

Chemistry Syllabus

There is one paper of two hours duration of 80 marks and Internal Assessment of practical work carrying 20 marks. The paper is divided into two sections: Section I (40 marks) and Section II (40 marks).

Section I (compulsory) contains short answer questions on the entire syllabus. Section II contains six questions. You are required to answer any four of these six questions.

1. Periodic Properties and variations of Properties - Physical and Chemical

(i) Periodic properties and their variations in groups and periods.

Definitions of following periodic properties and trends in these properties in groups and periods should be studied:

- atomic size
- metallic character
- non-metallic character
- ionisation potential
- electron affinity
- electronegativity

(ii) Periodicity on the basis of atomic number for elements.

Relation between atomic number for light elements (proton number) and atomic mass for light elements; the modern periodic table up to period 3 (students to be exposed to the complete modern periodic table but no questions will be asked on elements beyond period 3 - Argon); periodicity and other related properties to be described in terms of shells (not orbitals); special reference to the alkali metals and halogen groups.

2. Chemical Bonding

Electrovalent, covalent and co-ordinate bonding, structures of various compounds - orbit structure and electron dot structure.

Definition of Electrovalent Bond.

Structure of Electrovalent compounds NaCl, MgCl₂, CaO;

Characteristic properties of electrovalent compounds - state of existence, melting and boiling points, conductivity (heat and electricity), ionisation in solution, dissociation in solution and in molten state to be linked with electrolysis.

Covalent Bond - definition and examples, structure of Covalent molecules on the basis of duplet and octet of electrons (example: hydrogen, chlorine, nitrogen, water, ammonia,

carbon tetrachloride, methane.)

Characteristic properties of Covalent compounds - state of existence, melting and boiling points, conductivity (heat and electricity), ionisation in solution.

Comparison of Electrovalent and Covalent compounds.

Definition of Coordinate Bond: The lone pair effect of the oxygen atom of the water molecule and the nitrogen atom of the ammonia molecule to explain the formation of H_3O^+ and OH^- ions in water and NH_4^+ ion. The meaning of lone pair; the formation of hydronium ion and ammonium ion must be explained with help of electron dot diagrams.

3. Study of Acids, Bases and Salts

(i) Simple definitions in terms of the molecules and their characteristic properties. Self-explanatory.

(ii) Ions present in mineral acids, alkalis and salts and their solutions; use of litmus and pH paper to test for acidity and alkalinity.

Examples with equation for the ionisation/dissociation of ions of acids, bases and salts: acids form hydronium ions (only positive ions) which turn blue litmus red, alkalis form hydroxyl ions (only negative ions) with water which turns red litmus blue. Salts are formed by partial or complete replacement of the hydrogen ion of an acid by a metal should be explained with suitable examples. Introduction to pH scale to test for acidity, neutrality and alkalinity by using pH paper or Universal indicator.

(iii) Definition of salt; types of salts.

Types of salts: normal salts, acid salt, basic salt, definition and examples.

(iv) General properties of salts:

- Deliquescence, efflorescence, water of crystallization.

Definition and example of each of the above.

- Decomposition of hydrogen carbonates, carbonates, chlorides and nitrates by appropriate acids with heating if necessary. (relevant laboratory work must be done).

Action of dilute acids on carbonates, hydrogen carbonates and action of concentrated acid. Equations of formation of Acid rain. (Sulphuric acid) on chlorides and nitrates, to obtain carbon dioxide, hydrogen chloride and nitric acid, respectively should be taught. This will assist the students in their practical work.

(v) Preparation: laboratory preparation of salts (normal and acid salts) - relevant laboratory work is essential (no apparatus details are required).

Laboratory preparation of salts (normal and acid salts): Direct combination; decomposition; displacement; double decomposition; neutralization.

4. Analytical Chemistry - Use of Ammonium Hydroxide and Sodium Hydroxide

(i) On solution of salts: colour of salt and its solution; formation and colour of hydroxide precipitated for solutions of salts of Ca, Fe, Cu, Zn and Pb; special action of ammonium hydroxide on solutions of copper salt and sodium hydroxide on ammonium salts.

