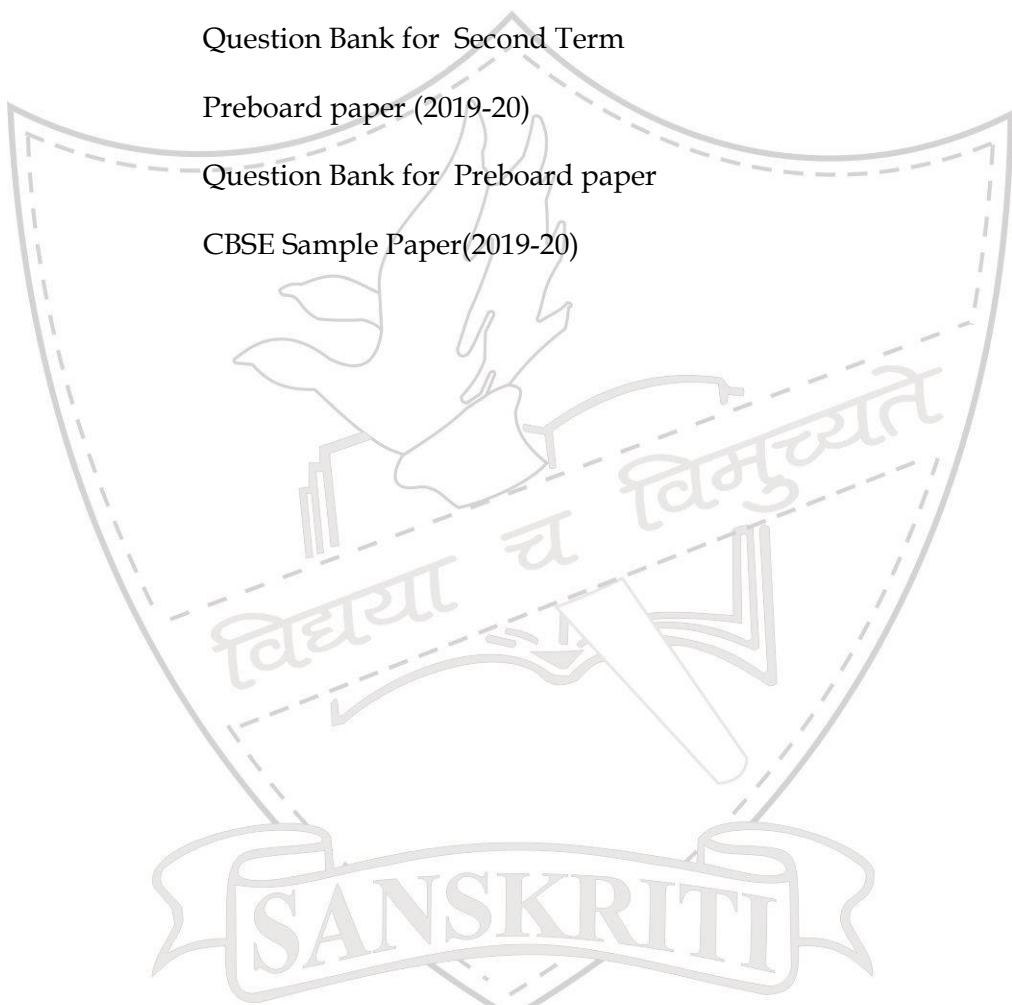


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CLASS XII (2020-21)

(THEORY)

Total Periods (For Theory -150 + For Practical -60)**Time: 3 Hours****70 Marks**

Unit No.	Title	No. of Periods	Marks
Unit I	Solid State	10	
Unit II	Solutions	10	
Unit III	Electrochemistry	12	23
Unit IV	Chemical Kinetics	10	
Unit V	Surface Chemistry	08	
Unit VI	General Principles and Processes of Isolation of Elements	08	
Unit VII	p -Block Elements	12	19
Unit VIII	d -and f -Block Elements	12	
Unit IX	Coordination Compounds	12	
Unit X	Haloalkanes and Haloarenes	10	
Unit XI	Alcohols, Phenols and Ethers	10	
Unit XII	Aldehydes, Ketones and Carboxylic Acids	10	
Unit XIII	Organic Compounds containing Nitrogen	10	28
Unit XIV	Biomolecules	12	
Unit XV	Polymers	08	
Unit XVI	Chemistry in Everyday Life	06	
Total		160	70

Unit I: Solid State**10 Periods**

Classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea). Unit cell in two dimensional and three dimensional lattices, calculation of density of unit cell, packing in solids, packing efficiency, voids, number of atoms per unit cell in a cubic unit cell, point defects, electrical and magnetic properties.

Band theory of metals, conductors, semiconductors and insulators and n and p type semiconductors.

Unit II: Solutions**10 Periods**

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, colligative properties - relative lowering of vapour pressure, Raoult's law, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Van't Hoff factor.

Unit III: Electrochemistry**12 Periods**

Redox reactions, conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's Law, electrolysis and law of electrolysis (elementary idea), dry cell -electrolytic cells and Galvanic cells, lead accumulator, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, Relation between Gibb's energy change and EMF of a cell, fuel cells, corrosion.

Unit IV: Chemical Kinetics**10 Periods**

Rate of a reaction (Average and instantaneous), factors affecting rate of reaction: concentration, temperature, catalyst; order and molecularity of a reaction, rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions), concept of collision theory (elementary idea, no mathematical treatment). Activation energy, Arrhenius equation.

Unit V: Surface Chemistry**08 Periods**

Adsorption - physisorption and chemisorption, factors affecting adsorption of gases on solids, catalysis, homogenous and heterogenous activity and selectivity; enzyme catalysis colloidal

state distinction between true solutions, colloids and suspension; lyophilic, lyophobic multimolecular and macromolecular colloids; properties of colloids; Tyndall effect, Brownian movement, electrophoresis, coagulation, emulsion - types of emulsions.

Unit VI: General Principles and Processes of Isolation of Elements 08 Periods

Principles and methods of extraction - concentration, oxidation, reduction - electrolytic method and refining; occurrence and principles of extraction of aluminium, copper, zinc and iron.

Unit VII: p-Block Elements 12 Periods

Group 15 elements: General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties; nitrogen - preparation, properties and uses; compounds of nitrogen: preparation and properties of ammonia and nitric acid, oxides of nitrogen (structure only); Phosphorous-allotropic forms; compounds of phosphorous: preparation and properties of phosphine, halides (PCl_3 , PCl_5) and oxoacids (elementary idea only)

Group 16 Elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties, dioxygen: Preparation, Properties and uses, classification of Oxides, Ozone, Sulphur -allotropic forms; compounds of Sulphur: Preparation Properties and uses of Sulphur-dioxide, Sulphuric Acid: industrial process of manufacture, properties and uses; Oxoacids of Sulphur (Structures only).

Group 17 Elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; compounds of halogens, Preparation, properties and uses of Chlorine and Hydrochloric acid, interhalogen compounds, Oxoacids of halogens (structures only).

Group 18 Elements: General introduction, electronic configuration, occurrence, trends in physical and chemical properties, uses.

Unit VIII: "d" and "f" Block Elements 12 Periods

General introduction, electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals - metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation, preparation and properties of $\text{K}_2\text{Cr}_2\text{O}_7$ and KMnO_4 .

Lanthanoids - Electronic configuration, oxidation states, chemical reactivity and lanthanoid contraction and its consequences.

Actinoids - Electronic configuration, oxidation states and comparison with lanthanoids.

Unit IX: Coordination Compounds

12 Periods

Coordination compounds - Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds. Bonding, Werner's theory, VBT, and CFT; structure and stereoisomerism, importance of coordination compounds (in qualitative inclusion, extraction of metals and biological system)

Unit X: Haloalkanes and Haloarenes.

10 Periods

Haloalkanes: Nomenclature, nature of C-X bond, physical and chemical properties, mechanism of substitution reactions, optical rotation.

Haloarenes: Nature of C-X bond, substitution reactions (Directive influence of halogen in monosubstituted compounds only).

Uses and environmental effects of - dichloromethane, trichloromethane, tetrachloromethane, iodoform, freons, DDT.

Unit XI: Alcohols, Phenols and Ethers

10 Periods

Alcohols: Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only), identification of primary, secondary and tertiary alcohols, mechanism of dehydration, uses with special reference to methanol and ethanol.

Phenols: Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols.

Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses.

Unit XII: Aldehydes, Ketones and Carboxylic Acids

10 Periods

Aldehydes and Ketones: Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes: uses.

Carboxylic Acids: Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

Unit XIII: Organic compounds containing Nitrogen**10 Periods**

Amines: Nomenclature, classification, structure, methods of preparation, physical and chemical properties, uses, identification of primary, secondary and tertiary amines.

Cyanides and Isocyanides - will be mentioned at relevant places in text.

Diazonium salts: Preparation, chemical reactions and importance in synthetic organic chemistry.

Unit XIV: Biomolecules**12 Periods**

Carbohydrates - Classification (aldoses and ketoses), monosaccharides (glucose and fructose), D-L configuration oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen); Importance of carbohydrates.

Proteins - Elementary idea of - amino acids, peptide bond, polypeptides, proteins, structure of proteins - primary, secondary, tertiary structure and quaternary structures (qualitative idea only), denaturation of proteins; enzymes. Hormones - Elementary idea excluding structure.

Vitamins - Classification and functions.

Nucleic Acids: DNA and RNA.

Unit XV: Polymers**08 Periods**

Classification - natural and synthetic, methods of polymerization (addition and condensation), copolymerization, some important polymers: natural and synthetic like polythene, nylon, polyesters, bakelite, rubber. Biodegradable and non-biodegradable polymers.

Unit XVI Chemistry in Everyday life**06 Periods**

Chemicals in medicines - analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines.

Chemicals in food - preservatives, artificial sweetening agents, elementary idea of antioxidants.

Cleansing agents- soaps and detergents, cleansing action.

CHEMISTRY (CODE-043)
QUESTION PAPER DESIGN
CLASS - XII (2020-21)

Time 3 Hours

Max. Marks: 70

S. No .	Typology of Questions	Very Short Answer (VSA) (1 mark)	Short Answer-I (SA-I) (2 marks)	Short Answer-II (SA-II) (3 marks)	Long Answer (L.A.) (5 marks)	Total Marks	% Weigh-tage
1	Remembering (Knowledge based Simple recall questions, to know specific facts, terms, concepts, principles, or theories, Identify, define, or recite, information)	2	1	1	-	7	10%
2	Understanding- (Comprehension -to be familiar with meaning and to understandconceptually, interpret, compare, contrast, explain,paraphrase information)	6	2	2	1	21	30%
3	Application (Use abstract information in concrete situation, to apply knowledge to new situations, Use given content to interpret asituation, provide an example, or solve a problem)	6	2	2	1	21	30%
4	High Order Thinking Skills (Analysis &Synthesis-Classify,compare, contrast, or differentiate between different pieces of information, Organize and/or integrate unique pieces of information from a variety of sources)	6	1	2	-	14	20%

5	Evaluation and Multi Disciplinary- (Appraise, judge, and/or justify the value or worth of a decision or outcome, or to predict outcomes based on values)	-	1		1	7	10%
	TOTAL	$20 \times 1 = 20$	$7 \times 2 = 14$	$7 \times 3 = 21$	$3 \times 5 = 15$	70(37)	100%



QUESTION WISE BREAK UP

Type of Question(s)	Mark(s) per Question	Total No. of Questions	Total Marks
VSA	1	20	20
SA-I	2	7	14
SA-II	3	7	21
LA	5	3	15
Total		37	70

- Internal Choice:** There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.
- The above template is only a sample. Suitable internal variations may be made for generating similar templates keeping the overall weightage to different form of questions and typology of questions same.

PRACTICALS

Evaluation Scheme for Examination	Marks
Volumetric Analysis	08
Salt Analysis	08
Content Based Experiment	06
Project work	04
Class record and viva	04
Total	30

PRACTICALS SYLLABUS

60 Periods

Micro-chemical methods are available for several of the practical experiments.
Wherever possible, such techniques should be used.

A. Surface Chemistry

- (a) Preparation of one lyophilic and one lyophobic sol
 - Lyophilic sol - starch, egg albumin and gum
 - Lyophobic sol - aluminium hydroxide, ferric hydroxide, arsenous sulphide.
- (b) Dialysis of sol-prepared in (a) above.
- (c) Study of the role of emulsifying agents in stabilizing the emulsion of different oils.

B. Chemical Kinetics

- (a) Effect of concentration and temperature on the rate of reaction between Sodium Thiosulphate and Hydrochloric acid.
- (b) Study of reaction rates of any one of the following:
 - (i) Reaction of Iodide ion with Hydrogen Peroxide at room temperature using different concentration of Iodide ions.
 - (ii) Reaction between Potassium Iodate, (KIO_3) and Sodium Sulphite: (Na_2SO_3) using starch solution as indicator (clock reaction).

C. Thermochemistry

- Any one of the following experiments
- i) Enthalpy of dissolution of Copper Sulphate or Potassium Nitrate.
 - ii) Enthalpy of neutralization of strong acid (HCl) and strong base (NaOH).
 - iii) Determination of enthalpy change during interaction (Hydrogen bond formation) between Acetone and Chloroform.

D. Electrochemistry

Variation of cell potential in $\text{Zn}/\text{Zn}^{2+} \parallel \text{Cu}^{2+}/\text{Cu}$ with change in concentration of electrolytes (CuSO_4 or ZnSO_4) at room temperature.

E. Chromatography

- Separation of pigments from extracts of leaves and flowers by paper chromatography and determination of R_f values.
- Separation of constituents present in an inorganic mixture containing two cations only (constituents having large difference in R_f values to be provided).

F. Preparation of Inorganic Compounds

- Preparation of double salt of Ferrous Ammonium Sulphate or Potash Alum.
- Preparation of Potassium Ferric Oxalate.

G. Preparation of Organic Compounds

Preparation of any one of the following compounds

- Acetanilide
- Di -benzal Acetone
- p-Nitroacetanilide
- Aniline yellow or 2 - Naphthol Aniline dye.

H. Tests for the functional groups present in organic compounds:

Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (Primary) groups.

I. Characteristic tests of carbohydrates, fats and proteins in pure samples and their detection in given food stuffs.**J. Determination of concentration/ molarity of KMnO_4 solution by titrating it against a standard solution of:**

- Oxalic acid,
- Ferrous Ammonium Sulphate

(Students will be required to prepare standard solutions by weighing themselves).

K. Qualitative analysis

Determination of one cation and one anion in a given salt.

Cation- NH_4^+ , Pb^{2+} , Cu^{2+} As^{3+} , Al^{3+} , Fe^{3+} , Mn^{2+} , Zn^{2+} , Co^{2+} , Ni^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mg^{2+}

Anions- CO_3^{2-} , S^{2-} , SO_3^{2-} , SO_4^{2-} , NO_2^- , NO_3^- , Cl^- , Br^- , I^- , PO_4^{3-} ; CH_3COO^-

(Note: Insoluble salts excluded)

PROJECT

Scientific investigations involving laboratory testing and collecting information from other sources.

A few suggested Projects.

- Study of the presence of oxalate ions in guava fruit at different stages of ripening.
- Study of quantity of casein present in different samples of milk.
- Preparation of soybean milk and its comparison with the natural milk with respect to curd formation, effect of temperature, etc.
- Study of the effect of Potassium Bisulphite as food preservative under various conditions (temperature, concentration, time, etc.)
- Study of digestion of starch by salivary amylase and effect of pH and temperature on it.
- Comparative study of the rate of fermentation of following materials: wheat flour, gram flour, potato juice, carrot juice, etc.
- Extraction of essential oils present in Saunf (aniseed), Ajwain (carom), Illaichi (cardamom).
- Study of common food adulterants in fat, oil, butter, sugar, turmeric powder, chilli powder and pepper.

Note: Any other investigatory project, which involves about 10 periods of work, can be chosen with the approval of the teacher.

MONTHWISE SYLLABUS DISTRIBUTION

MONTHS: March, April, May

Unit V: Surface Chemistry

Adsorption - physisorption and chemisorption, factors affecting adsorption of gases on solids, colloids distinction between true solutions, colloids and suspension; lyophilic, lyophobic multimolecular and macromolecular colloids; properties of colloids; Tyndall effect, Brownian movement, electrophoresis, coagulation, emulsion - types of emulsions.

Unit VI: General Principles and Processes of Isolation of Elements

(Periods 8)

Principles and methods of extraction - concentration, oxidation, reduction electrolytic method and refining; occurrence and principles of extraction of aluminium, copper, zinc and iron.

Unit XV: Polymers

(Periods 8)

Classification - natural and synthetic, methods of polymerization (addition and condensation), copolymerization. Some important polymers: natural and synthetic like polythene, nylon, polyesters, bakelite, rubber. Biodegradable and non- biodegradable polymers.

Unit XVI: Chemistry in Everyday life

(Period 8)

Chemicals in medicines - analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines.

Chemicals in food - preservatives, artificial sweetening agents.

Cleansing agents - soaps and detergents, cleansing action

Unit IX: Coordination Compounds

(Period 12)

Coordination Compounds - Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds. bonding; isomerism, importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems).

Unit VIII: d and f Block Elements

(Period 14)

General introduction, electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals - metallic character, ionization enthalpy, oxidation states, ionic radii, colour catalytic property,

magnetic properties, interstitial compounds, alloy formation preparation and properties of $K_2Cr_2O_7$ and $KMnO_4$.

Lanthanoids - electronic configuration, oxidation states, chemical reactivity and lanthanoid contraction.

Actinoids - Electronic configuration, oxidation states.

Practicals:

EXPERIMENT- 1-6

Qualitative analysis

Determination of one cation and one anion in a given salt.

Cations - Pb^{2+} Cu^{2+} As^{3+} Al^{3+} Fe^{3+} Mn^{2+} Zn^{2+} Co^{2+} Ni^{2+} Ca^{2+} Sr^{2+} Ba^{2+} Mg^{2+} NH_4^+

Anions - CO_3^{2-} , S^{2-} , SO_3^{2-} , SO_4^{2-} , NO_2^- , NO_3^- , Cl^- , Br^- , I^- , PO_4^{3-} ; CH_3COO^-

(Note: Insoluble salts excluded)

PROJECT WORK

MONTH : JULY

Unit III: Electrochemistry

(Periods 14)

Redox reactions, conductance in electrolytic solutions, specific and molar conductivity variations of conductivity with concentration, Kohlrausch's Law, electrolysis and laws of electrolysis (elementary idea), dry cell- electrolytic cells and Galvanic cells; lead accumulator, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, fuel cells; corrosion.

Unit IV: Chemical Kinetics

(Periods 12)

Rate of a reaction (average and instantaneous), factors affecting rate of reaction; concentration, temperature, catalyst; order and molecularity of a reaction; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment), Activation energy, Arrhenius equation

Unit II: Solutions

(Periods 12)

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, colligative properties - relative lowering of vapour pressure, elevation of Boiling Point, depression of freezing point, osmotic pressure,

determination of molecular masses using colligative properties, abnormal molecular mass, Van't Hoff factor.

MONTH : AUGUST

Unit I: Solid State

10 Periods

Classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea). Unit cell in two dimensional and three dimensional lattices, calculation of density of unit cell, packing in solids, packing efficiency, voids, number of atoms per unit cell in a cubic unit cell, point defects, electrical and magnetic properties.

Band theory of metals, conductors, semiconductors and insulators and n and p type semiconductors.

Unit VI: p-Block Elements

(Periods 14)

Group 15 elements: General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties; nitrogen - preparation, properties and uses; compounds of nitrogen: preparation and properties of ammonia and nitric acid, oxides of nitrogen (structure only); Phosphorous-allotropic forms; compounds of phosphorous: preparation and properties of phosphine, halides (PCl_3 , PCl_5) and oxoacids (elementary idea only).

Group 16 elements: General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; dioxygen: preparation, properties and uses; simple oxides; Ozone. Sulphur - allotropic forms; compounds of sulphur: preparation, properties and uses of sulphur dioxide; sulphuric acid: industrial process of manufacture, properties and uses, oxoacids of sulphur (structures only).

Group 17 elements: General introduction, electronic configuration, oxidation states, trends in physical and chemical properties; compounds of halogens: preparation, properties and uses of chlorine and hydrochloric acid, interhalogen compounds, oxoacids of halogens I (structures only).

Group 18 elements: General introduction, electronic configuration. Occurrence, trends in physical and chemical properties, uses.

Unit X: Haloalkanes and Haloarenes

(Periods 12)

Haloalkanes: Nomenclature, nature of C-X bond, physical and chemical properties, mechanism of substitution reactions.

Haloarenes: Nature of C-X bond, substitution reactions (directive influence of halogen for monosubstituted compounds only). Uses and environmental effects of - dichloromethane, trichloromethane, tetrachloromethane, iodoform, freons, DDT.

MONTH: SEPTEMBER- OCTOBER**Unit XI: Alcohols, Phenols and Ethers**

(Periods 12)

Alcohols: Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only); identification of primary, secondary and tertiary alcohols; mechanism of dehydration, uses of methanol and ethanol

Phenols: Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols.

Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses.

Unit XII: Aldehydes, Ketones and Carboxylic Acids

(Periods 12)

Aldehydes and Ketones: Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties mechanism of nucleophilic addition.

EXPERIMENT No.: 7-8

Determination of concentration/molarity of KMnO_4 solution by titrating it against a standard solution of:

- i) Oxalic acid,
- ii) Ferrous ammonium sulphate

(Students will be required to prepare standard solutions by weighing themselves).

EXPERIMENT No.: 9, 10

Effect of concentration on the rate of reaction between sodium thiosulphate and hydrochloric acid

Effect of temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid

Unit XII: Aldehydes, Ketones and Carboxylic Acids (Continued)

(Periods 12)

Aldehydes and Ketones : Reactivity of alpha hydrogen in aldehydes, chemical reactivity; uses.

Carboxylic Acids: Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

EXPERIMENT No.: 13-18**Tests for the functional groups present in organic compounds:**

Alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (primary) groups.

EXPERIMENT No.: 19-20**Preparation of Inorganic Compounds:**

- i) Preparation of double salt of ferrous ammonium sulphate
- ii) Preparation of double salt of potash alum.

EXPERIMENT No.: 20-21

Preparation of one lyophilic and one lyophobic sol.

- (a) Lyophilic sol- starch
- (b) Lyophobic sol- ferric hydroxide.

EXPERIMENT No.: 21-23

Characteristic tests of carbohydrates, fats and proteins in pure samples and their detection in given food stuffs.

EXPERIMENT No.: 24**Chromatography**

To separate the constituents present in an inorganic mixture containing Fe^{3+} and Cu^{2+} using paper chromatography and determination of their R_f values.

EXPERIMENT No.: 25

Preparation of Di-benzal Acetone

MONTH: NOVEMBER**Unit XIII: Organic compounds containing Nitrogen**

(Period 10)

Amines: Nomenclature, classification, structure, methods of preparation, physical and chemical properties, uses, identification of primary, secondary and tertiary amines.

Cyanides and Isocyanides - will be mentioned at relevant places in context.

Diazonium salts: Preparation, chemical reactions and importance in synthetic organic chemistry.

Unit XIV: Biomolecules

(Periods 12)

Carbohydrates - Classification (aldoses and ketoses), monosaccharides (glucose and fructose), oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen); importance.

Proteins - Elementary idea of α - amino acids, peptide bond, polypeptides, proteins, structure of amines-primary, secondary, tertiary structure and quaternary structures (qualitative idea only), denaturation of proteins; enzymes.

Vitamins -Classification and functions. Nucleic Acids: DNA and RNA.



Assignment
Chapter 1: Solid State

1. In which pair most efficient packing is present?
 - (i) hcp and bcc
 - (ii) hcp and ccp
 - (iii) bcc and ccp
 - (iv) bcc and simple cubic cell

2. Which kind of defects are introduced by doping?
 - (i) Dislocation defect
 - (ii) Schottky defect
 - (iii) Frenkel defects
 - (iv) Electronic defects

3. (a) An element has atomic mass 93 g mol⁻¹ and density 11.5 g cm⁻³. If the edge length of its unit cell is 300 pm, identify the type of unit cell.
 (b) Write any two differences between amorphous solids and crystalline solids.

4. (a) Calculate the number of unit cells in 8.1 g of aluminium if it crystallizes in a f.c.c. structure. (Atomic mass of Al = 27 g mol⁻¹)
 (b) Give reasons :
 - (i) In stoichiometric defects, NaCl exhibits Schottky defect and not Frenkel defect.
 - (ii) Silicon on doping with Phosphorus forms n-type semiconductor.
 - (iii) Ferrimagnetic substances show better magnetism than antiferromagnetic substances.

5. What is the maximum possible coordination number of an atom in
 - (a) hcp crystal structure
 - (b) ccp crystal structure of an element?

6. a) What is meant by 'doping' in a semiconductor?
 b) Account for the following:
 - (i) Impurity doped silicon is a semiconductor.
 - (ii) alkali metal halides sometimes coloured, which are otherwise colourless

7. Which point defect in crystals
 - (i) does not alter the density of the solid
 - (ii) decreases the density of the solid
 - (iii) Increases the density of the solid?

8. Classify each of the following solids as ionic, metallic, molecular, network (covalent) or amorphous.

a) tetra phosphorus decaoxide (P_4O_{10})	(c) Graphite
b) Brass	(d) Ammonium Phosphate
e) Rb	(f) SiC

9. Examine the illustration of a portion of the defective crystal given below and answer the

following questions.

- (a) What are these type of vacancy defects called?
- (b) How is the density of a crystal affected by these defects?
- (c) What type of ionic substances show such defect?
- (d) How is the stoichiometry of the compound affected?

10 . In an ionic compound the anion (N-) form cubic close type of packing. While the cation (M⁺) ions occupy one third of the tetrahedral voids. Deduce the empirical formula of the compound and the coordination number of (M⁺) ions.

11. What is the formula of a compound in which the element Y forms the ccp lattice and atom X occupy 1/3rd of the tetrahedral voids?

12. (i) What type of magnetism is shown in the following alignment of magnetic moment?

$$\uparrow \downarrow \downarrow \uparrow \downarrow \downarrow \uparrow$$

(ii) What type of semiconductor is produced when boron is doped with silicon?

(iii) What type of magnetism is shown by a substance if magnetic moments of domains are arranged in same direction ?

13. Tungsten crystallizes in body centred cubic unit cell. If the edge of the unit cell is 316.5 pm, what is the radius of tungsten atom? (r = 137 pm)

14. An element with density 11.2 gcm⁻³ forms a f.c.c. lattice with edge length of 4 X 10⁻⁸ cm. Calculate the atomic mass of the element. (Given: N_A= 6.022 × 10²³ mol⁻¹)

15. An element crystallizes in a f.c.c. lattice with cell edge of 250 pm. Calculate the density if 300 g of this element contain 2 X 10⁻²⁴ atoms.

16. Analysis shows that metal oxide has the formula M0.96O. What fractions of metal exist as M²⁺ and M³⁺ ions? (M²⁺ = 0.916; M³⁺ = 0.08)

17. Iron has a body centred cubic unit cells with cell edge of 286.65 pm. The density of iron is 7.874 g cm⁻³. Use this information to calculate Avogadro's number. (At. Mass of Fe = 55.845 gmol⁻¹) (6.02 × 10²³ mol⁻¹)

18.Explain the following with suitable examples:

- (i) n-type semiconductor
- (ii) Paramagnetism
- (iii) Ferromagnetism

More Practice
Solid State

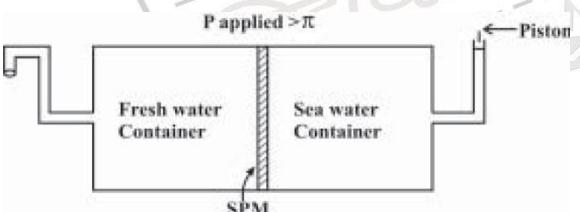
1. The well known mineral fluorite is chemically calcium fluoride. It is known that in one unit cell of this mineral there are 4 Ca²⁺ ions and 8F⁻ ions and that Ca²⁺ ions are arranged in a fcc lattice. The F⁻ ions fill all tetrahedral holes in the face centred cubic lattice of Ca²⁺ ions. The edge of the unit cell is 5.46×10^{-8} cm in length. The density of the solid is 3.18 g cm⁻³. Use this information to calculate Avogadro's number (Molar mass of Ca F₂ = 78.08 g mol⁻¹)
2. Analysis shows that Nickel oxide has the formula Ni0.98O. What fractions of metal exist as Ni⁺² and Ni⁺³ ions?
3. Aluminium metal forms a ccp crystal structure. Its atomic radius is 125×10^{-12} m.
 - i) Calculate the length of the side of the unit cell.
 - ii) How many such unit cells are there in 1.00 m³ of Aluminium?
4. An element has a body centered cubic structure with a cell edge of 288 pm. The density of the element is 7.2 g/cm³. Calculate the number of atoms present in 208 g of the element.
5. Sodium has a bcc structure with nearest neighbor distance 365.9 pm. Calculate its density. (Na = 23 u)

Assignment
Chapter 2: Solutions

1. An ideal solution of two liquids is a solution in which each component obeys Raoult's law which states that the vapour pressure of any component in the solution depends on the mole fraction of that component in the solution and the vapour pressure of that component in the pure state. However, there are many solutions which do not obey Raoult's law. In other words, they show deviations from ideal behavior which may be positive or negative. However, in either case, corresponding to a particular composition, they form constant boiling mixtures called azeotropes.
 - (a) Give an example of a mixture showing positive deviation and negative deviation from Raoult's law?
 - (b) When an azeotropic solution of two liquids has boiling point lower than either of the two liquids, what type of azeotrope will it be?
 - (c) A solution has a 1:4 mole ratio of pentane to hexane. The vapour pressures of the pure hydrocarbons at 20°C are 440mm of Hg for pentane and 120mm of Hg for hexane in the vapour phase. Calculate the mole fraction of pentane in the vapour phase? (0.478)
2. van't Hoff factors x, y, z for association, dissociation and no change of solute in the solution respectively are in the order:
 - (a) $x < y < z$
 - (b) $x > z > y$
 - (c) $x < z < y$
 - (d) $x > y > z$

In Q3 and Q4, a statement of assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements mark the correct answer as:

- (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
- (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
- (iii) Assertion is correct statement but reason is wrong statement.
- (iv) Assertion and reason both are incorrect statements.
- (v) Assertion is wrong statement but reason is correct statement
3. Assertion: 0.1 M solution of glucose has higher increment in the freezing point than 0.1 M solution of urea.
 Reason: K_f for both has different values.
4. Assertion: Molarity of a solution in liquid state changes with temperature.
 Reason: The volume of a solution changes with change in temperature.
5. Calculate the freezing point of a solution containing 60 g of glucose. (Molar mass = 180 g mol⁻¹) in 250 g of water. (K_f of water = 1.86 K kg mol⁻¹) (-2.48°C)
6. Give reasons for the following:

- (i) Measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers.
- (ii) Aquatic animals are more comfortable in cold water than in warm water.
- (iii) Elevation of boiling point of 1M KCl solution is nearly double than that of 1 M sugar solution.
7. A 10% solution (by mass) of sucrose in water has freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water, if freezing point of pure water is 273.15 K.
Given : (Molar mass of sucrose = 342 g mol⁻¹, Molar mass of glucose = 180 g mol⁻¹)
8. State the formula relating pressure of a gas with its mole fraction in a liquid solution in contact with it. Name the law and mention its two applications.
9. Two liquids A and B boil at 145°C and 190°C respectively. Which of them has a higher vapour pressure at 80°C?
10. (a) Why is the vapour pressure of a solution of glucose in water lower than that of water?
 (b) A 6.90 M solution of KOH in water contains 30% by mass of KOH. Calculate the density of the KOH solution? (molar mass of KOH = 56 g/mol)
 (1.288 g/ml)
11. Explain with suitable examples in each case why the molar masses of some substances determined with the help of colligative properties are (i) higher (ii) lower than actual values.
12. Given below is the sketch of a plant for carrying out a process.
- 
- (i) Name the process occurring in the above plant.
 (ii) To which container does the net flow of solvent take place?
 (iii) Name one SPM which can be used in this plant.
 (iv) Give one practical use of the plant.
13. Calculate the freezing point of solution when 1.9 g of MgCl₂(M=95 g mol⁻¹) was dissolved in 50 g of water, assuming MgCl₂ undergoes complete ionization. (K_f for water = 1.86 K kg mol⁻¹)
14. a) Out of 1 M glucose and 2 M glucose, which one has a higher boiling point and why?
 b) What happens when the external pressure applied becomes more than the osmotic pressure of solution ?

15. State Raoult's law for solutions of volatile liquids. Taking suitable examples explain the meaning of positive and negative deviations from Raoult's law. What is the sign of ΔH_{mix} for positive deviation?
16. a) Define the term osmotic pressure. Describe how the molecular mass of a substance can be determined by a method based on measurement of osmotic pressure.
b) Determine the osmotic pressure of a solution prepared by dissolving 0.025g of K_2SO_4 in 2L of water at $25^\circ C$, assuming that it is completely dissociated.
($R=0.0821 \text{ L atm/K/mol}$, molar mass of $K_2SO_4 = 174\text{g/mol}$)
17. 15 g of an unknown molecular material was dissolved in 450 g of water. The resulting solution was found to freeze at $-0.34^\circ C$. What is the molar mass of this material? K_f for water = $1.86 \text{ K Kg mol}^{-1}$. (182 g mol $^{-1}$)
18. A solution is prepared by dissolving 1.25g of oil of winter green (methyl salicylate) in 99.0g of benzene has a boiling point of $80.31^\circ C$. Determine the molar mass of this compound. (B.P. of pure benzene = $80.10^\circ C$ and K_b for benzene = $2.53^\circ C \text{ kg mol}^{-1}$) (152.21 g/mol)
19. A 1.00 molal aqueous solution of trichloroacetic acid (CCl_3COOH) is heated to its boiling point. The solution has the boiling point of $100.18^\circ C$. Determine the van't Hoff factor for trichloroacetic acid (K_b for water = $0.512 \text{ K Kg mol}^{-1}$). (i = 0.35)

More Practice
Chapter 1: Solutions

1. Calculate the temperature at which a solution containing 54 g of glucose, ($C_6H_{12}O_6$), in 250g of water will freeze (K_f for water = 1.86 K mol⁻¹ Kg).
2. Why it is better to find molality of a solution than its molarity?
3. The Henry law constant for oxygen dissolved in water is 4.34×10^4 atm at 25°C. If the partial pressure of oxygen in air is 0.2 atm. under ordinary atmospheric conditions. Calculate the concentration (in moles per litre) of dissolved oxygen in water in equilibrium with air at 25°C.
4. Define the following terms:
 - a) Mole fraction
 - b) Isotonic solutions
 - c) Van't Hoff factor
 - d) ideal solution.
 - e) Colligative properties
 - f) molality
5. What is the Van't Hoff factor for a compound which undergoes tetramerization in an organic solvent?
6. Benzoic acid completely dimerizes in benzene. What will be the vapour pressure of a solution containing 61 g of benzoic acid per 500 g benzene when the vapour pressure of pure benzene at the temperature of experiment is 66.6 torr? What would have been the vapour pressure in the absence of dimerisation?
7. Two elements A and B form compounds having molecular formulae AB_2 and AB_4 . When dissolved in 20 g of benzene, 1 g of AB_2 lowers the freezing point by 2.3 K whereas 1g of AB_4 lowers it by 1.3 K. The molar depression constant for benzene is 5.1 K Kg mol⁻¹.
 1. Calculate the atomic masses of A and B.
8. Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20×10^{-3} kg of phenol in 1 kg of benzene has its freezing point lowered by 0.69K. Calculate the fraction of phenol that has dimerised ($K_f = 5.1$ KKg mol⁻¹)
9. 100 g of a protein is dissolved in just enough water to make 10.0 ml of solution. If this solution has an osmotic pressure of 13.3 mm Hg at 25°C, what is the molar mass of the protein?
10. Calculate the amount of KCl which must be added to 1 Kg of water so that the freezing point is depressed by 2K. (K_f for water = 1.86 /K Kg mol⁻¹) (40.05 g)

11. A decimolar solution of $K_4[Fe(CN)_6]$ is 50% dissociated at 300K. Calculate the osmotic pressure of the solution in atm.
12. Heptane and Octane form an ideal solution at 373 K. The vapour pressures of the pure liquids at this temperature are 105.2 KPa and 46.8 KPa respectively. If the solution contains 25 g of heptane and 28.5 g of octane, calculate
 - (i) vapour pressure exerted by heptane.
 - (ii) vapour pressure exerted by solution.
 - (iii) mole fraction of octane in the vapour phase.
13. A solution is made by dissolving 30 g of a nonvolatile solute in 90 g of water. It has a vapour pressure 2.8 KPa at 298 K. At 298 K, vapour pressure of pure water is 3.64 KPa. Calculate the molar mass of the solute.
14. What type of azeotrope is formed on mixing nitric acid and water?
15. An antifreeze solution is prepared from 222.6 g of ethylene glycol ($C_2H_6(OH)_2$) and 200 g of water. Calculate the molality of the solution. If the density of this solution be 1.072 g ml^{-1} , what will be the molarity of the solution?

(9.1 M; 17.95 m)

THE CIVIL SERVICES SCHOOL

Assignment
Chapter 3: Electrochemistry

- If the E°_{cell} for a given reaction has a negative value, then which of the following gives the correct relationships for the values of ΔG^0 and K_{eq} ?
 (a) $\Delta G^0 > 0 ; K_{\text{eq}} < 1$ (b) $\Delta G^0 > 0 ; K_{\text{eq}} > 1$ (c) $\Delta G^0 < 0 ; K_{\text{eq}} > 1$ (d) $\Delta G^0 < 0 ; K_{\text{eq}} < 1$
- The metal that cannot be obtained by electrolysis of an aqueous solution of its salt is
 (a) Ag (b) Na (c) Cu (d) Hg

In Q3 and Q4, a statement of assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements mark the correct answer as:

- (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 - (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 - (iii) Assertion is correct statement but reason is wrong statement.
 - (iv) Assertion and reason both are incorrect statements.
 - (v) Assertion is wrong statement but reason is correct statement
- Assertion:** Conductivity of all electrolytes decrease on dilution.
Reason: On dilution, number of ions per unit volume decreases.
 - Assertion:** Current stops flowing when $E_{\text{cell}}=0$.
Reason: Equilibrium of the cell reaction is attained.
 - Write the cell reaction and calculate the e.m.f of the following cell at 298 K.
 $\text{Sn(s)} \mid \text{Sn}^{2+}(0.004 \text{ M}) \mid \mid \text{H}^+(0.020 \text{ M}) \mid \text{H}_2(\text{g}) \text{ (1 bar)} \mid \text{Pt (s)}$
 (Given : $E^\circ_{\text{Sn}^{2+}/\text{Sn}} = -0.14 \text{ V}$) (0.11 V)
 - For the reaction
 $2\text{AgCl(s)} + \text{H}_2(\text{g}) \text{ (1 atm)} \longrightarrow 2\text{Ag(s)} + 2\text{H}^+(\text{0.1M}) + 2\text{Cl}^-(\text{0.1M})$
 $\Delta G^0 = -43600 \text{ J}$ at 25°C . Calculate the emf of the cell. (0.344 V)
 - Give reasons:
 - On the basis of E° values, O_2 gas should be liberated at anode but it is Cl_2 gas which is liberated in the electrolysis of aqueous NaCl .
 - Conductivity of CH_3COOH decreases on dilution.
 - (a) Calculate the mass of Ag deposited at cathode when a current of 2 amperes was passed through a solution of AgNO_3 for 15 minutes.
 (Given : Molar mass of Ag = 108 g mol^{-1} $1\text{F} = 96500 \text{ C mol}^{-1}$)
 (b) Define fuel cell.
 - Calculate the degree of dissociation (α) of acetic acid if its molar conductivity (Λ_m) is $39.05 \text{ S cm}^2\text{mol}^{-1}$. Given $\lambda^\circ(\text{H}^+) = 349.6 \text{ Scm}^2\text{mol}^{-1}$ and $\lambda^\circ(\text{CH}_3\text{COO}^-) = 40.9 \text{ Scm}^2 \text{ mol}^{-1}$

10. i. Define molar conductivity of a solution and write their units and the relation between the two. How does molar conductivity changes with change in concentration of solution for weak and strong electrolyte.
ii. Define limiting molar conductivity. Why is the conductivity of an electrolyte solution decrease with the decrease in concentration?
11. Define fuel cells? Give electrode reactions of H₂-O₂ fuel cell. Name any other fuel which can be used instead of H₂. Write its two advantages.
12. From the given cells :
Lead storage cell, Mercury cell, Fuel cell and Dry cell
Answer the following :
(i) Which cell is used in hearing aids ?
(ii) Which cell was used in Apollo Space Programme ?
(iii) Which cell is used in automobiles and inverters ?
(iv) Which cell does not have long life ?
13. The resistance of a conductivity cell containing 0.001 M KCl solution is 1500 Ω at 298K. What is the cell constant, if the conductivity of 0.001 M KCl solution at 298K is 0.146×10⁻³ Scm⁻¹? (0.219 cm⁻¹)
14. Account for the following :
1. Alkaline medium inhibits the rusting of iron.
2. Iron does not rust even if the zinc coating is broken in a galvanized iron pipe.
15. Three iron sheets have been coated separately with three metals (A, B and C) whose standard electrode potentials are given below:

Metal	A	B	C	Iron
E° values	-0.46 V	-0.66 V	-0.20 V	- 0.44 V

Identify in which case rusting will take place faster when coating is damaged.
16. Write the reactions occurring during the electrolysis of ;
a) Solution of dil. Sulphuric acid using platinum electrodes.
b) Aqueous Silver Nitrate solution using Silver electrodes.
c) Aqueous Sodium Chloride solution.
17. $\text{Cu}^{2+} + 2\text{e} \longrightarrow \text{Cu} \quad E^\circ = +0.34 \text{ V}$
 $\text{Ag}^+ + \text{e} \longrightarrow \text{Ag} \quad E^\circ = +0.80 \text{ V}$
a. Construct a galvanic cell using the above data.
b. For what concentration of Ag⁺ ions will the emf of the cell be zero at 25°C, if the concentration of Cu²⁺ is 0.01 M ? [log 3.919 = 0.593] (calc. not reqd.)
18. (i) State Kohlrausch law of independent migration of ions. Write an expression for the molar conductivity of acetic acid at infinite dilution according to Kohlrausch law.

(ii) Calculate Λ^0_m for acetic acid. (Given that Λ^0_m HCl = 426 Scm² mol⁻¹ Λ^0_m NaCl = 126 Scm² mol⁻¹ Λ^0_m CH₃COONa = 91 Scm² mol⁻¹) (391 Scm²mol⁻¹)

19. What type of battery is lead storage battery? Write the anode and the cathode reactions and overall reaction occurring in a lead storage battery when current is drawn from it.
20. Following reactions occur at the cathode during the electrolysis of aqueous silver chloride solution:



On the basis of standard reduction potential values, which reaction is feasible at the cathode and why?

Hands -on / IT Enabled work:

- 1) working of Cu-Zn daneill cell
<https://www.youtube.com/watch?v=LahawEMMvvY>
- 2) batteries:
<https://drive.google.com/open?id=0B7-07wgSVzqTek0yQ2tOWG5MZW8>
- 3) Demonstration of electrochemical cell.

More Practice
Chapter 3: Electrochemistry

- Conductivity of 0.00241 M acetic acid is 7.896×10^{-5} Scm⁻¹. Calculate its molar conductivity. If Λ_0 for acetic acid is 390.5 Scm²mol⁻¹, what is its dissociation constant?
- Explain with examples the terms weak and strong electrolytes? How can these be distinguished? With the help of a diagram explain the difference in the variation of molar conductivity with concentration for strong and weak electrolytes
- Calculate the emf of the cell $Mg | Mg^{2+}(0.1\text{ M}) || Cu^{2+}(0.0001\text{ M}) | Cu$ at 298 K. Given $E_{Mg^{2+}/Mg}^{\circ} = -2.37\text{ V}$ and $E_{Cu^{2+}/Cu}^{\circ} = +0.34\text{ V}$.
- A voltaic cell is set up at 25°C with the following half -cells; Al | $Al^{3+}(0.001\text{ M})$ and Ni | $Ni^{2+}(0.50\text{ M})$
Calculate the cell voltage [$E_{Ni^{2+}/Ni}^{\circ} = -0.25\text{ V}$, $E_{Al^{3+}/Al}^{\circ} = -1.66\text{ V}$] (1.45 V)
- The following chemical reaction is occurring in an electrochemical cell

$$\text{Mg(s)} + 2\text{Ag}^{+}(0.0001\text{ M}) \quad \text{Mg}^{2+}(0.10\text{ M}) + 2\text{Ag(s)}$$

The E° values are $Mg^{2+}/Mg = -2.36\text{ V}$ and $Ag^{+}/Ag = 0.80\text{ V}$
For this cell calculate / write
 - The carriers of current within this cell.
 - E° value for the electrode $2\text{Ag}^{+}/2\text{Ag}$.
 - Standard cell potential E_{cell}° .
 - Cell potential E_{cell} .
 - How will the value of E_{cell} change if the concentration of Ag^{+} (aq.) is increased?
 - Symbolic representation of the above cell.
 - Will the above cell reaction be spontaneous?
- In the button cell , widely used in watches , the following reaction takes place

$$\text{Zn}_{(s)} + \text{Ag}_2\text{O}_{(s)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{Zn}^{2+}_{(aq)} + 2\text{Ag}_{(s)} + 2\text{OH}^{-}$$

Determine E° and ΔG° for the reaction.
(given: $E_{Ag^{+}/Ag}^{\circ} = 0.80\text{ V}$, $E_{Zn^{2+}/Zn}^{\circ} = -0.76\text{ V}$) (E=1.56 V, $\Delta G^{\circ} = -301.08\text{ KJ mol}^{-1}$)
- Three electrolytic cells A, B and C containing solutions of zinc sulphate, silver nitrate and copper sulphate, respectively are connected in series. A steady current of 1.5 ampere was passed through them until 1.45 g of silver were deposited at the cathode of cell B. How long did the current flow? What mass of copper and what mass of zinc were deposited in the concerned cells? (Atomic masses of Ag = 108, Zn = 65.4, Cu = 63.5)
- Calculate the emf of the following cell at 298K:

$$\text{Fe(s)} | \text{Fe}^{2+}(0.001\text{M}) || \text{H}^{+}(1\text{M}) | \text{H}_2(\text{g})(1\text{bar}), \text{Pt(s)}$$

Given $E_{cell}^{\circ} = 0.44\text{V}$
- How many coulombs of electric charge must be passed through a solution of silver nitrate to coat a silver sheet of area 100 cm²on both the sides with a 0.005 mm thick layer. Density of silver is 10.5 g/cm³. Relative atomic mass of silver is 108. (938.2 C)

Assignment
Chapter 4: Chemical Kinetics

1. Which of the following statement is not correct for the catalyst?
 - (a) It catalyses the backward and forward reaction to the same extent.
 - (b) It alters ΔG of the reaction.
 - (c) It is a substance that does not change the equilibrium constant of a reaction.
 - (d) It provides an alternate mechanism by reducing activation energy between reactants and products.

2. Rate law for the reaction, $A + 2B \rightleftharpoons C$ is found to be Rate = $k[A][B]$. Concentration of reactant 'B' is doubled, keeping the concentration of 'A' constant, the value of rate constant will be

 (a) the same (b) doubled (c) quadrupled (d) halved

In Q3 and Q4, a statement of assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements mark the correct answer as:

- (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 - (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 - (iii) Assertion is correct statement but reason is wrong statement.
 - (iv) Assertion and reason both are incorrect statements.
 - (v) Assertion is wrong statement but reason is correct statement
3. **Assertion:** The hydrolysis of methyl acetate by dilute HCl is a pseudo first order reaction.
Reason: HCl acts as a catalyst for the hydrolysis.

4. **Assertion:** The order of a reaction can have fractional value.
Reason: The order of reaction cannot be written from the balanced chemical equation.

5. For the reaction:



The rate of formation of $\text{NO}_2(\text{g})$ is $2.8 \times 10^{-3} \text{ M s}^{-1}$. Calculate the rate of disappearance of $\text{N}_2\text{O}_5(\text{g})$.

$$(1.4 \times 10^{-3} \text{ M/s})$$

6. A first order reaction is 50% completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction. (Given: $\log 2 = 0.3010$, $\log 4 = 0.6021$, $R = 8.314 \text{ J K}^{-1}\text{mol}^{-1}$)

$$(27.66 \text{ kJ/mol})$$
7. For a reaction $\text{R} \rightarrow \text{P}$, half-life ($t_{1/2}$) is observed to be independent of the initial concentration of reactants. What is the order of reaction?
8. For a reaction :

$$2\text{NH}_3(\text{g}) \xrightarrow{\text{Pt}} \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$$

 $\text{Rate} = k$

- (i) Write the order and molecularity of this reaction.
(ii) Write the unit of k.
9. Explain the following terms:
- Rate constant (k)
 - Half life period of a reaction($t_{1/2}$)
 - Order of the reaction
 - pseudo first order reaction.
10. The rate of a particular reaction triples when temperature changes from 50°C to 100°C . Calculate the activation energy of the reaction.
 $[\log 3 = 0.4771, R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}]$ (22.01 kJ/mol)
11. A reaction, reactant → product is represented by the graph below. predict
-
- (i)The order of the reaction in this case.
(ii)What does the slope of the graph represent?
(iii)What are the units of rate constant k?
(iv)Give the relationship between k and $t_{1/2}$ (half life period).
(v) Draw the plot of $\log [R]_0/[R]$ vs. time (s)
12. For the reaction
 $2 \text{NO}_{(\text{g})} + \text{Cl}_2(\text{g}) \rightarrow 2\text{NOCl}(\text{g})$
- The following data were collected . All the measurements were taken at 263 K:

Experiment No.	Initial(NO) (M)	Initial(Cl ₂) (M)	Initial rate of disappearance of Cl ₂ (M/min)
1	0.15	0.15	0.60
2	0.15	0.30	1.20
3	0.30	0.15	2.40
4	0.25	0.25	?

Write the expression for the rate law.

- Calculate the value of rate constant and specify in units.
- What is initial rate of disappearance of Cl₂ in exp.4 ?

[(a) $k = 177.7 \text{ M}^{-2} \text{ min}^{-1}$; (b) Rate = 2.8 M min^{-1}]

13. For a certain chemical reaction:



The experimentally obtained information is tabulated below.

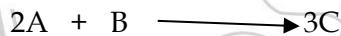
Experiment	[A]o	[B]o	Initial rate of reaction
1.	0.30	0.30	0.096
2.	0.60	0.30	0.384
3.	0.30	0.60	0.192
4.	0.60	0.60	0.768

For this reaction

- (i) derive the order of reaction w.r.t both the reactants A and B.
- (ii) write the rate law.
- (iii) calculate the value of rate constant k.
- (iv) write the expression for the rate of reaction in terms of A and C.

$$(k = 3.5 \text{ l}^2\text{mol}^{-2} \text{s}^{-1})$$

14. For an elementary reaction



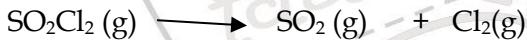
the rate of appearance of C at time 't' is $1.3 \times 10^{-4} \text{ mol l}^{-1}\text{s}^{-1}$

Calculate at this time

- i) rate of the reaction.
- ii) Rate of disappearance of A.

$$\{ (\text{i}) 4.33 \times 10^{-5} \text{ mol/l/s}, (\text{ii}) 8.66 \times 10^{-5} \text{ mol/l/s} \}$$

15. The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume:



Experiment	Time/s ⁻¹	Total pressure/atm
1	0	0.4
2	100	0.7

Calculate the rate constant. (Given $\log 4 = 0.6021$, $\log 2 = 0.3010$)

16. For a reaction, $A + B \rightarrow P$, the reaction is of first order in reactant A and second order in reactant B.

- (i) How is the rate of this reaction affected when the concentration of B doubled.
- (ii) What is the overall order of reaction if A is present in large excess.

17. The rate constant for the first order decomposition of H_2O_2 is given by the following equation:

$$\text{Log } k = 14.2 - \frac{1.0 \times 10^4}{T} \text{ K}$$

Calculate E_a for this reaction and rate constant k if its half-life period be 200 minutes. (Given: $R = 8.314 \text{ J K}^{-1}\text{mol}^{-1}$)

18. The rate constant for a reaction of zero order in A is $0.0030 \text{ mol L}^{-1} \text{ s}^{-1}$. How long will it take for the initial concentration of A to fall from 0.10 M to 0.075 M .
($t = 8.33 \text{ sec}$)
19. The half life for decay of radioactive ^{14}C is 5730 years. An archaeological artefact containing wood has only 80% of the ^{14}C activity as found in living trees. Calculate the age of the artefact.
- 20.

Time / s^{-1}	0	30	60
$[\text{CH}_3\text{COOCH}_3] / \text{mol L}^{-1}$	0.60	0.30	0.15

For hydrolysis of methyl acetate, the following data were obtained

- (i) Show that it follows pseudo first order reaction, as concentration of water remains constant.
(ii) Calculate the average rate between the time interval 30 to 60 seconds.
[$\log 2 = 0.3010$, $\log 4 = 0.6020$]

Hands-on/ IT Enabled work:

- 1) Collision theory <https://www.youtube.com/watch?v=wbGglfHsx-I>

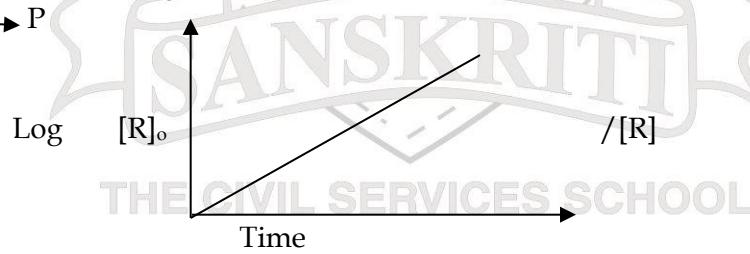
More Practice**Chapter 4: Chemical Kinetics**

1. Following data are obtained for the reaction :

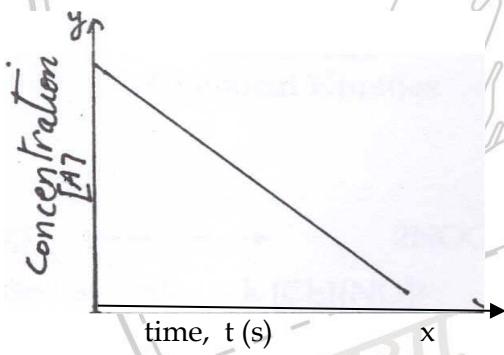


t/s	0	300	600
[O ₅] / mol L ⁻¹	5 × 10 ⁻²	3 × 10 ⁻²	1 × 10 ⁻²

Show that it follows first order reaction.

