

# CHEMISTRY (862)

## Aims:

1. To foster acquisition of knowledge and understanding of terms, concepts, facts, processes, techniques and principles relating to the subject of Chemistry.
2. To develop the ability to apply the knowledge of contents and principles of Chemistry in new or unfamiliar situations.
3. To develop skills in proper handling of apparatus and chemicals.
4. To develop an ability to appreciate achievements in the field of Chemistry and its role in nature and society.
5. To develop an interest in activities involving usage of the knowledge of Chemistry.
6. To develop a scientific attitude through the study of Physical Sciences.
7. To acquaint students with the emerging frontiers and interdisciplinary aspects of the subject.
8. To develop skills relevant to the discipline.
9. To apprise students with interface of Chemistry with other disciplines of Science, such as, Physics, Biology, Geology, Engineering, etc.

## CLASS XI

*There will be two papers in the subject.*

**Paper I:** Theory- 3 hours ... 70 marks

**Paper II:** Practical - 3 hours ... 20 marks

Project Work ... 7 marks

Practical File ... 3 marks

### PAPER I –THEORY – 70 Marks

*There will be one paper of 3 hours duration divided into 2 parts.*

**Part I (20 marks)** will consist of compulsory short answer questions, testing knowledge, application and skills relating to elementary/fundamental aspects of the entire syllabus.

**Part II (50 marks)** will be divided into 3 Sections, A, B and C. Candidates are required to answer **two** out of **three** questions from Section A (each carrying 10 marks), **two** out of **three** questions from Section B (each carrying 5 marks) and **two** out of **three** questions from Section C (each carrying 10 marks). Therefore, a total of **six** questions are to be answered in Part II.

### SECTION A

#### 1. Atoms and Molecules

- (i) The concept of atoms having fixed properties in explaining the laws of chemical combination.
- (ii) Atomic and isotopic masses.

(iii) Chemical equivalents, volumetric calculations in terms of normality. C = 12.00 should be taken as a standard for expressing atomic masses.

(iv) Relative molecular mass and mole. The following methods may be considered for the determination of relative molecular masses for the gases: the molar volume method; Victor Meyer's method (experimental details not required).

#### 2. Atomic Structure

- (i) Electrons, Protons and Neutrons as fundamental particles, their charges and masses.
- (ii) Rutherford's nuclear model based on the scattering experiment.
- (iii) Bohr's atomic model.
- (iv) Atomic structure: wave mechanical model- a simple mathematical treatment. Quantum numbers; shape, size and orientation of s and p orbitals only. Hund's rule of maximum multiplicity. Pauli's exclusion principle, Aufbau principle, electronic configuration of elements in terms of s, p, d, f subshells.

### 3. Periodic Table

- (i) Atomic number (Proton number) as the basis for classification of the elements in the Periodic Table. IUPAC nomenclature for elements with  $Z > 100$ .
- (ii) Extra nuclear structure as the basis of periodicity. Some idea of the following: ionisation enthalpy, electron gain enthalpy, atomic radius, atomic volume, electronegativity, etc must be given. The periodicity of electronic structure leading to the periodicity of elements e.g the relative ease of ionisation of elements.
- (iii) Periodicity of elements with reference to s, p, d and f block elements.

### 4. Chemical Bonding

#### Electrovalent Bond

- (i) Electrovalent or ionic bond e.g formation of NaCl,  $\text{Li}_2\text{O}$ , MgO, CaO,  $\text{MgF}_2$ , and  $\text{Na}_2\text{S}$ .
- (ii) Factors influencing the formation of ionic bond, e.g electron gain enthalpy, ionisation enthalpy, lattice energy and electronegativity.
- (iii) The relation between the ionic bonding and Periodic Table.
- (iv) Variable electrovalency and its causes.

#### Covalent Bond

- (i) Covalent bond, e.g. formation of ammonia, nitrogen, ethene, ethyne, and carbon dioxide. Resonance.
- (ii) Variable valency: chlorine exhibits the valency of 1,3,5 & 7 respectively.
- (iii) Deviation from Octet rule and Fajan's rules.

### 5. The Gaseous State

- (i) The gas laws, kinetic theory treated qualitatively.

- (ii)  $PV = nRT$  or  $PV = (w/M)RT$  and the application of this equation of state.
- (iii) Non ideal behaviour of gases and Van der Waals' equation.
- (iv) Dalton's law, the Avogadro constant, the mole, Graham's law of diffusion, simple numerical problems on the above.