On solution of salts:

- Colour of salt and its solution.
- Action on addition of Sodium Hydroxide to solution of Ca, Fe, Cu, Zn, and Pb salts drop by drop in excess. Formation and colour of hydroxide precipitated to be highlighted. with the help of equations.
- Action on addition of Ammonium Hydroxide to solution of Ca, Fe, Cu, Zn, and Pb salts drop by drop in excess. Formation and colour of hydroxide precipitated to be highlighted with the help of equations.
- Special action of Ammonium Hydroxide on solutions of copper salts and sodium hydroxide on ammonium salts.

(ii) On certain metals and their oxides (relevant laboratory work is essential).

The metals must include zinc and aluminium, their oxides and their hydroxides, which react with caustic alkalis (NaOH, KOH), showing the amphoteric nature of these substances.

5. Mole Concept and Stoichiometry

(i) Gay Lussac's Law of Combining Volumes; Avogadro's Law.

Idea of mole - a number just as dozen, a gross; Avogadro's Law - statement and explanation; Gay Lussac's Law of Combining Volumes. - statement and explanation, "the mass of 22.4 litres of any gas at S.T.P. is equal to its molar mass". (Questions will not be set on formal proof but may be taught for clear understanding) - simple calculations based on the molar volume.

(ii) Refer to the atomicity of hydrogen, oxygen, nitrogen and chlorine (proof not required).

The explanation can be given using equations for the formation of HCl, NH₃, and NO.

(iii) Relative atomic masses (atomic weight) and relative molecular masses (molecular weights): either H=1 or ¹²C=12 will be accepted; molecular mass = 2 x vapour density (formal proof not required). Deduction of simple (empirical) and molecular formula from the percentage composition of a compound; the molar volume of a gas at S.T.P.; simple calculations based on chemical equations; both reacting weight and volumes.

Idea of relative atomic mass and relative molecular mass - standard H atom or $1/12^{\text{th}}$ of carbon 12 atom.

Relating mole and atomic mass; arriving at gram atomic mass and then gram atom; atomic mass is a number dealing with one atom; gram atomic mass is the mass of one mole of atoms.

Relating mole and molecular mass arriving at gram molecular mass and gram molecule - molecular mass is a number dealing with a molecule, gram molecular mass is the mass of one mole of molecules.

Molecular mass = $2 \times$ vapour density (questions will not be set on formal proof but may be taught for clear understanding); - simple calculations based on the formula. Deduction of simple (empirical) and molecular formula from the percentage composition of a compound.

6. Electrolysis

(i) Electrolytes and non-electrolytes. Definitions and examples.

(ii) Substances containing molecules only, ions only, both molecules and ions.

Substances containing molecules only, ions only, both molecules and ions. Examples; relating their composition with their behaviour as electrolyte (strong and weak), non-electrolyte.

Definition and explanation of electrolysis, electrolyte, electrode, anode, cathode, anion, cation, oxidation and reduction (on the basis of loss and gain of electrons).

(iii) An elementary study of the migration of ions, with reference to the factors influencing selective discharge of ions, illustrated by the electrolysis of: molten lead bromide; acidified water with platinum electrodes and aqueous copper (II) sulphate with copper electrodes; electron transfer at the electrodes.

The above electrolytic processes can be studied in terms of electrolyte used, electrodes used, ionization reaction, anode reaction, cathode reaction, use of selective discharge theory wherever applicable.

(iv) Applications of electrolysis: electroplating with nickel and silver; purification of copper; choice of electrolyte for electroplating.

Reasons and conditions for electroplating;; names of the electrolytes and the electrodes used should be given. Equations for the reactions at the electrodes should be given for electroplating, refining of copper.

(v) Acids, bases and salts as electrolytes: reference should be made to the activity series as indicating the tendency of metals, e.g. Na, Mg, Fe, Cu, to form ions.

7. Metallurgy

(i) Definition of Metals and Non-metals. Self-explanatory.

(ii) Position of the metals (alkali metals and alkaline earth metals) in the Periodic table and general characteristics applied to these elements with reference to the following – occurrence, nature, bonding, action of air, action of water, action of acids. Self-explanatory.

(iii) Comparison of Metals and Non-metals.

General properties with special reference to physical properties: state, lustre, melting point, density, ductility, malleability, brittleness, conduction of electricity (exceptions to be specifically noted - e.g. graphite, mercury); chemical properties: a metal forms at least one basic oxide; non-metal, an acidic or neutral oxide; discharge of metallic ions at the cathode from fused metallic chlorides (link with bonding and ion formation); many metals liberate hydrogen from dilute HCl and H₂SO₄.