- Calculate the half-life.
-) calculate its concentration after 2 min, if rate constant is $5 \times 10^{-4} \text{ s}^{-1}$
 (Given $\log 2 = 0.3010$ $\log 4 = 0.6021$)
2. The decomposition of NH₃ on platinum surface, $2\text{NH}_3(\text{g}) \xrightarrow{\text{Pt}} \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$ is a zero order reaction with $k = 2.5 \times 10^{-4} \text{ MS}^{-1}$. What are the rates of production of N₂ and H₂?
 ($2.5 \times 10^{-4} \text{ Ms}^{-1}$, $7.5 \times 10^{-4} \text{ Ms}^{-1}$)
3. A first order reaction takes 69.3 minutes for 50% completion. Set up an equation for the determining the time needed for 80% completion of this reaction.
 (Calculation of result is not required).
4. For the reaction :
 $\text{Cl}_2(\text{g}) + 2\text{NO}(\text{g}) \longrightarrow 2\text{NOCl}(\text{g})$
 The rate law is expressed as rate = $k[\text{Cl}_2][\text{NO}]^2$
 What is the overall order of the reaction?
5. Answer the following questions on the basis of the curve for a first order reaction
 A → P
- 
- a) What is the relation between slope of this line and rate constant?
 b) Calculate the rate constant of the above reaction if the slope is $2 \times 10^{-4} \text{ S}^{-1}$
6. A first order decomposition reaction takes 40 minutes for 30% decomposition. Calculate its $t_{1/2}$ value.
7. For the reaction A → B, the rate of reaction becomes 27 times when the concentration of A is increased three times. What is the order of the reaction?

8. At elevated temperatures, HI decomposes according to the chemical equation;
 $2\text{HI(g)} \longrightarrow \text{H}_2\text{(g)} + \text{I}_2\text{(g)}$ at 443°C . The rate of the reaction increases with concentration of HI, as shown in the following table:
- | HI (mol/l) | 0.005 | 0.01 | 0.02 |
|----------------|----------------------|----------------------|----------------------|
| Rate (mol/l/s) | 7.5×10^{-4} | 3.0×10^{-3} | 1.2×10^{-2} |
- (a) Determine (i) order of this reaction and
(ii) write the rate expression
(b) Calculate the rate constant and give its units.
9. A first order reaction has a rate constant of 0.0051 min^{-1} . If we begin with 0.10 M concentration of the reactant, what concentration of reactant will remain in solution after 3 hours?
10. Consider the reaction $\text{A} \xrightarrow{k} \text{P}$. The change in concentration of A with time is shown in the following plot.



- (i) Predict the order of the reaction.
(ii) Derive the expression for the time required for the completion of the reaction.

Notes :Chapter 5: Surface Chemistry

- **Adsorption:**
 - (i) The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is termed as adsorption.
 - (ii) It is a surface phenomenon.
 - (iii) The concentration of adsorbate increases only at the surface of the adsorbent.
- **Adsorbate:** It is the substance which is being adsorbed on the surface of another substance.
- **Adsorbent:** It is the substance present in bulk, on the surface of which adsorption is taking place.
- **Desorption:** It is the process of removing an adsorbed substance from a surface on which it is adsorbed.
- **Absorption:**
 - (i) It is the phenomenon in which a substance is uniformly distributed throughout the bulk of the solid.
 - (ii) It is a bulk phenomenon.
 - (iii) The concentration is uniform throughout the bulk of solid.
- **Sorption:** When adsorption and absorption take place simultaneously, it is called sorption.
- **Enthalpy or heat of adsorption:** Since, adsorption occurs with release in energy, i.e., it is exothermic in nature. The enthalpy change for the adsorption of one mole of an adsorbate on the surface of adsorbent is called enthalpy or heat of adsorption.

Mechanism of Adsorption

Inside the Adsorbent (in bulk) the force acting between the particles are mutually balanced but on the surface, the particles are not surrounded by atoms or molecules of their kind on all sides and hence they posses attraction force so particle stick on the surface of the Adsorbent.

The extent of adsorption increases with increase in surface area per unit mass of the adsorbent at a given temperature and pressure.

Heat of adsorption: - With increase in heat Adsorption process decreases.

Adsorption equilibrium: - As the molecules of the adsorbate are held on the surface of the solid adsorbent.

Entropy decreases, i.e. ΔS is negative

$$\gg \Delta G = \Delta H - T\Delta S$$

For the process of adsorption to occur, ΔG must be negative which is possible only when, ΔS keeps on decreasing and $T\Delta S$ keeps on increasing till ultimately ΔH becomes equal.

To $T\Delta S$ so that $\Delta G = 0$, this state is called **adsorption equilibrium**.

Types of adsorption: There are different types of adsorption namely,

1. Physical adsorption
2. Chemical adsorption

- **Physical adsorption**

- (i) If the adsorbate is held on a surface of adsorbent by weak van der Waals' forces, the adsorption is called physical adsorption or physisorption.
- (ii) It is non-specific.
- (iii) It is reversible.
- (iv) The amount of gas depends upon nature of gas, i.e., easily liquefiable gases like NH_3 , CO_2 , gas adsorbed to greater extent than H_2 and He . Higher the critical temperature of gas, more will be the extent of adsorption.
- (v) The extent of adsorption increases with increase in surface area, e.g. porous and finely divided metals are good adsorbents.
- (vi) There are weak van der Waals' forces of attraction between adsorbate and adsorbent.
- (vii) It has low enthalpy of adsorption ($20 - 40 \text{ kJ mol}^{-1}$).
- (viii) Low temperature is favourable.
- (ix) No appreciable activation energy is needed.
- (x) It forms multimolecular layers.

- **Chemical adsorption or chemisorption:**

- (i) If the forces holding the adsorbate are as strong as in chemical bonds, the adsorption process is known as chemical adsorption or chemisorption.
- (ii) It is highly specific.
- (iii) It is irreversible.
- (iv) The amount of gas adsorbed is not related to critical temperature of the gas.
- (v) It also increases with increase in surface area.
- (vi) There is strong force of attraction similar to chemical bond.
- (vii) It has enthalpy heat of adsorption ($180 - 240 \text{ kJ mol}^{-1}$).
- (viii) High temperature is favourable.
- (ix) High activation energy is sometimes needed.
- (x) It forms unimolecular layers.

- **Factors affecting adsorption of gases on solids:**

a. Nature of adsorbate: Physical adsorption is non-specific in nature and therefore every gas gets adsorbed on the surface of any solid to a lesser or greater extent. However, easily liquefiable gases like NH_3 , HCl , CO_2 , etc. which have higher critical temperatures are adsorbed to greater extent whereas H_2 , O_2 , N_2 etc. are adsorbed to lesser extent. The chemical adsorption being highly specific, therefore, a gas gets adsorbed on specific solid only if it enters into chemical combination with it.

b. Nature of adsorbent: Activated carbon, metal oxides like aluminum oxide, silica gel and clay are commonly used adsorbents. They have their specific adsorption properties depending upon pores.

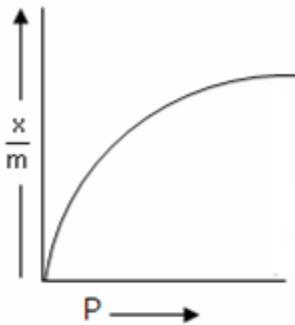
c. Specific area of the adsorbent: The greater the specific area, more will be the extent of adsorption. That is why porous or finely divided forms of adsorbents adsorb larger quantities of adsorbate. The pores should be large enough to allow the gas molecules to enter.

d. Pressure of the gas: Physical adsorption increases with increase in pressure.

- Adsorption isotherm:
- The variation in the amount of gas adsorbed by the adsorbent with pressure at constant temperature can be expressed by means of a curve termed as adsorption isotherm.
- Freundlich Adsorption isotherm: The relationship between $\frac{x}{m}$ and pressure of the gas at constant temperature is called adsorption isotherm and is given by

Where x - mass of the gas adsorbed on mass m of the adsorbent and the gas at a particular temperature k and n depends upon the nature of gas

- The adsorption first increases with increase in pressure at low pressure but becomes independent of pressure at high pressure.

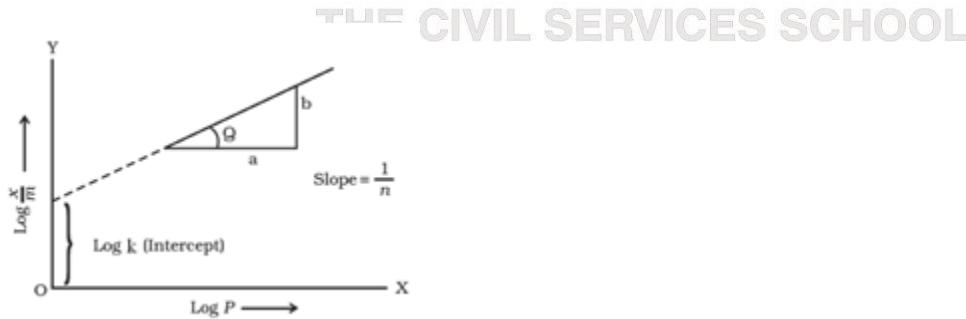


Taking logarithm on both sides, we get,

$$\log \frac{x}{m} = \log k + \frac{1}{n} \log p$$

Taking logarithm on both sides, we get,

- If we plot a graph between $\log \frac{x}{m}$ and $\log P$, we get a straight line.



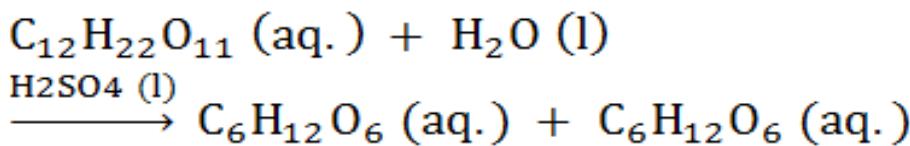
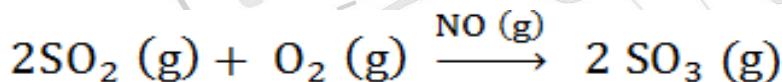
The slope of the line is and intercept will be equal to $\log k$.

Applications of Adsorption

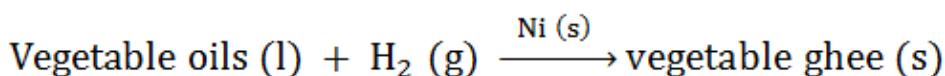
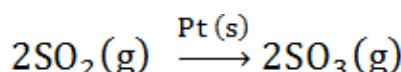
- 1) Production of high vacuum
- 2) Gas masks
- 3) Control of humidity
- 4) Removal of coloring matter from solution
- 5) Separation of inert gases
- 6) Froth floatation process
- 7) Chromatographic analysis

- Catalyst: These are substances which alter the rate of a chemical reaction and themselves remain chemically and quantitatively unchanged after the reaction and the phenomenon is known as catalysis.
- Promoters: These are the substances which increase the activity of catalyst. Example – Mo is promoter whereas Fe is catalyst in Haber’s Process.
- Catalytic poisons (Inhibitors): These are the substances which decrease the activity of catalyst. Example - Arsenic acts as catalytic poison in the manufacture of sulphuric acid by ‘contact process.’
- Types of catalysis:
- There are two types of catalysis namely,

1. Homogeneous catalysis: When the catalyst and the reactants are in the same phase, this kind of catalytic process is known as homogeneous catalysis.



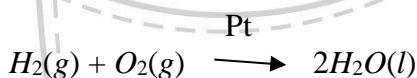
2. Heterogeneous catalysis: When the catalyst and the reactants are in different phases, the catalytic process is said to be heterogeneous catalysis.



3. Activity of catalyst:

4. It is the ability of a catalyst to increase the rate of a chemical reaction. Catalyst has an ability to increase the rate of reaction. This ability of catalyst is known as the activity of catalyst. It depends upon adsorption of reactants on the surface of catalyst. Chemisorption is the main factor governing the activity of catalysts. The bond formed during adsorption between the catalytic surface and the reactants must not be too strong or too weak.

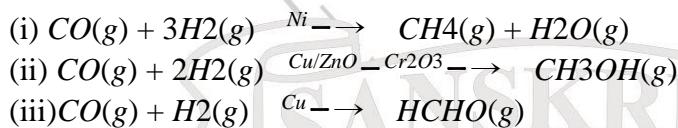
It must be strong enough to make the catalyst active whereas, not so strong that the reactant molecules get immobilized on the catalytic surface leaving no further space for the new reactants to get adsorbed. Generally for the hydrogenation reaction, from Group 5 to Group 11 metals, the catalytic activity increases. The catalytic activity is found to be highest for group 7-9 elements of the periodic table.



5. Selectivity of Catalyst

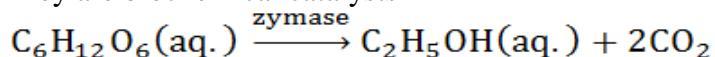
Catalysts are highly specific compounds. They have an ability to direct the reaction to yield a particular product. The reaction with same reactants but different catalyst may yield different products. This is termed as the selectivity of catalyst. Catalysts are highly selective in nature. They can accelerate a particular reaction while inhibit another reaction. Hence, we can say a particular catalyst can catalyse one particular reaction only. It may fail to catalyse another reaction of the same type. For example: reaction of hydrogen and carbon monoxide yields methane when nickel is used as catalyst, methanol when a mixture of zinc oxide and chromium oxide is used as catalyst and methanal when only copper is used as catalyst.

For example: CO and H₂ react to form different products in presence of different catalysts as follows:



- Shape – selective catalysis: It is the catalysis which depends upon the pore structure of the catalyst and molecular size of reactant and product molecules. Example – Zeolites are shape – selective catalysts due to their honey- comb structure. They are alumino silicates with Al-O-Si network. Example- ZSM-5 is a shape selective catalyst which catalysis dehydration of alcohols to for gasoline.
- Enzymes: These are complex nitrogenous organic compounds which are produced by living plants and animals. They are actually protein molecules of high molecular mass.

They are biochemical catalysts



Glucose

ethyl alcohol + gas

NH₂CONH₂

$$\xrightarrow{\text{urease}} \text{NH}_3(\text{g}) + \text{CO}_2(\text{g})$$

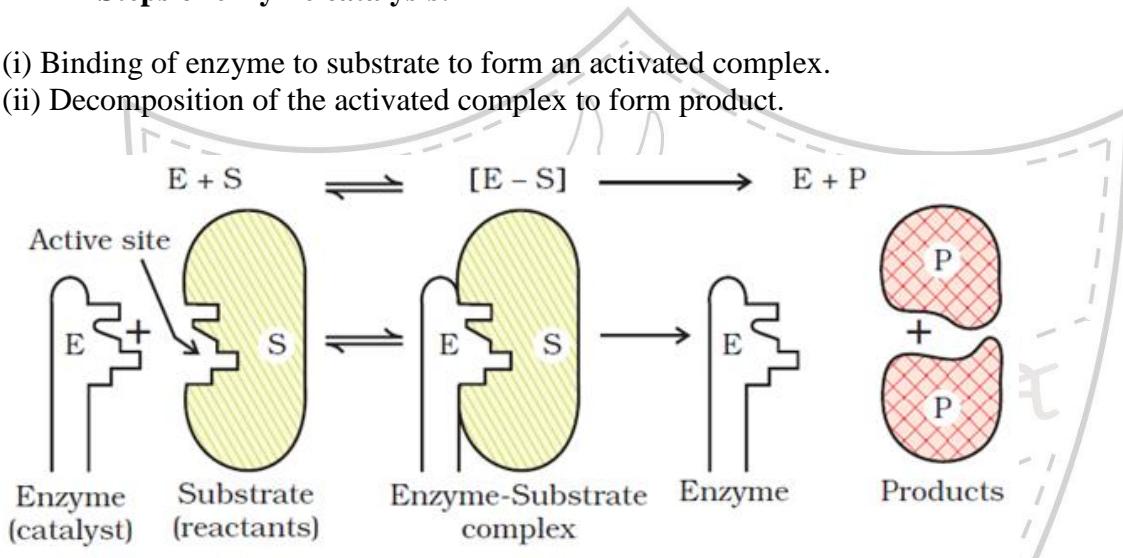
water

ammonia

carbon dioxide

• Steps of enzyme catalysis:

- (i) Binding of enzyme to substrate to form an activated complex.
 - (ii) Decomposition of the activated complex to form product.



- **Characteristics of enzyme catalysis:**

- (i) They are highly efficient. One molecule of an enzyme can transform 106 molecules of reactants per minute.
 - (ii) They are highly specific in nature. Example – Urease catalysis hydrolysis of urea only.
 - (iii) They are active at optimum temperature (298 – 310 K). The rate of enzyme catalysed reaction becomes maximum at a definite temperature called the optimum temperature.
 - (iv) They are highly active at a specific pH called optimum pH.
 - (v) Enzymatic activity can be increased in presence of coenzymes which can be called as promoters.
 - (vi) Activators are generally metal ions Na^+ , Co^{2+} and Cu^{2+} etc. They weakly bind to enzyme and increase its activity.
 - (vii) Influence of inhibitors (poison): Enzymes can also be inhibited or poisoned by the presence of certain substances.

- True solution:

- (i) It is homogeneous.
 - (ii) The diameter of the particles is less than 1 nm.
 - (iii) It passes through filter paper.
 - (iv) Its particles cannot be seen under a microscope.

- **Colloids:**

- It appears to be homogeneous but is actually heterogeneous.
- The diameter of the particles is 1 nm to 1000 nm.
- It passes through ordinary filter paper but not through ultra-filters.
- Its particles can be seen by a powerful microscope due to scattering of light.

- **Suspension:**

- It is heterogeneous.
- The diameter of the particles are larger than 1000 nm.
- It does not pass through filter paper.
- Its particles can be seen even with naked eye.

- Dispersed phase: It is the substance which is dispersed as very fine particles.
- Dispersion medium: It is the substance present in larger quantity.
- Classification of colloids on the basis of the physical state of dispersed phase and dispersion medium:

Name	Dispersed phase	Dispersed medium	Examples
Solid sol	solid	Solid	Coloured gem stones
Sol	Solid	Liquid	Paints
Aerosol	Solid	Gas	Smoke, dust
Gel	Liquid	Solid	Cheese, jellies
Emulsion	Liquid	Liquid	Hair cream, milk
Aerosol	Liquid	Gas	Mist, fog, cloud
Solid sol	Gas	Solid	Foam rubber, pumice stone
Foam	Gas	Liquid	Whipped cream

- Classification of colloids on the basis of nature of interaction between dispersed phase and dispersion medium, the colloids are classified into two types namely,
 1. Lyophobic sols
 2. Lyophilic sols

- **Lyophobic sols:**

- These colloids are liquid hating.
- In these colloids the particles of dispersed phase have no affinity for the dispersion medium.
- They are not stable.
- They can be prepared by mixing substances directly.
- They need stabilizing agents for their preservation.
- They are irreversible sols.

- **Lyophilic sols:**

- (i) These colloids are liquid loving.
- (ii) In these colloids, the particles of dispersed phase have great affinity for the dispersion medium.
- (iii) They are stable.
- (iv) They cannot be prepared by mixing substances directly. They are prepared only by special methods.
- (v) They do not need stabilizing agents for their preservation.
- (vi) They are reversible sols.

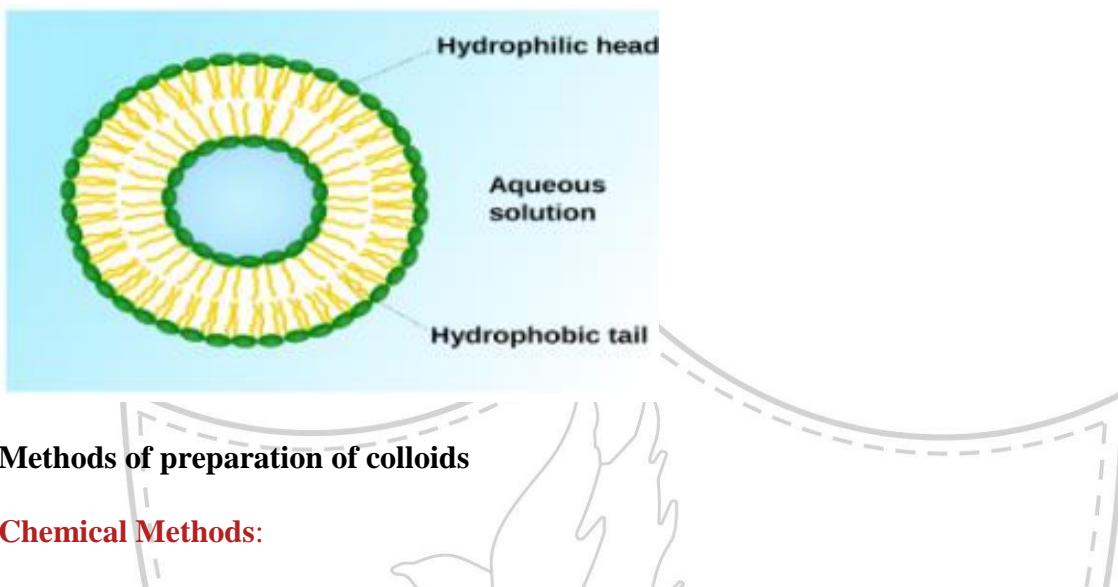
- Classification of colloids on the basis of types of particles of the dispersed phase:

There are three types of colloids based on the type of dispersed phase, namely,

1. Multimolecular colloids: The colloids in which the colloidal particles consist of aggregates of atoms or small molecules. The diameter of the colloidal particle formed is less than 1 nm.
 2. Macromolecular colloids: These are the colloids in which the dispersed particles are themselves large molecules (usually polymers). Since these molecules have dimensions comparable to those of colloids particles, their dispersions are called macromolecular colloids, e.g., proteins, starch and cellulose form macromolecular colloids.
 3. Associated colloids (Micelles): Those colloids which behave as normal, strong electrolytes at low concentrations, but show colloidal properties at higher concentrations due to the formation of aggregated particles of colloidal dimensions. Such substances are also referred to as associated colloids.
- Kraft Temperature (Tk): Micelles are formed only above a certain temperature called Kraft temperature.
 - Critical Micelle Concentration (CMC): Micelles are formed only above a particular concentration called critical micelle concentration.
 - Soaps: These are sodium or potassium salts of higher fatty acids e.g., sodium stearate $\text{CH}_3(\text{CH}_2)_{16}\text{COO-Na}^+$
 - **Cleansing action of soap:**

When **soap** is dissolved in water, its hydrophobic ends attach themselves to dirt and remove it from the cloth. First, the molecules of **soap** arrange themselves in micelle formation and trap the dirt at the centre of the cluster. These micelles remain suspended in water like particles in a colloidal solution.

Micelles



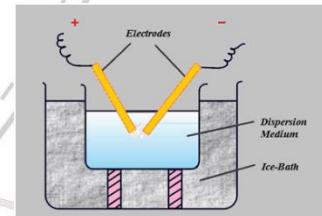
Methods of preparation of colloids

Chemical Methods:



Bredig's method:

An electric arc is struck between two metallic electrodes immersed in dispersion medium. The arc produced vapourises the metal which on further condensation produces particles of colloidal size.



Peptization:

Process of converting a freshly prepared precipitate into colloidal sol by shaking it with electrolyte in dispersion medium is called as peptization. The electrolyte used for this purpose is called peptizing agent.

- **Purification of colloids:**

1. Dialysis: It is a process of removing a dissolved substance from a colloidal solution by means of diffusion through a suitable membrane.
2. Electro dialysis. The process of dialysis is quite slow. It can be made faster by applying an electric field if the dissolved substance in the impure colloidal solution is only an electrolyte.
3. Ultrafiltration: It is the process of separating the colloidal particles from the solvent and soluble solutes present in the colloidal solution by specially prepared filters, which are permeable to all substances except the colloidal particles. Ultra filter paper is made by

dipping filter paper in 4% solution of nitro cellulose in alcohol and ether. This filter paper is hardened by dipping in formaldehyde.

4. **Ultracentrifugation:** In this process, the colloidal solution is taken in a tube which is placed in ultracentrifuge. On rotating the tube at very high speed, the colloidal particles settle down at the bottom of the tube and the impurities remain in solution. The settled particles are mixed with dispersion medium to regenerate the sol.

- **Properties of colloids:**

1. **Colour:** The colour of colloidal solution depends upon the wavelength of light scattered by the colloidal particles which in turn depends upon the nature and size of particles. The colour also depends upon the manner in which light is received by the observer. Example- Finest gold sol is red in colour and as the size of the particle keeps increasing its colour changes to blue, then purple and finally gold.
2. **Brownian movement:** Colloidal particles move in zig – zag path. This type of motion is due to colliding molecules of dispersion medium constantly with colloidal particles.
3. **Colligative properties:** The values of colligative properties (osmotic pressure, lowering in vapour pressure, depression in freezing point and elevation in boiling point) are of small order as compared to values shown by true solutions at the same concentrations.
4. **Tyndall effect:** The scattering of a beam of light by colloidal particles is called Tyndall effect. The bright cone of light is called the Tyndall cone.
5. **Charge on colloidal particles:** Colloidal particles always carry an electric charge. The nature of this charge is the same on all the particles in a given colloidal solution and may be either positive or negative.

Positively charged colloidal particles

- (i) These include hydrated metallic oxides such as $\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$, $\text{Cr}_2\text{O}_3 \cdot \text{H}_2\text{O}$, $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$
- (ii) Basic dye stuff like malachite green, methylene blue sols.
- (iii) Example – Haemoglobin (blood).

Negatively charged colloidal particles:

- (i) Metallic sulphides like As_2S_3 , Sb_2S_3 sols.
- (ii) Acid dye stuff like eosin, methyl orange, Congo red sols.
- (iii) Examples – Starch sol, gum, gelatin, clay, charcoal, egg albumin, etc.

6. **Helmholtz electrical double layer:** When the colloidal particles acquire negative or positive charge by selective adsorption of one of the ions, it attracts counter ions from the medium forming a second layer. The combination of these two layers of opposite charges around colloidal particles is called Helmholtz electrical double layer.
7. **Electrokinetic potential or zeta potential:** The potential difference between the fixed layer and the diffused layer of opposite charges is called electrokinetic potential or zeta potential.

8. **Electrophoresis:** The movement of colloidal particles under an applied electric potential is called electrophoresis.

9. **Coagulation-** It is process of settling of colloidal particles. Also called precipitation of sol

Coagulation of Lyophobic Sols-

Coagulation of lyophobic sols can be done by the following methods:

- By electrophoresis - The colloidal particles move towards oppositely charged electrodes get discharged and precipitate.
- By mixing two oppositely charged sols - Oppositely charged sols when mixed together in almost equal proportion, neutralise their charges and get partially or completely precipitated.
- By Boiling- When a sol is boiled the adsorbed layer is disturbed due to increased number of collisions with the molecules of the dispersion medium. This reduces the charge on the particles and they ultimately settle down in the form of a precipitate.
- By Persistent dialysis - On prolonged dialysis, traces of the electrolyte present in the sol are removed almost completely. Colloids become unstable and coagulate.
- By addition of electrolyte - When excess of electrolyte is added, colloidal particles precipitate as colloids interact with ions carrying charge opposite to that present on themselves. This causes neutralisation leading to their coagulation.

Example- A negatively charged ion when added to a positively charged sol causes coagulation. The negatively charged ion is called coagulating ion/flocculative ion as it neutralises the colloid to cause coagulation.

Coagulation of Lyophilic Sols-

Lyophilic sols are stable because of charge and solvation of colloidal particles. So we remove these two factors to coagulate them. This is done by

- Addition of an electrolyte
- Addition of a suitable solvent

Protection of colloids -

- Lyophilic sols are more stable than lyophobic sols
- Lyophilic colloids have a unique ability to protect lyophobic colloids from electrolytes
- When a lyophilic sol is added to lyophobic sol, the lyophilic particles (colloids) form a layer around the particles of lyophobic sol
- Lyophilic colloids are also called protective colloids

Hardy-Schulze Rule-

- The greater the valency of the flocculating ion added, the greater is its precipitation.
- For negative sols, when positive ions are added

$\text{Al}^{3+} > \text{Ba}^{2+} > \text{Na}^+$ is the order in terms of flocculating power

- For positive sols, when negative ions are added

$[\text{Fe}(\text{CN})_6]^{4-} > \text{PO}_4^{3-} > \text{SO}_4^{2-} > \text{Cl}^-$ is the order in terms of flocculating power

Coagulation Value/ Flocculation value: The number of millimoles of an electrolyte required to bring about the **coagulation** of one litre of a colloidal solution is called its flocculation **value**.

Emulsions: Emulsions are colloidal solutions where the dispersed phase and dispersion medium, both , are in liquid state.

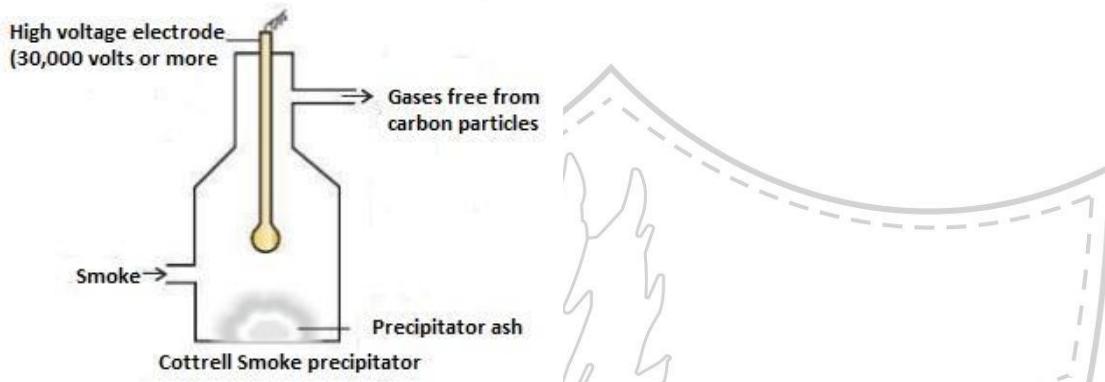
- Types of emulsions:
 1. Water dispersed in oil (W/O): When water is the dispersed phase and oil is the dispersion medium. E.g. butter
 2. Oil dispersed in water (O/W): When oil is the dispersed phase and water is the dispersion medium. E.g. milk
- Emulsification: It is the process of stabilizing an emulsion by means of an emulsifier.
- Emulsifying agent or emulsifier: These are the substances which are added to stabilize the emulsions. They form an interfacial layer between the dispersed phase and dispersion medium. Examples – soaps, gum for O/W type emulsion and lamp black and long chain alcohols act as emulsifying agents for W/O type
- Demulsification: It is the process of breaking an emulsion into its constituent liquids by freezing, boiling, centrifugation or some chemical methods.

Certain reasons related to colloids around us:

- Sky appears blue due to scattering of light by air molecules, water droplets, and other colloidal particles in the sky. Blue colour scatters the most.
- Deltas are formed when river carrying silt, clay colloidal particles meets sea, as there a lot many salts dissolved in sea water, they neutralize the charge on colloidal particles leading to the coagulation of clay and silt forming deltas.
- Albimunoids in blood are negatively charged colloids. If there is bleeding happening from a cut in the body, rubbing with alum (phikari), FeCl_3 salt leads to coagulation of blood due to neutralization of charged albimunoid colloidal particles.
- Artificial rain can be produced by spraying oppositely charged sol on the clouds which are colloids leading to their precipitation.

Applications of Colloids

Electro precipitation of smoke – The smoke is led through a chamber containing plates having a charged opposite to that carried by smoke particles. The particles on coming in contact with these plates lose their charge and get precipitated. The particles settle down on the floor of the chamber. The precipitator is called Cottrell precipitator.



2. Purification drinking water – Alum is added to impure water to coagulate the suspended impurities and make water fit for drinking.
3. Medicines – Most of the medicines are colloidal in nature. Colloidal medicines are more effective because they have a larger surface area and are more easily absorbed by the body. Eg- Argyrol is a silver sol used as an eye lotion, milk of magnesia is used to cure stomach disorders, Antimony sol is used to cure Kalazaar, Gold sol is used in intramuscular injections.
4. Tanning – Animal hides are colloidal in nature. When a hide that has positively charged particles is soaked in tannin/chromium salts, which contains negatively charged particles, mutual coagulation takes place. This results in the hardening of leather. This process is termed as tanning.
5. Cleansing action of soaps- already explained
6. Photographic plates and films – Photographic plates and films are prepared by coating an emulsion of the light sensitive silver bromide in gelatin over glass plates or celluloid films.
7. Rubber industry- Latex is a colloidal solution of rubber particles which are negatively charged. Rubber is obtained by coagulation of latex.
8. Industrial products- Paints inks, synthetic plastics, rubber, cement, graphite lubricants are all colloids.

Hands-on/ IT Enabled work:

Whole chapter will be done with the help of power point presentation.

Assignment

Chapter 5: Surface Chemistry

1. Extent of physisorption of a gas increases with _____.
(i) increase in temperature.
(ii) decrease in temperature.
(iii) decrease in surface area of adsorbent.
(iv) decrease in strength of van der Waals forces.

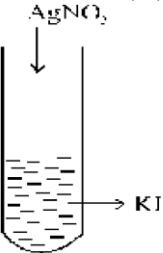
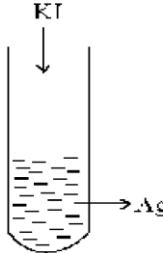
 2. At high concentration of soap in water, soap behaves as _____.
(i) molecular colloid
(ii) associated colloid
(iii) macromolecular colloid
(iv) lyophilic colloid
- In the following question no. 3 and 4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
- (i) Assertion and reason both are correct and the reason is correct explanation of assertion.
(ii) Assertion and reason both are correct but reason does not explain assertion.
(iii) Assertion is correct but reason is incorrect.
(iv) Both assertion and reason are incorrect.
(v) Assertion is incorrect but reason is correct
3. Assertion : Coagulation power of Al^{3+} is more than Na^+ .
Reason : Greater the valency of the flocculating ion added, greater is its power to cause precipitation (Hardy Schulze rule).

 4. Assertion : Colloidal solutions do not show brownian motion.
Reason : Brownian motion is responsible for stability of sols.

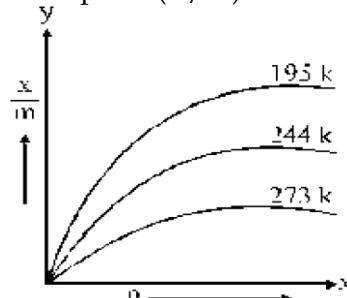
 5. What happens when
(i) a freshly prepared precipitate of Fe(OH)_3 is shaken with a small amount of FeCl_3 solution?
(ii) persistent dialysis of a colloidal solution is carried out?
(iii) size of dispersed phase changes in gold sol.

 6. (a) Define adsorption. Write any two features which distinguish physisorption and chemisorption. Which has higher enthalpy of adsorption?
(b) Write one similarity between Physisorption and Chemisorption.
(c) List four applications of adsorption.

 7. Write one difference in each of the following :
(i) Lyophobic sol and Lyophilic sol
(ii) Solution and Colloid

8. (a) How can a colloidal solution and true solution of the same colour be distinguished from each other?
 (b) Why is ferric chloride preferred over potassium chloride in case of a cut leading to bleeding?
 (c) Name the physical states of dispersed phase and dispersion medium of froth?
 (d) CO(g) and $\text{H}_2\text{(g)}$ react to give different products in the presence of different catalysts.
 Which ability of the catalyst is shown by these reactions?
9. How does an increase in temperature affect both physical and chemical adsorption?
10. What causes Brownian movement in a colloidal solution?
11. Explain the following observations:
 a) Lyophilic colloid is more stable than lyophobic colloid.
 b) Coagulation takes place when sodium chloride solution is added to a colloidal solution of ferric hydroxide.
 c) Sky appears blue in colour.
 d) Adsorption of a gas on the surface of solid is generally accompanied by a decrease in entropy, still it is a spontaneous process.
 e) Enzyme catalysts are highly specific in their action.
 f) The enthalpy in case of chemisorption is usually higher than that of physisorption.
 g) Cottrell's smoke precipitator is fitted at the mouth of the chimney used in factories.
 h) Physical adsorption is multilayered, while chemisorption is monolayered.
12. (i) Differentiate between adsorption and absorption.
 (ii) Out of MgCl_2 and AlCl_3 , which one is more effective in causing coagulation of negatively charged sol and why ?
 (iii) Out of sulphur sol and proteins, which one forms multimolecular colloids ?
13. A colloidal solution of AgI is prepared by two different methods shown below:-
 (A)  (B) 
- (a) What is the charge of AgI colloidal particles in the two test tubes (A) and (B)?
 (b) Give reasons for the origin of charge.
14. What are the two classes of emulsion? Give one example of each class.
15. Describe the following giving an example each:
 a) Mechanism of heterogeneous catalysis. Give a point of difference between Homogeneous catalysis and Heterogeneous catalysis.
 b) Hardy Schulze Rule
 c) Emulsification

16. Consider the adsorption isotherms given below and interpret the variation in the extent of adsorption (x/m) when:



- (a) (i) temperature increases at constant pressure.
(ii) pressure increases at constant temperature.
 - (b) Name the catalyst and the promoter used in Haber's process for manufacture of ammonia.
19. In reference to Freundlich adsorption isotherm write the expression for adsorption of gases on solids in the form of an equation.
Based on type of particles of dispersed phase, give one example each of associated colloid and multimolecular colloid.
20. Give reason for the following observations;
(i) Leather gets hardened after tanning.
(ii) It is necessary to remove CO when ammonia is prepared by Haber's process.

Notes- Chapter -6
PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

Minerals: These are naturally occurring chemical substances which are obtained from earth's crust by mining. In minerals metals are present in either native state or combined state.

Ores: The mineral from which metal can be economically and conveniently extracted is called ore.

Metallurgy: The entire scientific and technological process used for isolation of the metal from the ores is known as metallurgy. The major steps for extraction and isolation of metals are:--

- Concentration of the ore
- Isolation of metal from the concentrated ore
- Purification of metal

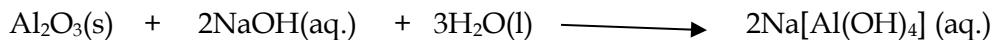
I) CONCENTRATION OF ORES

Removal of unwanted materials (ie; clay, sand etc.) from ores is known as concentration. These earthly or undesirable impurities are called GANGUE. Some important procedures are:-

- 1) Hydraulic washing: This is based on the difference in gravities of the ore and the gangue particles. In this an upward stream of running water is used to wash the powdered ore. The lighter gangue particles are washed away and heavier ores are left behind.
- 2) Magnetic Separation: This is based on the differences in the magnetic properties of the ore components. One of the two, ore or gangue is capable of being attracted by magnetic field.
- 3) Froth Floatation process: This method is used to remove gangue from sulphide ores. A suspension of powdered ore is made with water. To it collectors (E.g- Pine oil) and froth stabilizers (e.g., cresol, aniline) are added. Collectors enhance wettability of pine oil and froth stabilizers froth. Mineral particles wetted by oil are carried away with froth and gangue particles move into water.

Two sulphide ores can be separated using **depressants**. For eg. NaCN is used to separate ZnS and PbS present in a ore.

- 4) Chemical Methods(Leaching):
 - a) Leaching of Alumina from Bauxite: Bauxite contains SiO_2 , iron oxides and titanium oxide as impurities. Powdered ore is treated with concentrated solution of NaOH at 478-523 K and 35-36 bar pressure.



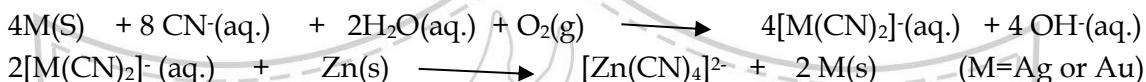
The aluminate solution is neutralized by passing CO₂ gas and hydrated Al₂O₃ separated out.



The sodium silicate remains in the solution and hydrated alumina is filtered, dried and heated to give pure Al₂O₃.



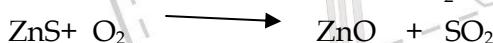
- b) Other example: In metallurgy of silver and gold, the respective metal is leached with dilute solution of NaCN or KCN in presence of air (Or O₂)



- II) **CALCINATION/ROASTING:** The concentrated ore is then converted to its oxide form by heating .

If the concentrated ore is heated strongly in the absence of air to get rid of impurities, and the ore changes to oxide form, it is called calcination. It is generally observed for carbonate ore. CaCO₃ \longrightarrow CaO + CO₂

If the concentrated ore is heated in the presence of oxygen, ore gets converted to oxide form and small molecules like SO₂ are released. It generally takes place for sulphide ore.



- III) **REDUCTION**

Reduction of oxide to metal:

This involves heating of the oxide with a reducing agent like C or CO or even another metal based on reactivity of the metal to be extracted.



Extraction of iron from its oxides



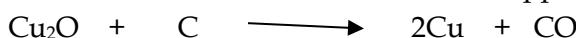
(Discussed later under extraction of Iron)

Extraction of copper from cuprous oxide:

The sulphide ores are roasted/smelted to give oxides (Most sulphide ores contain iron)



The oxide is then reduced to metallic copper using coke.

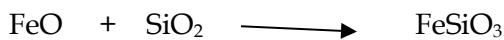
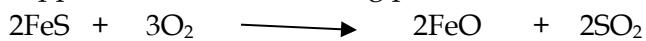


In actual process, the ore is heated in a reverberatory furnace after mixing with silica.

The iron oxide slags off as iron silicate and **copper is produced in the form of copper matte. This contains Cu₂S and FeS.**



Copper matte is then charged into silica lined convertor. Some silica is also added and hot air blast is blown to convert the remaining FeS, FeO and Cu₂S/Cu₂O to metallic copper. The reactions taking place are:



The solidified copper obtained has blistered appearance due to evaluation of SO₂ & so is called blister copper.

Extraction of zinc from zinc oxide:

The reduction of zinc oxide is done using coke. For the purpose of heating, the oxide is made into brickettes with coke and clay.



The metal is distilled off and collected by rapid chilling.

Thermodynamic principles of metallurgy:

Gibb's energy is described by the equation $\Delta G = \Delta H - T\Delta S$.

For any reaction, this change can be described by $\Delta G = -RT\ln K$

Negative ΔG implies positive K and this can happen when reaction proceeds towards products.

- (i) If ΔS is positive, on increasing T the value of $T\Delta S$ would increase ($\Delta H < T\Delta S$) and $\Delta H < T\Delta S$ and ΔG becomes negative.
- (ii) If reactants and products of two reactions are put together in a system and net ΔG is negative, overall reaction would occur. So the process involves coupling of two reactions and getting sum of their ΔG as negative.

For eg: In reduction of FeO



We couple the two so that net Gibb's energy change becomes

$$\Delta G_{(\text{C, CO})} + \Delta G_{(\text{FeO, Fe})} = \Delta G$$

The resultant will have ΔG as negative.

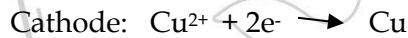
According to Ellingham diagram, the ΔG° Vs. T plot representing the reaction goes upward and that representing C → CO goes downward. At temp. above 1073 K the (C, CO) line come below the Fe, FeO line [$\Delta G(\text{C, CO}) < \Delta G(\text{Fe, FeO})$]. So coke will be reducing FeO and is itself oxidized to CO.

IV) REFINING

A metal extracted by any method is usually contaminated with some impurity. Some methods are

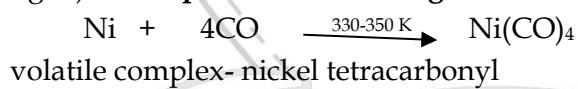
- Distillation:** The impure metal is evaporated to obtain pure metal as distillate. Used for low boiling metals like **Zn and mercury**.
- Liquation:** The low melting metal, like **tin** is separated from high melting impurities by this method. The metal is made to flow on sloping surface.
- Electrolytic refining:** In this method impure metal is made to act as anode. A strip of same metal in pure form is made cathode. The electrolyte used contains soluble salt of the same metal. The more basic metals remain in the solution and less basic form anode mud.

For e.g. **Copper** is refined by electrolytic method. Anode is impure copper and pure copper strips are taken as cathode and electrolyte is acidified solution of copper sulphate.



- Zone refining:** It is based on the fact that melting point of a substance is lowered by the presence of impurities. Consequently when an impure metal in molten state is cooled, crystals of pure metal are solidified first and impurities remain behind in the molten metal which crystallizes later. The semiconductors -silicon and germanium are purified by this method.
- Vapour Phase refining:** This method is used for preparing ultrapure metals by forming vapours of the compound of metal and later decomposition to get pure metal.

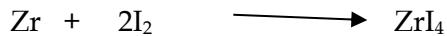
Eg- 1) Mond process for refining Ni



At higher temperature,



2) Van Arkel method for refining of Zr or Ti : This method is useful for removing all oxygen and nitrogen present as impurity. Crude metal is heated in evacuated vessel with iodine.



Metal iodide is then heated on a tungsten filament to about 1800 K.



- Chromatographic methods:** This method is based on the principle that different components are differently adsorbed on adsorbent. The mixture is put in a suitable solvent and applied on top of the column. The adsorbent is packed in a glass

column. The adsorbed components are removed (eluted) out using suitable solvent (eluent). The weakly adsorbed component is eluted first followed by the more strongly adsorbed and so on. This is called column chromatography. This method is used for purification of elements available in minute quantities and impurities not very different in chemical properties.

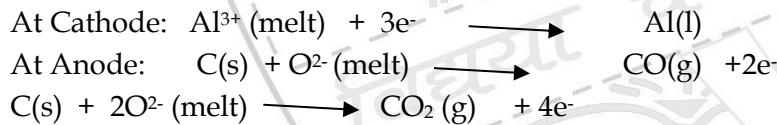
EXTRACTION OF ALUMINIUM:

Aluminium is extracted from bauxite ore, $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$. It involves two steps:

1. **Concentration (by Baeyer's Process) :** Purification of Bauxite ore is done by Baeyer's process. This Chemical method is called leaching.
(Explained under methods of concentration)
2. **Reduction { by Electrolysis of fused alumina (Hall-Heroult process)}:** The purified alumina is dissolved in molten cryolite and is electrolyse in an iron tank lined inside with carbon. The molten cryolite decreases the melting point to about 1173 K and also increases conductivity. The anode consists of a number of carbon rods which dip in fused electrolyte. The electrolyte is covered with a layer of powdered coke.



Reactions at electrodes are:



Therefore, aluminium is liberated at the cathode and gets collected at the bottom of the tank from where it is removed. The oxygen evolved combines with carbon of anode to form CO or CO_2 and escapes out. Because of reaction at carbon anodes, these need to be replaced periodically.

3. Refining of Aluminium:

The aluminium metal obtained above is 99% pure, which is further purified by **Hoop's electrolytic method**. The process is carried out in an iron tank lined with carbon. It has 3 layers of molten liquid having different densities.

- (i) The top layer consists of pure Al having carbon electrodes dipping in it. The carbon electrodes act as cathode.
- (ii) The middle layer has fluorides of sodium, barium and Aluminium in molten state. This acts as an electrolyte.
- (iii) The bottom layer consists of impure Al along with the carbon lining acts as anode.

On passing electric current aluminium ions from the middle layer are discharged at cathode as pure Al. The pure Al is removed from the tapping hole. An equivalent amount of Al from bottom layer moves into the middle layer leaving behind impurities.

EXTRACTION OF IRON

Iron is the second most abundant element occurring in earth's crust. The common ores are:

Haemite Fe_2O_3

Magnetite Fe_3O_4

Limonite $\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$

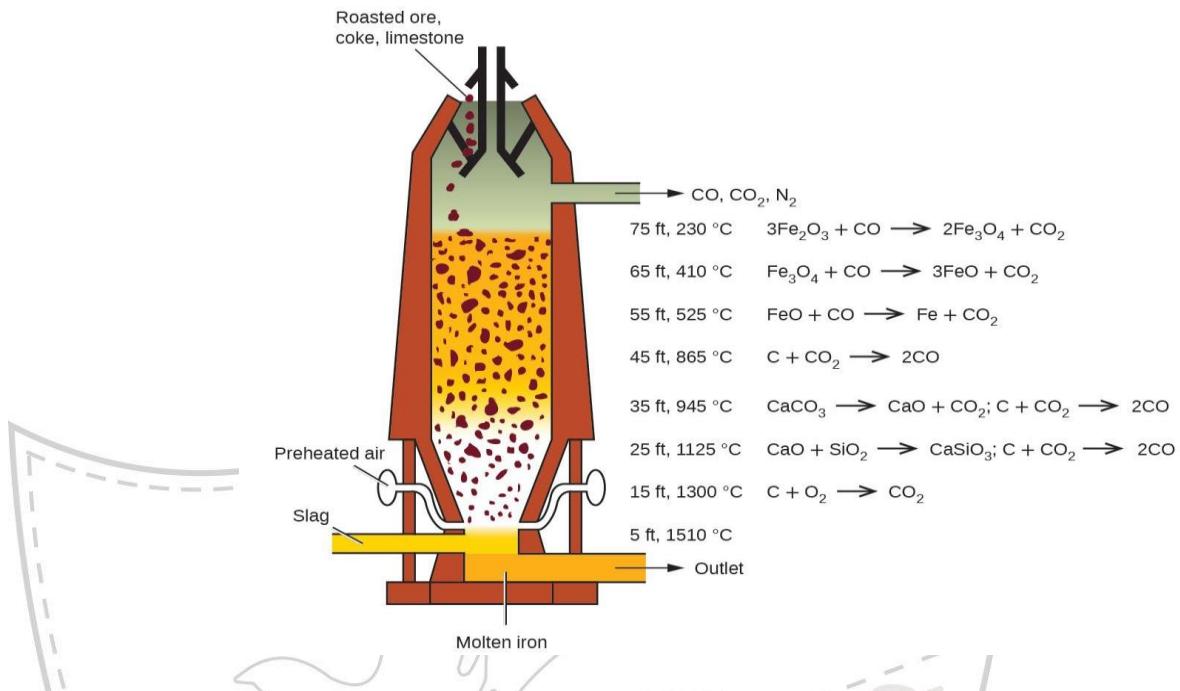
Iron Pyrites FeS_2

Siderite FeCO_3

Cast Iron is usually extracted from its oxide ore (haematite). It involves the following steps---

- 1) **Concentration:** The ore is first crushed and crushed ore is concentrated by gravity separation; ie hydraulic washing
- 2) **Calcination:** The concentrated ore is calcined, ie, heated strongly in limited supply of air in a reverberatory furnace. The following changes take place:
 - i) Moisture is removed
 - ii) Impurities of S, P₄ and As are converted to their gaseous oxides; SO_2 , As_2O_3 and P_4O_{10} which are volatile and escape out.
- 3) **Reduction (by Smelting)** : The calcined ore is reduced with carbon, ie smelted in a blast furnace. It is a tall cylindrical furnace made of steel lined with fire bricks. It is narrow at the top and has cup and cone arrangement for the introduction of charge and outlet for waste gases. At the base of furnace, it is provided with ---
 - i) Tuyeres arrangement for introduction of hot air
 - ii) A tapping hole for withdrawing molten iron and
 - iii) An outlet through which slag is flown out.

The calcined ore (8 parts) is mixed with coke (4 parts) and limestone (1 part) is introduced from top. At the same time a blast of hot air preheated at 1000 K is blown upwards with the help of tuyers arrangement. The added coke acts as a reducing agent and lime serves as flux. The burning of coke to carbon monoxide supplies most of the heat required for working temperature of furnace and give temp. upto 2200 K at the bottom of furnace. As the gases move up, they meet the descending charge and temp. falls. At the bottom reducing agent is carbon but at the top the reducing agent is CO.



The reactions occurring are:---

- 1) Combustion zone: At the base coke burns to produce CO_2 which starts rising upward. The reaction is exothermic and heat produced raises the temperature to about 2200 K.



- 2) Fusion zone: As CO_2 rises upward, it comes in contact with coke and gets reduced to CO.



The reaction is endothermic , the temperature is lowered to 1570 K. The iron produced in the upper region melts. Any Fe_2O_3 if present is reduced by hot coke to iron.



- 3) Slag formation zone; In the middle temperature is about 1270K. In this region limestone decomposes.

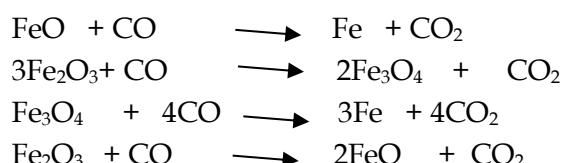


The lime acts as flux and combines with silica (present as an impurity) to produce slag.



The molten slag forms a separate layer above molten iron.

- 4) Reduction Zone: The temperature near the top of furnace is 875 K. The oxide is reduced by carbon monoxide to iron.



The spongy iron produced moves down slowly and melts in fusion zone.

At lower hotter part, reaction is



It dissolves some carbon, silicon, phosphorus and manganese and forms a layer at the bottom. The iron obtained is called **Pig iron**.

Cast iron is different from Pig Iron and is made by melting pig iron with scrap iron and coke using hot air blast. It has slightly less carbon content (about 3%). It is extremely hard but brittle.

