केंद्रीय विद्यालय संगठन

एरणाकुलम संभाग

KENDRIYA VIDYALAYA SANGATHAN

ERNAKULAM REGION

STUDENT SUPPORT MATERIAL

CHEMISTRY

CLASS XII

SESSION 2021-22

आर सेन्दिल कुमार
उपायुक्त

R. Senthil Kumar
Deputy Commissioner

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Message

I feel immense pleasure to publish the study material for class XII (Chemistry). This support material is prepared incorporating all the recent changes in curriculum and assessment process made by CBSE. I am sure it will definitely be of great help to class XII students of all Kendriya Vidyalayas.

Getting acquainted with the latest changes will help students to prepare well for the board examination and enable students to face case based and Multiple-Choice Questions with confidence. This support material has been prepared by a team of dedicated and veteran teachers with expertise in their respective subjects.

The Support material contains all the important aspects required by the students- the design of question paper, term wise split up syllabus, summary of all the chapters, important formulae, Sample question papers, problem solving and Case study questions.

I hope that this Support Material will be used by students and teachers as well and will prove to be a good tool for quick revision.

I would like to express my sincere gratitude to the In- charge principal and all the teachers who have relentlessly worked for the preparation of this study material. Their enormous contribution in making this project successful is praiseworthy.

Meticulous planning blended with hard work, effective time management and sincerity will help the students to reach the pinnacle of success.

Wish you all the best

(R Senthil Kumar)

Mr. G Sasi Kumar
Principal
Kendriya Vidyalaya
Kollam

STUDENT SUPPORT MATERIAL

CHEMISTRY

OUR PATRON

Shri. R Senthil Kumar
Deputy Commissioner
KVS RO, Ernakulam Region

OUR MENTORS

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Assistant Commissioner
KVS RO, Ernakulam

Shri. Santhosh Kumar N
Assistant Commissioner
KVS RO, Ernakulam

CO-ORDINATOR

Shri. G Sasikumar
Principal, Kendriya Vidyalaya Kollam

CONTENT DEVELOPMENT TEAM

S No	Name of the teacher	Designation	Name of the KV
1	Mr Praveen Kumar	PGT Chemistry	KV Kanhangad
2	Ms Anitha K George	PGT Chemistry	KV Keltron Nagar
3	Mr Sajeesh Kumar T V	PGT Chemistry	KV Payyannur
4	Mr Pramod N T	PGT Chemistry	KV Payyannur
5	Ms Ajitha A	PGT Chemistry	KV Kannur
6	Mr Purushothaman V	PGT Chemistry	KV No.1 Calicut
7	Ms Raseena M	PGT Chemistry	KV Kalpetta
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10	Mr P A Shadananan	PGT Chemistry	KV NAD Aluva
11	Ms Sulekha Rani	PGT Chemistry	KV INS Dronacharya
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13	Ms Raji K J	PGT Chemistry	KV Port Trust
14	Ms Marriette P Sebastian	PGT Chemistry	KV Rubber Board Kottayam
15	Ms Divya S	PGT Chemistry	KV Adoor
16	Ms. Suchitra Surendran	PGT Chemistry	KV Adoor
17	Mr Pratheesh N	PGT Chemistry	KV SAP Peroorkada
18	Ms Santha D	PGT Chemistry	KV Pattom (Shift-1)
19	Mr Vinu T Rao	PGT Chemistry	KV Pattom (Shift-1)

CONTENT REVIEW TEAM

S No	Name of the teacher	Designation	Name of the KV
1	Ms Shyla P	PGT Chemistry	KV Port Trust
2	Mr Sumesh M S	PGT Chemistry	KV Port Trust
3	Ms Raji K J	PGT Chemistry	KV Port Trust
4	Mr Sibu John	PGT Chemistry	KV Kollam

INDEX

CHEMISTRY SYLLABUS FOR SESSION 2021-22
CLASS XII Term-I

S.No	UNIT	Periods	MARKS
1	Solid State	8	10
2	Solutions	8	
3	p-Block Elements	7	10
4	Haloalkanes and Haloarenes	9	15
5	Alcohols, Phenols and Ethers	9	
6	Biomolecules	8	
	TOTAL	49	35

Solid State: 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.

Solutions: Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, Raoult's law, colligative properties - relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties.

p Block Elements: 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.
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: 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.

Haloalkanes and Haloarenes: Haloalkanes: Nomenclature, nature of C–X bond, physical and chemical properties, optical rotation mechanism of substitution reactions.
Haloarenes: Nature of C–X bond, substitution reactions (Directive influence of halogen in monosubstituted compounds only).

Alcohols, Phenols and Ethers: Alcohols: Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only), identification of primary, secondary and tertiary alcohols, mechanism of dehydration.
Phenols: Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophillic substitution reactions, uses of phenols.
Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses.

Biomolecules: Carbohydrates - Classification (aldoses and ketoses), monosaccahrides (glucose and fructose), D-L configuration
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.
Nucleic Acids: DNA and RNA

PRACTICALS

Term I: **A 15-mark Practical** would be conducted under the supervision of subject teacher/ internal examiner. This would contribute to the overall practical marks for the subject.

OR

In case the situation of lockdown continues until Nov-Dec 2021, a *Practical Based Assessment (pen-paper) of 15 marks* would be conducted at the end of Term I at the school level and marks would be submitted by the schools to the Board. This would contribute to the overall practical marks for the subject.

Term-I Evaluation Scheme

S. No	Practical	Marks
1.	Volumetric Analysis	4
2.	Salt Analysis	4
3.	Content Based experiment	2
4.	Class record and viva(Internal Examiner)	5
	TOTAL	15

(1) Volumetric analysis (4 marks)

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).

(2) Salt analysis (Qualitative analysis) (4 marks)

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

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

Anions – $(CO_3)^{2-}$, S^{2-} , NO_2^- , SO_3^{2-} , SO_4^{2-} , NO_3^-, Cl^- , Br^- , I^- , PO_4^{3-} , $C_2O_4^{2-}$,CH_3COO^- (Note: Insoluble salts excluded)

(3) Content Based Experiments (2 marks)

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

B. Characteristic tests of carbohydrates, fats and proteins in pure samples and their detection in given foodstuffs.

SYLLABUS FOR SESSION 2021-22 CLASS XII Term-II

S.No	UNIT	No. of Periods	MARKS
1	Electrochemistry	7	13
2	Chemical Kinetics	5	
3	Surface Chemistry	5	
4	d-and f-Block Elements	7	9
5	Coordination Compounds	8	
6	Aldehydes, Ketones and Carboxylic Acids	10	13
7	Amines	7	
	TOTAL	49	35

Electrochemistry: Redox reactions, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, Relation between Gibbs energy change and EMF of a cell, conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's Law, electrolysis.

Chemical Kinetics: 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).

Surface Chemistry: Adsorption - physisorption and chemisorption, factors affecting adsorption of gases on solids, colloidal state: distinction between true solutions, colloids and suspension; lyophilic, lyophobic, multi-molecular and macromolecular colloids; properties of colloids; Tyndall effect, Brownian movement, electrophoresis, coagulation.

d-and f-Block Elements: 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.
Lanthanoids - Electronic configuration, oxidation states and lanthanoid contraction and its consequences.

Coordination Compounds: Coordination compounds - Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds. Bonding, Werner's theory, VBT, and CFT.

Aldehydes, Ketones and Carboxylic Acids: 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.

Amines:

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

PRACTICALS

Term II: At the end of Term II, **a 15-mark Practical** would be conducted under the supervision of Board appointed external examiners. This would contribute to the overall practical marks for the subject.

OR

In case the situation of lockdown continues beyond December 2021, a *Practical Based Assessment (pen-paper) of 10 marks and Viva 5 marks* would be conducted at the end of Term II jointly by the external and internal examiners and marks would be submitted by the schools to the Board. This would contribute to the overall practical marks for the subject.

TERM-II Evaluation Scheme

S. No	Practical	Marks
1.	Volumetric Analysis	4
2.	Salt Analysis	4
3	Content Based Experiment	2
4	Project Work and Viva(Internal and External Both)	5
	TOTAL	15

1) **Volumetric analysis (4 marks)**
   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).

2) **Salt analysis (Qualitative analysis) (4 marks)**
   Determination of one cation and one anion in a given salt.

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

   Anions – $(CO_3)^{2-}$, S^{2-} , NO_2^- , SO_3^{2-} , SO_4^{2-} , NO_3^-, Cl^- , Br^- , I^- , PO_4^{3-} , $C_2O_4^{2-}$,CH_3COO^- (Note: Insoluble salts excluded)

3) **Content based experiment**
   A. Preparation of Inorganic Compounds
   Preparation of double salt of Ferrous Ammonium Sulphate or Potash Alum.
   Preparation of Potassium Ferric Oxalate.

   B. Tests for the functional groups present in organic compounds:
   Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (Primary) groups.

Guidelines on Syllabus for Visually Handicapped students.

Schools are expected to rationalise and divide the syllabus of practicums for visually handicapped students into two halves on the basis of collective guidelines given for the same in the complete syllabus and as per the convenience of their students. This flexibility is given in view of the special condition of visually handicapped students .They will, however, be assessed on 15 marks in practical examination in both the terms as rest of their peers.

Rubric for Assessment of Project

PARAMETER	Exemplary (4)	Accomplished (3)	Developing (2)	Beginner (1)
Factual information	Content covers the research well	Content from all eras but has few inaccuracies	Content does not cover all eras and has few inaccuracies	Content does not cover all eras and is historically inaccurate
Sources	Multiple sources (6 or more) used (library, books, interview with people, different websites, blogs etc.)	Many sources (4-5) used (Books, websites, blogs)	Few sources used (2-3)	Relied on only one source
Data collection	Collected data from a large random sample (50 people or more from different age group, gender, social status) OR collected data for different samples and at least 5 reading for each set of experiment	Collected data from a fairly large random sample (30 -50 people from different age group, gender, social status) OR collected data for different samples and 3 reading for each set of experiment	Collected data from a small random sample (20 people from different age group, gender, social status) OR collected data for one sample and 3-5 readings	Collected data from a small sample (10 or less people) OR collected data for one sample and 1-2 readings
Interpretations and conclusion	In correlation with data and aim of the project. Clear conclusions based on findings	In correlation with data and aim of the project. Conclusions not based on findings	Not in correlation with data but in correlation with the aim Random conclusions	Not in correlation with data and aim, No conclusions
Journal	Daily entries with details of discussions and brainstorming sessions with the teacher.	Most of the entries done with details of discussions with the teacher	Daily entries without details	Random entries
Project report	Exceptionally attractive, organized sequentially and logically, creatively presented with data and clear conclusions	Attractive, organized sequentially and logically, presented some data and conclusions	Information is organized sequentially and logically but not in an attractive manner. Random Data without conclusions	Presentation is confusing. There is no sequence.
Academic Honesty	Sites all sources and gives due credits	Most of the sources cited	Few sources cited	Uses other people’s ideas without giving credit

CHAPTER 1

SOLID STATE

GIST OF THE LESSON

SOLIDS	FLUIDS (LIQUIDS AND GASES)
• Fixed position of constituent particles • Cannot flow • Intermolecular distances are short and intermolecular forces are strong • Rigid and have definite shape	• Do not have fixed position of constituent particles • They flow • There are appreciable intermolecular distances and intermolecular forces are weaker • Not at all rigid and do not have definite shape

CLASSIFICATION OF SOLIDS - on the basis of the nature of order present in the arrangement of their constituent particles.

Crystalline	Amorphous	Polycrystalline solids.
• Characteristic geometrical shape • Plain and smooth cleavage planes on cutting with a sharp edged tool • Definite heat of fusion • Shows Anisotropy - different values for the measurements of refractive index or electrical resistance in different directions. •Long range order •True solids •Eg. graphite, diamond, quarts	• No geometrical shape • Irregular surfaces on cutting with a sharp-edged tool • No definite heat of fusion • Shows isotropy - same values for the measurements of refractive index or electrical resistance in different directions. • Short range order • Pseudo solids or super cooled liquids • Eg. Glass, rubber and plastics	These have microcrystalline structures. Metals often occur in polycrystalline condition. Individual crystals are randomly oriented and hence the metallic sample appears to be isotropic even though a single crystal is anisotropic.

CLASSIFICATION OF CRYSTALLINE SOLIDS- subdivided into 4 categories: MOLECULAR, IONIC, METALLIC and COVALENT/ NETWORK SOLIDS

1. **MOLECULAR SOLIDS**: - Further subdivided into following three categories

a) Non-polar molecular solids:	b) Polar molecular solids:	c) H-bonded molecular solids:
Made up of atoms or molecules, held together by weak dispersion forces or London forces, low melting points and soft solids. Eg. Solid H_2, Solid I_2, Solid Cl_2	Made up of polar covalent molecules, held together by relatively stronger dipole-dipole interactions, with melting points higher than those of non-polar molecular solids. Eg. Solid NH_3, Solid SO_2	Made up of polar covalent molecules having H and electronegative atoms like N, O or F; held together by stronger hydrogen bonds, melting points are higher than those of polar and non-polar molecular solids. Eg. Solid HF, ice (solid H_2O)

2. **IONIC SOLIDS**:

Three dimensional arrangements of cations and anions bound by strong electrostatic force of attraction, non-directional ionic bond, with very high melting points, bad conductors of electricity in the solid state as ions are immobile but good conductors in the molten and aqueous state.
Eg. Solid NaCl, KCl.

3. METALLIC SOLIDS:

Made up of metallic atoms with strong force of attraction between valence electron and the positively charged kernels. The atomic orbitals of metal atoms form molecular orbitals which are known as valence band. Electrons get excited from the valence band to the next higher unoccupied energy level known as conduction band. Valence electrons are mobile and hence are good conductors of heat and electricity even in the solid state. The force of attraction is weaker than in ionic solids.

4. COVALENT OR NETWORK SOLIDS:

Made up of atoms in a network fashion to form covalent bonds (strong and directional) between adjacent atoms throughout the crystal, with very high melting points and insulators. (Graphite is an exception-conductor of heat and electricity).
Eg. Diamond, graphite, AlN, SiC, quartz.

CRYSTAL LATTICE

- A regular three-dimensional arrangement of points in space, the smallest portion of a crystal lattice which repeats in different directions to produce the entire lattice.
- There are 14 possible 3-D lattices called Bravais lattices.
- A unit cell is characterized by six parameters, *a, b, c* (edges) and α, β and γ (angles).
- In a primitive unit cell, constituent particles present only at the corners.
- The centered unit cell is of three kinds, body-centred (one constituent particle at the body centre, rest at corners), face-centred (one constituent particle at the centre of each face, rest at corners) and end-centred unit cells (one constituent particle is present at the centre of any two opposite faces, rest at corners).
- The seven primitive unit cells in crystals are cubic, tetragonal, orthorhombic, hexagonal, rhombohedral, monoclinic and triclinic.

Close packing in:

(a) One dimension has coordination number 2.
(b) Two dimensions has two ways of arranging spheres and the coordination number is 4 (square) or 6 (hexagonal).
(c) Three dimensions has two ways of arranging spheres-hcp and ccp (or fcc)

3-dimensional packing

hexagonal close packed (*hcp*)	cubic close packed (*ccp*) or face-centered cubic (*fcc*) structure
• The spheres of the third layer are exactly aligned with those of the	• The spheres of the third layer are not aligned with those of either the first or the second layer. In ccp

first layer-AB, AB .... pattern.	fourth layer is in alignment with the first – ABC, ABC...pattern
• The third layer placed above the second layer cover the tetrahedral voids. Eg. Mg and Zn crystallize in this str.	• The third layer placed above the second layer cover the octahedral voids. Eg. Cu and Ag crystallize in this structure.
• Coordination number is 12 and contains 6 atoms per unit cell.	• Coordination number is 12 and contains 4 atoms per unit cell.

Kinds of voids in 3-dimensional packing

Tetrahedral void	Octahedral void
1. It is a void formed when 4 spheres (3 in one layer and 1 in next layer) are joined together	1. It is a void formed when 6 spheres (3 in one layer and 3 in next layer) are joined together
2. Its coordination number is 4.	2. Its coordination number is 6.
3. Its radius is 0.225R where R is the radius of the close packed sphere	3.Its radius is 0.414R where R is the radius of the close packed sphere
4. Tetrahedral void is much smaller than octahedral void	4. Octahedral void is much bigger than tetrahedral void
5. In ccp/fcc, there are 8 tetrahedral voids (located adjacent to 8 corners)	5. In ccp/fcc, one octahedral void at the body centre of the cube and there is one octahedral void at the centre of each of the 12 edges. Each edge is shared between four adjacent unit cells and hence the contribution is 1/4 No. of octahedral voids per ccp/ fcc = 1 from centre + ¼ from each edge x 12 edges= 1+3=4
6. For n atoms, there will be 2n tetrahedral voids (double tetrahedral voids)	6. for n atoms, there will be n octahedral voids (same number of octahedral voids)

Type of unit cell	No. of atoms per unit cell (z)	Relation between edge length (a) and radius of the atom (r).	Relation between (a) and (r).	Packing efficiency	Empty space
Simple cubic	1	$r = a/2$	$r = 0.5a$	52.4%	47.7%
bcc	2	$r = \sqrt{3}\,a/4$	$r = 0.433a$	68%	32%
fcc/ccp	4	$r = a/2\sqrt{2}$	$r = 0.353a$	74%	26%
hcp	6	$r = a/2\sqrt{2}$	$r = 0.353a$	74%	26%

Calculations Involving Unit Cell Dimensions

$$d = \frac{zM}{a^3 N_A}$$

Where d = density of the unit cell = density of substance
a = edge length in cm provided density is in g/cm^3 and 1pm = 10^{-10} cm.
If density is in kg/m^3, edge length will be in metre and 1pm = 10^{-12} m.
z = number of atoms per unit cell if element or number of molecules per unit cell for a compound (for CsCl n=1 as the unit cell contains 1 Cs^+ and 1 Cl^- and for NaCl, n=4 as the unit cell contains 4 Na^+ and 4 Cl^-.
M= atomic mass if element or molecular mass if compound.
N_A is Avogadro number of atoms or molecules = 6.02 x 10^{23}.

Note1:

$$d = \frac{zM}{a^3 N}$$

where M= given mass of the element / compound
N= number of atoms/ molecules present in the given mass of element/compound.

Note 2: M need not be atomic mass or molecular mass and number of particles in that case need not be Avogadro number.

Note 3: number of unit cells in a given amount of solid= $\frac{total\ volume\ of\ solid}{voume\ of\ unit\ cell}$
$= \frac{total\ number\ of\ atoms}{umber\ of\ atoms\ per\ unit\ cell} = \frac{N}{z}$

$$\text{Number of unit cells} = \frac{N}{z} = \frac{a^3 d}{M}$$

(There is no need of z to calculate number of unit cells)

IMPERFECTIONS IN SOLIDS: -_3 types

Point defects:	Line defects	Plane defects
irregularities or deviations from ideal arrangement around a point or an atom in a crystalline substance.	Irregularities or deviations from ideal arrangement in entire rows of lattice points.	Irregularities or deviations from ideal arrangement in entire plane of lattice points.

POINT DEFECT IN SOLIDS- 3 types:

<table>
<tr><td colspan="2">1.STOICHIOMETRIC DEFECT
It does not affect the stoichiometry of the solid. Also known as intrinsic or thermodynamic defects. These are of two types.</td><td colspan="3">2. NON -STOICHIOMETRIC DEFECT
It does not affect the stoichiometry of the solid. These are of two types.</td><td rowspan="3">3.IMPURITY DEFECT
Developed by introducing higher valence cation in a crystal, known as doping.
The higher valence cation occupies the site of one ion and the other site remains</td></tr>
<tr><td>Vacancy defects</td><td>Interstitial defects</td><td>Metal deficiency defect</td><td colspan="2">Metal excess defect; 2 types</td></tr>
<tr><td>An atom or ion missing</td><td>An atom, ion or</td><td>Contain less amount of the</td><td>Due to anionic vacancies:</td><td>Due to the presence of</td></tr>
</table>

from their original site, decreasing the density	molecule occupying an interstitial site, increasing the density	metal as compared to the stoichiometric proportion. Arises due to multiple oxidation state. Example FeO which is mostly found with a composition of $Fe_{0.95}O$. It actually ranges from $Fe_{0.93}O$ to $Fe_{0.96}O$. In it some Fe^{2+} cations are missing and the loss of positive charge is made up by required number of Fe^{3+} ions.	The anion is missing from its lattice point and an electron takes its place in order to maintain electrical neutrality. Such electrons impart colour to crystal and are referred to as F-centres or colour-centres. For eg. Excess of sodium makes NaCl crystal yellow, Li makes LiCl pink and K makes KCl violet (or lilac).	extra cations: Some crystals (ZnO) on heating lose oxygen (a gaseous product) and develops colour (in ZnO, it turns yellow). $ZnO \rightarrow Zn^{2+} + 2e^- + 1/2\ O_2$. Now there is excess of Zn^{2+} in the crystal and its formula becomes $Zn_{1+x}O$.	vacant. The cationic vacancies thus produced are equal to difference in valences of the cations. If $AlCl_3$ is doped in NaCl, each Al^{3+} replaces three Na^+ ions. It occupies the site of one ion and the other two sites (difference in charge, +3 − +1) remains vacant.

Point defects in Non-Ionic solids: 2 types:

Vacancy defect or Schottky defect	Interstitial defect
An atom is missing from its normal site creating a vacancy. It lowers the density of the solid.	An extra atoms or molecule occupy an interstitial site (void in between the constituent particles), causing an increase in the density of the solid.

Point defects in Ionic solids: 2 types

Frenkel defect or dislocation defect	Schottky defect
The smaller ion (usually cation) is dislocated from its normal site to an interstitial site creating a vacancy defect at its original site and an interstitial defect at its new location (hybrid defect). It does not change the density of the solid. Shown by ionic substance in which there is a large difference in the size of ions, for example, ZnS, AgCl, AgBr and AgI due to small size of Zn^{2+} and Ag^+ ions.	It is a vacancy defect. In order to maintain electrical neutrality, the number of missing cations and anions are equal. Schottky defect decreases the density of the substance. Schottky defect is shown by ionic substances in which the cation and anion are of almost similar sizes. For example, NaCl, KCl, CsCl and AgBr. AgBr shows both, Frenkel as well as Schottky defects.

MULTIPLE CHOICE QUESTIONS

1. Most crystals show good cleavage because their atoms, ions or molecules are
(a) weakly bonded together   (b) strongly bonded together
(c) spherically symmetrical   *(d)* arranged in planes.

2. The number of octahedral void(s) per atom present in a cubic close-packed structure is
(a) 1   (b) 3
(c) 2   (d) 4

3. In cube of any crystal *A*-atom placed at every corners and *B*-atom placed at every centre of face. The formula of compound is
(a) AB (b) AB_3
(c) A_2B_2 (d) A_2B_3

4. An element has a body centered cubic (*bcc*) structure with a cell edge of 288 pm. The atomic radius is
(a) $\sqrt{3}/4$ x 288 pm   (b) $\sqrt{2}/4$ x 288 pm
(c) $4/\sqrt{3}$ x 288 pm   (d) $4/\sqrt{2}$ x 288 pm

5. The sharp melting point of crystalline solids is due to ___________.
(a) a regular arrangement of constituent particles observed over a short distance in the crystal lattice.
(b) a regular arrangement of constituent particles observed over a long distance in the crystal lattice.
(c) same arrangement of constituent particles in different directions.
(d) different arrangement of constituent particles in different directions

6. Which of the following is a network solid?
(a) SO_2 (Solid)   (b) I_2
(c) Diamond   (d) H_2O (Ice)

7. Which of the following solids is not an electrical conductor?
(A) $Mg_{(s)}$ (B) $TiO_{(s)}$ (C) $I_{2(s)}$ (D) $H_2O_{(s)}$

(a) (A) only   (b) (B) Only
(c) (C) and (D)   (d) (B), (C) and (D)

8. Schottky defect is observed in crystals when __________.
(a) some cations move from their lattice site to interstitial sites.
(b) equal number of cations and anions are missing from the lattice.
(c) some lattice sites are occupied by electrons.
(d) some impurity is present in the lattice.

9. Copper crystallises in a face-centred cubic lattice with a unit cell length of 361 pm. What is the radius of copper atom in pm?

(a) 157 (b) 181
(c) 108 (d) 128

10. Name the non-stoichiometric point defect responsible for colour in alkali metal halides.
(a) Frenkel defect (b) Interstitial defect
(c) Schottky defect (d) F-centres

11. Which of the following defects is also known as dislocation defect?
(a) Frenkel defect (b) Schottky defect
(c) Non-stoichiometric defect (d) Simple interstitial defect

12.Which of the following point defects are shown by AgBr(s) crystals?
(A) Schottky defect (B) Frenkel defect (C) Metal excess defect (D) Metal deficiency defect
(a) (A) and (B) (b) (C) and (D)
(c) (A) and (C) (d) (B) and (D)

13. Which of the following statements is not true about amorphous solids?
(A) On heating they may become crystalline at certain temperature.
(B) They may become crystalline on keeping for long time.
(C) Amorphous solids can be moulded by heating.
(D) They are anisotropic in nature.
(a) Option A (b) Option B
(c) Option C (d) Option D

14. Examine the given defective crystal
A+ B– A+ B– A+
B– 0 B– A+ B–
A+ B– A+ 0 A+
B– A+ B– A+ B–

How is the density of the crystal affected by this defect?
(a) Density increases (b) Density decreases
(c) No effect on density (d) Density first increases then decreases

15. In the cubic close packing, the unit cell has ________.
(a) 4 tetrahedral voids each of which is shared by four adjacent unit cells.
(b) 4 tetrahedral voids within the unit cell.
(c) 8 tetrahedral voids each of the which is shared by four adjacent unit cells.
(d) 8 tetrahedral voids within the unit cells.

16. Which of the following statement is not true about the hexagonal close packing?
(a) The coordination number is 12.
(b) It has 74% packing efficiency.
(c) Tetrahedral voids of the second layer are covered by the spheres of the third layer.
(d) In this arrangement spheres of the fourth layer are exactly aligned with those of the first layer.

17. Formula of nickel oxide with metal deficiency defect in its crystal is Ni0.98O. The crystal contains Ni^{2+} and Ni^{3+} ions. The fraction of nickel existing as Ni2+ ions in the crystal is

(a) 0.96 (b) 0.04

(c) 0.50 (d) 0.3

18. Copper has the fcc structure. The coordination of each ion is

(a) 4 (b) 12

(c) 14 (d) 8

19. The vacant space in *bcc* lattice unit cell is

(a) 48% (b) 23%

(c) 32% (d) 26%

20. Ionic solids, with Schottky defects, contain in their structure

(a) cation vacancies only (b) cation vacancies and interstitial cations

(c) equal number of cation and anion vacancies (d) anion vacancies and interstitial anions.

21.The correct order of packing efficiency of different type of unit cells is -------------

(a) fcc> bcc<simple cubic (b) fcc >simple cubic> bcc

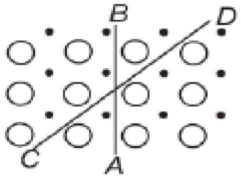
(c)fcc< bcc< simple cubic (d) bcc<fcc<simple cubic

22. Designation of the pattern as AB,AB,AB……etc., of successive vertical layers of identical atoms gives the arrangement called as

(a) Hexagonal Close packing (hcp) (b) cubic close packing (ccp)

(c)face centered Cubic (fcc) (d) body centred cubic (bcc)

23. Study the figure of a solid given below depicting the arrangement of particles.Which is the most appropriate term used for the figure:



(a) Amorphous nature (b) Anisotropy

(c) Irregular shape (d) Isotropy

24. Graphite is a good conductor of electricity due to the presence of ----------------

(a) lone pair of electrons (b) free valence electrons

(c) Cations (d) Anions

25. Which colour is observed when ZnO is heated?

(a) yellow (b) Violet

(c) Green (d) Blue

26. Which of the following is a good conductor of electricity in solution state?

(a) Covalent (b) Molecular
(c) Metallic (d) Ionic

27.In a face centred lattice atoms A are at the corner points and atoms B at the face centred points. If atom B is missing from one of the face centred points,the formula of the ionic compound is :

(a) AB_2 (b) A_5B_2
(c) A_2B_3 (d) A_2B_5

28. A solid having density of $9x10^{-3}$ kgm^{-3} forms face centred cubic crystals of edge length $200\sqrt{2}$ pm. What is the molar mass of the solid?

(a) 0.0432 kg mol^{-1} (b) 0.016 kg mol^{-1}
(c) 0.0305 kg mol^{-1} (d) 0.4320 kg mol^{-1}

29. Which of the following is true about the value of refractive index of quartz glass?

(a) same in all directions (b) different in different directions
(c) cannot be measured (d) always zero

30.A metal crystallises into two cubic namely face centred (fcc) and body centred (bcc),whose unit cell edge lengths are 3.5 A° and 3 A° respectively. The ratio of the densities of fcc and bcc will be

(a) 2.1 : 1 (b) 3.3:1
(c) 1.259 :1 (d) 2.259:1

31. How much part of any corner atom actually belongs to a particular unit cell?

(a) 1/4th (b) 1/6th
(c) 1/8th (d) 1/10th

32. Match the following Column I with Column II and choose the correct option from the codes

A. Ionic solids	1.Giant molecules
B. Network solids	2.Volatile liquids or soft solids at room temperature
C. Metallic Solids	3. No free ions to move in solid state.
D. Hydrogen bonded molecular solids	4. Positive ions surrounded by sea of electrons.

Codes:

	A	B	C	D
(a)	4	2	3	1
(b)	3	2	4	1
(c)	3	1	4	2
(d)	4	1	3	2

33. A compound is formed by cation C and anion A.The anions form hexagonal close packed(hcp) lattice and the cations occupy 75% of octahedral voids.The formula of the compound is-----------------

(a) C_3A_2 (b) C_3A_4
(c) C_4A_3 (d) C_2A_3

34. The ratio of number of atoms present in a simple cubic, body centered cubic and face centred cubic structure are, respectively

(a) 8:1:6 (b) 1:2:4
(c) 4:2:1 (d) 4:2:3

35. The largest void is

(a) Triangular (b) cubic
(c) Tetrahedral (d) octahedral

36. The total number of tetrahedral voids in 0.5 mol of a compound forming hexagonal close packed structure are

(a) 6.022×10^{23} (b)3.011×10^{23}
(c) 9.033×10^{23} (d) 4.516×10^{23}

37. Each of the following solids shows the Frenkel defect except

(a) ZnS (b) AgBr
(c) AgI (d) KCl

38. A metal crystallises out with a cubic structure having edge length of 361pm.If there are four metal atoms in one unit cell, then the radius of one atom is

(a) 108 pm (b) 80 pm
(c) 40 pm (d) 128 pm

39. Which of the following is a pseudo solid?

(a) CaF_2 (b) Glass
(c) NaCl (d) All of the above

40. When NaCl crystal is added with $MgCl_2$, the nature of defect produced is

(a) Interstitial (b) Schottky
(c) Frenkel (d) Impurity

41.Defect shown by ionic crystals with large difference in size

(a) Schottky Defect (b)Impurity Defect
(c) Frenkel Defect (d)Metal Deficiency Defect

42. The ratio of close-packed atoms to tetrahedral holes in cubic close packing is:

(a) 1 : 1 (b) 1 : 2
(c) 1 : 3 (d) 1 : 4

43. The total number of tetrahedral voids and octahedral voids per unit cell of face-centred cell (fcc) are

(a) 8, 4 (b) 4, 8
(c) 2, 4 (d) 4, 2

44. Analysis shows that FeO has a non-stoichiometric composition with formula $Fe_{0\cdot95}O$. Give reason.

(a) Schottky defect (b) Frenkel defect

(c) Metal excess defect (d) Metal deficiency defect

45. In a cubic lattice ABC, A atom present at all corners except one at corner which is occupied by B atoms. The formula of the compound is -----------------

(a) $A_7B_{24}C$ (b) ABC_3

(c) A_8BC_7 (d) A_7BC_{24}

46. Which one of the following cannot be called as a 'non-stoichiometric defect'?

(a) Metal excess defect due to anion vacancies

(b) Metal excess defect due to presence of extra cations

(c) Metal deficiency due to absence of cations

(d) Combination of vacancy and interstitial defects.

47. The lattice site in a pure crystal cannot be occupied by __________.

(a) Molecule (b) Ion

(c) Electron (d) Atom

48.The crystal with metal deficiency defect is

(a) NaCl (b) FeO

(c) KCl (d) ZnO

49. An element crystallizes in a fcc lattice with cell edge of 400 pm. The density of the element is 7g cm^{-3}. How many atoms are present in 280 g of the element?

(a) 2.5×10^{24} atoms (b) 1.2×10^{24} atoms

(c) 1.2×10^{12} atoms (d) 3.2×10^{24} atoms

50.Which one of the following statements about packing in solids is incorrect?

(a) Coordination number in bcc mode of packing is 8

(b) Coordination number in hcp mode of packing is 12

(c) void space in hcp mode of packing is 32 %

(d) void space in ccp mode of packing is 26 %

ANSWER KEY:

1 .d	2.a	3.b	4.a	5.b	6.c	7.c	8.b	9.d	10.d
11.a	12.a	13.d	14.b	15.d	16.d	17.a	18.b	19.c	20.c
21.a	22.a	23.b	24.b	25.a	26.d	27.d	28.c	29.a	30.c
31.c	32.c	33.b	34.b	35.b	36. c	37.d	38.d	39.b	40.d
41.c	42.b	43.a	44.d	45.d	46. d	47.c	48.b	49. a	50.c

ASSERTION-REASON TYPE OF QUESTIONS

This type of reasoning questions consists of two statements; an assertion (statement of fact) and a reason (explanation for the assertion). You have to determine whether each statement is correct. If both the statements are correct, you have to determine whether the reason supports the assertion. There will be four choices for the possible outcomes and you have to select the correct one.

(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
(C) Assertion is true, but Reason is false.
(D) Both Assertion is false and Reason are true.

1.	**Assertion:** Some of the glass objects from ancient civilizations are milky in appearance. **Reason:** Milkiness of the crystal is due to evaporation of glass
2	**Assertion:** Amorphous solids are called pseudo solids or super cooled liquids **Reason:** Amorphous solids have a tendency to flow.
3.	**Assertion:** Glass panes fixed to windows or doors of old buildings are invariably found to be thinner at the bottom **Reason:** The glass flows down very slowly and makes the bottom portion slightly thicker.
4	**Assertion:** A crystalline solid gives different values of refractive index when measured along different directions **Reason:** Long range order is seen in crystalline substances
5	**Assertion:** Crystalline solids are anisotropic **Reason:** It is due to difference in arrangement of particles in different directions
6	**Assertion:** Argon in the solid state is a non-polar molecular solid **Reason:** The atoms or molecules are held by strong electrostatic force of interaction
7	**Assertion:** Graphite a good solid lubricant **Reason:** Different layers of graphite can slide one over the other
8	**Assertion:** Graphite is a bad conductor of electricity **Reason:** The fourth valence electron of each atom is present between different layers and is free to move about
9	**Assertion:** Ionic solids are insulators in the solid state **Reason:** In ionic solid, the ions are free to move
10	**Assertion:** Ionic solids conduct electricity in the molten state or when dissolved in water. **Reason:** In the molten state or when dissolved in water, the ions become free to move

11	**Assertion:** Amorphous solids are anisotropic. **Reason:** There is no long range order in them and arrangement is irregular along all the directions
12	**Assertion:** Pure alkali halides do not show Frenkel defect **Reason:** Density remains the same in crystal showing Frenkel defect
13	**Assertion:** Silver halides show Frenkel defect **Reason:** Cation size is smaller than anion size
14	**Assertion:** ZnO turns red on heating **Reason:** On heating it loses oxygen and the excess Zn^{2+} ions move to interstitial sites and the electrons to neighbouring interstitial sites
15	**Assertion:** KCl becomes violet when heated in presence of K vapours **Reason:** KCl is an alkali metal halide
16	**Assertion:** The number of tetrahedral voids is double the number of octahedral voids. **Reason:** The size of the tetrahedral voids is half of that of the octahedral void
17	**Assertion:** Vacancy defect results in a decrease in density of the substance **Reason:** An atom goes missing from one of the lattice site thus decreasing the density
18	**Assertion:** Frenkel defect does not change density of the substance **Reason:** In Frenkel defect ions are missing from the crystal lattice site and no.t seen anywhere in the crystal lattice
19	**Assertion:** Interstitial defect results in an increase in the density of the substance **Reason:** This defect results in the increase in the density of the substance as the mass increases but volume remains the same
20	**Assertion:** Schottky defect results in an increase in density of the solid **Reason:** The equal number of missing anion and Cation effect the overall density.
21	**Assertion:** Frenkel defect does not change density of the substance **Reason:** Frenkel defect is also called dislocation defect
22	**Assertion:** Crystalline solids are having sharp melting point **Reason:** All the component atoms, molecules, or ions are the same distance from the same number and type of neighbours
23	**Assertion:** On heating Crystals of NaCl with Na vapours crystal start exhibiting violet or lilac colour **Reason:** The colour of NaCl is the result of the excitation of the electrons, which absorb energy from the visible spectrum of light that is falling on the crystals.