### 6. Colloidal Solutions

Preparation and properties of colloids, both lyophilic and lyophobic colloids. Precipitation as evidence that the colloidal particles are charged. Idea of gold number is required, but application of gold number is not required. The importance of large surface area in adsorption should also be appreciated.

### 7. Chemical Kinetics

- (i) Qualitative treatment of the dependence of reaction rates on: concentration of the reactants, size of the particles, temperature and presence of a catalyst. Catalyst – structure: enzymes and zeolites.
- (ii) The concept of energy barrier (it is suggested that some experiments may be devised which may deal with the above mentioned factors).

### 8. Chemical Equilibria

- (i) Reversible reactions and dynamic equilibrium. The concept of equilibrium constant in terms of concentration or partial pressure to indicate the composition of the equilibrium mixture. The following are the examples: the dissociation of dinitrogen tetroxide, hydrolysis of simple esters, the Contact Process for the manufacture of sulphuric acid, the synthesis of ammonia.
- (ii) Le Chatelier's Principle and its applications to chemical equilibria.

## SECTION B

**9. Study of Representative Elements:** Group 1, 2, 13, 14, 15 - The following should be included:

a) Occurrence, (b) Physical State, (c) Electronic Configuration, (d) Atomic and Ionic radii, (e) Common oxidation state, (f) Electropositive / Electronegative character, (g) Ionisation enthalpy, (h) Reducing/oxidising nature, (i) Distinctive behaviour of first member of each group (namely Lithium, Beryllium, Boron, Carbon, Nitrogen), (j) Nature of oxides, hydroxides, hydrides, carbonates, nitrates, chlorides, sulphates, wherever applicable.

**10. Preparation, properties and uses of Compounds of Groups 1, 2, 13, 14, 15.**

Only brief qualitative treatment is required for preparation. Main emphasis must be given to the chemistry of preparation, chemical properties and uses of the given compounds. Biological importance of magnesium, sodium, calcium and potassium.

Group 1: Sodium chloride, Sodium hydroxide, Sodium carbonate, Sodium bicarbonate, Sodium thiosulphate; Group 2: Magnesium chloride hexahydrate, Calcium oxide, Plaster of Paris; Group 13: Borax, Borax Bead Test, Alums; Group 14: Carbon monoxide, Carbon dioxide, Silicon dioxide, Silicon carbide, Silicones; Group 15: Oxides of nitrogen, Phosphorus trichloride, Phosphorus pentachloride, Oxoacids of phosphorus.

**11. Redox Reactions**

## SECTION C

**(Note: Aliphatic compounds containing upto 5 carbon atoms to be taught)**

**12. Introduction to Organic Chemistry**

- The unique nature of carbon atom and catenation.
- Classification of organic compounds and homologous series.

- Detection of carbon, hydrogen, sulphur, nitrogen and halogen.
- Estimation of carbon, hydrogen, nitrogen, halogens, sulphur and phosphorous.

**13. Types of Chemical Reactions and their Mechanisms**

- Substitution, addition and elimination reactions.
- Homolytic and heterolytic fission.
- Electrophiles and nucleophiles.
- Inductive, mesomeric and electromeric effects.
- Free radicals and polar mechanisms (in terms of fission of the bonds and formation of the new bonds) including  $S_N1$ ,  $S_N2$ ,  $E_1$  and  $E_2$  mechanisms. ( $S_N1$  and  $S_N2$ ,  $E_1$  and  $E_2$  mechanisms are to be taught at this point).
- Organometallic compounds.

**14. Aliphatic and Aromatic Hydrocarbons**

- Alkanes: General methods of preparation, Properties of alkanes.
- Alkenes: general methods of preparation and properties of alkenes.
- Alkynes: methods of preparation (including manufacture), properties and uses of ethyne.
- Benzene: Coal tar as an important source of aromatic compounds; preparation of benzene from sodium benzoate, properties and uses of benzene; resonance model of benzene; directive influence of substituents in the benzene ring.

**15. Alkyl and Aryl Halides**

- The nomenclature of aliphatic compounds containing halogen atom.
- Preparation, properties, uses of haloalkanes.
- Preparation, properties, and uses of the following: ethyl bromide, chloroform, iodoform, haloform reaction.
- Chlorobenzene.

## 16. Applications of Chemicals

- (i) In medicine: antipyretics, analgesics, tranquilisers, antiseptics, disinfectants, anti-microbials, anti-fertility drugs, antihistamines, antibiotics, antacids.
- (ii) Industry: advanced materials: carbon fibres, micro alloys. Detergents: classification, some important examples.
- (iii) Space: rockets propellants- characteristics, chemicals used.
- (iv) Food processing: preservatives, artificial sweetening agents, antioxidants and edible colours.

