nutrients**

- Simple idea of soil
- Types of soil
- Soil Texture
- Soil Reaction
- Plant Nutrients

#### **UNIT 2 manures and Fertilizers**

- Essential Plant Nutrients
- Types of manures
- Compost production
- Vermicompost and vermiculture
- Types of fertilizers
- Methods of using fertilizers

#### **UNIT 3 Pests and Pesticides**

- Pests
- Pest control
- Pesticides
- Pest management

#### **UNIT 4 Biological Nitrogen Fixation and Plant Growth Hormones**

- Nitrogen cycle
- Nitrogen fixation
- Biofertilizers
- Plant growth hormones

### **MODULE 2 : BIOCHEMISTRY**

#### **UNIT 1 Carbohydrates**

- Natural sources of carbohydrates
- Monosaccharide, disaccharide and polysaccharide
- Structure of carbohydrates
- Biological significance of carbohydrates

## **UNIT 2 Proteins**

- Simple idea of proteins
- Classification and structure of proteins
- Amino acids

## **UNIT 3 Fats and Lipids**

- Lipids
- Oils and fats

## **UNIT 4 Nucleic Acid**

- Nucleic Acid
- DNA and RNA

## **UNIT 5 Enzymes**

- A simple idea of enzymes
- Classification of enzymes
- Uses of enzymes

## **MODULES 3 : ENVIRONMENTAL CHEMISTRY**

### **UNIT 1 Environment and its pollution**

- Idea of environment
- Threats to environment
- Pollutants

### **UNIT 2 Atmosphere, Oxygen and air Pollution**

- Composition of air
- Respiration, photosynthesis and decay cycle
- Air pollutants
- Green house effect
- Global warming
- Depletion of ozone layer
- Acid rain

### **UNIT 3 Water Pollution**

- Water resources
- Water pollutants
- Biological oxygen demand
- Prevention of water pollution

- Legislative measures for prevention of water pollution

#### **UNIT 4 Heavy Metal Contamination**

- Heavy metal
- Effects of heavy metal contamination
- Preventive measures

#### **UNIT 5 Radioactive Waste Management**

- Radioactive sources
- Ill effects of radiation
- Preventive measures
- Regulations regarding safety



## CURRICULUM FOR PRACTICAL WORK IN CHEMISTRY

Objectives of the present course in practical work are as follows :

1. To develop and inculcate laboratory skills and techniques
2. To enable the students to understand the basic chemical concepts,
3. To develop basic competence of analyzing and synthesizing chemical compounds and mixtures.

To meet these objectives three different type of laboratory experiments are provided in the present practical course.

1. Experiment for developing laboratory skills/techniques
2. Concept based experiments
3. Traditional experiments (for analyzing and synthesizing chemicals)

### List of Practicals

1.
  - (i) General safety measures with special reference to safe handling of chemicals.
  - (ii) Acquaintance with boring of glass tubes, sealing of apparatus, filtration, distillation, crystallization, preparation calibration, cleaning of glass apparatus and use of burner, etc.)
  - (iii) Measurement of volume, length, mass and density and common errors therein.
2. Preparation, collection and study of some important physical and chemical properties of at least three gases, one each from the following groups :
  - (a) Hydrogen and oxygen
  - (b) Carbon dioxide and hydrogen sulphide
  - (c) Chlorine, hydrogen chloride, and sulphur dioxide
3. Preparation of dilute solutions of known concentration of sulphuric acid, hydrochloric acid and nitric acid. (Dilution should be carried out strictly under the supervision of a teacher).
4. Study of interaction of metals (any four) with salt solution and arranging them according to their activity (to form activity series). Metals and salts may be selected from the following.

Mg, Zn, Fe, Sn, Pb, Cu and Al and their salts. (Checking the order of metal series based on the electrode potential will be desirable.)
5.
  - (a) Determination of pH of following substances by using a universal indicator solution or pH papers.