24	**Assertion:** Nonstoichiometric compounds have variable stoichiometries over a given range with no dramatic change in crystal structure **Reason:** A large number of vacancies or substitutions of one ion by another ion with a different charge.
25	**Assertion:** Graphite is an example of hexagonal crystal system **Reason:** For a hexagonal system a=b ≠ c, $\alpha=\beta=90^{o}C$, $\gamma=120^{o}C$
26	**Assertion:** The packing efficiency is maximum for the fcc structure **Reason:** The coordination number is 12 in fcc structure.
27	**Assertion:** Quartz and quartz glass have different structure **Reason:** Quartz is a crystalline solid while quartz glass is amorphous solid
28	**Assertion:** Solids are not rigid in nature **Reason:** Constituent particles in solids have fixed positions and they can oscillate about their mean position
29	**Assertion:** In closed packing of spheres, a tetrahedral void is surrounded by four spheres whereas an octahedral void is surrounded by six spheres **Reason:** A tetrahedral void has a tetrahedral shape whereas an octahedral void has an octahedral shape
30	**Assertion:** No compound has both Schottky and Frenkel defect **Reason:** Only Schottky defect changes the density of the solid

Answer key Assertion reason type

1	C	11	C	21	C
2	A	12	B	22	A
3	D	13	A	23	D
4	B	14	D	24	A
5	A	15	B	25	A
6	C	16	C	26	B
7	A	17	A	27	A
8	D	18	C	28	D
9	C	19	A	29	C
10	A	20	D	30	D

CASE BASED QUESTIONS

1 **Read the following paragraph and answer the questions**

The compounds in which the numbers of positive and negative ions are exactly in the ratios indicated by their chemical formulae are called stoichiometric compounds. The defects do not disturb the stoichiometry (the ratio of numbers of positive and negative ions) are called stoichiometric defects. These are of following types,

Interstitial defect is caused due to the presence of ions in the normally vacant interstitial sites in the crystals.

Schottky defect: This type of defect when equal number of cations and anions are missing from their lattice sites so that the electrical neutrality is maintained.

Frenkel defect arises when an ion is missing from its lattice site and occupies an interstitial position. The crystal as a whole remains electrically neutral because the number of anions and cations remain same. Since cations are usually smaller than anions, they occupy interstitial sites.

i) Which of the following statements for crystals having Schottky defect is not correct?

a) Schottky defect arises due to the absence of a Cation and anion from the position which it is expected to occupy
b) Schottky defect are seen in ionic compounds with high coordination number
c) The density of the crystal having Schottky defect is larger than that of the perfect crystal
d) The crystal having Schottky defect is electrically neutral as a whole

ii) Name the defect shown by ZnS

a) Schottky defect
b) Frenkel defect
c) Impurity defect
d) Vacancy defect

iii) Schottky defects are observed in solids with cations and anions of similar sizes. Which of the following compounds, therefore, is NOT likely to have a Schottky defect?

a) NaCl
b) AgCl
c) CsCl
d) KCl

iv) Density of the crystal remain unchanged as a result of

a) Vacancy defect
b) Interstial defect
c) Schottky defect
d) Frenkel defect

2	**Read the following paragraph and answer the questions** Crystalline substances are the most common type of solids. Their characteristics are what we associate solids with. They are firm, hold a definite and fixed shape, are rigid and incompressible. They generally have geometric shapes and flat faces. And examples include diamonds, metals, salts etc. Amorphous solids are rigid structures but they lack a well-defined shape. They do not have a geometric shape. So they are non-crystalline. This is why they do not have edges like crystals do. The most common example of an amorphous solid is Glass. Gels, plastics, various polymers, wax, thin films are also good examples of amorphous solids.
i)	**Which of the following statements about amorphous solids is incorrect?** a) They melt over a range of temperature b) Gradually soften over a range of temperature c) Pseudo solids or super cooled liquids d) They have a definite and characteristic heat of fusion
ii)	**The sharp melting point of crystalline solids is due to** a) A regular arrangement of constituent particles observed over a short distance in the crystal lattice b) A regular arrangement of constituent particles observed over a long distance in the crystal lattice c) Same arrangement of constituent particles in different directions d) Different arrangement of constituent particles in different directions
iii)	**Which of the following is true about the value of refractive index of quartz glass?** a) Same in all directions b) Different in different directions c) Cannot be measured d) Always zero
iv)	**Which is not a characteristic of crystalline solids?** a) They undergo a clean cleavage b) They are true solids c) They are isotropic d) They have sharp melting points
3	**Read the following paragraph and answer the questions** In geometry, biology, mineralogy, and solid state physics, a unit cell is a repeating unit formed by the vectors spanning the points of a lattice. Despite its suggestive name, the unit cell (unlike a unit vector, for example) does not necessarily have unit size, or even a particular size at all. Rather, the primitive cell is the closest analogy to a unit vector, since it has a determined size for a given lattice and is the basic building block from which larger cells are constructed. The concept is used particularly in describing crystal structure in two and three

	dimensions, though it makes sense in all dimensions. A lattice can be characterized by the geometry of its unit cell. The unit cell is a section of the tiling (a parallelogram or parallelepiped) that generates the whole tiling using only translations. There are two special cases of the unit cell: the primitive cell and the conventional cell. The primitive cell is a unit cell corresponding to a single lattice point, it is the smallest possible unit cell. In some cases, the full symmetry of a crystal structure is not obvious from the primitive cell, in which cases a conventional cell may be used. A conventional cell (which may or may not be primitive) is a unit cell with the full symmetry of the lattice and may include more than one lattice point.
i)	**Which of the following is regarded as the 'repeatable entity' of a 3D crystal structure?** a) Bravais Index b) Lattice c) Crystal d) Unit cell
ii)	**What is the total volume of the particles present in a Face centered unit cell?** a) $\frac{4}{3}\pi r^3$ b) $\frac{8}{3}\pi r^3$ c) $\frac{16}{3}\pi r^3$ d) $\frac{32}{3}\pi r^3$
iii)	**How many parameters are used to characterize a unit cell?** a) Six b) Three c) Two d) Nine
iv)	**The vacant space in bcc lattice unit cell is** a) 23% b) 32% c) 26% d) 48%
4	**Read the following paragraph and answer the questions** The crystalline solids are characterized by their space lattices and close packing of atoms. However, these structures have some gaps in their arrangement we call voids. Many scientists believe that this spacing between atoms is of crucial importance to the properties of the substance Close packing in crystals refers to space efficient arrangement of constituent particles in

a crystal lattice. To understand this packing more clearly, we have to assume all particles (atoms, molecules and ions) are of the same spherical solid shape.

So the unit cell of a lattice is a cubic shape. Now when we stack spheres in the cell, there will always be some empty spaces. To minimize these empty spaces, the arrangement of these spheres must be very efficient. The spheres should be arranged as close together as possible to eliminate empty spaces.

i) Voids in two-dimensional hexagonal close packed structure are

a) Circular
b) Rectangular
c) Triangular
d) Hexagonal

ii) The correct order of the packing efficiency in different types of unit cells is ___.

a) fcc < bcc < simple cubic
b) fcc > bcc > simple cubic
c) fcc < bcc > simple cubic
d) bcc < fcc > simple cubic

iii) Coordination number in ABAB……. Type of arrangement is

a) 8
b) 6
c) 12
d) 24

iv) In hcp of A, ⅓ of tetrahedral voids are occupied by B. what is the formula of the compound?

a) A_2B_3
b) A_3B_2
c) AB_3
d) A_2B

ANSWER KEY

1	2	3	4
i) c	i) d	i) d	i) c
ii) b	ii) b	ii) c	ii) b
iii) b	iii) a	iii) a	iii) c
iv) d	iv) c	iv) b	iv) b

CHAPTER 2

SOLUTIONS

GIST OF LESSON

- **Solution:** A homogeneous mixture of two or more chemically non-reactive substances whose concentration can be varied within certain limits.
- **Solubility:** The amount of the solute present in 100g of the solvent in a saturated solution at a given temperature.
- **Saturated Solution:** A solution which cannot dissolve any more of the solute at a particular temperature.
- **Unsaturated Solution**: A solution in which more of the solute can be dissolved at a particular temperature.
- **Super Saturated Solution:** A solution in which the amount of solute present in 100g of the solvent at a particular temperature is more than its normal solubility at that temperature.

- **Mass Percent:** Mass of solute per 100g of solution.
- **Molarity:** Number of moles of solute per litre of solution.
- **Molality:** Number of moles of solute per kilogram of solvent.
- **Mole Fraction:** Ratio of number of moles of component to total number moles.
- **Parts per million:** The number of parts by mass of solute per million parts by mass of solution.

- **Gas in Liquid solution:**
    - Solubility of gas in liquid decreases with rise in temperature
    - Henry's law: At a given temperature, mole fraction of a gas is proportional to the partial pressure of the gas over the solution.
    - $p = K_H \chi$
    - **K_H α Temperature, K_H α 1/Solubility**

- **Liquid in Liquid solution:**
    - **Vapour Pressure:** The pressure developed above the liquid at particular temperature at the equilibrium point.
    - **Raoult's Law:** In solution of volatile liquids, the partial vapour pressure of each component is directly proportional to its mole fraction.
      $p_A = p^0_A \chi_A$, $p_B = p^0_B \chi_B$,Total pressure $p = p_A + p_B$
    - **Ideal Solution:** The liquid-liquid solution which obey Raoult's law at all concentrations.
      Forces of attraction between A-A, B-B is similar to A-B
      $p_{Total} = p_A + p_B$, $\Delta H_{mix} = 0$; $\Delta V_{mix} = 0$.
    - **Non–Ideal Solution:** The liquid-liquid solution which do not obey Raoult's law. Show positive or negative deviations from Raoult's law.

- **Azeotrope:** The mixture of liquids which boils at constant temperature like pure liquid and has same composition of component in liquid as well as vapour phase**.**
  Types of azeotropes : (i)Minimum boiling azeotrope : The solutions which show a large positive deviation from Raoult's law form minimum boiling azeotrope.
  Eg: ethanol-water mixture
  (ii)Maximum boiling azeotrope. : The solutions that show large negative deviation from Raoult's law form maximum boiling azeotrope at a specific composition. Eg: Nitric acid and water mixture.

- **Colligative Properties:** The properties of the solution which are independent of nature of solute but depend upon the concentration of solute particles.
- **Lowering of Vapour Pressure:** It is the difference in the vapour pressure of the pure solvent and that of solution which are added with non-volatile solute**.**
- **Relative Lowering of Vapour Pressure:** The ratio of the lowering of vapour pressure to the vapour pressure of pure solvent**.**
- **Molal Elevation Constant (K_b):** The elevation in the boiling point of the solution when its molality is unity. It is also called molal ebullioscopic constant**.**
- **Molal Depression Constant(K_f):** The depression in the freezing point when the molality of the solution is unity. It is also called molal cryoscopic constant.
- **Osmosis Pressure:** The excess pressure that must be applied to the solution side to prevent the flow of solvent into solution through a semi–permeable membrane**.**
- **Isotonic Solutions:** Two solutions having same osmotic pressure at a given temperature are called isotonic solutions. They have same molar concentration. When such solutions are separated by semipermeable membrane no osmosis occurs between them.
- Osmotic pressure associated with the fluid inside the blood cell is equivalent to that of 0.9% (mass/ volume) sodium chloride solution, called normal saline solution and it is safe to inject intravenously. On the other hand, if we place the cells in a solution containing more than 0.9% (mass/volume) sodium chloride, water will flow out of the cells and they would shrink. Such a solution is called hypertonic. If the salt concentration is less than 0.9% (mass/volume), the solution is said to be hypotonic. In this case, water will flow into the cells if placed in this solution and they would swell.
- **Reverse Osmosis**: If the pressure applied on the solution side is more than osmotic pressure of the solution then the solvent particles will move from solution to solvent side. This process is reverse osmosis. Reverse osmosis is used in desalination of sea water. Cellulose acetate is permeable to water but impermeable to impurities and ions present in sea water.

- **Important formulae:**

W_A = Mass of solvent in gram; **W_B = Mass of solute in grams;**
M_A = Mol. mass of solvent; **M_B = Mol. mass of solute;**
V = Volume of solution **V_A = Volume of solvent;**

Mass % $= \frac{W_B}{W_A+W_B}\times 100$, **Molarity (M)** $= \frac{n_B}{V_{(L)}} = \frac{W_B}{M_B V_{(L)}}$

Molarity $= \frac{d_{(Solution)}\times \text{Mass }\%\times 10}{M_B}$ **Molality (m)** = n_B/W_A(Kg) = $W_B/M_B * W_A$(Kg)

$x_A = \frac{n_A}{n_A+n_B} = \frac{W_A/M_A}{W_A/M_A+W_B/M_B}$ $x_B = \frac{n_B}{n_A+n_B} = \frac{W_B/M_B}{W_A/M_A+W_B/M_B}$

- Henry's law , $p = K_H \chi$
- Vapour pressure of liquid-liquid solution: $p_s = p^0_A \chi_A + p^0_B \chi_B$

  $p_A = y_A p_{total}$, $p_B = y_B p_{total}$ y_A & y_B are the mole fractions in vapour phase

- Relative lowering of vapour pressure: $\Delta P/P^o = \frac{P-P^o}{P} = x_B$,
- Elevation in Boiling point: $\Delta T_b = \frac{K_b\ W_B \times 1000}{M_B W_A}$
- Depression in freezing point: $\Delta T_f = \frac{Kf * W_B \times 1000}{M_B W_A}$
- Osmotic pressure: $\pi = \frac{W_B RT}{M_B V}$

$K_b = \frac{RM_A T_b^2}{1000\ \Delta H_{vap}}$, $K_f = \frac{RM_A T_f^2}{1000\ \Delta H_{fus}}$

MULTIPLE CHOICE QUESTIONS

1. The vapour pressure of pure liquids A and B are 900 and 450 mm Hg respectively, at 350 K. Calculate the composition of A – B mixture boiling at 350K at 1 atm.

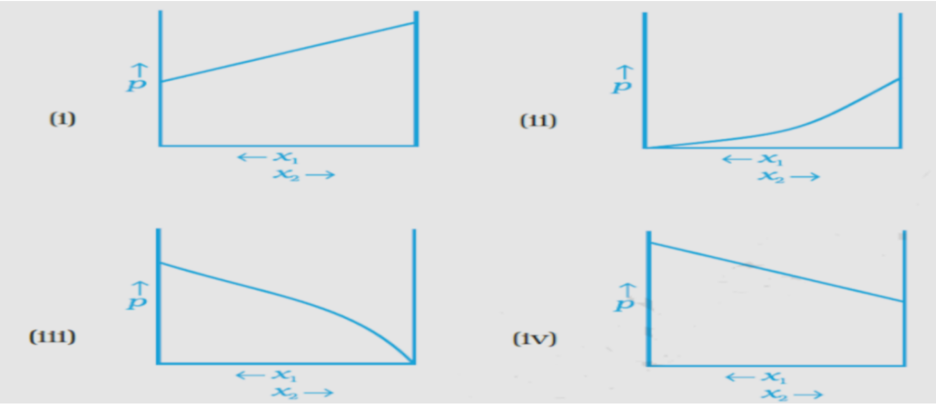
a) $\chi_A = 0.69$ $\chi_B = 0.31$

b) $\chi_A = 0.31$ $\chi_B = 0.69$

c) $\chi_A = 0.5$ $\chi_B = 0.5$

d) $\chi_A = 0.3$ $\chi_B = 0.7$

2. For a binary ideal liquid solution, the variation in total vapour pressure versus composition of solution is given by which of the curves?



a) (i) and (ii)

b) (i) and (iv)
c) (i) and (iii)
d) (iii) and (iv)

3. An azeotropic mixture of two liquids boils at a temperature lower than either of them when

a) it is saturated

b) it does not deviate from Raoults law

c) it shows positive deviation from Raoults law

d) shows negative deviation from Raoults law.

4. Osmotic pressure of a solution is 0.0821 atm at a temperature of 300 K. The concentration in moles/litre will be

(a) 0.33
(b) 0.666
(c) 0.3×10^{-2}
(d) 3

5. The value of Henry's Law constant is:

a. larger for gases with higher solubility
b. larger for gases with lower solubility
c. constant for all gases
d. not related to the solubility of gases

6. The Solutions boiled at a constant temperature are called:

(a) Amorphous (b) Azeotropic mixture

(c) Ideal solution (d) Super saturated solution

7. What is the effect of temperature on solubility of gases in liquids?

a) No effect

b) Increase in temperature decreases solubility

c) Increase in temperature increases solubility

d) It cannot be correlated

8. Scuba divers carry the cylinder consisting the mixture of gases diluted in air.

a) O_2, He, CO_2

b) O_2, He, N_2

c) O_2, He, Ne

d) O_2, Ar, N_2

9. Which of the following aqueous solutions should have the highest boiling point?

(a) 1.0 M NaOH

(b) 1.0 M Na_2SO_4

(c) 1.0 M NH_4NO_3

(d) 1.0 M KNO_3

10. Which of the following solution containing components A and B follow Raoult's Law?

a) A-B attraction force is greater than A-A and B-B
b) A-B attraction force is less than A-A and B-B
c) A-B attraction force remains same as A-A and B-B
d) Volume of solution is different from sum of volume of A and B

11. The elevation in boiling point of 0.01 M $BaCl_2$ solution is about -------------than that of 0.01 M solution of glucose.

a) Same
b) two times
c) three times
d) four times

12. Which of the following 0.1 m aqueous solution will have the lowest freezing point?

a) $Al_2(SO_4)_3$
b) $C_5H_{10}O_5$
c) KI
d) $C_{12}H_{22}O_{11}$

13. The solution containing 6.8 g of non -ionic solute 100 g of water was found to freezes at – 0.93^0 C. If K_f for water is 1.86, the molecular mass of solute is

a) 13.6
b) 68
c) 34
d) 136

14. Which of the following condition is not satisfied by an ideal solution?

(a) $\Delta H_{mixing} = 0$
(b) $\Delta V_{mixing} = 0$
(c) Raoult’s Law is obeyed
(d) Formation of an azeotropic mixture

15. Glucose is added to 1L of water (d=1) to such an extent that the ratio ΔTf / kf becomes 10^{-3} . The mass of glucose added is

a) 180 g
b) 18 g
c) 1.8 g
d) 0.18 g

16. If the vapour pressure of solutions of two liquids are less than those expected from ideal solution they are said to have:

(a) negative deviation from ideal behaviour
(b) positive deviations from ideal behaviour
(c) ideal behaviour
(d) sometime positive and sometime negative deviations

17. Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is

(a) 3.28 mol kg^{-1}
(b) 2.28 mol kg^{-1}
(c) 0.44 mol kg^{-1}
(d) 1.14 mol kg^{-1}

18. When a particular solution has a higher osmotic pressure than the given standard solution, it is most appropriately called as ……… with respect to the standard solution

a) Hypotonic
b) Hypertonic
c) Isotonic
d) None of these

19. The osmotic pressure of 5 % aqueous solution of glucose (π_1) is related to that of 5 % aqueous solution of urea (π_2) as

(a) $\pi_1 = \pi_2$
(b) $\pi_1 < \pi_2$
(c) $\pi_1 > \pi_2$
(d) $\pi_1 = \pi_2/2$

20. German silver is a homogeneous mixture of the following

a) Copper , Zinc and Nickel
b) Copper , Zinc and Tin
c) Copper and Nickel
d) Copper and Zinc

21. 10% Sugar in water means

a) 10 g of sugar in 100 g of water
b) 10 g of sugar in 95 g of water
c) 10 g of sugar in 90 g of water
d) 90 g of sugar in 10 g of water

22. Which of the following unit is useful in relating concentration of solution with its vapour pressure?

a) Mole fraction
b) Molality
c) Mass percentage
d) Molarity

23. Increasing the temperature of an aqueous solution will cause

a) Decrease the molarity
b) Increase the molality
c) Molarity remains same
d) Decrease in mole fraction

24. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to _____.

a) Low temperature
b) High atmospheric pressure
c) Low atmospheric pressure
d) Low temperature and high atmospheric pressure

25. The partial vapour pressure is equal to the product of pure pressure & mole fraction of the solute/solvent, this statement was given by

a) Raoult's law
b) Henry's law
c) Dalton's law
d) Joule's law

26. Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult's law?

(a) Methanol and acetone.
(b) Chloroform and acetone.
(c) Nitric acid and water.
(d) Phenol and aniline.

27. Equimolar solutions in the same solvent have

(a) Same freezing point but different boiling point
(b) Same boiling point but different freezing point
(c) Different boiling and different freezing point
(d) Same boiling and same freezing points

28. A solution containing 10 g per dm^3 of urea (molar mass 60 g mol^{-1}) is isotonic with 5% solution of non-volatile solute, M_B of solute is

(a) 300 g mol^{-1}
(b) 350 g mol^{-1}
(c) 200 g mol^{-1}
(d) 250 g mol^{-1}

29. What is mole fraction of solute in 1.00 m aqueous solution?

(a) 0.0354
(b) 0.0177
(c) 0.177
(d) 1.770

30. The hard shell of an egg was dissolved in HCl. The egg was then placed in a concentrated solution of NaCl. What will happen?

a) The egg will shrink
b) The egg will swell
c)The egg will become harder
d) There will be hardly any change

31. The depression in freezing point for 1M urea, IM glucose, and 1M NaCl are in the ratio

a) 1:2:3 b) 3:2:2 c) 1:1:2 d) None of these

32. The unit of Ebullioscopic constant is:

a) K kg mol-1 or K (molality)$^{-1}$
b) mol kg-1 K^{-1} or K^{-1} (molality)
c) kg mol-1 K^{-1} or K^{-1} (molality)$^{-1}$
d) K mol kg-1 or K (molality)

33. The molality of pure water is

(a) 55.5
(b) 50.5
(c) 18
(d) 60.5

34. The number of moles of NaCl in 3 litres of 3M solution is

(a) 1
(b) 3
(c) 9
(d) 27

35. Which of the following is an example of solid solution?

a) Sea water
b) Sugar solution
c) Smoke
d) 22 carat gold

36. How much ethyl alcohol must be added to 1 L of water so that solution will freeze at -14 ^{0}C?

a) 7.5 mol
b) 8.5 mol
c) 9.5 mol
d) 10.5 mol

37. Which among the following combinations is a maximum boiling azeotrope?

a) $H_2O + CH_3OH$
b) CCl_4+CHCl_3
c) $(CH_3)_2CO + C_2H_5OH$
d) H_2O+HNO_3

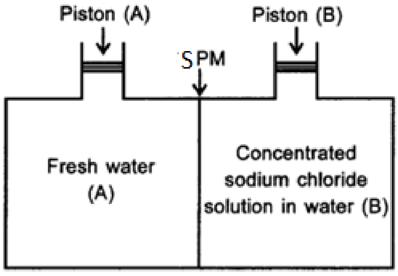
38. 100 mL of liquid A and 50 mL of liquid B are mixed to form 138 mL of solution, it is

a) Ideal solution
b) High boiling azeotrope
c)Low boiling azeotrope
d) None of these

39. What would be the percent strength of solution of urea that would be isotonic with 4.5% solution of glucose?

a) 4.5%
b) 13.5%
c) 1.5 %
d) 9 %

40. Consider the figure and mark the correct option.



(a) water will move from side (A) to side (B) if a pressure greater than osmotic pressure is applied on piston (B).
(b) water will move from side (B) to side (A) if a pressure greater than osmotic pressure is applied on piston (B).
(c) water will move from side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).
(d) water will move from side (A) to side (B) if pressure equal to osmotic pressure is applied on piston (A).

41. The boiling point of sea water at 1 atm pressure is -----that of distilled water

a) Same
b) Less than
c) Greater than
d) None of these

42. The increase in the boiling point of aqueous solution of sucrose is 0.1 K. The increase in the boiling point of aqueous solution of NaCl of same concentration is approximately.

a) 0.1 K
b) 0.2 K
c) 0.3 K
d) 0.05K

43. Match the following:

COLUMN A	COLUMN B
1. Elevation in boiling point	a. Ethylene glycol
2.Depression in freezing point	b. RO purifier
3.Osmotic pressure	c. Soda water
4.Henry’s Law	d. Sodium chloride

Which of the following is the best matched option?

a) 1.c , 2.d , 3.a , 4. b
b) 1.d, 2.a , 3.b , 4.c
c) 1.b , 2 .a , 3 .b , 4. C
d) 1 .c , 2.b , 3 .d , 4 .a

44. Match the following:

COLUMN A	COLUMN B
1. Gold ornaments	a. Liquid in solid
2. Sodium amalgam	b. Solid in liquid
3. Soda water	c. Solid in solid
4. Glucose solution	d. Gas in liquid

Which is the correctly matched option?

a) 1.c, 2.a, 3.d, 4.b
b) 1.c, 2.d, 3. a, 4. b
c) 1.d, 2.b, 3.c, 4. a
d) 1.b, 2.a , 3.c , 4d

45. Match the following:

COLUMN – A	COLUMN - B
1. Depression in freezing point	A. Ebullioscopy
2. Elevation in boiling point	B. Edema
3. Osmosis	C. Desalination of sea water
4. Reverse osmosis	D. Antifreeze Solution

Which is the correct option?

a) 1-C, 2-A ,3-D,4-B
b) 1-B, 2-C, 3-D,4-A
c) 1-C, 2-B,3-A, 4-D
d) 1-D, 2-A,3-B,4-C

46. Complete the following analogy:

Molarity: Mol/Litre:: _ _ _ _ _ _ : Mol/Kg

(a) Mole Fraction
(b) Molality
(c) Normality
(d) Formality

47. Which of the following analogies is correct?

a. Solid in solid : Alloy :: Liquid in liquid : Coolant in cars
b. Molality: Temperature:: Molarity : Volume
c. Henry's Law: Scuba Diver :: Raoult's Law : RO purifier
d. Helium : Cold Drinks:: Nitrogen : Bend

48. Complete the following analogy:

Ebullioscopy: Boiling point elevation : : ___________: Freezing point depression.

a. Osmotic pressure
b. Raoult’s law
c. Cryoscopy
d. Relative lowering in vapour pressure

49. Complete the following analogy:

Boiling point elevation: molality : : Molarity : ________________.

a. Freezing point depression
b. Osmotic pressure
c. Vapour pressure
d. Relative lowering in vapour pressure

50. Which of the following analogies is correct?

a. Low pressure: Anoxia :: High pressure : Bends
b. Solid solution : Amalgam ::Liquid solution : Solution of hydrogen in palladium
c. Mole fraction : Avogadro number :: Mass percentage : Concentration expression
d. Henry’s Law : Solubility related to partial pressure :: Raoult’s law : Partial pressure related to molarity

ANSWER KEY

1.a	2.b	3.c	4.c	5.b	6.b	7.b	8.b	9.b	10.c
11.c	12.a	13.d	14.d	15.d	16.a	17.b	18.b	19.b	20.a
21.c	22.a	23.a	24.c	25.a	26.a	27.d	28.a	29.b	30.a
31.c	32.a	33.a	34.c	35.d	36.a	37.d	38.b	39.c	40.b
41.c	42.b	43.b	44.a	45.d	46.b	47.a	48.c	49.b	50.a

ASSERTION -REASON TYPE QUESTIONS

- In the following questions, two statements (Assertion) A and Reason (R) are given. Mark
  (a) If A and R both are correct and R is the correct explanation of A
  (b) If A and R both are correct but R is not the correct explanation of A
  (c) A is true but R is false
  (d) A is false but R is true

1. **Assertion**: Camphor is used as a solvent in the determination of molecular weight on non-volatile solute.
   Reason: Camphor has high molal elevation constant

2. **Assertion**: When a blood cell is placed in hypertonic solution, it shrinks.
   Reason: Blood is isotonic with 0.9% NaCl solution.

3. **Assertion**: The aquatic species feel more comfortable in winter than summer
   Reason: Solubility of gases increases with increase of temperature.

4. **Assertion**: Solubility of gas increases with increase in K_H value.
   Reason: Henry's law constant, K_H is directly proportional to temperature.

5. **Assertion**: Azeotropic mixture are formed only by non-ideal solutions.
   Reason: Boiling point of an azeotropic is either higher than both the components or lower than both the components.

6. **Assertion**: Soft drink and soda water bottles are sealed under high pressure.
   Reason: The dissolution of gas in liquid is an endothermic process.

7. **Assertion**: On adding non-volatile solute to water its vapour pressure increases.
   Reason: Relative lowering of vapour pressure is a colligative property

8. **Assertion**: Addition of ethylene glycol to water lowers the freezing point of water, therefore, used as antifreeze.
   Reason: 1, 2-Ethanediol is soluble in water because it can form H-bond with water, therefore vapour pressure of solution is lowered.

9. **Assertion**: In an ideal solution, ΔH_{mix} is zero.
   Reason: In an ideal solution, A – B interactions are lower than A-A and B-B interactions.

10. **Assertion**: Mixture of ethanol and cyclohexane forms a solution with negative deviation from Raoult's law.
    Reason: When ethanol mixes in cyclohexane, it reduces the intermolecular force between ethanol molecules.

11. **Assertion**: The boiling point of an azeotropic mixture of water and ethanol is less than that of water and ethanol.
    Reason: Azeotropic mixture of water and ethanol show positive deviation from Raoult's law.

12. **Assertion**: Larger the value of cryoscopic constant of the solvent, lesser will be the freezing point of solution.
    Reason: Depression in freezing point depends on the nature of the solvent.

13. **Assertion**: An aqueous solution of NaCl freezes below 273 K.
    Reason: Vapour pressure of the solution is less than that of the pure solvent.

14. **Assertion**: Ebullioscopy or cryoscopy cannot be used effectively for measuring the molar mass of polymers.
    Reason: The high molecular weight solute leads to very low value of ΔT_b or ΔT_f

15. **Assertion**: Osmosis involves movement of solvent molecules from its lower concentration to its higher concentration.
    Reason: Solution having the same osmotic pressure are called isotonic solution.

16. **Assertion**: When blood cell is placed in a solution containing 1.5 % NaCl, it will shrink.

Reason: Blood is isotonic with 1.5% NaCl solution.

17. **Assertion**: Molarity of a solution in liquid state changes with temperature.
    Reason: The volume of a solution changes with change in temperature.

18. **Assertion**: On adding a non-volatile solute to a solvent, the vapour pressure of the solution gets lowered.
    Reason: A solution is said to be ideal if it strictly obeys Raoult's law at all concentrations and temperatures.

19. **Assertion**: The molar mass of polymers is best measured with osmotic pressure method.
    Reason: Osmotic pressure is directly proportional to molality of the solution.

20. **Assertion**: In a pressure cooker, the water is brought to boil. The cooker is then removed from the stove. Now on removing the lid of pressure cooker, the water starts boiling again.
    Reason: The impurities in water bring down its boiling point.

ANSWER KEY

1.(a)	2.(b)	3.(c)	4.(d)	5.(b)	6.(c)	7. (d)	8.(a)	9.(c)	10.(d)
11.(a)	12.(c)	13.(a)	14.(a)	15.(b)	16.(c)	17.(a)	18.(b)	19.(c)	20.(c)

CASE BASED QUESTIONS

I. Read the passage given below and answer the following questions.

Osmosis and reverse osmosis are two phenomena of paramount significance. Osmosis plays vital role in the transport of water and solutes through biological membranes. It accounts for fluid transport out of the kidney tubules and the gastrointestinal tract, into capillaries, and across cell membranes. Osmosis occurs through biological and artificial membranes of widely different composition. Osmotic pressure method is usually used for determination of molar masses of polymers and biomolecules. When the pressure greater than osmotic pressure is applied on solution side reverse osmosis occurs through the membrane. Reverse osmosis membrane technology has developed over the past 40 years to a 44% share in world desalting production capacity, and an 80% share in the total number of desalination plants installed worldwide. The use of membrane desalination has increased as materials have improved and costs have decreased. Today, reverse osmosis membranes are the leading technology for new desalination installations, and they are applied to a variety of salt water resources using tailored pretreatment and membrane system design.

1. **In isotonic solution:**
   (i) Osmotic pressure is same
   (ii) Solute and solvent both are same.

(iii) Solute is always same solvent may be different

(iv) Solute and solvent may or may not be same.

(a) (i) & (ii)

(b) (i) & (iii)

(c) (i) & (iv)

(d) Only (i)

2. Which of the following substance is used in synthetic semipermeable membrane for desalination of water?

(a) Cellulose acetate

(b) Charcoal

(c) Silica gel

(d) Glycogen

3. In the phenomenon of reverse osmosis through semi permeable membrane:

(a) Solvent molecules pass from solvent to solution.

(b) Solvent molecules pass from solution to solvent.

(c) Solute molecules pass from solution to solvent.

(d) Solute molecules pass from solvent to solution.

4. The semipermeable membrane used in the measurement of osmotic pressure of a solution allows the passage of:

(a) Only solvent molecules through it.

(b) Only solute molecules through it.

(c) Both solvent and solute molecules through it simultaneously.

(d) Either solvent or solute and not both.

II. Read the passage given below and answer the following questions:

Boiling point or freezing point of liquid solution would be affected by the dissolved solids in the liquid phase. A soluble solid in solution has the effect of raising its boiling point and depressing its freezing point. The addition of non-volatile substances to a solvent decreases the vapor pressure and the added solute particles affect the formation of pure solvent crystals. According to many researches the decrease in freezing point directly correlated to the concentration of solutes dissolved in the solvent. This phenomenon is expressed as freezing point depression and it is useful for several applications such as freeze concentration of liquid food and to find the molar mass of an unknown solute in the solution. Freeze concentration is a high quality liquid food concentration method where water is removed by forming ice crystals. This is done by cooling the liquid food below the freezing point of the solution. The freezing point depression is referred as a colligative property and it is proportional to the molal concentration of the solution (m), along with vapour pressure lowering, boiling point elevation, and osmotic pressure. These are physical characteristics of solutions that depend only on the identity of the solvent and the concentration of the solute. The characters are not depending on the solute's identity.

1. **Which of the following property does not depend upon the number of solute particles only?**

   (a) Boiling point elevation

   (b) Vapour pressure

   (c) Osmotic pressure

   (d) Depression in freezing point

2. **Identify which of the following is a colligative property:**

   (a) freezing point

   (b) boiling point

   (c) osmotic pressure

   (d) all of the above

3. **Determination of correct molecular mass from Raoult's law is applicable to:**

   (a) A volatile solute in concentrated solution.

   (b) An electrolyte in concentrated solution.

   (c) A non-volatile solute in a dilute solution

   (d) A non-electrolyte in concentrated solution.

4. **Which of the following compounds is used as antifreeze in automobile radiators in cold countries?**

   (a) Ethyl alcohol

   (b) Ethylene glycol

   (c) Ethyl Methyl ether

   (d) Ethyl benzene

ANSWER KEY

I	1.(c)	2.(a)	3.(b)	4.(a)
II	1.(b)	2. (c)	3.(c)	4.(b)

CHAPTER 7

P-BLOCK ELEMENTS

GIST OF LESSON

GROUP 15 ELEMENTS

Nitrogen and phosphorus are non-metals, arsenic and antimony metalloids and bismuth is a metal.

Only a small increase in covalent radius is observed from arsenic to bismuth due to presence of half-filled d/f orbitals.

Ionisation enthalpy of group 15 elements is higher than that group 14, due to extra stability of half-filled p-orbitals and small size.

The stability of +5 oxidation state of these elements decreases as we move from top to bottom in the group and +3 state become more stable due to inert pair effect.

Maximum covalency of nitrogen is 4, due to small size and it contain only four orbitals.

Bond enthalpy of nitrogen is very high due to the presence of triple bond present between nitrogen atoms.

$R_3P=O$ exists but $R_3N=O$ does not exist; coz nitrogen lacks d-orbital and not able to form $d\pi - P\pi\ bonding$.

BiH_3 is reducing due to low bond dissociation enthalpy.

Basicity decreasing order among hydrides is $NH_3>PH_3>AsH_3>SbH_3>BiH_3$.

N_2O_3, P_2O_3 are acidic oxides, As_2O_3 and Sb_2O_3 are amphoteric while Bi_2O_3 is basic.

NCl_5 is not possible but PCl_5 is possible because nitrogen lacks d-orbitals.

PH_3 has lower boiling point than NH_3 due absence of hydrogen bonding.

Very pure nitrogen can be prepared from barium azide,

$$Ba(N_3)_2 \longrightarrow Ba + 3N_2.$$

Ammonia is manufactured by Haber process where Iron oxide with K_2O and Al_2O_3 is catalyst.

Ammonia can be used to detect metals since it a Lewis base and it can donate an electron pair and can produce coloured complexes. For example,

$$Cu^{2+} + 4NH_3 \longrightarrow [Cu\ (NH_3)_4]^{2+} \text{ (deep blue).}$$

N_2O, NO are neutral, NO_2, N_2O_3, N_2O_4, N_2O_5 are acidic.

Starting material for the preparation of nitric acid by Ostwald's process is NH_3.

In structure of nitric acid, the N-O bond is shorter than N-OH bond due to double bond character (resonance).

Due to oxide layer formation, metals like chromium and aluminium will not dissolve in nitric acid.