### PAPER II

#### PRACTICAL WORK- 20 Marks

1. Measurement of the rate of reaction based on the size of the particle, concentration of reactants, temperature and presence of catalyst, e.g. the study of the rate of dissolving of magnesium or zinc in dilute sulphuric or hydrochloric acid.

2. Qualitative analysis; identification of the following:

Cations:  $\text{NH}_4^+$ ,  $\text{Ag}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$

Anions:  $\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ .

Formal analytical procedure required.

3. Titration: acid-base titration involving molarity.
4. Construction of Voltaic cell and Daniel cell and measuring their emf.

#### PROJECT WORK AND PRACTICAL FILE -

**10 Marks**

#### Project Work – 7 Marks

The candidate is to creatively execute one project/assignment on a selected topic of Chemistry. Teachers may assign or students may choose any one project of their choice.

#### Practical File – 3 Marks

Teachers are required to assess students on the basis of the Chemistry Practical file maintained by them during the academic year.

## CLASS XII

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### PAPER I –THEORY – 70 Marks

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### SECTION A

#### 1. Relative Molecular Mass and Mole

- Normality, molality, molarity, mole fraction, as measures of concentration.
- Raoult's law and colligative properties.
- Nonvolatile, non electrolytic solute.
- Dissociation- Electrolytic solute.
- Association.
- Relative molecular mass of non-volatile substances:
  - By relative lowering of vapour pressure.
  - Depression in freezing point.
  - Elevation in boiling point method.
  - Osmotic pressure and its application in the determination of relative molecular mass.
  - Van't Hoff factor.
  - Van't Hoff equation and its interpretation.
  - Simple numerical problems on different methods mentioned above for the

determination of molecular masses. Abnormal molecular masses in case of electrolytes and in case of solutes which associate.

#### 2. Chemical Bonding

- Co-ordinate or dative covalent bond, e.g. formation of oxy-acids of chlorine.
- Hydrogen bonding: its essential requirements, the examples of hydrogen fluoride, water (ice), alcohol, etc may be considered.
- Metallic bonding, Van der Waals' forces.
- Valence Shell Electron Pair Repulsion Theory; Hybridisation and shapes of molecules: hybridisation involving s, p and d orbitals only; sigma and pi bonds.
- Molecular orbital theory, Qualitative treatment of homonuclear diatomic molecules of first two periods. Energy level diagrams, bonding, antibonding molecular orbitals, bond order, paramagnetism of O<sub>2</sub> molecule. Relative stabilities of O<sub>2</sub>, O<sub>2</sub><sup>-</sup>, O<sub>2</sub><sup>2-</sup>, O<sub>2</sub><sup>+</sup>, O<sub>2</sub><sup>2+</sup>

#### 3. States of Matters: Structure and Properties

##### Solid State

Crystalline and amorphous substances; lattice; unit cell; 3-D packing of atoms in a crystal lattice; relation between radius, edge length and nearest neighbour distance of atoms in a unit cell; density of a unit cell; interstitial void; imperfections in solids, ionic, metallic and atomic solids, electrical and magnetic properties.

#### 4. Chemical Energetics

- Introduction.
- First law of Thermodynamics and its mathematical statement.
- Ideas about Heat, Work and Energy.
- Second law of thermodynamics – Entropy, Free Energy. Spontaneity of a chemical change.  $\Delta G^\circ = -2.303 RT \log K_{eq}$ ; reversible and irreversible changes, isobaric, isochoric adiabatic processes.

- (v) Thermochemistry:
  - (a) Definitions.
  - (b) Constancy in the heat of neutralisation.
  - (c) Calorific value of a fuel.
  - (d) Hess's law of constant heat summation - simple problems based on the above definitions and concepts.

## 5. Chemical Kinetics (including numericals)

Detailed study of -

- (i) Collision theory.
- (ii) The law of mass action.
- (iii) Effect of concentration of the reactants on -
  - (a) The rate of the reaction.
  - (b) The rate constant.
- (iv) Molecularity and order of the reaction.
  - (a) Meaning of the order of reaction.
  - (b) Meaning of molecularity.
- (v) Mechanisms of the reactions.
- (vi) Variation of rate constant with temperature. Arrhenius equation  $K = Ae^{-E_a/RT}$  and related graphs.
- (vii) Catalyst - Catalysis: types of catalysts, theories of catalysts, characteristics of catalyst.

## 6. Ionic Equilibria

- (i) Ostwald's dilution law and its derivation. Strength of acids and bases based on their dissociation constant.
- (ii) Brønsted-Lowry and Lewis concept of acids and bases.
- (iii) Ionic product of water, pH of solutions and pH indicators, problems.