In the physical properties of metals and non-metals, atomicity and valence electrons should also be included; suitable examples must be given for basic, acidic and neutral oxides; formation and discharge of ions at the cathode (metallic) and anode (non-metallic) should be explained with examples.

(iv) Reduction of metallic oxides; some can be reduced by hydrogen, carbon and carbon monoxide (e.g. copper oxide, lead oxide, iron (II) oxide) and some cannot (e.g. Al₂O₃, MgO) - refer to activity series).

Equations with conditions and observations should be given.

(v) Extraction of metals based on the activity series.

Extraction of metals: principle of extraction of metal from its compounds by reduction - carbon reduction, electrolytic reduction. Active metals by electrolysis e.g. sodium, aluminum (reference only).

(vi) Corrosion of iron and its prevention.

Experiment to illustrate that moisture and oxygen in air are responsible for the corrosion. Reaction of corrosion. Prevention by painting and galvanization.

(vii) Metals and their alloys: common ores of iron, aluminium and zinc. Extraction of Aluminium.

Metals and their alloys: Occurrence of metals in nature - mineral and ore. Common ores of iron, aluminium and zinc. Dressing of the ore – hydrolytic method, magnetic separation, froth flotation method, chemical method by using chemical - NaOH for purifying bauxite - Baeyer's Process.

Extraction of Aluminium: the constituents in the charge, method of electrolytic extraction (flow chart to be used); structure of electrolytic cell and reason for using cryolite, electrolyte, electrodes, electrode reaction.

Description of the changes occurring, purpose of the substances used and the main reactions with their equations.

(a) Uses of iron, aluminium and zinc and their alloys.

Uses of iron, aluminium and zinc and their alloys. Composition of their alloys - steel, duralumin, brass.

(b) Other important alloys – bronze, fuse metal and solder. Uses only.

8. Study of Compounds

Hydrogen Chloride

Hydrogen chloride: preparation of hydrogen chloride from sodium chloride; refer to the density and solubility of hydrogen chloride (fountain experiment); reaction with ammonia; acidic properties of its solution.

Preparation of hydrogen chloride from sodium chloride; (the laboratory method of preparation can be learnt in terms of reactants, product, condition, equation, diagram or setting of the apparatus, procedure, observation, precaution, collection of the gas and identification).

Simple experiment to show the density of the gas (Hydrogen Chloride) - heavier than air.

Solubility of hydrogen chloride (fountain experiment); (setting of the apparatus, procedure, observation, inference) - method of preparation of hydrochloric acid by dissolving the gas in water - the special arrangement and the mechanism by which the back suction is avoided should be learnt.

Reaction with ammonia

Acidic properties of its solution - (reaction with metals, their oxides, hydroxides and carbonates to give their chlorides; decomposition of carbonates, hydrogen carbonates, sulphides, sulphites, thiosulphates and nitrates).

Ammonia

(i) Ammonia: its laboratory preparation from ammonium chloride and collection; ammonia from nitrides like Mg_3N_2 and AlN and ammonium salts. Manufacture by Haber's Process; density and solubility of ammonia (fountain experiment); aqueous solution of ammonia; its reactions with hydrogen chloride and with hot copper (II) oxide and chlorine; the burning of ammonia in oxygen; uses of ammonia.

Laboratory preparation from ammonium chloride and collection (the preparation can be studied in terms of, setting of the apparatus and diagram, procedure, observation, collection and identification).

Manufacture of ammonia on a large scale - reference should be made to Haber Process for the manufacture of ammonia.

Ammonia from nitrides like Mg_3N_2 and AlN and ammonium salts; the reactions can be studied in terms of reactant, product, condition, equation.

Density and solubility of ammonia (fountain experiment); the property can be learnt in terms of setting of the apparatus, procedure and observation and inference.

Aqueous solution of ammonia - reaction with sulphuric acid, nitric acid, hydrochloric acid and solutions of iron(III) chloride, iron(II) sulphate, lead nitrate, zinc nitrate and copper sulphate.

Its reaction with: hydrogen chloride, hot copper (II) oxide, with chlorine in excess and ammonia in excess, burning of ammonia in oxygen; all these reactions may be studied in terms of reactants, products, condition, equation and observation; reference should be made to preparation of nitrogen from air and from ammonium nitrite.