Zinc and copper react with concentrated nitric acid to give NO_2 as one of the major products while copper reacts with dilute nitric acid to give NO similarly zinc reacts with dilute HNO_3 to give N_2O.

GROUP-16 ELEMENTS

Ionisation enthalpy of these elements is very low because of change from p^4 to more stable p^3 electronic configuration.

Because of compact nature of oxygen atom, it has less negative electron gain enthalpy than sulphur

Oxygen is having an anomalous behaviour due to small size and high electronegativity.

Absence of d orbitals limits covalency of oxygen to four.

H_2O is a liquid while H_2S is gas, due to hydrogen bonding in H_2O.

Among hydrides the acidity decreases from H_2O to H_2Te, due to decrease in bond dissociation enthalpy.

SF_6 is exceptionally stable due to steric reasons.

The geometry of tetrafluorides of group 16 elements is See-Saw with sp^3d hybridisation.

Some initial heating is needed for the reaction of oxygen which is used for the breakage of oxygen-oxygen double bond.

SO_2, Cl_2O_7, CO_2, N_2O_5 are acidic oxides, Na_2O, CaO, BaO are basic oxides, Al_2O_3 is amphoteric, CO, NO, N_2O are neutral oxides.

$$Al_2O_{3(s)} + 6HCl_{(aq)} + 9H_2O \longrightarrow 2[Al(H_2O)_6]^{3+}_{(aq)} + 6Cl^-_{(aq)}$$

$$Al_2O_{3(s)} + 6NaOH_{(aq)} + 3H_2O_{(l)} \longrightarrow 2Na[Al(OH)_6]_{(aq)}$$

Ozone is thermodynamically unstable with respect to oxygen because its decomposition in to oxygen results in liberation of heat and an increase in entropy.

Due to liberation of nascent oxygen, ozone acts as a powerful oxidising agent.

Ozone reacts with excess of potassium iodide solution buffered with borate buffer; iodine will be liberated which can be titrated against standard solution of sodium thiosulphate solution. This is the most effective method for the estimation of ozone.

NO gas from emission of jet airways will slowly deplete because NO club with ozone to give higher oxides of nitrogen.

The two oxygen-oxygen bond length in ozone are same because of resonance.

Rhombic sulphur is most stable at room temperature, which transforms in to monoclinic above 369K (transition temperature).

Due to unpaired electrons in antibonding $\pi *$ orbital like O_2, S_2 molecule which is in vapour state is also paramagnetic in nature.

Sulphur dioxide reacts with water to give sulphurous acid (H_2SO_3).

Moist SO_2 gas is a reducing agent, it decolourises acidified potassium permanganate as;

$$5SO_2 + 2MnO_4^- + 2H_2O \longrightarrow 5SO_4^{2-} + 4H^+ + 2Mn^{2+}$$

Sulphuric acid is manufactured by contact process, where vanadium pentoxide is used as catalyst.

It is low volatile, so used for preparing more volatile acids. Strongly acidic, have great affinity towards water and is a good oxidising agent.

$$C_{12}H_{22}O_{11} \rightarrow 12C + 11H_2O$$

$$Cu + 2H_2SO_4 \text{ (conc)} \rightarrow CuSO_4 + SO_2 + 2H_2O$$

GROUP 17 ELEMENTS

Halogens have the smallest atomic radii in their respective periods due to maximum effective nuclear charge.

Halogens have little tendency to lose electron, thus they have high ionisation enthalpy. Due to increase in size I.E decreases down the group.

The negative electron gain enthalpy of halogens is maximum across the period due to the fact that the atoms of these elements have only one electron less than stable noble gas configuration.

Electron gain enthalpy of fluorine is less than that of chlorine, because the presence of strong interelectronic repulsion in relatively small 2p orbital of fluorine.

Bond dissociation enthalpy of X-X bond in halogens is in the order Cl-Cl>Br-Br>F-F>I-I, this anomalous value of fluorine is due to relatively large electron-electron repulsion among lone pairs in F_2molecule.

Fluorine shows only -1 oxidation state due to its high electronegativity and lack of d-orbitals.

Fluorine oxidises water to oxygen whereas chlorine and bromine oxidises water to corresponding hydrohalic as well as hypohalous acid.

Acidic strength order of hydrogen halides is $HF<HCl<HBr<HI$

Stability order of hydrogen halides is $HF>HCl>HBr>HI$.

OF_2 and O_2F_2 are strong fluorinating agents, O_2F_2 oxidises plutonium to PuF_6 and this reaction is used for the removal of plutonium from spent nuclear fuel.

Iodine oxides are insoluble solids, I_2O_5 is used in the estimation of carbon monoxide.

Chlorine can be prepared from MnO_2 and $KMnO_4$ as,

$$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$$

$$2KMnO_4 + 16HCl \rightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$$

Deacon's process: -Preparation of chlorine by oxidation of hydrogen chloride in presence of $CuCl_2$

$$4HCl + O_2 \rightarrow 2Cl_2 + 2H_2O$$

Some reactions of chlorine

$$8NH_3(\text{excess}) + 3Cl_2 \rightarrow 6NH_4Cl + N_2$$

$$NH_3 + 3Cl_2(\text{excess}) \rightarrow NCl_3 + 3HCl$$

$$2NaOH\ (\text{cold and dilute}) + Cl_2 \rightarrow NaCl + NaOCl + H_2O$$

$$6NaOH\ (\text{hot and conc.}) + 3Cl_2 \rightarrow 5NaCl + NaClO_3 + 3H_2O$$

When chlorine gas is passed through dry slacked lime, bleaching powder is formed

$$2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O.$$

Chlorine water on standing loses its yellow colour due to the formation of HCl and HOCl. Hypochlorous acid (HOCl) so formed, gives nascent oxygen which is responsible for the oxidising and bleaching power of chlorine.

$$Cl_2 + H_2O \rightarrow 2HCl + (O)$$

Poisonous gases like phosgene, tear gas, mustard gas can be prepared from chlorine.

Hydrogen chloride gas can be dried by passing it through concentrated sulphuric acid.

Aqueous solution of hydrogen chloride gas is called hydrochloric acid, its dissociation constant value is very high so it is a strong acid.

Three part of concentrated HCl and one part of concentrated nitric acid is called aqua regia, even noble metals like gold and platinum will dissolve in it.

The main Oxo-acids of halogens are Hypohalous acid, halous acid, halic acid and perhalic acid.

Fluorine forms only one Oxo-acid and is HOF (fluoric acid/hypofluorous acid).

Interhalogen compounds have general formula XX'. Where X is larger in size than X'. Also X is more electropositive.

The common formula of inter halogen compounds are XX', XX3', XX5', XX7'.

Shapes of these compounds are XX3'-Bent-T-shape, XX5'-Square pyramidal, XX7'-Pentagonal bipyramidal.

The bond strength in interhalogen compounds is lower than normal halogens.

GROUP-18 ELEMENTS

Because of stable electronic configuration (ns^2np^6), ionisation energy of noble gases is very high.

Noble gases have very low boiling point because they are monoatomic.

First noble gas compound found is $Xe^+PtF_6^-$.

Xenon reacts with fluorine to form a large number of compounds,

$Xe_{(g)} + F_{2\,(g)} \xrightarrow{673K,\ 1bar} XeF_2(s)$

(Xenon in excess)

$Xe_{(g)} + 2F_{2\,(g)} \xrightarrow{873K,\ 7br} XeF_4(s)$

(1:5 ratio)

$Xe_{(g)} + 3F_{2\,(g)} \xrightarrow{573K,\ 60\text{-}70bar} XeF_{6(s)}$

(1:20ratio)

Some reactions of xenon compounds

$XeF_2 + PF_5 \longrightarrow [XeF]^+[PF_6]^-$

$XeF_4 + SbF_5 \longrightarrow [XeF_3]^+[SbF_6]^-$

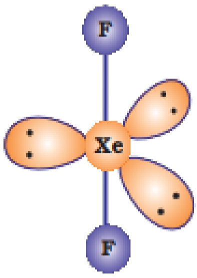
$XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$

$XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4HF$

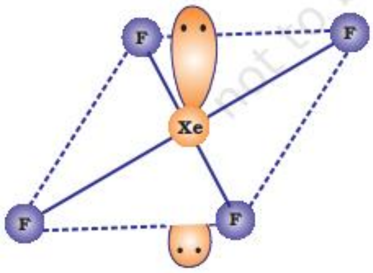
$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

Shapes of xenon compounds

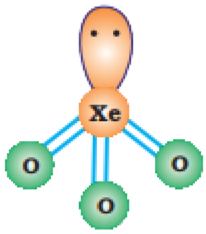
XeF_2-Linear



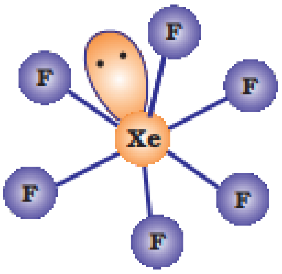
XeF_4 –Square planar



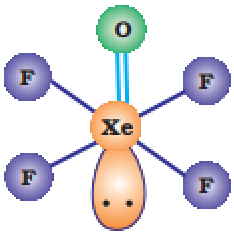
XeO_3-pyramidal



XeF_6-Distorted octahedral



$XeOF_4$-Square pyramidal



MULTIPLE CHOICE QUESTIONS

GROUP 15

1. **Dinitrogen is inert at room temperature. Why?**
   a) High bond dissociation enthalpy of N≡N
   b) High electronegativity of Nitrogen
   c) Small size of Nitrogen
   d) Absence of d orbitals in the valence shell of Nitrogen

2. **Arrange the hydrides of group 15 in the decreasing order of reducing strength**
   a) $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
   b) $BiH_3 > SbH_3 > AsH_3 > PH_3 > NH_3$
   c) $PH_3 > AsH_3 > SbH_3 > BiH_3 > NH_3$
   d) $AsH_3 > SbH_3 > BiH_3 > NH_3 > PH_3$

3. **The element which doesn't show allotropy among the following is**
   a) Antimony.
   b) Bismuth
   c) Nitrogen
   d) Phosphorus

4. **NH_3 has exceptionally higher boiling point compared to the other hydrides of group 15 because of**
   a) Strong intermolecular hydrogen bonding among NH_3 molecules
   b) Strong intra molecular hydrogen bond in NH_3 molecule
   c) Absence of d- orbitals in the valence shell of Nitrogen
   d) High bond enthalpy of N-H bond

5. **Very pure nitrogen can be obtained in the laboratory by which of the following methods**

a) Thermal decomposition of ammonium dichromate.
b) Thermal decomposition of sodium azide.
c) By treating an aqueous solution of ammonium chloride with sodium nitrite.
d) By treating an aqueous solution of ammonium sulphate with sodium nitrite

6. Ammonia acts as a Lewis base because of…
a) One Lone pair of electrons on N-atom in NH_3
b) Small size of N atom
c) High bond dissociation enthalpy of N-H bond
d) High electronegativity of N-atom

7. Match the following

I	II
i) Ostwald's process	A) Sulphuric acid
ii) Haber's process	B) Nitric acid
iii) Contact process	C) Ammonia

Which of the following is the best matched option
a) i-C,ii-A,iii-B
b) i-B,ii-C,iii-A
c) i-B,ii-A,iii-C
d) i-C,ii-B,iii-A

8. Which of these gases is released upon treating zinc with diluted and then concentrated nitric acid?
a) N_2 and N_2O
b) NO_2 and N_2O
c) NO and NO_2
d) N_2O and NO_2

9. For which of the following ions is the brown ring test useful for determining?
a) NO_2^+
b) NO_3^-.
c) N_3^-
d) NO_2^-

10. Which of these gases is released upon treating copper with diluted and then concentrated nitric acid?
a) N_2 and N_2O
b) NO_2 and N_2O
c) NO and NO_2
d) N_2O and NO_2

11. Products obtained when concentrated nitric acid is treated with sulphur are
a) SO_2, H_2O and NO_2

- b) H_2SO_4, H_2O and NO_2.
- c) H_2S, H_2O and NO.
- d) H_2SO_4, H_2O and N_2O.

12. Name the nitrogen containing gas obtained when ammonium sulphate is treated with caustic soda

- a) NO_2
- b) NO
- c) N_2O
- d) NH_3

13. Select the incorrect statement from the following

- a) PH_3 has lower boiling point than NH_3.
- b) Nitrogen doesn't form pentahalides.
- c) H-N-H bond angle in NH_3 is smaller than H-P-H bond angle in PH_3.
- d) BiH_3 is the least thermally stable hydride of group 15

GROUP 16

14. Which of the following methods is used to produce ozone from oxygen?

- a) Standard electric discharge
- b) Silent electric discharge.
- c) Thermal decomposition
- d) Heating in an atmosphere of excess oxygen

.

15. H_2S is more acidic than H_2O because

- a) H — O bond dissociation enthalpy is less as compared to H — S bond
- b) H — S bond dissociation enthalpy is less as compared to H — O bond
- c) Oxygen is more electronegative than sulphur
- d) Intermolecular hydrogen bonding in H_2O

16. Arrangement of hydrides of group 16 elements in order of increasing stability is,

- a) $H_2S < H_2O < H_2Te > H_2Se$
- b) $H_2O < H_2Te < H_2Se < H_2S$
- c) $H_2O < H_2S < H_2Se < H_2Te$
- d) $H_2Te < H_2Se < H_2S < H_2O$

17. **Why is ozone a powerful bleaching agent?**

a) It is highly electronegative
b) It can easily liberate Nascent oxygen
c) Instability of molecule
d) Large negative Gibb's energy.

18. H_2O is a liquid while H_2S is a gas. Why?

a) Due to high electronegativity of Oxygen water molecules are associated with strong intermolecular hydrogen bonding
b) Since H-O bond is stronger than H-S bond.
c) H_2O has greater van der Waal forces of attraction than H_2S
d) H_2O has angular geometry whereas H_2S has triagonal planar geometry.

19. Dioxygen exists as gas whereas other elements of the group are solids. Why?

a) Oxygen can form pΠ-dΠ multiple bond with itself
b) Oxygen cannot form pΠ-pΠ multiple bond with itself
c) Oxygen can form pΠ-pΠ multiple bond with itself
d) Elements of group 16 other than Hydrogen can form pΠ-pΠ multiple bond with itself

20. Which among the following is an exceptionally stable compound of Sulphur?

a) SF_4
b) S_2F_2
c) SF_6
d) SCl_4

21. What are the favorable conditions for maximum yield of Sulphur trioxide in contact process for the manufacture of sulphuric acid?

a) High pressure, low temperature, excess of oxygen.
b) High pressure, low temperature, less oxygen.
c) Low pressure, low temperature, excess of oxygen.
d) High pressure, high temperature, excess of oxygen.

22. What is the catalyst used in contact process in the conversion of Sulphur dioxide to Sulphur trioxide?

a) Finely divided iron.
b) Molybdenum.
c) Divanadium pentoxide.
d) Platinum

23. Amphoteric oxide among the following is,

a) MgO
b) CaO
c) SO_2
d) Al_2O_3

24. Oxoacid of Sulphur having a lone pair of electrons on Sulphur

a) H_2SO_3
b) H_2SO_4
c) $H_2S_2O_8$
d) $H_2S_2O_7$

25. The acid obtained when Sulphur trioxide gas is passed through water is,

a) $H_2S_2O_7$.
b) H_2SO_4
c) H_2SO_3
d) $H_2S_2O_8$

26. For an aqueous solution of sulphuric acid which among the following is correct

a) $K_{a1} << K_{a2}$
b) $K_{a1} = K_{a2}$
c) $K_{a2} << K_{a1}$
d) $K_{a2} << K_{a3}$

GROUP 17

27. What is the correct order of enthalpy of dissociation of halogens?

a) $F_2 > Cl_2 > Br_2 > I_2$
b) $Cl_2 > Br_2 > F_2 > I_2$
c) $Cl_2 > F_2 > Br_2 > I_2$
d) $F_2 > Br_2 > Cl_2 > I_2$

28. Affinity for hydrogen decreases in the group from fluorine to iodine. Which of the halogen acids should have highest bond dissociation enthalpy?

a) HF
b) HCl
c) HBr
d) HI

29. Pick the oxidation state possible for Fluorine from the following.

a) +1
b) -1
c) +3
d) +7

30. Increasing order of acidity of grp 17 hydrohalic acids are.

a) HF<HCl<HBr<HI
b) HF>HCl>HBr>HI
c) HI>HBr>HCl>HF
d) HI<HBr<HCl<HF

31. The oxoacid formed by fluorine is

a) HOF
b) HFO_2
c) HFO_3
d) HFO_4

32. The products obtained when chlorine reacts with water are,

a) HCl and HOCl
b) HCl and O_2
c) HClO and O_2
d) HCl and $HClO_2$

33. Select the liquid hydrogen halide

a) HI
b) HBr
c) HCl
d) HF

34. With cold dilute alkali, chlorine produces a mixture of…

a) Chloride and hypochlorite
b) Chloride and chlorate
c) Hypochlorite and chlorate
d) Hypochlorite and chlorite

35. Choose the correct analogy

a) ClF:Linear :: ClF_3: Triagonal planar
b) BrF_3: Bent T- shape :: BrF_5: Square pyramidal
c) ICl:Linear :: IF_7:Octahedral
d) IF_7:Pentagonal bipyramidal :: ICl_3: Triagonal planar

36. ICl is more reactive than I_2

a) I-Cl bond is stronger than I-I bond.
b) I-I bond is weaker than I-Cl bond.
c) I-Cl bond is weaker than I-I bond.
d) Cl-Cl bond is weaker than I-Cl bond

37. The interhalogen compound used in the enrichment of ^{235}U among the following is

a) ClF_3
b) ICl
c) BrF_5
d) IF_7

38. Fluorine exhibits only -1 oxidation state whereas other halogens exhibit $^+1$,$^+3$,$^+5$ and $^+7$ because of

a) Greater interelectronic repulsion in Fluorine
b) Low bond dissociation enthalpy of F-F
c) Strong oxidising property of fluorine
d) Absence of d orbitals in fluorine

39. The products obtained when excess of ammonia react with chlorine are,

a) NH_4Cl and N_2
b) NCl_3 and HCl
c) NH_4Cl and HCl
d) NCl_3 and N_2

GROUP 18

40. The complete hydrolysis of XeF_6 gives

a) $XeOF_4$
b) XeO_3
c) XeO_2F_2
d) XeF_4

41. Helium is used in diving apparatus because it is

a) highly soluble in water.
b) having high ionisation enthalpy.
c) less soluble in water.
d) non polarizable

42. The formation of $O_2^+ [PtF_6]^-$ is the basis for the formation of first xenon compound. This is because

a) O_2 and Xe have different sizes
b) both O_2 and Xe are gases
c) O_2 and Xe have comparable electro-negativities
d) O_2 and Xe have comparable first ionisation enthalpies

43. The noble gas which does not form compounds is

a) He
b) Kr
c) Xe
d) Rn

44. Match the following

I	II
i) XeF_2	A) Square planar
ii) XeF_4	B) Distorted octahedral
iii) XeF_6	C) Linear
iv) XeO_3	D) Square pyramidal
v) $XeOF_4$	E) Pyramidal

Which of the following is the best matched option?

a) i-B,ii-A,iii-D,iv-E,v-C
b) i-C,ii-D,iii-B,iv-E,v-A.
c) i-E,ii-B, iii-E,iv-A,v-C.

d) i-C,ii-A,iii-B,iv-E,v-D

45. XeF_6 +NaF→

a) $Na^+[XeF_7]^-$
b) $[XeF_7]^-Na^+$.
c) $Na^+[XeF_6]^{-.}$
d) Na+[XeF_5]-

46. XeF_4 +SbF_5→

a) $[XeF_4]^+[SbF_5]^-$
b) $[SbF_6]^-[XeF_3]^+$
c) $[XeF_3]^+[SbF_6]^-$.
d) $[XeF_5]^+[SbF_4]^-$

47. XeF_2 + H_2O→

a) Xe +HF +O_2+ XeO_3
b) Xe +HF +O_2
c) XeO_3 + HF
d) $XeOF_4$ +HF

48. The molecule with more than one lone pair of electrons on Xe is,

a) XeO_3
b) XeF_6
c) $XeOF_4$
d) XeF_2

49. Name the noble gas obtained as a decay product of ^{226}Ra.

a) He
b) Kr
c) Xe
d) Rn

50. Noble gases have very low boiling points because of

a) Low molecular masses
b) High molecular masses
c) Weak dispersion forces.
d) High Ionisation enthalpies

ANSWER KEY

1	a	6	a	11	b	16	d	21	a	26	c	31	a	36	c	41	c	46	c
2	b	7	b	12	d	17	b	22	c	27	b	32	a	37	a	42	d	47	b
3	c	8	d	13	c	18	a	23	d	28	a	33	d	38	d	43	a	48	d
4	a	9	c	14	b	19	b	24	a	29	b	34	a	39	a	44	d	49	d

5	b	10	d	15	b	20	c	25	b	30	a	35	b	40	b	45	a	50	c

ASSERTION - REASON TYPE OF QUESTIONS

In the following questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
b) Assertion and reason both are correct statements, but reason is not correct explanation for assertion.
c) Assertion is correct statement, but reason is wrong statement.
d) Assertion is wrong statement, but reason is correct statement.

1. **Assertion**: PH_3 has lower boiling point than NH_3.
   Reason: N-N bond is weaker than P-P bond.

2. **Assertion**: N exists as N_2 but P exists as P_8.
   Reason: Due to smaller size, N can form pπ-pπ multiple bonding and exists as discrete N_2 molecule but P cannot form pπ-pπ multiple bonding.

3. **Assertion**: $R_3P=O$ exists but $R_3N=O$ does not.
   Reason: Due to absence of d-orbitals, nitrogen cannot form pπ-dπ multiple bonds.

4. **Assertion**: +3 oxidation state of Bi is less stable than +5.
   Reason: Inert pair effect is prominent in Bi.

5. **Assertion**: Ozone is a powerful oxidizing agent.
   Reason: It decomposes to form nascent oxygen.

6. **Assertion**: Sulphur exhibits catenation but not oxygen.
   Reason: Because S-S bond is weaker than O-O bond.

7. **Assertion**: Thermal stability decreases from H_2O to H_2Te in group 16.
   Reason: Due to increase in atomic size from O to Te the bond dissociation energy decreases.

8. **Assertion:** SF_6 is less reactive than SF_4.
   Reason: In SF_6 sulphur atom is sterically hindered due to six F atoms.

9. **Assertion:** H_2S is less acidic than H_2Te.
   Reason: Bond energy of H-S is less than that of H-Te.

10. **Assertion**: H_2SO_4 has high viscosity and high boiling point.
Reason: H_2SO_4 shows strong H bonding.

11. **Assertion**: N_2 is less reactive at room temperature.
Reason: Nitrogen shows little catenation.

12. **Assertion**: O_2 is paramagnetic although it has even number of electrons.
Reason: Due to the presence of paired electrons in anti-bonding molecular orbitals.

13. **Assertion**: Halogens are coloured.
Reason: Due to absorption of radiation from VR.

14. **Assertion**: Noble gases have comparatively small atomic size.
Reason: Noble gases are mostly inert.

15. **Assertion**: Bond angle of H_2S is smaller than H_2O.
Reason: Electronegativity of the central atom increases, bond angle decreases.

16. **Assertion**: Bleaching by Cl_2 is permanent but by SO_2 is temporary.
Reason: Cl_2 bleaches by reduction while SO_2 does it by oxidation.

17. **Assertion**: Acid strength increases in the order HF< HCl < HBr < HI
Reason: As size increases from F to I, the bond dissociation energy decreases from HF to HI.

18. **Assertion**: HF is more volatile than HCl.
Reason: In HF there is intermolecular H-bonding so the HF molecules get associated.

19. **Assertion**: The magnitude of electron gain enthalpy of F is less than that of Cl.
Reason: Due to very small size of F there is inter electronic repulsion.

20. **Assertion**: ICl is more reactive than I_2.
Reason: The $I - Cl$ bond in ICl is stronger than $I - I$ bond in I_2.

21. **Assertion**: Helium is used in diving apparatus.
Reason: Helium is sparingly less soluble in blood.

22. **Assertion**: Noble gases have very low b.pt.
Reason: Noble gases have comparatively large atomic size.

23. **Assertion**: It is difficult to study the chemistry of Radon.
Reason: Because Radon is radioactive and hence very unstable.

24. **Assertion**: Halogens have maximum negative electron gain enthalpy.
Reason: Halogens have maximum electronegativity.

25. **Assertion**: Noble gases are diatomic.
Reason: Van der Wall's radii measured which is longer than covalent/ionic or metallic radii.

ANSWER KEY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
b	d	a	d	a	c	a	a	c	a	b	c	a	d	c	c	a	d	a	c	a	b	a	b	d

CASE BASED QUESTIONS

CASE STUDY -1

Read the passage given below and answer the following questions:

Group 15 elements exhibit variant physical properties due to their valence shell electronic configuration. Nitrogen is a diatomic gas, and the rest of the elements are solid in nature. Nitrogen and phosphorous are non-metal in nature while arsenic and antimony are metalloids. Bismuth is the heaviest non-radioactive metal in the periodic table. Likewise, as we go down the group the density of the element increases. All the group 15 elements except bismuth exhibit allotropy. As we go down the group, the main energy level also increases as new orbital are added with increasing atomic number. The valence electrons move further away from the nucleus making the atomic radii to increase. With increasing nuclear size, the melting and boiling also increase. Ionization energy shows how hard the nucleus is holding onto its outer most electrons while electronegativity shows the effectiveness of the shielding effect of the nucleus on the valence shell.

1. **Maximum covalency of nitrogen is**

   (a) 3 (b) 4 (c) 5 (d) 6

2. **Which of the following statements is not correct for nitrogen?**
   (a) Its electronegativity is very high
   (b) d-orbitals are available for bonding
   (c) It is a typical non-metal
   (d) Its molecular size is small

3. **Which of the following group 15 element forms metallic bonds in elemental state?**

(a)As (b) P (c) Sb (d) Bi

4. **Ionic radii of As^{3+}, Sb^{3+} and Bi^{3+} follow the order …**

   a) $As^{3+} > Sb^{3+} > Bi^{3+}$
   b) $Sb^{3+} > Bi^{3+} > As^{3+}$
   c) $Bi^{3+} > As^{3+} > Sb^{3+}$
   d) $Bi^{3+} > Sb^{3+} > As^{3+}$

5. **Amongst the following elements (whose electronic configurations are given below), the one having the highest ionization energy is**

   a) $[Ne]3s^2 3p^3$
   b) $[Ne] 3s^2 3p^1$
   c) $[Ne] 3s^2 3p^2$
   d) $[Ne] 3s^1$

ANSWER KEY

1	2	3	4	5
b	b	d	d	a

CASE STUDY -2

Read the passage given below and answer the following questions:

Nitric acid, (HNO_3) is colourless, fuming, and highly corrosive liquid . It is a common laboratory reagent and an important industrial chemical for the manufacture of fertilizers and explosives. It is toxic and can cause severe burns . The preparation and use of nitric acid were known to the early alchemists. A common laboratory process used for many years, ascribed to a German chemist, Johann Rudolf Glauber (1648), consisted of heating potassium nitrate with concentrated sulphuric acid. The principal method of manufacture of nitric acid is the catalytic oxidation of ammonia. Nitric acid decomposes into water, nitrogen dioxide, and oxygen, forming a brownish yellow solution. It is a strong acid, completely ionized into hydronium (H_3O^+) and nitrate (NO_3^-) ions in aqueous solution, and a powerful oxidizing agent .

1. **What is the name of the industrial process to manufacture nitric acid?**
   a) Contact process
   b) Haber-Bosch process
   c) Solvay process
   d) Ostwald's process

2. **What is the catalyst used in the industrial manufacture of nitric acid?**
   a) Powdered iron (III) oxide
   b) Vanadium (V) oxide
   c) Zinc-mercury amalgam
   d) Platinum-Rhodium gauze sheet

3. **Which of these gases is released upon treating zinc with diluted and then concentrated nitric acid?**
   a) Nitrogen dioxide and nitrous oxide
   b) Nitric oxide and nitrous oxide
   c) Nitrous oxide and nitrogen dioxide
   d) Nitrous oxide and nitric oxide

4. **The formula of the complex formed during Brown ring test of nitrate radical is**
   (a) $[Fe (H_2O)_3 (NO)]^{2+}$
   (b) $[Fe (H_2O)_5(NO)]^{2+}$
   (c) $[Fe (H_2O)_4 (NO)]^{2+}$
   (d) $[Fe (H_2O)_2(NO)]^{2+}$

5. **Which of the following is true regarding nitric acid?**
   (a) It is a strong reducing agent
   (b) It is a weak oxidizing agent
   (c) Its basicity is unity
   (d) It is non-planar in gaseous state

ANSWER KEY

1	2	3	4	5
d	d	c	b	c

CASE STUDY -3

Read the passage given below and answer the following questions:

Sulphur dioxide is the chemical compound with the formula SO_2.It is a toxic gas responsible for the smell of burnt matches. It is released naturally by volcanic activity and is produced as a by-product of copper extraction and the burning of sulphur-bearing fossil fuels. Sulphur dioxide has a pungent smell like nitric acid. Sulphur dioxide is found on earth and exists in very small concentrations and in the atmosphere at about 1 ppm. Sulphur dioxide is primarily produced for sulphuric acid manufacture. Sulphur dioxide is also a good reductant. In the presence of water, sulphur dioxide can decolourise substances. Specifically, it is a useful reducing bleaching agent for papers and delicate materials such as clothes. Sulphur dioxide is a major air pollutant and has significant impacts upon human health. In addition, the concentration of sulphur dioxide in the atmosphere can influence the habitat suitability for plant communities, as well as animal life. Sulphur dioxide emissions are a precursor to acid rain and atmospheric particulates.

1.**Which of the following product is formed by the reaction of sulphur dioxide with chlorine in presence of sunlight:**

(a)SO_2Cl
(b) SO_2Cl_2
(c) $SOCl_2$
(d) SO_3Cl

2. **Bleaching action of SO_2 is due to**
a) Reduction
b) Oxidation
c) Hydrolysis
d) Its acidic nature

3. **Acid rain reacts with marble and limestone to form**

(a) calcium carbonate
(b) calcium hydroxide
(c) calcium sulphate
(d) none of the above

4. **The hybridization of sulphur in SO_2, is**
a) sp^3
b) sp
c) dsp^2
d) sp^2

5. **$xSO_2 + yMnO_4^- + zH_2O \rightarrow Mn^{2+} + SO_4^{2-} + H^+$. In this, three values of x, y, z**
(a) 5,2,2
(b) 4,3,2
(c) 5,3,2
(d) 6,3,2

ANSWER KEY

1	2	3	4	5
b	a	c	d	a

CASE STUDY -4

Read the passage given below and answer the following questions:

Chlorine was discovered in 1774 by Carl Wilhelm Scheele, who mistakenly thought it as oxygen. Chlorine was given its name in 1810 by Humphry Davy, who insisted that it was in fact an element. The pure chemical element has the physical form of a diatomic green gas. The name chlorine is derived from ‘chloros’ meaning green, referring to the colour of the gas. Chlorine gas is two and one-half times as heavy as air, has an intensely disagreeable suffocating odour, and is exceedingly poisonous. In its liquid and solid form, it is a powerful oxidising, bleaching, and disinfecting agent.

The halogens react with each other to form interhalogen compounds. Interhalogens are all prone to hydrolysis and ionise to give rise to polyatomic ions. The inter halogens are generally more reactive. The structures found for the various interhalogens conform to what would be expected based on the VSEPR model.

1.**Chlorine is a powerful bleaching agent; identify the correct statement/s**

I) Bleaching action is due to oxidation
II) It bleaches in presence of moisture only
III) Bleaching effect of chlorine is temporary
IV) Bleaching effect of chlorine is permanent
V) Bleaching action is due to reduction
VI) It bleaches in dry state also

(a) I, II,IV (b) I,II,III (c) IV,V,VI (d) II,IV,VI

2.**The shape of ClF_5 is**

(a) Square pyramidal
(b) Octahedral
(c) Trigonal bipyramidal
(d) T-shape

3.**Chlorine water loses its yellow colour on standing because:**

(a) HCl gas is produced, due to the action of sunlight.
(b) A mixture of HOCl and HCl is produced in the presence of light
(c) HOCl and hydrogen gas is produced
(d) a mixture of HCl and ClO_3 is produced, due to the action of sunlight

4.**Ammonia reacts with excess Cl_2 of to form**

(a) NH_4Cl
(b) N_2 + HCl
(c) N_2 + NH_4Cl
(d) NCl_3 + HCl

5.**Preparation of chlorine by the oxidation of hydrogen chloride gas in presence of $CuCl_2$ is**

(a)Deacon's process
(b)Contact process
(c)Electrolytic process
(d)None of the above

ANSWER KEY

1	2	3	4	5
a	a	b	d	a

CASE STUDY -5

Read the passage given below and answer the following questions:

Noble gases located next to the halogen group in the periodic table have closed-shell electronic configurations, they lack reactivity, and their compounds were unknown. Consequently, they were also called inert gases. Although the first xenon compound was reported (1962) as $XePtF_6$, the discoverer, N. Bartlett, later corrected that it was not a pure compound but a mixture of Xe $[PtF_6]_x$ (x = 1-2). If this is mixed with fluorine gas and excited with heat or light, fluorides XeF_2, XeF_4, and XeF_6 and are generated. Although preparation of these compounds is comparatively simple, it is not easy to isolate pure compounds. Xenon reacts with elements with the largest electronegativities, such as fluorine, oxygen, and chlorine and with the compounds containing these elements, like platinum fluoride, PtF_6. Hydrolysis of the xenon fluorides forms xenon oxides. Although these compounds are stable in aqueous solution, these solutions are very oxidising.

1. **The number of bond pairs and lone pairs of electrons around Xe in XeF_2 respectively are**
   (a) 2 and 4
   (b) 1 and 5
   (c) 1 and 4
   (d) 2 and 3

2. **When Xenon reacts with fluorine in a ratio of 1:5 at a temperature of 873K it forms**
   (a)XeF_4
   (b)XeF_6
   (c)$XeOF_4$
   (d) XeF

3.**The shape of XeF_6 is**
   (a) Square pyramidal
   (b) Octahedral
   (c) Trigonal bipyramidal
   (d) Distorted Octahedral

4. **Which of the following statement is incorrect about noble gases**
   (a)They have more positive electron gain enthalpy
   (b)They have very high ionisation energy
   (c)They have low boiling points.
   (d)They all have an outer electronic configuration of ns^2np^6.

5.**Hydrolysis of XeF_4 and XeF_6 with water gives**
   (a)XeO_3
   (b)XeO
   (c)XeO_2F_4
   (d)$XeOF_2$

ANSWER KEY

1	2	3	4	5
d	a	d	d	a

CHAPTER 10

HALOALKANES AND HALOARENES

GIST OF THE LESSON

CLASSIFICATION

a) Compounds containing halogen atom bonded to *sp*^{3} hybridised carbon atom:

i) Alkyl halides or Haloalkanes (R-X) : They form a homogeneous series represented by the formula C_nH_{2n+1} . R-X can be primary (1^0) R-CH_2-X , secondary (2^0) R_2CH-X or Tertiary (3^0) R_3C-X

Examples : Primary : CH_3Cl, CH_3-CH_2-Br

Secondary : $(CH_3)_2$ –CH-Br

Tertiary : $(CH_3)_3$-C-Cl

ii) Allylic halides : Halogen atom is bonded to ***sp*^{3}** carbon which in turn is bonded to ***sp*^{2}** carbon of an aliphatic chain/ alicyclic chain.

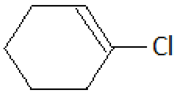
Example : CH_2═CH-CH_2-Cl

iii) Benzylic halides : Halogen is bonded to ***sp*^{3}** carbon which in turn is bonded to ***sp*^{2}** carbon of an aromatic ring .

b) Compounds containing halogen atom bonded to *sp*^{2} hybridised carbon atom:

i) Vinylic halides : Halogen atom is bonded to sp^2 carbon atom of an aliphatic/ alicyclic chain

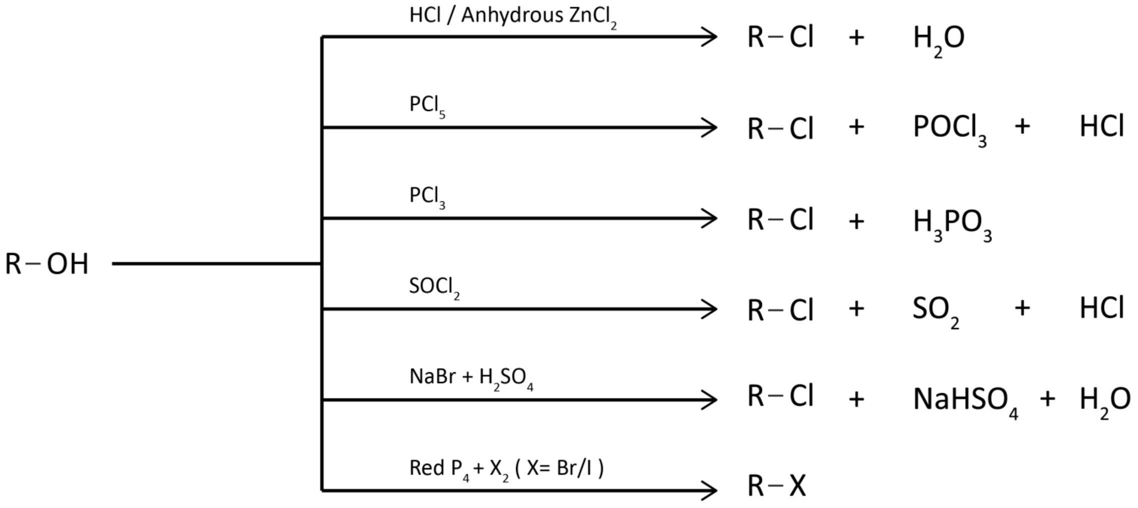
Example: CH_2 = CH-Cl,



ii) Aryl halides : Halogen is bonded to ***sp*^{2}** carbon of an aromatic ring. Halogen is bonded to ***sp*^{2}** carbon of an aromatic ring.