- (iv) Common ion effect.
- (v) Salt hydrolysis.
- (vi) Buffer solutions.
- (vii) Solubility product and its applications.

## 7. Electrochemistry

- (i) Faraday's laws of Electrolysis, Coulometer.
- (ii) Relation between Faraday, Avogadro's number and charge on an electron.  $F = N_A e$  should be given (no details of Millikan's experiment are required).
- (iii) Galvanic cells, mechanism of current production in a galvanic cell; and electrode potential, standard hydrogen electrode, electrochemical series, Nernst equation.
  - (a) Standard electrode potential, measurement of standard electrode potential.
  - (b) Idea of heterogeneous equilibria on the surface of the electrode.
  - (c) Factors affecting electrode potential.
  - (d) Electrochemical series and its explanation on the basis of standard electrode potential.
  - (e) Numericals based on calculation of emf of a cell from the values of standard electrode potential.
  - (f) Nernst equation (correlation with the free energy of the reaction in thermodynamics derivation of the equation).
- (iv) Electrolytic conductance: specific conductance. Measuring of molar and equivalent conductance; Kohlrausch's law.
- (v) Corrosion.
- (vi) Batteries.

## SECTION B

### 8. Coordination Compounds

Concept of complexes; definition of ligands; classification of ligands, coordination number, coordination sphere; IUPAC nomenclature of coordination compounds; isomerism; magnetic characteristics of coordination compounds on the basis of valence bond theory. Stability constant; uses of coordination compounds in different fields.

### 9. Chemistry of p-Block Elements: Group 16, 17, 18 - The following should be included:

(a) Occurrence, (b) Physical State, (c) Electronic configuration, (d) Atomic and ionic radii, (e) Common oxidation state, (f) Electronegative character, (g) Ionisation enthalpy, (h) Oxidising nature, (i) Nature of oxides, hydroxides, hydrides, carbonates, nitrates, chlorides, sulphates, wherever applicable.

### 10. Preparation/ Manufacture, Properties and Uses of Compounds of Groups 16, 17, – Ozone, Sulphur Dioxide, Sulphuric Acid, Hydrochloric Acid

### 11. Chemistry of Transition and Inner-Transition Elements:

**d-Block: 3d, 4d and 5d series**

**f-Block: 4f and 5f series**

Study in terms of metallic character, atomic and ionic radii, ionisation enthalpy, oxidation states, variable valency, formation of coloured compounds, formation of complexes, alloy formation.

Lanthanoid contraction, shielding effect, radioactive nature.

Metallurgy of Fe, Cu, Zn and Ag in terms of equations; electrolytic refining and uses.

Compounds –

1. Silver nitrate: equation of preparation, use in laboratory and in photography.
2. Potassium permanganate: structure, shape, equation of extraction from pyrolusite ore, its

oxidising nature in acidic, basic and neutral medium, use in redox titration.

3. Potassium dichromate: equation of extraction from chromite ore, structure and shape of molecule and its use in titration.

## SECTION C

**(Note: Aliphatic compounds containing upto 5 carbon atoms to be taught)**

### 12. Alcohols and Phenols

- (i) Classification, general formulae, structure and nomenclature.
- (ii) Methods of preparation, manufacture, properties and uses.
- (iii) Preparation, properties and uses of ethane-1,2 diol, propane-1,2,3 triol (outline - no details).
- (iv) Conversion of one alcohol into another.
- (v) Distinction between primary, secondary and tertiary alcohols.

### 13. Ethers, Carbonyl Compounds.

- (i) **Ethers:** general formula and structure. Nomenclature; preparation, properties and uses of ether (outline, no detail), with reference to diethyl ether.
- (ii) **Carbonyl compounds:** methods of preparation, properties and uses of aldehydes and ketones.

### 14. Carboxylic acids and Acid Derivatives

- (i) **Carboxylic acids:** classification, general formulae, structure and nomenclature: monocarboxylic acids, general methods of preparation, properties and uses of acids.
- (ii) **Acid derivatives:** laboratory preparation, properties and uses of acetyl chloride, acetic anhydride, acetamide, ethylacetate; urea preparation (by Wohler's synthesis), properties and uses of urea, manufacture of urea from ammonia and by cyanamide process.

## 15. Cyanide, Isocyanide, Nitro compounds and Amines

Their nomenclature, general methods of preparation, correlation of physical properties, their structure, chemical properties, their uses.