Wrought iron is purest form of iron and is prepared from cast iron by oxidizing impurities in reverberatory furnace lined with haematite. Haematite oxidizes carbon.

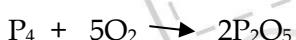


Limestone is added as flux and S, Si and P are oxidized and passed into slag. The metal is then removed.

EXTRACTION OF COPPER:

Copper is mainly extracted from copper pyrites (CuFeS_2). The various steps are:

- 1) **Crushing and concentration:** The ore is crushed in haw crushers and is finally powdered. It is concentrated by froth floatation process.
- 2) **Roasting:** The concentrated ore is roasted ,i.e, heated strongly in the presence of excess of air in a reverberatory furnace.
 - a) Moisture is removed from ore and it becomes dry.
 - b) The impurities of S, P₄, As and Sb are removed as their volatile oxides.

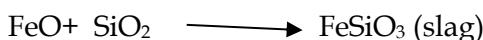


- c) Copper pyrites is converted to ferrous sulphide (FeS) and cuprous sulphide (Cu_2S)



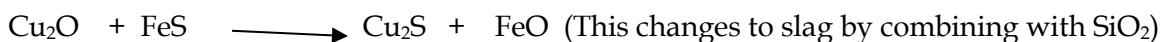
- 3) **Smelting:** The roasted ore is mixed with powdered coke and sand and is strongly heated in a blast furnace . The blast furnace is made of steel and is lined with fire bricks. A blast of hot air is introduced at the lower part of the furnace and changes occurring are:

- a) Ferrous sulphide is oxidized to ferrous oxide which combines with silica to form slag.



The slag being lighter forms the upper layer and is removed from time to time.

- b) During roasting if any oxide of copper is formed, it combines with FeS and is changed back into its sulphide



As a result two separate layers are formed at the bottom of furnace. Upper layer is slag which is removed as waste. The lower layer of molten mass contains mostly cuprous sulphide and some traces of ferrous sulphide. It is called matte and is taken out from tapping hole at bottom.

- 4) **Bessemerisation:** The molten matte from Blast-furnace is transferred to Bessemer converter. The vessel is silica lined from inside. A blast of hot air is mixed with sand is blown into molten matte. During this process

- a) Traces of ferrous sulphide present in matte are oxidized to FeO which combines with silica to form slag.



- b) Copper sulphide is oxidized to cuprous oxide which further reacts with remaining copper sulphide to form copper and sulphur dioxide.



After the reaction has been completed, the converter is tilted and molten copper is put in moulds. The copper thus obtained is 99% pure and is known as blister copper. The name blister is given because as metal solidifies, the dissolved SO₂ escapes out producing blisters on metal surface.

- 5) **Refining:** Blister copper is purified by:

- a) **Poling:** Heating strongly in a reverberatory furnace in the presence of excess of air.

Impurities are either converted to oxides or converted to slag. Some copper also changes to cuprous oxide. This is reduced back to copper by stirring the molten metal with green poles of wood. This gives 99.5 % pure Cu, which is then purified by electrolytic refining.

- b) **Electrolytic refining:** A thin sheet of metal is made cathode and block of crude metal is made as anode. Both the electrodes are placed in an acidified CuSO₄ solution when electric current is passed through the solution, impure Cu from anode goes into the solution and pure Cu from the solution gets deposited on the cathode.



The impurities of Zn, Ni, Fe etc. gets collected below as anode mud.

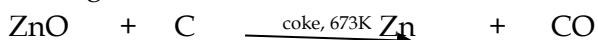
EXTRACTION OF ZINC

Principal ore of Zinc is Zinc Blende. Extraction is carried out in the following steps:-

- 1) **Concentration:** Ore is concentrated by froth floatation process.
- 2) **Roasting:** Concentrated ore is roasted in excess of air at about 1200 K and ZnS is converted to ZnO.



- 3) **Reduction:** ZnO is reduced by heating with crushed coke at 673 K. For the purpose of heating, the oxide is made into briquettes with coke and clay.



The metal is distilled off and collected by rapid chilling.

- 4) **Refining:** Impure metal is refined by electrolysis. In this process, impure zinc is made the anode and a plate of pure zinc is made the cathode. The electrolyte is zinc sulphate with little dil. H₂SO₄. On passing current zinc is deposited at cathode while equal amount of zinc from anode goes into electrolyte. Thus, pure zinc is obtained on cathode.

Some extractions based on oxidation:

1) EXTRACTION OF CHLORINE FROM BRINE

Chlorine is abundant in sea water and hence is obtained from electrolysis of brine solution.

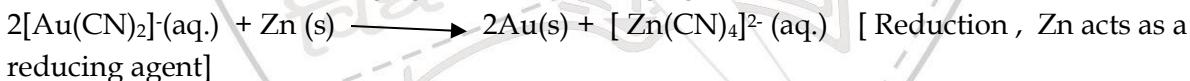


$$\Delta G^\circ = +422 \text{ KJ} \text{ and using } \Delta G^\circ = -nFE^\circ_{\text{Cell}}, E^\circ = -2.2 \text{ V.}$$

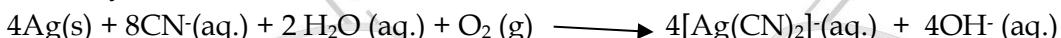
So it requires emf greater than 2.2 V. But electrolysis requires an excess potential to overcome some hindering reaction. Thus, Cl₂ is obtained by electrolysis giving out H₂ and aqueous NaOH as by products.

2) EXTRACTION OF GOLD AND SILVER:

Extraction of Gold involves leaching the metal with CN⁻ (OXIDATION)



Similarly for Silver



Hands-on/ IT Enabled work

Whole chapter is taught with the help of a presentation with animations.

Assignment**Chapter 6: General Principles and Processes of Isolation of Elements**

1. In the extraction of copper from its sulphide ore, the metal is formed by the reduction of Cu_2O with

(a) FeS	(b) CO	(c) Cu_2	(d) SO_2
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2. In the metallurgy of aluminium....
 (a) Al^{3+} is oxidized to Al(s)
 (b) graphite anode is oxidized to carbon monoxide and carbon dioxide.
 (c) oxidation state of oxygen changes in the reaction at anode
 (d) oxidation state of oxygen changes in the overall reaction involved in the process

In Q3 and Q4, a statement of assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements mark the correct answer as:

- (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 - (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 - (iii) Assertion is correct statement but reason is wrong statement.
 - (iv) Assertion and reason both are incorrect statements.
 - (v) Assertion is wrong statement but reason is correct statement
3. **Assertion:** Ag and Au are extracted by leaching their ores with a dilute solution of NaCN .
Reason: Impurities associated with these ores dissolve in NaCN .
 4. **Assertion:** Carbonate and hydroxide ores are concentrated by froth floatation process.
Reason: In froth floatation process, mineral oil is used because it preferentially wets the gangue particles.
 5. Write the chemical reactions involved in the process of extraction of Gold. Explain the role of dilute NaCN and Zn in this process.
 6. (a) Write the principle of method used for the refining of germanium.
 (b) Out of PbS and PbCO_3 (ores of lead), which one is concentrated by froth floatation process preferably?
 (c) What is the significance of leaching in the extraction of aluminium?
 7. What do you understand by the following terms?
 (a) Roasting (b) Flux (c) Calcination (d) Smelting (e) Slag
 8. a) In the extraction of Al, impure Al_2O_3 is dissolved in conc. NaOH to form sodium aluminate and leaving impurities behind. What is the name of this process ? also write the reactions involved
 b) What is the role of coke in the extraction of iron from its oxides?

9. Write the reactions occurring in the different zones of blast furnace during extraction of iron from concentrated Haemetite ore.
10. Explain Hall Heroult process of reduction of aluminium oxide. What is the role of graphite and cryolite in electrometallurgy of aluminium?
11. (a) Why is the froth floatation method selected for the concentration of Sulphide ores? Write reactions taking place in the extractions of zinc from zinc blende.
(b) An ore sample of galena (PbS) is contaminated with zinc blende (ZnS). Name one chemical compound which can be used to concentrate galena selectively by froth floatation method. What are such substances called?
12. (a) What is the role of silica in the extraction of copper?
(b) Explain electrorefining of copper. Name the common metals present as anode mud in electrorefining of copper.
13. Account for the following facts :
 - a) The reduction of a metal oxide is easier if the metal formed is in liquid state at the temperature of reduction.
 - b) The reduction of Cr_2O_3 with Al is thermodynamically feasible, yet it does not occur at room temperature.
 - c) Pine oil is used in froth floatation method
14. a) Indicate the principle behind the method used for refining of zinc.
b) Out of C and CO, which is a better reducing agent at the lower temperature range in the blast furnace to extract iron from the oxide ore?
c) Which form of iron is the purest form of iron?

p- block Elements

General Configuration: $ns^2 np^{1-6}$

Maximum oxidation state = Group 10

Across a period: Covalent radii and metallic character decreases, but electro negativity, electron affinity, oxidizing power and ionization energy increases.

Down the group: Covalent radii and metallic character increases, but electro negativity, electron affinity, oxidizing power and ionization energy decreases.

Inert pair effect: While going down the group, the ns^2 electrons become more and more reluctant to participate in bond formation. This is because down the group bond energy decreases and so the energy required to un-pair ns^2 electrons is not compensated by the energy released in forming two additional bonds.

Group 15

N	$2s^2 2p^3$	Non Metals	<ul style="list-style-type: none"> • Solids and show allotropic modifications • s-orbitals in these elements are completely filled and p-orbitals are half filled, making their electronic configuration extra stable. 	
P	$3s^2 3p^3$			
As	$4s^2 4p^3$	Metalloids		
Sb	$5s^2 5p^3$			
Bi	$6s^2 6p^3$	Metal		

Down the group covalent radii increases and electro negativity decreases, ionization energy decreases and hence metallic nature increases. Nitrogen has maximum electro negativity.

There is considerable increase in covalent radius from N to P. However from As to Bi only a small increase in covalent radius is observed.

Successive ionization enthalpy: $\Delta_i H_1 < \Delta_i H_2 < \Delta_i H_3$

Boiling point (bp) increases from top to bottom, but mp increases upto As and decreases upto Bi.

Except N all elements show allotropy.

Chemical properties of group 15

Oxidation State and Trends in group 15

N	-3, +3	<ul style="list-style-type: none"> • Covalent character decreases down the group. • Most common oxidation state are -3, +3 and +5 • -3 O.S decreases down the group due to increase in size and metallic nature.
P	-3, +3, +5	
As	-3, +3, +5	
Sb	+3, +5	
Bi	+3, +5	

- The stability of +5 O.S decreases due to inert pair effect down the group. Only Bi(V) compound is BiF_5
- Nitrogen exhibits +1, +2 and +4 O.S also when it reacts with oxygen. All these O.S tend to disproportionate in acid solution. E.g

$$3\text{HNO}_2 \rightarrow \text{HNO}_3 + \text{H}_2\text{O} + 2\text{NO}$$
- Nitrogen is restricted to a maximum covalency of 4 since 4 orbitals (one s and three p) are available for bonding.
- Phosphorous exhibits nearly all intermediate O.S from +5 and -3.
- The heavier elements have vacant d-orbitals which can be used for bonding as in PF_6^-

Anomalous properties of nitrogen

- Nitrogen differs from the rest of the members of this group due to its smaller size, high electro negativity, high ionization enthalpy and non-availability of d-orbitals.
- Nitrogen can form $p\pi-p\pi$ multiple bond.
- Nitrogen exists as diatomic molecule with a triple bond.
- Heavier elements do not form $p\pi-p\pi$ bonds as their atomic orbitals are so large and differ that they cannot have effective overlapping.
- P, As and Sb form P-P, As-As and Sb-Sb single bonds whereas Bi forms metallic bonds. However, N-N single bond is weaker than P-P single bond, because of high inter electronic repulsion of non-bonding electrons owing to small bond length.
- Catenations tendency is weaker in N as N-N bond is much weaker than P-P, As-As and Sb-Sb due to inter electronic repulsions because of small bond length.
- Except nitrogen, the heavier elements can form $d\pi-p\pi$ bonds, e.g $\text{R}_3\text{P=O}$ or $\text{R}_3\text{P=CH}_2$ and also when transition elements like $\text{P}(\text{C}_2\text{H}_5)_3$ and $\text{As}(\text{C}_6\text{H}_5)_3$ act as ligands; they form $d\pi-d\pi$ bonds.

1) Reactivity towards hydrogen: Form hydrides of formula EH_3

- Structure pyramidal
- Bond angle decreases down the group due to decrease in electro negativity.
- Stability decreases due to increase in size.
- Reducing character increases due to decrease in stability. NH_3 is a mild reducing agent while BiH_3 is strongest.
- Basic character decreases in the order: $\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3 > \text{BiH}_3$.

2) Reactivity towards oxygen: Form two types of oxides of the formula: E_2O_3 and E_2O_5 . The oxide in the higher oxidation state is more acidic than that of lower oxidation state. Acidic character decreases down the group.

$\text{N}_2\text{O}_3, \text{P}_2\text{O}_3 \rightarrow$ Acidic
 $\text{As}_2\text{O}_3, \text{Sb}_2\text{O}_3 \rightarrow$ Amphoteric
 $\text{Bi}_2\text{O}_3 \rightarrow$ Basic oxide

3) Reactivity towards halogens: They form halides of the formula: EX_3 and EX_5 .

- Nitrogen does not form pentahalide due to absence of the d orbitals.
- Pentahalides are more covalent than trihalides.
- All trihalides except those of nitrogen are stable. Only NF_3 is stable. Trihalides except BiF_3 are predominantly covalent.

4) Reactivity towards metals: All these elements react with metals to form their binary compounds exhibiting -3 oxidation state, such as, Ca_3N_2 (calcium nitride) Ca_3P_2 (calcium phosphide), Na_3As_2 (sodium arsenide), Zn_3Sb_2 (zinc antimonide) and Mg_3Bi_2 (magnesium bismuthide).

Dinitrogen

Preparation

1. Dinitrogen is prepared commercially by the liquefaction and fractional distillation of air.
2. In the laboratory, dinitrogen is prepared by treating an aqueous solution of ammonium chloride with sodium nitrite.
 $\text{NH}_4\text{Cl}(\text{aq}) + \text{NaNO}_2(\text{aq}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + \text{NaCl}(\text{aq})$
3. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \xrightarrow{\text{Heat}} \text{N}_2 + 4\text{H}_2\text{O} + \text{Cr}_2\text{O}_3$
4. Pure nitrogen is obtained by the thermal decomposition of sodium or barium azide.
 $\text{Ba}(\text{N}_3)_2 \rightarrow \text{Ba} + 3\text{N}_2$
 $2\text{NaN}_3 \rightarrow 2\text{Na} + 3\text{N}_2$

Properties

1. Dinitrogen is a colourless, odourless, tasteless and non-toxic gas.
2. It is inert at room temperature because of the high bond enthalpy of $\text{N} \equiv \text{N}$ bond.
3. At high temperature, it directly combines with some metals to form ionic nitrides and with non-metals to form covalent nitrides.
 $6\text{Li} + \text{N}_2 \xrightarrow{\text{Heat}} 2\text{Li}_3\text{N}$
 $3\text{Mg} + \text{N}_2 \xrightarrow{\text{Heat}} 2\text{Mg}_3\text{N}_2$
4. It combines with hydrogen at about 773 K to form ammonia:
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \xrightleftharpoons{773\text{K}} 2\text{NH}_3(\text{g}); \quad \Delta_f\text{H}^\circ = -46.1 \text{ kJ mol}^{-1}$
5. It combines with dioxygen only at about 2000 K to form nitric oxide, NO.
 $\text{N}_2 + \text{O}_2(\text{g}) \xrightleftharpoons{\text{Heat}} 2\text{NO}(\text{g})$

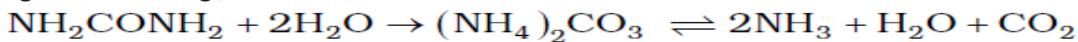
Thermal decomposition of sodium azide gives dinitrogen gas. ($2\text{NaN}_3 \rightarrow 2\text{Na} + 3\text{N}_2$)

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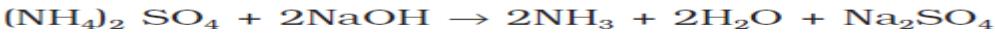
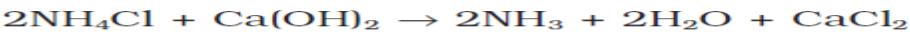
Ammonia

Preparation

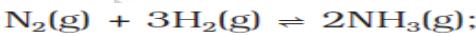
Ammonia is present in small quantities in air and soil where it is formed by the decay of nitrogenous organic matter e.g., urea.



On a small scale ammonia is obtained from ammonium salts which decompose when treated with caustic soda or lime.

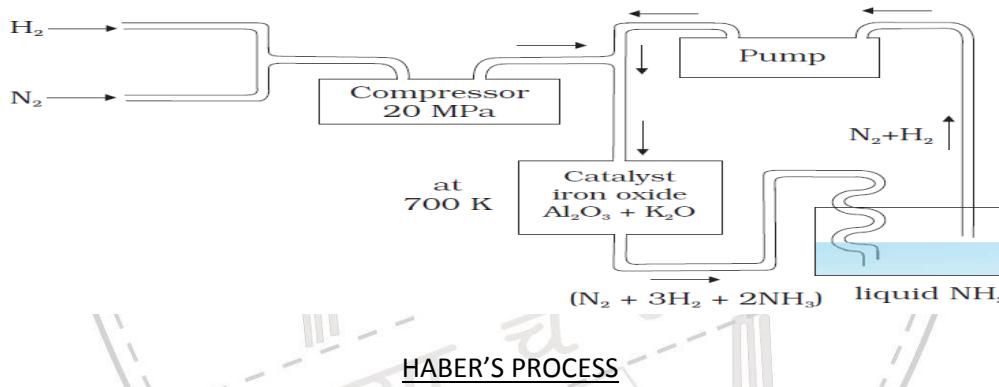


On a large scale, ammonia is manufactured by Haber's process.



$$\Delta_f H^\ominus = -46.1 \text{ kJ mol}^{-1}$$

The optimum conditions are a pressure of $200 \times 10^5 \text{ Pa}$ (about 200 atm), a temperature of $\sim 700 \text{ K}$ with iron oxide and small amount of K_2O and Al_2O_3 as catalyst.



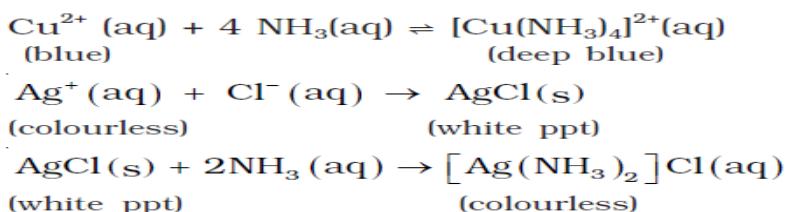
Properties

1. Ammonia is a colourless gas with a pungent odour.
2. In the solid and liquid state there exists H-bond, which accounts for its higher melting and boiling points.
3. It is trigonal bipyramidal with three bond pairs and 1 lone pair.
4. Highly soluble

$$\text{NH}_3(\text{g}) + \text{H}_2\text{O(l)} \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$$
(weakly basic in aq. Solution)
5. Forms ammonium salts with acids, e.g., NH_4Cl , $(\text{NH}_4)_2\text{SO}_4$, etc. It precipitates the hydroxides of many metals from their salt solutions. For example,

$$2\text{FeCl}_3(\text{aq}) + 3\text{NH}_4\text{OH}(\text{aq}) \rightarrow \text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O(s)} + 3\text{NH}_4\text{Cl(aq)}$$
(brown ppt)

$$\text{ZnSO}_4(\text{aq}) + 2\text{NH}_4\text{OH}(\text{aq}) \rightarrow \text{Zn(OH)}_2(\text{s}) + (\text{NH}_4)_2\text{SO}_4(\text{aq})$$
(white ppt)
6. Presence of a lone pairs makes it a Lewis base. It donates the electron pair and forms linkage with metal ions.

**Uses**

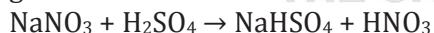
To produce nitrogenous fertilizers and manufacture of inorganic nitrogen compounds. Liquid ammonia is also used as a refrigerant.

Oxides of Nitrogen

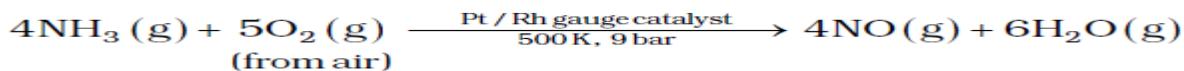
Formula	Oxidation state	Resonance Structures	Common Methods of Preparation
N_2O	+1	$\ddot{\text{N}}=\text{N}=\ddot{\text{O}} \leftrightarrow :\text{N}\equiv\text{N}-\ddot{\text{O}}:$	$\text{NH}_4\text{NO}_3 \xrightarrow{\text{Heat}} \text{N}_2\text{O} + 2\text{H}_2\text{O}$
NO	+2	$:\text{N}=\ddot{\text{O}}: \leftrightarrow :\text{N}=\ddot{\text{O}}:$	$2\text{NaNO}_2 + 2\text{FeSO}_4 + 3\text{H}_2\text{SO}_4 \rightarrow \text{Fe}_2(\text{SO}_4)_3 + 2\text{NaHSO}_4 + 2\text{H}_2\text{O} + 2\text{NO}$
N_2O_3	+3		$2\text{NO} + \text{N}_2\text{O}_4 \xrightarrow{250\text{K}} 2\text{N}_2\text{O}_3$
NO_2	+4		$2\text{Pb}(\text{NO}_3)_2 \xrightarrow{673\text{K}} 4\text{NO}_2 + 2\text{PbO}$
N_2O_4	+4		$2\text{NO}_2 \xrightleftharpoons[\text{Heat}]{\text{Cool}} \text{N}_2\text{O}_4$
N_2O_5	+5		$4\text{HNO}_3 + \text{P}_4\text{O}_{10} \rightarrow 4\text{HPO}_3 + 2\text{N}_2\text{O}_5$

Preparation

1. In the laboratory, nitric acid is prepared by heating KNO_3 or NaNO_3 and concentrated H_2SO_4 in a glass retort.



2. On a large scale it is prepared mainly by Ostwald's process.

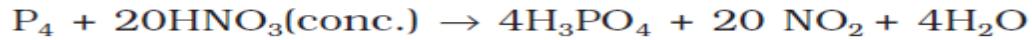
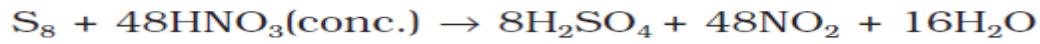
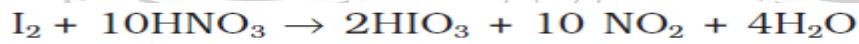


3. $2\text{NO(g)} + \text{O}_2\text{(g)} \rightleftharpoons 2\text{NO}_2\text{(g)}$
4. $3\text{NO}_2\text{(g)} + \text{H}_2\text{O(l)} \rightarrow 2\text{HNO}_3\text{(aq)} + \text{NO(g)}$
5. NO thus formed is recycled and the aqueous HNO_3 can be concentrated by distillation upto ~ 68% by mass. Further concentration to 98% can be achieved by dehydration with concentrated H_2SO_4 .

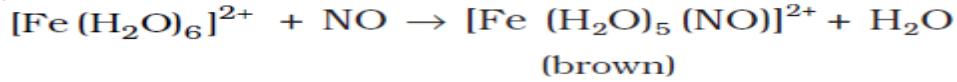
Properties

1. A colourless liquid. In gaseous state it has a planar structure.
2. In aq. Solution, behaves as a strong acid.
 $\text{HNO}_3 \text{ (aq)} + \text{H}_2\text{O (l)} \rightarrow \text{H}_3\text{O}^+ \text{ (aq)} + \text{NO}_3^- \text{ (aq)}$
3. Conc. HNO_3 is a strong oxidizing agent and can react with metals and non-metals.
 $3\text{Cu} + 8\text{HNO}_3 \text{ (dil)} \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO} + \text{H}_2\text{O}$
 $\text{Cu} + 4\text{HNO}_3 \text{ (conc)} \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$
 $4\text{Zn} + 10\text{HNO}_3 \text{ (dil)} \rightarrow 4\text{Zn}(\text{NO}_3)_2 + 5\text{H}_2\text{O} + \text{N}_2\text{O}$
 $\text{Zn} + 4\text{HNO}_3 \text{ (conc)} \rightarrow \text{Zn}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{N}_2\text{O}$

With Non-metals



Brown Ring Test: Aq. Solution of nitrate ion + dil. FeSO_4 solution + conc. H_2SO_4 along the sides of the test tube.

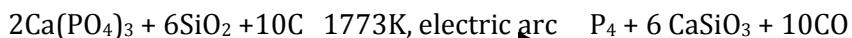


PHOSPHORUS

Occurrence: Occurs as fluoroapatite $\text{Ca}_5(\text{PO}_4)_3\text{F}$ and hydroxyapatite $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$

Preparation:

- Calcination of phosphate rock.
- Reduction with coke and sand

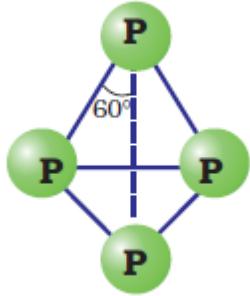


Vapours condensed to solid under water

Allotropes:

1. **White Phosphorus:**

Condensation of gaseous or liquid state. It glows in dark (chemiluminescence). It is a waxy solid, insoluble in water, soluble in CS_2 and benzene. It is stored under water as it ignites spontaneously in air. It shows phosphorescence.

	<ul style="list-style-type: none"> • Each 'P' located at the corner of a tetrahedron is attached to 3 other 'P' atoms. • Angle is 60°. P_4 units face lot of angle strain. • It readily catches fire in air to give white dense fumes of P_4O_{10} $\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$ • It dissolves in NaOH (boiling) to give phosphine. $\text{P}_4 + 3\text{NaOH} + 3\text{H}_2\text{O} \rightarrow \text{PH}_3 + 3\text{NaH}_2\text{PO}_2$ (sodium hypophosphite)
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2. **Red Phosphorus:**



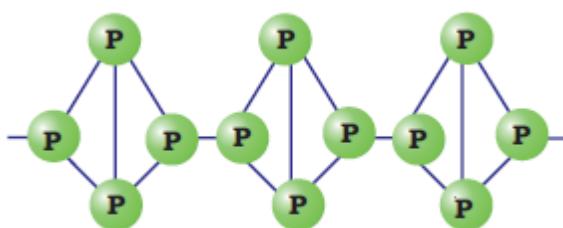
It is insoluble in water and CS_2 .

It does not glow in the dark.

It has a high melting point (870K), amorphous, less reactive.

Red P is less reactive than white P.

Safe to handle and shows a polymeric structure.



3. **Black Phosphorus:**

It has two forms: α -black phosphorus and β -black phosphorus.

Red P $\xrightarrow{803\text{k}}$ Black P (α -form)

White P $\xrightarrow{473\text{k, high pressure}}$ Black P (β -form)

It is the most stable variety with an extended layer structure

Uses:

In the form of phosphatic fertilizers.

Manufacture of food grade phosphates.

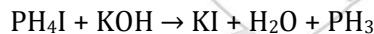
Detergents, pharmaceuticals, water industry.

Manufacture of organo phosphorus compounds used as pesticides.

Compounds: Hydrides: (MH₃)

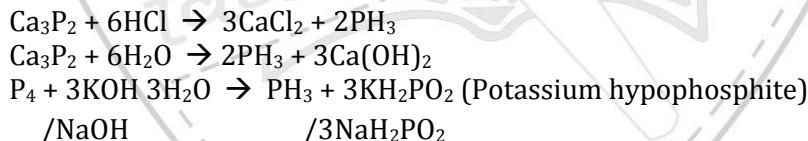
NH₃ – Ammonia, most stable, shows H-bonding. Therefore, soluble in water

PH₃ – Phosphine : When pure, it is non inflammable but becomes inflammable owing to the presence of P₂H₄ or P₄ vapours. To purify it from the impurities, it is absorbed in HI to form phosphonium iodide (PH₄I) which on treating with KOH gives off phosphine.



AsH₃
SbH₃
BiH₃} no H-bond insoluble in water. Strong reducing agent and poisonous.

Preparation of PH₃:



Preparation of AsH₃, SbH₃:

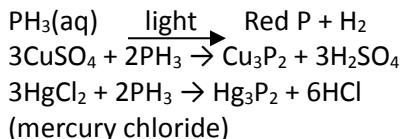
M=As, Sb



- Basic character of hydrides decrease down the group due to decrease in charge density. NH₃ is the most basic whereas AsH₃, SbH₃, BiH₃ do not show any basic properties.
- Thermal stability decreases down the group as the size of the central atom increases and the tendency to form stable M-H bond decreases.
- Reducing character increases down the group, because thermal stability of hydrides decreases.

Properties of Phosphine:

It is a colourless gas with rotten fish smell and is highly poisonous. It explodes in contact with traces of oxidising agents like HNO_3 , Cl_2 and Br_2 vapours.



Phosphine is weakly basic and gives phosphonium compounds with acids e.g.,

**Halides:**

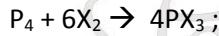
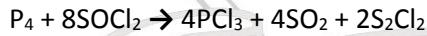
MX_3 (known for all) MX_5 (except N)

N: $2s^22p^3$, It can easily form 3 covalent bonds and 1 coordinate bond. Thus total 4 bonds.

Since there is non-availability of d-orbital, it cannot extend its coordination number beyond 4.

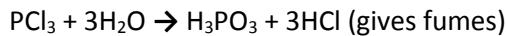
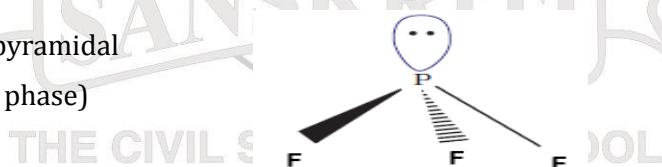
However, for P and other group 15 elements, 5 covalent bonds can also be formed due to availability of d orbitals. (sp^3d hybridization).

MX_3 NX_3 AsX_3 Covalent SbX_3 $\text{BiX}_3 - \text{ionic}$	<ul style="list-style-type: none"> Ionic character increases down the group, because of increased size of central atom, the electro positive character increases. MX_3 have pyramidal structure. They are hydrolysed by water. (except NX_3)
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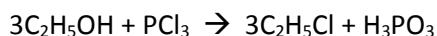
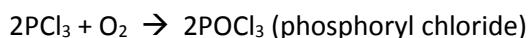
Preparation:

PF_3 is pyramidal

(in gas phase)



PCl_3 fumes in moisture due to formation of HCl(g)



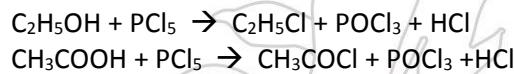
MX₅
PX ₅
PF ₅
PCl ₅
PBr ₅
AsX ₅
AsF ₅
AsCl ₅
SbX ₅
SbF ₅
SbCl ₅
BiX ₅
BiF ₅

Structure: Trigonal bipyramidal

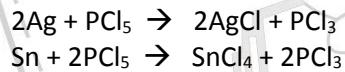
PF₅ exist as PF₅ molecule in gas and solid state. There are 2 kinds of bond lengths, 3 equatorial and 2 axial bonds.

PCl₅ exist as PCl₅ molecule in gas or liquid and as [PCl₄]⁺ [PCl₆]⁻ in solid state.

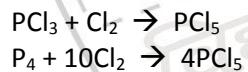
PCl₅ reacts with organic compounds.



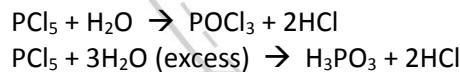
Finely divided metals on heating with PCl₅ give corresponding chlorides.



Preparation:



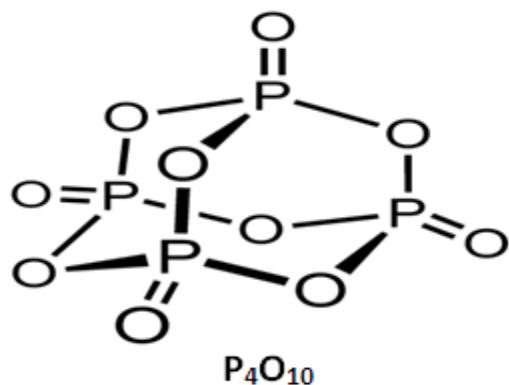
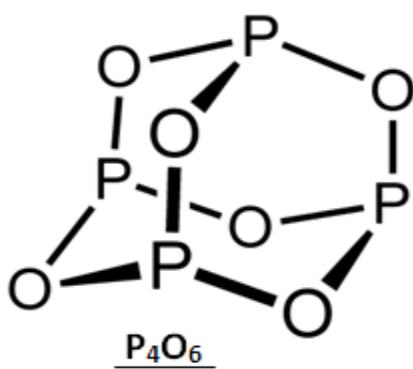
Hydrolysis:



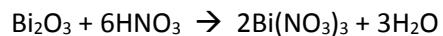
Oxides:

E₂O₃ and E₂O₅ [E=P to Bi]

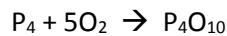
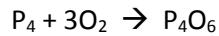
But due to the reluctance of P-Bi to form pπ-pπ bonding, they actually form dimers E₄O₆ and E₄O₁₀



- Bi_4O_{10} is unstable.
- Basic character increases down the group with atomic number.
- P_4O_6 – Acidic As_4O_6 – Acidic
- Sb_4O_6 – Amphoteric Bi_4O_6 – Basic



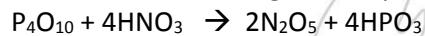
Preparation:



They dissolve in water to give acids.



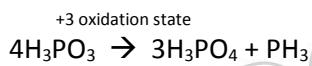
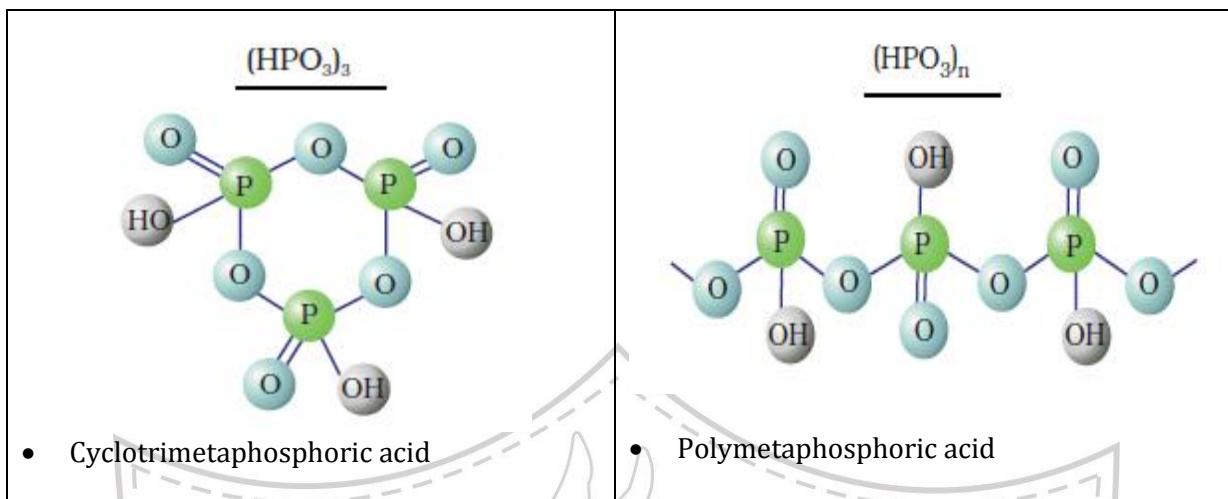
Due to affinity of P_4O_{10} for H_2O , it is a good dehydrating agent.



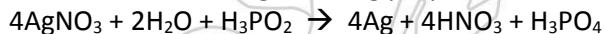
Oxoacids:

All oxoacids have at least one $\text{P}=\text{O}$ and one $\text{P}-\text{OH}$ bond. They have cyclic or linear structure.

H_3PO_2 <ul style="list-style-type: none"> • Monoprotic acid • Hypophosphorous or Phosphinic acid 	H_3PO_3 <ul style="list-style-type: none"> • Phosphorus acid • Diprotic acid, forms 2 series of salts: NaH_2PO_3 & Na_2HPO_3
H_3PO_4 <ul style="list-style-type: none"> • Orthophosphoric acid • Triprotic acid, Na_2HPO_4, NaH_2PO_4, Na_3PO_4 • Used for manufacture of phosphatic fertilizers. 	$\text{H}_4\text{P}_2\text{O}_7$ <ul style="list-style-type: none"> • Diphosphonic acid or Pyrophosphoric acid



The acids with P – H bond have strong reducing properties.



That is why H_3PO_2 imparts reducing character to the acid as it has 2H atoms bonded to P.



Group 16

Elements in group 16 are Oxygen (O), Sulphur (S), Selenium (Se), Tellurium (Te) and Polonium (Po). Also called Chalcogens.

Occurrence:

1. Oxygen is the most abundant element.
2. Sulphur exists as gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, Epsom salt $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ or galena PbS , Zinc blende ZnS etc.
3. Selenium and Tellurium as Selenides and Tellurides in sulphur ores.
4. Polonium exists as decay product of thorium and uranium minerals.

Electronic Configuration:

General electronic config – ns^2np^4

Atomic and Ionic Radii:

Due to increase in number of shells, atomic and ionic radii increase from top to bottom in the group.

Ionization Enthalpy:

1. Decreases down the group due to increase in size.
2. Group 16 elements have lower ionization enthalpy than corresponding elements of group 15 due to stability of half filled p-orbital electronic configuration in group 15.

Electron Gain Enthalpy:

1. Oxygen has less negative electron gain enthalpy due to its compact nature.
2. Sulphur onwards the value again becomes negative upto Po.

Electronegativity:

Oxygen is the second most electronegative element, next to fluorine. Within a group electronegativity decreases with increase in atomic number.

Metallic Character:

Increase from oxygen to polonium.

Physical Properties:

O,S - Non-Metals Se, Te - Metalloids Po - Metal	<ol style="list-style-type: none"> 1. All of them exhibit Allotropy. 2. M.P and B.P increases with increase in atomic number but there is large difference in m.p of O and S due to its atomicity - O_2 and S_8.
---	--

Chemical Properties:

1. Stability of -2 oxidation state decreases down the group.
2. Oxygen shows only negative oxidation state of -2 and in case of OF_2 , oxidation state of +2.
3. Other elements of the group easily show +2, +4, and +6 oxidation state.
4. Stability of +4 oxidation state increase down the group due to inert pair effect.

Reactivity with Hydrogen:

All the elements form hydrides of the formula H_2E ($\text{E} = \text{S}, \text{Se}, \text{Te}, \text{Po}$).

H_2O	1. Acidic nature increases from H_2O to H_2Te due to decrease in bond dissociation enthalpy.
H_2S	2. Thermal Stability decreases from H_2O to H_2Po .
H_2Se	3. All hydrides except water posses reducing property and this characteristic increases from H_2S to H_2Te .
H_2Te	
H_2Po	

Reactivity with Oxygen:

All these elements form oxides of the formula EO_2 and EO_3 where $\text{E} = \text{S}, \text{Se}, \text{Te}$ or Po .

1. SO_2 is gas but SeO_2 is solid.
2. Reducing property decreases from SO_2 and TeO_2 . SO_2 is reducing and TeO_2 is an oxidising agent.
3. Also form EO_3 type oxides. Both types are acidic.

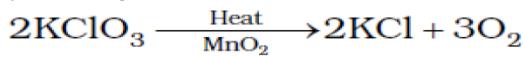
Reactivity towards halogens:

1. Form halides of the formula EX_6 , EX_4 and EX_2 .
2. Stability of halides decrease in the order $\text{F}^- > \text{Cl}^- > \text{Br}^- > \text{I}^-$.
3. Among hexahalides, hexafluorides are only stable. They (hexafluorides) are gaseous octahedral in nature. Most stable is SF_6 due to steric reasons.
4. Amongst tetrafluorides, SF_4 is gas, SeF_4 is liquid and TeF_4 a solid. They have Sp^3d hybridization and have trigonal bipyramidal structures and are regarded as see-saw geometry.
5. All elements except Se form dichlorides and dibromides. Dihalides have Sp^3 hybridisation.
6. Monohalides are dimeric in nature. E.g – S_2Fe , S_2Cl_2 , S_2Br_2 , Se_2Cl_2 and Se_2Br_2 . Dimeric halides undergo disproportionation as:- $2\text{Se}_2\text{Cl}_2 \rightarrow \text{SeCl}_4 + 3\text{Se}$

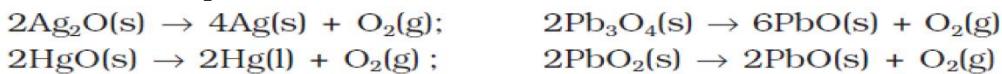
THE CIVIL SERVICES SCHOOL
DIOXYGEN

Methods of Preparation:

1. By heating chlorates, nitrates and permanganates.



2. Thermal decomposition of oxides.



3. $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$ Catalyst used - finely divided metals and manganese dioxide.
4. On large scale, prepared by electrolysis of water.
5. Industrially, from air \rightarrow first carbon dioxide and water vapour are removed and remaining gases liquefied are fractionally distilled.

Properties of DIOXYGEN:

1. Colourless and odourless gas.
2. Directly reacts with nearly all metals and non-metals except Au, Pt and some noble gases. Its combination with other elements is exothermic.
3. Some reactions with metals and non-metals are :

$$\begin{aligned} 2\text{Ca} + \text{O}_2 &\rightarrow 2\text{CaO} \\ 4\text{Al} + 2\text{O}_2 &\rightarrow 2\text{Al}_2\text{O}_3 \\ \text{P}_4 + 5\text{O}_2 &\rightarrow \text{P}_4\text{O}_{10} \\ \text{C} + \text{O}_2 &\rightarrow \text{CO}_2 \\ 2\text{ZnS} + 3\text{O}_2 &\rightarrow 2\text{ZnO} + 2\text{SO}_2 \\ \text{CH}_4 + 2\text{O}_2 &\rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \end{aligned}$$
4. Some compounds are catalytically oxidized.

$$\begin{aligned} 2\text{SO}_2 + \text{O}_2 &\xrightarrow{\text{V}_2\text{O}_5} 2\text{SO}_3 \\ 4\text{HCl} + \text{O}_2 &\xrightarrow{\text{CuCl}_2} 2\text{H}_2\text{O} \end{aligned}$$

Uses:

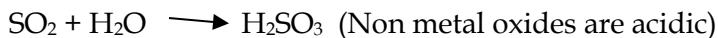
1. Importance in normal respiration and combustion.
2. Oxyacetylene welding.
3. Manufacture of steel.
4. Oxygen cylinders are used in hospitals, high altitude flying and in mountaineering.
5. Combustion of fuels, e.g. hydrazine in liquid oxygen provides thrust in rockets.

OXIDES

A binary compound of oxygen with another element is called oxide.

Oxides can be simple (MgO , Al_2O_3) or mixed (Pb_3O_4 , Fe_3O_4). Simple oxides can be acidic, basic or amphoteric oxides.

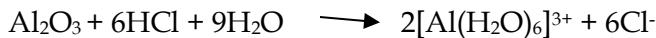
An oxide which combines with water to give an acid is termed as acidic oxide. (e.g SO_2 , CO_2 , N_2O_5)



The oxide which gives a base with water is called basic oxides. Metal oxides are basic (e.g- Na_2O , CaO , BaO)



Some metal oxides exhibit dual behavior. They show characteristics of both acidic as well as basic oxides. They are known as amphoteric oxides. E.g Al_2O_3



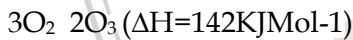
Some oxides are neither acidic nor basic. E.g CO, NO and N_2O

OZONE

Ozone is an allotrope of oxygen. It is too reactive to remain at sea level. At a height of 20km above sea level it is formed from atmospheric oxygen in the presence of sunlight. The ozone layer protects earth's surface from excessive concentration of UV radiation.

Preparation:

When silent electric discharge is passed through dry oxygen, ozonised oxygen (10%) is produced.



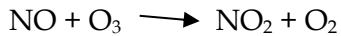
Properties:

1. Pale blue gas, dark blue liquid and violet black solid.
2. In small concentrations, it is harmless and if concentration rises above 100ppm breathing becomes uncomfortable.
3. Ozone is thermodynamically unstable. Its decomposition to oxygen results in liberation of heat and increase in entropy. The two effects results in negative Gibb's energy change for conversion into oxygen. High concentration of ozone can be dangerously explosive.
4. Acts as good oxidising agent because $[\text{O}_3 \rightarrow \text{O}_2 + \text{O}]$ due to liberation of nascent oxygen.



This reaction can be used for estimating O_3 gas. I_2 liberated titrated against standard $\text{Na}_2\text{S}_2\text{O}_3$ solution helps in estimation.

5. Nitrogen oxides emitted from exhaust system of supersonic aeroplanes might be slowly depleting ozone layer in upper atmosphere.



6. Ozone layer is also depleted by refrigerants and aerosol sprays.

7.



Bond length is 128pm and bond angle is 117° .

Uses:

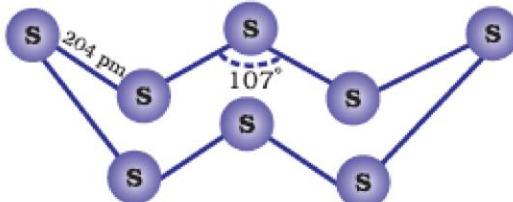
- Used as germicide, disinfectant and sterilizing water.
- Used for bleaching oils, ivory, flour and starch.
- Acts as oxidising agent in manufacture of KMnO_4 .

SULPHURAllotropic forms of Sulphur:

- Yellow rhombic sulphur (α -sulphur)
- Monoclinic sulphur (β -sulphur)

Rhombic is stable at room temperature which transforms to monoclinic when heated above 369K. Rhombic sulphur is yellow in colour, insoluble in water and dissolves to some extent in benzene, alcohol and ether. It is readily soluble in CS_2 .

Monoclinic sulphur is stable above 369K and α -sulphur below 369K, called transition temperature, both forms are stable. Both exist as S_8 molecules. At high temperature (~1000K), S_2 is dominant and it is para magnetic.

SULPHUR DIOXIDEPreparation:

- $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$ Sulphur burnt in air or oxygen gives SO_2 along with a little (6-8%) SO_3 .
- Suplhites with dilute sulphuric acid.

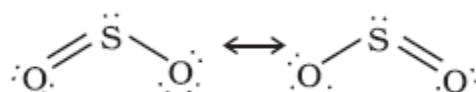
$$\text{SO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{SO}_2(\text{g})$$
- By product of roasting sulphide ores.

$$4\text{FeS}_2 + 11\text{O}_2(\text{g}) \rightarrow 2\text{Fe}_2\text{O}_3(\text{s}) + 8\text{SO}_2(\text{g})$$

Properties:

- Colourless gas with pungent smell.
- Highly soluble in water.
- Liquifies at room temp. under a pressure of 2atm and boils at 263K.
- $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_3(\text{aq})$ (sulphurous acid)

5. $\text{NaOH} + \text{SO}_2 \rightarrow \text{Na}_2\text{SO}_3$ (sodium sulphite) + H_2O
 $\text{Na}_2\text{SO}_3 + \text{H}_2\text{O} + \text{SO}_2 \rightarrow 2\text{NaHSO}_3$ (sodium hydrogen sulphite)
6. Reacts with chlorine in the presence of charcoal as catalyst to give sulphuryl chloride.
 $\text{SO}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow \text{SO}_2\text{Cl}_2(\text{l})$
7. Oxidised to sulphur trioxide in the presence of V_2O_5
 $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \xrightarrow{\text{V}_2\text{O}_5} 2\text{SO}_3(\text{g})$
8. Moist SO_2 behaves as reducing agent. Converts Iron(III) ions to Iron(II) ions and
 $2\text{Fe}^{3+} + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Fe}^{2+} + \text{SO}_4^{2-} + 4\text{H}^+$
 decolourizes acidified KMnO_4 solution
 $5\text{SO}_2 + 2\text{MnO}_4^- + 2\text{H}_2\text{O} \rightarrow 5\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{Mn}^{2+}$
9. SO_2 is angular.

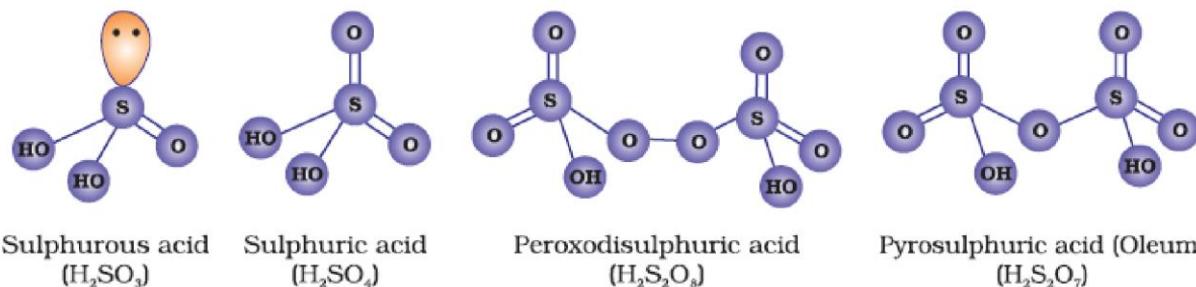


Uses of SO_2 :

1. In refining petroleum.
2. In bleaching wool and silk.
3. As an anti-colour, disinfectant and preservative.
4. Sulphuric acid, NaHSO_3 and $\text{Ca}(\text{HSO}_3)_2$ are manufactured from sulphur dioxide.
5. Liquid SO_2 is used as a solvent to dissolve a number of organic and inorganic chemicals.

OXOACIDS OF SULPHUR

Forms oxoacids of the formula H_2SO_3 , $\text{H}_2\text{S}_2\text{O}_3$, $\text{H}_2\text{S}_2\text{O}_4$, $\text{H}_2\text{S}_2\text{O}_5$, $\text{H}_2\text{S}_x\text{O}_6$ ($x=2$ to 5), H_2SO_4 , $\text{H}_2\text{S}_2\text{O}_7$, H_2SO_5 , $\text{H}_2\text{S}_2\text{O}_8$.



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SULPHURIC ACID

Manufacture:

By contact process. The steps are:

1. Burning of sulphur or sulphide ores in air to generate SO_2 .
 $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$
- 4 FeS_2 (Iron pyrites) + 11 $\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2$

2. Conversion of SO_2 to SO_3 by the reaction with oxygen in the presence of catalyst V_2O_5 .

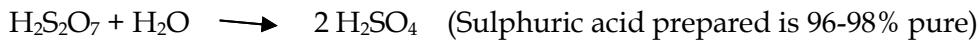


This is the key reaction in the process. High yield of SO_3 will lead to more production of H_2SO_4 .

3. Absorption of SO_3 in 98% H_2SO_4 to give Oleum ($\text{H}_2\text{S}_2\text{O}_7$).



4. Dilution of oleum with water to get desired concentration of sulphuric acid.



Conditions favouring maximum yield of sulphur trioxide:

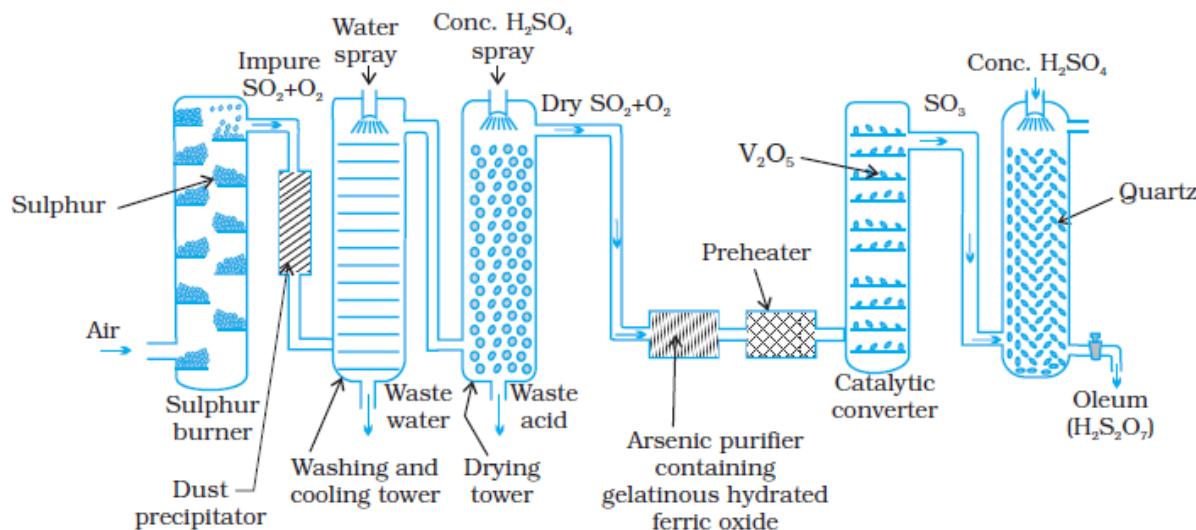
Key step in the manufacture of sulphuric acid is catalytic oxidation of SO_2 with O_2 to give SO_3 .



The reaction is exothermic and reversible.

- Low temperature:** Favours oxidation of SO_2 as reaction is exothermic (according to Le-Chatelier's principle). But it is essential to have a minimum temperature of 720K, to give maximum yield.
- High Pressure:** Favours oxidation as volume of gaseous products are less. A pressure of 2 to 3 bar is sufficient. Very high may cause corrosion of the vessel.
- Use of catalyst:** V_2O_5 increases the speed of reaction.