METHOD OF PREPARATION OF ALKYL HALIDES

a) From alcohols



b) From Alkenes

i) By addition of HX (Markovnikov's rule)

eg : $CH_3- CH= CH_2 + HCl \xrightarrow{} CH_3- CH(Cl)- CH_3$ (major product)

Antimarkovnikov's rule for HBr addition in presence of Benzoyl peroxide

$$CH_3- CH= CH_2 + HBr \xrightarrow{\text{Benzoyl peroxide}} CH_3-CH_2-CH_2-Br \text{ (major product)}$$

ii) By addition of halogen

$$CH_2=CH_2 + Br_2 \xrightarrow{CCl_4} Br-CH_2-CH_2-Br$$

(Test for unsaturation since the reddish brown colour of Br_2 is discharged)

c) By halogen exchange reactions

i) Finkelstein reaction

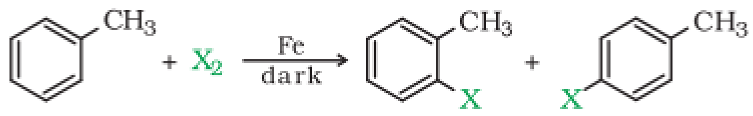
$$R-X \text{ (X= Cl or Br) } + NaI \xrightarrow{\text{Acetone}} R-I + NaX$$

ii) Swarts reaction

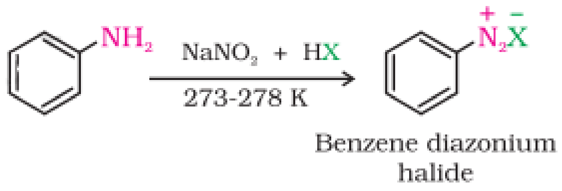
$$R-X \text{ (X= Cl or Br) } + AgF \xrightarrow{} R-F + AgF$$

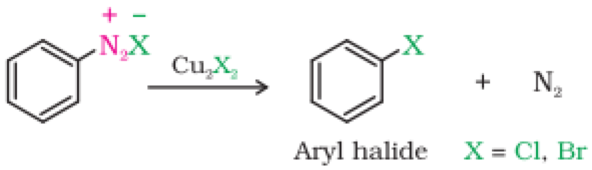
PREPARATION OF ARYL HALIDES

a) By electrophilic substitution



b) By Sandmeyer's reaction





Physical properties of alkyl halides

Melting and boiling points

1. Boiling points of alkyl halides are higher than those of the hydrocarbons of comparable molecular mass, due to stronger intermolecular force (dipole –dipole interaction and van der Waal's forces) in

alkyl halides.

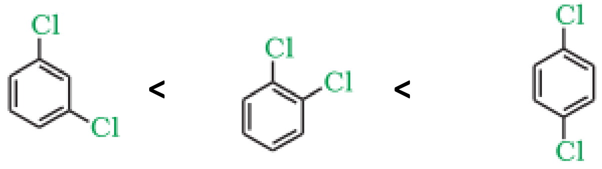
2. For the same alkyl group , the boiling points of alkyl halides increase in the order R-Cl <R-Br< R-I

3. The boiling points of isomeric halo alkanes decrease with increase in branching, because the surface area decreases as the branching increases and hence the intermolecular force decreases.

Eg: The boiling points of various isomers of butyl bromide follow the order

CH_3-CH_2- CH_2-CH_2-Br > CH_3- CH_2-CH(Br)-CH_3 > CH_3-C(Br) (CH_3) – CH_3

4. Among the isomers of dichlorobenzene , the para isomer has the highest melting point. This is due to the symmetry of para isomer that fits into the crystal lattice better as compared to ortho and meta isomers . Melting points of dichloro benzene follow the order:



Solubility

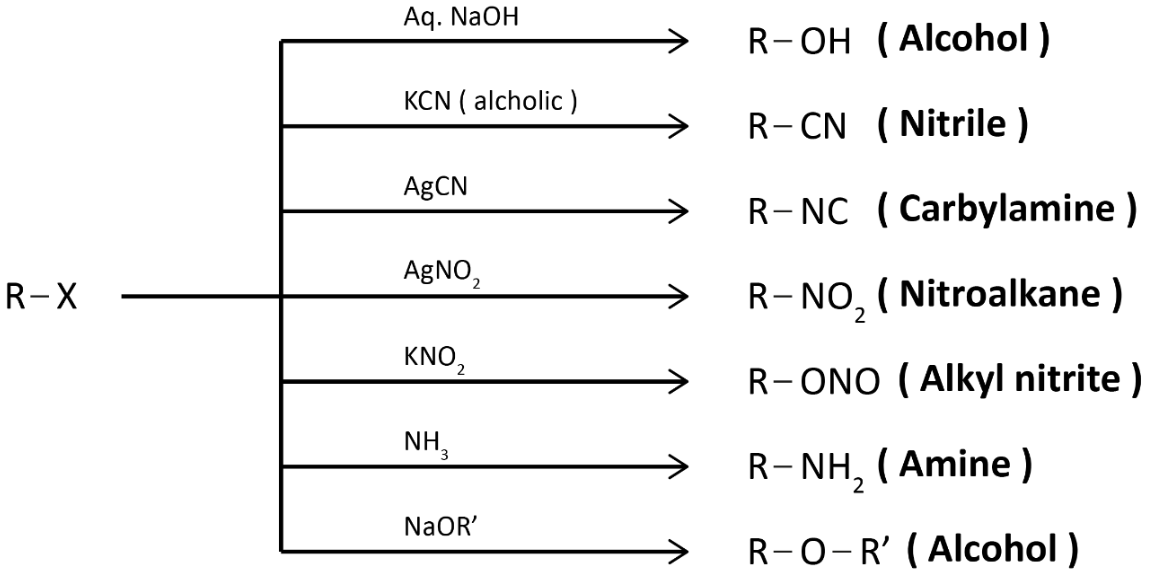
Haloalkanes are sparingly soluble in water , because they can't form hydrogen bond with water . However they are highly soluble in organic solvents.

Reactions of Haloalkanes

a) Nucleophilic substitution reactions

Due to polar nature of C-X bond carbon atom gets a partial positive charge . As a result , a nucleophile can attack this carbon atom and causes the departure of the halogen atom as halide ion. This type of reaction is called nucleophilic substitution.

Examples



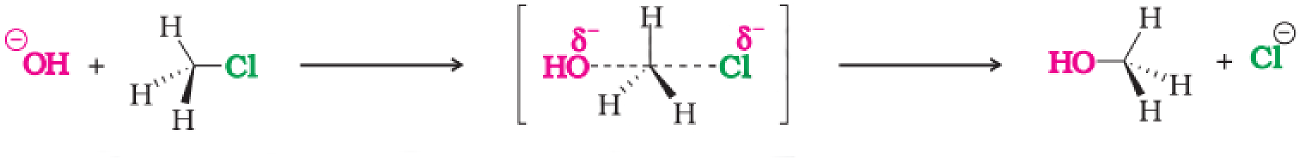
Ambident nucleophiles: These are nucleophiles which possess two nucleophilic centres. Eg: CN^- , NO_2^-

MECHANISM OF NUCLEOPHILIC SUBSTITUTION

a) Substitution nucleophilic bimolecular (S_N2)

In this mechanism the rate of the reaction depends upon the concentration of both the reactants (nucleophile and alkyl halide)

Eg:



Transition state

The incoming nucleophile (^-OH) interacts with alkyl halide (CH_3-Cl) causing carbon –halogen bond (C-Cl) to break while forming a new carbon – OH bond . These two processes takes place in a single step and no intermediate is formed.

The presence of bulky alkyl groups around the carbon bearing the halogen atom will hinder the approach of the incoming nucleophile . Hence the rate of reaction decreases

Thus the order of reactivity of alkyl halides in **S_N2** reaction is

Primary(1^0) > secondary(2^0) > tertiary(3^0)

Stereo chemical impact of S_N2 mechanism

Since the incoming nucleophile is attacking the carbon atom from the rear side (opposite) of the leaving group (halogen) the configuration (3D arrangement) of the product formed will be opposite of the alkyl halide. This is known as inversion of configuration.

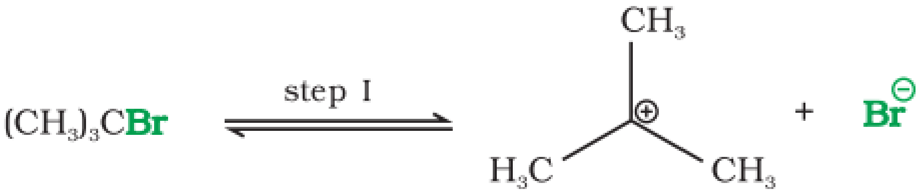
If the alkyl halide is optically active (dextro or laevo rotatory) , the optical activity of the product formed will be inverted , ie, dextro will become laevo and vice versa.

b) Substitution nucleophilic unimolecular (S_N1)

In this mechanism , the rate of reaction depends upon the concentration of only one reactant , ie the alkyl halide .

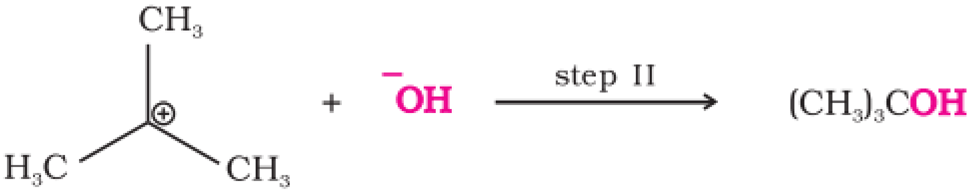
It occurs in two steps

Step 1 : The polarised carbon-halogen (C-X) bond undergoes slow cleavage to produce a carbocation and a halide ion.



As the stability of carbocation increases, the rate of reaction also increases.

Step 2 : The carbocation formed in step 1 is attacked by nucleophile to form the product.



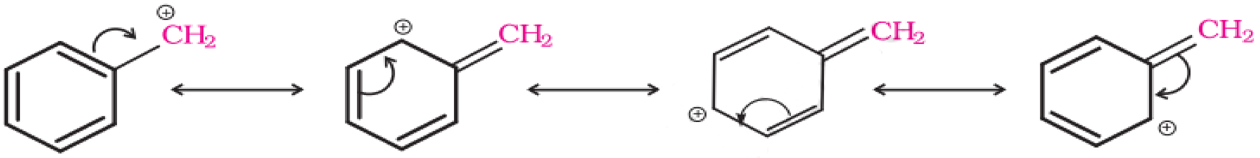
SN^1 reactions are generally carried out in polar protic solvents like water , alcohol etc.
Since the reactivity in SN^1 mechanism depends on the stability of the intermediate , the rate of the reaction follows the order :

Primary(1^0) < secondary(2^0) < tertiary(3^0)

Allylic and benzylic halides show high reactivity towards the SN^1 mechanism due to the stability of allylic and benzylic carbocation intermediates through resonance.

Resonance in allylic carbocation

Resonance in Benzylic carbocation



For the same alkyl group , the order of reactivity in both mechanisms is

R-I > R-Br > R-Cl > R-F

Stereo chemical impact of SN^1 mechanism

In SN^1 mechanism , 50% of the products will have the same configuration as that of the alkyl halide (retention) and remaining 50% will have opposite configuration (inversion) . Therefore the resultant mixture is optically inactive and is called as racemic mixture and the process is known as racemisation.

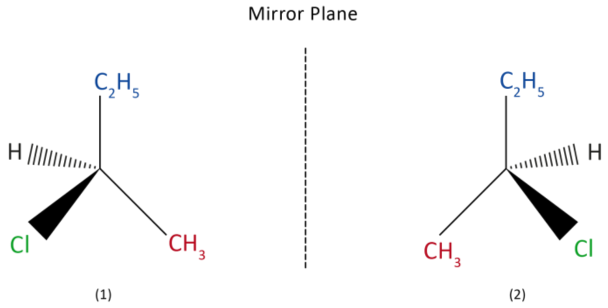
OPTICAL ACTIVITY

The ability of a compound to rotate the plane of a plane polarised light , when passed through the solution of the compound is known as optical activity.
The compound which can rotate the plane of the plane polarised light towards clockwise direction is called dextrorotatory (d or +) and which rotate towards anticlockwise direction is called laevorotatory (l or -)

Reason for optical activity : The molecular asymmetry is responsible for optical activity. Molecular asymmetry arises when the molecule does not possess any elements of symmetry like plane of symmetry, centre of symmetry , axis of symmetry etc.

An organic compound shows molecular asymmetry when it has at least one asymmetric carbon atom ie the carbon atom that is bonded to 4 different atoms/groups. Example of an asymmetric compound is

2-Chlorobutane . It has one asymmetric (Chiral) carbon atom(C_2) .The two configurations are

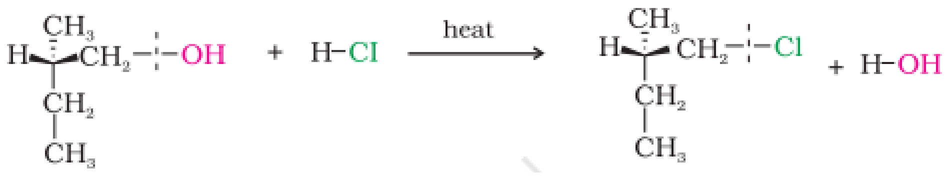


Enantiomers of 2-Chlorobutane

Compounds (1) and (2) are related to each other as object and it's non-superimposable mirror image . Such a pair of molecules is known as **enantiomers** or **Chiral** molecules. If one form is dextro rotatory (d) then the other will be laevorotatory(l).

Racemic mixture or Racemic modification : A mixture containing the two enantiomers of a compound (d and l) in equal proportions , which is optically inactive due to cancellation of the optical rotation of one enantiomer by the other , is called racemic mixture denoted as 'dl' or (±). The process of conversion of an enantiomer into a racemic mixture is known as racemisation.

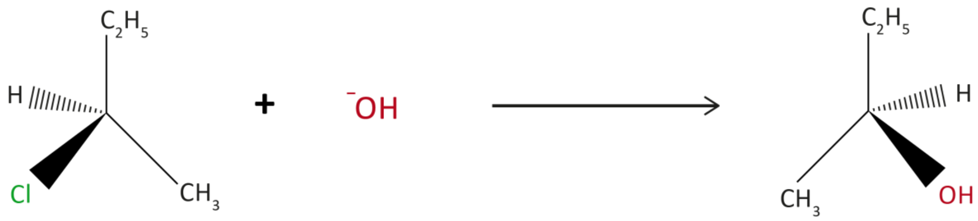
Retention : retention of configuration is the preservation of configuration around an asymmetric carbon atom during a chemical reaction. This will happen when no bonds around the asymmetric carbon atom are broken.



(-) 2-Methylbutan-1-ol (-) 1- Chloro-2-methylbutane

Inversion : During a chemical reaction , if a bond around an asymmetric carbon atom is broken and a new bond is formed so that the configuration of the new compound formed is opposite of the initial compound . This results in inversion of optical rotation ie dextro rotatory reactant molecule will become laevo rotatory product and vice versa.

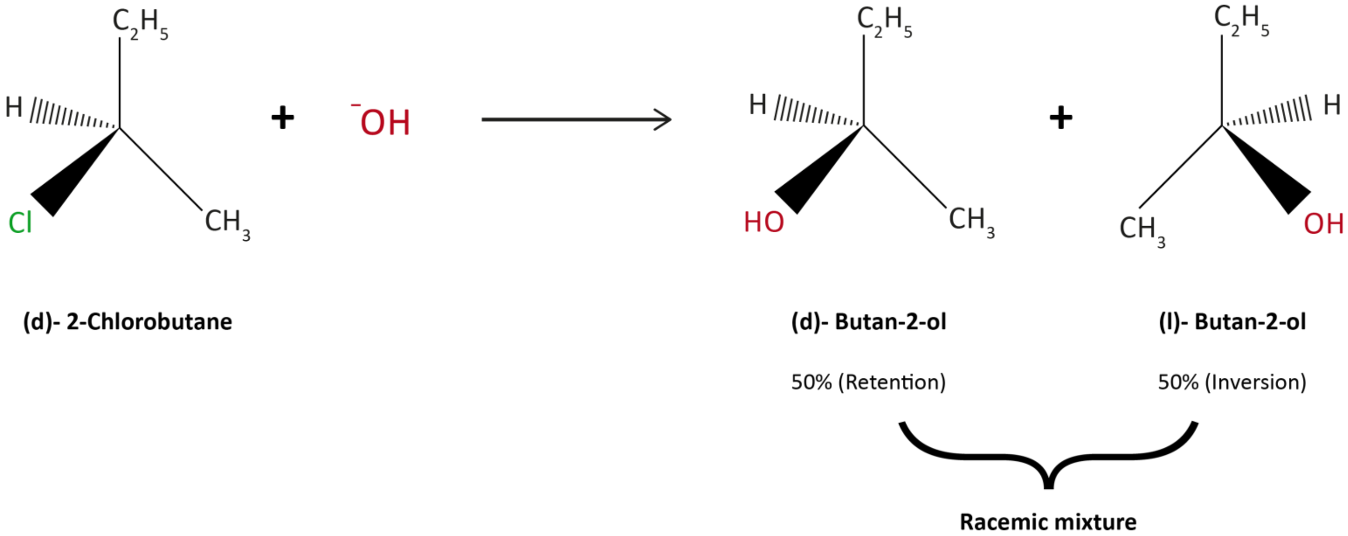
During S_N^2 reaction inversion takes place



(d)- 2-Chlorobutane **(l)- Butan-2-ol**

During SN^1 reaction 50% of the products will retain the configuration of the reactant and remaining 50% of the products will undergo inversion. So the resultant product will be racemic mixture and optically inactive.

Example SN^1 mechanism

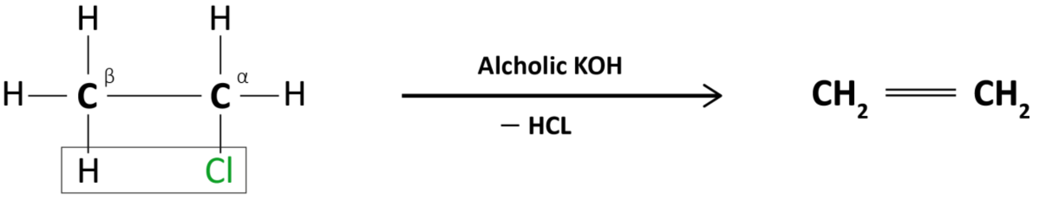


(d)- 2-Chlorobutane

(d)- Butan-2-ol
50% (Retention)

(l)- Butan-2-ol
50% (Inversion)

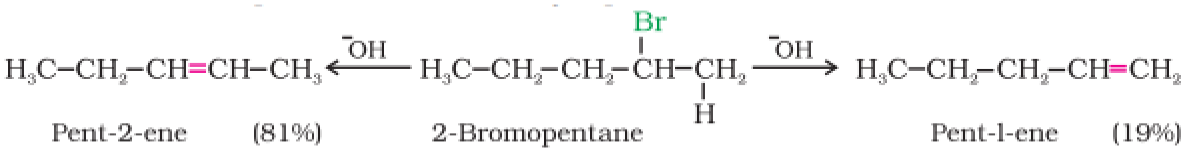
β- Elimination reactions in alkyl halides



Cholorethane **Ethene**

If there is a possibility of more than one alkene formation due to availability of more than one **β-** hydrogen atom, the major alkene is formed according to to **Zaitsev rule** . This rule states that “ In dehydrohalogenation reactions, the preferred product is that alkene which has the greater number of alkyl groups attached to the doubly bonded carbon atoms.

Example



Reaction with metals: Alkyl halides react with Magnesium in dry ether medium and form alkyl magnesium halides known as **'Grignard Reagent'**

Eg : CH_3-CH_2-Br + Mg(Dry ether medium) $\longrightarrow$ CH_3-CH_2-MgBr

Grignard reagents should be prepared under anhydrous conditions, because they react with water (or any other protic solvents like alcohol) and form the corresponding hydrocarbon.

R-MgX + H_2O → R-H + Mg(OH)X

Nucleophilic substitution in Aryl halides

Aryl halides are extremely less reactive towards nucleophilic substitution due to the following reasons.

1. C-X bond acquires a partial double bond character due to resonance and hence the cleavage of C-X bond becomes difficult.

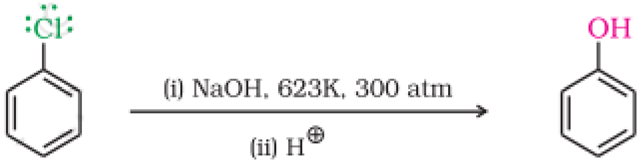
2. The C-X bond is shorter due to greater electronegativity of sp^2 carbon

3. The phenyl carbocation formed during SN^1 reaction is highly unstable

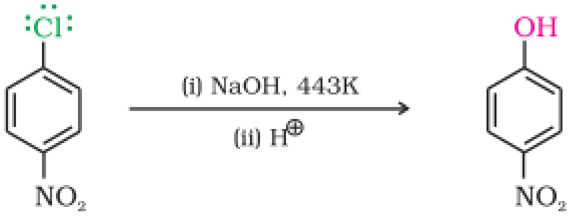
4. Due to electron rich arenes , there is greater electron-electron repulsion when an electrophile approaches the aryl halide.

However under drastic conditions aryl halides undergo nucleophilic substitution.

Eg:



The presence of –I groups like –NO_2 at ortho/para positions in aryl halides increases the reactivity.

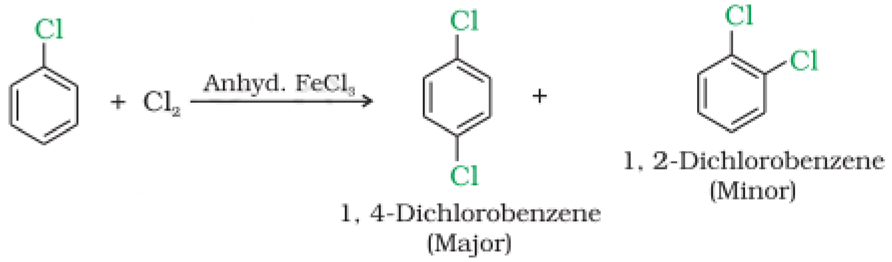


There is no effect on reactivity when the –I groups are present at meta position

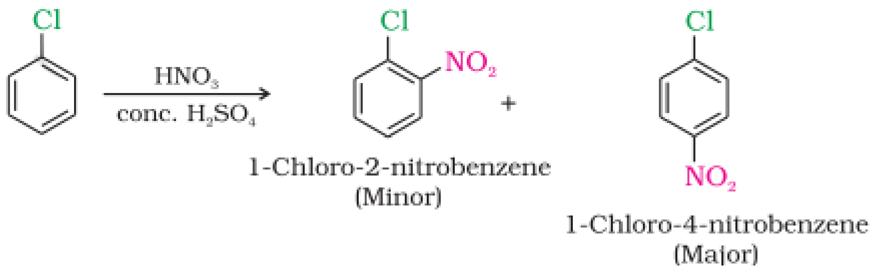
Electrophilic substitution reactions in aryl halides

Due to resonance in aryl halides , the electron density increases at ortho/para positions compared to meta position. So electrophilic substitution occurs at ortho/para positions

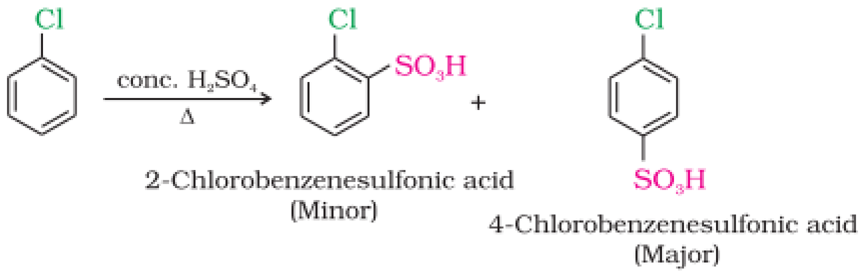
Halogenation:



Nitration

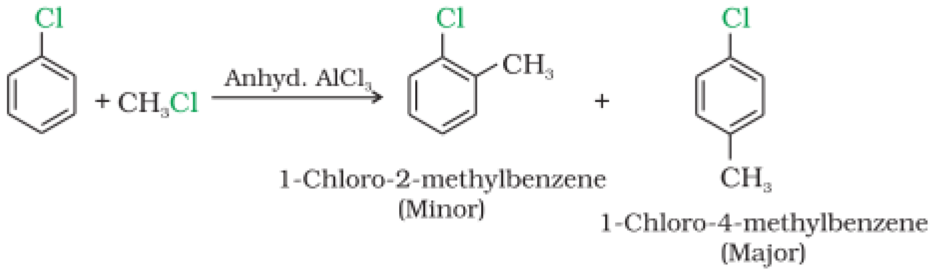


Sulphonation

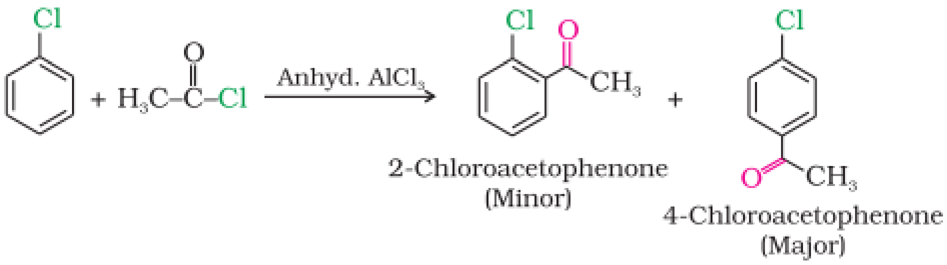


Friedel craft’s reaction

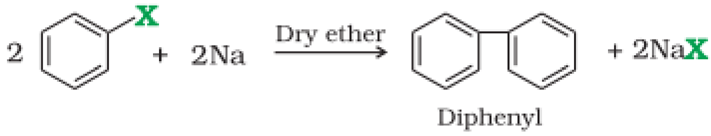
a) Alkylation



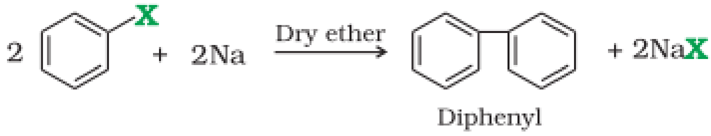
b) Acylation



Fittig reaction



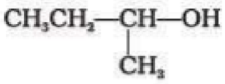
Wurtz-Fittig reaction



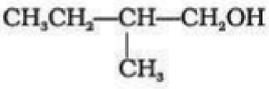
MULTIPLE CHOICE QUESTIONS

1 1.Which of the following alcohols will yield the corresponding alkyl chlorid
reaction with concentrated HCl at room temperature?

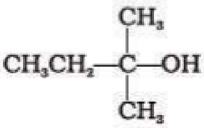
(i) $CH_3CH_2—CH_2—OH$

(ii) 

$CH_3CH_2—CH(CH_3)—OH$

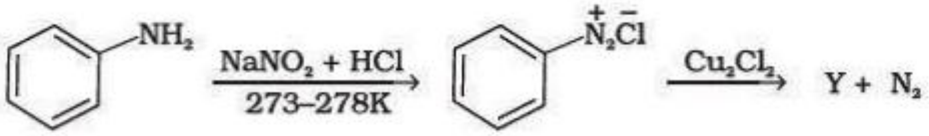
(iii) 

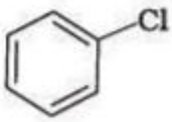
$CH_3CH_2—CH(CH_3)—CH_2OH$

(iv) 

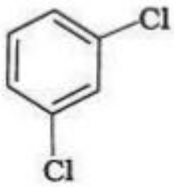
$CH_3CH_2—C(CH_3)_2—OH$

2 Identify the compound Y in the following reaction.



(i) 

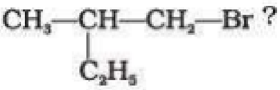
(ii) 

(iii) 

(iv) 

3 3.Toluene reacts with a halogen in the presence of iron (III) chloride giving ortho and para halo compounds. The reaction is

- (i) Electrophilic elimination reaction
- (ii) Electrophilic substitution reaction
- (iii) Free radical addition reaction
- (iv) Nucleophilic substitution reaction

4 Which is the correct IUPAC name for 

$CH_3—CH(C_2H_5)—CH_2—Br$?

(i) 1-Bromo-2-ethylpropane
(ii) 1-Bromo-2-ethyl-2-methyl ethane
(iii) 1-Bromo-2-methylbutane
(iv) 2-Methyl-1-bromobutane

5 **Among the following which one will have lowest boiling point?**

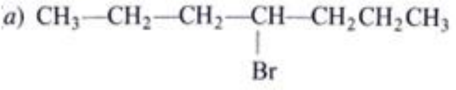
a) 1- Chloropropane

b) Isopropyl chloride

c) Isobutyl chloride

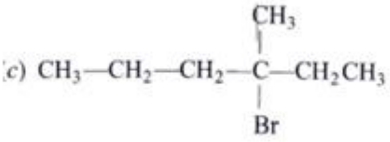
d) 1- Chlorobutane

6 An optically active compound having molecular formula $C_7H_{15}Br$ reacts with aq KOH to give a racemic mixture of products. The compound is: c

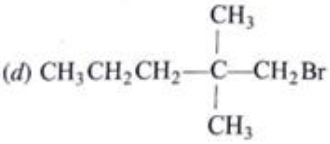
a) 

$CH_3-CH_2-CH_2-\underset{Br}{CH}-CH_2CH_2CH_3$

(b) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2Br$

(c) 

$CH_3-CH_2-CH_2-\overset{CH_3}{\underset{Br}{C}}-CH_2CH_3$

(d) 

$CH_3CH_2CH_2-\overset{CH_3}{\underset{CH_3}{C}}-CH_2Br$

7 Which is the correct increasing order of boiling points of the following compounds?

1-Bromoethane, 1-Bromopropane, 1-Bromobutane, Bromobenzene

(a) Bromobenzene < 1-Bromobutane < 1-Bromopropane < 1-Bromoethane

(b) Bromobenzene < 1-Bromoethane<1-Bromopropane< 1-Bromobutane

(c) 1-Bromopropane <1-Bromobutane < 1-Bromoethane < Bromobenzene

(d) 1-Bromoethane < 1-Bromopropane < 1-Bromobutane < Bromobenzene

8 Ethylene dichloride and ethylidene chloride are isomers. Identify the correct statement.

(a) Both the compounds form same product on treated with alcoholic KOH

(b) Both the compounds form same product on treatment with aq. KOH

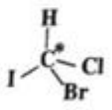
(c) Both the compounds have same IUPAC name.

(d) Bothe the compounds are optically active.

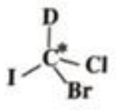
9 The correct order of S_N^2 reactivity of compounds (i) 1 – Bromo – 3 methyl butane (ii) 2 – Bromo – 2 methyl butane and (iii) 3 – Bromo – 2 – methyl butane is:

(a) (i) > (ii) > (iii) (b) (i) > (iii) > (ii) (c) (iii) > (i) > (ii) (d) (iii) > (ii) > (i)

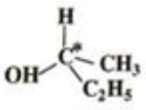
10 In which of the following molecules carbon atom marked with asterisk (*) is asymmetric?



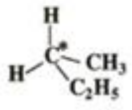
(i)



(ii)



(iii)



(iv)

(a) (i), (ii), (ii), (iv) (b) (i), (iii), (iv) (c) (ii), (iii), (iv) (d) (i), (ii), (iii)

11 KCN reacts readily to form cyanide with:

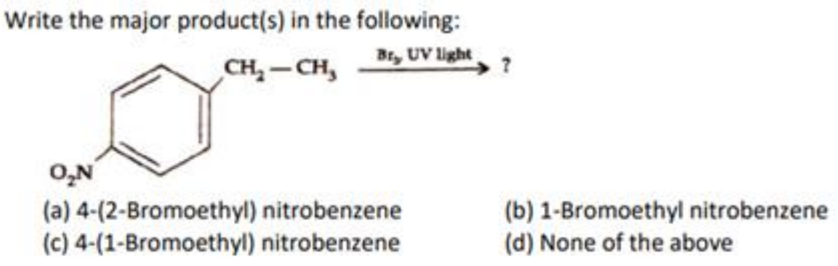
(a) ethanol (b) ethyl bromide (c) bromobenzene (d) chlorobenzene

12 **The halogen compound which is used in the treatment of typhoid fever**

is

a)Chloroform b)freons c)Chloramphenicol d)Halothane

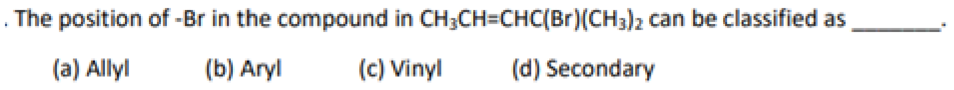
13



Write the major product(s) in the following:

(a) 4-(2-Bromoethyl) nitrobenzene (b) 1-Bromoethyl nitrobenzene
(c) 4-(1-Bromoethyl) nitrobenzene (d) None of the above

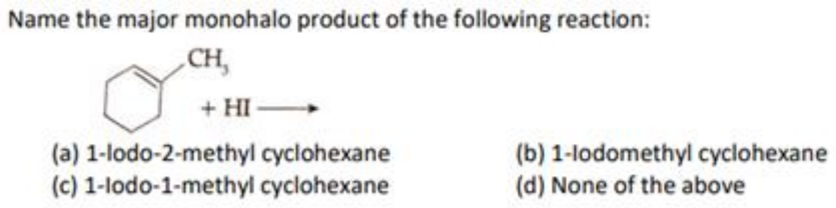
14



. The position of -Br in the compound in $CH_3CH{=}CHC(Br)(CH_3)_2$ can be classified as _______.

(a) Allyl (b) Aryl (c) Vinyl (d) Secondary

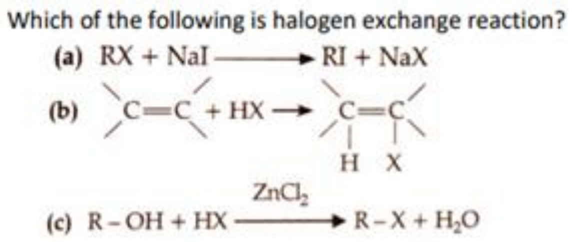
15



Name the major monohalo product of the following reaction:

(a) 1-Iodo-2-methyl cyclohexane (b) 1-Iodomethyl cyclohexane
(c) 1-Iodo-1-methyl cyclohexane (d) None of the above

16



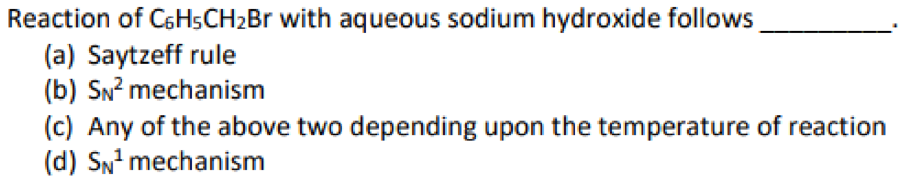
Which of the following is halogen exchange reaction?

(a) $RX + NaI \longrightarrow RI + NaX$

(b) $\rangle C{=}C\langle + HX \longrightarrow \rangle\underset{H}{C}{=}\underset{X}{C}\langle$

(c) $R-OH + HX \xrightarrow{ZnCl_2} R-X + H_2O$

17



Reaction of $C_6H_5CH_2Br$ with aqueous sodium hydroxide follows _________.