## 16. Polymers

Polymerisation: the principle of addition and condensation polymerisation illustrated by reference to natural and synthetic polymers e.g. proteins, polyolefines and synthetic fibres; thermoplastics, thermosetting plastics, chemotrophs; reference should also be made to the effect of chain-length and cross-linking on physical properties of polymers.

## 17. Isomerism

Definition. Classification of isomerism.

- (i) Structural Isomerism.
- (ii) Stereo Isomerism.
  - (a) Geometric isomerism (cis and trans only).
  - (b) Optical isomerism

## 18 Biomolecules – carbohydrates, proteins, enzymes, vitamins and nucleic acids.

### PAPER II

#### PRACTICAL WORK – 20 Marks

### 1. Qualitative analysis

Candidates would be required to carry out tests and make deductions:

Cations:  $\text{NH}_4^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Sn}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$

Anions:  $\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{SO}_4^{2-}$

A formal group analysis is required for the identification of cations and anions in a mixture that may contain two cations and two anions.

Interfering combinations will not be allowed.

### 2. Study of the rate of reaction

The candidates will be required, having been given full instructions, to carry out an experiment on the rate of reaction, e.g. reaction between sodium thiosulphate and hydrochloric acid.

### 3. Titrations

- oxidation-reduction titrations: iodine / sodium thiosulphate; potassium manganate (VII) / ammonium iron (II) sulphate; potassium manganate (VII) / oxalic acid; potassium dichromate / sodium thiosulphate; copper (II) sulphate/ sodium thiosulphate.

The candidate may be required to determine the percent purity of a compound and the number of molecules of water of crystallization in hydrated salts. In such experiments sufficient working details including recognition of the end point will be given.

### 4. Identification of the following compounds and functional groups based on observations

- Aliphatic compounds: formaldehyde; ethanol; acetic acid; acetone; glycerol; glucose.
- Aromatic compounds: benzoic acid; phenol; aniline (carbylamine reaction should be avoided); benzaldehyde.

\*Please Note: Carbylamine reactions are not performed under ordinary laboratory conditions. Ethyl, methyl or phenyl isocyanides are highly obnoxious and cause dizziness and headache.

### 5. Testing of food material for adulteration which may include:

- pure ghee (mixed with vanaspati or animal fat).
- butter (mixed with starch or vanaspati ghee).
- turmeric (mixed with starch or chromate salt).
- milk (either fat is removed or some starch is also mixed).
- sweets (non-permissible colouring matter such as metanil yellow).

### 6. Testing of vitamins A and B

## PROJECT WORK AND PRACTICAL FILE -

10 Marks

### Project Work – 7 Marks

The project work is to be assessed by a Visiting Examiner appointed locally and approved by the Council.

The candidate is to creatively execute **one** project/assignment on an aspect of Chemistry. Teachers may assign or students may select a topic of their choice. Following is only a suggestive list of projects.

#### Suggested assignments:

1. Aminoacids: Peptides, structure and classification, proteins structure and their role in the growth of living beings.
2. Nucleic Acid: DNA and RNA – their structure. Unique nature. Importance in evolution and their characteristic features.
3. Lipids: structure, membranes and their functions.
4. Carbohydrates and their metabolism, Haemoglobin-blood and respiration.
5. Immune systems.
6. Vitamins and hormones
7. Simple idea of chemical evolution.
8. Natural polymers (any **five**)- structure, characteristics, uses.
9. Synthetic polymers (any **five**)- method of preparation, structure, characteristics and uses.
10. Thermoplastics and Thermosetting plastics - methods of preparation, characteristics and uses.
11. Types of dyes- methods of preparation, characteristics and uses.
12. Chemicals in medicines: antiseptics, antibiotics, antacids, etc. and their uses – chemical names.
13. Various rocket propellants and their characteristics.
14. Preparation of soap, alcohol, nail polish, boot polish, varnish, nail polish remover, shampoo and scents.
15. Chemical and chemical processes in forensic studies.
16. Air pollution, water pollution.
17. Insecticides, pesticides and chemical fertilisers.
18. Coal and coal tar as a source of many chemicals.
19. Ancient Indian medicines and medicinal plants.
20. Explosives - preparations and their uses.

### Practical File – 3 Marks

The Visiting Examiner is required to assess students on the basis of the Chemistry Practical file maintained by them during the academic year.

**NOTE:** According to the recommendation of International Union of Pure and Applied Chemistry (IUPAC), the groups are numbered from 1 to 18 replacing the older notation of groups IA ..... VIIA, VIII, IB ..... VIIB and 0. However, for the examination both notations will be accepted.

Old notation	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	0
New notation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18