Description of the Plant (Manufacture of H_2SO_4 by Contact Process):



Flow diagram for the manufacture of sulphuric acid

- Sulphur burners:** Sulphur or Iron pyrites are burnt.
- Purification unit:** The gaseous mixture coming out of sulphur burner is generally impure. Purified as:

- I. **Dust Chambers:** Steam is introduced to remove dust.
 - II. **Coolers:** The gases are cooled to about 373K by passing them through cooling pipes.
 - III. **Scrubber:** Gases are passed into washing tower which dissolves mist and other soluble impurities.
 - IV. **Drying Tower:** A spray of conc. H_2SO_4 used for drying gases.
 - V. **Arsenic purifier:** This chamber contains shelves with gelatinous ferric hydroxide. The impurities of arsenic oxide are absorbed by ferric hydroxide.
3. **Testing Box:** The purifies gases are tested by passing a strong beam of light. Impurities present will scatter the light.
 4. **Contact Chamber or Converter:** Pure gases are then heated to about 723-823K in a pre-heater and then introduced into contact chamber. It is a cylindrical chamber fitted with iron pipes packed with catalyst V_2O_5 . In this SO_2 is oxidized to SO_3 . As the forward reaction is exothermic, the pre-heating is stopped once the oxidation has started.
 5. **Absorption tower:** It is a cylindrical tower packed with acid proof flint. SO_3 escaping out from converter is led from the bottom of the tower and conc. H_2SO_4 (98%) is sprayed from top. SO_3 gets absorbed by H_2SO_4 to form oleum or fuming sulphuric acid.

$$H_2SO_4 + SO_3 \longrightarrow H_2S_2O_7 \text{ (oleum)}$$

Oleum is then diluted with calculated amount of water to get acid of desired concentration.

$$H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$$

PROPERTIES OF H_2SO_4 :

1. Colourless, dense and oily liquid.
2. Conc. H_2SO_4 dissolves in water with evolution of large quantity of heat. Hence conc. H_2SO_4 must be added slowly in water with constant stirring.
3. Chemical reactions of H_2SO_4 are as a result of:
 - a) Volatility
 - b) Strong acidic character
 - c) Strong affinity of water
 - d) Ability to act as oxidising agent
4. In aqueous solution, sulphuric acid ionizes as:

$$H_2SO_4(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + HSO_4^-(aq) \quad K_{a1}=\text{very large } (>10)$$

$$HSO_4^-(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + SO_4^{2-}(aq) \quad K_{a2}=1.2\times 10^{-2}$$

Larger K_{a1} means – easily dissociated into H^+ and HSO_4^- and is a stronger acid.
5. Forms two types of salt:
 Normal sulphates (e.g. sodium sulphate, copper sulphate)
 Acid sulphates (e.g. hydrogen sulphate)
6. Can be used to form more volatile acids from their corresponding salts.

$$2MX + H_2SO_4 \longrightarrow 2HX + M_2SO_4 \quad (X=F, Cl, NO_3^-)$$
7. Acts as dehydrating agent. Can dry gases and also removes water from organic compounds.



8. Hot conc. H_2SO_4 is a strong oxidising agent. Both metals and non-metals are oxidized and itself is reduced to SO_2 .



USES:

1. Important industrial chemical.
2. Used in manufacture of fertilizers (e.g. ammonium sulphate, superphosphate)
3. Petroleum refining
4. Paints, pigments and dyestuff
5. Detergent industry
6. Metallurgical applications
7. storage batteries
8. Laboratory reagent
9. In the manufacture of nitrocellulose products

GROUP 17

F, Cl, Br, I, At (radioactive) are called halogens. Most reactive non-metals and most electronegative.

F_2 : Pale yellow gas

Cl_2 : Greenish yellow gas

Br_2 : Reddish brown liquid, sparingly soluble in H_2O

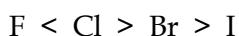
I_2 : Lustrous, grayish black solid, sublimes on heating sparingly soluble in H_2O , soluble in org. solvents.

Bond Energy:



Anomalous behavior of F_2 is due to the fact that the lone pair of electrons are very close which lead to repulsions.

Electron Affinity:



This is because F being small in size repels the incoming electron.

Occurs as:

- F – Fluorides
- Cl – NaCl in oceans
- Br – Bromides
- I – Iodides and iodates (IO_3^-)

Oxidizing power	$\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$
Radii	$\text{F} < \text{Cl} < \text{Br} < \text{I}$
I.E	$\text{F} > \text{Cl} > \text{Br} > \text{I}$
E.N	$\text{F} > \text{Cl} > \text{Br} > \text{I}$

Preparation of Chlorine:

Cl_2 :

*Electrolysis of natural brine (NaCl)

* Deacon's process: Oxidation of HCl(g) in presence of CuCl_2 at 723K



By oxidation of HCl by MnO_2 or KMnO_4 (Lab Method)



By oxidation of NaCl



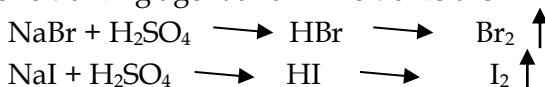
Trends in Group 17:

F_2	F is the most electronegative element i.e. has good acceptance of an electron and is therefore the strongest oxidizing agent.
Cl_2	
Br_2	
I_2	Oxidizing character decreases down the group. Thus one halogen oxidises halide ions of higher atomic number halogens.

Oxidizing Action:

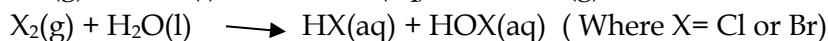
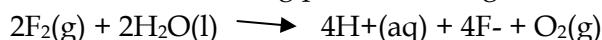


Similar reactions as above cannot be used for the preparation of HBr and HI as H_2SO_4 is a stronger oxidizing agent and will oxidize the HBr, HI formed to Br_2 , I_2 respectively.

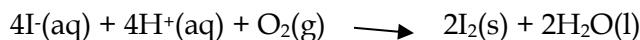


The decreasing oxidizing ability of the halogens in aqueous solution is evident from their standard electrode potentials which is dependent on the dissociation enthalpy of $X_2(g)$, electron gain enthalpy of $X(g)$ and hydration enthalpy to form $X^-(aq)$.

The relative oxidizing power of halogens can be further illustrated by their reaction with water:



I can be oxidized with O_2 in acidic medium:

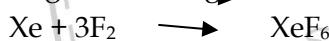


Reverse reaction is true for F.

HX are colourless, irritating gases.

HF has a higher b.p due to H-bonding.

Reactivity of halogens with metals or non-metals decreases down the group. $F_2 > Cl_2 > Br_2 > I_2$



Ionic character of M-X bond decreases down the group. $M-F > M-Cl > M-Br > M-I$



Acidic Character:



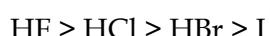
Low acidic character of HF is due to strong H-bonding and higher bond dissociation enthalpy.

HF is corrosive and attacks glass.

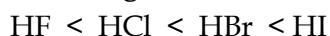
NF_3 is an exothermic compound but BCl_3 is endothermic because bond energy of F_2 is lower than Cl_2 and N-F bond is smaller and stronger than N-Cl bond.

Stability:

Decreases down the group due to decreased bond dissociation enthalpy.

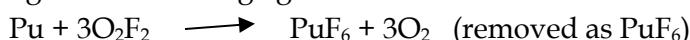


Reducing Nature:



Oxides:

Halogens form many oxides with oxygen. Fluorine forms only OF_2 and O_2F_2 - oxygen fluorides, they are good fluorinating agents.



O_2F_2 oxidises Pu to PuF_6 and the reaction is used in removing Pu as PuF_6 from spent nuclear fuel.

Chlorine, Bromide and iodine form oxides where O.S ranges from +1 to +7. The higher oxides of halogens tend to be more stable than the lower ones.

Chlorine oxides, Cl_2O , ClO_2 , Cl_2O_6 and Cl_2O_7 are highly reactive oxidizing agents. ClO_2 is used as bleaching agent for paper pulp and textiles and in water treatment.

Bromine oxides Br_2O , BrO_2 , BrO_3 are least stable halogen oxides. They are powerful oxidizing agents.

The iodine oxides, I_2O_4 , I_2O_5 , I_2O_7 are insoluble solids and decompose on heating. I_2O_5 is a very good oxidizing agent and is used in the estimation of CO.

Reactivity towards Metals:

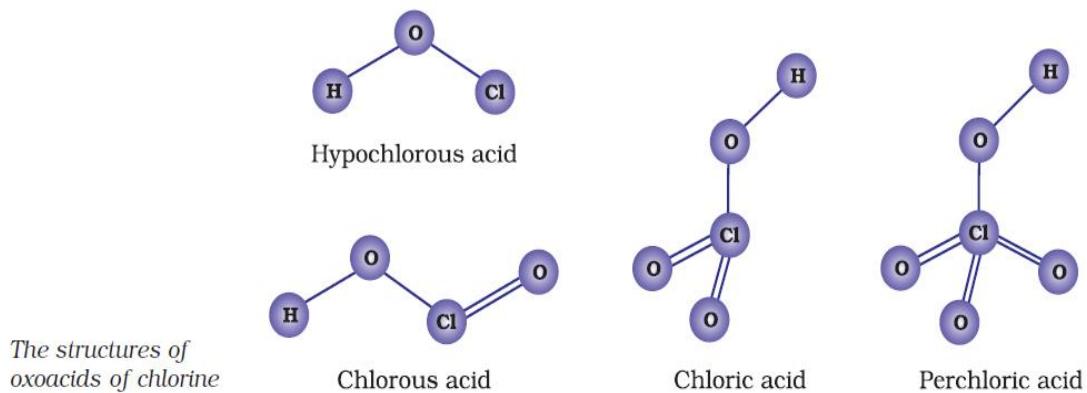
Halogens react with metals to form metal halides. $Mg(s) + Br_2(l) \rightarrow MgBr_2(s)$

Ionic character of the halides decreases in the order: $MF > MCl > MBr > MI$ where M is a monovalent metal.

If metal exhibits more than one O.S, higher O.S halides are more covalent than low O.S halides

Oxoacids of Halogens:

Halic (I) acid (Hypohalous acid)	HOF (Hypofluorous acid)	HOCl (Hypochlorous acid)	HOBr (Hypobromous acid)	HOI (Hypoiodous acid)
Halic (III) acid (Halous acid)	-	HOCIO (chlorous acid)	-	-
Halic (V) acid (Halic acid)	-	HOCIO ₂ (chloric acid)	HOBrO ₂ (bromic acid)	HOIO ₂ (iodic acid)
Halic (VII) acid (Perhalic acid)	-	HOCIO ₃ (perchloric acid)	HOBrO ₃ (perbromic acid)	HOIO ₃ (periodic acid)

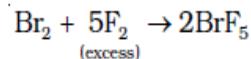
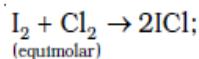
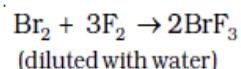
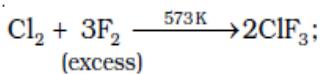
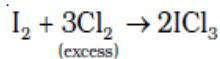
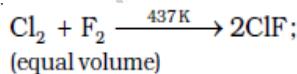


Inter Halogen Compounds:

When two different halogens react with each other, interhalogen compounds are formed. E.g. XX' , XX'_3 , XX'_5 and XX'_7 where X is halogen of larger size and X' of smaller size and X is more electropositive than X' .

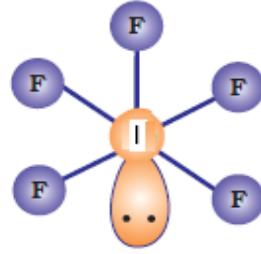
Preparation:

They are prepared by the direct combination or by the action of halogen on lower interhalogen compounds. For e.g.,

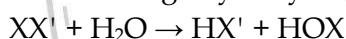


Properties:

XX'	ClF , BrF , IF (unstable), $BrCl$, ICl , IBr	
XX'_3	ClF_3 (Bent T-Shaped,, because it is sp ³ d hybridized) BrF_3 (Bent T-Shaped,, because it is sp ³ d hybridized) IF_3 (Bent T-Shaped,, because it is sp ³ d hybridized) ClF_3 (Bent T-Shaped,, because it is sp ³ d hybridized)	

$XX'{}_5$	IF ₅ (Square pyramid) BrF ₅ (Square pyramid) ClF ₅ (Square pyramid)	
$XX'{}_7$	IF ₇ (Pentagonal bipyramidal)	

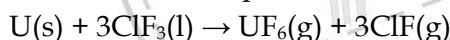
- They are all covalent and diamagnetic in nature. They are volatile solid or liquid except ClF which is a gas.
- They are more reactive than halogens because X-X' bond in inter halogens is weaker than X-X bond in halogens except F-F bond.
- All these undergo hydrolysis giving halide ion.



the bigger one forms hypohalous acid.

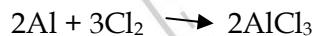
Uses:

The compounds are used as non aqueous solvents. They are useful fluorinating agents. ClF₃ and BrF₃ are used for the production of UF₆ in the enrichment of ²³⁵U.



Properties of Chlorine:

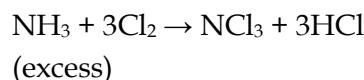
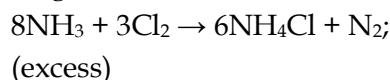
- Greenish yellow gas with pungent and suffocating odour.
- Reacts with metals and non-metals to form chlorides.



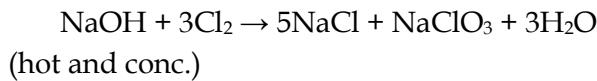
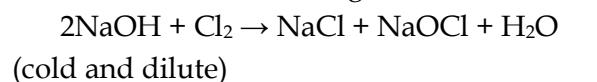
- Can react with hydrogen to form HCl.



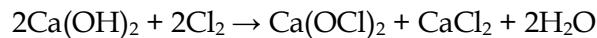
- With excess of NH₃, chlorine gives nitrogen and ammonium chloride while with excess of chlorine, nitrogen trichloride is formed.



5. With cold and dilute alkalies chlorine produces a mixture of chloride and hypochlorite but with hot and concentrated alkalies it gives chloride and chlorate.



6. With dry slaked lime it gives bleaching powder.



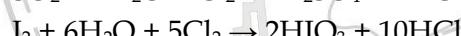
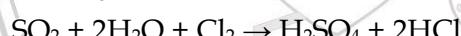
The composition of bleaching powder is $\text{Ca}(\text{OCl})_2 \cdot \text{CaCl}_2 \cdot \text{Ca}(\text{OH})_2 \cdot 2\text{H}_2\text{O}$.

7. Chlorine reacts with hydrocarbons and gives substitution products with saturated hydrocarbons and addition products with unsaturated hydrocarbons. For example,

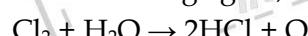


8. Chlorine water on standing loses its yellow colour due to the formation of HCl and HOCl.

9. It oxidises ferrous to ferric, sulphite to sulphate, sulphur dioxide to sulphuric acid and iodine to iodic acid.



10. It is a powerful bleaching agent; bleaching action is due to oxidation.



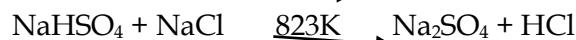
Uses:

- Used for bleaching woodpulp, bleaching cotton and textiles.
- In extraction of gold and platinum.
- In manufacture of dyes, drugs and organic compounds.
- In sterilizing drinking water.
- Preparation of poisonous gases such as phosgene (COCl_2), tear gas and mustard gas.

THE CIVIL SERVICES SCHOOL HYDROGEN CHLORIDE:

Preparation:

Prepared by heating sodium chloride with concentrated sulphuric acid.



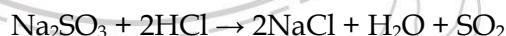
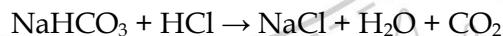
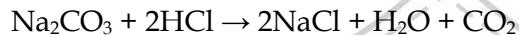
HCl gas can be dried by passing through concentrated sulphuric acid.

Properties:

- Colourless and pungent smelling gas. Easily liquefied.
- Extremely soluble. $\text{HCl(g)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
Its aqueous solution is called hydrochloric acid.
- Reacts with NH_3 and gives white fumes. $\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$
- 3 parts of conc. HCl and 1 part of con. HNO_3 forms aqua regia.

$$\text{Au} + 4\text{H}^+ + \text{NO}_3^- + 4\text{Cl}^- \rightarrow \text{AuCl}_4^- + \text{NO} + 2\text{H}_2\text{O}$$

$$3\text{Pt} + 16\text{H}^+ + 4\text{NO}_3^- + 18\text{Cl}^- \rightarrow 3\text{PtCl}_6^{2-} + 4\text{NO} + 8\text{H}_2\text{O}$$
- It decomposes salts of weaker acids, e.g., carbonates, hydrogencarbonates, sulphites, etc.

**Uses:**

- In manufacture of chlorine, NH_4Cl and glucose.
- In medicine and as laboratory reagent.

Uses of halogens and its compounds:

F_2	<ul style="list-style-type: none"> Manufacture of UF_6 for nuclear power generation and SF_6 for dielectrics.
HF	<ul style="list-style-type: none"> Chemicals obtained are chlorofluorocarbons like Freon used as a refrigerant and polytetra-fluorethylene called Teflon used in nonstick pans. Also used in glass industry as an etching agent and in the manufacture of fluoride salts.
NaF	<ul style="list-style-type: none"> Used for fluoridation of water, (1ppm of fluoride in drinking ware prevents tooth decay)
SnF_2	<ul style="list-style-type: none"> Used in fluoride toothpastes.
Cl_2	<ul style="list-style-type: none"> Used for bleaching paper, pulp, textiles. Used as disinfectant for sterilizing drinking water. Used in production of organic compounds- PVC, chlorinated hydrocarbons, pharmaceuticals. Used in production of inorganic compounds. E.g. HCl, PCl_3, NaOCl
$\text{C}_2\text{H}_2\text{Br}_2$	<ul style="list-style-type: none"> Used as gasoline additive.
Br_2	<ul style="list-style-type: none"> Used to make AgBr for photography.
I_2	<ul style="list-style-type: none"> Used for preparation of iodoform and KI
NaI , NaIO_3 or KI , KIO_3	Added to table salt and is called iodised salt. (Insufficient iodine in the diet leads to Goitre.)

GROUP 18

Known as Noble gases as their valance shell orbitals are completely filled and react with a few elements under certain conditions.

He $1s^2$	• Atmospheric abundance of the noble gases in dry air ~1% by volume of which Ar is major constituent.
Ne $2s^22p^6$	• Helium or Neon is also found in radioactive minerals, e.g. pitchblende, monazite, cleveite.
Ar $3s^23p^6$	• Natural gas is commercial source of helium.
Kr $4s^24p^6$	• Radon is obtained as decay product of ^{226}Ra .
Xe $5s^25p^6$	$^{226}\text{Ra} \rightarrow ^{222}\text{Rn} + ^4\text{He}$
Rn $6s^26p^6$	88 86 2

Electronic Configuration:

General electronic configuration is ns^2np^6 except He ($1s^2$). Due to fully filled configuration noble gases are inactive in nature

Ionization Enthalpy:

Due to stable electronic configuration, they have high I.E. Decreases down the group due to increase in atomic size.

Atomic Radii:

Increases down the group due to increase in number of shells.

Electron Gain Enthalpy:

Noble gases have stable electronic configuration, so no tendency to accept electron and hence have large positive values of $\Delta_{eg}\text{H}$.

Physical Properties:

1. Monoatomic, colourless, odourless and tasteless.
2. Sparingly soluble in water.
3. Low m.p and b.p due to weak dispersion forces.
4. Can be liquefied at low temperature due to weak forces.

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Chemical Properties:

Chemically inert due to:

1. Completely filled electronic config. ns^2np^6 in their valance shell.
2. High ionization enthalpy.
3. More positive electron gain enthalpy.

Uses of Noble Gases:

Helium:

- Non inflammable and light gas. Used in filling balloons for meteorological observations.
- Used in gas cooled nuclear reactors.
- Liquid He (b.p. 4.2K) is used as cryogenic agent for carrying out various experiments at low temperatures.
- Used to produce and sustain powerful superconducting magnets which form an essential part of modern NMR spectrometers and Magnetic Resonance Imaging (MRI) systems.

Neon:

- Used in discharge tubes.
- Used in fluorescent bulbs for advertisement display purpose.

Argon:

- Used to provide an inert atmosphere in high temperature metallurgical processes.
- Used for filling electric bulbs.
- Used in lab for handling substances that is air sensitive.

Kr, Xe:

- Used in light bulbs used for special purposes.

Energy of Compounds of Noble Gases:

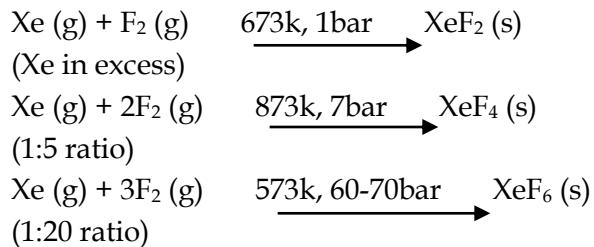
In 1962, Neil Bartlett prepared a red compound $O_2^+PtF_6^-$. He realised that the first I.E of $O_2=1175\text{ kJmol}^{-1}$ was almost identical to I.E of $Xe=1170\text{ kJmol}^{-1}$. He prepared a similar red colour compound by mixing Xe and PtF_6^- .



After this, a number of compounds of Xe with electronegative elements like fluorine and oxygen have been synthesised.

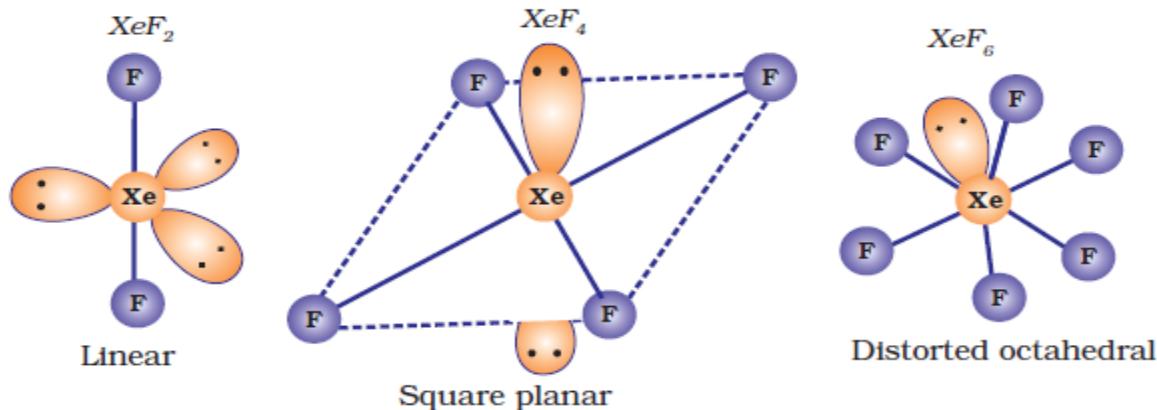
Xenon-fluorine compounds

Xenon forms three binary fluorides, XeF_2 , XeF_4 and XeF_6 by the direct reaction of elements.



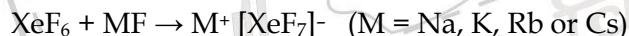
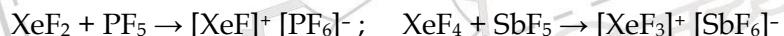
XeF_6 is also prepared as $\text{XeF}_4 + \text{O}_2\text{F}_2 \rightarrow \text{XeF}_6 + \text{O}_2$ at 143K.

Structure:

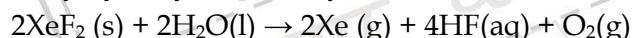


Properties:

1. XeF_2 , XeF_4 and XeF_6 are colourless crystalline solids.
2. Sublime readily at 298 K.
3. They are powerful fluorinating agents. They react with fluoride ion acceptors to form cationic species and fluoride ion donors to form fluoroanions.

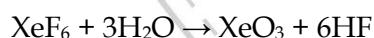
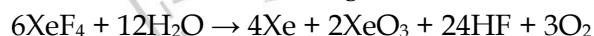


4. They are readily hydrolysed even by traces of water.



Xenon-oxygen compounds:

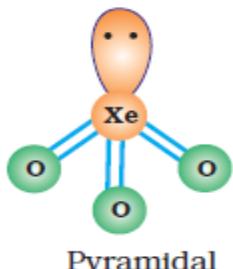
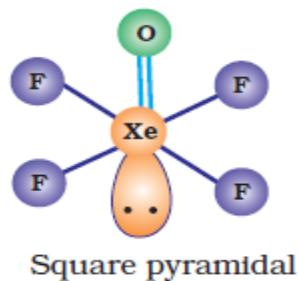
Hydrolysis of XeF_4 and XeF_6 with water gives XeO_3 .



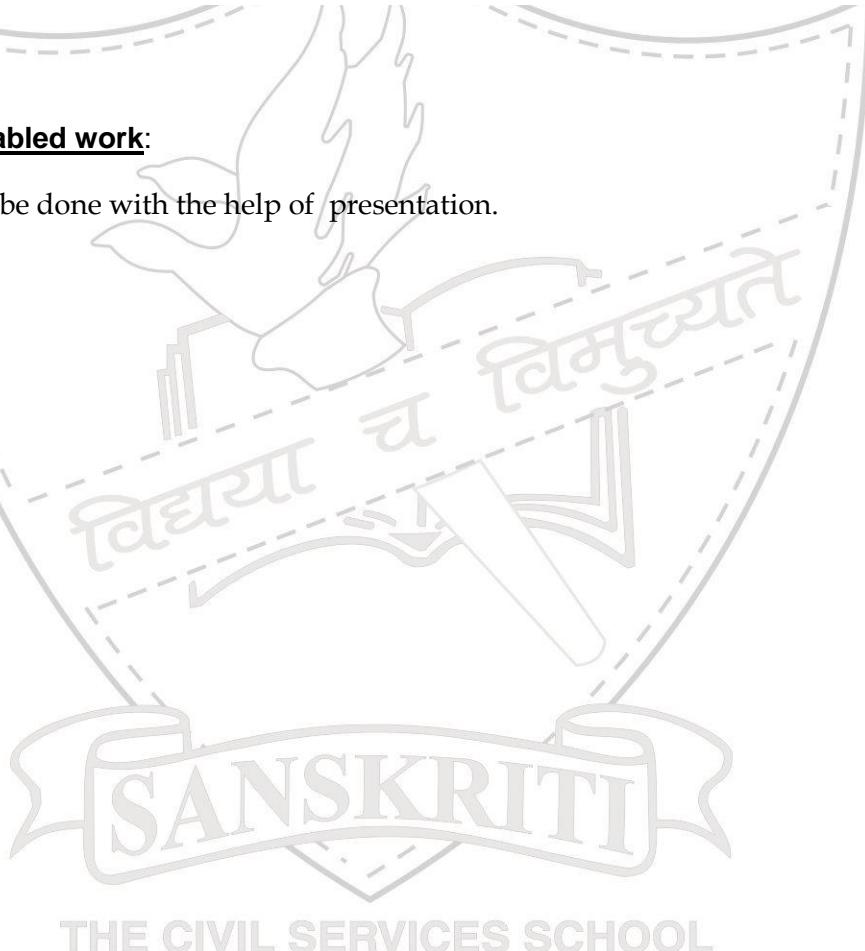
Partial hydrolysis of XeF_6 gives oxyfluorides



Hydrolysis of XeF_6 is not a redox reaction as there is no change in oxidation state.

Structure: XeO_3 (colourless explosive solid) $XeOF_4$ (colourless volatile liquid)**Hands -on / IT Enabled work:**

Whole chapter will be done with the help of presentation.



Assignment**Chapter 7: p -Block Elements**

1. The reactions of Cl_2 with cold dilute and hot concentrated NaOH in water give sodium salts of two different oxoacids of chlorine P and Q respectively. The Cl_2 gas reacts with SO_2 gas, in presence of charcoal, to give a product R.
 (a) Identify P, Q and R.
 (b) Write the balanced chemical equations for the above mentioned reactions.

 2. The compound with two lone pairs of electrons on the central atom is
 (a) BrF_5 (b) SO_2 (c) XeF_4 (d) SF_4
- In Q3 and Q4, a statement of assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements mark the correct answer as:
- (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 - (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 - (iii) Assertion is correct statement but reason is wrong statement.
 - (iv) Assertion and reason both are incorrect statements.
 - (v) Assertion is wrong statement but reason is correct statement.
3. **Assertion:** SF_6 cannot be hydrolysed but SF_4 can be.
Reason: Six F atoms in SF_6 prevent the attack of H_2O on sulphur atom of SF_6 .

 4. **Assertion:** HI cannot be prepared by the reaction of KI with concentrated H_2SO_4 .
Reason: HI has lowest H-X bond strength among halogen acids.

 5. (a) Give reasons:
 (i) When Cl_2 reacts with excess of F_2 , ClF_3 is formed and not FCl_3 .
 (ii) Dioxygen is a gas while sulphur is a solid at room temperature.
 (b) Draw the structures of the following:
 i. HClO_3
 ii. $\text{H}_2\text{S}_2\text{O}_7$
 iii. XeF_6

 6. (a) Arrange the following in the decreasing order of their reducing character:
 $\text{HF}, \text{HCl}, \text{HBr}, \text{HI}$
 (b) Complete the following reaction:
 (i) $\text{XeF}_4 + \text{SbF}_5 \longrightarrow$
 (ii) $\text{NH}_3 + 3\text{Cl}_2(\text{excess}) \longrightarrow$
 (iii) $\text{XeF}_6 + 2\text{H}_2\text{O} \longrightarrow$

 7. Give reasons:
 (i) Thermal stability decreases from H_2O to H_2Te .
 (ii) Fluoride ion has higher hydration enthalpy than chloride ion.

8. Assign appropriate reason for each of the following observations:
- Sulphur in vapour state exhibits some paramagnetic behaviour.
 - H_2O is a liquid but H_2S is a gas.
 - Hydrogen bonding in Hydrogen fluoride is much stronger than that in water, yet water has much higher boiling point.
 - The majority of known noble gas compounds are those of Xenon.
 - Halogens are strong oxidants.
 - The value of electron gain enthalpy with negative sign for sulphur is higher than that for oxygen.
 - ClF_3 molecule has a T-shaped structure and not a trigonal planar one.
 - O_2 and F_2 both stabilize higher oxidation states of metals but O_2 exceeds F_2 in doing so.
 - Structures of xenon fluorides cannot be explained by Valence Bond Approach.
 - SF_6 is kinetically inert.
 - All the bonds in SF_4 are not equivalent..
 - ICl is more reactive than I_2 .
 - Despite lower value of its electron gain enthalpy with negative sign, F_2 is a stronger oxidizing agent than Cl_2 .
 - Bond dissociation enthalpy of F_2 is lower than that of Cl_2 .
 - Ozone is thermodynamically unstable.
 - Fluorine forms only one oxoacid HOOF .
 - Solid PCl_5 is ionic in nature.
 - NH_3 is stronger base than phosphine.
 - SbF_5 is more stable than BiF_5 .
 - PH_3 has a lower boiling point than NH_3 .
9. (a) Write the reaction of preparation of XeF_4 , XeF_6 , XeO_3
 (b) What happens when (i) PCl_5 is heated
 (ii) H_3PO_3 is heated
10. Draw the structures of the following:
 a) XeF_2 b). XeF_4 c) XeOF_4 d) BrF_3 e) XeO_3 f) XeOF_4 g) SF_4 h) H_2SO_5 i) ClF_3
 j) $\text{H}_2\text{S}_2\text{O}_7$ k) $\text{H}_2\text{S}_2\text{O}_8$ l) BrF_5 m) H_3PO_3 n) H_3PO_2
11. Complete the equations:
- $\text{XeF}_2 + \text{PF}_5 \rightarrow$
 - $\text{F}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow$
 - $\text{I}(\text{aq.}) + \text{H}_2\text{O}(\text{l}) + \text{O}_3(\text{g}) \rightarrow$
 - $\text{XeF}_4 + \text{O}_2\text{F}_2 \rightarrow$
 - $\text{Xe}(\text{g}) \text{ (excess)} + \text{F}_2(\text{g}) \xrightarrow{-673\text{K}, 1\text{bar}}$
 - $\text{P}_4(\text{s}) + \text{NaOH}(\text{aq.}) + \text{H}_2\text{O}(\text{l}) \rightarrow$

12. (i) Compare the oxidizing action of F_2 and Cl_2 by considering parameters such as bond dissociation enthalpy, electron gain enthalpy and hydration enthalpy.
(ii) Write the conditions to maximize the yield of H_2SO_4 by contact process.
(iii) How is SO_2 an air pollutant?
13. Predict the shape and the asked angle (90° or more or less) in each of the following cases:
(a) SO_3^{2-} and the angle O-S-O.
(b) XeF_2 and the angle F-Xe-F.
14. Which noble gas is used for filling balloons for meteorological observations?
15. How does supersonic jet aeroplanes responsible for depletion of ozone layers?
16. Complete the following reactions :
(i) $NH_3 + 3Cl_2$ (excess) ----->
(ii) $XeF_6 + 2H_2O$ ----->
OR
What happens when
(i) $(NH_4)_2Cr_2O_7$ is heated ?
(ii) H_3PO_3 is heated ?
Write the equations.
17. Arrange the following in the increasing order of property mentioned :
(a) H_3PO_3 , H_3PO_4 , H_3PO_2 (Reducing character)
(b) NH_3 , PH_3 , AsH_3 , SbH_3 , BiH_3 (Base strength)
18. On adding NaOH to ammonium sulphate, a colourless gas with pungent odour is evolved which forms a blue coloured complex with Cu^{2+} ion. Identify the gas.
19. Draw the structures of white phosphorus and red phosphorus. Which one of these two types of phosphorus is more reactive and why?
20. Which one of PCl_4^+ and PCl_4^- is not likely to exist to exist and why?

More Practice
Chapter 7: p -Block Elements

1. Assign appropriate reason for each of the following observations:
 - 1) Hydrogen fluoride is a much weaker acid than HCl in aqueous solution.
 - 2) SCl_6 is not known whereas SF_6 is known
 - 3) Halogens are coloured .
 - 4) Dioxygen is a gas but sulphur is a solid.
 - 5) Fluorine forms only one oxoacid, HOF .
 - 6) Sulphur has a greater tendency for catenation than oxygen.
 - 7) The lower oxidation state becomes more stable with increasing atomic number in group 18.
 - 8) Fluorine exhibits only -1 oxidation state whereas halogens exhibit higher positive oxidation states also.
 - 9) On addition of ozone gas to KI solution, violet vapours are obtained.
 - 10) Chlorine acts as both oxidizing and bleaching properties.
 - 11) Chlorine loses its yellow colour on standing.
 - 12) Bond dissociation energy of F_2 is less than that of Cl_2 .
 - 13) SF_4 is easily hydrolysed whereas SF_6 is not easily hydrolysed.
 - 14) XeF_2 has a straight linear structure and not a bent angular structure.
 - 15) Fluorine does not exhibit any positive oxidation state.
 - 16) Oxygen shows catenation property less than Sulphur.
 - 17) Helium is used in diving apparatus.

2. Describe the steps involved in the contact process for the manufacture of H_2SO_4 .

3. Give Chemical reaction in support of each of the following statements:
 - a) Bleaching of flowers by Cl_2 is permanent while by SO_2 is temporary.
 - b) Fluorine is a stronger oxidizing agent than chlorine.
 - c) Chlorine reacts with a cold and dilute solution of sodium hydroxide.
 - e) Orthophosphorous acid is heated.
 - f) PtF_6 and Xenon are mixed together.

4. Arrange the following in the decreasing order of the property indicated:

a. H_2O , H_2S , H_2Se , H_2Te	boiling point
b. MF, MBr, MCl, MI	Ionic character of the bond
d. HF, HCl, HBr, HI	Acid strength
e. H_2S , H_2O , H_2Se , H_2Te	Thermal stability
f. HClO_4 , HClO_3 , HClO_2 , HClO	Oxidizing power
g. Cl_2 , Br_2 , F_2 , I_2	Oxidizing power
h. HClO_4 , HIO_4 , HBrO_4	Oxidising ability

5. With what neutral molecule ClO^- is isoelectronic? Also give the formula of a noble gas species isostructural with ICl_4^- and IBr^- .

d-and f-block elements

d-block of the periodic table contains elements of the groups 3-12 in which the orbitals are progressively filled in each of the four long periods. The elements constituting the f-block are those in which the 4f and 5f are progressively filled in the later two long periods; these elements are formal members of group 3 from which they have been taken out to form separate f-block of the periodic table.

The transition metals are those elements which have incompletely filled d-subshells in their ground state or in any one of their oxidation states.

Cu, Ag and Au are transition metals because in their commonly occurring states, they have partly filled d-subshells. Zn, Cd and Hg of group 12 do not have partly filled d-subshell in their elementary state or commonly occurring oxidation state, and hence, are not considered as transition elements. However, being the end members their chemistry is studied with transition elements.

Electronic Configuration- (n-1)d¹⁻¹⁰ ns¹⁻²

Transition series- The d-block elements are called transition elements as they represent change in properties from most electropositive s-block elements to least electropositive (or most electropositive) p-block elements.

Transition elements consist of 4 rows: These series are called transition series.

First transition series- 3d series

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
21	22	23	24	25	26	27	28	29	30
3d ¹ 4s ²	3d ² 4s ²	3d ³ 4s ²	3d ⁵ 4s ¹	3d ⁵ 4s ²	3d ⁶ 4s ²	3d ⁷ 4s ²	3d ⁸ 4s ²	3d ¹⁰ 4s ¹	3d ¹⁰ 4s ²

Second Transition series – 4d series

Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
39	40	41	42	43	44	45	46	47	48
4d ¹ 5s ²	4d ² 5s ²	4d ⁴ 5s ²	4d ⁵ s ¹	4d ⁶ 5s ¹	4d ⁷ 5s ¹	4d ⁸ 5s ¹	4d ¹⁰ 5s ⁰	4d ¹⁰ 5s ¹	4d ¹⁰ 5s ²

Third transition Series - 5d series

La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
57	72	73	74	75	76	777	78	79	80

Fourth transition Series- 6d Series

Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub
89	104	105	106	107	108	109	110	111	112

GENERAL PROPERTIES OF TRANSITION ELEMENTS

Atomic radii: The atomic radii is intermediate between those of s-and p-block elements. The following trends are observed:

- a) The atomic radii of elements of a particular series decrease with increase in atomic number but this decrease in atomic radii become small after midway.

Reason- The atomic radii decreases in the beginning because of increase in atomic no., the nuclear charge goes on increasing progressively, but the electrons enter the penultimate shell and the added d-electrons screen the outermost s-electrons. The shielding effect is small so that net electrostatic attraction between the nuclear charge and outermost electrons increases. Consequently atomic radius decreases. As the no. of d-electrons increase the screening effect increases. This neutralizes the effect of increased nuclear charge due increase in atomic number and consequently atomic radius remains almost unchanged after chromium.

- b) At the end of each period, there is slight increase in atomic number

Reason- This is because of increased electron-electron repulsions between the added electrons in the same orbital which exceeds the attractive forces due to increased nuclear charge. Therefore, electron cloud expands and size increase.

- c) The atomic radii increase while going down the group.

Reason - The atomic radii of second transition series is larger than that of first transition series because of increase in no. of outermost shell.

The third transition series have nearly the same radii as metals of second transition series. This is because of lanthanide contraction. This is associated with the interventions of 4f-orbitals which are filled before 5d-series. 4f-orbital have poor screening effect, This results in regular decrease in atomic radii which compensates the expected increase in atomic size with increase in atomic no.

Ionic Radii- The ionic radii follows the same trend as atomic radii. Since metals exhibit different oxidation states, radii of ions also differ. The ionic radii decrease with increase in nuclear charge.

Metallic character- All transition elements are metals. They have high density, hardness, high m.p.& b.p. & high tensile strengths, ductility, high, thermal and electrical conductivity and lustre.

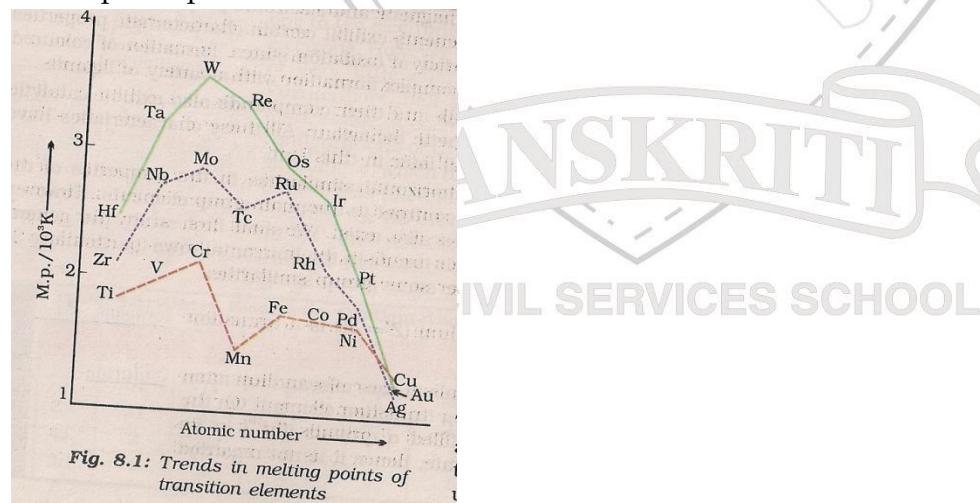
Reason – The metallic character is due to their relatively low ionization enthalpies and number of vacant orbitals in the outermost shell. The hardness of these metals suggests the presence of strong bonding due to overlap of unpaired electrons between different metal atoms. Therefore, they exhibit high enthalpy of atomization. Enthalpy of atomization is maximum in the middle indicates one unpaired electron is particularly favorable for strong atomic interaction. Hence, max enthalpy of atomization.

Density- All metals have high density. Within a period, the densities vary inversely with atomic radii, ie., densities increase along a period. Also densities increase upon descending down the group.

Reason – The atomic volumes of transition elements are low because electrons are added in $(n-1)d$ sub shell and not in ns subshell. Therefore, increased nuclear charge is partly screened by the d-electrons and outer electrons are strongly attracted by the nucleus. Moreover, electrons are added in inner orbital. Consequently, densities of transition metals are high.

Melting and boiling points

The transition metals have high m.p. & b.p. The m.p. and b.p. of metals rise to a maximum value and then decrease with increase in atomic number. However, Mn and Tc have abnormally low m.p. & b.p.



Reason – The high m.p. &b.p. is due to strong metallic bonds between the atoms of these elements. The metallic bond is formed due to interaction of electrons in the outermost orbital.

The strength of bonding depends on the number of outer most electrons. Greater is the number of valance electrons, stronger is the metallic bonding and consequently, m.p. is high.

Therefore metallic strength increase up to the middle till d^5 configuration and then decreases with the decrease in availability of unpaired d- electrons (from Fe onwards). Therefore, m.p. decrease after the middle because of increase an pairing of electrons.

The dip in the curve in Mn and Tc is due to the fact that Mn has stable electronic configuration ($3d^5 4s^2$). As a result 3d electrons are more tightly held by Mn atomic nucleus and this reduces delocalization of electrons resulting in weaker metallic bonding.

Ionization Enthalpies- The following trend is observed in the ionization enthalpies of d-block elements. The ionization enthalpies of d-block elements are lower than those of p-block elements. The I.E. increase along a series.

Reason - The increase in ionization enthalpy is due to the effect of increasing nuclear charge which would tend to attract outer electron with greater force. Consequently, ionization enthalpy is expected to increase. But the addition of electrons take place in last but one d-sub shell and this increases the screening effect. With the increase in electrons in d-sub shell the outer electrons are shielded more & more. Thus, effect of increased nuclear charge is opposed by additional screening effect of the nucleus and ionization enthalpy increases but slowly.

The irregular trend in first I.E. of first transition series elements is due to the fact that removal of one electron alters the relatives energies of 4s and 3d orbitals. Therefore, there is reorganization energy which gains in exchange energy due to increase in no. of electrons in d^n configuration and from transference of s-electrons in d- orbital.

Some exceptions observed in ionization enthalpies are:-

- Cr and Cu have high I.E. This is attributed to their half filled (d^5) and completely (d^{10}) electronic configuration .
- The value of second I.E. for zinc is low because ionization involves removal of an electron resulting in stable $3d^{10}$ configuration.
- The trend in third I.E. shows high value for Mn^{+2} and Zn^{+2} because of stable $3d^5$ and $3d^{10}$ electronic configuration.

Similarly, $I.E_3$ for Fe $< I.E_3$ for Mn because of stable $3d^5$ in Fe. In general, third I.E. values are very high because of filled 4f-orbitals which have poor shielding effect.

Oxidation States-

- Transition metals exhibit a larger number of oxidation states in their compound.

Reason - This is because of participation of inner ($n-1$)d electrons in addition to outer ns-electrons because the energies of ns and ($n-1$)d electrons are almost equal.

The elements which gave the greatest number of oxidation states occur in or near the middle of the series. Eg. Mn ; oxidation states from + 2 & +7

The lesser number of oxidation states at the extreme ends is either due to too few electrons to lose or share or too many d electrons, hence fewer orbital are available in to available to share electrons with others, thus higher valence cannot be attained.

eg. Cu can have oxidation state of +1 & +2

Zn can have oxidation state of +2 only

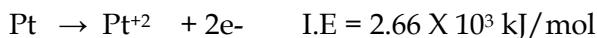
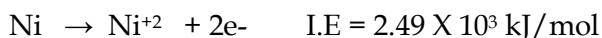
Oxidation state of first row transition elements

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
21	22	23	24	25	26	27	28	29	30
	$3d^14s^2$	$3d^24s^2$	$3d^34s^2$	$3d^54s^1$	$3d^54s^2$	$3d^64s^2$	$3d^74s^2$	$3d^84s^2$	$3d^{10}4s^1$
+3	+2	+2	+2	+2	+2	+2	+2	+1	+2
	+3	+3	+3	+3	+3	+3	+3	+2	
	+4	+4	+4	+4	+4	+4	+4		
		+5	+5	+5	+5				
			+6	+6	+6				
				+7					

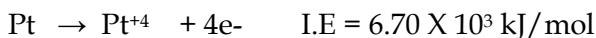
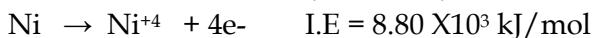
- b) Except Sc, the most common oxidation state of first row transition elements is +2 which arises due to loss of 4s-electrons. This means Sc, 3d-orbitals are more stable and lower in energy than 4s-orbital. As a result electrons are first removed from 4s-orbital.
 - c) Zinc is +2 in which no d-electrons are involved.
 - d) Within a group, maximum oxidation state increases with atomic number. For e.g. in group 8, Fe shows +2 and +3 but Ruthenium and Osmium form compounds in +4, +6 and +8 oxidation state.
 - e) In +2 and +3 oxidation state, bonds formed are ionic and in the compounds of higher oxidation state bonds are covalent.
- Transition elements show low oxidation states in some compounds or complexes having ligands such as CO, for e.g. in $\text{Ni}(\text{CO})_4$, Ni has zero oxidation state.

Standard electrode potential

The magnitude of ionization enthalpy gains the amount of energy required to remove electrons from particular oxidation state of metal in compounds. Smaller the I.E. the metal, the stable is its compound.

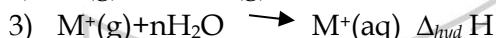
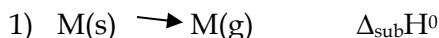


Ni(II) compounds are thermodynamically more stable than Pt(II) compounds.



Pt(IV) compounds are relatively more stable than Ni(IV) compounds. Stability of the compounds depend on electrode.

In addition to ionization enthalpy, ΔH_{sub} , ΔH_{hyd} energy, explain the stability of a particular oxidation state.



$$\Delta H = \Delta_{\text{sub}}H + \text{I.E} + \Delta_{\text{hyd}}H$$

Smaller the value of total energy charge for a particular oxidation state in aqueous solution, greater will be the stability of that oxidation state. The electrode potential is a measure of total energy charge.

The lower the electrode potential, ie, more negative the standard reduction potential of the electrode, more stable is the oxidation state of the transition metal in aqueous solution.

More negative values of E° for Mn and Zn are due to the stability of half filled ($3d^5$) in Mn^{+2} and completely filled ($3d^{10}$) configuration in Zn^{+2} .

Trend in M^{3+}/M^{2+} standard electrode potential

Except copper and Zinc, all other elements of first transition series show +3 oxidation states to from M^{+3} in aqueous solution.

- a) Low value of Sc reflects stability of Sc^{+3} which has a noble gas configuration.
- b) High value for Mn shows that Mn^{+2} (d^5) is particularly stable.
- c) Low value for Fe, shows extra stability for Fe^{+3} configuration.

Trends in stability of higher oxidation states-

The highest oxidation state is generally shown among halides and oxides.

- a) Transition metals react with halogens at high temp as they have high activation energies. High temp is required to start the reaction but heat of reaction is sufficient to continue. The reaction.
Order of reactivity: $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$
- b) In general elements of I transition series react in low oxidation state.
- c) The ability of fluorine to stabilize the highest oxidation state is due to its high electronegativity and higher lattice energy as in CoF_3 of high bond enthalpy for high covalent compounds as in VF_5 or CrF_6 .
- d) The highest oxidation states are found in TiX_4 , VF_5 , CrF_6 .
- e) The +7 oxidation states are not shown by simple halides but MnO_3F is known.

- f) V(V) is shown by VF₃ only. Other halides undergoing hydrolysis form oxo halides VOX₃.
- g) Fluorides are unstable in their low oxidation state. Eg -V forms VX₂ (X = Cl, Br or I) Cu can form CuX (X=Cl, I) Cu (II) halides are known except the iodide.
- h) Copper(I) compounds are unstable in aqueous solutions and undergo disproportionation. $2\text{Cu}^+ \rightarrow \text{Cu}^{2+} + \text{Cu}$.
- i) The ability of oxygen to stabilize the highest oxidation state is exhibited in their oxides. The highest oxidation states in member of group number. Eg-Sc in Sc₂O₃ is +3 and is a member of group 3. Mn in group 7 has +7 oxidation states in Mn₂O₇. Manganese forms highest oxidation state fluorides as MnF₄ whereas the highest oxide is Mn₂O₇. This is due to tendency of oxygen to form multiple bonds. In the covalent oxide Mn₂O₇, each Mn is tetrahedrally surrounded by oxygen atoms and has Mn-O-Mn bridge. Tetrahedral MO₄²⁻ ions are also known for V(V), Cr(VI), Mn(VI) and Mn(VII).

Formation of colored ions-

Most of the compounds of transition metals are colored in solid or solution form.

Reason- The colour is due to the presence of incomplete (n-1)d sub shell. Under the influence of approaching ions towards central metal ion, the d-orbitals of central metal split into different energy levels. This phenomenon is called crystal field splitting. For e.g. When six ions or molecules approach the metal ion (octahedral field), the d-orbitals split into two sets:- One set consisting of two d-orbitals of higher energy (dx²-y², dz²) and other set consisting of d-orbitals (dxy, dyz & dxz) of lower energy. The electrons are easily promoted from one to another energy level in the same d-sub shell. These are called d-d transitions. The amount of energy required to excite some of the electrons to higher energy states within the same d-sub shell corresponds to energy of certain colours of visible light. Therefore, when white light falls on the compounds, some part of its energy corresponding to certain colour is absorbed and the electron gets raised from lower energy to higher energy & the excess colour is transmitted. The observed colour is complementary of colour absorbed. Eg-Ti³⁺ (d¹) is purple.

Magnetic Properties-

Paramagnetism arises from the presence of unpaired electrons. Diamagnetic substances are repelled by the applied magnetic field while the paramagnetic substances are attracted whereas the ferromagnetic substances are attracted the most.

Each unpaired electron has a magnetic moment associated with its spin angular momentum and orbital angular momentum. For the compounds of the 1st transition series, the contribution of orbital angular momentum is effectively less and hence is of no significance. For these, the magnetic moment is determined by the number of unpaired electrons and can be calculated by 'spin only'

$$\mu = \sqrt{n(n+2)} \text{ BM}$$

N= no. of unpaired e-

μ = Magnetic moment in Bohr magneton (μ_b) units

$$(\mu_b = eh / 4m = 9.27 \times 10^{-24} \text{ Am}^2 \text{ or } \text{Jt}^{-1})$$

μ increase with the increasing number of unpaired

Eg- Calculate the magnetic moment of Mn^{2+} if the at no. =25 ,

Z=25 So, d⁵ has 5 unpaired electrons , n=5

$$\mu = 5(5+2) = 5.92\mu_b$$

Formations of complex compounds :- The transition metals form a large no. of complex compounds due to

- (i) the comparatively smaller sizes of the metal ions,
- (ii) their high ionic charges and
- (iii) the availability of d-orbital for bond formation

Eg . $[\text{PtCl}_4]^{2-}$, $[\text{Cu}(\text{NH}_3)_4]$, $[\text{Fe}(\text{CN})_6]^{4-}$ etc.

Catalytic Properties-

- a) Transition metals show catalytic property because of their ability to adopt multiple oxidation states. Catalysts at a solid surface involve the formation of bond between reactant molecules and atoms of the surface of the catalyst. This has the effect of increasing the concentration of the reactants at the catalyst surface and also weakening of the bonds in the reacting molecules & the activation energy is lowered, moreover transition metals can change their oxidation states.
Eg- Fe^{3+} catalyses the reaction between I_2 & persulphate ions.
- b) The catalytic property of transition metals is due to their tendency to form reaction intermediates with suitable reactants. These intermediates give reaction paths of low activation energy and therefore increase the rate of reaction. The reaction intermediates decompose yielding products and regenerating the original substance. The transition metals form reaction intermediates due to the presence of vacant orbitals & tendency to form variable oxidation state.

Formation of interstitial compounds :-

Many of the transition metals form interstitial compounds which are formed when small atoms like B,H, N or C are trapped inside the crystal lattices of metals. They are usually non-stoichiometric and are neither typically ionic nor covalent. There small atoms enter into the void sites, eg In, Ti. If C enters the void going the composition TiC or $\text{TiH}_{1.7}$, $\text{VH}_{0.56}$ etc.