(a) Saytzeff rule
(b) S_N2 mechanism
(c) Any of the above two depending upon the temperature of reaction
(d) S_N1 mechanism

18 **Molecules whose mirror image is non super imposable over them are known as chiral. Which of the following molecules is chiral in nature?**

(a) 2-Bromobutane
(b) 1-Bromobutane
(c) 2-Bromopropane
(d) 2-Bromopropan-2-ol

19 **Which of the following is a secondary allylic alcohol?**

a)But-3-en-2-ol
b)But-2-en-2-ol
c)Prop-2-enol
d)Butan-2-ol

20 **The product formed when Ethoxy benzene reacts with HBr**

i) C_6H_5Br, C_2H_5OH ii) C_6H_5OH, C_2H_5Br

iii) $C_6H_5CH_2Br$, C_2H_5OH iv) C_6H_5Br, CH_3OH

21 **-------warmed with water gives phenol**

a) C_6H_5 CH_2Cl b) C_6H_5Cl c) C_6H_5 N_2 Cl d) C_6H_5 $CHCl_2$

22 **Which one is most reactive towards SN^1 reaction ?**

(a) $C_6H_5CH(C_6H_5)Br$

(b) $C_6H_5CH(CH_3)Br$

(c) $C_6H_5C(CH_3)(C_6H_5)Br$

(d) $C_6H_5CH_2Br$

23 **Haloarenes are ortho and para directing due to**

(a) Resonance in aryl halide

(b) – I effect of halogen atom

(c) + I effect of halogen atom

(d) Both (a) and (b)

24 **The organic chloro compound, which shows complete stereo chemical inversion during a S_N^2 reaction, is**

(a) $(C_2H_5)_2CHCl$

(b) $(CH_3)_3CCl$

(c) $(CH_3)_2$ CHCl

(d) CH_3Cl

25 **The major product of the reaction between tert-butyl chloride and sodium ethoxide is**

(a) 2-Methylprop-1-ene

(b) But-1-ene

(c) But-2-ene

(d) Ethene

26 **S_N^1 reaction of alkyl halides leads to**

(a) Retention of configuration

(b) Racemisation

(c) Inversion of configuration

(d) None of the above

27 **Fitting reaction can be used to prepare**

(a) Toluene (b) Acetophenone

(c) Diphenyl (d) Chlorobenzene

28 **Identify X in the following rn**

$C_2H_5Br + X \rightarrow C_2H_5CN$

(a) X = KCN,

(b) X = AgCN

(c) X = CH_3Cl

(d) X = CH_3NH_2

29 **Which of the following is the correct order of decreasing S_N^2 reactivity?**
(a) $RCH_2X > R_2CHX > R_3CX$
(b) $R_3CX > R_2CHX > RCH_2X$
(c) $R_2CHX > R_2CX > RCH_2X$
(d) $RCH_2X > R_3CX > RCHX$

30 **S_N^1 mechanism is favoured in which of the following solvents:**
(a) benzene (b) carbon tetrachloride
(c) acetic acid (d) carbon disulphide

31 **Nucleophilic substitution will be fastest in case of**
(a) 1-Chloro-2,2-dimethyl propane
(b) 1-Iodo-2,2-dimethyl propane
(c) 1-Bromo-2,2-dimethyl propane
(d) 1-Fluoro-2,2-dimethyl propane

32 **When X reacts with CH_3COCl in the presence of anhy. $AlCl_3$, the reaction is known as**
(a) Fitting reaction
(b) Ullmann reaction
(c) Wurtz-Fittig reaction
(d) Friedel-Crafts acylation reaction

33 **Aryl halides are less reactive towards nucleophilic substitution reaction as compared to alkyl halides due to**
(a) the formation of less stable carbonium ion
(b) resonance stabilisation
(c) larger carbon-halogen bond
(d) inductive effect

34 **C – X bond is strongest in**
(a) CH_3 Cl
(b) CH_3 Br
(c) CH_3 I
(d) CH_3 F

35 **Reaction of t-butyl bromide with sodium methoxide produces**
(a) sodium t-butoxide (b) t-butyl methyl ether
(c) iso-butane (d) iso-butylene

36 **The general reaction, R—X aq. KOH → ROH + X–, is expected to follow decreasing order of reactivity as in**
(a) t-BuI > t-BuBr > t-BuCl > t-BuF
(b) t-BuF > t-BuCl > t-BuBr > t-BuI
(c) t-BuBr > t-BuCl > t-BuI > t-BuF
(d) t-BuF > t-BuCl > t-BuI > t-BuBr

37 **Which of the following compounds are gem-dihalides?**

(a) Ethylidene chloride (b) Ethylene dichloride
(c) Methyl chloride (d) Benzyl chloride

38 **Among the following, the molecule with the highest dipole moment is :**

a. CH_3Cl
b. CH_2Cl_2
c. $CHCl_3$
d. CCl_4

39 **p-dichlorobenzene has higher melting point than its o- and m-isomers because**

(a) p-dichlorobenzene is more polar than o- and m- isomer
(b) p-isomer has a symmetrical crystalline structure
(c) boiling point of p-isomer is more than o-and m-isomer
(d) All of these are correct reasons

40 **Alkyl halides are insoluble in water though they are polar because**

(a) they react with water to give alcohols
(b) C -X bond cannot be broken easily
(c) they cannot form hydrogen bonds with water
(d) they are stable compounds and are not reactive

41 **Methyl bromide reacts with AgF to give methyl fluoride and silver bromide. This reaction is called**

(a) Fittig reaction
(b) Swartz reaction
(c) Wurtz reaction
(d) Finkelstein reaction

42 **Which of the following statements are correct?**

(a) Benzyl halides are less reactive than vinyl and aryl halides
(b) Vinyl halides are more reactive than alkyl halides
(c) Aryl halides are less reactive than alkyl halide
(d) Aryl halides are more reactive than benzyl halides

43 **Which reagent will you use for the following reaction?**

$CH_3CH_2CH_2CH_3 \rightarrow CH_3CH_2CH_2CH_2Cl + CH_3CH_2CH(Cl)CH_3$

(a) Cl_2 /UV light
(b)NaCl + H_2SO_4
(c) Cl_2 gas in dark
(d)Cl_2 gas in the presence of iron in dark

44 **Match the items of Column I and Column II.**

Column I	**Column II**
(i) SN1 reaction	(a) vic-dibromides
(ii) Chemicals in fire extinguisher	(b) Saytzeff rule
(iii) Bromination of alkenes	(c) Racemisation
(iv) Elimination of HX from alkyl halide	(d) Chlorobromocarbons

(i) - (c) (ii) - (d) (iii) - (a) (iv) - (b)

(i) - (b) (ii) - (d) (iii) - (c) (iv) - (a)
(i) - (c) (ii) - (a) (iii) - (d) (iv) - (b)
(i) - (a) (ii) - (d) (iii) - (c) (iv) - (b)

45 **Compound A reacts with PCl_5 to give B which on treatment with KCN followed by hydrolysis gave propanoic acid. What are A and B respectively**

(a) C_3H_8 and C_3H_7Cl
(b) C_2H_6 and C_2H_5Cl
(c) C_2H_5OH and C_2H_5Cl
(d) C_2H_5OH and $C_2H_4Cl_2$

46 **Among the isomeric alkanes of the molecular formula C_5H_{12}, the one which gives a single monochloride on photochemical chlorination is**

(a) 2-Methyl butane
(b (2,2-Dimethyl propane
(c) n- Pentane
(d) Isopentane

47 **Which reagents are required for the one step conversion of chlorobenzene to toluene?**

(a) CH_3Cl, Na, Dry ether
(b) CH_3Cl/ $AlCl_3$
(c)CH_3Cl/Fe dark
(d)$NaNO_2$/HCl/ 0-5^0 C

48 **The correct increasing order of boiling points for the following is:**

(a)RCl < RF < RI < RBr
(b)RF < RCl < RBr < RI
(c)RI < RBr < RCl < RF
(d)RCl < RBr < RI < RF

49 **An alkyl halide forms its Grignard reagent followed by treating with water yields propane. The original alkyl halide is**

(a) Methyl iodide
(b) Ethyl bromide
(c) Propyl bromide
(d) Butyl bromide

50 **Arrange the following compounds in the increasing order of their boiling points.**

(a) $(CH_3)_2CHCH_2Br$
(b) $CH_3CH_2CH_2CH_2Br$
(c) $(CH_3)_3CBr$
(i) (b) < (a) < (c) (ii) (a) < (b) < (c)
(iii) (c) < (a) < (b) (iv) (c) < (b) < (a)

Answers

Qn No	Answer	Qn No	Answer	Qn No	Answer	Qn No	Answer	Qn no	Answer
1	iv	11	b	21	c	31	b	41	b
2	i	12	c	22	c	32	d	42	c
3	ii	13	c	23	a	33	b	43	a
4	iii	14	a	24	d	34	d	44	i
5	b	15	c	25	b	35	b	45	c
6	c	16	a	26	b	36	a	46	b
7	d	17	d	27	c	37	a	47	a
8	a	18	a	28	a	38	c	48	b
9	b	19	a	29	a	39	b	49	c
10	d	20	ii	30	c	40	b	50	iii

ASSERTION-REASON TYPE OF QUESTIONS

The question given below consist of an assertion and a reason use the following key to choose appropriate answer

a) Both assertion and reason are correct and reason is the correct explanation of the assertion

b) Both assertion and reason are correct and reason is not the correct explanation of the assertion

c) Assertion is correct but reason is incorrect

d) Assertion is wrong Reason is correct.

1) **Assertion**: Alkyl halides are insoluble in water
Reason: Energy is required to break H bonds in water

2) **Assertion**: Para chloro-benzene is having higher melting point than other two isomers
Reason: Due to symmetry molecule is well fit in to the lattice.

3) **Assertion:** Tertiary alkyl halides are least reactive in S_N^2 reactions
Reason: Steric hindrance is minimum in tertiary Alkyl halides

4) **Assertion**: Only achiral molecules when undergo substitution, optical rotation changes
Reason: When molecule and its mirror images are non superimposable, they show optical activity.

5) **Assertion**: Alkyl iodides are more reactive towards nucleophilic substitution reaction
Reason: C-I bond is stronger than any other carbon halogen bond

6) **Assertion:** The reaction of Arenes and iodine is carried out in presence of HIO_4
Reason: HIO_4 Oxidises HI formed during the reaction to I_2 and prevents backward reaction.

7) **Assertion**: During Finkelstein reaction alkyl chloride is treated with NaI in presence of Acetone
Reason: Acetone is a very good organic solvent

8) **Assertion**: Boiling points of alkyl iodides are lower than that of Alkyl chlorides
Reason: Vander force is more in alkyl iodides due to large size of iodine

9) **Assertion:** Among isomeric alkyl halides straight chain alkyl halides have highest boiling point
Reason: Dispersion force is minimum in branched chain alkyl halides.

10) **Assertion**: Alkyl halides mainly form alkyl cyanides when treated with AgCN

Reason: Due to covalent nature of AgCN attack takes place through Nitrogen.

11) **Assertion**: Alkyl halides forms Nitriles when treated with KCN

Reason: CN^- is an ambident nucleophile

12) **Assertion:** In Mono haloarenes further electrophilic substitution takes place at ortho and para position.

Reason: The lone pair of electrons on Cl is in conjugation with benzene ring, increasing electron density at ortho and para position...

13) **Assertion**: Nitration of chloro benzene leads to the formation of Meta nitro chlorobenzene.

Reason: NO_2 group is Meta directing towards electrophilic substitution reaction.

14) **Assertion**: Allyl halides react faster in SN^1 reaction

Reason: Allyl cations are stabilized by resonance

15) **Assertion**: Among different halogens alkyl chlorides are more reactive than iodides towards substitution reaction

Reason: C-Cl bond is stronger than C-I bond

16) **Assertion**: Hydrolysis of (-) 2-bromo octane Proceeds with the inversion of configuration

Reason: This reaction proceeds via the formation of carbocation.

17) **Assertion**: Benzyl halides react faster in S_N1 reaction

Reason: Benzyl cations formed is stabilized by resonance.

18) **Assertion**: When 2-bromo butane is treated with alcoholic KOH But-1-ene is the major product

Reason: During dehydrohalogenation reactions more alkylated alkene is the major product.

19 **Assertion**: During the reaction between Tertiary butyl bromide and C_2H_5ONa Alkene is the major product.

Reason: In presence of strong base Elimination competes over substitution.

20) **Assertion**: It is necessary to avoid even traces of water from Grignard reagent.
Reason: Grignard reagent is used in preparing alcohols

21) **Assertion:** It is difficult to break C-X bond in alkyl halides
Reason: C-X bond in aryl halides have partial double character

22) **Assertion**: Propene when treated with HBr form 1- bromo propane as the major product
Reason: During the addition of HBr a secondary carbocation is formed.

23) **Assertion**: The presence of NO_2 group at ortho position of aryl halides increases reactivity of haloarenes towards nucleophilic substitution reaction
Reason: Presence of NO_2 group at ortho and para position of aryl halides reduces the electron density in benzene and hence facilitates the attack.

24) **Assertion**: Alkyl halides are more reactive towards nucleophilic substitution reaction compared to aryl halides
Reason: In alkyl halides halogen is connected to SP^3 hybridised carbon.

25) **Assertion**: $S_N{}^1$ reaction are generally carried out in presence polar protic solvents such as water
Reason: The energy needed to break C-X bond is obtained through solvation of halide ion with proton of protic solvent.

CASE BASED QUESTIONS

Case i) Read the following passage and answer the questions given below.

Alkyl halides are best prepared from alcohols, on treating with Hydrogen halides, phosphorus halides or thionyl chloride. Thionyl chloride is preferred because other two products are escapable gases. The reaction of primary secondary and tertiary alcohols with HCl need a catalyst $ZnCl_2$. With tertiary alcohol the reaction is conducted by shaking with Con.HCl at room temperature. Tertiary alcohols are more reactive...The above methods are not applicable for the preparation of Aryl halides because the carbon oxygen bond in phenols has a partial double bond character and is difficult to break being stronger than a single bond

A statement of assertion is followed by a statement of reason. Mark the correct choice from the options given below :

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true

26)) **Assertion**: Thionyl chloride is the best reagent to convert alcohols to Alkyl chlorides
Reason: With Thionyl chloride alkyl chloride is the only product formed.
27) **Assertion**: Primary secondary and tertiary alcohols can be distinguished using Lucas test
Reason: Tertiary alcohols immediately form turbidity due to the formation of alkyl halides.
28) **Assertion**: Primary alcohols react fast with HCl and forms alkyl halide at room temperature.
Reason: Alkyl halides are insoluble in water.
29) **Assertion**: Aryl halides can be prepared by treating phenols with halogen acid
Reason: In phenol C-O bond is having partial double bond character.

Case ii) Read the following passage and answer the questions given below.

S_N^1 reactions are generally carried out in presence of protic solvents. Like acetic acid. The reaction between a tertiary alkyl halide and nucleophile follows the first order kinetics. The rate of reaction depends on the concentration of alkyl halide .it occurs in two steps. In first step step C-X bond undergoes cleavage to form carbocation, it is then attacked by nucleophile in second step which is very fast. The energy needed for breaking C-X bond is obtained through solvation of halide ion with proton of protic solvent. Greater the stability of carbocation, Greater will be its ease of formation and faster will be its rate of reaction. In the case of optically active alkyl halide S_N1 reaction is accompanied by Racemisation. The carbocation formed in step one is sp^2 hybridised. Which is triagonal planar. The attack of nucleophile may be accomplished from either side to give a mixture of products.

30) **Assertion:** S_N2 reaction takes place in presence of protic solvent.
Reason: The energy is released by the solvation of halide ion with proton.

31) **Assertion**. The rate of S_N^1 reaction depends only on the concentration of alkyl halide.
Reason: Formation of carbocation is slow step and slow step determines the rate of reaction.

32) **Assertion**: Tertiary alkyl halides reacts faster in S_N^1 reaction
Reason. Tertiary carbocations are more stable and formed at faster rate.

33) **Assertion**: During S_N^1 reaction of an optically active alkyl halide Racemisation takes place
Reason. Racemic mixture consists of equal amount of dextro and leavo isomer.

34) **Assertion:** Attack of nucleophile to carbon of carbocation takes place through either side forming two isomers with opposite configuration.
Reason: Carbocation is sp^3 hybridised and have triogonal planar geometry

35) **Assertion**: - In S_N1 reaction second step is very fast and reversible.
Reason: - The carbocation formed is highly unstable and highly reactive.

ANSWER KEY

1) b 2) a 3) c 4) d 5) c 6) a 7) b 8) d 9) b 10) d 11) b 12) a 13) d 14) a
15) d 16) c 17) a 18) d 19) a 20) b 21) d 22) d 23) a 24) b 25) a 26) c
27) b 28) d 29) d 30) d 31) a 32) a 33) b 34) c 35) d

CHAPTER 11
ALCOHOLS, PHENOLS & ETHERS

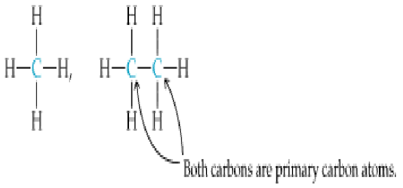
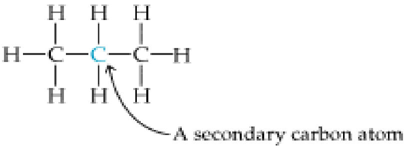
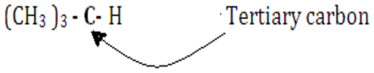
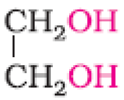
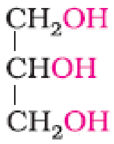
GIST OF LESSON

Organic compounds that contain a hydroxyl group (- OH) as functional group

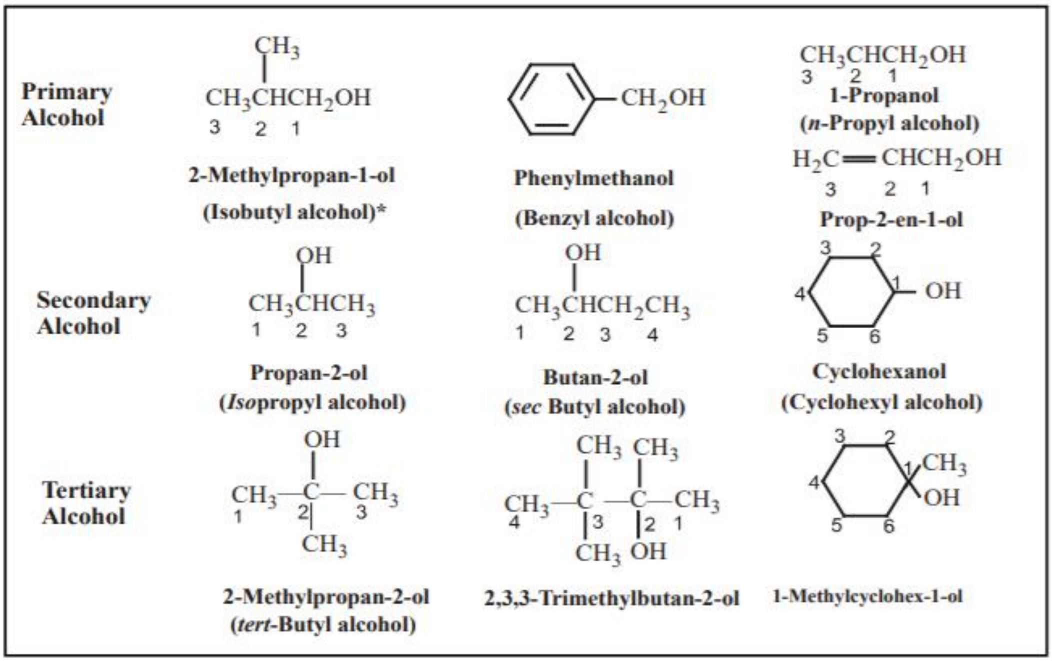
Alcohols and Phenols

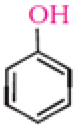
- Alcohols R-O-H
- Phenols Ar-OH (Benzene ring with -OH)
- Ethers R-O-R
-

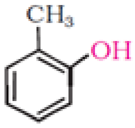
Classification and Nomenclature of Alcohols

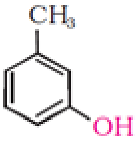
Properties of alcohols depend on the arrangement of the carbon atoms of the molecule		
Primary (1°) carbon atom 	Secondary (2°) carbon atom 	Tertiary (3°) carbon atom 
depending on whether they contain one, two, three or many hydroxyl groups		
C_2H_5OH Monohydric	 CH_2OH-CH_2OH Dihydric	 $CH_2OH-CHOH-CH_2OH$ Trihydric

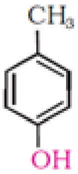
According to the IUPAC system of nomenclature, alcohols are called **alkanols**. They are named as the derivatives of the corresponding alkane in which the -e of the alkane is replaced by -ol .



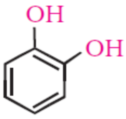


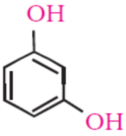


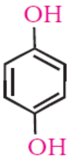




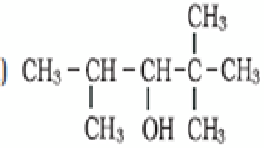
Common name	Phenol	*o*-Cresol	*m*-Cresol	*p*-Cresol
IUPAC name	Phenol	2-Methylphenol	3-Methylphenol	4-Methylphenol





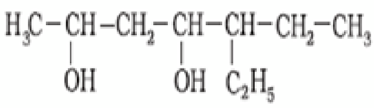


Common name	Catechol	Resorcinol	Hydroquinone or quinol
IUPAC name	Benzene-1,2-diol	Benzene-1,3-diol	Benzene-1,4-diol

(i) 

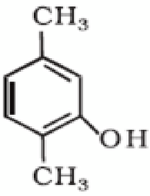
$$CH_3-\underset{CH_3}{CH}-\underset{OH}{CH}-\overset{CH_3}{\underset{CH_3}{C}}-CH_3$$

2, 2, 4-Trimethyl pentan-3-ol

(ii) 

$$H_3C-\underset{OH}{CH}-CH_2-\underset{OH}{CH}-\underset{C_2H_5}{CH}-CH_2-CH_3$$

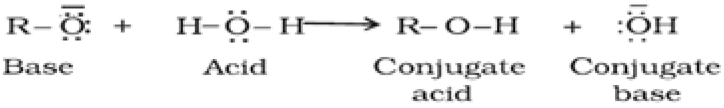
5-Ethyl heptane- 2, 4 - diol



2, 5-Dimethylphenol

Important points to remember

- Boiling Point of alcohols increases with increase in number of –OH groups present
- Boiling point of alcohols decrease with increase in branching of chain
- Lower alcohols (C_1 to C_3) are completely soluble in water due to their ability to form hydrogen bonds with water.
- The acidic character of alcohols is due to the polar nature of O–H bond. An electron-releasing group ($-CH_3$, $-C_2H_5$) increases electron density on oxygen tending to decrease the polarity of O-H bond. This decreases the acid strength. Primary > secondary > tertiary
- Alcohols are, however, weaker acids than water. This can be illustrated by the reaction of water with an alkoxide.

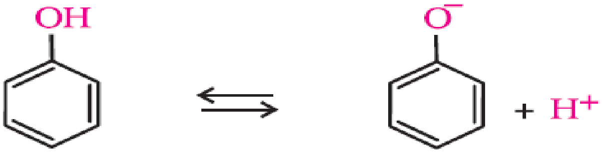


$$\underset{\text{Base}}{R-\bar{\ddot{O}}:} + \underset{\text{Acid}}{H-\ddot{O}-H} \longrightarrow \underset{\text{Conjugate acid}}{R-O-H} + \underset{\text{Conjugate base}}{:\bar{\ddot{O}}H}$$

  - This reaction shows that water is a better proton donor (i.e., stronger acid) than alcohol. Also, in the above reaction, we note that an alkoxide ion is a better proton acceptor than hydroxide ion, which suggests that alkoxides are stronger bases (sodium ethoxide is a stronger base than sodium hydroxide).

- The reaction of phenol with aqueous sodium hydroxide indicates that phenols are stronger acids than alcohols and water. The ionisation of an alcohol and a phenol takes place as follows:

$$R-\ddot{\underset{\cdot\cdot}{O}}-H \rightleftharpoons R-\ddot{\underset{\cdot\cdot}{O}}:^{-} + H^{+}$$



- In substituted phenols, the presence of electron withdrawing groups such as nitro group, enhances the acidic strength of phenol. This effect is more pronounced when such a group is present at ortho and para positions. It is due to the effective delocalization of negative charge in phenoxide ion.

- On the other hand, electron releasing groups, such as alkyl groups, in general, do not favour the formation of phenoxide ion resulting in decrease in acid strength. Cresols, for example, are less acidic than phenol

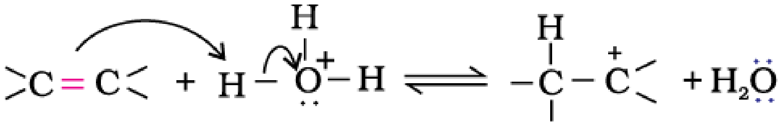
- In the presence of air, phenols are slowly oxidized to dark colored mixtures containing quinones.
- o-Nitrophenol is steam volatile due to intra molecular hydrogen bonding while p-nitrophenol is less volatile due to intermolecular hydrogen bonding which causes the association of molecules.

MECHANISMS

1. Acid catalysed hydration of alkene to alcohol

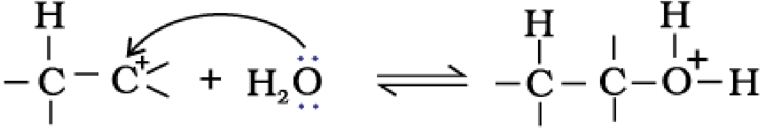
Step 1: Protonation of alkene to form carbocation by electrophilic attack of H_3O^+.

$$H_2O + H^+ \rightarrow H_3O^+$$



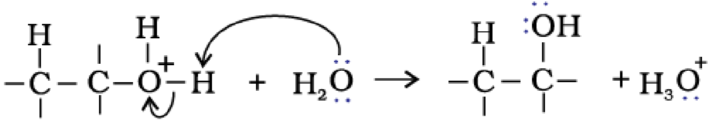
2.

Step 2: Nucleophilic attack of water on carbocation.

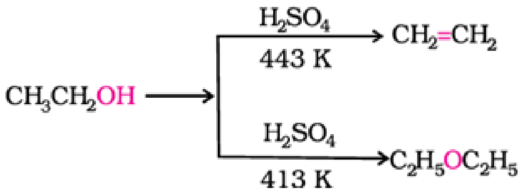


3.

Step 3: Deprotonation to form an alcohol.



2. Dehydration OF Alcohols



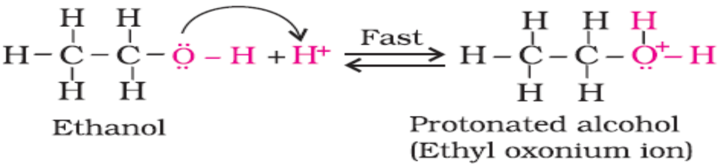
- Alcohols undergo dehydration (removal of a molecule of water) to form alkenes on treating with a concentrated H_2SO_4
- Ethanol undergoes dehydration by heating it with concentrated H_2SO_4 at 443 K

$$C_2H_5OH \xrightarrow[443\ K]{H_2SO_4} CH_2 = CH_2 + H_2O$$

- Secondary and tertiary alcohols are dehydrated under milder conditions. Thus, the relative ease of dehydration of alcohols follows the following order:Tertiary>Secondary>Primary

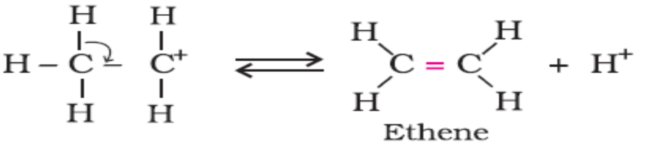
Mechanism – ALCOHOL TO ALKENE

Step 1: Formation of protonated alcohol.



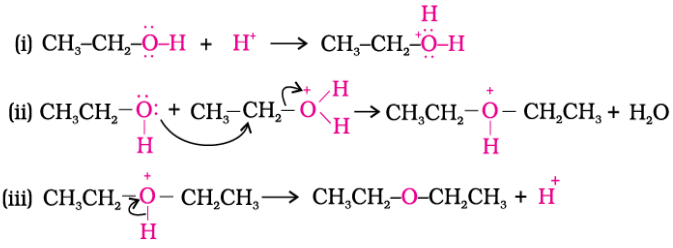
Step 2 :Formation of carbocation: It is the slowest step and hence, the rate determining step of the reaction.

Step 3: Formation of ethene by elimination of a proton

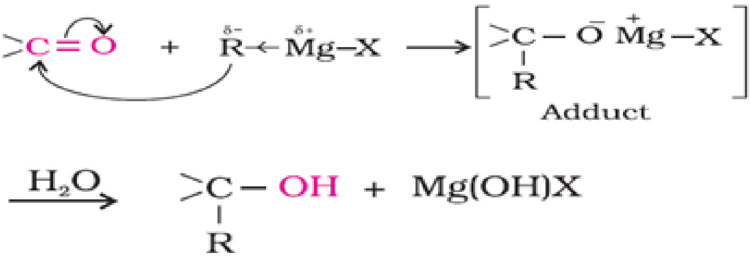


ALCOHOL TO ETHER

Ethanol is dehydrated in the presence of sulphuric acid At 413 K, ethoxyethane is the main product

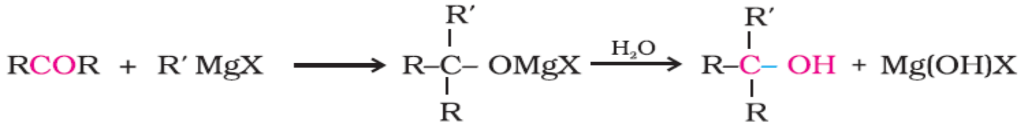


3. Preparation of alcohol using Grignard Reagent



$$HCHO + RMgX \rightarrow RCH_2OMgX \xrightarrow{H_2O} RCH_2OH + Mg(OH)X$$

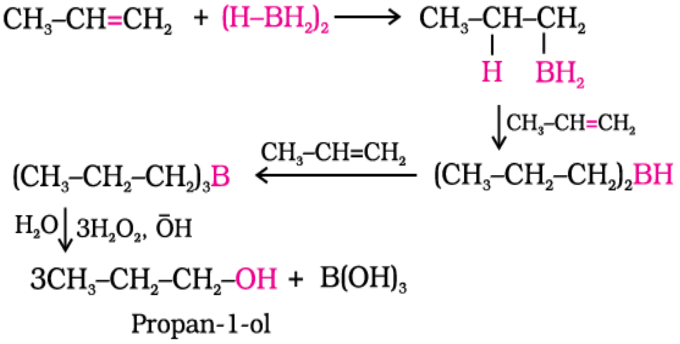
$$RCHO + R'MgX \xrightarrow{H_2O} R{-}\overset{R'}{\overset{|}{C}}H{-}OMgX \xrightarrow{H_2O} R{-}\overset{R'}{\overset{|}{C}}H{-}OH + Mg(OH)X$$



$$RCOR + R'MgX \longrightarrow R{-}\underset{R}{\underset{|}{\overset{R'}{\overset{|}{C}}}}{-}OMgX \xrightarrow{H_2O} R{-}\underset{R}{\underset{|}{\overset{R'}{\overset{|}{C}}}}{-}OH + Mg(OH)X$$

4. Hydroboration : Preparation of alcohol

***Diborane $(BH_3)_2$ reacts with alkenes* to give trialkylboranes as addition product. This is oxidised to alcohol by hydrogen peroxide in the presence of aqueous sodium hydroxide**



5. Esterification :

Alcohols and phenols react with carboxylic acids, acid chlorides and acid anhydrides to form esters

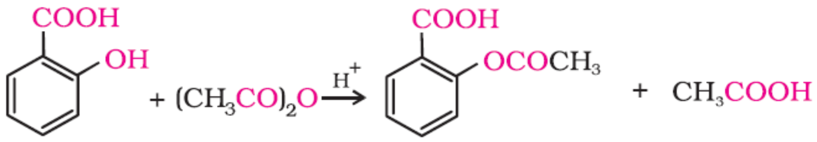
$$Ar/RO-H + R'-COOH \overset{H^+}{\rightleftharpoons} Ar/ROCOR' + H_2O$$

$$Ar/R-OH + (R'CO)_2O \overset{H^+}{\rightleftharpoons} Ar/ROCOR' + R'COOH$$

$$R/ArOH + R'COCl \xrightarrow{Pyridine} R/ArOCOR' + HCl$$

6. ACYLATION

Acetylation of salicylic acid produces aspirin.

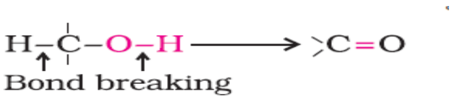


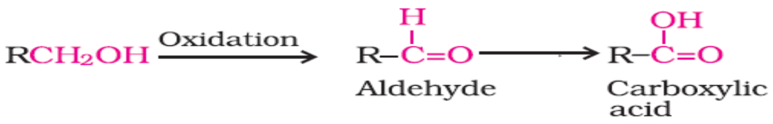
Salicylic acid

Acetylsalicylic acid
(Aspirin)

7. Oxidation:

Depending on the oxidising agent used, a primary alcohol is oxidised to an aldehyde which in turn is oxidised to a carboxylic acid.

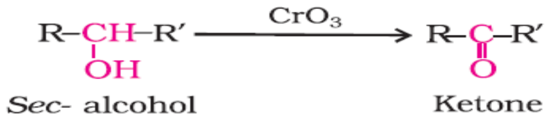




$$RCH_2OH \xrightarrow{\text{Oxidation}} \underset{\text{Aldehyde}}{R-\overset{H}{\overset{|}{C}}=O} \longrightarrow \underset{\text{Carboxylic acid}}{R-\overset{OH}{\overset{|}{C}}=O}$$

$$RCH_2OH \xrightarrow{CrO_3} RCHO$$

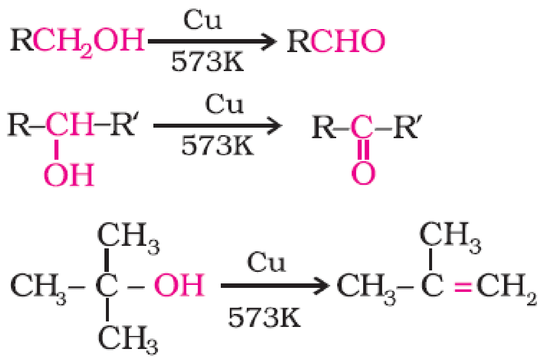
$$CH_3-CH=CH-CH_2OH \xrightarrow{PCC} CH_3-CH=CH-CHO$$



$$\underset{Sec\text{- alcohol}}{R-\underset{OH}{\underset{|}{CH}}-R'} \xrightarrow{CrO_3} \underset{\text{Ketone}}{R-\underset{O}{\underset{\|}{C}}-R'}$$

8. DEHYDROGENATION

When the vapours of a primary or a secondary alcohol are passed over heated copper at 573 K, dehydrogenation takes place and an aldehyde or a ketone is formed while tertiary alcohols undergo dehydration.