- (i) Salt solution
  - (ii) Acids and bases of different dilutions
  - (iii) Vegetable and fruit juices
- (b) Study of pH change by common-ion effect in base of weak acids and weak bases by above method (specific examples of  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{COONa}$  and  $\text{NH}_4\text{OH}$  and  $\text{NH}_4\text{OH}$  and  $\text{NH}_4\text{Cl}$  may be taken).
6. Determination of melting point of a solid substance or low melting point (below  $100^\circ\text{C}$ ) by glass capillary tube method (Paraffin oil may be used as bath).
7. Study of solubility of solid substances in water at different temperatures and plotting of a solubility curve.
8. Study of the shift in equilibrium between ferric ions and thiocyanate ions by increasing/decreasing the concentration of their ions.
9. **Study of:**
- (a) The effect of concentration on the rate of reaction between sodium thio-sulphate and hydrochloric acid.
  - (b) The effect of temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid.
10. Separation of coloured substances by paper chromatography and comparison of their  $R_f$  values.
- (a) a mixture of red and blue ink or a black ink.
  - (b) Juice of a flower or grass.
11. Detection of nitrogen, sulphur and halogens in an organic compound (combinations of halogens to be avoided). Not more than two of the above elements should be present in the given organic compound.
12. Study of simple reactions of carbohydrates, fats and proteins in pure form and detection of their presence in given food stuffs.
13. Preparation of soap by using different oils and its comparison with the market soap by determining the foaming capacity and cleaning effect.
14. Use of chemical balance to be demonstrated.
- (a) preparation of solution of oxalic acid and ferrous ammonium sulphate of known molarity by weighing (non-evaluative)
  - (b) A study of (i) acid-base and (ii) redox titrations (single titration only). (both the solutions to be provided).

- (i) Oxalic acid and sodium hydroxide
- (ii) Ferrous ammonium sulphate and potassium permanganate.

15. Elementary qualitative analysis of a salt involving detection of one cationic and one anionic species from the following groups. (Salts insoluble in hydrochloric acid excluded).

Cations:

$Pb^{2+}$ ,  $Cu^{2+}$ ,  $Cd^{2+}$ ,  $Fe^{3+}$ ,  $Al^{3+}$ ,  $Ni^{2+}$ ,  $Zn^{2+}$   
Mn, Ca, NH

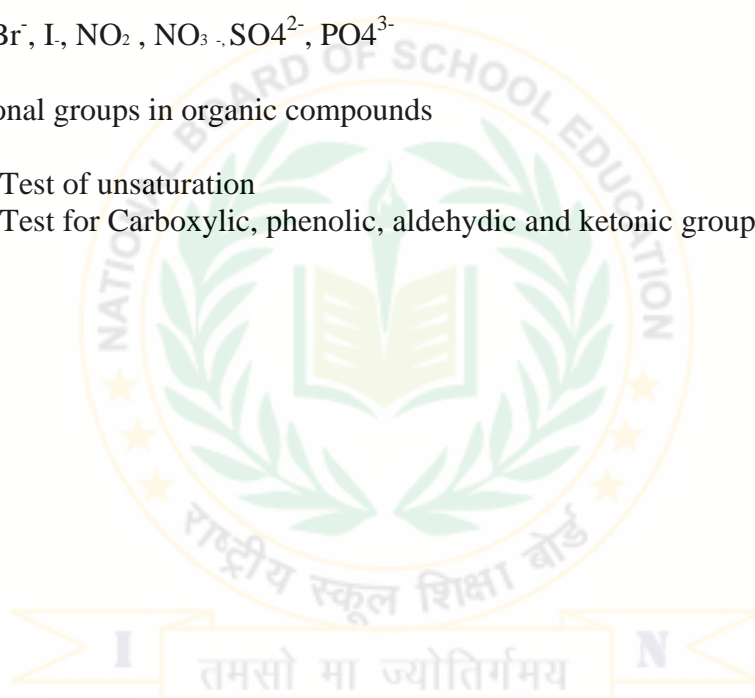
Anions:

$Co_3^{2-}$ ,  $S^{2-}$ ,  $Cl^-$ ,  $Br^-$ ,  $I^-$ ,  $NO_2^-$ ,  $NO_3^-$ ,  $SO_4^{2-}$ ,  $PO_4^{3-}$

16. Functional groups in organic compounds

Test of unsaturation

Test for Carboxylic, phenolic, aldehydic and ketonic groups.



## PRACTICAL EXAMINATION

There will be a practical examination of 20 marks and 3 hours duration.  
The distribution of marks is as follows:

	Marks
Salt Analysis (one cation + one anion)	4
Velumetric Analysis	6
(i) (write-up in which student may be asked to write brief method, indicator, equation, end point.	2
(ii) Set-up of experiment	2
(iii) Results	2
3. (i) Detection of elements in an organic compound	2
(ii) Detection of functional group	2
OR	
Setting up of one experiment from experiments at serial number 2 to 10, 12 and 13.	4
4. Viva-voce	3
5. Record book	3
Total	20