Physical & Chemical characteristics of these compounds

- (i) High m.pt, higher than pure metals.
- (ii) Very hard , some borides approach diamond in hardness
- (iii) Retain metallic conducting
- (iv) Chemically inert

Alloy Formation:-

Alloys are homogenous solid solutions in which the atoms of one metal are distributed randomly among the atoms of the other but the metals should have similar metallic radii within 15% of each other.

The alloys formed have high m.pt & are hard.

Eg. Alloys of Cr, V, W, Mo, Mn etc, stainless steel is or alloys of Fe, Ni, Cr

Alloys of transition metals with non-transition metals, such as Brass (Cu-Zn), Bronze (Cu-Sn).

Some important compounds of transition elements***Oxides & oxo metals ions***

The higher oxidation state in the oxides coincides with the group no. eg, Sc_2O_3 (Sc is +3), Mn_2O_7 (Mn is +7).

Beyond group 7- no higher oxides. Eg- Fe_2O_3 (Fe is +3)

Besides the oxides, oxocations, stabilize V(V) as VO_2^+ , V(IV) as VO_2^{2+} and Ti(IV) as TiO_2^{2+} .

As the oxidation number of metal increases, ionic character decreases.

Mn_2O_7 is a covalent compound which is green oil.

Mn_2O_7 gives HMnO_4 . Acids in high oxidation state CrO_3 gives H_2CrO_4 and $\text{H}_2\text{Cr}_2\text{O}_7$

V_2O_5 is amphoteric, V_2O_3 is basic and V_2O_4 is less basic. When dissolved in acidic salts it gives VO_2^+ salts.

CrO is basic and Cr_2O_3 is amphoteric. (High oxidation states are more covalent and more acidic).

Potassium Dichromate , $\text{K}_2\text{Cr}_2\text{O}_7$ -***Preparation - From Chromite ore***

Chromates in turn are formed by fusion of Chromite ore (FeCr_2O_4) with Na_2CO_3 or K_2CO_3 .



Excess

Na_2CrO_4 is filtered and treated with H_2SO_4 to obtain orange crystals of $\text{Na}_2\text{CrO}_7 \cdot 2\text{H}_2\text{O}$

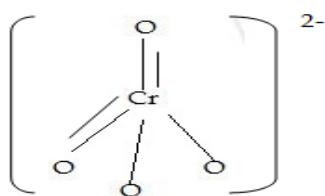
Sodium dichromate is more stable than pot. dichromate



Chromates and dichromates are interchangeable in aqueous solution depending upon pH of the solution.

The O.S. of Cr in CrO_4^{2-} and $\text{Cr}_2\text{O}_7^{2-}$ is same.



Chromate ion**Dichromate ion**

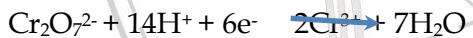
$\text{Na}_2\text{Cr}_2\text{O}_7 \& \text{K}_2\text{Cr}_2\text{O}_7$: Strong oxidizing agents

Used in
Organic
Chemistry

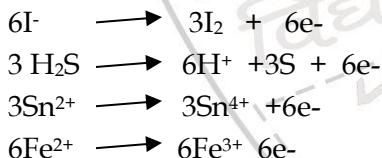
Used in volumetric
analysis

Chemical properties of $\text{K}_2\text{Cr}_2\text{O}_7$:-

In acidic solution, its oxidizing action can be represented as follows –



Acidified $\text{K}_2\text{Cr}_2\text{O}_7$ oxidises iodides to iodine, sulphide to S, Sn(II) to Sn(IV), Fe(II) to Fe(III)



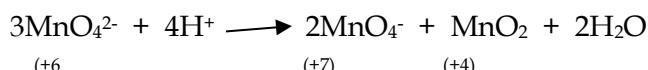
The full ionic equation can be obtained by adding half equation for potassium dichromate to half equation for the reducing agent, for eg.,



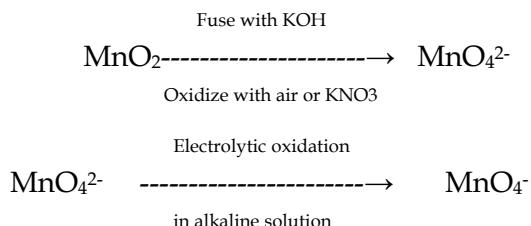
Uses - In leather industry, preparation of azo dyes.

Potassium Permanganate (KMnO_4)

Preparation – KNO_3



Commercially prepared by alkaline oxidative fusion of MnO_2 followed by the electrolytic oxidation of Manganate (VI)

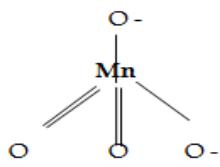


In the laboratory manganese (II) ion salt is oxidized by peroxodisulphate to permanganate

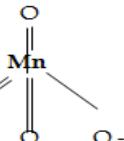


Properties-

1. Forms dark purple crystals
 2. Not very soluble in water
 3. Decomposes when heated at 513K
- $$2\text{KMnO}_4 \longrightarrow \text{K}_2\text{MnO}_4 + \text{MnO}_2 + \text{O}_2$$



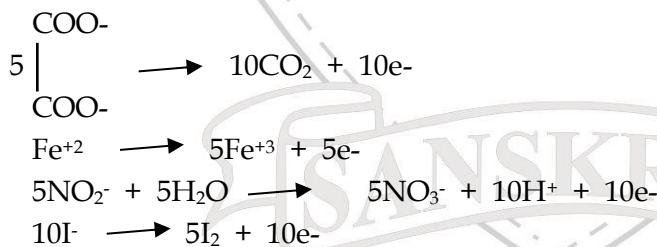
Tetrahedral manganese (green)ion



Tetrahedral Permanganate (purple) ion

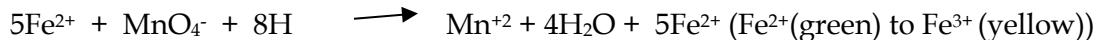
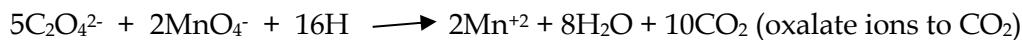
MnO_4 is a strong oxidizing agent, both in neutral & acidic medium

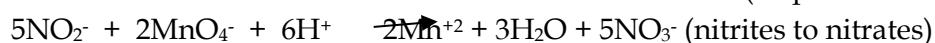
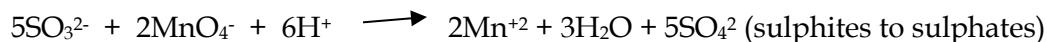
Acidified KMnO_4 oxidises oxalates to CO_2 , Iron(II) to iron (III), nitrites to nitrates and iodides to free iodine The half reaction of reductants are-



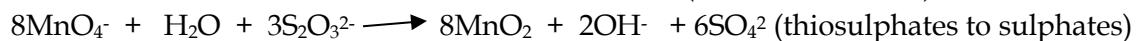
Full reactions can be written by adding the half reactions of KMnO_4 to half reactions of the reducing agents and balancing them.

Acidic solutions -





Neutral medium -



Uses- Used as oxidant, used for bleaching wool, cotton, silk and decolorization of oils.

The Inner Transition elements (*f*- Block)

Consists of two series:-

Lanthanoids (Ln; general Symbol)
(14 elements following La)

Actinoides
(14 elements following Ac)

Lanthanoids :-

Electronic Configuration:-

<u>Atomic No.</u>	<u>Name</u>	<u>Symbol</u>	<u>E.C.</u>
57	Lanthanum	La	5d ¹ 6s ²
58	Cerium	Ce	4f ¹ 5d ¹ 6s ¹
59	Praseodymium	Pr	4f ³ 6s ²
60	Neodymium	Nd	4f ⁴ 6s ²
61	Promethium	Pm	4f ⁵ 6s ²
62	Samarium	Sm	4f ⁶ 6s ²
63	Europium	Eu	4f ⁷ 6s ²
64	Gadolinium	Gd	4f ⁷ 5d ¹ 6s ²
65	Terbium	Tb	4f ⁹ 6s ²
66	Dysprosium	Dy	4f ¹⁰ 6s ²
67	Holmium	Ho	4f ¹¹ 6s ²
68	Erbium	Er	4f ¹² 6s ²
69	Thulium	Tm	4f ¹³ 6s ²
70	Ytterbium	Yb	4f ¹⁴ 6s ²
71	Lutetium	Lu	4f ¹⁴ 5d ¹ 6s ²

Atomic & Ionic Series :- Decrease from La to Lu is due to Lanthanoid Contraction (The shielding of one $4f$ electron by another less than that by one d electron by another & the increase in nuclear charge along the series).

The almost identical radii of Zr (160pm.) and Hf (159), a consequence of the lanthanoid contraction, account their occurrence together in nature and for the difficulty faced in their separation.

Colour and Para magnetism

Ln^{3+} are coloured both in solid and in aqueous solution due to the presence of f electrons. La^{3+} and Lu^{3+} do not show any colour. However absorption bands are narrow probably because of the excitants with in f level. Ln^{3+} are paramagnetic except La^{3+} & Ce^{4+} (f^0 type) & f^{14} type (Yb^{2+} & Lu^{3+}). Paramagnetism rises to maximum in Neodymium .

Ionization enthalpies

I.E. depends on the degree of stability of empty, half filled and completely filled f-level. This is indicated from the abnormally low values of the third ionization enthalpy of La, Gd, Lu.

Oxidation states:-

Ln^{3+} compounds are predominant species. +2 & +4 ions in solution or in solid compounds are also obtained occasionally.

Ce (IV) formation is favoured due to extra stability of noble gas configuration, but it is a strong oxidant reverting to the common +3 state .

Pr, Nd, Tb and Dy also exhibit +4 state but only in oxides, MO_2

Eu^{2+} is formed by losing the two s- electrons & its +7 configuration.

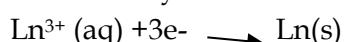
Properties and use :-

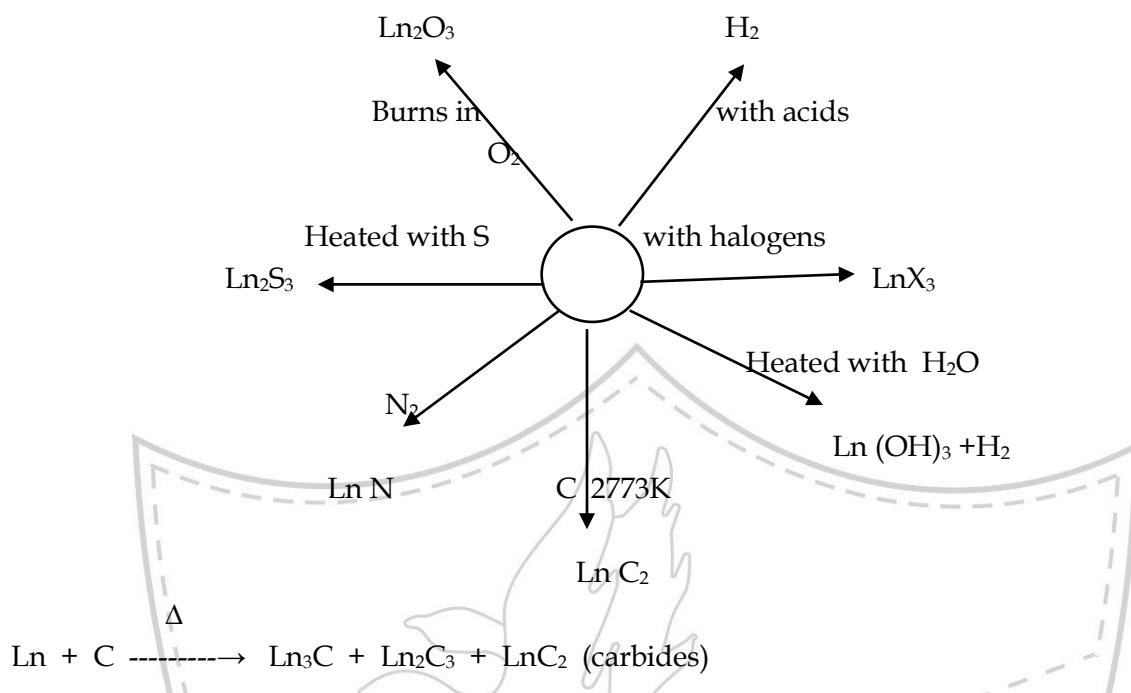
Ln are silvery white soft metals and tarnish rapidly in air. Hardness increases with increasing atomic number. M.pt. ranges from 1000K – 1200K

Sm is steel hard. (m.pt 1623K)

Chemical behaviour

In general earlier members of the series are quite reactive similar to Ca, with increasing atomic number they behave more like aluminum.





Use :- Used in the production of alloy steels for plates & pipes eg. Mischmetal is an alloy which consists of a lanthanoid metal (95%) and iron (5%) and trace of S, C, Ca and Al. A good amount of this alloy is used in Mg-based alloy to produce bullets, shell & lighter flint.

- Mixed oxides of Ln are used as catalyst in petroleum cracking .
- Ln oxides are used as phosphors in television screens & similar fluorescing surfaces.

The Actinoids:-

<u>Atomic no.</u>	<u>Name</u>	<u>Symbol</u>	<u>E.C.</u>
89	Actinium	Ac	$6d^17s^2$
90	Thorium	Th	$5f^06d^27s^2$
91	Protactinium	Pa	$5f^26d^17s^2$
92	Uranium	U	$5f^36d^17s^2$
93	Neptunium	Np	$5f^46d^17s^2$
94	Plutonium	Pu	$5f^67s^2$
95	Americium	Am	$5f^{77}s^2$
96	Curium	Cm	$5f^76d^17s^2$
97	Berkelium	Bk	$5f^97s^2$
98	Californium	Cf	$5f^{10}7s^2$
99	Einsteinium	Es	$5f^{11}7s^2$
100	Fermium	Fm	$5f^{12}7s^2$
101	Mendelevium	Md	$5f^{13}7s^2$
102	Nobelium	No	$5f^{14}7s^2$
103	Lawrencium	Lr	$5f^{14}6d^17s^2$

Although the naturally occurring elements & the earlier member have relatively long half lives, the latter members have values ranging from a day to 3 minutes for Lr ($Z=103$) These facts and high radioactivity renders their study more difficult.

Electronic Configuration

The irregularities in the electronic configurations of the actinoids like those of in the lanthanoids are related to the stability of f^0 , f^7 and f^{14} occupancies of the $5f$ orbitals.

Eg.Am : [Rn] $5f^7 7s^2$

Cm : [Rn] $5f^7 6d^1 7s^2$

5f orbital can & do participate in bonding.

Common oxidation state is +3

The maximum oxidation state increases from +4 in Th, +5 in Pa, +6 in U and +7 in Np but decreases in succeeding elements.

Magnetic Properties:- the variation of magnetic properties with the no. of unpaired 5f electrons is similar to that of Ln.

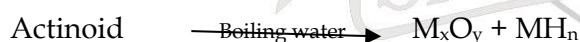
Ionic Sizes: Decrease in size due to increase in the effective nuclear charge on the outermost shell and poor shielding by 5f electrons. This is referred to as **actinoid contractions**.

Ionization Enthalpy :

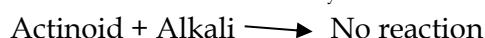
The I.E. of early actinoids is lesser than that of early Ln as when 5f orbitals are beginning to be occupied, they will penetrate less into the inner core of electrons. The 5f electrons, will therefore, be more effectively shielded from the nuclear charge than are the 4f electrons of the corresponding Ln. Because the outer electrons are less firmly held, they are available for bonding in the actinoids.

Physical and Chemical Reactivity

The actinoids are highly reactive when they are finely divided.



moderate temp



Metallic radii of actinoids is more as compared to lanthanoids.

Comparison With Lanthanoids

1. Structural variability in actinoids is obtained due to irregularities in metallic radii which are greater than lanthanoids.
2. Magnetic properties in actinoids are more complex than lanthanoids.
3. Ionization enthalpies of early actinoids, though not accurately known are lower than early lanthanoids. This is because 5f electrons penetrate less into the inner core and hence the outer electrons are less firmly held, they are available for bonding in actinoids.

Applications of d-and f Block Elements

1. Iron and steel are important construction materials. Their production is based on reduction of iron oxides, removal of impurities, and addition of carbon and alloying metals such as Cr, Mn, and Ni.
2. TiO₂ is used in pigment industry.
3. MnO₂ is used in battery cell. Also Zn and Ni/Cd.
4. Elements of group II are coinage metals.
5. V₂O₅ catalyses oxidation of SO₂ in contact process,
6. Iron catalyst is used in Haber's process.
7. TiCl₄ and Al(CH₃)₃ forms Ziegler-Natta Catalyst.
8. Ni complexes are used in polymerization of alkynes.

Hands –on / IT Enabled work:

Whole chapter is done with the help of a presentation.

Assignment**Chapter 8: d -and f -Block Elements**

1. The electronic configuration of Cu(II) is $3d^9$ whereas that of Cu(I) is $3d^{10}$. Which of the following is correct?
 - (i) Cu(II) is more stable
 - (ii) Cu(II) is less stable
 - (iii) Cu(I) and Cu(II) are equally stable
 - (iv) Stability of Cu(I) and Cu(II) depends on nature of copper salts

2. Which of the following reactions are disproportionation reactions?
 - (a) $Cu^+ \rightarrow Cu^{2+} + Cu$
 - (b) $3MnO_4^- + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$
 - (c) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$
 - (d) $2MnO_4^- + 3Mn^{2+} + 2H_2O \rightarrow 5MnO_2 + 4H^+$
 - (i) a, b
 - (ii) a, b, c
 - (iii) b, c, d
 - (iv) a, d

In the following questions no. 3 and 4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (i) Both assertion and reason are true, and reason is the correct explanation of the assertion.
 - (ii) Both assertion and reason are true but reason is not the correct explanation of assertion.
 - (iii) Assertion is not true but reason is true.
 - (iv) Both assertion and reason are false.
-
3. Assertion : Cu cannot liberate hydrogen from acids.
Reason : Because it has positive electrode potential.

 4. Assertion : Separation of Zr and Hf is difficult.
Reason : Because Zr and Hf lie in the same group of the periodic table.

 5. Complete and balance the following equations:
 - (i) $Fe^{2+} + MnO_4^- + H^+ \rightarrow$
 - (ii) $MnO_4^- + H_2O + I^- \rightarrow$

 6. Give reason:
 - (i) E° value for the Mn^{3+}/Mn^{2+} couple is highly positive as compared to Fe^{3+}/Fe^{2+} .
 - (ii) Iron has high enthalpy of atomization than that of copper.
 - (iii) Sc^{3+} is colourless in aqueous solution whereas Ti^{3+} is coloured.
 - (iv) Actinoid contraction is greater from element to element than lanthanoid contraction.

8. Account for the following :
- Transition metals form large number of complex compounds.
 - The lowest oxide of transition metal is basic whereas the highest oxide is amphoteric or acidic.
 - E° value for the Mn^{3+}/Mn^{2+} couple is highly positive (+1.57 V) as compare to Cr^{3+}/Cr^{2+} .
9. (i) How is the variability in oxidation states of transition metals different from that of the p-block elements ?
- Out of Cu^+ and Cu^{2+} , which ion is unstable in aqueous solution and why ?
 - Orange colour of $Cr_2O_7^{2-}$ ion changes to yellow when treated with an alkali. Why?
 - Write the formula of an oxo-anion of Manganese (Mn) in which it shows the oxidation state equal to its group number
10. Describe the general characteristics of transition elements with special reference to the following :
- Variable oxidation states
 - Formations of coloured ions.
11. (i) What are interstitial compounds? Why are such compounds well known for transition elements?
- (ii) What are alloys? Name an alloy which contains a lanthanoid metal.
12. How is it that several transition metals act as catalysts? Give two examples of reactions catalyzed by them?
13. Complete the following reactions:
- $Cr_2O_7^{2-}(aq.) + I^-(aq.) + H^+ \longrightarrow$
 - $MnO_4^-(aq.) + Fe^{2+}(aq.) + H^+(aq.) \longrightarrow$
 - $MnO_4^-(aq.) + S_2O_3^{2-}(aq.) + H_2O(l) \longrightarrow$
 - $5NO_2(aq.) + 2MnO_4^-(aq.) + 6H^+(aq.) \longrightarrow$
 - $Cr_2O_7^{2-}(aq.) + H_2S(g) + H^+(aq.) \longrightarrow$
 - $Cr_2O_7^{2-}(aq.) + Fe^{2+}(aq.) + H^+(aq.) \longrightarrow$
 - $MnO_2(s) + KOH(aq.) + O_2 \longrightarrow$
 - $2CrO_4^{2-} + 2H^+ \longrightarrow$
 - $Cr_2O_7^{2-}(aq.) + 3Sn^{2+} + 14 H^+ \longrightarrow$
14. (a) Compare the chemistry of actinoids with that of lanthanoids with reference to
- electronic configuration
 - oxidation state
 - atomic sizes
 - chemical reactivity
- (b) Chemistry of actinoids is complicated as compared to lanthanoids. Give two reasons.
- (c) Write one similarity and one difference between the chemistry of lanthanoid and actinoid elements.
15. When chromite ore $FeCr_2O_4$ is fused with $NaOH$ in presence of air, a yellow coloured compound (A) is obtained which on acidification with dilute sulphuric acid gives a

- compound (B). Compound (B) on reaction with KCl forms a orange coloured crystalline compound (C).
- (i) Write the formulae of the compounds (A), (B) and (C).
(ii) Write one use of compound (C).
16. What may be the possible oxidation states of the transition metals with the following d electronic configurations in the ground state of their atoms:
 $3d^34s^2$, $3d^54s^2$ and $3d^64s^2$. Indicate relative stability of oxidation states in each case.
17. Calculate the number of unpaired electrons in following gaseous ions: Mn^{3+} , Cr^{3+} , V^{3+} and Ti^{3+} . Which one of these is the most stable in aqueous solution?
18. How would you account for the following:
(a) The metallic radii of the third(5d) series of transition metals are virtually the same as those of corresponding group members of the second (4d) series.
(b) Among lanthanoids, $Ln(III)$ compounds are predominant. However, occasionally in solutions form solid compounds, +2 and +4 ions are also obtained.
(c) The $E^\ominus_{M2+/M}$ for copper is positive (0.34V), copper is the only metal in the first series of transition elements showing this behavior.
(d) The higher oxidation states are usually exhibited by the members in the middle of the series of transition elements.
(e) Mn shows the highest oxidation state of +7 with oxygen but with fluorine it shows the highest oxidation state of +4.
(f) Actinoids show irregularities in their electronic configurations.
19. a) Which metal in the first transition series(3d series) exhibits +1 oxidation state most frequently and why?
b) Which of the following cations are coloured in aqueous solution and why?
 Sc^{3+} , V^{3+} , Ti^{4+} , Mn^{2+}

More Practice**Chapter 8: d- and f -Block Elements**

1. What is Lanthanide contraction? What effect does it have on the chemistry of the elements which follow lanthanoids.
2. Why is HCl not used to acidify a permanganate solution in volumetric estimations of Fe^{2+} or $\text{C}_2\text{O}_4^{2-}$?
3. Why are Zn , Cd and Hg normally not regarded as transition metals ?
4. Which of the following ion is paramagnetic: Sc^{3+} ($Z=21$), Cu^+ ($Z=29$).
5. Why is the third ionization energy of Manganese ($Z=25$) unexpectedly high?
6. Evaluate the magnetic moment of a divalent ion in aqueous solution if its atomic no. is 25.
7. Explain why:
 - (i) Ce^{3+} can be easily oxidized to Ce^{4+} (At. no. of Ce =58).
 - (ii) Zr ($Z=40$) and Hf ($Z=70$) have very close value of atomic radii.
 - (iii) The lowest oxidation state of manganese is basic while the highest is acidic.
 - (iv) CrO_4^{2-} is a strong oxidizing agent while MnO_4^{2-} is not.
8. Predict which of the following will be coloured in aqueous solution?
 $\text{Ti}^{3+}, \text{V}^{3+}, \text{Cu}^+, \text{Sc}^{3+}, \text{Mn}^{2+}, \text{Fe}^{3+}, \text{Co}^{2+}$
9. Explain the following observations:
 - (i) In general the atomic radii of transition elements decrease with atomic number in a given series.
 - (ii) The E° value for $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple is much more positive than for $\text{Cr}^{3+}/\text{Cr}^{2+}$ or $\text{Fe}^{3+}/\text{Fe}^{2+}$ couple.
 - (iii) Cu^+ ion is unstable in aqueous solutions.
 - (iv) Although Co^{2+} ion appears to be stable, it is easily oxidised to Co^{3+} ion in the presence of a strong ligand.
 - (v) With the same d^4 d-orbital configuration Cr^{2+} ion is reducing while Mn^{3+} ion is oxidising.
 - (vi) The enthalpies of atomisation of the transition elements are quite high.
 - (vii) Transition metals form compounds which are usually coloured.
 - (viii) Transition metals exhibit variable oxidation states.
 - (ix) The actinoids exhibit a greater range of oxidation states than the lanthanoids.
 - (x) There occurs much more frequent metal-metal bonding in compounds of heavy transition elements (3rd series).
 - (xi) There is in general an increase in density of element from titanium ($Z=22$) to copper ($Z=29$).

- (xii) The gradual decrease in size (actinoid contraction) from element to element is greater among the actinoids than that among the lanthanoids. (lanthanoid contraction).
- (xiii) The greatest numbers of oxidation states are exhibited by the members in the middle of a transition series.
- (xiv) With the same d-orbital configuration (d^4) Cr^{2+} ion is a reducing agent but Mn^{3+} ion is an oxidising agent.
10. What is meant by 'disproportionation' ? Give two examples.
11. Why Ce^{4+} is oxidizing and Sm^{2+} , Eu^{2+} are reducing in nature?
12. A mixed oxide of iron and chromium $\text{FeO}\text{Cr}_2\text{O}_3$ is fused with sodium carbonate in the presence of air to form an yellow coloured compound (A) On acidification the compound the compound forms an orange coloured compound (B), which is a strong oxidizing agent .
(i) Identify the compounds (A) and (B)
(ii) Write balanced chemical equation for each step.
13. Explain the following facts:
(a) transition metals act as catalysts.
(b) Chromium group elements have the highest melting points in their respective series.
(c) The enthalpies of atomization of transition elements are high.
(d) From element to element the actinoid contraction is greater than the lanthanoid contraction.
(e) The E° value for the $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple is much more positive than that for $\text{Cr}^{3+}/\text{Cr}^{2+}$
(f) Scandium ($Z=21$) does not exhibit variable oxidation states and yet it is regarded as a transition element.
14. An element 'A' exists as a yellow solid in standard state . It forms a volatile hydride 'B' which is a foul smelling gas and is extensively used in qualitative analysis of salts. When treated with oxygen , 'B' forms an oxide 'C' which is a colourless , pungent smelling gas. This gas when passed through acidified KMnO_4 solution , decolorizes it.'C' gets oxidized to another oxide'D' in the presence of a heterogenous catalyst . Identify A,B,C,D, and also give the chemical equation of reaction of 'C' with acidified KMnO_4 solution and for conversion of 'C' to 'D'.
15. (a) A blackish brown coloured solid 'A' when fused with alkali metal hydroxides in the presence of air, produces a dark green compound 'B', which on electrolytic oxidation in alkaline medium gives a dark purple coloured compound C. Identify A, B and C and write the reactions involved.
(b) What happens when acidic solution of green compound (B) is allowed to stand for some time? Give the equations involved .What is this type of reaction called?

Assignment**Chapter 9: Coordination Compounds**

1. The stabilisation of coordination compounds due to chelation is called the chelate effect.
Which of the following is the most stable complex species?
 (i) $[\text{Fe}(\text{CO})_5]$
 (ii) $[\text{Fe}(\text{CN})_6]^{3-}$
 (iii) $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$
 (iv) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$

2. A chelating agent has two or more than two donor atoms to bind to a single metal ion.
Which of the following is not a chelating agent?
 (i) thiosulphato
 (ii) oxalate
 (iii) glycinato
 (iv) ethane-1,2-diamine

In the following question no. 3 ans 4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

 - (i) Assertion and reason both are true, reason is correct explanation of assertion.
 - (ii) Assertion and reason both are true but reason is not the correct explanation of assertion.
 - (iii) Assertion is true, reason is false.
 - (iv) Assertion is false, reason is true.

3. Assertion : $[\text{Fe}(\text{CN})_6]^{3-}$ ion shows magnetic moment corresponding to two unpaired electrons. Reason : Because it has d^2sp^3 type hybridisation.

4. Assertion : Linkage isomerism arises in coordination compounds containing ambidentate ligand. Reason : Ambidentate ligand has two different donor atoms.

5. Write the coordination number and oxidation state of Platinum in the complex $[\text{Pt}(\text{en})_2\text{Cl}_2]$

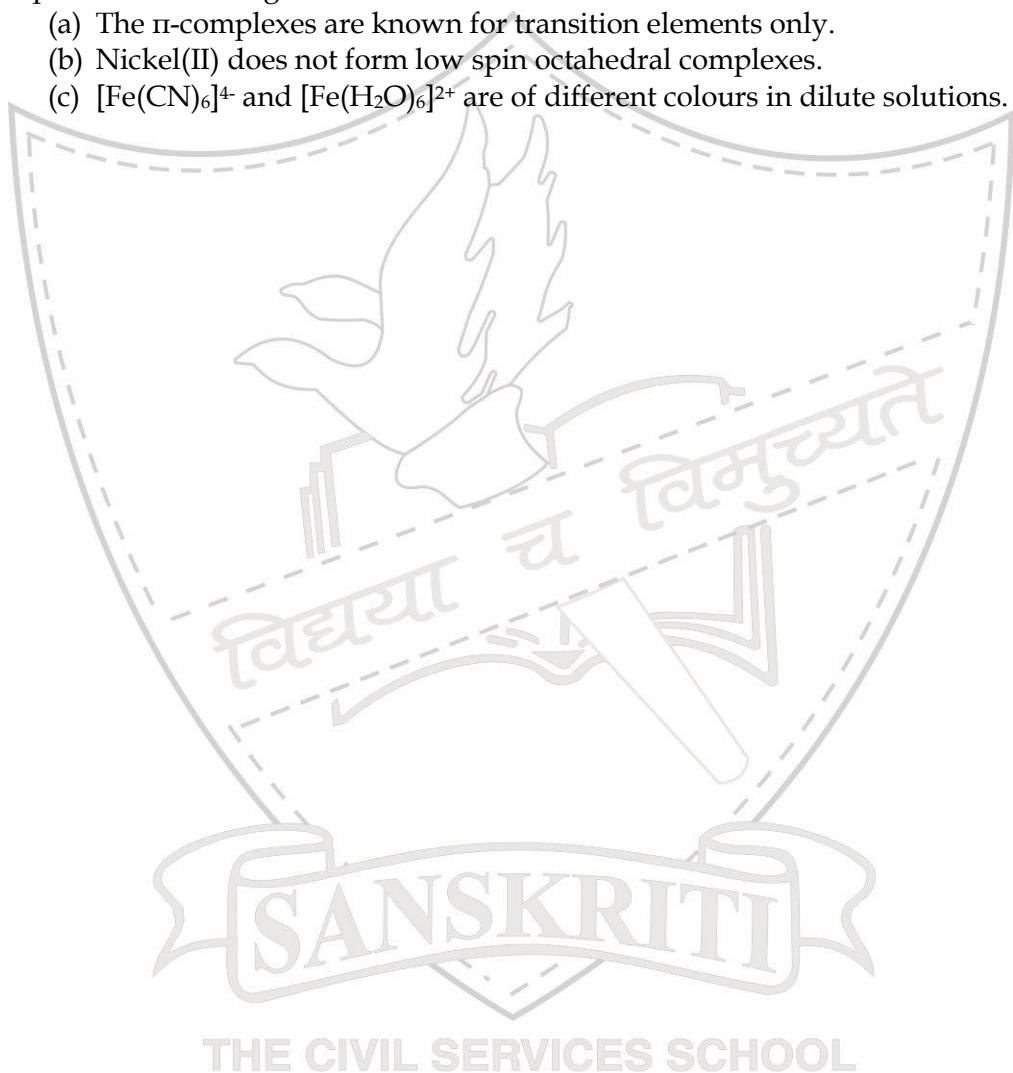
6. (a) Write the formula of the following coordination compound:
Iron(III)hexacyanoferrate(II).
 (b) What type of isomerism is exhibited by the complex $[\text{Co}(\text{NH}_3)\text{Cl}]\text{SO}_4$?
 (c) Write the hybridization and number of unpaired electrons in the complex $[\text{CoF}_6]^{3-}$

7. (i) What type of isomerism is shown by the complex $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$?
 (ii) Why a solution of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is green while a solution of $[\text{Ni}(\text{CN})_4]^{2-}$ is colourless ?
 (At. no. of Ni = 28)
 (v) Write the IUPAC name of the following complex : $[\text{Co}(\text{NH}_3)_5(\text{CO}_3)]\text{Cl}$.

8. Write IUPAC name of the following:
 1) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ 2) $[\text{CoBr}_2(\text{en})_2]^+$ 3) $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$
 4) $\text{K}_4[\text{Fe}(\text{CN})_6]^{3+}$ 5) $[\text{NiCl}_4]^{2-}$ 6) $[\text{CrCl}_2(\text{en})_2]\text{Cl}$

9. Write the formulas in the following cases.
 1) Tetrahydroxozincate(II), 2) Hexaamminecobalt(III) sulphate
 3) Hexaammineplatinum(IV) 4) Pentaamminenitrito-N-cobalt(III)
10. Give the formula of each of the following coordination entities:
 (a) Co^{3+} ion is bound to one Cl^- , one NH_3 molecule and two bidentate ethylene diamine(en) molecules.
 (b) Ni^{2+} ion is bound to two water molecules and two oxalate ions.
 Write the name and magnetic behavior of each of the above coordination entities.
11. In the ring test for identification of nitrate ion, what is the formula of the compound responsible for the brown ring formed at the interface of two liquids?
12. When a coordination compound $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ is mixed with AgNO_3 , 2 moles of AgCl are precipitated per mole of the compound. Write
 (i) Structural formula of the complex
 (ii) IUPAC name of the complex.
13. a) For the complex $[\text{Fe}(\text{CN})_6]^{3-}$, write the hybridization type, magnetic character and spin nature of the complex. (At. number : Fe = 26).
 b) Draw one of the geometrical isomers of the complex $[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$ which is optically active.
14. Show the possible isomers of the following coordination entities?
 (i) $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$ (ii) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ (iii) $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
15. Name the isomerism exhibited by the following pair of coordination compounds:
 $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$
 Give one chemical test to distinguish between these two compounds.
16. How many ions are produced from the complex $[\text{Co}(\text{NH}_3)_6]\text{Cl}_2$ in aqueous phase.
17. What is spectrochemical series? Explain the difference between a weak field ligand and a strong field ligand.
18. (i) Draw a sketch to show the splitting of d- orbitals in an octahedral crystal field. State for a d^6 ion how the actual configuration of the split d- orbitals in an octahedral crystal field is decided by the relative values of Δ° and P.
 (ii) On the basis of CFT, write the electronic configuration of d^4 ion if $\Delta_0 > P$.
19. Give reasons:
 1) $\text{K}_3[\text{Fe}(\text{CN})_6]$ is weakly paramagnetic whereas $\text{K}_3[\text{FeF}_6]$ is highly paramagnetic.
 2) Though CO is a weak lewis base yet it forms a number of stable metal carbonyls . Explain.
20. Compare the following complexes with respect to their shape, magnetic behaviour and the hybrid orbitals involved: (i) $[\text{CoF}_4]^{2-}$, (ii) $[\text{Cr}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]$.
 (Atomic number Co = 27, Cr = 24)

21. Discuss briefly giving an example in each case the role of coordination compounds in:
- (i) biological systems (ii) medicinal chemistry
 - (iii) analytical chemistry (iv) metallurgy of metals.
22. (a) What is a ligand? Give an example of a bidentate ligand.
(b) Explain as to how the two complexes of nickel, $[\text{Ni}(\text{CN})_4]^{2-}$ and $\text{Ni}(\text{CO})_4$, have different structures but do not differ in their magnetic behaviour. ($\text{Ni} = 28$)
23. Explain the following:
- (a) The π -complexes are known for transition elements only.
 - (b) Nickel(II) does not form low spin octahedral complexes.
 - (c) $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ are of different colours in dilute solutions.



More Practice**Chapter 9: Coordination Compounds**

1. Write IUPAC name of the following:
 - 1) $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{NH}_2\text{CH}_3)]\text{Cl}$
 - 2) linkage isomer of $[\text{Co}(\text{NH}_3)_5(\text{ONO})]^{2+}$
 - 3) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
 - 4) $[\text{Co}(\text{NH}_3)_4\text{Cl}(\text{NO}_2)]\text{Cl}$
 - 5) $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$
 - 6) $[\text{Co}](\text{en})_3]^{3+}$
 - 7) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}$
 - 8) $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{Cl}_3$
 - 9) $[\text{Pt}(\text{NH}_3)_4][\text{NiCl}_4]$

2. Give the electronic configuration of the
 - (a) d-orbitals of Ti in $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ion in an octahedral crystal field.
 - (b) Why is this complex coloured? Explain on the basis of distribution of electrons in the d-orbitals.
 - (c) How does the colour change on heating $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ion?

3. A metal ion M^{n+} having d^4 valence electronic configuration combines with three didentate ligands to form a complex compound. Assuming $\Delta_o > \Delta_g$
 - a. draw the diagram showing d orbital splitting during this complex formation.
 - b. Write the electronic configuration of the valence electrons of the metal M^{n+} ion in terms of t_{2g} and e_g .
 - c. What type of hybridization will M^{n+} ion have?
 - d. Name the type of isomerism exhibited by this complex.

4. Write the shape of $\text{Fe}(\text{CO})_5$, $\text{Mn}_2(\text{CO})_{10}$, $\text{Co}_2(\text{CO})_8$, $\text{Ni}(\text{CO})_4$ molecule

5. For the complex $[\text{Fe}(\text{en})_2\text{Cl}_2]\text{Cl}$, (en = ethylene diamine), identify
 - 1) The oxidation number of iron.
 - 2) The hybrid orbitals and the shape of the complex
 - 3) The magnetic behaviour of the complex
 - 4) The number of geometrical isomers
 - 5) Whether there is an optical isomer
 - 6) Name of the complex. (At. No. of Fe = 26)

6. Write the formulas in the following cases.
 - 1) Tetrabromidocuprate(II)
 - 2) Diamminedichloridoplatinum(II)
 - 3) Amminebromidochloridonitrito-N-platinato (II)
 - 4) Dichlorodobis (ethane-1,2-diamine) platinum (IV) nitrate

Chapter 10- Haloalkanes and Haloarenes

POLYHALOGEN COMPOUNDS

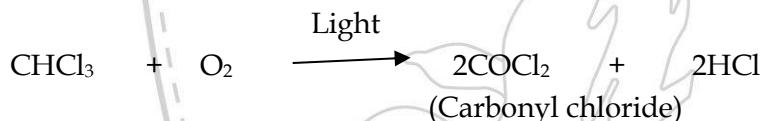
1. CH₂Cl₂ (Methylene Chloride) / (Dichloromethane)

Uses: Used as a solvent as a paint remover, propellant in aerosol, as a process solvent in the manufacture of drugs and as a metal cleaning and finishing solvent.

Harmful effects: Harms human central nervous system. Higher level in air causes dizziness, nausea, tingling and numbness in the fingers and toes. Direct contact with skin causes intense burning and can burn cornea of eyes.

2. CHCl₃ (chloroform/trichloromethene)

Uses: Solvents, fats, alkaloids, iodine and other substances, in production of Freon refrigerant R-22. Inhaling chloroform vapours depresses the central nervous system. Was used as an anesthetic but now has been replaced by less toxic anesthetics.



Chloroform is slowly oxidized by the presence of light to an extremely poisonous gas, phosgene which when inhaled may cause damage to liver, kidneys, and some people develop sores when the skin is immersed in closed dark coloured bottles completely filled so that air is kept out.

3. CHI₃ (Iodoform/ Triiodomethane)

It has strong unpleasant smell .It was used as an antiseptic but the antiseptic properties are due to the liberation of I₂ and not due to CHI₃. Due to its objectionable smell objectionable smell, other formulations containing I₂ are used.

4. CCL₄(carbon tetrachloride/ Tetra chloromethane)

Uses: Used in synthesis of chlorofluorocarbons, manufacture of refrigerants and propellants or aerosol cans, s a solvent, cleaning fluid, fire extinguishers.

Harmful effects: Exposure to CCl₄ may cause liver cancer, dizziness, lightheadedness, nausea and vomiting which can cause permanent damage to nerve cells. When CCl₄ is released into the air , it rises to the atmosphere and depletes the ozone layer which increases human exposure to UV rays, leading to increased skin cancer, eye diseases and disorders and possible disruptions to the immune system.

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5. Freon (Chlorofluoro carbon compounds of CH₄ and C₂H₆)

Freon is stable, unreactive, non toxic, non corrosive and easily liquefiable gases. Eg. Freon 12 (CCl₂F₂)

Preparation- CCl₄ + 2 AgF / SbF₂ → CCl₂F₂ (Swartz reaction)

Uses- Aerosol propellants, refrigeration and air conditioning.

Freons, eventually diffuse unchanged into the stratosphere here it initiates radical chain reaction that can upset O₃ balance.

6. **DDT (p,p'-Dichlorodiphenyltrichloromethane)** - It is the first organic chlorinated insecticide.

Uses- as used against mosquito that spreads malaria and lice that carry typhus. Later, many species of insects developed resistance to DDT, and it was also discovered to have toxicity towards fish. DDT is not metabolized very rapidly by animals; instead it is deposited and stored in fatty tissues.



Assignment**Chapter 10: Haloalkanes and Haloarenes**

1. Which of the following reactions is most suitable for the preparation of n-propyl benzene?
 (a) Friedel-Crafts alkylation (b) Wurtz reaction (c) Wurtz-Fittig reaction (d) Grignard reaction

2. S_N1 reaction of optically active alkyl halides leads to,
 (a) retention of configuration (b) racemization (c) inversion of configuration (d) none of these

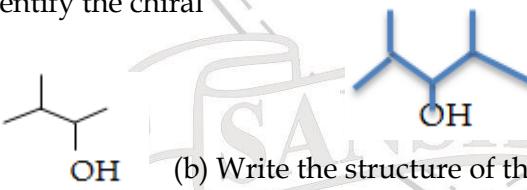
In Q3 and Q4, a statement of assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements mark the correct answer as:

- (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
- (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
- (iii) Assertion is correct statement but reason is wrong statement.
- (iv) Assertion and reason both are incorrect statements.
- (v) Assertion is wrong statement but reason is correct statement.

3. **Assertion:** Alkyl iodide can be prepared by treating alkyl chloride/bromide with NaI in acetone.
Reason: NaCl/NaBr are soluble in acetone while NaI is not.

4. **Assertion:** S_N2 reactions proceed with inversion of configuration.
Reason: S_N2 reactions occur in one step.

5. Out of chlorobenzene and benzyl chloride, which one gets easily hydrolysed by aqueous NaOH and why?

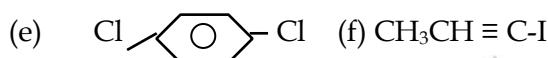
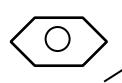
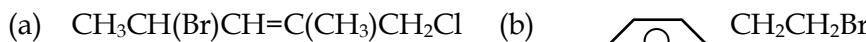
6. (a) Identify the chiral molecule in the following pair:


 (b) Write the structure of the product when chlorobenzene is treated with methyl chloride in the presence of sodium metal and dry ether.
 (c) Write the structure of the alkene formed by dehydrohalogenation of 1-bromo-1-methylcyclohexane with alcoholic KOH.

7. Write the structure of 1-Bromo-4-chlorobut-2-ene.

8. Following compounds are given to you :
 2-Bromopentane, 2-Bromo-2-methylbutane, 1-Bromopentane
 - (i) Write the compound which is most reactive towards S_N2 reaction.
 - (ii) Write the compound which is optically active.
 - (iii) Write the compound which is most reactive towards β -elimination reaction.

9. Name the following halides according to IUPAC system:



10. Out of $\text{CH}_3 - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_2 - \text{Cl}$ and $\text{CH}_3 - \text{CH}_2 - \underset{\text{CH}_3}{\text{CH}} - \text{Cl}$, which is more reactive

towards $\text{S}_{\text{N}}1$ reaction and why?

11. What happens when bromine attacks $\text{CH}_2=\text{CH}-\text{CH}_2-\text{C}\equiv\text{CH}$?

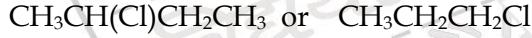
12. Write the structures of the following organic compounds:

- (i) 2-Chloro-3-methylpentane
- (ii) 1-Chloro-4-ethylcyclohexane
- (iii) 2-(2-Chlorophenyl)-1-iodooctane
- (iv) 4-tert-Butyl-3-iodoheptane

13. Answer the following questions:

(i) What is meant by chirality of the compound? Give an example.

(ii) Which of the following compounds is more easily hydrolysed by KOH and why?



(iii) Which one undergoes $\text{S}_{\text{N}}2$ faster and why?



14. Which one of the following reacts faster in an $\text{S}_{\text{N}}1$ reaction and why?



15. State one use of DDT and iodoform. Why chloroform is kept in dark coloured bottles completely filled?

16. What are ambident nucleophiles? Explain with the help of an example.

17. Write short notes on:

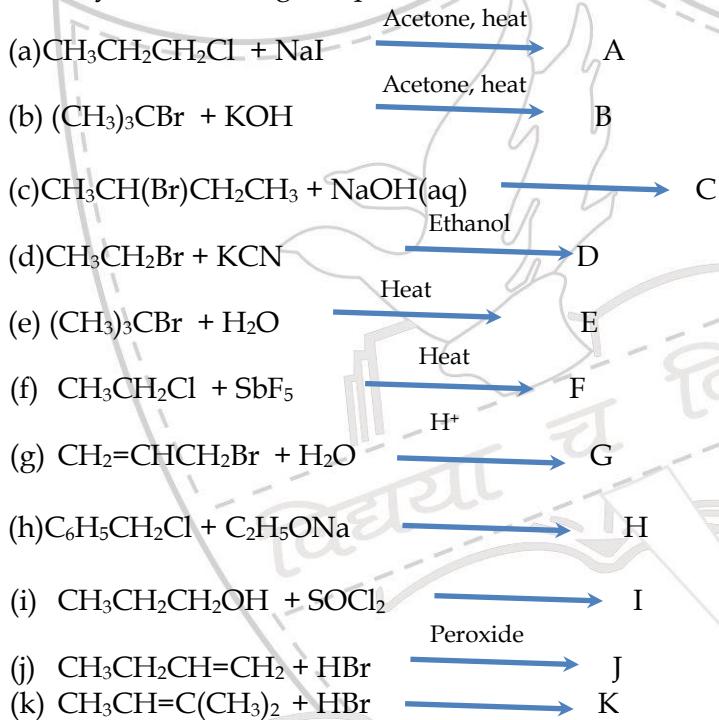
- (a) Fittig reaction (b) Swartz reaction

18. Account for the following:

- a) tert-Butyl chloride reacts with aqueous NaOH by $\text{S}_{\text{N}}1$ mechanism while n-butyl chloride reacts by $\text{S}_{\text{N}}2$ mechanism.
- b) Among HI, HBr and HCl, HI is most reactive.
- c) Alkyl halides though polar, are immisicible with water.

- d) Chlorobenzene is extremely less reactive towards nucleophilic substitution reaction.
 e) C-Cl bond length in chlorobenzene is shorter than C-Cl bond length in CH₃-Cl.
 f) The dipole moment of chlorobenzene is lower than that of cyclohexyl chloride.
 g) S_N1 reactions are accompanied by racemization in optically active alkyl halides.
19. Carry out the following conversions:
 i) 1-Chlorobutane to n-octane
 ii) Toluene to benzyl alcohol
 iii) Benzyl chloride to benzyl alcohol
20. What will be the mechanism for the substitution of -Br by -OH in (CH₃)₂C(Br)CH₂CH₃?

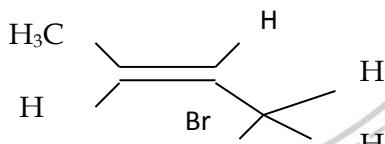
21. Identify the following compounds from A to K:



More Practice
Chapter 10: Haloalkanes and Haloarenes

1. Name the following halides according to IUPAC system:

- (i) $(\text{CCl}_3)_3\text{CCl}$
- (ii) $\text{CH}_3\text{C}(\text{p-ClC}_6\text{H}_4)_2\text{CH}(\text{Br})\text{CH}_3$
- (iii) $(\text{CH}_3)_3\text{CCH}=\text{C}(\text{Cl})\text{C}_6\text{H}_4\text{I-p}$



2. Arrange the following compounds in an increasing order of their acid strengths:
 $(\text{CH}_3)_2\text{CHCOOH}$, $\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{COOH}$, $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{COOH}$

3. Write the structures of the following organic compounds:

4. Arrange the following compounds in increasing order of reactivity towards nucleophilic substitution reaction:
 1,4-Dichlorobenzene, 4-Methoxy chlorobenzene, benzene, 2,4,6- Trinitro chlorobenzene

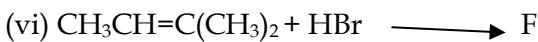
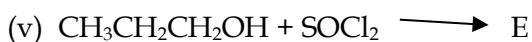
5. Account for the following:

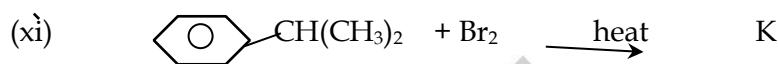
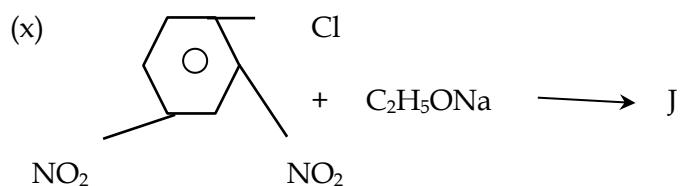
- a) The dipole moment of chloro benzene is lower than that of cyclohexyl chloride.
- b) Vinyl chloride is unreactive towards nucleophilic substitution reactions.
- c) Grignard reagent should be prepared under anhydrous conditions.
- d) Haloarenes are much less reactive than haloalkanes towards nucleophilic substitution reactions.

6. Carry out the following conversions:

- (i) Propene to propyne
- (ii) Ethanol to but-1-yne

7. Identify the following compounds from A to K:





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Assignment**Chapter 11: Alcohols, Phenols and Ethers**

1. IUPAC name of m-cresol is....
 (a)3-Methyl phenol (b) 3-Chlorophenol (c) 3-Methoxyphenol (d) Benzene-1,3-diol

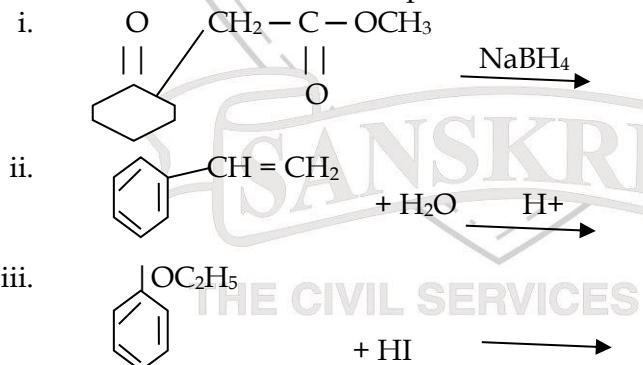
2. $\text{CH}_3\text{CH}_2\text{OH}$ can be converted into CH_3CHO by.....
 (a)catalytic hydrogenation (b) treatment with LiAlH_4
 (c)treatment with pyridinium chlorochromate (d) treatment with KMnO_4

In Q3 and Q4, a statement of assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements mark the correct answer as:
 (i) Assertion and reason both are correct statements and reason is correct explanation for assertion.

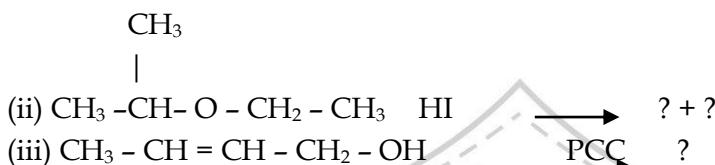
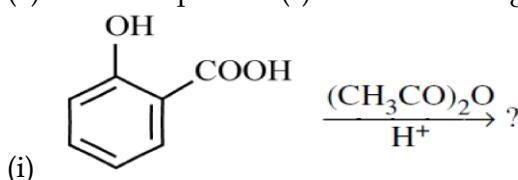
- (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 (iii) Assertion is correct statement but reason is wrong statement.
 (iv) Assertion and reason both are incorrect statements.
 (v) Assertion is wrong statement but reason is correct statement.
3. **Assertion:** Bond angle in ethers is slightly less than the tetrahedral angle.
Reason: There is repulsion between two bulky (-R) groups.

 4. **Assertion:** p-Nitrophenol is more acidic than phenol.
Reason: Nitro group helps in the stabilization of the phenoxide ion by dispersal of negative charge due to resonance.

5. Write the structures of the main products in the following reactions:



6. (a) Write the product(s) in the following reactions :



Give simple chemical tests to distinguish between the following pairs of compounds :

- (i) Ethanol and Phenol
(ii) Propanol and 2-methylpropan-2-ol

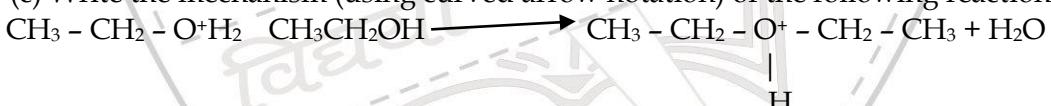
7. (a) Write the formula of reagents used in the following reactions :

- (i) Bromination of phenol to 2,4,6-tribromophenol
(ii) Hydroboration of propene and then oxidation to propanol.