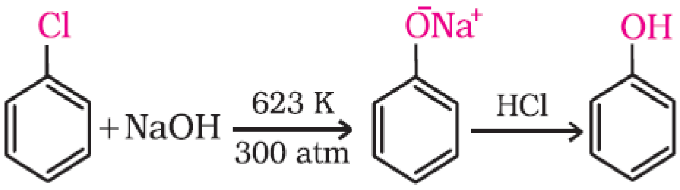
$$RCH_2OH \xrightarrow[573K]{Cu} RCHO$$

$$R-\underset{OH}{\underset{|}{CH}}-R' \xrightarrow[573K]{Cu} R-\underset{O}{\underset{\|}{C}}-R'$$

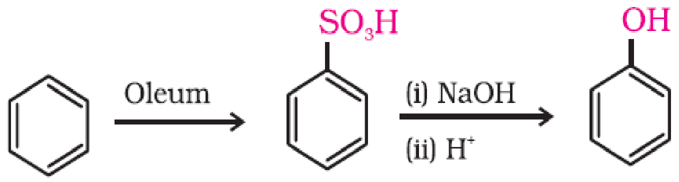
$$CH_3-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-OH \xrightarrow[573K]{Cu} CH_3-\overset{CH_3}{\overset{|}{C}}=CH_2$$

PREPARATION OF PHENOLS

1. Phenol from Chlorobenzene

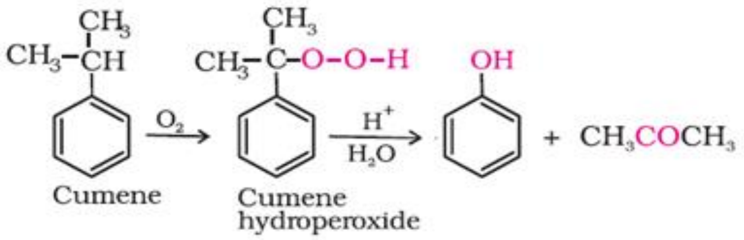


2. Phenol from Benzene

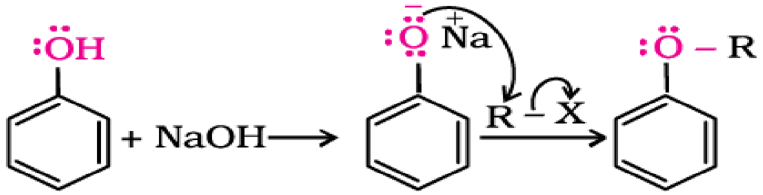


3. Phenol from aniline

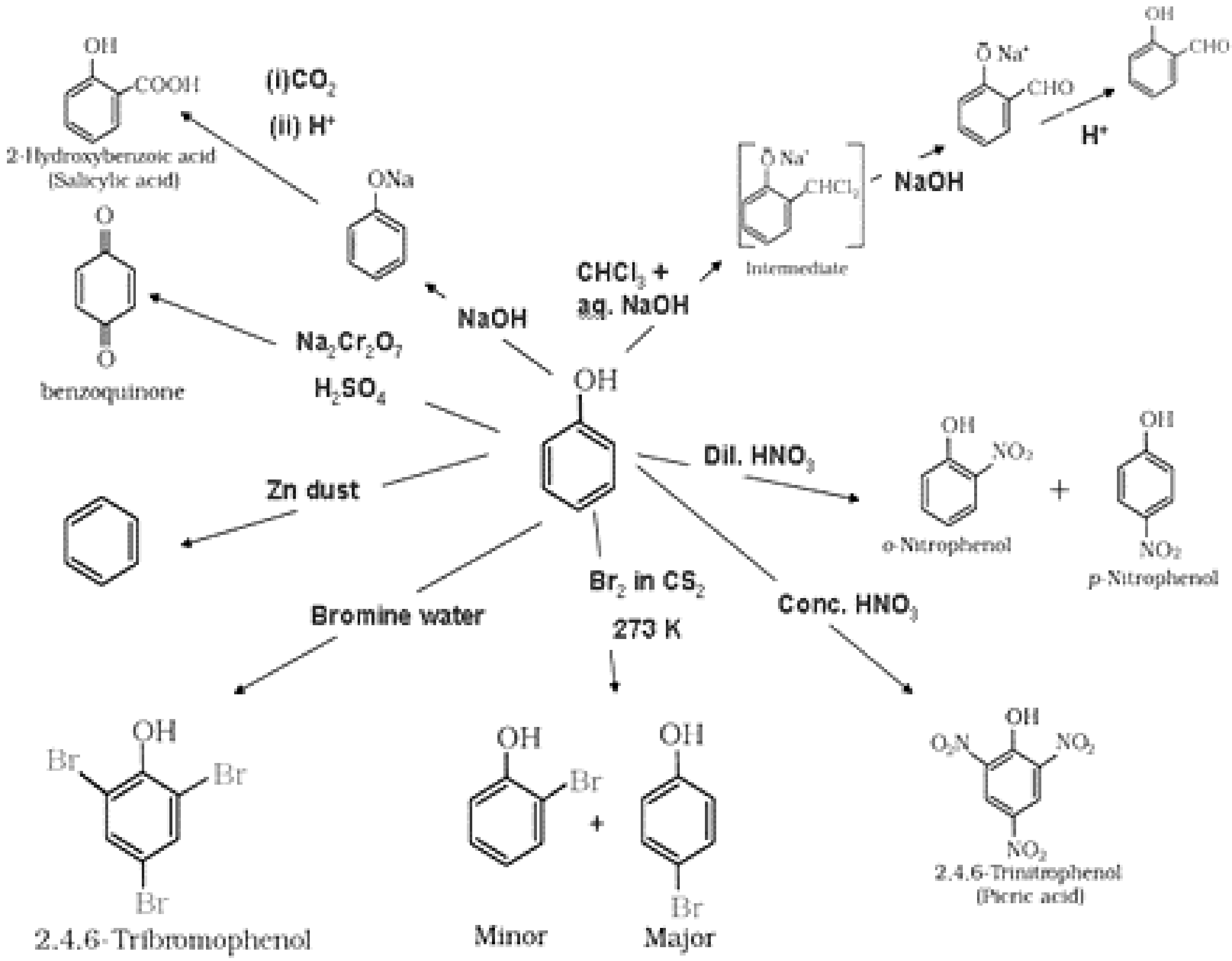
4. Cumene to phenol



PREPERATION OF ARYL ETHERS FROM PHENOL



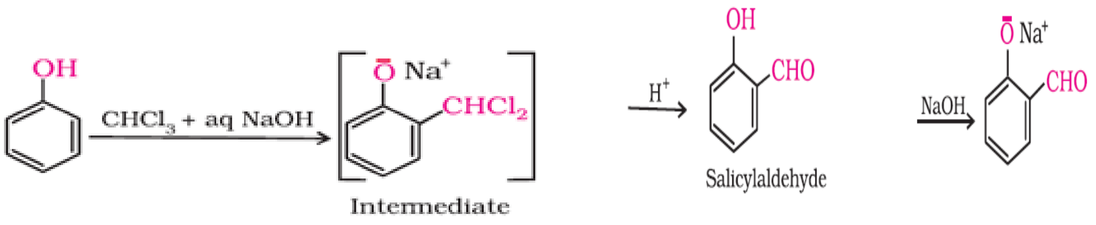
REACTIONS OF PHENOL



NAME REACTIONS:

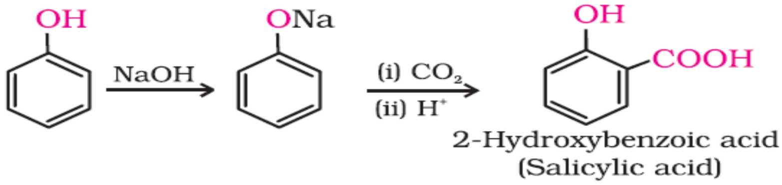
1. Reimer-Tiemann reaction:

On treating phenol with chloroform in the presence of sodium hydroxide, a –CHO group is introduced at ortho position of benzene ring. The intermediate substituted benzal chloride is hydrolysed in the presence of alkali to produce salicylaldehyde.



2. Kolbe's reaction :

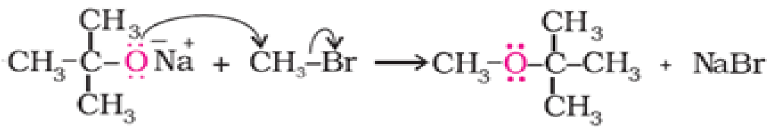
Phenoxide ion generated by treating phenol with sodium hydroxide and then undergoes electrophilic substitution with carbon dioxide, *Ortho hydroxyl benzoic acid is* formed as the main reaction product on hydrolysis.

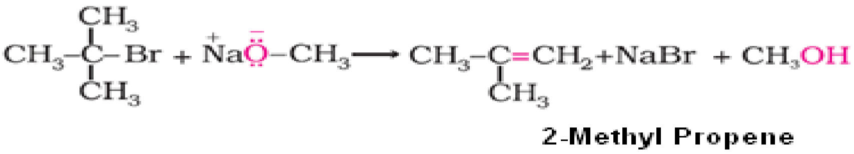


3. Williamson synthesis

In this method, an alkyl halide is allowed to react with sodium alkoxide to prepare ether.

$$R{-}X + R'{-}\ddot{\underset{..}{O}}\,Na \longrightarrow R{-}\ddot{\underset{..}{O}}{-}R' + Na\,X$$

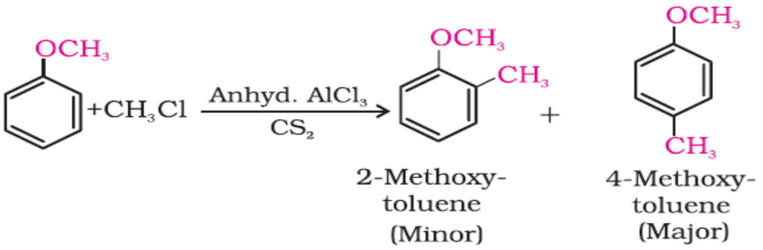


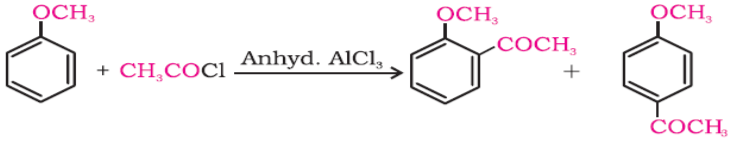


- Better results are obtained if the alkyl halide is primary.
- In case of secondary and tertiary alkyl halides, elimination competes over substitution.
- If a tertiary alkyl halide is used, an alkene is the only reaction product and no ether is formed. It is because alkoxides are not only nucleophiles but strong bases as well. They react with alkyl halides leading to elimination reactions.

4 .Friedel-Crafts reaction:

Anisole undergoes Friedel-Crafts reaction, i.e., the alkyl and acyl groups are introduced at ortho and para positions by reaction with alkyl halide and acyl halide in the presence of anhydrous aluminium chloride (a Lewis acid) as catalyst.





TEST TO DISTINGUISH COMPOUNDS

1. LUCAS TEST

Primary ,secondary and tertiary alcohols :

When 1^0 , 2^0 , 3^0 alcohol treated with Lucas reagent [Conc HCl anhydrous $ZnCl_2$] at room temp

(i) If turbidity appears immediately alcohol is 3^0
(ii) If turbidity appears in five minutes alcohol is 2^0
(iii) 1^0 alcohol does not react withLucas reagent at room temp.

2. Ethanol and methanol – Halo form test

Compounds treated with NaOI , yellow ppt of iodoform will be given by molecule having – CO – CH_3 group . Ethanol gives yellow ppt.

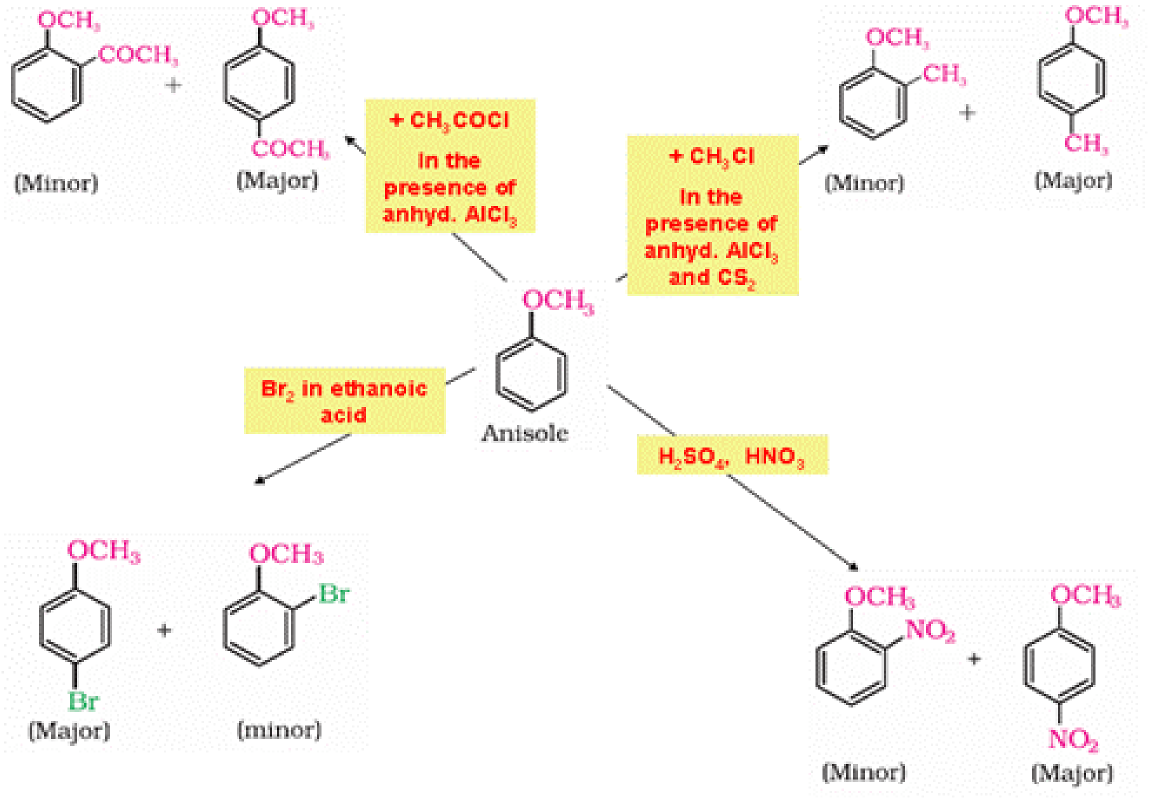
3. Ethanol & phenol : Neutral ferric chloride test Ethanol on treating with NaOH and I_2 give yellow colour iodoform but not 1-propanol

Phenol gives violet colouration when we treated it with neutral ferric chloride

4. 1-Propanol and ethanol : Iodoform test

Ethanol on treating with NaOH and I_2 give yellow coloured iodoform but not 1-proponol

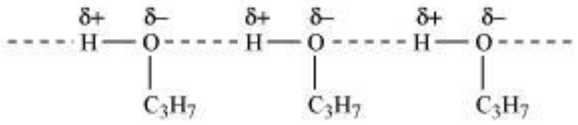
Reactions of ANISOLE



GIVE REASON QUESTIONS

1. Explain why propanol has higher boiling point than that of the hydrocarbon, butane?

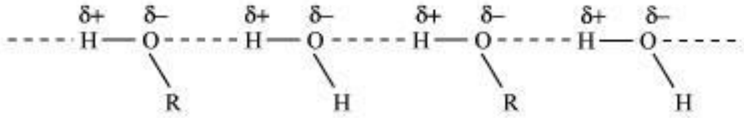
Propanol undergoes intermolecular H-bonding because of the presence of −OH group. On the other hand, butane does not



Therefore, extra energy is required to break hydrogen bonds. For this reason, propanol has a higher boiling point than hydrocarbon butane.

2. Alcohols are comparatively more soluble in water than hydrocarbons of comparable molecular masses. Explain this fact.

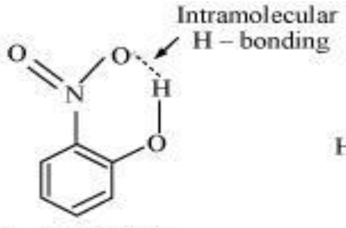
Alcohols form H-bonds with water due to the presence of −OH group. However, hydrocarbons cannot form H-bonds with water.



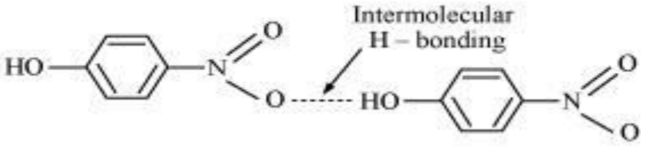
As a result, alcohols are comparatively more soluble in water than hydrocarbons of comparable molecular masses.

3. While separating a mixture of *ortho* and *para* nitrophenols by steam distillation, name the isomer which will be steam volatile. Give reason.

Intramolecular H-bonding is present in *o*-nitrophenol. In *p*-nitrophenol, the molecules are strongly associated due to the presence of intermolecular bonding. Hence, *o*-nitrophenol is steam volatile.

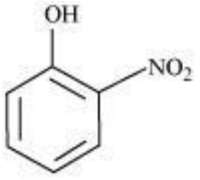


o - Nitrophenol

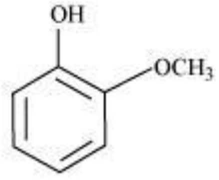


p - Nitrophenol

4. Explain why is *ortho* nitrophenol more acidic than *ortho* methoxy phenol?



o – Nitrophenol

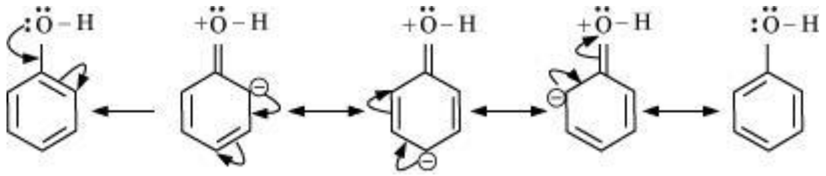


o – Methoxyphenol

The nitro-group is an electron-withdrawing group. The presence of this group in the ortho position decreases the electron density in the O−H bond. As a result, it is easier to lose a proton. Also, the *o*-nitrophenoxide ion formed after the loss of protons is stabilized by resonance. Hence, *ortho* nitrophenol is a stronger acid.
On the other hand, methoxy group is an electron-releasing group. Thus, it increases the electron density in the O−H bond and hence, the proton cannot be given out easily.
For this reason, ortho-nitro phenol is more acidic than ortho-methoxy phenol.

5. Explain how does the −OH group attached to a carbon of benzene ring activate it towards electrophilic substitution?

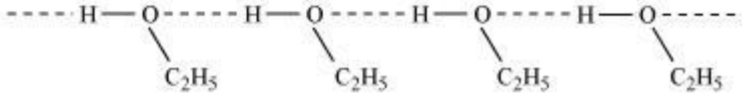
The −OH group is an electron-donating group. Thus, it increases the electron density in the benzene ring as shown in the given resonance structure of phenol.



As a result, the benzene ring is activated towards electrophilic substitution.

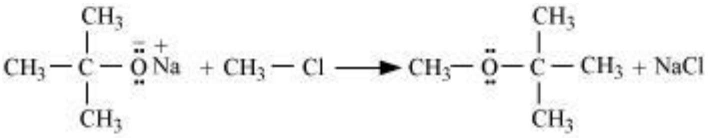
6. Give reason for the higher boiling point of ethanol in comparison to methoxymethane.

Ethanol undergoes intermolecular H-bonding due to the presence of −OH group, resulting in the association of molecules. Extra energy is required to break these hydrogen bonds. On the other hand, methoxymethane does not undergo H-bonding. Hence, the boiling point of ethanol is higher than that of methoxymethane.



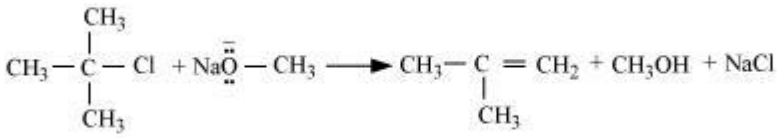
7. Illustrate with examples the limitations of Williamson synthesis for the preparation of certain types of ethers.

The reaction of Williamson synthesis involves S_N2 attack of an alkoxide ion on a primary alkyl halide.



$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-\overset{-}{\ddot{O}}\overset{+}{Na} + CH_3-Cl \longrightarrow CH_3-\ddot{O}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3 + NaCl$$

But if secondary or tertiary alkyl halides are taken in place of primary alkyl halides, then elimination would compete over substitution. As a result, alkenes would be produced. This is because alkoxides are nucleophiles as well as strong bases. Hence, they react with alkyl halides, which results in an elimination reaction.



$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Cl + Na\ddot{\bar{O}}-CH_3 \longrightarrow CH_3-\underset{CH_3}{C}=CH_2 + CH_3OH + NaCl$$

Tertiary alkyl halide Alkene

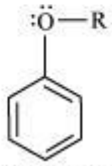
8. **Preparation of ethers by acid dehydration of secondary or tertiary alcohols is not a suitable method. Give reason.**

The formation of ethers by dehydration of alcohol is a bimolecular reaction (S_N2) involving the attack of an alcohol molecule on a protonated alcohol molecule. In the method, the alkyl group should be unhindered. In case of secondary or tertiary alcohols, the alkyl group is hindered. As a result, elimination dominates substitution. Hence, in place of ethers, alkenes are formed.

9. **Explain the fact that in aryl alkyl ethers**

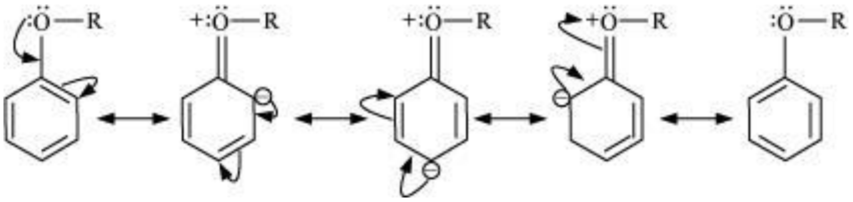
(i) The alkoxy group activates the benzene ring towards electrophilic substitution and

(ii) It directs the incoming substituents to ortho and para positions in benzene ring.



Aryl alkyl ether

In aryl alkyl ethers, due to the +R effect of the alkoxy group, the electron density in the benzene ring increases as shown in the following resonance structure.



Thus, benzene is activated towards electrophilic substitution by the alkoxy group.

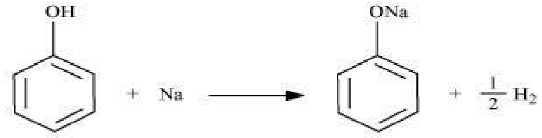
(ii) It can also be observed from the resonance structures that the electron density increases more at the ortho and para positions than at the meta position. As a result, the incoming substituents are directed to the ortho and para positions in the benzene ring.

10. **Phenols do not give protonation reactions readily. Why?**

The lone pair on oxygen of O-H in phenol is being shared with benzene ring through resonance. Thus, lone pair is not fully present on oxygen and hence phenols do not undergo protonation reactions.

11. **Give two reactions that show the acidic nature of phenol.**

1) The acidic nature of phenol can be represented by the following reactions: (i)Phenol reacts with sodium to give sodium phenoxide, liberating H_2.
2) It changes blue litmus to red



Phenol Sodium phenoxide

12. Which out of propan-1-ol and propan-2-ol is stronger acid?

Propan-1-ol is stronger acid than propan-2-ol. The acidic strength of alcohols is in the order $1^o>2^0>3^0$.

13. Account for the following:

i)Phenols has a smaller dipole moment than methanol

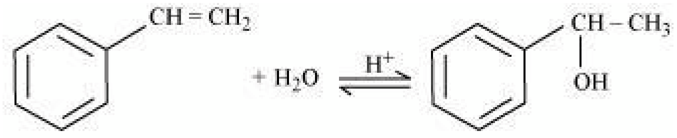
ii)Phenols do not give protonation reactions readily.

(i). In phenol the electron withdrawing inductive effect of –OH group is opposed by electron releasing the resonance effect of –OH.

(ii). The lone pair on oxygen of–OH in phenol is being shared with benzene ring through resonance. Thus, lone pair is not fully present on oxygen and hence phenols do not undergo protonation reactions.

14. Synthesis of (i) 1- phenyl ethanol from suitable alkene (ii) cyclohexyl methanol using an alkyl halide by an SN2reaction (iii) pentan-1-ol using a suitable alkyl halide?

(i) By acid-catalyzed hydration of ethyl benzene (styrene), 1- phenyl ethanol can be synthesized.



Phenylethene 1 – phenylethanol

(ii)When chloro methyl cyclohexane is treated with sodium hydroxide, cyclohexyl methanol is obtained

(iii)When 1-chloropentane is treated with NaOH, pentan-1-ol is produced.

$$CH_3CH_2CH_2CH_2CH_2Cl + NaOH \longrightarrow CH_3CH_2CH_2CH_2CH_2OH + NaCl$$

1-Chloropentane Pantan-1-ol

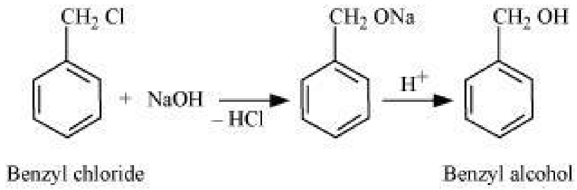
15. Convert (i)Propene to Propan-2-ol
(ii)Benzyl chloride to Benzyl alcohol
(iii)Ethyl magnesium chloride to Propan-1-ol.

(i) If propene is allowed to react with water in the presence of an acidas a catalyst, then propan-2-ol is obtained

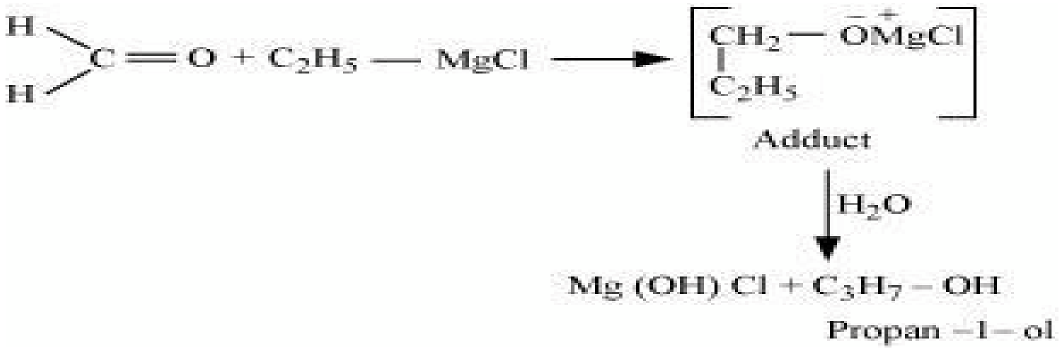
$$CH_3-CH=CH_2 + H_2O \xrightleftharpoons{H^+} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$$

Propene Propan – 2 – ol

(ii) If benzyl chloride is treated with NaOH (followed by acidification) then benzyl alcohol is produced.



(iii) When ethyl magnesium chioride is treated with methanol, an adduct is the produced which gives propan -1-ol on hydrolysis.

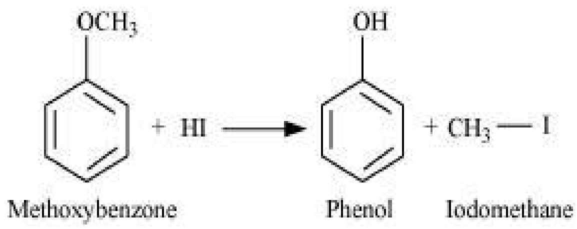


16. Write the equation of the reaction of hydrogen iodide with:
(i)1-propoxypropane (ii) Methoxy benzene (iii) Benzyl ethyl ether

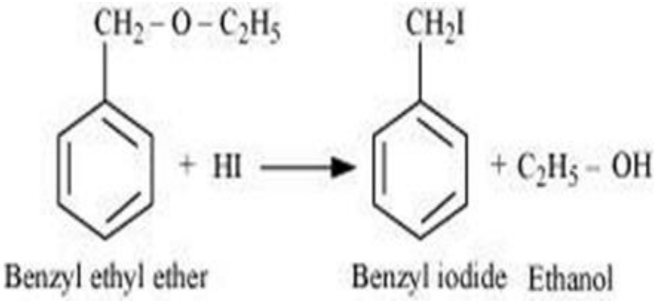
(i)

$$C_2H_5CH_2-O-CH_2C_2H_5+HI\xrightarrow{373K}CH_3CH_2CH_2-OH+CH_3CH_2CH_2-I$$

1-Propoxypropane Propan-1-ol 1–Iodopropane



(ii)



(iii)

MULTIPLE CHOICE QUESTIONS

1. **The IUPAC name of *tert*- Butyl alcohol is :**
   (a) Propan-1-ol
   (b) Propan-2-ol
   (c) 2-methyl propan-2-ol
   (d) Butane-2-ol

2**. Identify allylic alcohol from the following:**
   (a) $CH_3CH_2CH_2OH$
   (b) $CH_3CH=CHOH$
   (c) $CH_2=CHCH_2OH$
   (d) $CH_3CH(OH)CH_3$

3**. Reaction of propanone with methyl magnesium bromide followed by hydrolysis :**
   (a) Butan-1-ol
   (b) Butan-2-ol
   (c) 2-Methyl propan-2-ol
   (d) Propan-2-ol

4. **Mechanism of acid catalysed hydration reaction of Alkenes involves** :
   (i) Protonation of alkene to form carbocation by electrophilic attack of H_3O^+
   (ii) Nucleophilic attack of water on carbocation.
   (iii) Deprotonation to form alcohol.
   (a) (i) and (ii)
   (b) (i) and (iii)
   (c) (i), (ii) and (iii)
   (d) (ii) and (iii)

5.**Identify the compound having highest boiling point:**
   (a) Propan-1-ol
   (b) Propan-2-ol
   (c) Butan-2-ol
   (d) Butan-1-ol

6. **The compound obtained by the reaction of Propene with diborane followed by hydrolysis with alkaline H_2O_2 is**
   a) Ethanol
   b) Propan -1-ol
   c) Ethanal
   d) Triethyl borane.

7. **Ethanol can be prepared from Grignard reagent by the reaction of :**
   (a) HCHO
   (b) $(CH_3)_2CO$
   (c) CH_3CN
   (d) CH_3COCl

8.Which of the following reagents cannot, be used to oxidise primary alcohols to aldehydes?

(a) CrO_3 in anhydrous medium
(b) $KMnO_4$ in acidic medium
(c) Pyridinium chlorochromate
(d) Heat in the presence of Cu at 573 K

9. When the vapours of a primary alcohol are passed over heated copper at 573 K

a) Only Aldehyde is formed
b) Only Ketone is formed
c) Aldehyde & Ketone both are formed
d) Alkene is formed

10. Which of the following are benzylic alcohols?

(i) $C_6H_5 – CH_2 – CH_2OH$
(ii) $C_6H_5 – CH_2OH$
(iii) $C_6H_5 – CH(CH_3)OH$
(iv) $C_6H_5 – CH_2 – CH(CH_3)OH$

(a) (i) and (ii)
(b) (ii) and (iii)
(c) (i), (ii) and (iv)
(d) (i) and (iv)

11. Arrange the following compounds in increasing order of their acid strength: Propan-1-ol, 2,4,6-trinitrophenol, 3-nitrophenol, 3,5-dinitrophenol, phenol, 4-methylphenol.

a) 4-methylphenol, phenol, , 3,5-dinitrophenol, 2,4, 6-trinitrophenol, Propan-1-ol, 3-nitrophenol
b) phenol, 3-nitrophenol, 3,5-dinitrophenol, 2,4, 6-trinitrophenol, Propan-1-ol, 4-methylphenol
c) 4-methylphenol, phenol, 3-nitrophenol, 3,5-dinitrophenol, 2,4, 6-trinitrophenol, Propan-1-ol
d) Propan-1-ol, 4-methylphenol, phenol, 3-nitrophenol, 3,5-dinitrophenol, 2,4, 6-trinitrophenol.

12.Which of the following compound do not give turbidity with Lucas reagent at room temperature:

(a) $CH_3CH_2CH_2OH$
(b) $CH_3CH_2CHOHCH_3$
(c) $CH_2=CHCHOHCH_3$
(d) $(CH_3)_3C(OH)$

13.The IUPAC name of Picric acid is:

a) 2,4,6 -Tribromophenol
b) 2,4 - Dibromophenol
c) 2,4,6 -Trinitrophenol
d) 2,4 -Dinitrophenol

14. When phenol is treated with dilute. HNO_3 gives

a) m-Nitrophenol

b) o- and p-Nitrophenol

c) 2,4-Dinitrophenol

d) 2,4,6-Trinitrophenol

15. On heating with zinc dust Phenol is converted to

a) Benzene

b) Benzaldehyde

c) Zinc Phenoxide

d) Benzene diazonium chloride

16. In the following reaction,

$$CH_3CH_2OH \xrightarrow[\text{443K}]{\text{Con.H2SO4}} Z \text{ , Identify Z}$$

(a) $CH_2 = CH_2$
(b) $CH_3CH_2OCH_2CH_3$
(c) $CH_3CH_2\text{–}HSO_4$
(d) $(CH_3CH_2)_2SO_4$

17.Phenol reacts with Chloroform and alkali gives Salicylaldehyde is

(a) Kolbe's reaction
(b) Cumene synthesis
(c) Reimer -Tiemann reaction
(d) Fittig reaction

18. Williamson's synthesis is used to prepare

(a) Acetone
(b)Ethers
(c) Aldehydes
(d)Phenols

19. The ether that undergoes electrophilic substitution reactions is

(a) $CH_3OC_2H_5$
(b) $C_6H_5OCH_3$
(c) CH_3OCH_3
(d) $C_2H_5OC_2H_5$

20. Which one is formed when sodium phenoxide is heated with ethyl iodide ?

(a) Ethanol
(b) Ethyl phenyl alcohol
(c) Phenol
(d) Ethyl phenyl ether

21. Williamson's synthesis of preparing dimethyl ether is an:

(a) S_N1 reaction
(b) Elimination reaction
(c) $S_N2$reaction
(d) Nucleophilic addition reaction.

22. The product obtained by Kolbe's reaction is:

(a) Benzoic acid
(b) 2-Hydroxybenzoic acid
(c) Salicylaldehyde
(d) Benzaldehyde

23. $(CH_3)_3COCH_3$ +HI ------------>X +Y, X & Y are respectively

(a) $(CH_3)_3$ COH &CH_3I
(b) CH_3CH_2OH & $(CH_3)_2CHI$
(c) CH_3OH &$(CH_3)_3CI$
(d) $(CH_3)_2CHOH$ &CH_3CH_2I

24.Acid catalysed hydration of alkene is an example for

(a) Free radical substitution
(b) Nucleophilic addition
(c) Electrophilic substitution
(d) Electrophilic addition.

25.Among the alkenes which one produces tertiary butyl alcohol on acid hydration.

(a) $CH_3CH_2CH=CH_2$
(b) $CH_3CH=CH_2$
(c) $CH_3CH =CHCH_3$
(d) $(CH_3)_2C=CH_2$

26. Which of the following pair of compound is suitable for the preparation of 3-methyl-2-butanol

(a) 2-Butanone +Methyl magnesium bromide
(b) Acetone+ Ethyl magnesium bromide
(c) Acetaldehyde+ Isopropyl magnesium bromide
(d) Ethyl propionate + Methyl magnesium bromide

27.Which among the following compounds will give a secondary alcohol on reacting with Grignard reagent followed by acid hydrolysis

I.HCHO **II.C_2H_5CHO**

III.CH_3COCH_3 **IV.$RCOOC_2H_5$**

(a) Only II
(b) Only III
(c) II and IV
(d) III and IV

28. The conversion of m-Nitrophenol to resorcinol (Benzene 1,3-diol) involves respectively

(a) Hydrolysis, Diazotization and reduction
(b)Diazotization , reduction and Hydrolysis
(c) Hydrolysis, reduction and Diazotization
(d) Reduction ,Diazotization and Hydrolysis

29. The major product obtained on interaction of phenol with sodium hydroxide and Carbon dioxide is

(a) Salicylaldehyde
(b) Salicylic acid
(c) Benzoic acid
(d) Phthalic acid

30. What are the products of the following reaction. $C_6H_5OCH_2CH_2OH \xrightarrow[\text{Heat}]{\text{Excess HBr}} ?$

(a) $BrCH_2CH_2Br + C_6H_5OH$
(b) $C_6H_5OH + HOCH_2CH_2OH$
(c) $C_6H_5Br + HOCH_2CH_2OH$
(d) $C_6H_5OH + BrCH_2CH_2OH$

31. Out of o-nitro phenol and p-nitro phenol which is steam volatile

(a) Both ortho and para nitrophenol
(b) Only ortho nitrophenol
(c) Only para nitrophenol
(d) Both are not steam volatile.

32. Cumene is oxidised in the presence of air to cumene hydroperoxide which on treating with dilute sulphuric acid gives.