Uses of ammonia - manufacture of fertilizers, explosives, nitric acid, refrigerant gas (Chlorofluoro carbon - and its suitable alternatives which are non-ozone depleting), cleansing agents, source of hydrogen.

(ii) The catalytic oxidation of ammonia, as the source of nitric acid; (refer to Ostwald process) simple diagram for a catalytic oxidation of ammonia in the laboratory (with conditions and reactions only). Self-explanatory.

Nitric Acid

Nitric Acid: one laboratory method of preparation of nitric acid from potassium nitrate or sodium nitrate. Nitric acid as an oxidizing agent.

Nitric Acid: Laboratory method of preparation of nitric acid from potassium nitrate or sodium nitrate; the laboratory method can be studied in terms of reactant, product, condition, equation, setting, diagram, precaution, collection, identification.

As an oxidising agent: its reaction with copper, carbon, sulphur.

Sulphuric Acid

Sulphuric Acid: its behaviour as an acid when dilute, as an oxidizing agent when concentrated - oxidation of carbon and sulphur; as a dehydrating agent - dehydration of sugar and copper (II) sulphate crystals; its non-volatile nature.

Manufacture by Contact process (reference only). Detail of the process to be avoided.

Its behaviour as an acid when dilute - reaction with metal, metal oxide, metal hydroxide, metal carbonate, metal bicarbonate, metal sulphite, metal sulphide.

Concentrated sulphuric acid as an oxidizing agent - the oxidation of carbon and sulphur.

Concentrated sulphuric acid as a dehydrating agent- (a) the dehydration of sugar (b) Copper(II) sulphate crystals.

Non-volatile nature of sulphuric acid - reaction with sodium or potassium chloride and sodium or potassium nitrate.

9. Organic Chemistry

(i) Introduction to Organic compounds.

Unique nature of Carbon atom - tetra valency, catenation, formation of single, double and triple bonds, straight chain, branched chain and cyclic compounds.

(ii) Structure and Isomerism.

Structure of compounds with single, double and triple bonds; Isomerism - structural (chain, position)

(iii) Homologous series - characteristics with examples.

Alkane, alkene, alkyne series and their gradation in properties and the relationship with the molecular mass or molecular formula.

(iv) Simple nomenclature.

Simple nomenclature - of the hydrocarbons with simple functional groups - (double bond, triple bond, alcoholic, ether, aldehydic, keto, carboxylic group) longest chain rule and smallest number for functional groups rule - trivial and IUPAC names.

(v) Hydrocarbons: alkanes, alkenes, alkynes.

Alkanes - general formula; methane (green house gas) and ethane - methods of preparation from sodium ethanoate (sodium acetate), sodium propanoate (sodium propionate), from iodomethane (methyl iodide) and bromoethane (ethyl bromide). Oxidation of methane and ethane in presence of oxygen under suitable conditions, reaction of methane and ethane with chlorine through substitution.

Alkenes - (unsaturated hydrocarbons with a double bond); ethene as an example. Methods of preparation of ethene by dehydro halogenation reaction and dehydration reactions.

Alkynes - (unsaturated hydrocarbons with a triple bond); ethyne as an example of alkyne; Methods of preparation from calcium carbide and 1,2 dibromoethane ethylene dibromide). Only main properties, particularly addition products with hydrogen and halogen namely Cl, Br and I; structural formulae of hydrocarbons. Structural formula must be given for: alkanes (up to butane), alkene (C_2H_4); alkynes (C_2H_2). Uses of methane, ethane, ethene, acetylene.

(vi) Alcohols: ethanol - preparation, properties and uses.

Preparation of ethanol:

- hydration of ethene;
- by hydrolysis of alkyl halide;

Properties - Physical: Nature, Solubility, Density, Boiling Points. Chemical: Combustion, Oxidation with acidified Potassium dichromate, action with sodium, ester formation with acetic acid, dehydration with conc. Sulphuric acid with reference to Ethanol.

Denatured alcohol

Important uses of Ethanol.

(vii) Carboxylic acids (aliphatic - mono carboxylic acid):

Acetic acid - preparation, properties and uses of acetic acid.

Preparation of acetic acid from Ethyl alcohol. Properties of Acetic Acid: Physical properties - odour (vinegar), glacial acetic acid (effect of sufficient cooling to produce ice like crystals). Chemical properties - action with litmus, alkalis and alcohol (idea of esterification).

Uses of acetic acid.