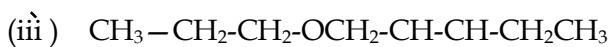
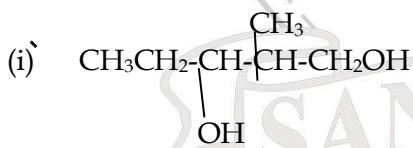
- (b) Arrange the following compound groups in the increasing order of their property indicated :

- (i) p-nitrophenol, ethanol, phenol (acidic character)
(ii) Propanol, Propane, Propanal (boiling point)

- (c) Write the mechanism (using curved arrow notation) of the following reaction :



8. Give the I.U.P.A.C. name of the following:

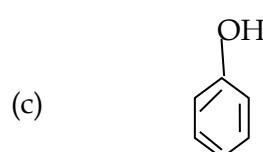
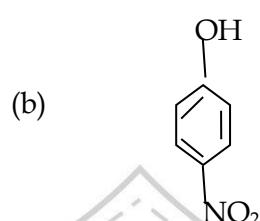
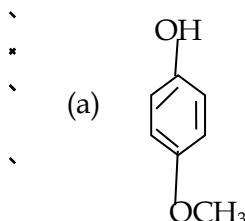


9. Arrange the following as

(i) Decreasing order of boiling points:

2-methyl-2-propanol, 1-butanol, 2-methyl-1-propanol and 2-butanol.

(ii) Decreasing order of their acidic character:



(iii) Increasing reactivity towards Lucas reagent:

1-butanol, 2-methyl-2-propanol, 2-butanol.

10. Write the chemical equation when 1-propanol react with

(iii) H_2SO_4 at 443K (iv) acidified KMnO_4

11. How does phenol react with the following?

(i) Acetyl chloride.

(ii) Bromine in water.

(iii) Chloroform in presence of NaOH.

12. Convert

(1) Phenol to picric acid

(2) Cumene to phenol.

(3) Phenol to Salicyaldehyde

(4) Phenol to anisole

(5) Propan-2-ol to 2-Methylpropan-2-ol

13. Explain giving reasons:-

(i) Alcohols are generally soluble in water but alkyl halides are not.

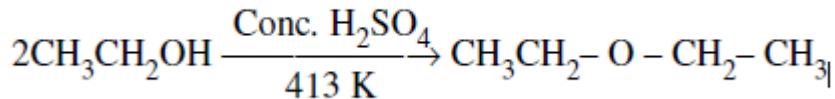
(ii) Phenols exhibit an acidic character.

(iii) Phenols has a smaller dipole moment than methanol.

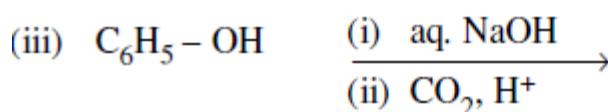
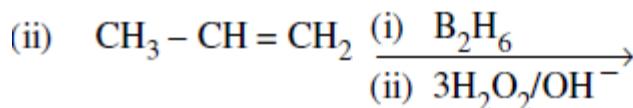
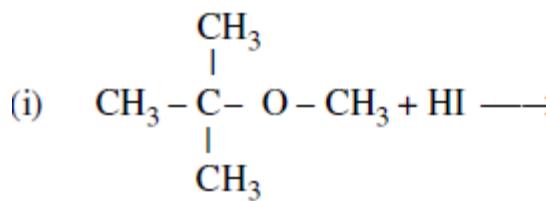
(iv) 2,3- dimethylbutanol has got lower boiling point than hexanol .

(v) 2-Nitrophenol is more volatile than 4-Nitrophenol.

14. Write the mechanism of the following reaction :



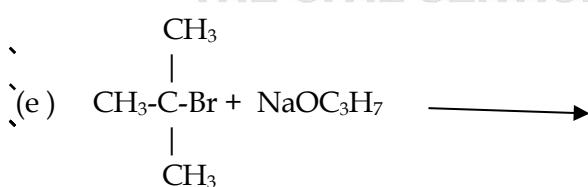
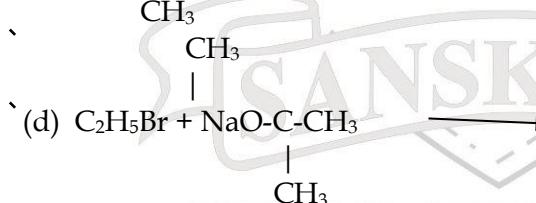
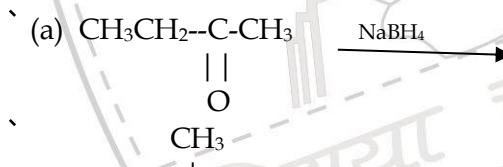
15. Write the main product(s) in each of the following reactions :

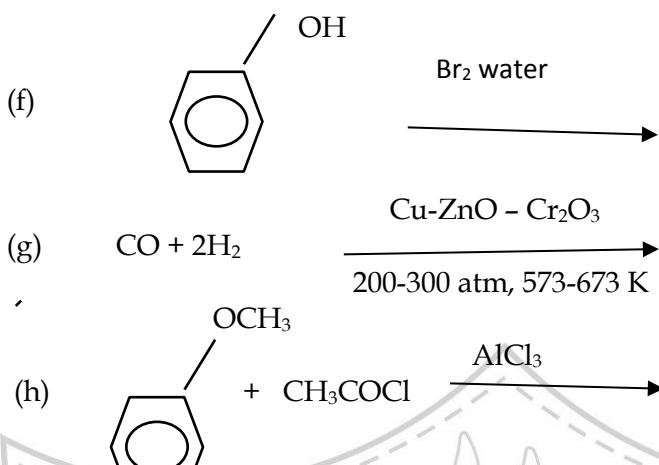


More Practice

Chapter 11: Alcohols, Phenols and Ethers

1. Complete the following reactions:





2

Convert:

- (i) Chlorobenzene to Phenol
- (ii) Aniline to phenol
- (iii) Propanone to Propene

Assignment

Chapter 12: Aldehydes, Ketones and Carboxylic Acids

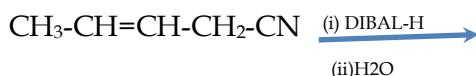
- 1 The correct order of increasing acidic strength is _____.
- (i) Phenol < Ethanol < Chloroacetic acid < Acetic acid
 - (ii) Ethanol < Phenol < Chloroacetic acid < Acetic acid
 - (iii) Ethanol < Phenol < Acetic acid < Chloroacetic acid
 - (iv) Chloroacetic acid < Acetic acid < Phenol < Ethanol
- 2 In Clemmensen Reduction carbonyl compound is treated with _____.
- (i) Zinc amalgam + HCl
 - (ii) Sodium amalgam + HCl
 - (iii) Zinc amalgam + nitric acid
 - (iv) Sodium amalgam + HNO₃
- In the following questions 3 and 4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
- (i) Assertion and reason both are correct and reason is correct explanation of assertion.
 - (ii) Assertion and reason both are wrong statements.
 - (iii) Assertion is correct statement but reason is wrong statement.
 - (iv) Assertion is wrong statement but reason is correct statement.
 - (v) Assertion and reason both are correct statements but reason is not correct explanation of assertion.
- 3 **Assertion :** Aldehydes and ketones, both react with Tollen's reagent to form silver mirror.
Reason : Both, aldehydes and ketones contain a carbonyl group.
- 4 **Assertion :** Aromatic aldehydes and formaldehyde undergo Cannizaro reaction.
Reason : Aromatic aldehydes are almost as reactive as formaldehyde.

- 5 (A), (B) and (C) are three non-cyclic isomers of a carbonyl compound with molecular formula C_4H_8O . Isomers (A) and (C) give positive Tollen's test whereas isomer (B) does not give Tollen's test but gives positive Iodoform test. Isomers (A) and (B) on reduction with $Zn(Hg)/conc.HCl$ gives the same product D.
- Write the structures of (A), (B), (C) and (D).
 - Out of (A), (B) and (C) isomers, which one is most reactive towards addition of $NaHSO_3$ and why?
- 6 How do you convert the following:
- Ethanal to propanone
 - Toluene to benzoic acid
 - Benzoic acid to benzaldehyde
 - Benzoic acid to benzaldehyde
 - Propanone to Propene
- 7 Account for the following:
- Aromatic carboxylic acids do not undergo Friedel-Crafts reaction.
 - pK_a value of 4-nitrobenzoic acid is lower than that of benzoic acid.
- 8 Write structures of compounds A, B and C in each of the following reactions :
- $C_6H_5Br \xrightarrow{Mg/dry\ ether} A \xrightarrow{(a) CO_2(g)\ (b) H_3O^+} B \xrightarrow{PCl_5} C$
 - $CH_3CN \xrightarrow{(a) SnCl_2/HCl\ (b) H_3O^+} A \xrightarrow{dil.\ NaOH} B \xrightarrow{\Delta} C$
- 9 Write IUPAC names for the following :
- (a)
-
- (b) $CH_2=CHCH_2CHO$
- (c) $(CH_3)_2C=CHCOCH_2CH_3$
- 10 a) Arrange the following compounds as directed:
b) Acetaldehyde, acetone, Methyl tert-butyl ketone (reactivity towards HCN)
c) Benzoic acid, 3,4-Dinitrobenzoic acid, 4-methoxybenzoic acid
d) $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $(CH_3)_2CHCOOH$ (acid strength)
e) a) CH_3CHO , CH_3CH_2OH , CH_3OCH_3 , $CH_3CH_2CH_3$ (increasing order of their boiling point)
f) b) Ethanal, propanal, propanone, butanone (increasing order of their reactivity towards nucleophilic addition).
- 11 Give brief description with suitable example:
- Cannizzaro Reaction
 - Hell-Volhard Zelinsky Reaction.
 - Clemmensen Reduction
 - Wolff-Kishner Reduction.
 - Cross aldol condensation
 - Etard reaction
- 12 Account for the following:

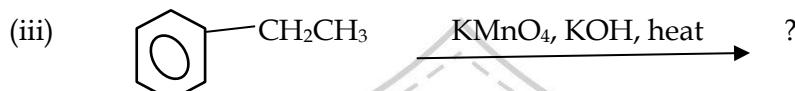
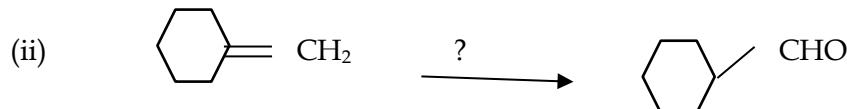
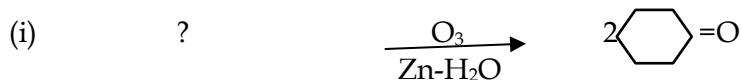
- a) Carboxylic acids have higher boiling points than alcohols of comparable molecular masses.
 b) Electrophilic substitution in benzoic acid takes place at meta-position.
 c) Monochloroethanoic acid has a higher pKa value than dichloroethanoic acid.
 d) Ethanoic acid is a weaker acid than benzoic acid.
 e) The boiling points of aldehydes and ketones are lower than of the corresponding acids.
- 13 How will you convert the following?
 a) Acetaldehyde into 2-Butenal
 b) Acetic acid to Acetic anhydride
 c) Butanol to butanoic acid
 d) 4-Methylacetophenone to benzene-1,4-dicarboxylic acid
 e) Butan-2-one to butan-2-ol
 f) Phenol to 2,4,6- tribromophenol
- 14 Distinguish between the following
 a) CH_3CHO and $\text{C}_6\text{H}_5\text{CHO}$
 b) $\text{C}_2\text{H}_5\text{OH}$ and $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$
 c) $\text{C}_6\text{H}_5\text{COOH}$ and $\text{C}_6\text{H}_5\text{OH}$
 d) $\text{C}_6\text{H}_5\text{COCH}_3$ and $\text{C}_6\text{H}_5\text{COC}_6\text{H}_5$
 e) CH_3COCH_3 and $\text{C}_2\text{H}_5\text{OH}$
 f) CH_3COCH_3 and $\text{C}_3\text{H}_7\text{OH}$
 g) Propanal and Propanone
- 15 Complete the following reactions:
 (a) $\text{CH}_3\text{COCH}_3 + \text{NH}_2\text{NH}_2 \xrightarrow{\text{KOH/glycol}}$
 (b) $\text{C}_6\text{H}_5\text{COCH}_3 + \text{C}_6\text{H}_5\text{OH} \xrightarrow{\text{NaOH/I}_2}$
 (c) $\text{C}_6\text{H}_5\text{NH}_2 \xrightarrow[\Delta]{\text{NaOH/CaO}}$
- 16 (a) Write the structures of A, B, C, D and E in the following reactions :

$$\text{C}_6\text{H}_6 \xrightarrow[\text{Anhyd. AlCl}_3]{\text{CH}_3\text{COCl}} \text{A} \xrightarrow{\text{Zn-Hg/conc. HCl}} \text{B} \xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) KMnO}_4 - \text{KOH, } \Delta} \text{C}$$

$$\text{A} \xrightarrow{\text{NaOI}} \text{D} + \text{E}$$
- 17 (iii) Write chemical equation for the reaction involvd in Cannizaro reaction.
 (iv) Draw structure of Semicarbazone of Ethanal.
 (v) Why is pka value of $\text{F}-\text{CH}_2-\text{COOH}$ lower than $\text{Cl}-\text{CH}_2-\text{COOH}$?
 (vi) Write product for the reaction:



- 18 Complete the following reaction statements by giving the missing starting material, reagent or product as required:

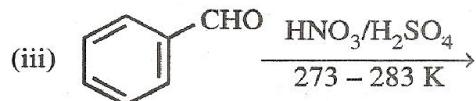
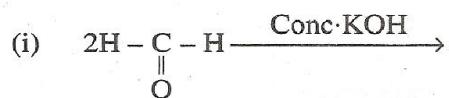


More Practice

Chapter 12: Aldehydes, Ketones and Carboxylic Acids

- 1 Account for the following:
 - a) Formaldehyde gives Cannizzaro's reaction whereas acetaldehyde does not.
 - b) Carboxylic acids do not give the characteristic reactions of carbonyl group.
 - c) Aldehydes are more reactive than ketones towards nucleophilic addition reactions.
 - d) Chloroacetic acid has lower pKa value than acetic acid.
 - e) The aldehydes and ketones undergo a number of addition reactions.
 - f) Ethanoic acid is a weaker acid than benzoic acid.
- 2 How will you convert the following?
 - i) Acetophenone to Ethyl benzene
 - ii) Acetone to tert-butyl alcohol
 - iii) Benzyl alcohol to phenyl ethanoic acid
 - iv) Bromobenzene to benzoic acid
 - v) p-methyl acetophenone to benzene 1,4 -dicarboxylic acid
 - vi) Benzoic acid to benzyl amine
 - vii) p-nitrobenzamide to p-nitroaniline
 - viii) A primary alcohol to an aldehyde
 - ix) Ethanol to acetone
 - x) Benzene to acetophenone
 - xi) Benzoic acid to benzaldehyde
 - xii) propane to Propane
 - xiii) Benzoyl chloride to Benzaldehyde
 - xiv) Ethanol to But-2-enal
- 3 Although phenoxide ion has more number of resonance structures than carboxylate ion, carboxylic acid is a stronger acid than phenol. Give two reasons.

4 (a) Complete the following reactions :



(b) Give simple chemical tests to distinguish between the following pairs of compounds :

(i) Ethanal and Propanal

(ii) Benzoic acid and Phenol

- 5** An organic compound contains 69.77% carbon, 11.63% hydrogen and the rest is oxygen. The molecular mass of the compound is 86. It does not reduce Tollen's reagent but forms an addition compound with sodium hydrogen sulphite and gives a positive iodoform test. On vigorous oxidation it gives ethanoic and propanoic acids. Deduce the possible structure of the organic compound.
- 6** An organic compound with molecular formula $\text{C}_9\text{H}_{10}\text{O}$ forms 2,4-DNP derivative, reduces Tollen's reagent and undergoes Cannizzaro's reaction. On vigorous oxidation it gives 1,2-benzenedicarboxylic acid. Identify the compound.

Assignment

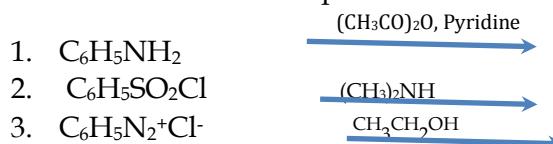
Chapter 13: Organic Compounds containing Nitrogen

1. Reduction of aromatic nitro compounds using Fe and HCl gives _____.
 - (i) aromatic oxime
 - (ii) aromatic hydrocarbon
 - (iii) aromatic primary amine
 - (iv) aromatic amide
2. Best method for preparing primary amines from alkyl halides without changing the number of carbon atoms in the chain is
 - (i) Hoffmann Bromamide reaction
 - (ii) Gabriel phthalimide synthesis
 - (iii) Sandmeyer reaction
 - (iv) Reaction with NH_3

In the following questions 3 and 4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

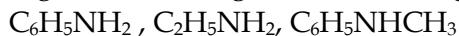
- (i) Both assertion and reason are wrong.
 - (ii) Both assertion and reason are correct statements but reason is not correct explanation of assertion.
 - (iii) Assertion is correct statement but reason is wrong statement.
 - (iv) Both assertion and reason are correct statements and reason is correct explanation of assertion.
 - (v) Assertion is wrong statement but reason is correct statement
3. **Assertion :** N-Ethylbenzene sulphonamide is soluble in alkali.
Reason : Hydrogen attached to nitrogen in sulphonamide is strongly acidic.
 4. **Assertion :** Acylation of amines gives a monosubstituted product whereas alkylation of amines gives polysubstituted product.
Reason : Acyl group sterically hinders the approach of further acyl groups.
 5. (a) Write the reactions involved in the following:
 - (i) Hofmann bromamide degradation
 - (ii) Diazotization
 - (iii) Gabriel phthalimide synthesis
(b) Give reasons:
 - (i) $(\text{CH}_3)_2\text{NH}$ is more basic than $(\text{CH}_3)_3\text{N}$ in an aqueous solution.
 - (ii) Aromatic diazonium salts are more stable than aliphatic diazonium salts.

6. (a) Write the structures of the main products of the following reactions:



(b) Give a simple chemical test to distinguish between Aniline and N,N-dimethylaniline.

(c) Arrange the following in the increasing order of their pK_b values:

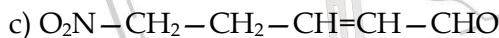
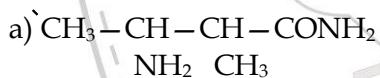


7. Write IUPAC name of the following compound : $(\text{CH}_3\text{CH}_2)_2\text{NCH}_3$

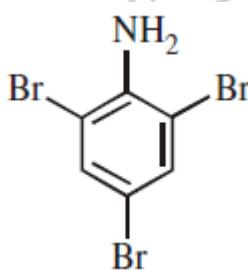
8. Give reasons :

- (i) Acetylation of aniline reduces its activation effect.
- (ii) CH_3NH_2 is more basic than $\text{C}_6\text{H}_5\text{NH}_2$.
- (iii) Although $-\text{NH}_2$ is o-/p- directing group, yet aniline on nitration gives a significant amount of m-nitroaniline.

9. Write IUPAC names of the following:



e)

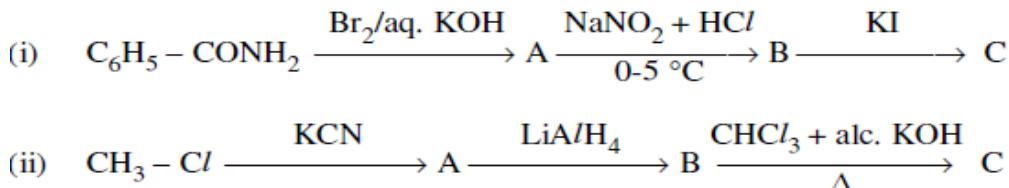


10. For an amine RNH_2 , write the expression for K_b to indicate its basic strength

11. Describe the following processes giving suitable examples of each:

- i) Diazotization
- ii) Coupling reaction
- iii) Carbyl amine reaction
- iv) Hofmann's bromamide reaction

12. How will you carry out the following conversions:
- Nitrobenzene to acetanilide
 - Methyl amine to ethyl amine
 - Nitrobenzene to phenol
 - Toluene to m-nitro benzoic acid
 - Acetic acid to ethyl amine
13. Write structures of the following:
- P-Toluidine
 - Picric acid
 - Sulphanilic acid
14. Write a chemical reaction in which the iodide ion replaces the diazonium group in a diazonium salt.
15. Write reactions for what happens when:
- Phenol is treated with benzene diazonium chloride in presence of NaOH
 - Aniline is treated with benzaldehyde
 - Ethyl amine is treated with excess of methyl iodide.
16. Arrange in increasing order of boiling point: $\text{C}_2\text{H}_5\text{NH}_2$, $\text{C}_2\text{H}_5\text{OH}$, $(\text{CH}_3)_3\text{N}$
17. Complete the following reaction equations:
- $\text{C}_6\text{H}_5\text{N}_2\text{Cl} + \text{H}_3\text{PO}_2 + \text{H}_2\text{O} \longrightarrow$
 - $\text{C}_6\text{H}_5\text{NH}_2 + \text{Br}_2(\text{aq}) \longrightarrow$
18. Write the structures of A, B and C in the following :



More Practice**Chapter 13: Organic Compounds containing Nitrogen**

1. Account for the following:
 - a) Ammonolysis of alkyl halide does not give a corresponding pure amine
 - b) pK_b for aniline is more than that for methylamine
 - c) Boiling point of methylamine is less than that of methanoic acid
 - d) Aniline cannot be prepared by Gabriel Pthalimide synthesis
 - e) Nitration of toluene is easier compared to nitrobenzene
 - f) Before nitration aniline is converted to acetanilide.
 - g) Aniline does not undergo Friedel-Crafts reaction.
 - h) Methylamine solution in water reacts with ferric chloride solution to give a precipitate of ferric hydroxide.
2. A compound X having molecular formula C_3H_7NO , reacts with Br_2 in presence of NaOH to give another compound Y. The compound Y reacts with HNO_2 to form ethanol and N_2 gas. Identify the compounds X and Y and write the reactions involved.
3. A compound A of the molecular formula $C_3H_7O_2N$ on reaction with Fe and conc. HCl gives a compound B of the molecular formula C_3H_9N . Compound B on treatment with $NaNO_2$ and HCl gives another compound C of the molecular formula C_3H_8O . The compound C gives effervescence with Na. On oxidation with CrO_3 , the compound C gives a saturated aldehyde having 3 carbon atoms. Deduce the structures of A, B and C and write the reactions involved.
4. Describe a test to distinguish between each of the following pairs
 - a) Ethyl amine and aniline
 - b) N-methyl aniline and N,N-dimethyl aniline
5. Show how you will carry out the following conversions:
 - i) Aniline to N-phenyl ethanamide
 - ii) Aniline to benzoic acid
 - iii) Benzene to m-dichlorobenzene
 - iv) 2-nitropropane to acetone
 - v) Benzonitrile to acetophenone

Assignment

Chapter 14: Biomolecules

1. Globular proteins are present in
(a) Keratin (b) Muscles (c) Eggs (d) nucleoside
2. Purine and Pyrimidine bases present in both DNA and RNA are
(a) Uracil (b) Thymine (c) Cytosine (d) Adenine
In Q3 and Q4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
 - (i) Both assertion and reason are wrong.
 - (ii) Both assertion and reason are correct statements but reason is not correct explanation of assertion.
 - (iii) Assertion is correct statement but reason is wrong statement.
 - (iv) Both assertion and reason are correct statements and reason is correct explanation of assertion.
 - (v) Assertion is wrong statement but reason is correct statement
3. **Assertion:** Cellulose is not digested by human beings.
Reason: Cellulose is a polymer of β -D-glucose.
4. **Assertion:** Alpha amino acids exist as internal salt in solution as they have amino acid and carboxylic acid groups in near vicinity.
Reason: H^+ ion given by carboxyl group (-COOH) is captured by amino group (-NH₂) having lone pair of electrons.
5. Define the following with an example of each;
 - (i) Polysaccharides
 - (ii) Denatured proteins
 - (iii) Essential aminoacids
6. (i) Write the product when D-Glucose reacts with bromine water.
(ii) Amino acids show amphoteric behaviour. Why?
(iii) Write one difference between α -helix and β -pleated structures of proteins.
7. State two main differences between globular proteins and fibrous proteins. Give one example of each.
8. a) Write the full forms of DNA and RNA. Write the names of the bases in them.
b) What are three types of RNA molecules which perform different functions?
9. Write chemical equations for the reactions of glucose with
(i) Acetic Anhydride (ii) NH₂OH (iii) HNO₃ (iv) HI

10. Define and classify vitamins. Name the main disease caused due to lack of vitamins and its sources in each of the following ;A₁, B₆, E, D, B₁₂ and K.
11. (a) Write any two reactions of glucose which cannot be explained by the open chain structure of glucose molecule.
(b) Write the structure of the product obtained when glucose is oxidized with nitric acid.
12. Define enzymes .State the activity of enzyme. How do enzymes differ from ordinary chemical catalysis? Comment on the specificity of enzyme action.
13. In what way is a nucleotide different from a nucleoside? Illustrate with examples?
14. What is essentially the difference between alpha-glucose and beta-glucose? What is meant by pyranose structure of glucose?
15. (a) Name some biological functions of nucleic acids.
(b) What is the name given to the linkage which holds together two nucleotides
16. Explain what is meant by
(i) a peptide linkage
(ii) a glycosidic linkage
17. a) Write the name of two monosaccharides obtained on hydrolysis of lactose sugar.
b) Why Vitamin C cannot be stored in our body ?
c) What is the difference between a nucleoside and nucleotide ?
18. What is glycogen? How is it different from starch? How is starch structurally different from cellulose?
19. How do you explain amphoteric behaviour of amino acids?
20. Define denaturation in proteins.
21. Which of the following is a disaccharide: Starch, Maltose, Fructose, Glucose?

Hands-on/ IT Enabled work:

- The entire chapter is done with the help of a presentation.
- A hand-out is given on proteins, vitamins and nucleic acids.

Assignment**Chapter 15: Polymers**

1. The commercial name of polyacrylonitrile is _____.
 (i) Dacron
 (ii) Orlon (acrilan)
 (iii) PVC
 (iv) Bakelite
2. Which of the following is not a semisynthetic polymer?
 (i) cis-polyisoprene
 (ii) Cellulose nitrate
 (iii) Cellulose acetate
 (iv) Vulcanised rubber

In the following question no. 3 and 4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (i) Assertion and reason both are correct statement but reason does not explain assertion.
 (ii) Assertion and reason both are correct statements and reason explains the assertion.
 (iii) Both assertion and reason are wrong statement.
 (iv) Assertion is correct statement and reason is wrong statement.
 (v) Assertion is wrong statement and reason is correct statement.
3. Assertion : Olefinic monomers undergo addition polymerisation.
 Reason : Polymerisation of vinylchloride is initiated by peroxides/ persulphates.
4. Assertion : For making rubber synthetically, isoprene molecules are polymerised.
 Reason : Neoprene (a polymer of chloroprene) is a synthetic rubber.
5. Write a difference between LDPE and HDPE.
6. What are biodegradable polymers? Give an example.
7. Write the structures of the monomers used for getting the following polymers :
 (i) Dacron
 (ii) Melamine - formaldehyde polymer
 (iii) Buna-N
8. Write the names and molecular structures of the monomers of the following and classify them as addition or condensation polymers :
 (i) Natural rubber (ii) Glyptal (iii) Buna-S (iv) Bakelite
 (v) PVC (vi) Nylon-6 (vii) Neoprene (viii) Polypropene
9. (i) What is the role of t-butyl peroxide in the polymerization of ethene? Write its mechanism.
 (ii) Identify the monomers in the following polymer :

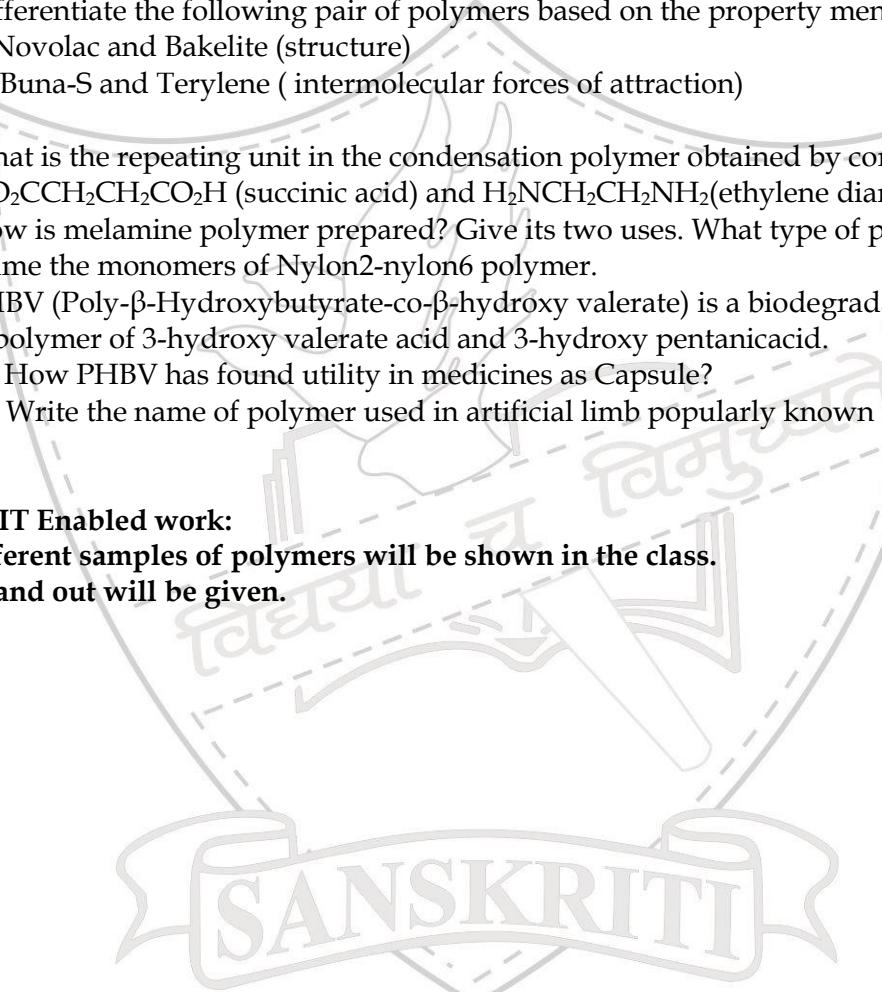
$$[NH - (CH_2)_6 - NH - CO - (CH_2)_4 - CO -]_n$$

 (iii) Arrange the following polymers in the increasing order of their intermolecular forces : Polystyrene, Terylene, Buna-S

- (iv) What are elastomers? Give an example of it.
10. (a) Describe chain growth and step growth polymerization with the help of an example.
(b) Classify the following as addition or condensation polymers:
Nylon-66, Neoprene, Polythene
11. (a) What is the difference between nylon-6 and nylon-66?
(b) What does the part '6,6 mean in the name nylon-6,6 ?
12. What is Teflon? What are its uses?
13. Differentiate the following pair of polymers based on the property mentioned against each.
(i) Novolac and Bakelite (structure)
(ii) Buna-S and Terylene (intermolecular forces of attraction)
14. What is the repeating unit in the condensation polymer obtained by combining $\text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{H}$ (succinic acid) and $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$ (ethylene diamine).
15. How is melamine polymer prepared? Give its two uses. What type of polymer is it?
16. Name the monomers of Nylon2-nylon6 polymer.
17. PHBV (Poly- β -Hydroxybutyrate-co- β -hydroxy valerate) is a biodegradablepolymer. It is a copolymer of 3-hydroxy valerate acid and 3-hydroxy pentanicacid.
(a) How PHBV has found utility in medicines as Capsule?
(b) Write the name of polymer used in artificial limb popularly known as Jaipurfoot.

Hands-on/ IT Enabled work:

- Different samples of polymers will be shown in the class.
- A hand out will be given.



THE CIVIL SERVICES SCHOOL

CHEMISTRY IN EVERYDAY LIFE

DRUGS

Drugs are chemicals of low molecular masses which interact with macromolecular targets and produce a biological response. When biological response is therapeutic and useful, these chemicals, are called medicines and if taken in higher doses, they behave as poisons. Use of chemicals for therapeutic effect is called Chemotherapy.

Classification of Drugs:

- On the basis of pharmacological effect: It is useful for doctors because it provides them the whole range of drugs available for treatment of a particular problem. For e.g.: analgesics for pain killing effect, antiseptics kill or arrest growth of microorganisms.
- On the basis of drug action: It is based on the action of a drug on a particular biochemical process. Eg- antihistamines which inhibit the action of histamines which causes inflammation in the body.
- On the basis of Chemical structure: Some drugs share a common feature and often have similar Pharmacological activity. Eg; Sulphonamides have $\text{H}_2\text{N}-\text{C}_6\text{H}_4-\text{SO}_2-\text{NHR}$ structural feature in common.
- On the basis of molecular targets: Drugs usually interact with biomolecules such as carbohydrates, lipids, proteins & nucleic acid. These are called target molecules. Drugs possessing some common structural feature have the same mechanism of action on targets.

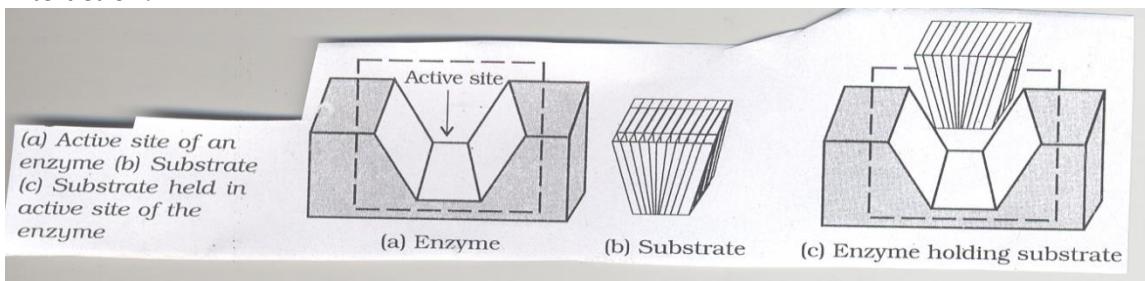
DRUG -TARGET INTERACTION

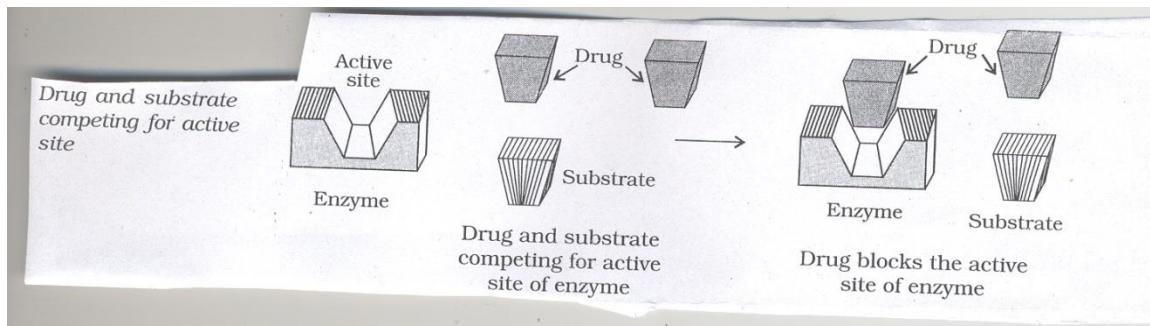
Macromolecules of biological origin perform various functions in the body. For eg- Proteins which perform role of biological catalyst in the body are called ENZYMES & those which are crucial to communication system are called RECEPTORS.

Hormones are biological chemical messengers secreted by endocrine glands. Example- Insulin, noradrenalin.

ENZYMES AS DRUG TARGETS:

- Catalytic action of enzymes : For understanding interaction between drug and enzyme we first study the function of enzymes. Enzymes hold the substrate for a chemical reaction. Active sites of enzymes hold substrate molecule in a suitable position, so that it can be attacked by the reagent effectively. Substrate binds themselves to the active sites by ionic bonding, hydrogen or by vanderwaals interaction.

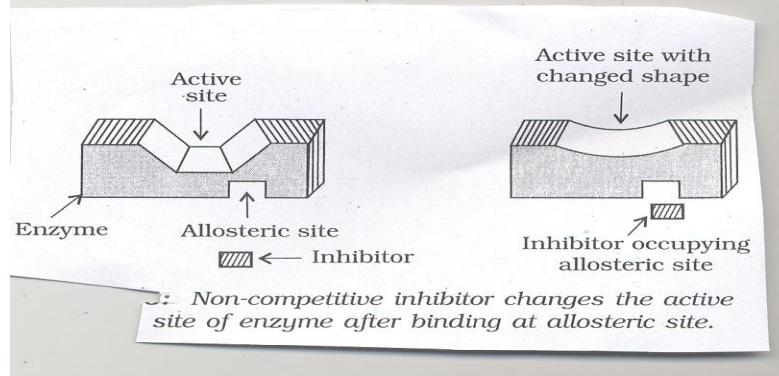




It provides functional groups that will attack the substrate and carry out chemical reaction.

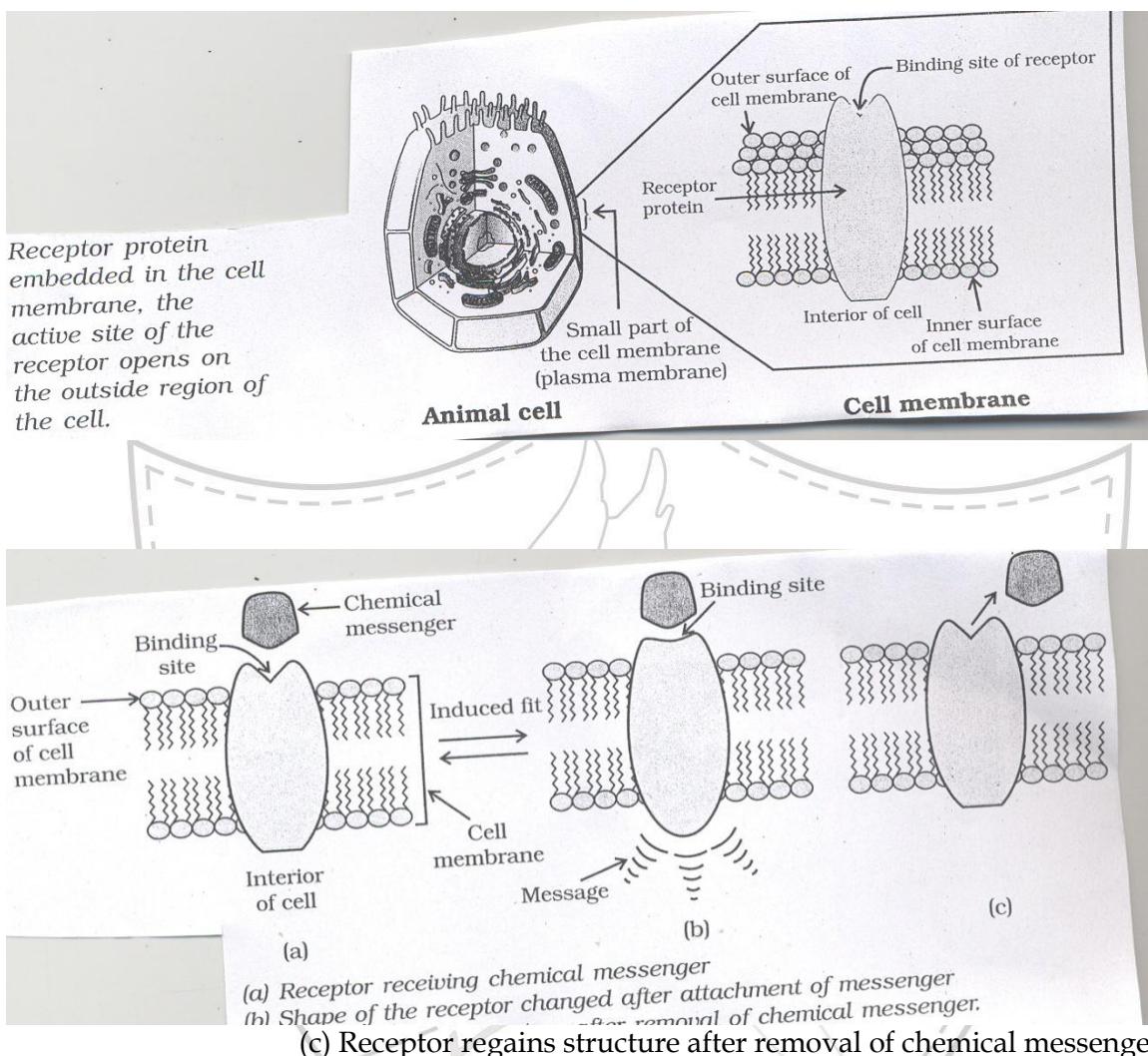
- b) Drug-enzyme interaction: Drugs inhibit any of the above mentioned activities of enzymes. These can block the binding site of enzyme and prevent the binding of substrate or can inhibit catalytic activity of enzyme. These are called enzyme inhibitor. These can occur in two different ways---
- Drugs compete with the natural substrate for their attachment on active sites of enzymes. These are called competitive inhibitors.
 - Some drugs do not bind to the enzyme's active site. These bind to some different enzyme site called allosteric site. This binding of inhibitor at allosteric site changes the shape of the active site in such a way that substrate cannot recognize it.

If the bond between an enzyme and inhibitor is a strong covalent bond and it cannot be easily broken, then the enzyme is blocked permanently. The body then degrades the enzyme-inhibitor complex and synthesizes the new enzyme.



RECEPTORS AS DRUG TARGETS

Receptors are proteins that are crucial to body's communication process. Receptor proteins are embedded in cell membranes in such a way that their small part possessing active site projects out of the surface of the membrane and opens on the outside region of the cell membrane.



There are a large no. of different receptors in the body that interact with different chemical messengers. These receptors show selectivity for one chemical messenger over the other because their binding sites have different shape, structure and aminoacid composition.

Drugs that bind to the receptor site and inhibit its natural function are called antagonists. Drugs that mimic the natural messenger by switching on the receptors are called agonists. These are useful when there is lack of natural chemical messenger.

CHEMICALS IN MEDICINE

THE CIVIL SERVICES SCHOOL

The chemical substances used for treatment of diseases and for reducing suffering from pain are called medicines or drugs.

Chemotherapy- is a science in which suitable chemicals are used for treatment of diseases.

- 1) **Antipyretics-** The chemicals used to lower body temperature in high fever are called antipyretics. Eg- Aspirin, paracetamol and phenacetin

2) **Analgesics-** The chemical substances used to relieve pains without causing impairment of consciousness, mental confusion, incoordination or paralysis or some other disturbances of nervous system are called analgesics. These are of two types.

a) Non-narcotic drugs or non-addictive drugs- Eg- aspirin, analgin, novalgin, naproxen, ibuprofen & diclofenac sodium or potassium.

Aspirin: Finds use as antipyretic, prevention of heart attack because of its anti-blood clotting action. Aspirin is supposed to be toxic to liver which gets hydrolysed in stomach giving salicylic acid which sometimes cause bleeding in stomach. Therefore, overdosage and its use in empty stomach should be avoided.

b) Narcotic drugs or Addictive drugs- Which produce sleep and unconsciousness. These can also be used as analgesics. Eg- morphine, codeine, heroin, marijuana. When used in medicinal doses, they relieve pain and produce sleep. In excessive doses, they produce stupor coma, convulsions and ultimately leading to death. These narcotics are called opiates because they are obtained from opium poppy.

3) **Antiseptics and disinfectants:**

Antiseptics are chemical substances used either to kill or prevent the growth of micro-organisms. These are not harmful to living tissues and can be applied on wounds, ulcers, diseased skin surfaces. They are also used to reduce odours resulting from bacterial decomposition of the body or in the mouth. Eg- Soframycin, Bithional is added to medicated soaps, tincture of Iodine (2-3% soln of iodine in alcohol-water mixture), Iodoform, Boric acid in dilute aqueous solution is antiseptic for eyes etc.

Disinfectants are chemical substances which are used to kill micro-organisms but they cannot be applied on living tissues. They play a major role in water treatment and public health sanitation. These are commonly applied on inanimate objects like floors, drainage system etc. Eg- Cl_2 at a conc. of 0.2 to 0.4 ppm makes water fit for drinking, Phenol derivative, thymol.

Some substances act both as antiseptics and disinfectants. Eg- Dettol (a mixture of chloroxylenol and terpineol), 0.2% soln. of phenol acts as antiseptic & 1% soln acts as disinfectant.

4) **Tranquilizers:** The chemical substances used for treatment of stress, mild and severe mental diseases are called tranquilizers. They release mental tension and reduce anxiety. These are essential component of sleeping pills. These are also called psychotherapeutic drugs. Noradrenaline, a hormone which induces feeling of well being and helps in changing mood. If the level of noradrenaline is low for some reason, then signal sending activity becomes low, and the person suffers from depression. In such situations, antidepressant drugs are required. Eg: iproniazid and phenalzine are antidepressant drugs. They inhibit the enzyme which catalyse the degradation of noradrenaline.

Chlordiazepoxide and meprobamate are used to relieve tension.

Equanil, diazepam, veronal and serotonin are used in controlling depression and hypertension

Barbiturates like veronal, amytal, membutal, seconal and luminal are hypotonic ie: sleep producing agents.

5) **Antimalarials:** These are chemical substances used for treatment of malaria. Eg- Chloroquine, paraquine etc.

- 6) **Antimicrobials:** are chemical substances used to cure infections due to micro-organisms. The disease in human beings may be caused due to variety of micro-organisms like virus, bacteria etc. which are called microbes. They can be seen only by microscope. The disease causing microbes are called pathogens. Our body possesses natural defense mechanism against the pathogenic microbes. Skin is impervious to microbes. Our body secretions kill the microbes or inhibit their growth. Some common examples are lysozyme in tears, nasal secretions, saliva, lactic acid in sweat etc. The pathogens reach the tissues due to breach in defence mechanism and cause infections.

The control of microbial diseases can be achieved by:

- (i) Drugs which kill organisms in the body (bactericidal)
- (ii) Drugs which inhibit or arrest the growth of organisms (bacteriostatic)
- (iii) Increasing immunity and resistance to infections of the body (immunity)

Antimicrobial substances may be synthetic chemicals like sulphonamides or antibiotics- like tetracycline, penicillin, chloramphenicol etc. The common example of antimicrobial drug is sulphanilamides which are effective in wide range of micro-organisms.

- 7) **Antifertility Drugs:** These chemical substances control pregnancy. Their basic aim is to prevent conception or fertilization. The birth control pills are essentially a mixture of estrogen and progesterone derivative. Both of these compounds are hormones. Progesterone suppresses ovulation. Synthetic progesterone are more potent than progesterone.
The common pills used for a combination of progesterone, norethindrone and estrogen (ethynodiol diacetate) is novestrol.

- 8) **Antacids:** The chemical substances which neutralize excess acid in the gastric juices and give relief from acid indigestion, acidity, heart burns, and gastric ulcers are called antacids. Baking soda in water is a common antacid. Other examples are magnesium hydroxide, calcium carbonate, sodium bicarbonate, potassium bicarbonate, magnesium carbonate, potassium bicarbonate, aluminium phosphate. Magnesium oxide is also used as an antacid ingredient since it reacts with water to form $Mg(OH)_2$. The antacids are available in the form of liquids, gels or tablets. Generally, liquid antacids are more effective than tablets because of great surface area available for interaction and neutralization of acid. An advancement in treatment of hyperacidity came through the discovery that histamines stimulates the secretion of pepsin and hydrochloric acid. To prevent interaction of histamines with the receptors present in the stomach wall, the drug cimetidine has been designed. This resulted in release of lesser amount of acid. The drug is now replaced by ranitidine. A more effective new class of drugs is omeprazole and lansoprazole which prevents formation of acid in stomach.

- 9) **Antihistamines:** are chemical substances which diminish or abolish the main actions of histamines release in the body and hence prevent the allergic reactions caused by antigens. Histamines are responsible for nasal congestion associated with common colds, cough, allergic response to pollens etc. Synthetic drugs such as bromopheniramine (Dimetapp) and terfenadine (seldane) are used as antihistamines. Antihistamines are also called anti-allergic drugs. These are used to treat allergy, e.g., skin rashes, conjunctivitis etc. These drugs relieve

sneezing , nasal discharge, mild asthma, itching of eyes, nose and throat. The common antihistamine drugs are Benadryl, avil, zeet, bromethazine, actidil, anistine, foristal etc.

10) **Anaesthetics:** are chemical substances which produce general or local insensibility to pains and other sensations. Cocaine, novocaine are local anaesthetic chloroform, diethyl & vinyl ethers are general anaesthetics.

11) **Antibiotics:** are chemical substances which are produced by micro-organisms (bacteria, fungi and moulds) and can inhibit the growth or even destroy micro-organisms. Antibiotic refers to a substance (produced wholly or partly by chemical synthesis) which in low concentration inhibits growth or destroys micro-organisms by intervening in their metabolic processes.

First antibiotic produced was penicillin by Alexander Fleming in 1929. Antibiotic can be either bactericidal or bacteriostatic.

Bactericidal: Pencillin, Aminoglycosides, Ofloxacin.

Bacteriostatic: Erythromycin, Tetracycline, Chloramphenicol.

Pencillin is narrow spectrum. These can be used for curing sore throat, rheumatic fever, local infections etc. Streptomycin, neomycin is used for treatment of tuberculosis, meningitis, pneumonia etc.

Broad spectrum antibiotics are effective against several micro-organisms. Therefore these are for curing a variety of diseases. Eg- thetacycline, chloromycetin and chloramphenicol.

Eg- Chloramphenicol is a broad spectrum antibiotic which is used for curing typhoid, acute fever, dysentery, whooping cough, pneumonia, eye infections, certain urine infections etc.

Sulphadiazine, sulphathiazole, sulphaacetamide etc. Some examples are sulphadiazine, sulphathiazole, sulphaacetamide etc.

S.No.	Type of Medicine	Used as	Examples
1	Analgesics	Relieve Pain	Aspirin, Ibuprofen
2	Antipyretics	Lowers body temperature	Paracetamol, Phenacetin
3	Antiseptics & Disinfectants	Kill or prevent growth of microorganism	Phenol, Chlorine, Dettol
4	Tranquilizers	Treatment of stress & mental diseases	Barbituric acid & its derivatives (Seconal, Luminal, Veronal etc)
5	Antimicrobials	Cure infections due to microorganisms	Sulphonamides
6	Antifertility drugs	Birth control	Novestrol (ethynodiolide) & Progesterone (norethindrone), mifepristone
7	Antacids	Removes excess acid in stomach	Magnesium hydroxide, Magnesium trisilicate, aluminium hydroxide gel, Ranitidine
8	Antihistamines	Treatment of hyperacidity, stimulates secretion of pepsin &	Brompheniramine & terfenadine

		HCl in the stomach. Also responsible for nasal congestion associated with common cold	
9	Antibiotics	Produced by microorganisms & can inhibit the growth of other microbes	Pencillin, Tetracycline, Chloramphenicol

Chemicals in Food

Many chemicals are added to food for their preservation and enhancing their appeal. These include flavourings, sweetness, antioxidants, fortifiers, emulsifiers and antifoaming agents.

1. Antioxidants:

Antioxidants are the important class of compounds which prevent oxidation of food materials. These compounds retard the action of oxygen on the food and thereby help in preservation. These act as sacrificial materials. i.e. they are more reactive towards oxygen than the materials they are protecting. They also reduce the rate of involvement of free radicals in the aging process. Most important antioxidants used are butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT). The addition of BHA to butter increases its storage life.



Sometimes BHT and BHA are added in combination with citric or ascorbic acid to produce a more active synergistic effect. SO_2 and sulphate are useful antioxidants for wine and beers, sugar syrups and cut peeled on dried fruits and vegetables.

2. Preservatives:

These are the chemical substances which are added to the food materials to prevent their spoilage and to retain their nutritive value for long periods. These preservatives prevent rancidity of food & inhibit the growth of microorganisms during storage. Example: Common salt, sugar, oils, Sodium benzoate, salts of propanoic acid and ascorbic acid.

3. Artificial Sweetening agents:

The artificial sweeteners are another type of food additives. Eg; Saccharin which is marketed as soluble of calcium salt. It is 300 times sweet than cane sugar. It is life saver for diabetic patients and is of great value to people who need to control intake of calories.

Aspartame: Unstable at cooking temperature, therefore it is used as a sugar substitute to cold foods and soft drinks.

Alitame: more stable during cooking than aspartame
 Sucralose: good artificial sweetener.

4. Edible colors:

Edible colour that are used for food are dyes; ex- dyes are used to dye orange peels so that oranges retain their colour. Colour is also added to fruit juices. Food colours do not have any nutritional value. The use of some of the azodyes are dangerous for young children and asthma patients.

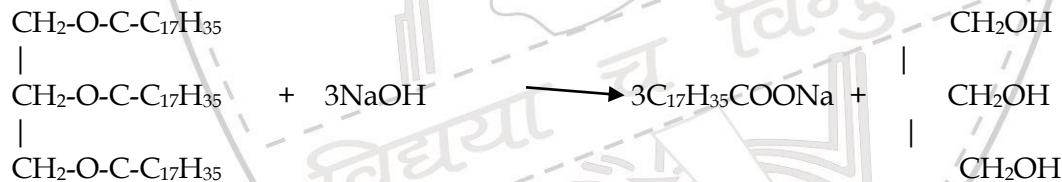
Terazime, a widely used dye is harmful

Natural dyes like carotene are safe food edible colours.

PFA {Prevention of food Adulteration Act}- govt. has passed it for the protection of consumer interests.