(a) phenol and acetone
(b) Only Phenol
(c) Phenol and Water
(d) Only acetone

33. Lucas reagent is

(a) Conc. HCl and anhydrous $ZnCl_2$
(b) Conc. HNO_3 and hydrous $ZnCl_2$
(c) Conc. HCl and hydrous $ZnCl_2$
(d) Conc. HNO_3 and anhydrous $ZnCl_2$

34. A compound X with the molecular formula C_3H_8O can be oxidised to another compound Y whose molecular formulae is $C_3H_6O_2$. The compound X may be

(a) $CH_3CH_2OCH_3$
(b) CH_3CH_2CHO
(c) $CH_3CH_2CH_2OH$
(d) $CH_3CHOHCH_3$

35. The ortho and para isomers of Nitrophenol can be separated by steam distillation because

(a) o-Nitrophenol is less volatile due to intramolecular hydrogen bonding
(b) p-nitrophenol is more volatile due to intermolecular hydrogen bonding
(c) o-Nitrophenol is more volatile due to intramolecular hydrogen bonding
(d) p-nitrophenol is less volatile due to intramolecular hydrogen bonding

36. The correct order of increasing acidity of the following compounds
A-Phenol , B- 4-Nitrophenol , C- Propan-1-ol D- 4-Methylphenol

(a) C<D<A<B
(b) A<C<D<B
(c) C<A<B<D
(d) A<D<C<B

37.Williamson's synthesis is an example of

(a) Electrophilic addition reaction
(b) Nucleophilic addition reaction
(c) Electrophilic substitution reaction
(d) Nucleophilic substitution reaction

38. Ethers can be distinguished from alcohols by the following reaction:

(a) Reaction with Na
(b) Reaction with PCl_5
(c) Reaction with 2,4 -dinitrophenyl hydrazine
(d) None of these

39.Ethanol on warming with conc.H_2SO_4 at 413 K gives

(a) Ethene
(b) Diethyl ether
(c) Di methyl ether
(d) Ethyl hydrogen sulphate

40.The order of reactivity of halogen acids towards ethers is :

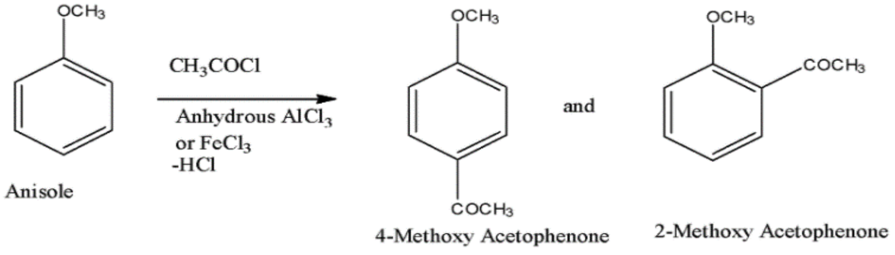
(a) HI > HBr> HCl
(b) HI > HCl > HBr
(c) HCl > HBr > HI
(d) HCl > HI > HBr

41. In the reaction:

$CH_3CH(Br)\ CH_3 \xrightarrow[\text{KOH}]{\text{alc}} A \xrightarrow[\text{Peroxide}]{\text{HBr}} B \xrightarrow{\text{CH3ONa}} C$, C is

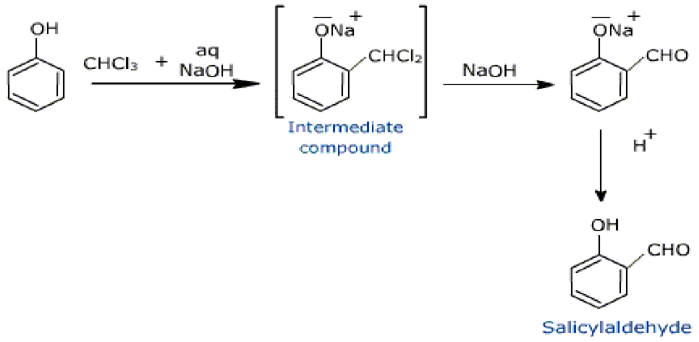
(a) Isopropyl alcohol
(b) Diethyl ether
(c) 1-Methoxypropane
(d) Propylene glycol

42. The equation given below represents



(a) Friedel -Crafts alkylation
(b) Williamson's synthesis
(c) Reimer -Tiemann reaction
(d) Fridel crafts acetylation

43. The equation given below represents



(a) Friedel -Crafts alkylation
(b) Kolbe's reaction
(c) Reimer -Tiemann reaction
(d) Cumene synthesis

44 . Aspirin is
(a) 2,4,6 Tri bromo phenol
(b) Acetyl salicylaldehyde
(c) Acetyl salicylic acid
(d) 2-Methyl benzoic acid

45. Sodium salt of benzene sulphonic acid on fusion with caustic soda followed by acidification gives
(a) Benzene
(b) Phenol
(c) Thio phenol
(d) Benzoic acid

46. Diethyl ether can be decomposed by heating with
(a) HI
(b) NaOH
(c) Water
(d) $KMnO_4$

47. **Which of the following is not true in case of reaction with heated copper at 300°C?**
(a) Phenol ------>Benzyl alcohol
(b) Secondary alcohol-------->Ketone
(c) Primary alcohol------> Aldehyde
(d) Tertiary alcohol --------> Alkene

48. Acidity of phenol is due to
(a) hydrogen bonding
(b) phenolic group
(c) benzene ring
(d) resonance stabilisation of its anion

49. Ethanol exhibits acidic character on reaction with
(a) acetic acid
(b) sodium metal
(c) hydrogen chloride
(d) acidic $K_2Cr_2O_7$

50. Diethyl ether on heating with conc. HI gives two moles of

(a) ethanol
(b) iodoform
(c) ethyl iodide
(d) methyl iodide

ANSWERS

1.c	11.d	21.c	31.b	41.c
2.c	12.a	22.b	32.a	42.d
3.c	13.c	23.c	33.a	43.c
4.c	14.b	24.d	34.c	44.c
5.d	15.a	25.d	35.c	45.b
6.b	16.a	26.c	36.a	46.a
7.a	17.c	27.a	37.d	47.a
8.b	18.b	28.d	38.a	48.d
9.a	19.b	29.b	39.a	49.b
10.b	20.d	30.a	40.a	50.c

ASSERTION REASON TYPE QUESTIONS

Directions: These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.
(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

Q.1. Assertion : The bond angle in alcohols is slightly less than the tetrahedral angle.
Reason : In alcohols, the oxygen of –OH group is attached to sp3 hybridized carbon atom.

Q.2. Assertion : In Lucas test, 3º alcohols react immediately.
Reason : An equimolar mixture of anhyd. $ZnCl_2$ and conc. HCl is called Lucas reagent.

Q.3. Assertion : Reimer-Tiemann reaction of phenol with CCl_4 in NaOH at 340 K gives salicyclic acid as the major product.
Reason : The reaction occurs through intermediate formation of dichlorocarbene.

Q.4. Assertion : Phenol is more reactive than benzene towards electrophilic substitution reaction.
Reason : In the case of phenol, the intermediate carbocation is more resonance stabilized.

Q.5. Assertion : In case of phenol, bromination takes place even in absence of Lewis acid whereas bromination of benzene takes place in presence of Lewis acid like $FeBr_3$.
Reason : – OH group attached to benzene ring is highly deactivating.

Q.6. Assertion : ter – Butyl methyl ether is not prepared by the reaction of ter-butyl bromide with sodium methoxide.
Reason : Sodium methoxide is a strong nucleophile.

Q.7. Assertion : Ethers behave as bases in the presence of mineral acids.
Reason : Due to the presence of lone pairs of electrons on oxygen.

Q.8. Assertion : With HI, anisole gives iodobenzene and methyl alcohol.
Reason : Iodide ion combines with smaller group to avoid steric hindrance.

Q.9. Assertion : With HI at 373 K, ter-butyl methyl ether gives ter-butyl iodide and methanol.
Reason : The reaction occurs by SN^2 mechanism.

Q.10. Assertion : Ethyl phenyl ether on reaction with HBr form phenol and ethyl bromide.
Reason : Cleavage of C–O bond takes place on ethyl-oxygen bond due to the more stable phenyl-oxygen bond.

Q 11.**Assertion** : Addition reaction of water to but-1-ene in acidic medium yields butan-2-ol
Reason : Addition of water in acidic medium proceeds through the formation of primary carbocation.

Q 12.**Assertion** : p-nitrophenol is more acidic than phenol.
Reason : Nitro group helps in the stabilisation of the phenoxide ion by dispersal of negative charge due to resonance.

Q 13.**Assertion** : IUPAC name of the compound is 2-Ethoxy-2-methylethane.
Reason : In IUPAC nomenclature, ether is regarded as hydrocarbon derivative in which a carbon atom is replaced by —OR or —OAr group [where R = alkyl group and Ar = aryl group]

Q 14.**Assertion** : Bond angle in ethers is slightly less than the tetrahedral angle.
Reason : There is an attraction between the two bulky (—R) groups.

Q 15.**Assertion** : Boiling points of alcohols and ethers are high.
Reason : They cannot form intermolecular hydrogen-bonding.

Q 16.**Assertion** : Like bromination of benzene, bromination of phenol is also carried out in the presence of Lewis acid.
Reason : Lewis acid polarises the bromine molecule.

Q 17.**Assertion** : o-Nitrophenol is less soluble in water than the m- and p-isomers.
Reason : m- and p- Nitrophenols exist as associated molecules.

Q 18.**Assertion** : Ethanol is a weaker acid than phenol.
Reason : Sodium ethoxide may be prepared by the reaction of ethanol with aqueous NaOH.

Q 19.**Assertion**: Phenol forms 2, 4, 6 – tribromophenol on treatment with Br2 in carbon disulphide at 273K.
Reason: Bromine polarises in carbon disulphide.

Q 20.**Assertion**: Phenols give o- and p-nitrophenol on nitration with conc.HNO3 and H2SO4 mixture.
Reason: —OH group in phenol is o–, p– directing.

ANSWERS

1	a	11	b
2	b	12	a
3	c	13	d
4	a	14	d
5	c	15	d
6	b	16	d
7	a	17	b
8	d	18	c
9	c	19	e
10	c	20	d

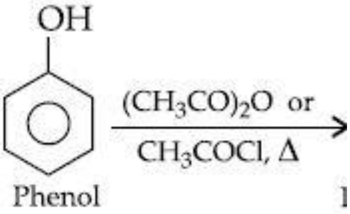
CASE BASED QUESTIONS

CASE BASED QUESTIONS:1

ACYLATION OF PHENOLS:

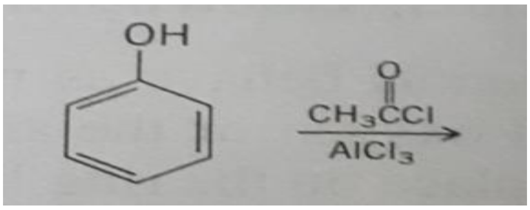
Acylating agents like acyl chlorides and acid anhydrides can react with phenols either at the aromatic ring (C-acylation) or at the hydroxyl oxygen (O-acylation). C-acylation of phenols is observed under the conditions of the Friedel – Crafts reaction in which reaction with acyl chloride or acid anhydride is done in presence of aluminium chloride. But in the absence of aluminium chloride O-acylation occurs. Preference for O-acylation is due to kinetic factors. O-acylation is faster than C-acylation. But the presence of aluminium chloride makes it subject to thermodynamic control and more stable C-acyl isomers are formed. So aryl esters get converted to aryl ketones in presence of aluminium chloride. This isomerization is called Fries rearrangement.

Q.1. **Product formed in the following reaction is**



(a) Phenyl ethanoate
(b) 2-Hydroxy acetophenone
(c) 4-Hydroxy acetophenone
(d) Ethyl benzoate

Q.2. **Identify correct statement/statements about the following reaction**



(i) Aryl ester is formed through C-acylation
(ii) Aryl ketone is formed through O-acylation
(iii) Fries rearrangement takes place
(iv) C-acylated product is formed
- (a) (i),(iv)
- (b) (ii), (iii)
- (c) (iii),(iv)
- (d) (iii)

Q.3.Conversion of salicylic acid to aspirin takes place

(a) on treating salicylic acid with acetic anhydride
(b) on treating salicylic acid with acetic anhydride and $AlCl_3$
(c) through C-acylation
(d) both (a) and (c)

CASE BASED QUESTION -2

PREPARATION OF ALCOHOLS BY REDUCTION OF ALDEHYDES AND KETONES

The most obvious way to reduce an aldehydes or a ketone to an alcohol is by hydrogenation of the carbon-oxygen double bond. Finely divided metals such as Pt, Pd and Ni are effective catalysts in hydrogenation. For most laboratory-scale reductions of aldehydes and ketones, catalytic hydrogenation has been replaced by methods based on metal hydride reducing agents. The two most common reagents are sodium borohydride and lithium aluminium hydride. $NaBH_4$ is especially easy to use, needing only to be added to an aqueous or alcoholic solution of an aldehydes or a ketone. $LiAlH_4$ reacts violently with water and alcohols, so a separate hydrolysis step is required to liberate the alcohol product. $NaBH_4$ and $LiAlH_4$ do not reduce isolated carbon-carbon double bonds unlike in catalytic hydrogenation.

Q.1. IUPAC name of the product formed when 6-Methylhept-5-en-2-one is reduced using lithium aluminium hydride is

(a) 6-Methylhept-5-en-2-ol
(b) 6-Methylheptan-2-ol
(c) 6-Methylheptan-1-ol
(d) 6-Methylhept-5-en-1-ol

Q.2.Cyclopentanol is obtained from Cyclopent-3-en-1-one by reduction using

(a) H_2/Pd
(b) $LiAlH_4$
(c) $NaBH_4$
(d) both (b) and (c)

Q.3. Isobutylalcohol is obtained by the reduction of which of the following?

(a) Butanal
(b) Butan-2-one
(c) 2-Methylpropanal
(d) 2,2-Dimethylpropanal

ANSWERS

1.1. (a)	**2.1. (a)**
1.2. (c)	**2.2.(a)**
1.3. (a)	**2.3.(c)**

CASE BASED QUESTIONS -3

Read the passage given below and answer the following questions:

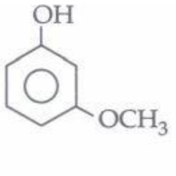
Both alcohols and phenols are acidic in nature, but phenols are more acidic than alcohols. Acidic strength of alcohols mainly depends upon the inductive effect. Acidic strength of phenols depends upon a combination of both inductive effect and resonance effects of the substituent and its position on the benzene ring. Electron withdrawing groups increases the acidic strength of phenols whereas electron donating groups decreases the acidic strength of phenols. Phenol is a weaker acid than carboxylic acid.

The following questions are multiple choice questions. Choose the most appropriate answer:

(i) Phenols are highly acidic as compare to alcohols due to

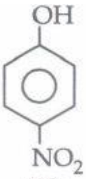
(a) the higher molecular mass of phenols (b) the stronger hydrogen bonds in phenols
(c) alkoxide ion is a strong conjugate base (d) phenoxide ion is resonance stabilised.

(ii) The correct decreasing order of pK_a value is

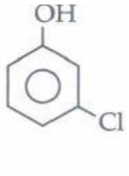


(I)

(II)



(III)



(IV)

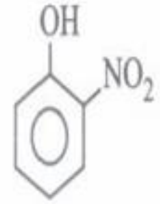
(a) II > IV > I > III (b) IV > II > III > I (c) III > II > IV > I (d) IV > I > II > III

(iii) The compound that does not liberate CO_2, on treatment with aqueous sodium bicarbonate solution is

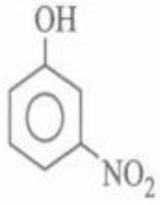
(a) benzoic acid (b) benzenesulphonic acid (c) salicylic acid (d) carbolic acid.

iv) Most acidic amongst the following is

(a)



(b)



(c)

(d)

ANSWERS – (i) d (ii) a (iii) d (iv) c

CASE – 4

Read the passage given below and answer the following questions:

An organic compound (A) having molecular formula C_6H_6O gives a characteristic colour with aqueous $FeCl_3$ solution. (A) on treatment with CO_2 and NaOH at 400 K under pressure gives (B), which on acidification gives a compound (C). The compound (C) reacts with acetyl chloride to give (D) which is a popular pain killer.

The following questions are multiple choice questions. Choose the most appropriate answer:

(i) Compound (A) is

(a) 2-hexanol (b) dimethyl ether (c) phenol (d) 2-methyl pentanol.

(ii) Number of carbon atoms in compound (D) is

(a) 7 (b) 6 (c) 8 (d) 9

(iii) The conversion of compound (A) to (C) is known as

(a) Reimer- Tiemann reaction (b) Kolbe's reaction (c) Schimdt reaction (d) Swarts reaction

(iv) Compound (A) on heating with compound (C) in presence of $POCl_3$ gives a compound (D) which is used

(a) in perfumery as a flavouring agent (b) as an antipyretic (c) as an analgesic (d) as an intestinal antiseptic.

Answers – (i) c (ii) d (iii) b (iv) d

CHAPTER 14

BIOMOLECULES

GIST OF THE LESSON

CARBOHYDRATES

Optically active polyhydroxy aldehydes or poly hydroxy ketones or substance which give these on hydrolysis. Carbohydrates are used as storage molecules as starch in plants and glycogen in animals.

CLASSIFICATION

- **On the basis of their behaviour towards hydrolysis** they are classified as

(i) Monosaccharides: Simple carbohydrates which cannot be hydrolysed into smaller molecules. eg: Glucose, Fructose, Ribose etc.

(ii) Oligo saccharides: Carbohydrates which give 2-10 mono saccharide units on hydrolysis. eg: sucrose, maltose, lactose

Oligosaccharides may further classified as

a) Disaccharide: carbohydrates which upon hydrolysis give two molecules of the same or different monosaccharides. eg. sucrose, maltose, lactose
b) Trisaccharide: carbohydrates which upon hydrolysis give three molecules of the same or different monosaccharides. eg. raffinose
c) Tetrasaccharides: carbohydrates which upon hydrolysis give four molecules of the same or different monosaccharides. eg. stachyrose

(iii) Polysaccharides: carbohydrates which upon hydrolysis give large number of monosaccharide molecules. eg. Starch, cellulose, glycogen.

- **Sugars**: All the monosaccharides and oligosaccharides are crystalline solids, soluble in water and sweet in taste are collectively called sugars.
- **Non sugars**: Polysaccharides which are amorphous solids insoluble in water and tasteless.
- **Reducing sugar**: Carbohydrates in which aldehydic or ketonic groups are free and are capable of reducing Fehling’s solution or Tollen’s reagent are known as reducing sugars.eg.Glucose,fructose,ribose etc.

- **Non reducing sugars**: Carbohydrates in which aldehydic or ketonic group are bonded and are not capable of reducing Fehling's solution or Tollen's reagent are called non-reducing sugars. eg. Starch, cellulose, glycogen, dextrins etc.
- **On the basis of number of carbon atoms and the functional group** present in them, monosaccharides are further classified into

  (i) **Aldose**: If aldehyde group is present in monosaccharides.

  eg. Glucose contains aldehyde group and it has six carbon atoms. Hence it is aldohexose.

  A monosaccharide with three carbon atoms and aldehyde group is

  (ii) **Ketose**: If monosaccharides contain keto group, then it is called ketose.

  eg. Fructose contains keto group and six carbon atoms. Hence it is ketohexose.

  A monosaccharide with keto group and five carbon atom is a ketopentose.

- **Glucose**: It is present in sweet fruits, honey, ripe grapes. It is also called grape sugar or dextrose.
- Glucose is prepared IN laboratory by the hydrolysis of alcoholic solution of sucrose (cane sugar)

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{H+} C_6H_{12}O_6 + C_6H_{12}O_6$$

- On large scale glucose is obtained by the hydrolysis of starch by boiling it with hot dilute sulphuric acid at 393K under 2-3 atmospheric pressure.

STRUCTURE OF GLUCOSE

- Glucose contains Aldehydic group, four 2°alcoholic groups and a 1°alcoholic group.
- Molecular formula of glucose is $C_6H_{12}O_6$
- Presence of straight chain: When heated with HI for long time glucose forms n-hexane which shows that all six carbon atoms are linked in a straight chain.
- Presence of carbonyl group: with hydroxylamine glucose reacts to form an oxime which confirms the presence of a carbonyl group.

  Glucose when reacts with HCN, cyanohydrin is formed which again shows the presence of carbonyl group in glucose.

  Glucose gets oxidized to six carbon carboxylic acid (gluconic acid) on reaction with a mild oxidizing agent like bromine water.
- Glucose is dextrorotatory.

- Presence of five -OH groups attached to different carbon atoms: can be confirmed by the reaction of glucose with acetic anhydride(acetylation) to give glucose pentaacetate.
- Presence of primary alcoholic group can be confirmed by oxidizing glucose as well as gluconic acid by nitric acid where both yield a dicarboxylic acid, saccharic acid.
- D-L configuration: The letters D or L before the name of any compound indicate the relative configuration of a particular stereoisomer. This refers to their relation with a particular isomer of glyceraldehyde.

Fructose: Structure

- Contains a ketonic functional group at carbon number 2, six carbons in straight chain.
  It belongs to D series and is a laevorotatory compound.
  It is also known as fruit sugar.

- As some monosaccharides undergoes cyclisation, glucose exists in six membered pyranose form and fructose exists in five membered furanose form.

- Monosaccharides joins with another monosaccharide unit through **glycosidic linkage**.

Hydrolysis products of some disaccharides:

- Sucrose on hydrolysis gives equimolar mixture of D-(+)-glucose and D-(-)-fructose
- One mole maltose on hydrolysis gives two moles of D-glucose.
- Lactose on hydrolysis yields equimolar mixture of D-glucose and D-galactose.

PROTEINS

- All proteins are polymers of ɑ-amino acids.
- Amino acids contain amino and carboxyl functional groups. Only ɑ-amino acids are obtained on hydrolysis of proteins.
- Classification of amino acids depending upon the relative number of amino and carboxyl groups in their molecules. More number of amino groups make the molecule basic, more number of carboxyl functional groups make it acidic and equal number of amino and carboxyl functional groups make it neutral.
- Amino acids that can be synthesized in the body are known as non -essential amino acids. eg. glycine, alanine, glutamic acid, aspartic acid, glutamin etc.

- Amino acids which cannot be synthesized in the body and must be obtained through diet are known as essential aminoacids. eg. Valine, leucine, isoleucine, arginine, lysine, Methionine, phenylalanine tryptophan, histidine etc.
- Amino acids are usually colourless, crystalline solids, they are water soluble high melting solids.
- In aqueous solution the carboxyl group can lose a proton and amino group can accept a proton giving rise to a dipolar ion known as zwitter ion. In this form amino acids show amphoteric behavior as they react both with acids and bases.
- **Except** glycine all other naturally occurring ɑ-amino acids are optically active, since the ɑ-carbon atom is asymmetric. Exist in both D and L forms. Most naturally existing amino acids have L- configuration.
- In proteins, ɑ-amino acids are connected to each other by peptide bond or peptide linkage.
- Peptide bond: Chemically peptide linkage is an amide(-CO-NH-) bond formed between carboxyl group and amino group.
- The reaction between two similar or different amino acids results in the elimination of a water molecule and formation of peptide bond. As the product of this reaction is formed from two amino acid molecules, the product is a **dipeptide**.
- Gly-Ala is a dipeptide formed from Glycine and Alanine.
- When the number of amino acids joined through peptide bonds is more than ten, then the products are called polypeptides.
- A polypeptide with more than hundred amino acid residues having molecular mass more than 10,000u is called a **protein.**
- Insulin is a polypeptide which contains only 51 amino acids also considered as a protein as it has a well-defined conformation of protein.

- On the basis of their molecular shape proteins are classified as **Fibrous proteins** and **Globular proteins.**
- **Fibrous proteins** have thread or fibre like structures in which polypeptide chains run parallel and are held together by hydrogen bonds and disulphide bonds. These are insoluble in water. eg. keratin and myosin.
- **Globular proteins** have spherical shape in which chains of poly peptide coil around. These are soluble in water. eg. insulin and albumin.

- **On the basis of structure and shape of proteins, four different levels** are found,
  i)Primary structure: The specific sequence in which various amino acids are linked with each other to form a poly peptide. The change of just one amino acid in the sequence can alter its biological activity as it becomes a different protein.
  ii) Secondary structure: The conformation in which the poly peptide chains assume as the result of hydrogen bonding between '-CO-' and '-NH-' of peptide bond is called secondary structure. It may be α-helix structure or beta pleated sheet structure.
  iii) Tertiary structure: Further folding of secondary structure is known as tertiary structure. This folding give rise to Globular and fibrous molecular shapes. The main binding forces existing here are hydrogen bonds, disulpide linkages, van der Waal's force and electrostatic force of attractions.
  iv)Quaternary structure: Some of the proteins are composed of two or more poly peptide chains known as sub units. The spatial arrangement of these subunits with respect to each other is known as Quaternary structure.

- **Denaturation of proteins**: When a native protein is subjected to physical change or chemical change the hydrogen bonds are disturbed and unfolding and uncoiling of secondary and tertiary structure occurs and the protein loses its biological activity. This is called denaturation. Change in temperature or change in pH may cause denaturation of protein.
- During denaturation primary structure remains intact.

NUCLEIC ACIDS

- Nucleic acid contains a pentose sugar, Phosphoric acid Nitrogen base. These three are the products of hydrolysis of complete hydrolysis of two types of nucleic acids(DNA and RNA)
- Nitrogen bases are of two types: **Purines**: Adenine and Guanine; **Pyrimidines**: Uracil, Thymine, Cytosine
- DNA has Adenine, Guanine, Cytosine and **Thymine** as nitrogen bases where as in RNA the nitrogen bases are Adenine, Guanine, Cytosine and **Uracil.**
- A **nucleoside** consists of a pentose sugar and a nitrogen base.
- When nucleoside is linked to phosphoric acid at5' position of sugar moiety a **Nucleotide** is formed.

- Nucleotides are joined together by phosphodiester linkage.
- When large number of nucleotides are connected, they form nucleic acid.
- The information regarding the sequence of nucleotides is called primary structure.
- Secondary structure, proposed by James Watson and Francis Crick gives a double stranded helical structure for DNA. The two strands are complementary to each other because the hydrogen bonds are formed between the specific pairs of bases.
- Adenine forms two hydrogen bonds with Thymine whare as cytosine of one strand makes three hydrogen bonds with guanine of the other strand.
- If one strand of DNA has a base sequence of ATTAAGGC, its complementary strand should be TAATTCCG
- These biomolecules are responsible for heredity.

MULTIPLE CHOICE QUESTIONS

1. **One molecule of sucrose on hydrolysis gives:**

(A) 2 molecules of β -D glucose
(B) 1 molecule of α-D glucose + 1 molecule of β -D fructose
(C) 2 molecules of α-D glucose
(D) 1 molecule of α-D glucose + 1 molecule of β -D galactose

2. **Which of the following statement is not true about glucose?**

(A) It is an aldohexose
(B) On heating with HI it forms n-hexane
(C) It is present in furanose form
(D) It does not give 2,4-DNP test

3. **In fibrous protein polypeptide chains are held together by _______**

(A) Vander Waals force
(B) Disulphide linkages
(C) Electrostatic force of attraction
(D) Hydrogen bonds

4. **Which of the following are purine bases?**
(i) Guanine (ii) Adenine (iii) Thymine (iv) Uracil

(A) (i) and (ii)
(B) (i) and (iii)
(C) (ii) and (iii)
(D) (ii) and (iv)

5. **Both DNA and RNA have nitrogenous bases. Base which is not present in DNA is _________**

(A) Adenine
(B) Uracil
(C) Guanine
(D) Thymine

6. Primary structure of protein refers to ________

(A) Shape in which long polypeptide chain can exist
(B) Overall folding of polypeptide chain
(C) The spatial arrangement of sub units with respect to each other
(D) Sequence of amino acids in polypeptide chain

7. Naturally occurring amino acids are optically active but the amino acid which is not optically active is ________

(A) Alanine
(B) Valine
(C) Proline
(D) Glycine

8. No. of amino acids present in the protein insulin is ________

(A) 51
(B) 56
(C) 50
(D) 41

9. Which among the following statements are true about globular protein?
(i) Polypeptide chains run parallel
(ii) Polypeptide chains coil around and to give spherical shape
(iii) Soluble in water
(iv) Insoluble in water

(A) (i) and (ii)
(B) (i) and (iii)
(C) (ii) and (iii)
(D) (i) and (iv)

10. Monosaccharides are classified into aldoses and ketoses. D-ribose and 2-deoxy D-ribose are examples of ________

(A) Aldohexoses
(B) Ketopentoses
(C) Ketohexoses
(D) Aldopentoses

11. Which among the following is not a reducing sugar?

(A) Glucose
(B) Sucrose
(C) Lactose
(D) Fructose

12. Identify the incorrect statement about fructose from the following _______

(A) It is a ketopentose
(B) It is a reducing sugar
(C) It exists in two cyclic forms
(D) Its cyclic structure is pyranose structure

13. Reaction of gluconic acid with conc. HNO_3 gives saccharic acid. This indicates the presence of _________

(A) -CHO group
(B) Keto group
(C) Primary alcoholic group
(D) Secondary alcoholic group

14. Presence of -CHO group in glucose is confirmed by ________

(A) Reaction with **NH_2OH**
(B) Reaction with HCN
(C) Reaction with HI
(D) Reaction with Bromine water

15. Glucose reacts with Hydrogen cyanide to give Cyanohydrin. This indicates the presence of ________

(A) Primary alcoholic group
(B) Carbonyl group
(C) Secondary alcoholic group
(D) Straight chain of six Carbon atoms

16. Which among the following statements is incorrect about reducing sugar?

(A) Reduces Fehling’s solution
(B) Reduces Tollens reagent
(C) They have free aldehyde or ketonic group
(D) All disaccharides are reducing sugars

17. The linkage between two monosaccharide units in oligosaccharides or polysaccharides is _________

(A) Peptide linkage
(B) Phosphodiester linkage
(C) Glycosidic linkage
(D) None of the above

18. Maltose is a disaccharide. On hydrolysis, one molecule of maltose gives _______

(A) α-D-glucose and β -D-fructose
(B) Two molecules of α-D-glucose
(C) Two molecules of α-D-fructose
(D) β -D-galactose and β -D-fructose

19. A carbohydrate which does not have general formula $C_x(H_2O)y$ is _______

(A) Ribose
(B) Rhamnose
(C) Fructose
(D) Glucose

20. Reaction of glucose with Bromine water produces _______

(A) $OHC - (CHOH)_4 - COOH$
(B) $CH_3 - (CH_2)_4 – CH_3$
(C) $COOH - (CHOH)_4 – COOH$
(D) $HO(CN)HC - (CHOH)_4 - CH_2OH$

21. Which among the following is a fibrous protein?

(A) Keratin
(B) Insulin
(C) Albumin
(D) Haemoglobin

22. In the secondary structure of protein the bond present in between -NH group and C=O group is ________

(A) Disulphide linkages
(B) Van der Waal's bond
(C) Hydrogen bond
(D) Electrostatic force of attraction

23. Dinucleotide is obtained by joining two nucleotides together by phosphodiester linkage. Between which Carbon atom of pentose sugars of nucleotides are those linkages present?

(A) $5'$ and $3'$
(B) 1 and $5'$
(C) $5'$ and $5'$
(D) $3'$ and $3'$

24. Nucleic acids are the polymers of ________

(A) Nucleosides
(B) Nucleotides
(C) Bases
(D) Sugars

25. Which of the following reactions of glucose can be explained only by its cyclic structure?

(A) Glucose forms pentaacetate
(B) Glucose reacts with hydroxylamine to form an oxime
(C) Pentaacetate of glucose does not react with hydroxyl amine
(D) Glucose is oxidized by nitric acid to saccharic acid

26. Nucleic acids are polymers of nucleotides. The linkage between two nucleotides in the nucleic acid is ________

(A) Glycosidic linkage
(B) Phosphodiester linkage
(C) Peptide linkage
(D) Disulphide linkage

27. Which among the following are non-essential amino acids?
(i) Alanine (ii) Glycine (iii) Leucine (iv) Valine

(A) (i) and (iii)
(B) (i) and (iv)
(C) (i) and (ii)
(D) (iii) and (iv)

28. Identify the statement which is true regarding base pairing in DNA
(A) Adenine forms a double bond with Cytosine
(B) Guanine forms a tripe bond with Cytosine
(C) Adenine forms double bond with Guanine
(D) Thymine form triple bond with Guanine

29. Which among the following Carbohydrate is Mono Saccharide?

(A) 2-deoxyribose
(B) Sucrose
(C) Maltose
(D) Lactose

30. Fructose reduces Tollens reagent due to ______

(A) Primary alcoholic group
(B) Asymmetric carbons
(C) Secondary alcoholic group
(D) Enolization of fructose followed by conversion to aldehyde by base.

31. DNA and RNA contain four bases. Which of the following base is not present in RNA?

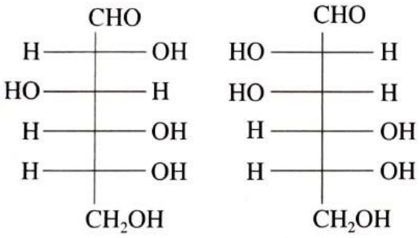
(A) Adenine
(B) Uracil
(C) Thymine
(D) Cytosine

32. The presence or absence of hydroxyl group on which Carbon atom of Sugar differentiate RNA and DNA _______

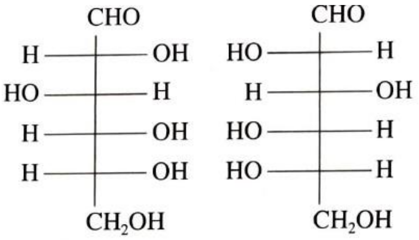
(A) 2nd
(B) 4th
(C) 3rd
(D) 1st

33. Which of the following pairs represents anomers?

(A)



(B)



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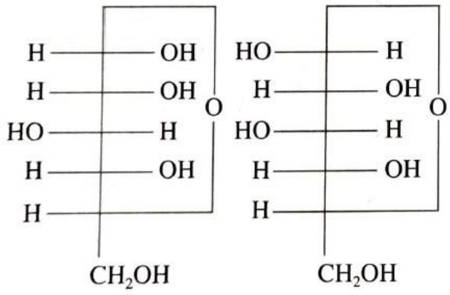

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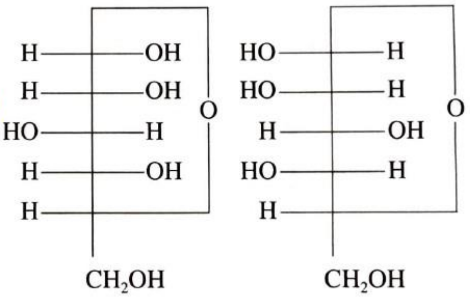
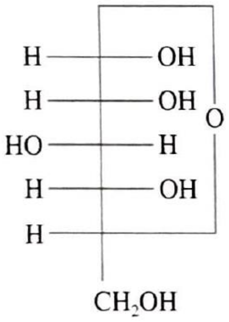
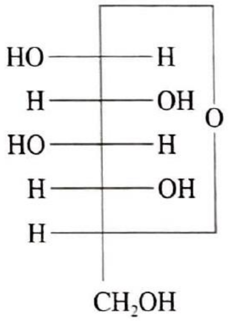


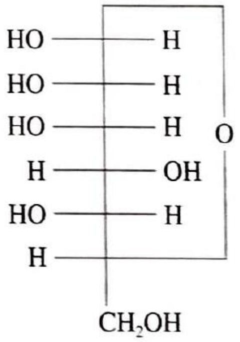
34. Three cyclic structures of monosaccharides are given below which of these are anomers?



(I)



(II)



(III)

(A) I and II
(B) II and III
(C) I and II
(D) III is anomer of I and II

35. The symbols D and L in the name of Carbohydrate represents _______

(A) Dextro rotatory nature
(B) Laevo rotatory nature
(C) The relative configuration of a particular isomer
(D) The optical activity of compounds.

36. Denaturation of protein leads to loss of its biological activity. Which of the following is not affected by denaturation?

(A) Secondary structure of protein
(B) Tertiary structure of protein
(C) Sequence of amino acid in the polypeptide chain

(D) None of the above

37. Proteins are condensation polymers of _______

(A) α-amino acids
(B) 2-hydroxy acids
(C) β amino acids
(D) β -hydroxy acids

38. Curdling of milk is an example of _______

(A) Breaking of protein into amino acids
(B) Hydrolysis of lactose
(C) Breaking of peptide linkage
(D) Denaturation of protein

39. α-D glucose and β -D glucose differ by ________

(A) Position of -OH group in the ring
(B) Configuration of hydroxyl group at C_6
(C) Configuration of hydroxyl group at C_1
(D) Position of Oxygen atom in the ring

40. Which of the following refers to the spatial arrangement of subunits with respect to each other?

(A) Tertiary structure of protein
(B) Quaternary structure of protein
(C) Secondary structure of protein
(D) Primary structure of protein

41. Glucose and Fructose are ______

(A) Functional isomers
(B) Structural isomers
(C) Anomers
(D) Geometrical isomers

42. Glucose on heating with HI gives n-Hexane. This suggests the presence of _______

(A) One aldehyde group
(B) One primary alcoholic group
(C) Straight chain of six carbon atoms
(D) Four secondary alcoholic group

43. Which of the following is a polysaccharide?

(A) Glucose
(B) Maltose
(C) Sucrose
(D) Cellulose

44. Which of the following is a keto hexose?

(A) Fructose
(B) Galactose
(C) Glucose
(D) Mannose

45. Which of the following amino acid is neutral?

(A) Aspartic acid
(B) Lysine
(C) Glycine
(D) Arginine

46. In basic medium Glycine predominantly exists as _______

(A) Cation
(B) Zwitterion
(C) Anion
(D) Covalent form

47. In nucleic acids the individual nucleotides are linked through ______

(A) Peptide linkage
(B) Phosphate group
(C) Hydrogen bond
(D) Covalent bond

48. In DNA, Thymine is held by two hydrogen bonds with the base ________

(A) Adenine
(B) Cytosine
(C) Thymine
(D) Guanine

49. Which of the following reactions statement is not correct about Amino acids?

(A) Amino acids exist as zwitter ion
(B) All naturally occurring α-amino acids have $-NH_2$group on the right
(C) Except glycine all other naturally occurring α-amino acids have a chiral carbon atom
(D) The basic character in amino acids is due to $-COO^-$group

50. The two forms of D-glucopyranose obtained from the solution of D-glucose are called _________

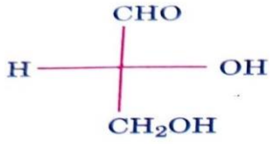
(A) Isomers
(B) Anomers
(C) Epimers
(D) Enantiomers

51. The number of chiral carbon in glucose is _________

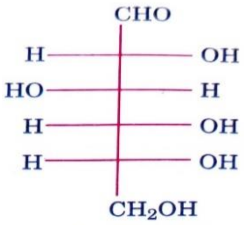
(A) 4

(B) 5
(C) 3
(D) 1

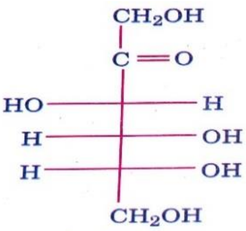
52. Optical rotations of some compounds along with their structures are given below. Which of them have D configuration?