SOAP AND DETERGENT

Soaps are sodium or potassium salts of long chain fatty acids. Soaps containing sodium salts are formed by heating fat (ie glycerol ester of fatty acid) with aqueous sodium hydroxide solution and potassium salts are prepared by using potassium hydroxide. This reaction is known as saponification. Soap obtained remains in colloidal form and is precipitated from the solution by adding NaCl.



Soaps cannot be used in hard water as hard water contains certain metal ions such as Ca^{2+} and Mg^{2+} which form a curdy white precipitate of calcium and magnesium salt. This is called scum and is hindrance to good washing because this insoluble ppt. adheres onto the fibre of the cloth as gummy mass.

Synthetic detergents: They are sodium or potassium salts of sulphonic acid. Eg: sodium alkylbenzene sulphonate which have a general formula: $\text{CH}_3(\text{CH}_2)_x\text{C}_6\text{H}_4\text{SO}_3\text{Na}^+$

Advantages of detergents:

Detergents can work in hard water. The anions of synthetic detergent do not precipitate in the presence of Ca^{2+} and Mg^{2+} . They can work well even in acidic water.

Types of detergents;

There are three types of detergents;

(a) Anionic detergents are synthesized from long chain alcohol. The long chain alcohols are treated with conc. H_2SO_4 to form alkyl hydrogen sulphate of high molecular mass and finally

alkyl sulphate are neutralized with alkali to form salts. It is called anionic detergent because large part of the molecule is anion. The anionic detergent is largest in use as household detergents. E.g.- Alkylbenzenesulphonate . They are effective in acidic solutions to form an alkyl hydrogen sulphate which is soluble whereas soap are not effective due to formation of insoluble fatty acids.



- (b) Cationic detergent: These are mostly acetates or chlorides of quaternary ammonium salt. They are more expensive therefore are used to limited extent. Such detergent possess germicidal properties and are extensively used as germicides. e.g $[\text{CH}_3(\text{CH}_2)_{11}\text{N}^+(\text{CH}_3)_3]\text{Br}$
- (c) Non-Ionic detergent: Some of the detergent are non- ionic , like the esters of high molecular mass formed by reactions between polyethylene glycol and stearic acid. They do not possess any ion.



Some liquid dishwashing detergents are of non-ionic type branched hydrocarbon chain detergents are non-biodegradable and cause water pollution. The hydrocarbon side chain stops bacteria from attacking and breaking the chain. These molecules degrade slowly leading to water pollution.

Unbranched or linear alkyl chain detergents do not create pollution as they are more prone to attack by bacteria, thus can be biodegraded.

Hands-on/ IT Enabled work:

Whole chapter is done with the help of a presentation with animations.

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Assignment

Chapter 16: Chemistry in Everyday Life

1. Cetyltrimethyl ammonium bromide is a popular
(a) anionic detergent (b) cationic detergent (c) non-ionic detergent (d) antioxidant
2. The artificial sweetner containing chlorine that has the appearance and taste as that of sugar and is stable at cooking temperature is
(a) Aspartame (b) Saccharin (c) Sucrolose (d) alitame

In Q3 and Q4, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (i) Both assertion and reason are wrong.
(ii) Both assertion and reason are correct statements but reason is not correct explanation of assertion.
(iii) Assertion is correct statement but reason is wrong statement.
(iv) Both assertion and reason are correct statements and reason is correct explanation of assertion.
(v) Assertion is wrong statement but reason is correct statement
3. **Assertion:** Transparent soaps are made by dissolving soap in ethanol.
Reason: Ethanol makes things invisible.
4. **Assertion:** Chemical messenger gives message to the cell without entering the cell.
Reason: Chemical messenger is received at the binding site of receptor proteins.
5. (i) Why is bithional added to soap?
(ii) What is tincture of iodine? Write its one use.
(iii) Among the following, which one acts as a food preservative?
Aspartame, Aspirin, Sodium Benzoate, Paracetamol
6. Define the following and give one example :
(i) Anionic detergents
(ii) Antimicrobials
(iii) Antioxidants
(iv) Broad spectrum antibiotics
(v) Artificial sweetening agents
(vi) Foodpreservatives
7. What type of medicines are omeprazole and lansoprazole?
8. Give an example of drug used in case of mental depression.
9. For which disease chloramphenicol is used?
10. (a) Name the sweetening agent used in preparation of a sweet for a diabetic patient.

- (b) What problem arises in using alitame as artificial sweeteners?
(c) Why is use of aspartame limited to cold foods?
11. Name a broad spectrum antibiotic and diseases for which it is prescribed.
 12. (a) How are antiseptics distinguished from disinfectants? Give 2 examples of each.
(b) Name a substance that can be used as an antiseptic as well as disinfectant.
 13. Name the action of the following on the human body:
(i) Equanil (ii) Morphine (iii) Norethindrone (iv) Aspirin (v) Penicillin
(vi) Luminal (vii) Seconal
 14. What are the essential components of dettol?
 15. What are detergents? Give their scheme of classification. Why are detergents preferred over soaps?
 16. Why is ethanol added to soaps?
 17. What are biodegradable and non-biodegradable detergents? What are the consequences of using the latter kind? Give one example of each kind.
 18. Why soaps do not act on hard water?
 19. Explain the term 'chemotherapy'.
 20. Describe the function of the following with one example for each :
a. Tranquilizers b. Antifertility drugs c. Antihistamines
d. Analgesics e. Antioxidants f. Antacids
 21. Explain the cleansing action of soaps.
 22. Account for the following:
 - a) Aspirin drug helps in the prevention of heart attack.
 - b) Diabetic patients are advised to take artificial sweetener instead of natural sweeteners.
 - c) Detergents are non-biodegradable while soaps are biodegradable.
 23. Except for vitamin B₁₂, all other vitamins of group B, should be supplied regularly in diet. Why?
 24. In order to wash clothes with water containing dissolved calcium hydrogen carbonate which cleaning agent will you prefer and why, soaps or synthetic detergents? Give one advantage of soap over detergents

Practice paper**(Electrochemistry, Chemical Kinetics, Solutions,
p-block elements, Salt Analysis)**

Time: 1 hr 45 min

Max. Marks -50

No. of printed pages: 2

General Instructions:

- (i) All questions are compulsory.
- (ii) This paper has two parts.
- (iii) Part A is theory from question nos. 1 to 18 carrying 35 marks.
- (iv) Part B is practical related questions numbering 19 to 23 carrying 15 marks.
- (v) Use log tables if necessary, use of calculators is not permitted.

PART A

There are two types of cells; Primary and Secondary. Primary cells once used cannot be recharged whereas secondary cells once used can be recharged. Electrolysis may be defined as a process of decomposition of an electrolyte by the passage of electricity through its aqueous solution or molten state.

- | | | |
|----|--|---|
| 1. | What type of cell is mercury cell? Write its overall reaction? | 1 |
| 2. | Write the anodic and cathodic reaction for lead storage battery while discharging. | 1 |
| 3. | Write the products of electrolysis of $\text{CuSO}_4\text{(aq)}$ using Pt electrodes. | 1 |
| 4. | How many Faradays of electricity is required to obtain 1 mol of Mn^{2+} from KMnO_4 ? | 1 |
| 5. | Which of the following has maximum number of lone pairs associated with Xe?
(a) XeO_3 (b) XeF_4 (c) XeF_6 (d) XeF_2 | 1 |

In Q6 and Q7, a statement of assertion followed by a statement of reason is given.

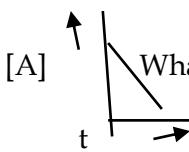
Choose the correct answer out of the following choices.

- (i) Both assertion and reason are wrong.
- (ii) Both assertion and reason are correct statements but reason is not correct explanation of assertion.
- (iii) Assertion is correct statement but reason is wrong statement.
- (iv) Both assertion and reason are correct statements and reason is correct explanation of assertion.
- (v) Assertion is wrong statement but reason is correct statement

- | | | |
|----|---|---|
| 6. | Assertion: Higher the molal depression constant of the solvent used, higher the freezing point of the solution.
Reason: Depression in freezing point does not depend on the nature of the solvent. | 1 |
| 7. | Assertion: All collisions of reactant molecules lead to product formation. | 1 |

- Reason:** Only those collisions in which molecules have correct orientation and sufficient kinetic energy lead to compound formation.
8. For a reaction, $A + B \rightarrow P$, the reaction is of first order in reactant A and second order in reactant B. 1
 i) How is the rate of this reaction affected when the concentration of B doubled.
 ii) What is the overall order of reaction if A is present in large excess.
9. How many grams of chlorine can be produced by the electrolysis of molten NaCl with a current of 1A for 15 minutes? 2
 (given atomic mass of Cl=35.5u, 1F=96500 C/mol)
10. State Kohlrausch law of independent migration of ions. Write an expression for the molar conductivity of acetic acid at infinite dilution according to Kohlrausch law. 2
11. Non ideal solutions exhibit either positive or negative deviations from Raoult's law. What are these deviations and why are they caused? Explain with one example for each type. 2
12. i) Why is the freezing point depression of 0.1M sodium chloride solution nearly twice that of 0.1M glucose solution?
 ii) A solution containing 8g of a substance in 100g of diethyl ether boils at 36.86°C , whereas pure ether boils at 35.6°C . Determine molecular mass of solute. [For ether, $K_b = 2.02 \text{ K Kg mol}^{-1}$] 3
13. The decomposition of phosphine, PH_3 , proceeds according to the following equation: $4\text{PH}_3(\text{g}) \rightarrow 3\text{P}_4(\text{g}) + 6\text{H}_2(\text{g})$ 2
 It is found that the reaction follows the following rate equation: Rate = $k[\text{PH}_3]$
 The half-life of PH_3 is 37.9s at 120°C . How much time is required for $3/4^{\text{th}}$ of PH_3 to decompose? [$\log 2 = 0.3010$]
14. a) What is meant by the 'rate constant, k' of a reaction? If the concentration be expressed in mol L⁻¹ units and time in seconds, what would be the units for k (i) for a zero order reaction and (ii) for a first order reaction?
 b) What type of collisions is known to be effective? 2
15. Write the Nernst equation and calculate the e.m.f of the following cell at 298K 3
 $\text{Zn(s)} | \text{Zn}^{2+}(0.1 \text{ M}) || \text{Cd}^{2+}(0.01 \text{ M}) | \text{Cd(s)}$
 $(E^0_{\text{Zn}^{2+}/\text{Zn}} = -0.761 \text{ V}, E^0_{\text{Cd}^{2+}/\text{Cd}} = 0.40 \text{ V})$. Further show:
 i) The carriers of current within the cell.
 ii) E^0 values for the electrode $2 \text{ Zn}^{2+}/2\text{Zn}$.
 iii) Which electrode is negatively charged?
 iv) Individual reactions at each electrode.

16. a) From the graph:



What is the order of the reaction?

3

- b) A first order decomposition reaction takes 40 min for 30% decomposition.
Calculate its $t_{1/2}$ value. ($\log 10 = 1$, $\log 7 = 0.8451$)
17. a) 2g each of two solutes A and B (molar mass of A > B) are dissolved separately in 200g each of the same solvent. Which will show greater elevation in boiling point?

3

- b) The molal elevation constant for H_2O is 0.52 K/m. Calculate the boiling point of solution made by dissolving 6 g of urea (NH_2CONH_2) in 200 g of H_2O .
18. a) Complete the following chemical reaction equations:
- $XeF_4(s) + H_2O(l) \longrightarrow$
 - $ClF + H_2O \longrightarrow$
- b) Explain the following observations giving appropriate reasons:
- Halogens are strong oxidizing agents.
 - Bleaching action of chlorine is permanent whereas that of SO_2 is temporary.

5

PART B

19. Why is it that tests for Barium, Strontium and Calcium to be done in order? 2
20. Explain one confirmatory test for Ni^{2+} . 2
21. (a) Give the formula of reddish yellow vapours evolved during chromyl chloride test? 1,2
(b) Explain the Cl_2 water test for iodide with equation.
22. Explain the indicator and confirmatory tests for sulphide. 3
23. (a) How can one distinguish between sulphite and sulphate using $BaCl_2$ test.
(b) What is the colour seen in flame for strontium salt.
(c) What is the yellow ppt. in K_2CrO_4 test for lead due to?
(d) What is the canary yellow ppt. in Ammonium Molybdate test for Phosphate due to?
(e) What is the formula for brown ring?

Academic Session: 2019-20

First Term Examination

Subject: Chemistry

M/2/1

Time : 3 Hrs

Max marks : 70

General Instructions:

- All questions are compulsory.
- Question nos. 1 – 20 are very short answer questions and carry 1 mark each.
- Question nos. 20 – 27 are short answer questions and carry 2 mark each.
- Question nos. 28 – 34 are also short answer questions and carry 3 mark each.
- Question nos. 35 – 37 are long answer questions and carry 5 mark each.
- Use of calculators is not permitted.
- This paper has 4 printed sides.

SECTION : AChoose the correct option in the questions from Q1-Q5

Q1. Which of the following have the same value of van't Hoff factor as that of $\text{Al}_2(\text{SO}_4)_3$ (if all are 100% ionized). (1)

(i) K_2SO_4
(iii) $\text{Al}(\text{NO}_3)_3$

(ii) $\text{K}_4[\text{Fe}(\text{CN})_6]$
(iv) $\text{K}_3[\text{Fe}(\text{CN})_6]$

Q2. Zn is coated on Iron to produce galvanized iron to protect it because (1)

- (i) Zn is lighter than Iron
(iii) Zn has lower negative electrode potential than Iron

- (ii) Zn has lower melting point than Iron
(iv) Zn has higher negative electrode potential than Iron

Q3. Treatment of ketone with Grignard's reagent followed by hydrolysis gives (1)

- | | |
|---------------------------------|--------------------------------|
| (i) 2 ⁰ Alcohol | (ii) 1 ⁰ Alcohol |
| (iii) 3 ⁰ Alcohol | (iv) Aldehyde |

Q4. When sodium phenoxide is heated with CO₂ under pressure followed by acidification with HCl, the product obtained is (1)

- | | |
|-------------------------|------------------------|
| (i) Salicylic acid | (ii) Salicyaldehyde |
| (iii) Benzoic acid | (iv) Benzaldehyde |

Q5. Synthesis of alkyl fluorides is best accomplished by (1)

- | | |
|------------------------------------|------------------------------|
| (i) Finkelstein Reaction | (ii) Swartz Reaction |
| (iii) Free radical fluorination | (iv) Sandmeyer's reaction |

Fill in the blanks in the Question No. 6-10

Q6. The hydrolysis of ester is an example of a ----- order reaction. (1)

Q7. Electrolysis of an aqueous solution of copper sulphate using platinum electrodes (1) produces ----- at cathode and ----- at anode.

Q8. According to collision theory, the rate constant, $k = PZ_{AB}e^{-E_a/RT}$. Here Z_{AB} represents ----- and P represents ----- . (1)

- Q9. Cl_2 reacts with hot and conc.----- to form sodium chlorate and Sodium Chloride. (1)
- Q10. Complex compound of Xenon prepared by Neil Bartlett was ----- . (1)

Write True or False in the Questions from Q11-Q15.

- Q11. In case of zero order reaction half life period is independent of initial concentration. (1)
- Q12. A solution of chloroform and Acetone show negative deviation from Raoult's law. (1)
- Q13. Benzaldehyde cannot undergo Cannizaro reaction. (1)
- Q14. Phenol undergoes electrophilic substitution more easily than Benzene. (1)
- Q15. Dipole moment of chlorobenzene lower than that of cyclohexyl chloride. (1)

Write very short answers for the questions from Q16- Q20.

- Q16. Write the overall reaction taking place during charging of a lead storage battery. (1)
- Q17. Arrange the following in decreasing order of boiling point: (1)
Pentan-1-ol, n-Butane, Pentanal, Ethoxyethane, Pentanoic acid.
- Q18. Draw structure of Phenylhydrazone of cyclobutanone. (1)

Q19. Why is sulphuric acid not used during reaction of Alcohols with KI to form alkyl halides? How is this difficulty overcome? (1)

Q20. Why do aquatic species feel more comfortable in cold water than in warm water? (1)

SECTION : C

Q21. Write structures of the compounds A and B in the following reactions: (2)



Q22. (i) S_N1 reactions are accompanied by racemization in optically active halides. Explain. (2)

(ii) Predict the structure of the major alkene formed by dehydrohalogenation of 1-bromo-1-methylcyclohexane on reaction of sodium ethoxide in ethanol.

Q23. Account for the following: (2)

(i) o-nitrophenol is more steam volatile than p-nitrophenol.

(ii) t-butyl chloride on heating with sodium methoxide gives 2-methylpropene instead of t-butylmethylether.

Q24. For the reaction $2\text{NH}_3(\text{g}) \xrightarrow{\text{Pt}} \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$, Rate = k (2)

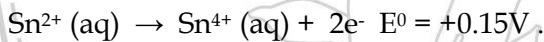
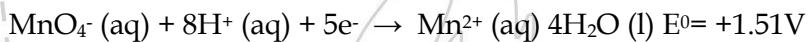
- (i) What is the order and molecularity of this reaction?
- (ii) What is the unit of k?

Q25. Give reason for the following: (2)

- (i) Vinyl chloride is less reactive than ethyl chloride towards nucleophilic substitution .
- (ii) Haloalkanes are partially soluble in water.

Q26. The measured resistance of a conductivity cell containing 7.5×10^{-3} M solution of KCl at 25°C was 1005 ohm. Calculate (a) Conductivity (b) molar conductivity of the solution. Cell constant= 1.25cm^{-1} . (2)

Q27. Two half cell reactions of an electrochemical cell are given below: (2)



Construct a redox reaction from the two half cell reactions and find E°_{cell} .

SECTION : C

Q28. (i) How will you convert the following:
a) Phenol to Anisole (3)

b) Ethanol to Propan-2-ol

(ii) Give chemical test to distinguish between 1-Propanol and Phenol.

Q29. (i) Out of $(\text{CH}_3)_3\text{C-Br}$ and $(\text{CH}_3)_3\text{C-I}$, which one is more reactive towards $\text{S}_{\text{N}}2$ and why? (3)

(ii) Write the product formed when p-Chloronitrobenzene is heated with aqueous NaOH at 443K followed by acidification.

(iii) Why dextro and laevo - rotatory isomers of Butan-2-ol are difficult to separate by fractional distillation?

Q30. Write chemical equations for the following: (3)

- (i) Propanone is treated with dilute Ba(OH)_2 .
- (ii) Acetophenone is treated with $\text{Zn(Hg)}/\text{Conc.HCl}$.
- (iii) Benzoyl chloride is hydrogenated in the presence of Pd/BaSO_4 .

Q31. The decomposition of a hydrocarbon has value of rate constant as $2.5 \times 10^4 \text{ s}^{-1}$ at 27°C . At what temperature would the rate constant be $7.5 \times 10^4 \text{ s}^{-1}$ if the activation energy $19.147 \times 10^3 \text{ J mol}^{-1}$. ($\log 3 = 0.4771$, $\log 5 = 0.6990$, $R = 8.314 \text{ J/K/mol}$) (3)

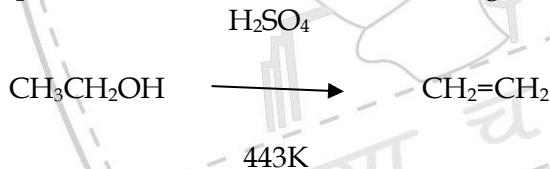
Q32. (i) Write balanced chemical equation when
 (a) XeF_6 is completely hydrolysed (b) MnO_2 is heated with conc. HCl (3)

(ii) Draw structure of $\text{H}_2\text{S}_2\text{O}_7$.

Q33. Account for the following: (3)

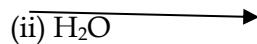
- (i) Bond dissociation enthalpy decreases from H_2O to H_2Te .
- (ii) HOI is a weaker acid than HOCl.
- (iii) Chlorine water has both oxidizing and bleaching properties.

Q34. (i) Write reaction involved in Riemer - Tiemann reaction.
 (ii) Explain the mechanism of the following reaction: (3)



SECTION : D

Q35. (i) Complete the following reactions: (5)



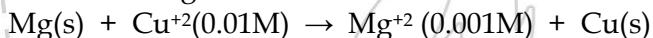
- (ii) Give chemical test to distinguish between benzophenone and Acetophenone.
 (iii) Convert Benzaldehyde to α - Hydroxyphenylacetic acid.

Q36. (i) A decimolar solution of Potassium Ferrocyanide, $K_4[Fe(CN)]_6$ is dissociated to the extent of 95% at 300K. What would be the osmotic pressure of the solution? ($R = 8.314 \text{ J/K/mol}$).

(ii) A sample of drinking water is severely contaminated with chloroform. The level of contamination is 15ppm by mass. Express this in percent by mass. Determine the molality of chloroform ($CHCl_3$) in water sample. Molar mass of $CHCl_3 = 119.5 \text{ g/mol}$

Q37. (i) A steady current of 2 amperes was passed through two electrolytic cells X and Y connected in series containing electrolytes $FeSO_4$ and $ZnSO_4$ until 2.8g of Fe gets deposited at the cathode of the cell X. How long did the current flow? Calculate the mass of Zn deposited at the cathode of cell Y. (Molar mass: $Fe=56\text{g/mol}$, $Zn=65.3\text{g/mol}$, $1F=96500C/mol$).

(ii) E°_{cell} for the given redox reaction is 2.71V.



Calculate the E_{cell} for the reaction. Write the direction of flow of current when an external opposite potential applied is less than 2.71V.

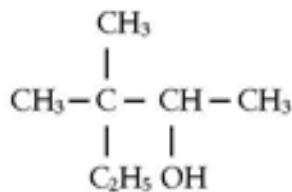
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Question Bank for First term exam

- Q1. Refractive index of a solid is observed to have the same value along all directions. Comment on the nature of the solid. Would it show cleavage property? (1)

- Q2. Write the IUPAC name of the following: (1)



- Q3. State Raoult's law. (1)

- Q4. Write the cathodic and anodic reaction for corrosion of iron. (1)

- Q5. Give an example of pseudo first order reaction. (1)

- Q6. A compound forms hexagonal close-packed structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids? (2)

- Q7. The vapour pressure of water is 12.3 kPa at 300K. Calculate the vapour pressure of 1 molal solution of a non-volatile solute in it.
(Atomic mass of O=16u and H=1u) (2)

- Q8. For the reaction: (2)



The rate of formation of $\text{NO}_2(\text{g})$ is $2.8 \times 10^{-3} \text{ Ms}^{-1}$. Calculate the rate of disappearance of $\text{N}_2\text{O}_5(\text{g})$.

- Q9. Draw the structures of the following: (2)

- a) XeF_4
- b) HClO_3

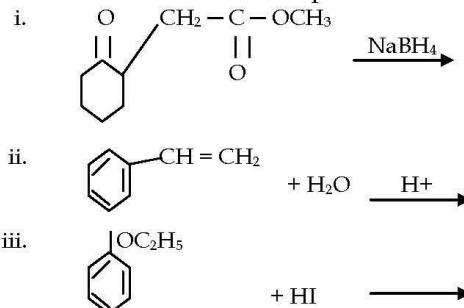
- Q10. a) Arrange the following in the decreasing order of their reducing character: (2)
HF, HCl, HBr, HI
- b) Complete the following reaction:
 $\text{XeF}_4 + \text{SbF}_5 \rightarrow$
- Q11. a) Out of Chlorobenzene and benzyl chloride, which one gets easily hydrolysed by aqueous NaOH and why? (2)
- b) Convert aniline to chlorobenzene.
- Q12. a) Write the equation involved in Reimer-Tiemann reaction. (2)
- b) Ortho-nitrophenol is more acidic than ortho-methoxyphenol. Why?
- Q13. An element 'X' (At mass = 40 g/mol) having f.c.c. structure, has unit cell edge length of 400 pm. Calculate the density of 'X' and the number of unit cells in 4g of 'X' ($\text{Na} = 6.023 \times 10^{23} \text{ mol}^{-1}$) (3)
- Q14. a) Analysis shows that FeO has a non-stoichiometric composition with formula $\text{Fe}_{0.95}\text{O}$. Give reason. (3)
- b) What is Schottky defect?
- c) What is meant by the term 'forbidden zone' in reference to band theory of solids?
- Q15. a) Calculate the freezing point of a solution containing 60g of glucose in 250g of water.
(Molar mass of glucose = 180 g/mol, k_f of water = 1.8k KKg mol^{-1}) (3)
- b) What are hypertonic solutions?
- Q16. a) Identify the chiral molecule in the following pair: (3)
-
- Give reasons for your answer
- b) Write the structure of the product formed when chlorobenzene is treated with methyl chloride in the presence of sodium metal and dry ether.
- c) Write the structure of the alkene formed by dehydrohalogenation of 1-bromo-1-methylcyclohexane with alcoholic KOH.
- Q17. Give reasons for the following: (3)
- a) Measurement of osmotic pressure method is preferred for the determination of molar masses of macro molecules such as proteins and polymers.
- b) Aquatic animals are more comfortable in cold water than in warm water.
- c) Elevation of boiling point of 1M KCl solution is nearly double than that of 1M sugar solution.

Q18. A first order reaction is 50% completed in 40 minutes at 300K and in 20 minutes at 320K. Calculate the activation energy of the reaction. (3)
 [Given $\log 2 = 0.3010$, $\log 4 = 0.6020$, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$]

Q19. For the reaction: (3)
 $2\text{AgCl}(\text{s}) + \text{H}_2(\text{g}) \rightarrow 2\text{Ag}(\text{s}) + 2\text{H}^+(\text{0.1M}) + 2\text{Cl}^-(\text{0.1M})$
 Calculate the e.m.f of the cell.
 [Given $\Delta G^\circ = -43600 \text{ J at } 25^\circ\text{C}$, $\log 10^{-n} = -n$]

Q20. Give reasons: (3)
 a) H_3PO_3 undergoes disproportionation reaction but H_3PO_4 does not.
 b) When Cl_2 reacts with excess F_2 , ClF_3 is formed and not FCl_3 .
 c) Dioxygen is a gas while sulphur is a solid at room temperature.

Q21. Write the structures of the main products in the following reactions: (3)



Q22. a) Compound 'A' with molecular formula $\text{C}_3\text{H}_8\text{O}$ gives positive Lucas reagent test in 5 minutes. Write the reaction for the test with the structure of 'A'. (3)
 b) Convert methyl magnesium bromide to 2- Methylpropan-2-ol

Q23. a) What is denatured alcohol? (3)
 b) State a test to distinguish between phenol and ethanol.
 c) Arrange the following in increasing order of their boiling points:
 Pentan-1-ol, butan-1-ol, ethanol, propan-1-ol, methanol.

Q24. The following rate data were obtained at 303 K for the following reaction: (3)
 $2\text{A} + \text{B} \rightarrow \text{C} + \text{D}$

Experiment	[A]/mol L ⁻¹	[A]/mol L ⁻¹	Initial rate of formation of D/mol L ⁻¹ min ⁻¹
I	0.1	0.1	6.0×10^{-3}
II	0.3	0.2	7.2×10^{-2}
III	0.3	0.4	2.88×10^{-1}
IV	0.4	0.1	2.40×10^{-2}

What is the rate law? What is the order with respect to each reactant and the overall order? Also calculate the rate constant and write its unit.

Q25. a) Write the cell reaction and calculate the e.m.f of the following cell at 298 K.

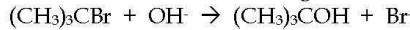


[Given: $E^\circ_{\text{Sn}^{2+}/\text{Sn}} = -0.14 \text{ V}$]

b) Give reasons:

- On the basis of E° values, O_2 gas should be liberated at anode but it is Cl_2 gas which is liberated in the electrolysis of aqueous NaCl .
- Conductivity of CH_3COOH decreases on dilution.

Q26. a) Give mechanism for the following reaction:



b) Write short note on Swartz reaction.

c) Account for the following:

Haloalkanes react with KCN to form alkyl cyanides as main product while AgCN forms isocyanides as the major product.

d) What are freons? Why are they harmful?

Q27. a) When concentrated sulphuric acid was added to an unknown salt present in a tube, a brown gas (A) was evolved. This gas intensified when copper turnings were added to this test tube. On cooling, this gas (A) changed into a colourless solid (B).

- Identify (A) and (B).
- Write the structures of (A) and (B).
- Why does gas (A) change to solid on cooling?

b) Among the hydrides of group 15 elements, which have the:

- Highest boiling point?
- Maximum basic character?
- Highest bond angle?
- Maximum reducing character?

Academic Session: 2019-20
Practice Examination
Subject: Chemistry
M/1

Time: 2 Hours**Max marks: 45****General Instructions:**

- All questions are compulsory.
- Question nos. 1-15 are very short answer questions and carry 1 mark each.
- Question nos. 16 -18 are short answer questions and carry 2 mark each.
- Question nos. 19 - 21 are also short answer questions and carry 3 mark each.
- Question no. 22 - 24 are long answer question and carry 5 mark each.
- This paper has 3 printed sides.

SECTION : A

Read the given passage and answer the questions 1 to 5 that follow:

Polymers are made up of small molecules called monomers. Based on the molecular forces between the polymeric units. Polymers which are formed by one type of monomer are called as homopolymers and which are formed by more than one type of monomers are called as co-polymers. Natural polymers are biodegradable whereas synthetic polymers may or may not be. Addition or chain growth polymerization involves the repeated addition of monomers to the polymer chain. Condensation or step growth polymerization involves a series of condensation reactions between the monomers.

- | | | |
|-----|--|-----|
| Q1. | Draw the structure of Buna-S. Is it a homopolymer or a co-polymer? | (1) |
| Q2. | Name the monomer of Nylon 6. Does it polymerize by chain growth or step growth polymerization? | (1) |
| Q3. | Give an example of biodegradable synthetic polymer. | (1) |
| Q4. | Melamine is a condensation polymer. Draw the structure of the polymer. | (1) |
| Q5. | What are thermoplastics? Give an example. | (1) |

Questions 6 to 8 are Multiple Choice Questions:

- | | | |
|-----|---|-----|
| Q6. | The correct order of increasing acid strength is | (1) |
| | (a) Phenol < Ethanol < Chloroacetic acid < acetic acid | |
| | (b) Ethanol < Phenol < Chloroacetic acid < acetic acid | |
| | (c) Ethanol < Phenol < acetic acid < Chloroacetic acid | |
| | (d) Chloroacetic acid < acetic acid < Phenol < Ethanol | |
| Q7. | Compound Ph-OCO-Ph can be prepared by the reaction of: | (1) |
| | (a) Phenol and benzoic acid in presence of NaOH. | |
| | (b) Phenol and benzoyl chloride in the presence of pyridine. | |
| | (c) Phenol and benzoyl chloride in the presence of $ZnCl_2$. | |
| | (d) Phenol and benzaldehyde in the presence of palladium. | |
| Q8. | Colloidion is a colloidal solution of : | (1) |

- (a) cellulose in ethyl alcohol (b) cellulose nitrate in water and ether
 (c) sucrose in water (d) cellulose nitrate in ethyl alcohol and ether

Questions 9 to 12 are one word questions:

- Q9. Which product is formed when MnO_2 is fused with KOH? (1)
- Q10. Out of the following ions, which one is colourless? (1)
 V^{3+} , Cr^{3+} , Sc^{3+} , Ni^{3+}
- Q11. Based on the type of particles of the dispersed phase, Sulphur sol is what type of colloid? (1)
- Q12. Name the polymer formed from ethylene glycol and terephthalic acid. (1)

The questions 13 to 15 consist of Assertion (A) and Reason (R). Use the following key to select the correct answer.

(a) If both assertion and reason are correct and reason is correct explanation for assertion.

(b) If both assertion and reason are correct but reason is not correct explanation for assertion.

(c) If assertion is correct but reason is incorrect.

(d) If assertion and reason both are incorrect.

- Q13. Assertion : Lyophilic sols are more stable than lyophobic sols.
 Reason : Lyophilic sols are more readily hydrated than lyophobic sols. (1)
- Q14. Assertion : $\Delta_f G^\ominus$ for the formation of Al_2O_3 and Cr_2O_3 involving one mole of oxygen are -827 kJ/mol and -540 kJ/mol respectively.
 Reason : Al can reduce Cr_2O_3 since more energy is liberated when Al_2O_3 is formed. (1)
- Q15. Assertion : Ce^{4+} is used as oxidizing agent in volumetric analysis.
 Reason: Ce^{4+} has the tendency to acquire +3 oxidation state. (1)

SECTION : B

- Q16. Write the products and give balanced equations for the following: (2)
 (a) $3MnO_4^{2-} + 4H^+ \text{ } \textcircled{B}$
 (b) $Cr_2O_7^{2-} + 8H^+ + 3H_2S \text{ } \textcircled{B}$
- Q17. (a) Why is adsorption always exothermic? (2)
 (b) Give the expression of Freundlich adsorption isotherm.
- Q18. (a) Give the IUPAC name of $CH_3CH_2COCH_2CH(CH_3)CH_2CHO$ (2)
 (b) Give chemical test to distinguish between acetaldehyde and benzaldehyde.

SECTION : C

- Q19. (a) A compound 'X' (C_2H_4O) on oxidation gives 'Y' ($C_2H_4O_2$). 'X' undergoes haloform reaction. On treatment with HCN, 'X' forms a product 'Z' which on hydrolysis gives 2-Hydroxy propanoic acid. (3)
 (i) Write down the products of 'X', 'Y' and 'Z'.
 (ii) Write the name of the product when 'X' reacts with dil NaOH.
 (b) Convert benzoic acid to benzaldehyde.

- Q20. (a) What is coagulation value? (3)
 (b) Define peptization.
 (c) Why does leather get hardened after tanning?
- Q21. (a) Write a short note on Clemmensen reduction. (3)
 (b) Give the mechanism of nucleophilic addition of OH^- in $RCHO$.

SECTION : D

- Q22. (a) Which site of enzyme is called allosteric site?
 (b) What is the chemical composition of cationic detergents?
 (c) Which class of drugs is used in sleeping pills? Write a short note on them.
 (d) Account for the following:
 (i) Aspirin is pain relieving antipyretic drug but can be used to prevent heart attack.
 (ii) Diabetic patients are advised to take artificial sweeteners instead of natural sweeteners.
- Q23. (a) An ore sample of galena (PbS) is contaminated with zinc blende (ZnS). (5)
 Name one chemical which can be used to concentrate galena selectively by froth floatation method.
 (b) Describe the role of :
 (i) SiO_2 in the extraction of copper from copper matte.
 (ii) Iodine in the refining of zirconium.
 Write chemical equations for the involved reactions.
 (c) The extraction of Au by leaching involves both oxidation and reduction. Justify giving equations.
- Q24. (a) Give reasons for the following: (5)
 (i) 4d and 5d series have higher enthalpies of atomization than 3d series.
 (ii) Transition metals and their many compounds act as good catalysts.
 (iii) Of the d^4 species, Cr^{2+} is strongly reducing while manganese (III) is strongly oxidising.
 (iv) The highest oxidation state is exhibited in oxo-anions of a metal.
 (c) Out of Cu_2Cl_2 and $CuCl_2$, which is more stable in water and why?

Question Bank for Second Term exam

- 1 Name the linkage connecting the monosaccharide units in polysaccharides. 1
- 2 Write the coordination number and oxidation state of Platinum in the complex $[\text{Pt}(\text{en})_2\text{Cl}_2]$ 1
 OR
 Draw the possible optical isomers of $[\text{CrCl}_2(\text{en})(\text{NH}_3)_2]^+$
- 3 What are thermoplastic and thermosetting polymers? 1
- 4 Complete the reaction:
 $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl} \xrightarrow{\text{CH}_3\text{CH}_2\text{OH}}$ 1
- 5 Which forces are involved in holding the drug to the active site of the enzymes? 1
- 6 (i) CO(g) and $\text{H}_2\text{(g)}$ react to give different products in the presence of different catalysts. Which ability of catalyst is shown in these reactions?
 (ii) Draw and write the expression of Freundlich adsorption isotherm. 2
- 7 Complete and balance the following equations: 2
 (i) $\text{Fe}^{2+} + \text{MnO}_4^- + \text{H}^+ \rightarrow$
 (ii) $\text{MnO}_4^- + \text{H}_2\text{O} + \text{I}^- \rightarrow$
- 8 $\text{CoSO}_4\text{Cl.5NH}_3$ exists in two isomeric forms 'A' and 'B'. Isomer 'A' reacts with AgNO_3 to give white precipitate, but does not react with BaCl_2 . Isomer 'B' gives white precipitate with BaCl_2 but does not react with AgNO_3 . Answer the following questions: 2

M/1 Page 1 of set 1

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- (i) Identify 'A' and 'B' and write their structural formulae.
(ii) Name the type of isomerism involved.

OR

FeSO_4 solution mixed with $(\text{NH}_4)_2\text{SO}_4$ solution in 1:1 molar ratio gives a test of Fe^{2+} but CuSO_4 solution mixed with aqueous ammonia in 1:4 molar ratio does not give a test of Cu^{2+} ion. Explain why?

9. (i) Write the IUPAC name of the following complex: $[\text{Co}(\text{NH}_3)_5(\text{CO}_3)]\text{NO}_3$. 2
(ii) Write the formula of the following coordination compound:
Iron(III)hexacyanoferate(II).
10. Describe the role of 2
(i) Cryolite in extraction of Aluminum from its ore.
(ii) Flux in metallurgy of iron.
11. How will you prepare 2
(i) K_2MnO_4 from MnO_2
(ii) $\text{Na}_2\text{Cr}_2\text{O}_7$ from Na_2CrO_4 ?
Write balanced chemical equations.
12. Describe how the following changes are brought about: 2
(i) Zinc oxide into metallic Zinc.
(ii) Impure Ti into pure Ti.
(i) Separate two sulphide ores by froth floatation process
(ii) Pig iron into steel.
13. (A), (B) and (C) are three non-cyclic isomers of a carbonyl compound with molecular formula $\text{C}_4\text{H}_8\text{O}$. Isomers (A) and (C) give positive Tollen's test whereas isomer (B) does not give Tollen's test but gives positive Iodoform test. Isomers (A) and (B) on reduction with $\text{Zn}(\text{Hg})/\text{conc. HCl}$ gives the same product D.
(i) Write the structures of (A), (B), (C) and (D).
(ii) Out of (A), (B) and (C) isomers, which one is most reactive towards addition of NaHSO_3 and why? 3
14. Write the chemical reactions involved in the process of extraction of gold. Explain the role of dilute NaCN and Zn in this process. 3
15. (i) Write one structural difference between low density polythene and high density polythene.
(ii) What is a biodegradable polymer? Give an example.
(iii) Arrange the following in increasing order of intermolecular forces:
Nylon6, Neoprene, Polyvinyl chloride 3

16. (i) Why is bithional added to soap? 3
(ii) What is tincture of iodine? Write its one use.
(iii) Among the following, which one acts as a food preservative?
Aspartame, Aspirin, Sodium Benzoate, Paracetamol
17. Define the following and give one example : 3
(i) Anionic detergents
(ii) Antimicrobials
(iii)Antioxidants
18. (i) Write the structures of the monomer and one use of the following polymers: 3
Nylon 6 and Polypropene
(ii) Write the structures of the monomers used for getting the polymers:
Melamine - formaldehyde polymer
19. Define the following with an example of each; 3
(i) Polysaccharides
(ii) Denatured proteins
(iii)Essential aminoacids
OR
(i) Write the product when D- Glucose reacts with bromine water.
(ii) Amino acids show amphoteric behaviour. Why?
(iii) Write one difference between α -helix and β -pleated structures of proteins.
20. What happens when 3
(i) a freshly prepared precipitate of Fe(OH)_3 is shaken with a small amount of FeCl_3 solution?
(ii) persistent dialysis of a colloidal solution is carried out?
(iii) size of dispersed phase changes in gold sol.
21. (i) What is the difference between a nucleotide and nucleoside? Mention two important functions of nucleic acids. 3
(ii) What is the deficiency disease caused by Vitamin A. Mention important sources of this vitamin.
22. (i) Why does acetylation of aniline reduce its activating effect? 3
(ii) Although amino group is o, p- directing in aromatic substitution reactions, aniline on nitration gives substantial amount of m- nitro aniline. Why?
(iii)Account for: $(\text{CH}_3)_2\text{NH}$ is more basic than $(\text{CH}_3)_3\text{N}$.
23. (i) Arrange in increasing order of boiling point: $\text{C}_2\text{H}_5\text{OH}$, $(\text{CH}_3)_2\text{NH}$, $\text{C}_2\text{H}_5\text{NH}_2$. 3
(ii) Draw structures of any two different isomers corresponding to the molecular formula $\text{C}_3\text{H}_9\text{N}$. Write the IUPAC names of the isomers. Will any of these isomers liberate nitrogen gas on treatment with nitrous acid?

24. (i) Why is adsorption process always exothermic? 3
(ii) What are shape selective catalysts? Give example.
(iii) What are the physical states of dispersed phase and dispersion medium in froth?
25. Give reason: 5
(i) E⁰ value for the Mn³⁺/Mn²⁺ couple is highly positive as compared to Fe³⁺/Fe²⁺.
(ii) Iron has high enthalpy of atomization than that of copper.
(iii) Sc³⁺ is colourless in aqueous solution whereas Ti³⁺ is coloured.
(iv) Actinoid contraction is greater from element to element than lanthanoid contraction.
(v) Cu⁺ ion is not stable in aqueous solution.

OR

- Suggest reasons for the following:
- (i) The lowest oxide of transition metal is basic, the highest is amphoteric/acidic.
(ii) A transition metal exhibits highest oxidation state in oxides and fluorides.
(iii) Transition metal forms interstitial compounds.
(iv) Of the d⁴ species, Cr²⁺ is strongly reducing while manganese(III) is strongly oxidising.
(v) Transition metals act as good catalysts.
26. (i) The hexaaquomanganese(II) ion contains 5 unpaired electrons while the hexacyanoion contains only one unpaired electron. Explain using crystal field theory in terms of t_{2g} and e_g configuration. 5
(ii) [NiCl₄]²⁻ is paramagnetic while [Ni(CO)₄] is diamagnetic though both are tetrahedral. Explain using Valence bond theory.

OR

- (i) A metal ion Mⁿ⁺ having d⁴ valence electronic configuration combines with three bidentate ligands to form a complex compound. Assuming Δo > P
a) Write the electronic configuration of the valence electrons of the metal Mⁿ⁺ ion in terms of t_{2g} and e_g.
b) What type of hybridization will Mⁿ⁺ ion have? Name the type of isomerism exhibited by this complex.
(ii) Write the hybridization and number of unpaired electrons in the complex [CoF₆]³⁻
27. (i) Draw the structure of semicarbazone of cyclobutanone. 5
(ii) Two moles of organic compound 'A' on treatment with a strong base gives two compounds 'B' and 'C'. Compound B on hydrogenation with Cu at 573K gives back 'A' while acidification of 'C' yields carboxylic acid 'D' having the formula of CH₂O₂. Identify the compound 'A', 'B', 'C' and 'D'.
(iii) Give chemical test to distinguish between : Ethanal and Propanone.
(iv) Convert : Ethanal to But-2-enoic acid .

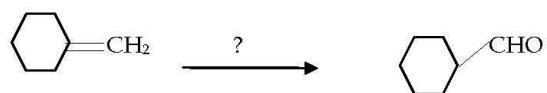
OR

Complete each synthesis by giving missing reagents or products:

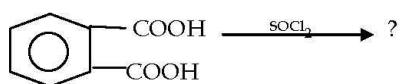
(i)



(ii)



(iii)



(iv)



(v)



Academic Session: 2019-20
Pre Board Examination
Subject: Chemistry
M/1/2

Time : 3 Hrs**Max marks : 70**

General Instructions:

- All questions are compulsory.
- Section A : Q.no. 1 to 20 are very short answer questions (objective type) and carry 1 mark each
- Section B : Q.no. 21 to 27 are short answer questions and carry 2 marks each.
- Section C: Q. no. 28 to 34 are long answer questions and carry 3 marks each.
- Section D: Q.no. 35 to 37 are also long answer questions and carry 5 marks each.
- There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks. You have to attempt only one of the choices in weightage such questions.
- Use log tables, if necessary. Use of calculators is not allowed.
- This paper has 7 printed sides.

SECTION : A

Read the given passage and answer the questions 1 to 5 that follow:

In case of solutions showing positive deviation from Raoult's law, at one of the intermediate composition, the total vapour pressure is the highest and the boiling point is the lowest. For liquid pairs of such intermediate compositions, the composition of the liquid and vapour phases is the same i.e the mixture distils over as if it were a pure liquid. This type of liquid mixture, having a definite composition, and boiling like a pure liquid is called a constant boiling mixture or an azeotropic mixture or simply azeotrope.

- (1) Give an example of mixture showing minimum boiling azeotrope.
- (2) What is the sign of enthalpy change , volume change in the case of positive deviation from Raoult's law
- (3) Define Raoult's law.
- (4) When does a mixture of two components show positive deviation from Raoult's law.
- (5) Draw a graph, showing positive deviation from Raoult's law

Questions 6 to 10 are one word answers:

- (6) Draw the structure of trans -[Pt(NH₃)₂Cl₂]
- (7) What is the structural difference between HDP and LDP?
- (8) Write IUPAC name of linkage isomer of [Co(NH₃)₅(ONO)]²⁺

- (9) What are glycosidic linkages? In which type of biomolecules are they present?
- (10) What is the role of pyridine in the acylation reaction of amines?

Questions 11 to 15 are multiple choice questions:

- (11) Extraction of gold and silver involves leaching the metal with CN⁻ ion. The metal is recovered by-----
- (a) Displacement of metal by some other metal from the complex ion
 - (b) Roasting of metal complex
 - (c) Calcination followed by roasting
 - (d) Thermal decomposition of metal complex.
- (12) In the preparation of compounds of Xe, Barlett had taken O₂⁺PtF₆⁻ as a base compound. This is because:
- (a) Both O₂ and Xe have same size
 - (b) Both O₂ and Xe have same electron gain enthalpy
 - (c) Both O₂ and Xe have almost same ionization enthalpy
 - (d) Both Xe and O₂ are gases.
- (13) The absorption maxima of several octahedral complex ions are as follows:

S.No.	Compound	λ _{max}
1	[Co(NH ₃) ₆] ³⁺	475
2	[Co(CN) ₆] ³⁺	310
3	[Co(H ₂ O) ₆] ³⁺	490

The crystal field splitting is maximum for :

- (a) [Co(NH₃)₆]³⁺
 - (b) [Co(CN)₆]³⁺
 - (c) [Co(H₂O)₆]³⁺
 - (d) All the complex ions have the same splitting , Δ_o
- (14) DNA and RNA contain four bases each. Which of the following is not present in RNA?
- (a) Adenine
 - (b) Uracil
 - (c) Thymine
 - (d) Cytosine

- (15) Which reagent will you use for the following reaction?
- $$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \xrightarrow{\hspace{1cm}} \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl} + \text{CH}_3\text{CH}_2\text{CHClCH}_3$$
- (a) Cl₂/UV light
 - (b) NaCl + H₂SO₄
 - (c) Cl₂ gas in dark
 - (d) Cl₂ gas in the presence of iron in dark

Questions 16 to 20 :

- (A) Both assertion and reason are correct statements, and reason is the correct explanations of the assertion.
- (B) Both assertion and reason are correct statements, and reason is not the correct explanations of the assertion.
- (C) Assertion is correct, but reason is wrong statement.
- (D) Assertion is wrong, but reason is correct statement.

(16) Assertion: Bond angle in ethers is slightly less than the tetrahedral angle.

Reason: There is repulsion between the two bulky (-R) groups

(17) Assertion: Polytetrafluoroethylene is used in making non stick cookwares.

Reason: Fluorine has highest electronegativity

(18) Assertion: KCN reacts with methyl chloride to give methyl isocyanide.

Reason: CN⁻ is an ambident nucleophile

(19) Assertion: D- (+)- Glucose is dextrorotatory in nature

Reason: 'D' represents the dextrorotatory nature.

(20) Assertion: Vitamin D can be stored in our body

Reason: Vitamin D is fat soluble vitamin.

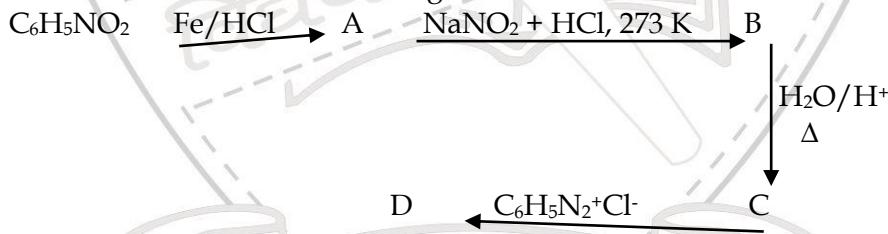
SECTION : B

(21) Write balanced chemical equations for the following processes:

(i) XeF₂ undergoes hydrolysis .

(ii) MnO₂ is heated with conc. HCl.

(22) Predict A, B,C, D in the following reaction:



(23) Show diagrammatically the splitting of degenerate d-orbitals in octahedral crystal field. Write the electronic configuration for a d⁷ metal ion considering a high spin complex.

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(24) Give reasons;

(i) CH₃NHCH₃ is more basic than CH₃CH₂NH₂

(ii) Although -NH₂ is o/p directing group, yet aniline on nitration gives a significant amount of m-nitroaniline.

- (25) Give reasons for the following observations:
- p-dichlorobenzene has higher melting point than those of o- and m-isomers.
 - The treatment of alkyl chloride with aqueous KOH leads to the formation of alcohol but in the presence of alcoholic KOH, alkene is the major product
- (26) (a) Why can't the molecularity of any reaction be equal to zero?
 (b) Define collision frequency

OR

- (27) Write the role of the following:
- CO in the purification of nickel
 - Graphite rod in the electrolytic reduction of aluminium.

OR

Describe the principle involved in each of the following processes:

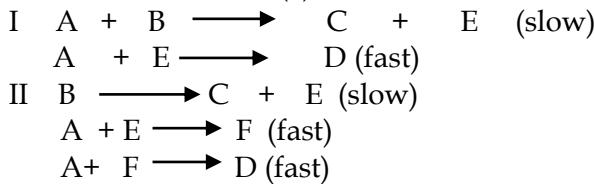
- Mond's process for refining of Nickel
- Column chromatography for purification of rare elements.

SECTION : C

- (28) Consider the reaction $2A + B \longrightarrow C + D$
 Following results were obtained in experiments designed to study the rate of the reaction

Exp. No.	Initial Concentration (mol L^{-1})		Initial rate formation [D] (M/min)
	[A]	[B]	
1	0.10	0.10	1.5×10^{-3}
2	0.20	0.20	3.0×10^{-3}
3	0.20	0.40	6.0×10^{-3}

- (a) Write the rate law for the reaction.
 (b) Calculate the value of rate constant for the reaction.
 (c) Which of the following possible reaction mechanisms is correct with the rate law found in (a)?



- (29) Calculate the mass of ascorbic acid (vitamin C, $C_6H_8O_6$) to be dissolved in 75 g of acetic acid to lower its melting point by 1.5°C . ($K_f = 3.9 \text{ K kg mol}^{-1}$) (At. Mass C=12 u, H=1u, O =16 u)

OR

Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0 g of polymer of molar mass 185,000 in 450 ml of water at 37°C . ($R = 8.314 \text{ J/mol/K}$)

- (30) Arrange the following in order of property indicated for each set:
- $\text{H}_2\text{O}, \text{H}_2\text{S}, \text{H}_2\text{Se}, \text{H}_2\text{Te}$ - increasing acidic character
 - $\text{HF}, \text{HCl}, \text{HBr}, \text{HI}$ -- decreasing bond enthalpy
 - $\text{F}_2, \text{Cl}_2, \text{Br}_2, \text{I}_2$ - oxidizing power
- (31) Write short note on:
- Wolff-kishner reaction
 - Cannizzaro reation
 - Hell volhard Zelinsky reaction
- (32)
- Which of the following electrodes is most effective for the coagulation of AgI/Ag^+ sol?
 $\text{MgCl}_2, \text{K}_2\text{SO}_4, \text{K}_4[\text{Fe}(\text{CN})_6]$
 - What happens when freshly prepared Fe(OH)_3 is shaken with a little amount of dilute solution of FeCl_3 .
 - Out of gold sol and starch , which one forms macromolecular colloids?
- (33)
- Write the mechanism of acid hydration of ethene to ethanol
 - Give the equation of reaction for the preparation of phenol from cumene.
- (34) Give reasons for the following:
- Use of aspartame as an artificial sweetener is limited to cold foods.
 - Metal hydroxides are better alternatives than sodium hydrogen carbonate for treatment of acidity.
 - Aspirin is used in prevention of heart attacks.

OR

Define the following with an example:

- Anionic detergents
- Broad spectrum antibiotic
- Antiseptic

SECTION :D

- (35) (a) Calculate the potential of hydrogen electrode in contact with a solution whose pH is 10.
 (b) Aqueous solution of copper sulphate and silver nitrate are electrolysed by 1 ampere current for 10 minutes in separate electrolytic cells. Will the mass of copper and silver deposited in the cathode be same or different? Explain your answer. (At mass Cu = 63.5 u, Ag = 108 u)

OR

- (a) The e.m.f of the following cell at 298 K is 0.1745 V.



$$\text{Given: } E^\circ_{\text{Fe}^{2+}/\text{Fe}} = -0.44 \text{ V}$$

Calculate the H⁺ ions concentration of the solution at the electrode where hydrogen is being produced.

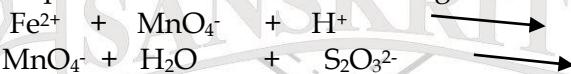
- (b) How much electricity is required in coulomb for the oxidation of 1mol of FeO to Fe₂O₃?

- (c) Predict the products of electrolysis when an aqueous solution of AgNO₃ is electrolysed using Platinum electrodes.

- (36) (a) When MnO₂ is fused with KOH in the presence of KNO₃ as an oxidising agent, it gives a dark green compound (A). Compound (A) disproportionates in acidic solution to give purple compound (B). An alkaline solution of compound (B) oxidises KI to compound (C) whereas an acidified solution of compound (B) oxidises KI to (D). Identify (A), (B), (C) and (D).
 (b) Give reasons for the following:
 (i) Transition metals form alloys.
 (ii) Mn₂O₃ is basic whereas Mn₂O₇ is acidic.
 (iii) Eu²⁺ is strong reducing agent.

OR

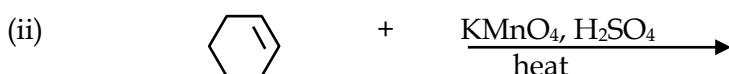
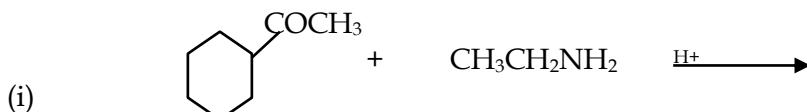
- (a) Complete and balance the following chemical equations:



- (b) Give reasons :

- (i) E° value for Mn³⁺/Mn²⁺ couple is much more positive than that for Fe³⁺/Fe²⁺.
 (ii) Iron has higher enthalpy of atomization than that of copper.
 (iii) Sc³⁺ is colourless in aqueous solution whereas Ti³⁺ is coloured.

- (37) (a) A compound A (C₂H₆O) on oxidation by PCC gave B, which on treatment with aqueous alkali and subsequent heating furnished C, B on oxidation by KMnO₄, forms a monobasic carboxylic acid with molar mass 60 g mol⁻¹. Deduce the structures of A, B, C.
 (b) Predict the products of the following reaction:

**OR**

(a) How the following conversions can be carried out?

- (i) Ethanol to Propanenitrile
- (ii) Benzene to 4-bromonitrobenzene
- (iii) Methylamine to N-methylbenzamide

(b) Complete the following reactions:

**SANSKRITI**

THE CIVIL SERVICES SCHOOL

Question Bank for Pre board Exam

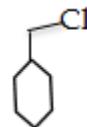
Section- A

- 1 Analysis shows that FeO has a non-stoichiometric composition with formula $\text{Fe}_{0.95}\text{O}$. 1
Give reason.

OR

The intermetallic compound LiAg crystallizes in cubic lattice in which both lithium and silver have coordination number of eight. What is the type of crystal lattice?

- 2 What is the reason for stability of lyophilic sols? 1
- 3 What type of isomers are $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$. 1
OR
Write the structures of geometrical isomers of complex ion $[\text{Co}(\text{en})_2\text{Cl}_2]^+$.
- 4 In the following pairs of halogen compounds, which would undergo $\text{S}_{\text{N}}2$ reaction faster? Explain. 1



- 5 Identify the monomers in the following polymer: 1
 $-\text{[NH-(CH}_2\text{)}_6\text{-NH-CO-(CH}_2\text{)}_4\text{-CO-]}_n$

Section - B

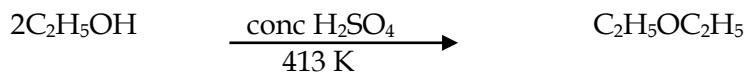
- 6 The rate constant for a first order reaction is 60 s^{-1} . How much time will it take to reduce 1 g of the reactant to 0.625 g? ($\log 1.6 = 0.204$) 2
- 7 Draw the molecular structures of the following : 2
 (a) Noble gas species which is isostructural with BrO_3^-
 (b) Dibasic oxoacid of phosphorus.
- 8 Calculate the freezing point of a solution containing 8.1 g of HBr in 100 g of water, assuming the acid to be 90% ionized. [Given : Molar mass HBr = 81 g/mol, K_f water = 1.86 K Kg/mol] 2

OR

Calculate the molality of ethanol solution in which the mole fraction of water is 0.88.

9. (a) Arrange the following in increasing order of Acidic character: 2
 $\text{MnO}_2, \text{Mn}_2\text{O}_3, \text{MnO}$
 (b) What happens when KMnO_4 is heated? Give chemical equation.

10. Explain the mechanism of the following reaction: 2



11. How will you bring about the following conversions? 2

- (a) Propanone to propane
- (b) Ethanal to but-2-enal

OR

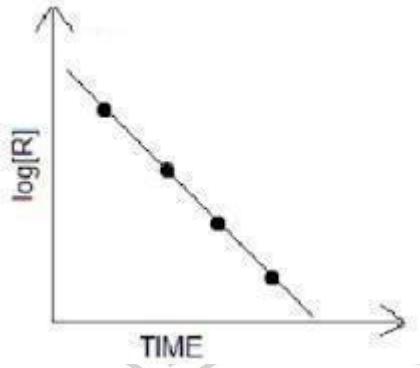
Give simple chemical tests to distinguish between the following pairs of compounds:

- (a) Ethanal and Propanal
- (b) Benzoic acid and Phenol

12. Name the type of polymerization involved in the formation of the following polymers from their respective monomers. Draw the structure of the polymer. 2

- (i) PVC
- (ii) Nylon 6

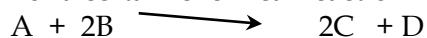
13. Observe the graph in diagram and answer the following questions 3



- (a) What is the order of the reaction?
- (b) If slope is equal to $-2.0 \times 10^{-6} \text{ sec}^{-1}$, what will be the value of rate constant?
- (c) Give the relationship between half life and its rate constant?

OR

For a certain chemical reaction



The experimentally obtained information is tabulated below.

Experiment	$[\text{A}]_0$ Moles/L	$[\text{B}]_0$ Moles/L	Initial Rate of reaction
------------	---------------------------	---------------------------	-----------------------------

			Moles/L/s
1	0.30	0.30	0.096
2	0.60	0.30	0.384
3	0.30	0.60	0.192
4	0.60	0.60	0.768

For this reaction

- (a) Derive the order of reaction w.r.t both the reactants A and B.
- (b) Write the rate law.

14. Give a reason for the following: 3
- (a) Rough surface of catalyst is more effective than smooth surface.
 - (b) Smoke passed through charged plates before allowing it to come out of chimneys in factories.
 - (c) Ne gets easily adsorbed over charcoal than He.
15. Niobium crystallises in body-centred cubic structure. If the atomic radius is 143.1 pm, calculate the density of Niobium. (Atomic mass of Niobium = 93 u). 3
16. (a) What process takes place when fruits are preserved by adding concentrated sugar solution to protect against bacterial action. 3
- (b) Give Reasons:
- (i) When 2 g of benzoic acid is dissolved in 25 g of benzene, the experimentally determined molar mass is always greater than the true value.
 - (ii) Mixture of chloroform and acetone shows negative deviation from Raoult's Law.
17. Account for the following facts: 3
- (a) The reduction of a metal oxide is easier if the metal formed is in the liquid state at the temperature of reduction.
 - (b) Limestone is used in the manufacture of pig iron from haematite.
 - (c) Pine oil is used in the froth floatation process used to concentrate sulphide ores.

OR

Describe how the following steps can be carried out?

- (a) Recovery of Gold from leached gold metal complex.
- (b) Conversion of Zirconium iodide to pure Zirconium,
- (c) Formation of slag in the extraction of copper.

(Write the chemical equations also for the reactions involved)

18. (a) Mn²⁺ compounds are more stable than Fe²⁺ towards oxidation to +3 state. 3
- (b) In 5d-transition series, which element is not regarded as transition metal and why?
- (c) Which bivalent cation in 3d-transition series is most paramagnetic and why?

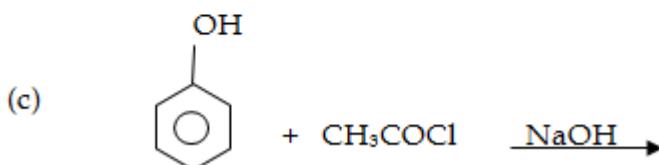
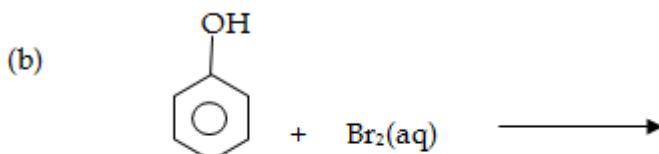
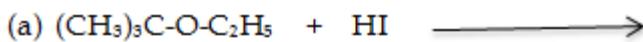
19. (a) Write IUPAC name of $[\text{Co}(\text{en})_3][\text{Cr}(\text{C}_2\text{O}_4)_3]$. 3
 (b) Discuss the hybridization, shape and magnetic behaviour of $[\text{Mn}(\text{CN})_6]^{4-}$.
 (Atomic number of Mn = 25)
20. Give reasons: 3
 (a) C-Cl bond length in chlorobenzene is shorter than C-Cl bond length in $\text{CH}_3\text{-Cl}$.
 (b) Grignard reagent is kept under anhydrous conditions.
 (c) $\text{S}_{\text{N}}1$ reactions are accompanied by racemisation in optically active alkyl halide.

OR

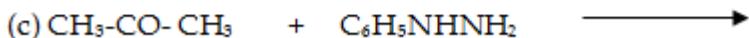
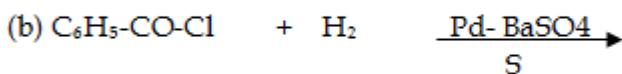
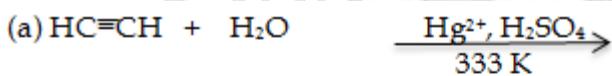
Give reasons:

- (a) n-Butyl bromide has higher boiling point than t- butyl bromide.
 (b) Racemic mixture is optically inactive.
 (c) The presence of nitro group ($-\text{NO}_2$) at o/p positions increases the reactivity of haloarenes towards nucleophilic substitution reactions.

21. Complete the following equations: 3



22. Complete the following reactions: 3



23. (a) Give one example of reducing sugar and one example of non-reducing sugar. 3
 (b) Give two differences between RNA and DNA.

OR

- (a) Which of the following biomolecule is insoluble in water? Justify.

Insulin, Haemoglobin , Keratin

- (b) Draw the Haworth structure for α -D-Glucopyranose.

- (c) Write chemical reaction to show that glucose contains aldehyde as carbonyl group.

24. Explain the following terms with one suitable example for each:

3

(a) A sweetening agent for diabetic patients

(b) Enzymes

(c) Analgesics

Section- D

25. (a) Given are the conductivities and molar conductivities of NaCl solutions at 298 K at different concentrations:

5

Concentration, M	Conductivity, Scm ⁻¹	Molar Conductivity S cm ² mol ⁻¹
0.100	106.74×10^{-4}	106.7
0.05	55.53×10^{-4}	111.1
0.02	23.15×10^{-4}	115.8

Compare the variation of conductivity and molar conductivity of NaCl on dilution. Give reason.

- (b) Silver is electrodeposited on a metallic vessel of total surface area 900 cm^2 by passing a current of 0.5 A for two hours. Calculate the thickness of silver deposited. [Given: density of Ag = 10.5 g cm^{-3} , Atomic mass of Ag = 108 u , $1F = 96500 \text{ C/mol}$]

OR

- (a) On the basis of the standard reduction potential values for following solution, predict whether Ti^{4+} species may be used to oxidise Fe^{2+} to Fe^{3+} .



- (b) Why is rusting of iron quicker in saline water than in ordinary water?

- (c) A copper-silver cell is set up. The copper ion concentration in it is 0.10 M . The conc. of Ag^+ is not known. The cell potential measured is 0.422 V . Determine $\log [\text{Ag}^+]$. [$E^\circ_{\text{Ag}^+/\text{Ag}} = +0.80 \text{ V}$, $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +0.34 \text{ V}$]

26. (a) Write down the equations for hydrolysis of XeF_4 and XeF_6 . Which of these two reactions is a Redox reaction?

5

- (b) Account for the following:

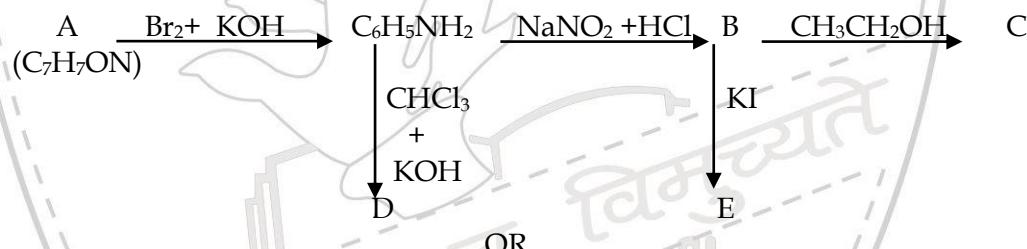
(i) F_2 is strongest oxidising agent among halogens.

(ii) Fluorine exhibits only -1 oxidation state whereas other halogens exhibit

- higher +ve oxidation state.
 (iii) Acidity of oxoacid of chlorine is $\text{HOCl} < \text{HOClO} < \text{HOClO}_2 < \text{HOClO}_3$

OR

- (a) Why does chlorine water lose its yellow colour on standing? How chlorine water has both oxidising and bleaching properties. Give reason
 (b) What happens when Cl_2 reacts with cold dilute solution of sodium hydroxide? Write equations only.
 (c) Account for the following:
 (i) H_3PO_2 and H_3PO_3 act as good reducing agents while H_3PO_4 does not.
 (ii) ICl is more reactive than I_2
- 27 An aromatic compound 'A' of molecular formula $\text{C}_7\text{H}_7\text{ON}$ undergoes a series of reactions as shown below. Write the structures of A, B, C, D and E in the following reactions:



- (a) Write the structures of main products when aniline reacts with the following reagents:
 (i) Br_2 Water
 (ii) HCl
 (iii) $(\text{CH}_3\text{CO})_2\text{O}$ /pyridine
 (b) Arrange the following in the increasing order of their boiling point:
 $\text{C}_2\text{H}_5\text{NH}_2, \text{C}_2\text{H}_5\text{OH}, (\text{CH}_3)_3\text{N}$
 (c) Give a simple chemical test to distinguish between the following pair of compounds:
 $(\text{CH}_3)_2\text{NH}$ and $(\text{CH}_3)_3\text{N}$

SAMPLE PAPER XII 2019-20

CHEMISTRY

Time : 3 hrs.**M. Marks : 70*****General Instructions***

- (a) All questions are compulsory.
- (b) Section A: Q.no. 1 to 20 are very short answer questions (objective type) and carry 1 mark each.
- (c) Section B: Q.no. 21 to 27 are short answer questions and carry 2 marks each.
- (d) Section C: Q.no. 28 to 34 are long answer questions and carry 3 marks each.
- (e) Section D: Q.no. 35 to 37 are also long answer questions and carry 5 marks each.
- (f) There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
- (g) Use log tables if necessary, use of calculators is not allowed.

SECTION - A

Read the given passage and answer the questions 1 to 5 that follow:

A Lead storage battery is the most important type of secondary cell having a lead anode and a grid of lead packed with PbO_2 as cathode. A 38% solution of sulphuric acid is used as electrolyte. (Density=1.294 g mL^{-1}) The battery holds 3.5 L of the acid. During the discharge of the battery, the density of H_2SO_4 falls to 1.139 g mL^{-1} . (20% H_2SO_4 by mass)

- (1) Write the reaction taking place at the cathode when the battery is in use.
- (2) How much electricity in terms of Faraday is required to carry out the reduction of one mole of PbO_2 ?
- (3) What is the molarity of sulphuric acid before discharge?
- (4) Lead storage battery is considered a secondary cell. Why?
- (5) Write the products of electrolysis when dilute sulphuric acid is electrolysed using Platinum electrodes.

Questions 6 to 10 are one word answers:

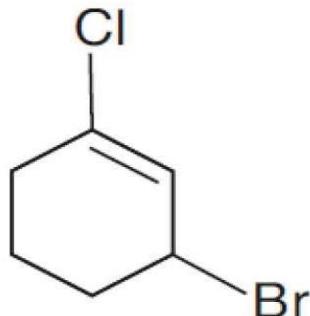
- (6) Name the substance used as depressant in the separation of two sulphide ores in Froth floatation method.
- (7) Name the unit formed by the attachment of a base to 1' position of sugar in a nucleoside.
- (8) Name the species formed when an aqueous solution of amino acid is dissolved in water?
- (9) What type of reaction occurs in the formation of Nylon 6,6 polymer?

(10) Which of the following compounds would undergo Cannizzaro reaction:

Benzaldehyde, Cyclohexanone, 2-Methylpentanal.

Questions 11 to 15 are multiple choice questions:

(11) The IUPAC name of the compound shown below is:



- (a) 2-bromo-6-chlorocyclohex-1-ene
 - (b) 6-bromo-2-chlorocyclohexene
 - (c) 3-bromo-1-chlorocyclohexene
 - (d) 1-bromo-3-chlorocyclohexene
- (12) When one mole of $\text{CoCl}_3 \cdot 5\text{NH}_3$ was treated with excess of silver nitrate solution, 2 mol of AgCl was precipitated. The formula of the compound is:
- (a) $[\text{Co}(\text{NH}_3)_5\text{Cl}_2]\text{Cl}$
 - (b) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
 - (c) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2](\text{NH}_3)\text{Cl}$
 - (d) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3](\text{NH}_3)_2$
- (13) The absorption maxima of several octahedral complex ions are as follows:

S.No	Compound	λ_{\max} nm
1	$[\text{Co}(\text{NH}_3)_6]^{3+}$	475
2	$[\text{Co}(\text{CN})_6]^{3-}$	310
3	$[\text{Co}(\text{H}_2\text{O})_6]^{3+}$	490

The crystal field splitting is maximum for :

- (a) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
- (b) $[\text{Co}(\text{CN})_6]^{3-}$
- (c) $[\text{Co}(\text{NH}_3)_6]^{3+}$

- (d) All the complex ions have the same splitting, Δ_o ,
- (14) Predict the number of ions produced per formula unit in an aqueous solution of $[\text{Co}(\text{en})_3]\text{Cl}_3$
- 4
 - 3
 - 6
 - 2
- (15) The incorrect statement about LDP is:
- It is obtained through the free radical addition of ethene.
 - It consists of linear molecules.
 - It is obtained by the H-atom abstraction.
 - Peroxide is used as an initiator.

Questions 16 to 20 :

- Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
- Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
- Assertion is correct, but reason is wrong statement.
- Assertion is wrong, but reason is correct statement.

16. Assertion: The two strands in double strand helix structure of DNA are complementary to each other

Reason: Disulphide bonds are formed between specific pairs of bases

17. Assertion: Glucose reacts with hydroxylamine to form an oxime and also adds a molecule of hydrogen cyanide to give cyanohydrin.

Reason: The carbonyl group is present in the open chain structure of glucose.

18. Assertion: The acidic strength of halogen acids varies in the order $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$

Reason: The bond dissociation enthalpy of halogen acids decreases in the order $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$

19. Assertion: $\text{C}_2\text{H}_5\text{OH}$ is a weaker base than phenol but is a stronger nucleophile than phenol. (1)

Reason: In phenol the lone pair of electrons on oxygen is withdrawn towards the ring due to resonance.

20. **Assertion:** Aryl halides undergo nucleophilic substitution reactions with ease.

Reason: The carbon halogen bond in aryl halides has partial double bonds character.

SECTION : B

21. Calculate the number of lone pairs on central atom in the following molecule and predict the geometry.

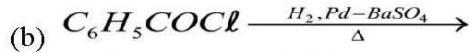


22. The rate of a reaction depends upon the temperature and is quantitatively expressed as

$$k = A e^{-E_a/RT}$$

- i) If a graph is plotted between $\log k$ and $1/T$, write the expression for the slope of the reaction?
 - ii) If at under different conditions E_{a1} and E_{a2} are the activation energy of two reactions. If $E_{a1} = 40 \text{ J/mol}$ and $E_{a2} = 80 \text{ J/mol}$. Which of the two has a larger value of the rate constant?
23. The experimentally determined molar mass for what type of substances is always lower than the true value when water is used as solvent. Explain. Give one example of such a substance and one example of a substance which does not show a large variation from the true value.

24. **Write structure of the products formed:**



25. Draw one of the geometrical isomers of the complex $[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$ which is optically inactive. Also write the name of this entity according to the IUPAC nomenclature.

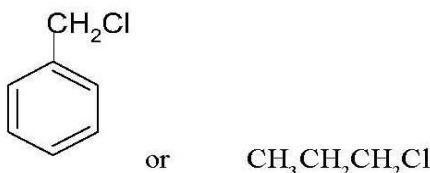
OR

Discuss the bonding in the coordination entity $[\text{CO}(\text{NH}_3)_6]^{3+}$ on the basis of valence bond theory. Also, comment on the geometry and spin of the given entity. (Atomic no. of Co = 27)

26. What is meant by Vapour phase refining? Write any one example of the process which illustrates this technique, giving the chemical equations involved.

OR

- Write and explain the reactions involved in the extraction of gold.
27. Which one of the following compounds will undergo hydrolysis at a faster rate by S_N1 mechanism? Justify.



SECTION: C

28. Calculate the freezing point of a solution containing 0.5 g KCl (Molar mass = 74.5 g/mol) dissolved in 100 g water, assuming KCl to be 92% ionized.
 K_f of water = 1.86 K kg / mol.
29. For the reaction A + B → products, the following initial rates were obtained at various given initial concentrations

S.No.	[A] mol / L	[B] mol / L	Initial rate M/s
1.	0.1	0.1	0.05
2.	0.2	0.1	0.10
3.	0.1	0.2	0.05

Determine the half-life period.

OR

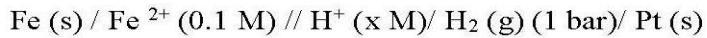
A first order reaction is 50 % complete in 50 minutes at 300 K and the same reaction is again 50 % complete in 25 minutes at 350 K. Calculate activation energy of the reaction.

30. Answer the following questions:
- Which of the following electrolytes is most effective for the coagulation of AgI/Ag⁺ sol?
 a. MgCl_2 , K_2SO_4 , $\text{K}_4[\text{Fe}(\text{CN})_6]$
 - What happens when a freshly precipitated $\text{Fe}(\text{OH})_3$ is shaken with a little amount of dilute solution of FeCl_3 .
 - Out of sulphur sol and proteins, which one forms macromolecular colloids?
31. Account for the following:
- Moist SO_2 decolourises KMnO_4 solution.

- b) In general interhalogen compounds are more reactive than halogens (except fluorine).
- c) Ozone acts as a powerful oxidizing agent
32. Identify the product formed when propan-1-ol is treated with Conc. H_2SO_4 at 413 K . Write the mechanism involved for the above reaction.
33. (a) Give chemical tests to distinguish between the following pairs of compounds:
- (i) Ethanal and Propanone.
 - (ii) Pentan-2-one and Pentan-3-one.
- (b) Arrange the following compounds in increasing order of their acid strength:
Benzoic acid, 4- Nitrobenzoic acid, 3,4-Dinitrobenzoic acid,
4- Methoxybenzoic acid.
- OR
- Compare the reactivity of benzaldehyde and ethanal towards nucleophilic addition reactions. Write the cross aldol condensation product between benzaldehyde and ethanal.
34. Define and write an example for the following :
- (a) Broad spectrum antibiotics.
- (b) Analgesics

SECTION: D

35. (a) The e.m.f. of the following cell at 298 K is 0.1745 V



$$\text{Given : } E_{\text{Fe}^{2+}/\text{Fe}}^{\circ} = -0.44V$$

Calculate the H^+ ions concentration of the solution at the electrode where hydrogen is being produced.

- (b) Aqueous solution of copper sulphate and silver nitrate are electrolysed by 1 ampere current for 10 minutes in separate electrolytic cells. Will the mass of copper and silver deposited on the cathode be same or different? Explain your answer.

OR

- (a) Calculate the degree of dissociation of 0.0024 M acetic acid if conductivity of this solution is $8.0 \times 10^{-5} \text{ S cm}^{-1}$.

Given $\lambda_{H^+}^\circ = 349.6 \text{ S cm}^2 \text{ mol}^{-1}$; $\lambda_{CH_3COO^-}^\circ = 40.9 \text{ S cm}^2 \text{ mol}^{-1}$

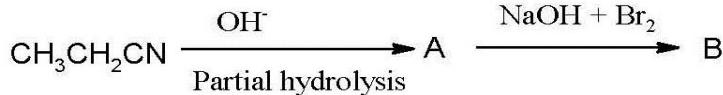
- (b) Solutions of two electrolytes ‘A’ and ‘B’ are diluted. The limiting molar conductivity of ‘B’ increases to a smaller extent while that of ‘A’ increases to a much larger extent comparatively. Which of the two is a strong electrolyte? Justify your answer.

36. An organic compound A' with molecular formula C₇H₇NO reacts with Br₂/aqKOH to give compound B', which upon reaction with NaNO₂ & HCl at 0°C gives C'. Compound C' on heating with CH₃CH₂OH gives a hydrocarbon D'. Compound B' on further reaction with Br₂ water gives white precipitate of compound E'. Identify the compound A, B, C, D&E; also justify your answer by giving relevant chemical equations.

OR

- (a) How will you convert:
- (i) Aniline into Fluorobenzene.
 - (ii) Benzamide into Benzylamine.
 - (iii) Ethanamine to N,N-Diethylethanamine.
- (b) Write the structures of A and B in the following:

i)



ii)



37. (a) When a chromite ore (A) is fused with an aqueous solution of sodium carbonate in free excess of air, a yellow solution of compound (B) is obtained. This solution is filtered and acidified with sulphuric acid to form compound (C). Compound (C) on treatment with solution of KCl gives orange crystals of compound (D). Write the chemical formulae of compounds A to D.

- (b) Describe the cause of the following variations with respect to lanthanoids and actinoids:

- (i) Greater range of oxidation states of actinoids as compared to lanthanoids.

- (ii) Greater actinoid contraction as compared to lanthanoid contraction.
- (iii) Lower ionisation enthalpy of early actinoids as compared to the early lanthanoids.

OR

(a) What happens when

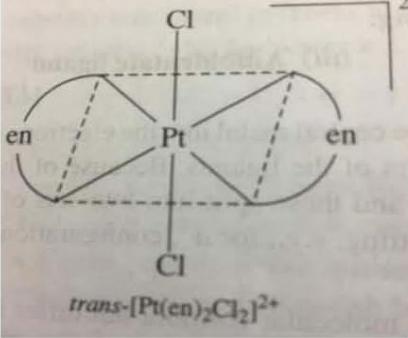
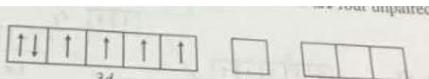
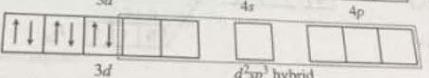
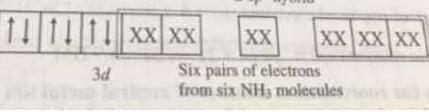
- (i) Manganate ions (MnO_4^{2-}) undergoes disproportionation reaction in acidic medium?
- (ii) Lanthanum is heated with Sulphur?

(b) Explain the following trends in the properties of the members of the First series of transition elements:

- (i) $E^\circ(M^{2+}/M)$ value for copper is positive(+0.34 V) in contrast to the other members of the series.
- (ii) Cr^{2+} is reducing while Mn^{3+} is oxidising, though both have d⁴ configuration.
- (iii) The oxidising power in the series increases in the order $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$.

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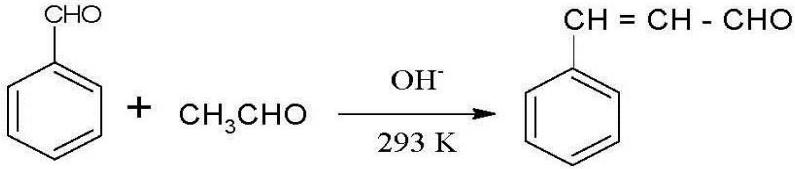
Q.No.	Value points	Marks
	SECTION:A	
1.	Reaction taking place at cathode when the battery is in use: $PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$	1
2.	2 F	1
3.	$Molarity = \frac{38 \times 1.294 \times 1000}{98 \times 100} = 5.02M$	1
4.	It can be recharged after use.	1
5.	At anode: O ₂ (g) At cathode: H ₂ (g)	$\frac{1}{2}$ $\frac{1}{2}$
6.	Sodium cyanide.	1
7.	Nucleotide	1
8.	Zwitterion / dipolar ion	1
9.	Condensation	1
10.	Benzaldehyde	1
11.	(c)	1
12.	(b)	1
13.	(b)	1
14.	(a)	1
15.	(b)	1
16.	(c)	1
17.	(a)	1
18.	(d)	1
19.	(d)	1
20.	(d)	1
	SECTION:B	
21.	Lone pairs : 2 Geometry : Square planar	1 1
22. (i)	$Slope = -\frac{E_a}{2.303 R}$	1
(ii)	$k_1 > k_2$	1
23.	When there is dissociation of solute into ions, in dilute solutions (ignoring interionic attractions) the number of particles increases. As the value of colligative properties depends on the number of particles of the solute , the experimentally observed value of colligative property will be higher than the true value, therefore the experimentally determined (observed) molar mass is always lower than the true value. For KCl(electrolyte) the experimentally determined molar mass is always	1 $\frac{1}{2}$

	lower than the true value when water is used as solvent. Glucose (non-electrolyte) does not show a large variation from the true value.	½
24. (a)	$\text{CH}_3\text{-CH(Cl)-COOH}$	1
(b)	$\text{C}_6\text{H}_5\text{CHO}$	1
25.	 $\text{trans-}[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$	1
	IUPAC Name of the entity: Dichloridobis(ethane-1,2-diamine)platinum(IV) ion	1
	OR	
	Bonding in $[\text{CO}(\text{NH}_3)_6]^{3+}$ d^2sp^3 hybridisation <i>i)</i> Atomic orbitals of Co (III) ion  <i>ii)</i> d^2sp^3 hybridised orbitals of Co (III) ion  Formation of $[\text{Co}(\text{NH}_3)_6]^{3+}$ 	½
	Geometry: Octahedral	½
	Diamagnetic	½
26.	Vapour phase refining: It is a refining method in which the metal is converted into its volatile compound and collected elsewhere. It is then decomposed to give pure metal. Example: Mond's Process for refining of Nickel / van Arkel method for refining of Zirconium	1

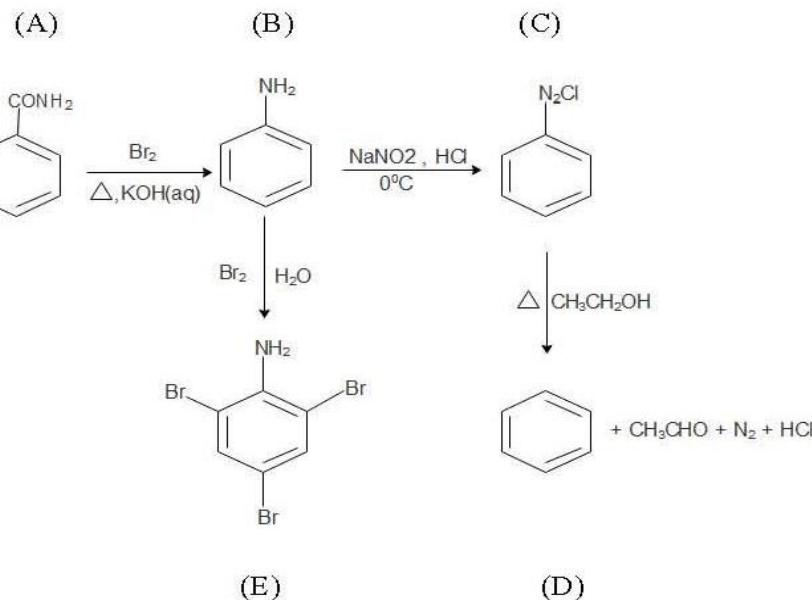
	<p>Equations involved:</p> $Ni + 4CO \xrightarrow{330-350K} Ni(CO)_4$ $Ni(CO)_4 \xrightarrow{450-470K} Ni + 4CO$ <p>OR</p> <p>Extraction of gold involves leaching the metal with CN^-</p> <p>Oxidation reaction:</p> $4 \text{ Au (s)} + 8 \text{ CN}^- \text{ (aq.)} + 2\text{H}_2\text{O (aq.)} + \text{O}_2 \text{ (g)} \rightarrow 4[\text{Au}(\text{CN})_2]^- \text{ (aq.)} + 4 \text{ OH}^- \text{ (aq.)}$ <p>The metal is recovered by displacement method:</p> $2[\text{Au}(\text{CN})_2]^- \text{ (aq.)} + \text{Zn (s)} \rightarrow 2 \text{ Au (s)} + [\text{Zn}(\text{CN})_4]^{2-} \text{ (aq.)}$ <p>Zinc acts as a reducing agent.</p>	$\frac{1}{2}$
27.	<p>The following compound will undergo S_N1 faster:</p> <p>CH_2Cl</p> <p>Greater the stability of the carbocation, greater will be its ease of formation from the corresponding halide and faster will be the rate of reaction. The benzylic carbocation formed gets stabilised through resonance.</p> <p>(i) </p> <p>(ii) </p> <p>(iii) </p> <p>(iv) </p> <p>(v) </p> <p>(vi) </p> <p>$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ forms a 1° carbocation, which is less stable than benzylic carbocation.</p>	$\frac{1}{2}$
	SECTION :C	
28.	$\text{KCl} \rightarrow \text{K}^+ + \text{Cl}^-$ $n=2$ $i = 1 - \alpha + n\alpha$ $i = 1 + \alpha$	$\frac{1}{2}$
		$\frac{1}{2}$
		$\frac{1}{2}$

	$\Delta T_f = iK_f m$ $= (1 + 0.92) \times 1.86 \times \frac{0.5 \times 1000}{74.5 \times 100}$ $\Delta T_f = 0.24$ $\Delta T_f = T_f^0 - T_f'$ $T_f' = -0.24 {}^\circ C$	$\frac{1}{2}$
29.	$rate = k [A]^x [B]^y$ $0.05 = k[0.1]^x [0.1]^y \quad \dots \dots (i)$ $0.10 = k[0.2]^x [0.1]^y \quad \dots \dots (ii)$ $0.05 = k[0.1]^x [0.2]^y \quad \dots \dots (iii)$ $(ii) \div (i)$ $\frac{0.10}{0.05} = (2)^x$ $x = 1$ $(iii) \div (i)$ $\frac{0.05}{0.05} = (2)^y$ $y = 0$ $rate = k[A]^1[B]^0$ <p>It is a first order reaction.</p> $k = \frac{rate}{[A]} = 0.5 s^{-1}$ $t_{\frac{1}{2}} = \frac{0.693}{k} = \frac{0.693}{0.5}$ $t_{\frac{1}{2}} = 1.386 s$	$\frac{1}{2}$
	OR	
	$t_{\frac{1}{2}} = \frac{0.693}{k}$ $k_2 = \frac{0.693}{25} \quad 350K$ $k_1 = \frac{0.693}{50} \quad 300K$ $\frac{k_2}{k_1} = 2$	$\frac{1}{2}$

	$\log \frac{k_2}{k_1} = \frac{E_a}{2.303 R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$ $\log 2 = \frac{E_a}{2.303 \times 8.314} \left[\frac{350 - 300}{350 \times 300} \right]$ <p>Ea = 12.104 kJ / mol.</p>	$\frac{1}{2}$ $\frac{1}{2}$ (1/2 +1/2)
30.		
(a)	K ₄ [Fe(CN) ₆]	1
(b)	Fe(OH) ₃ is converted into colloidal state by preferential adsorption of Fe ³⁺ ions.	1
(c)	Proteins	1
31.		
(a)	Moist sulphur dioxide behaves as a reducing agent, reduces MnO ₄ ⁻ to Mn ²⁺ .	1
(b)	X-X' bond in interhalogens is weaker than X-X bond in halogen except F-F bond.	1
(c)	Due to the ease with which it liberates atoms of nascent oxygen.	1
32.	<p>1-Propoxypropane is formed. Mechanism involved: Step 1: Formation of protonated alcohol</p> $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{H}^+ \xrightarrow{\text{H}_2\text{SO}_4} \text{CH}_3\text{CH}_2\text{CH}_2-\overset{\text{H}}{\underset{\text{H}}{\text{O}}}{}^+$ <p>Step 2: Nucleophilic attack</p> $\text{CH}_3\text{CH}_2\text{CH}_2-\overset{\text{H}}{\underset{\text{H}}{\text{O}}}{}^+ + \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{O}-\text{CH}_2\text{CH}_2\text{CH}_3 \longrightarrow \text{CH}_3\text{CH}_2\text{CH}_2-\overset{\text{H}}{\underset{\text{H}_2\text{O}}{\text{O}}}{}^+-\text{CH}_2\text{CH}_2\text{CH}_3$ <p>Step 3: Deprotonation</p> $\text{CH}_3\text{CH}_2\text{CH}_2-\overset{\text{H}}{\underset{\text{H}}{\text{O}}}{}^+-\text{CH}_3\text{CH}_2\text{CH}_2 \longrightarrow \text{CH}_3\text{CH}_2\text{CH}_2-\text{O}-\text{CH}_2\text{CH}_2\text{CH}_3 + \text{H}^+$ <p>1 – Propoxypropane</p>	1 $\frac{1}{2}$ 1 $\frac{1}{2}$
33.		
(a)		
(i)		

(ii)	Experiment	Ethanal	Propanone	
	<p>1. Tollen's Test: Warm the organic compound with freshly prepared ammonical silver nitrate solution (Tollen's reagent).</p> <p>2. Fehling's Test: Heat the organic compound with Fehling's reagent.</p> <p>Any one test</p>	A bright silver mirror is produced A reddish brown precipitate is obtained.	No silver mirror is formed. No precipitate is obtained	
(b)	Experiment	Pentan-2-one	Pentan-3-one	
	<p>Iodoform Test: The organic compound is heated with iodine in presence of sodium hydroxide solution.</p>	A yellow precipitate is obtained.	No yellow precipitate is obtained.	
	Or any other suitable test.		1	
	4- Methoxybenzoic acid < Benzoic acid < 4- Nitrobenzoic acid < 3,4-Dinitrobenzoic acid			
	OR			
	<p>The carbon atom of the carbonyl group of benzaldehyde is less electrophilic than carbon atom of the carbonyl group present in ethanal. The polarity of the carbonyl group is reduced in benzaldehyde due to resonance hence less reactive than ethanal.</p>		1	
			1	
34.	(a)	<p>Broad spectrum antibiotics: Antibiotics which kill or inhibit a wide range of Gram-positive and Gram-negative bacteria. e.g. Chloramphenicol.</p>		1
		<p>any other suitable example. Analgesics:</p>		½

36.



5

(1/2 x 5 marks for structure and 1/2 x 5 for writing equations)

OR

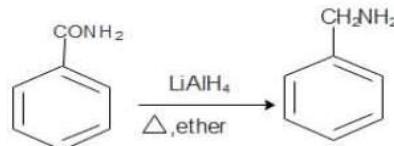
(a)

(i)



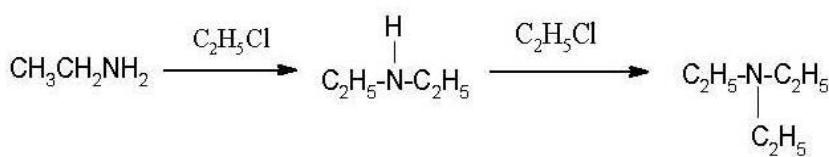
1

(ii)



1

(iii)



1

(b)

(i)

A : $\text{CH}_3\text{CH}_2\text{CONH}_2$
B : $\text{CH}_3\text{CH}_2\text{NH}_2$

1/2

1/2

(ii)

1/2

1/2

	A: CH ₃ CH ₂ CH ₂ NH ₂ B:CH ₃ CH ₂ CH ₂ OH	
37.		
(a)	A = FeCr ₂ O ₄ B = Na ₂ CrO ₄ C = Na ₂ Cr ₂ O ₇ D = K ₂ Cr ₂ O ₇	(1/2x 2)
(b)		
(i)	5f, 6d and 7s levels in actinoids are of comparable energies.	1
(ii)	This is due to poorer shielding by 5f electrons in actinoids as compared to shielding by 4f electrons in lanthanoids.	1
(iii)	In actinoids, 5f electrons are more effectively shielded from the nuclear charge than the 4f electrons of the corresponding lanthanoids. Since the outer electrons are less firmly held, they are available for bonding in the actinoids.	1
	OR	
(a)		
(i)	MnO ₄ ²⁻ ions disproportionate in acidic medium to give Permanganate ions and Manganese(IV) oxide.	½
	$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$	½
(ii)	Lanthanum sulphide if formed. $2La + 3S \xrightarrow{\text{heat}} La_2S_3$ (Deduct overall ½ mark if equation not balanced/ statements not written)	½ ½ ½
(b)		
(i)	Copper has high enthalpy of atomisation and low enthalpy of hydration. Since the high energy to transform Cu(s) to Cu ²⁺ (aq) is not balanced by hydration enthalpy, therefore $E^\circ(M^{2+}/M)$ value for copper is positive(+0.34 V).	1
(ii)	Cr ²⁺ is reducing as its configuration changes from d ⁴ to d ³ , the latter having more stable half filled t _{2g} level. On the other hand, the change from Mn ³⁺ to Mn ²⁺ results in extra stable d ⁵ configuration.	1

(iii)	This is due to the increasing stability of the species of lower oxidation state to which they are reduced.	1

COMMON LOGARITHMIC TABLES $\log_{10} x$

x	0	1	2	3	4	5	6	7	8	9	Δ	1	2	3	4	5	6	7	8	9
											+				A	D	D			
10	0.0000	0043	0086	0128	0170	0212					42	4	8	13	17	21	25	29	34	38
11	0.0414	0453	0492	0531	0569	0607	0253	0294	0334	0374	40	4	8	12	16	20	24	28	32	36
12	0.0792	0828	0864	0899	0934	0969	0645	0682	0719	0755	37	4	7	11	15	19	22	26	30	33
13	0.1139	1173	1206	1239	1271	1303	1004	1038	1072	1106	34	3	7	10	14	17	20	24	27	31
14	0.1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	30	3	6	9	12	15	18	21	24	27
15	0.1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	28	3	6	8	11	14	17	20	22	25
16	0.2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	26	3	5	8	10	13	16	18	21	23
17	0.2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	25	3	5	8	10	13	15	18	20	23
18	0.2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	24	2	5	7	10	12	14	17	19	22
19	0.2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	22	2	4	7	9	11	13	15	18	20
20	0.3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	21	2	4	6	8	11	13	15	17	19
21	0.3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	20	2	4	6	8	10	12	14	16	18
22	0.3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	19	2	4	6	8	10	11	13	15	17
23	0.3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	18	2	4	5	7	9	11	13	14	16
24	0.3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	18	2	4	5	7	9	11	13	14	16
25	0.3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	17	2	3	5	7	9	10	12	14	15
26	0.4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	16	2	3	5	6	8	10	11	13	14
27	0.4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	16	2	3	5	6	8	10	11	13	14
28	0.4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	15	2	3	5	6	8	9	11	12	14
29	0.4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	15	2	3	5	6	8	9	11	12	14
30	0.4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	14	1	3	4	6	7	8	10	11	13
31	0.4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	14	1	3	4	6	7	8	10	11	13
32	0.5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	13	1	3	4	5	7	8	9	10	12
33	0.5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	13	1	3	4	5	7	8	9	10	12
34	0.5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	13	1	3	4	5	7	8	9	10	12
35	0.5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	12	1	2	4	5	6	7	8	10	11
36	0.5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	12	1	2	4	5	6	7	8	10	11
37	0.5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	12	1	2	4	5	6	7	8	10	11
38	0.5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	11	1	2	3	4	6	7	8	9	10
39	0.5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	11	1	2	3	4	6	7	8	9	10
40	0.6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	11	1	2	3	4	6	7	8	9	10
41	0.6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	10	1	2	3	4	5	6	7	8	9
42	0.6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	10	1	2	3	4	5	6	7	8	9
43	0.6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	10	1	2	3	4	5	6	7	8	9
44	0.6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	10	1	2	3	4	5	6	7	8	9
45	0.6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	10	1	2	3	4	5	6	7	8	9
46	0.6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	9	1	2	3	4	5	5	6	7	8
47	0.6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	9	1	2	3	4	5	5	6	7	8
48	0.6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	9	1	2	3	4	5	5	6	7	8
49	0.6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	9	1	2	3	4	5	5	6	7	8
50	0.6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	9	1	2	2	3	4	5	6	6	7
51	0.7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	8	1	2	2	3	4	5	6	6	7
52	0.7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	8	1	2	2	3	4	5	6	6	7

COMMON LOGARITHMIC TABLES

 $\log_{10} x$

x	0	1	2	3	4	5	6	7	8	9	Δ	1	2	3	4	5	6	7	8	9
											+				A	D	D			
53	0.7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	8	1	2	2	3	4	5	6	6	7
54	0.7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	8	1	2	2	3	4	5	6	6	7
55	0.7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	8	1	2	2	3	4	5	6	6	7
56	0.7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	8	1	2	2	3	4	5	6	6	7
57	0.7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	8	1	2	2	3	4	5	6	6	7
58	0.7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	8	1	2	2	3	4	5	6	6	7
59	0.7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	7	1	1	2	3	4	4	5	6	6
60	0.7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	7	1	1	2	3	4	4	5	6	6
61	0.7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	7	1	1	2	3	4	4	5	6	6
62	0.7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	7	1	1	2	3	4	4	5	6	6
63	0.7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	7	1	1	2	3	4	4	5	6	6
64	0.8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	7	1	1	2	3	4	4	5	6	6
65	0.8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	7	1	1	2	3	4	4	5	6	6
66	0.8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	7	1	1	2	3	4	4	5	6	6
67	0.8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	6	1	1	2	2	3	4	4	5	5
68	0.8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	6	1	1	2	2	3	4	4	5	5
69	0.8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	6	1	1	2	2	3	4	4	5	5
70	0.8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	6	1	1	2	2	3	4	4	5	5
71	0.8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	6	1	1	2	2	3	4	4	5	5
72	0.8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	6	1	1	2	2	3	4	4	5	5
73	0.8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	6	1	1	2	2	3	4	4	5	5
74	0.8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	6	1	1	2	2	3	4	4	5	5
75	0.8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	6	1	1	2	2	3	4	4	5	5
76	0.8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	6	1	1	2	2	3	4	4	5	5
77	0.8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	6	1	1	2	2	3	4	4	5	5
78	0.8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	6	1	1	2	2	3	4	4	5	5
79	0.8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	6	1	1	2	2	3	4	4	5	5
80	0.9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	5	1	1	2	2	3	3	4	4	5
81	0.9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	5	1	1	2	2	3	3	4	4	5
82	0.9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	5	1	1	2	2	3	3	4	4	5
83	0.9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	5	1	1	2	2	3	3	4	4	5
84	0.9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	5	1	1	2	2	3	3	4	4	5
85	0.9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	5	1	1	2	2	3	3	4	4	5
86	0.9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	5	1	1	2	2	3	3	4	4	5
87	0.9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	5	1	1	2	2	3	3	4	4	5
88	0.9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	5	1	1	2	2	3	3	4	4	5
89	0.9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	5	1	1	2	2	3	3	4	4	5
90	0.9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	5	1	1	2	2	3	3	4	4	5
91	0.9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	5	1	1	2	2	3	3	4	4	5
92	0.9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	5	1	1	2	2	3	3	4	4	5
93	0.9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	5	1	1	2	2	3	3	4	4	5
94	0.9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	5	1	1	2	2	3	3	4	4	5
95	0.9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	5	1	1	2	2	3	3	4	4	5
96	0.9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	4	0	1	1	2	2	2	3	3	4
97	0.9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	4	0	1	1	2	2	2	3	3	4
98	0.9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	4	0	1	1	2	2	2	3	3	4
99	0.9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	4	0	1	1	2	2	2	3	3	4

ANTILOGARITHMS 10^x

x	0	1	2	3	4	5	6	7	8	9	Δ	1	2	3	4	5	6	7	8	9
											+				A	D	D			
0.00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	2	0	0	1	1	1	1	1	2	2
0.01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	2	0	0	1	1	1	1	1	2	2
0.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	2	0	0	1	1	1	1	1	2	2
0.03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	2	0	0	1	1	1	1	1	2	2
0.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	3	0	1	1	1	2	2	2	2	3
0.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	3	0	1	1	1	2	2	2	2	3
0.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	3	0	1	1	1	2	2	2	2	3
0.07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	3	0	1	1	1	2	2	2	2	3
0.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	3	0	1	1	1	2	2	2	2	3
0.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	3	0	1	1	1	2	2	2	2	3
0.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	3	0	1	1	1	2	2	2	2	3
0.11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	3	0	1	1	1	2	2	2	2	3
0.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	3	0	1	1	1	2	2	2	2	3
0.13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	3	0	1	1	1	2	2	2	2	3
0.14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	3	0	1	1	1	2	2	2	2	3
0.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	3	0	1	1	1	2	2	2	2	3
0.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	3	0	1	1	1	2	2	2	2	3
0.17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	4	0	1	1	2	2	2	3	3	4
0.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	4	0	1	1	2	2	2	3	3	4
0.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	4	0	1	1	2	2	2	3	3	4
0.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	4	0	1	1	2	2	2	3	3	4
0.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	4	0	1	1	2	2	2	3	3	4
0.22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	4	0	1	1	2	2	2	3	3	4
0.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	4	0	1	1	2	2	2	3	3	4
0.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	4	0	1	1	2	2	2	3	3	4
0.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	4	0	1	1	2	2	2	3	3	4
0.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	4	0	1	1	2	2	2	3	3	4
0.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	4	0	1	1	2	2	2	3	3	4
0.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	4	0	1	1	2	2	2	3	3	4
0.29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	4	0	1	1	2	2	2	3	3	4
0.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	5	1	1	2	2	3	3	4	4	5
0.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	5	1	1	2	2	3	3	4	4	5
0.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	5	1	1	2	2	3	3	4	4	5
0.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	5	1	1	2	2	3	3	4	4	5
0.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	5	1	1	2	2	3	3	4	4	5
0.35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	5	1	1	2	2	3	3	4	4	5
0.36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	5	1	1	2	2	3	3	4	4	5
0.37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	6	1	1	2	2	3	4	4	5	5
0.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	6	1	1	2	2	3	4	4	5	5
0.39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	6	1	1	2	2	3	4	4	5	5
0.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	6	1	1	2	2	3	4	4	5	5
0.41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	6	1	1	2	2	3	4	4	5	5
0.42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	6	1	1	2	2	3	4	4	5	5
0.43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	6	1	1	2	2	3	4	4	5	5
0.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	6	1	1	2	2	3	4	4	5	5
0.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	7	1	1	2	3	4	4	4	5	6
0.46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	7	1	1	2	3	4	4	4	5	6
0.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	7	1	1	2	3	4	4	4	5	6
0.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	7	1	1	2	3	4	4	4	5	6
0.49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	7	1	1	2	3	4	4	4	5	6

x	ANTILOGARITHMS 10^x										Δ	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9										
0.50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	7	1	1	2	3	4	4	5	6	6
0.51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	8	1	2	2	3	4	5	6	6	7
0.52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	8	1	2	2	3	4	5	6	6	7
0.53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	8	1	2	2	3	4	5	6	6	7
0.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	8	1	2	2	3	4	5	6	6	7
0.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	8	1	2	2	3	4	5	6	6	7
0.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	8	1	2	2	3	4	5	6	6	7
0.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	9	1	2	3	4	5	5	6	7	8
0.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	9	1	2	3	4	5	5	6	7	8
0.59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	9	1	2	3	4	5	5	6	7	8
0.60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	9	1	2	3	4	5	5	6	7	8
0.61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	10	1	2	3	4	5	6	7	8	9
0.62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	10	1	2	3	4	5	6	7	8	9
0.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	10	1	2	3	4	5	6	7	8	9
0.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	10	1	2	3	4	5	6	7	8	9
0.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	10	1	2	3	4	5	6	7	8	9
0.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	11	1	2	3	4	6	7	8	9	10
0.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	11	1	2	3	4	6	7	8	9	10
0.68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	11	1	2	3	4	6	7	8	9	10
0.69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	11	1	2	3	4	6	7	8	9	10
0.70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	12	1	2	4	5	6	7	8	10	11
0.71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	12	1	2	4	5	6	7	8	10	11
0.72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	12	1	2	4	5	6	7	8	10	11
0.73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	12	1	2	4	5	6	7	8	10	11
0.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	13	1	3	4	5	7	8	9	10	12
0.75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	13	1	3	4	5	7	8	9	10	12
0.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	13	1	3	4	5	7	8	9	10	12
0.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	14	1	3	4	6	7	8	10	11	13
0.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	14	1	3	4	6	7	8	10	11	13
0.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	14	1	3	4	6	7	8	9	10	12
0.80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	15	2	3	5	6	8	9	11	12	14
0.81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	15	2	3	5	6	8	9	11	12	14
0.82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	15	2	3	5	6	8	9	11	12	14
0.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	16	2	3	5	6	8	10	11	13	14
0.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	16	2	3	5	6	8	10	11	13	14
0.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	16	2	3	5	6	8	10	11	13	14
0.86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	17	2	3	5	7	9	10	12	14	15
0.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	17	2	3	5	7	9	10	12	14	15
0.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	18	2	4	5	7	9	11	13	14	16
0.89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	18	2	4	5	7	9	11	13	14	16
0.90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	18	2	4	5	7	9	11	13	14	16
0.91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	19	2	4	6	8	10	11	13	15	17
0.92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	19	2	4	6	8	10	11	13	15	17
0.93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	20	2	4	6	8	10	12	14	16	18
0.94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	20	2	4	6	8	10	12	14	16	18
0.95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	21	2	4	6	8	11	13	15	17	19
0.96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	21	2	4	6	8	11	13	15	17	19
0.97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	22	2	4	7	9	11	13	15	17	19
0.98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	22	2	4	7	9	11	13	15	17	19
0.99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	23	2	5	7	9	12	14	16	18	21