(+) Rotation
(I)



(+) Rotation
(II)



(–) Rotation
(III)

(A) I, II, III
(B) II, III
(C) I, II
(D) III

53. The β-pleated structure of protein is _______ structure of protein

(A) Quaternary
(B) Primary
(C) Tertiary
(D) Secondary

54. The total no. of known essential amino acids are _______

(A) 6
(B) 8
(C) 10
(D) 2

55. α-helix structure and β-pleated structures of proteins are ________

(A) Primary structure of protein
(B) Tertiary structure of protein
(C) Secondary structure of protein
(D) Quaternary structure of protein

ANSWER KEY

1	B	12	D	23	A	34	A	45	C
2	C	13	C	24	B	35	C	46	C
3	D	14	D	25	C	36	C	47	B
4	A	15	B	26	B	37	A	48	A
5	B	16	D	27	C	38	D	49	D
6	D	17	C	28	B	39	C	50	B

7	D	18	C	29	A	40	B	51	A
8	A	19	B	30	D	41	A	52	A
9	C	20	A	31	C	42	C	53	D
10	D	21	A	32	A	43	D	54	C
11	B	22	C	33	C	44	A	55	B

ASSERTION-REASON TYPE OF QUESTIONS

(A) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
(B) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
(C) Assertion is correct, but reason is wrong statement.
(D) Assertion is wrong, but reason is correct statement.

1**.** **Assertion**: The hydrolysis of sucrose to glucose and fructose is called inversion of cane sugar.
Reason: The dextro rotatory sucrose forms a laevo rotatory mixture on hydrolysis.

2. **Assertion**: Glycine is not optically active.
Reason: There is no asymmetrical carbon in glycine to make it chiral.

3. **Assertion**: Amino acids in a protein remain intact even when it is denatured.
Reason: The primary structure of protein is broken to give individual amino acid on denaturation.

4. **Assertion**. Despite having aldehyde group, glucose does not show Schiff's test.
Reason: The aldehyde group in glucose is used to from the ring structure of glucose.

5. **Assertion**: Non-essential amino acids are not necessary for protein synthesis.
Reason: Non-essential amino acids are produced in the human body.

6. **Assertion**: Naturally occurring amino acids have L-configuration.
Reason: The structure of naturally occurring amino acids have similarity with L-glyceraldehyde.

7. **Assertion**: Less intake of iodine in diet leads to enlargement of thyroid gland
Reason: Iodine deficiency leads to hyperthyroidism.

8.**Assertion**: The bond between adenine and thymine is stronger than the bond between Cytosine and guanine.
Reason: Cytosine and guanine have a triple hydrogen bond while adenine and thymine have a double hydrogen bond.

9. **Assertion**: β pleated structure of protein shows maximum extension
Reason: Intermolecular Hydrogen bonding is present in them

10. **Assertion**: Nucleotides are phosphate esters of nucleosides
Reason: Nucleotides are linked through purine or pyrimidine bases

11. **Assertion**: Solubility of protein is minimum at the isoelectric point
Reason: At isoelectric point protein behaves as a Zwitter ion

12. **Assertion**: Insulin is water soluble
Reason: Insulin is a Globular protein

13. **Assertion**: Glucose gives reddish brown precipitate with Fehling's solution
Reason: The reaction leads to formation of CuO & Gluconic acid

14. **Assertion**: Cysteine can crosslink peptide chains
Reason: Amino acids are subdivided into essential & nonessential amino acids

15. **Assertion**: Uracil occurs in DNA
Reason: DNA undergoes replication

ANSWERS

1.A
2.A
3.C
4.A
5.D
6.B
7.C
8.D
9.B
10.C
11.A
12.B
13.C
14.B
15.D

CASE BASED QUESTIONS

Case 1. Read the passage given below and answer the following questions 1-3

A cell needs to store energy so that it can move, make proteins, divide, and transport materials. Because a cell cannot generate its own energy, it is found in the form of food molecules or sunlight. Human and animal cells get their energy from food molecules. These food molecules come in different forms, including proteins, fats, and carbohydrates. This is where bio macromolecules come into place, as they those sources of energy. Carbohydrates are the preferred source of energy for the body. They can be divided into three main groups. The first is monosaccharides. The most common monosaccharide is glucose, which is essentially one of the most important molecules. This molecule has both a carbonyl group coupled with multiple hydroxyl groups and forms a ring for stability. Every cell in the human body contains proteins. A protein structure is a 3-dimensional arrangement of atoms in a protein molecule. The primary structure is held together by peptide bonds. Secondary structure of a protein refers to the shape in which a long polypeptide chain can exist.

The tertiary structure protein exists as Globular proteins & Fibrous proteins.

The following questions are multiple choice questions. Choose the most appropriate answer:

1. In glucose – OH group of (C5) reacts with carbonyl carbon to form a six membered ring structure consisting of five carbon atoms and one oxygen atom is called:
(a) Furanose structure
(b) Pyranose structure
(c) Amylose structure
(d) Ribose structure

2. The two cyclic hemiacetal forms of glucose which differ in configuration of hydroxyl group at C1 are called:
(a) Enantiomers
(b) Racemic mixture
(c) Anomers
(d) Mesoisomers

3. In the following, the example of Globular proteins is/are:

(i) keratin (a) Only (iv)	(ii) myosin (b) (ii), (iii) & (iv)	(iii) insulin (c) (ii) & (iv)	(iv) albumin (d) (iii) & (iv)

Case 2. Read the passage given below and answer the following questions:

EVIDENCE FOR THE FIBROUS NATURE OF DNA

The basic chemical formula of DNA is now well established. It consists of a very long chain, the backbone of which is made up of alternate sugar and phosphate groups, joined together in regular 3' 5' phosphate di-ester linkages. To each sugar is attached a nitrogenous base, only four different kinds of which are commonly found in DNA. Two of these---adenine and guanine--- are purines, and the other two thymine and cytosine-are pyrimidines. A fifth base, 5-methyl cytosine, occurs in smaller amounts in certain organisms, and a sixth, 5-hydroxy-methyl-cytosine, is found instead of cytosine in the T even phases. It should be noted that the chain is unbranched, a consequence of the regular inter-nucleotide linkage. On the other hand, the sequence of the different nucleotides is, as far as can be ascertained, completely irregular. Thus, DNA has some features which are regular, and some which are irregular. A similar conception of the DNA molecule as a long thin fibre is obtained from physicochemical analysis involving sedimentation, diffusion, light scattering, and viscosity measurements. These techniques indicate that DNA is a very asymmetrical structure approximately 20 A wide and many thousands of angstroms long. Estimates of its molecular weight currently centre between 5 X 106 and 107 (approximately 3 x104 nucleotides). Surprisingly each of these measurements tend to suggest that the DNA is relatively rigid, a puzzling finding in view of the large number of single bonds (5 per nucleotide) in the phosphate-sugar back bone. Recently these indirect inferences have been confirmed by electron microscopy.

(source: Watson, J. D., & Crick, F. H. (1953, January). The structure of DNA. In *Cold Spring Harbor symposia on quantitative biology* (Vol. 18, pp. 123-131). Cold Spring Harbor Laboratory Press.)

1.Purines present in DNA are:
A. adenine and thymine
B. guanine and thymine
C. cytosine and thymine
D. adenine and guanine

2. DNA molecule has ___________ inter-nucleotide linkage and __________ sequence of the different nucleotides
A. regular, regular
B. regular, irregular
C. irregular, regular
D. irregular, irregular

3. DNA has a ___________ backbone
A. phosphate -purine
B. pyrimidines- sugar
C. phosphate- sugar
D. purine- pyrimidine

4. Out of the four different kinds of nitrogenous bases which are commonly found in DNA, ___________ has been replaced in some organisms.
A. adenine
B. guanine
C. cytosine
D. thymine

Case 3. Read the passage given below and answer the following questions:

When a protein in its native form, is subjected to physical changes like change in temperature or chemical changes like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called denaturation of protein. The denaturation causes change in secondary and tertiary structures but primary structures remains intact. Examples of denaturation of protein are coagulation of egg white on boiling, curding of milk, formation of cheese when an acid is added to milk.

The following questions are multiple choice question. Choose the most appropriate answer:

(i) Mark the wrong statement about denaturation of proteins.
(a) The primary structure of the protein does not change.
(b) Globular proteins are converted into fibrous proteins.
(c) Fibrous proteins are converted into globular proteins.
(d) The biological activity of the protein is destroyed.

(ii) Which statement(s) of protein remain(s) intact during denaturation process?
(a) Both secondary and tertiary structures
(b) primary structure only
(c) secondary structure only
(d) tertiary structure

(iii) α-helix and β-pleated structures of proteins are classified as
(a) primary structure
(b) secondary structures
(c) tertiary structure
(d) quaternary structure

OR

Cheese is a
(a) globular protein
(b) conjugated protein
(c) denatured protein
(d) derived protein

(iv) Secondary structure of protein refers to
(a) mainly denatured of proteins and structures of prosthetic groups
(b) three-dimensional structure, especially the bond between amino acid residues that are distant from each other in the polypeptide chain
(c) linear sequence of amino acid residues in the polypeptide chain
(d) regular folding patterns of continuous portions of the polypeptide chain.

ANSWER KEY

Case 1. 1 b 2.c 3.d

Case 2. 1D, 2 B, 3 C, 4 C

Case 3.(i)c (ii) b (iii)b or c (iv) d

Sample Question Paper 2021-22
Term 1
Subject: Chemistry (043)

Time: 90 Minutes Max. Marks: 35

General Instructions:

1. The Question Paper contains three sections.
2. Section A has 25 questions. Attempt any 20 questions.
3. Section B has 24 questions. Attempt any 20 questions.
4. Section C has 6 questions. Attempt any 5 questions.
5. All questions carry equal marks.
6. There is no negative marking.

SECTION A

This section consists of 25multiple choice questions with overall choice to attempt **any 20** questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

1.Which of the following statements is true:
(a)Melting point of Phosphorous is less than that of Nitrogen
(b)N_2 is highly reactive while P_4 is inert
(c)Nitrogen shows higher tendency of catenation than P
(d)N-N is weaker than P-P

2. Which of the following is a non-stoichiometric defect?
(a)Frenkel defect
(b)Schottky defect
(c)metal deficiency defect
(d)interstitial defect

3. Identify the law which is stated as:
"For any solution, the partial vapour pressure of each volatile component in the solution is directly proportional to its mole fraction."
(a)Henry's law
(b) Raoult's law
(c)Dalton's law
(d)Gay-Lussac's Law

4. Pink colour of LiCl crystals is due to:
(a) Schottky defect
(b)Frenkel defect
(c) Metal excess defect
(d) Metal deficiency defect

5. Which of the following isomer has the highest meltingpoint:
(a) 1,2-dicholorbenzene
(b) 1,3 -dichlorobenzene
(c) 1,4-dicholorbenzene
(d) all isomers have same melting points

6. Which one of the following reactions is not explained by the open chain Structureof glucose:
(a) Formation of pentaacetate of glucose with acetic anhydride.
(b) formation of addition product with 2,4 DNP reagent
(c) Silver mirror formation with Tollen's reagent
(d) existence of alpha and beta forms of glucose.

7. Williamson's synthesis of preparing dimethyl ether is an:
(a) S_N^1 reaction
(b) Elimination reaction
(c) S_N^2 reaction
(d) Nucleophilic addition reaction

8. Chlorine water loses its yellow colour on standing because:
(a) HCl gas is produced, due to the action of sunlight.
(b) a mixture of HOCl and HCl is produced in the presence of light
(c) HOCl and hydrogen gas is produced
(d) a mixture of HCl and ClO_3 is produced, due to the action of sunlight

9. During dehydration of alcohols to alkenes by heating with concentrated H_2SO_4, the initiation step is:
(a) protonation of alcohol molecule
(b) formation of carbocation
(c) elimination of water
(d) formation of an ester

10. Amorphous solids are:
(a) isotropic
(b)anisotropic
(c) isotopic
(d) isomeric

11. Which of the following reactions is used to prepare salicylaldehyde?
(a) Kolbe's reaction
(b) Etard reaction
(c) Reimer- Tiemann reaction
(d) Stephen's reduction.

12. Which of the following is an example of a solid solution?
(a)sea water
(b)sugar solution
(c)smoke
(d)22 carat gold

13. The boiling points of alcohols are higher than those of hydrocarbons of comparable masses due to:
(a) Hydrogen bonding
(b) Ion – dipole interaction
(c) Dipole- dipole interaction
(d) Van der Waal's forces.

14. Which of the following has the lowest boiling point:
(a)H_2O
(b)H_2S
(c)H_2Se
(d)H_2Te

15. Which of the following statement is correct:
(a)Fibrous proteins are generally soluble in water
(b)Albumin is an example of fibrous proteins
(c)In fibrous proteins, the structure is stabilised by hydrogen bonds and disulphide bonds
(d)pH does not affect the primary structure of protein.

16. Major product obtained on reaction of 3-Phenyl propene with HBr in presence of organic peroxide
(a)3- Phenyl 1- bromopropane
(b) 1 –Phenyl -3- bromopropane
(c) 1-Phenyl -2-bromopropane
(d) 3-Phenyl -2- bromopropane

17. Which of the following is a correct statement for C_2H_5Br?
(a) It reacts with metallic Na to give ethane.
(b) It gives nitroethane on heating with aqueous solution of $AgNO_2$
(c) It gives C_2H_5OH on boiling with alcoholic potash.
(d) It forms diethylthioether on heating with alcoholic KSH.

18.Covalency of nitrogen is restricted to:
(a)2
(b)3
(c)4
(d)5

19.Solubility of gases in liquids decreases with rise in temperature because dissolution is an:
(a)endothermic and reversible process
(b)exothermic and reversible process
(c)endothermic and irreversible process
(d) exothermic and irreversible process

20.All elements of Group 15 show allotropy except:
(a)Nitrogen
(b)Arsenic
(c)Antimony
(d)Bismuth

21.Which of the following is a polysaccharide?
(a)glucose
(b)maltose
(c)glycogen
(d)lactose

22. Substance having the lowest boiling point:
(a)Hydrogen
(b)Oxygen
(c)Nitrogen
(d) Helium

23.Lower molecular mass alcohols are:
(a)miscible in limited amount of water
(b) miscible in excess of water
(c) miscible in water in all proportions
(d) immiscible in water

24.Maximum oxidation state exhibited by Chlorine is:
(a) +1
(b) +3
(c)+5
(d)+7

25.In which of the following cases blood cells will shrink:
(a)when placed in water containing more than 0.9% (mass/ volume) NaCl solution.
(b)when placed in water containing less than 0.9% (mass /volume) NaCl solution.
(c)when placed in water containing 0.9% (mass/volume) NaCl solution.
(d)when placed in distilled water.

SECTION B

This section consists of 24multiple choice questions with overall choice to attempt **any 20** questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

26. How much ethyl alcohol must be added to 1 litre of water so that the solution will freeze at– 14°C ? (K_f for water = 1.86°C/mol)
(a) 7.5 mol
(b)8.5 mol
(c)9.5 mol
(d)10.5 mol

27. Which reagents are required for one step conversion of chlorobenzene to toluene?
(a) CH_3Cl / $AlCl_3$
(b) CH_3Cl, Na, Dry ether
(c)CH_3Cl/Fe dark
(d) $NaNO_2$/ HCl /0-5^{0}C

28. On partial hydrolysis, XeF_6 gives:
(a) XeO_3 +4HF
(b) XeO_2F + HF
(c) $XeOF_4$+ H_2
(d) XeO_2F_2 + 4HF

29. Which one of the following statement is correct about sucrose :
(a) It can reduce tollen's reagent however cannot reduce fehling's reagent
(b) It undergoes mutarotation like glucose and fructose
(c) It undergoes inversion in the configuration on hydrolysis
(d) It is laevorotatory in nature .

30. Phenol does not undergo nucleophilic substitution reaction easily due to:
(a) acidic nature of phenol
(b) partial double bond character of C-OH bond
(c) partial double bond character of C-C bond
(d)instability of phenoxide ion

31. Which of the following has highest ionisation enthalpy?
(a)Nitrogen
(b)Phosphorus
(c)Oxygen
(d)Sulphur
32. Metal M ions form accp structure. Oxide ions occupy ½ octahedral and ½ tetrahedral voids. What is the formula of the oxide?
(a)MO
(b)MO_2
(c)MO_3
(d) M_2O_3

33. The reaction of toluene with Cl_2 in presence of $FeCl_3$ gives 'X' while theof toluene with Cl_2in presence of light gives 'Y'. Thus 'X' and 'Y'are:
(a) X = benzyl chloride Y = o and p – chlorotoluene
(b) X = m – chlorotoluene Y = p – chlorotoluene
(c) X = o and p–chlorotoluene Y = trichloromethylbenzene
(d) X= benzyl chloride, Y = m-chlorotoluene

34.Ozone is a/ an __________ molecule and the two O-O bond lengths in ozone are (i)_______-and (ii) ____________

(a) linear ,110pm ; 148pm

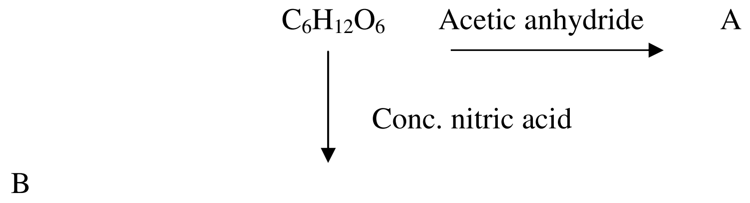
(b) angular, 110pm ; 148pm

(c)linear, 128pm ; 128pm

(d)angular, 128pm ; 128pm

35. Water retention or puffiness due to high salt intake occurs due to:
(a)diffusion
(b)vapour pressure difference
(c) osmosis
(d)reverse osmosis

36. In the following reaction,identify A and B:



(a) A= $COOH\text{-}(CH_2)_4\text{-}COOH$, B= $OHC\text{-}(CHOCOCH_3)_4\text{-}CH_2OCOCH_3$
(b) A= $COOH\text{-}(CH_2)_4\text{-}CHO$, B= $OHC\text{-}(CHOCOCH_3)_4\text{-}CH_2OCOCH_3$
(c) A= $OHC\text{-}(CHOCOCH_3)_3\text{-}CH_2OCOCH_3$ B= $COOH\text{-}(CH_2)_4\text{-}CHO$,
(d) A= $OHC\text{-}(CHOCOCH_3)_4\text{-}CH_2OCOCH_3$ B= $COOH\text{-}(CH_2)_4\text{-}COOH$

37. In lake test for Al^{3+} ions, there is the formation of coloured 'floating lake'. It is due to:
(a)Absorption of litmus by $[Al(OH)_4]^-$
(b)Absorption of litmus by $Al(OH)_3$
(c)Adsorption of litmus by $[Al(OH)_4]^-$
(d) Adsorption of litmus by $Al(OH)_3$

38. A unit cell of NaCl has 4 formula units. Its edge length is 0.50 nm. Calculate the density if molar mass of NaCl = 58.5 g/mol.
(a) 1 g/cm^3
(b)2 g/cm^3
(c) 3 g/cm^3
(d)4g/cm^3

39.Which one of the following are correctly arranged on the basis of the property indicated:
(a)$I_2 < Br_2 < F_2 < Cl_2$ [increasing bond dissociation enthalpy]
(b) $H_2O > H_2S < H_2Te < H_2Se$ [increasing acidic strength]
(c) $NH_3 < N_2O < NH_2OH < N_2O_5$ [increasing oxidation state]
(d) $BiH_3 < SbH_3 < AsH_3 < PH_3 < NH_3$ [increasing bondangle]

40. What would be the reactant and reagent used to obtain 2, 4-dimethyl pentan-3-ol?
(a) Propanal and propyl magnesium bromide
(b) 3-methylbutanal and 2-methyl magnesium iodide
(c) 2-dimethylpropanone and methyl magnesium iodide
(d) 2- methylpropanal and isopropyl magnesium iodide

41. o-hydroxy benzyl alcohol when reacted with PCl_3 gives the product as (IUPAC name)
(a) o- hydroxy benzyl chloride
(b) 2- chloromethylphenol
(c) o-chloromethylchlorobenzene
(d) 4-hydroxymethylphenol

42. Which of the following statements is true:

(a)Ammonia is the weakest reducing agent and the strongest base among Group 15 hydrides.

(b) Ammonia is the strongest reducing agent as well as the strongest base among Group 15 hydrides.

(c)Ammonia is the weakest reducing agent as well as the weakest base among Group 15 hydrides.

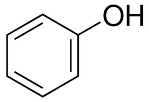
(d) Ammonia is the strongest reducing agent and the weakest base among Group 15 hydrides.

43.Identify the secondary alcohols from the following set:

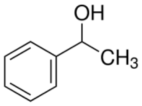
(i)$CH_3CH_2CH(OH)CH_3$

(ii) $(C_2H_5)_3COH$

(iii)



(iv)



(a)(i) and (iv)
(b)(i) and (iii)
(c)(i) and (ii)
(d)(i), (iii) and (iv)

44.Alkenes decolourise bromine water in presence of CCl_4 due to formation of:

(a)allyl bromide

(b)vinyl bromide

(c)bromoform

(d)vicinal dibromide

45**.** Given below are two statements labelled as Assertion (A) and Reason (R)
Assertion (A): Electron gain enthalpy of oxygen is less than that of Flourine but greater than Nitrogen.
Reason (R): Ionisation enthalpies of the elements follow the order Nitrogen > Oxygen > Fluorine
Select the most appropriate answer from the options given below:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A.
(c)A is true but R is false.
(d) A is false but R is true.

46. Given below are two statements labelled as Assertion (A) and Reason (R)
Assertion (A): Alkyl halides are insoluble in water.
Reason (R): Alkyl halides have halogen attached to sp^3 hybrid carbon.
Select the most appropriate answer from the options given below:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A.
(c)A is true but R is false.
(d) A is false but R is true.

47. Given below are two statements labelled as Assertion (A) and Reason (R)
Assertion(A): Molarity of a solution changes with temperature.
Reason (R): Molarity is a colligative property.
Select the most appropriate answer from the options given below:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A.
(c)A is true but R is false.
(d) A is false but R is true.

48. Given below are two statements labelled as Assertion (A) and Reason (R)
Assertion(A):SO_2 is reducing while TeO_2 is an oxidising agent.
Reason(R): Reducing property of dioxide decreases from SO_2 to TeO_2.
Select the most appropriate answer from the options given below:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A.
(c)A is true but R is false.
(d) A is false but R is true.

49.Given below are two statements labelled as Assertion (A) and Reason (R)
Assertion (A): Cryoscopic constant depends on nature of solvent.
Reason(R): Cryoscopic constant is a universal constant.
Select the most appropriate answer from the options given below:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A.
(c)A is true but R is false.
(d) A is false but R is true.

SECTION C

This section consists of 6multiple choice questions with an overall choice to attempt any**5.** In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.

50.Match the following:

I	II
(i)Amino acids	(A)protein
(ii)Thymine	(B)Nucleic acid
(iii)Insulin	(C)DNA
(iv)phosphodiester linkage	(D)Zwitter ion
(v) Uracil	

Which of the following is the best matched options?

(a) i-A, v- D, iii- C, iv-B

(b) i-D, ii-C, iii- A, iv-B

(c) i-D, v- D, iii- A, iv-B

(d) i-A, ii- C, iii- D, iv-B

51. Which of the following analogies is correct:
(a)Nitrogen: $1s^2 2s^2 2p^3$ :: Argon:$1s^2 2s^2 2p^6$
(b)Carbon: maximum compounds :: Xenon: no compounds
(c) XeF_2: Linear :: ClF_3: Trigonal planar
(d)Helium: meteorological observations:: Argon: metallurgical processes

52. Complete the following analogy:
Same molecular formula but different structures: A:: Non superimposable mirror images: B
(a) A:Isomers B: Enantiomer
(b) A: Enantiomers B: Racemic mixture
(c) A: Sterioisomers B: Retention
(d) A: IsomersB: Sterioisomers

CASE1: **Read the passage given below and answer the following questions 53-55**

Early crystallographers had trouble solving the structures of inorganic solids using X-ray diffraction because some of the mathematical tools for analyzing the data had not yet been developed. Once a trial structure was proposed, it was relatively easy to calculate the diffraction pattern, but it was difficult to go the other way (from the diffraction pattern to the structure) if nothing was known *a priori* about the arrangement of atoms in the unit cell. It was important to develop some guidelines for guessing the coordination numbers and bonding geometries of atoms in crystals. The first such rules were proposed by Linus Pauling, who considered how one might pack together oppositely charged spheres of different radii. Pauling proposed from geometric considerations that the quality of the "fit" depended on the **radius ratio** of the anion and the cation.

If the anion is considered as the packing atom in the crystal, then the smaller cation fills interstitial sites ("holes"). Cations will find arrangements in which they can contact the largest number of anions. If the cation can touch all of its nearest neighbour anions then the fit is good. If the cation is too small for a given site, that coordination number will be unstable and it will prefer a lower coordination structure. The table below gives the ranges of cation/anion radius ratios that give the best fit for a given coordination geometry.

Coordination number	Geometry	$\rho = r_{cation}/r_{anion}$
2	linear	0 - 0.155
3	triangular	0.155 - 0.225
4	tetrahedral	0.225 - 0.414
4	square planar	0.414 - 0.732
6	octahedral	0.414 - 0.732
8	cubic	0.732 - 1.0
12	cuboctahedral	1.0

(Source: Ionic Radii and Radius Ratios. (2021, June 8). Retrieved June 29, 2021, from https://chem.libretexts.org/@go/page/183346)

Q53. The radius of Ag^+ ion is 126pm and of I^- ion is 216pm. The coordination number of Ag^+ ion is:

(a)2
(b)3
(c)6
(d)8

Q54. A solid AB has square planar structure. If the radius of cation A^+ is 120pm, calculate the maximum possible value of anion B^-

(a)240 pm
(b)270 pm
(c)280 pm
(d)290 pm

Q55.A “good fit” is considered to be one where the cation can touch:

(a)all of its nearest neighbour anions.
(b) most of its nearest neighbour anions.
(c)some of its nearest neighbour anions.
(d) none of its nearest neighbour anions.

CHEMISTRY (043)
Marking Scheme

SECTION A

1.(d)N-N is weaker than P-P
other statements as incorrect as Phosphorus has a higher melting point due to bigger size than Nitrogen. Nitrogen is inert due to formation of triple bonds and has a lower covalence due to non - availability of d –orbitals

2. (c)metal deficiency defect (anion is missing from lattice site)
In Frenkel defect the smaller ion occupies the interstitial sites and Schottky defect equal number of cations and anions are missing. Interstitial defect an atom or molecule occupies intestinal sites so in these three defects the ratio of positive and negative ions (Stoichiometric) of a solid is not disturbed in these three

3. (b) Raoult's law

4. (c) Metal excess defect (formation of F centres)

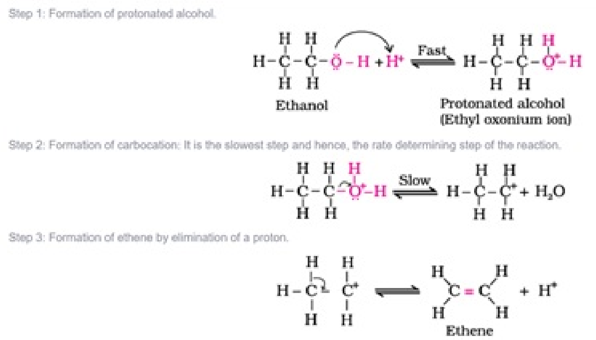
5. (c) 1,4-dicholorbenzene (para isomers are more symmetric and ortho and meta)

6. (d) existence of alpha and beta forms of glucose .

7. (c) S_N^2 reaction (alkoxide ion reacts with primary alkyl halide in a single step to form ether)

8. (b) a mixture of HOCl and HCl is produced in the presence of sunlight
$Cl_2(g) + H_2O (l) \rightarrow HCl (g) + HOCl(aq)$

9. (a)protonation of alcohol molecule



10. Amorphous solids are:
(a) isotropic (the value of any physical property is same along any direction)

11. (c) Reimer- Tiemann reaction (Kolbe's reaction is used to prepare salicylic acid, Etard reaction for benzaldehyde, Reimer- Tiemann reaction for salicylaldehyde and Stephen's reduction for aldehyde)

12. (d)22 carat gold (it is an alloy so solid in solid solution)

13. (a) Hydrogen bonding (alcohols form intermolecular hydrogen bonds)

14. (b)H_2S (boiling point increases down the group but water forms strong hydrogen bonds so has higher boiling point than H_2S)

15. (d)pH does not affect the primary structure of protein (pH effects the tertiary structure)

16. (b) 1 –Phenyl -3- bromopropane
(($(C_6H_5)CH_2CH{=}CH_2$ + HBr (organic peroxide) $\rightarrow$ $(C_6H_5)CH_2CH_2CH_2Br$ anti-Markovnikov addition)

17. (b) It gives nitroethane on heating with aqueous solution of $AgNO_2$
(C_2H_5Br reacts with metallic Na to give butane , gives ethene on boiling with alcoholic potash. and forms C_2H_5SH (thiol) on heating with alcoholic KSH)

18. (c)4 (Covalency of nitrogen is restricted to 4 due to non availability of d orbitals)

19. (b)exothermic and reversible process (according to Le -Chatlier principle Solubility of gases in liquids decreases with rise in temperature)

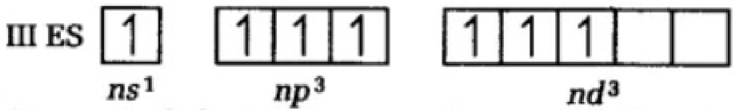
20. (a)Nitrogen (due to small size and high electronegativity N-N is weak)

21.(c)glycogen (It is a polymer of glucose)

22. (d) Helium (He is monoatomic and has low atomic mass)

23.(c) miscible in water in all proportions Lower molecular mass alcohols are able to form hydrogen bonds with water

24.(d)+7 (Cl : $1s^2 2s^2 2p^6 3s^2 3p^5$)



(7 unpaired electrons account for +7 oxidation state)

25.(a)When placed in water containing more than 0.9% (mass/ volume) NaCl solution because fluid inside blood cells is isotonic with 0.9% NaCl solution

SECTION B

26. (a) 7.5 mol

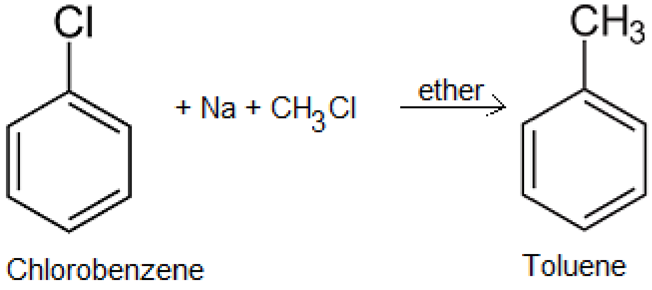
$\Delta T_f = K_f\, m$

$\Delta T_f = K_f \dfrac{n_2 \times 1000}{w_1}$

$14 = 1.86 \times \dfrac{n_2 \times 1000}{1000}$

$n_2 = 7.5$ mol

27. (b) CH_3Cl, Na, Dry ether



28. (d) $XeO_2F_2 + 4HF$

$XeF_4 + H_2O \rightarrow XeO_2F_2 + 4HF$

29. (c) It undergoes inversion in the configuration on hydrolysis

30. (b) partial double bond character of C-OH bond

31. (a)Nitrogen (High IE of N is because of smallest size in the group and completely half - filled p subshell)

32. (d) M_2O_3

Metal M ions form ccp structure. Let number of ions of M be : X

No. of tetrahedral voids = 2x

No. of octahedral voids = x

Number of oxide ions will be 1/2 x + ½ (2x) = 3/2 x

Formula of oxide = $M_xO_{3/2\,x}$ = M_2O_3

33. c) X = o and p–chlorotoluene Y = trichloromethylbenzene

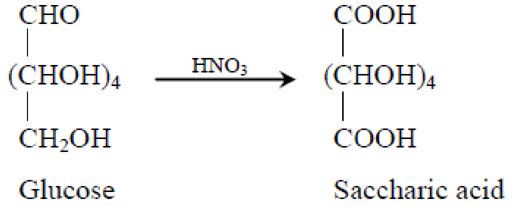
The reaction of toluene with Cl_2 in presence of $FeCl_3$ gives 'X' due to electrophilic substitution reaction taking place at ortho and para positions and reaction in the presence of light gives 'Y', due to substitution reaction occurring via free radical mechanism

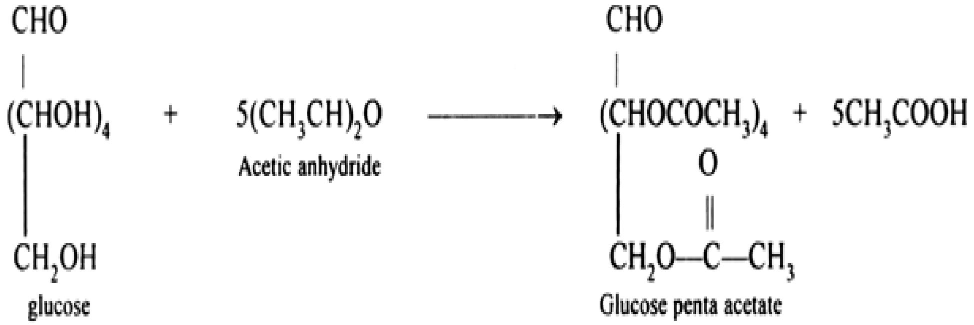
. Thus 'X' and 'Y'are X = o and p–chlorotoluene Y = trichloromethylbenzene

34. (d)angular, 128pm ; 128pm (Ozone is a resonance hybrid of two equivalent structures)

35. (c) Osmosis

36. d) A= $OHC\text{-}(CHOCOCH_3)_4\text{-}CH_2OCOCH_3$ B= $COOH\text{-}(CH_2)_4\text{-}COOH$





37. (d) Adsorption of litmus by $Al(OH)_3$

In lake test for Al^{3+} ions, there is the formation of coloured 'floating lake' In lake test for Al^{3+} ions, there is the formation of coloured 'floating lake' due to adsorption

38. (c) 3 g/cm^3

Using formula

$$\text{Density} = \frac{(Z \ X \ m)}{(a^3 \ X \ Na)}$$

$$D = \frac{4 \ x \ 58.5}{(0.5x10^{-7})^3 \ x \ 6.023x10^{23}}$$

$= 3.1 \ g/cm^3$

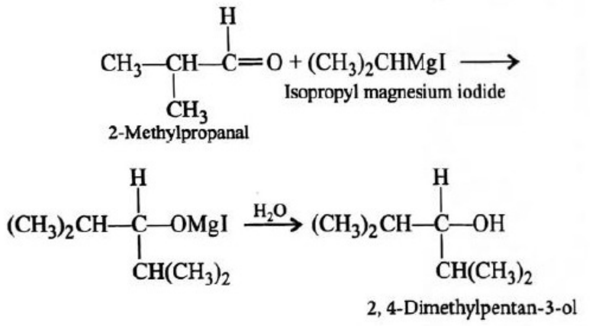
39. **(d)** $BiH_3<SbH_3<AsH_3<PH_3<NH_3$ [increasing bond angle] correct order

(a) $I_2 < Br_2<F_2<Cl_2$ [increasing bond dissociation enthalpy]: incorrect order , correct order is $Cl_2 > Br_2 > F_2 > I_2$.

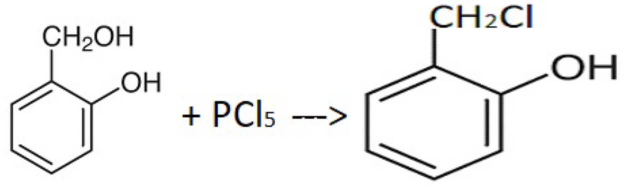
(b) $H_2O > H_2S<H_2Te<H_2Se$ [increasing acidic strength]: incorrect order , correct order is
$H_2O<H_2S<H_2Se<H_2Te$

(c) $NH_3 < N_2O< NH_2OH<N_2O_5$ [increasing oxidation state] : incorrect order NH_3 (Oxidation state -3) N_2O (Oxidation state +1) NH_2OH(Oxidation state -1) N_2O_5 (Oxidation state +5)

40. (d) 2- methylpropanal and isopropyl magnesium iodide

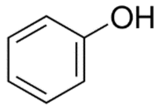


41. (b) 2- chloromethylphenol

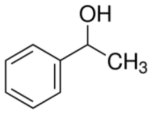


42. (a)Ammonia is the weakest reducing agent and the strongest base among Group 15 hydrides. The reducing character of hydrides increases down the group due to decrease in bond dissociation enthalpy.

43 (a)(i) and (iv)
(i)$CH_3CH_2CH(OH)CH_3$ (secondary) (ii) $(C_2H_5)_3COH$ (tertiary)
(iii) (iv)



Phenol not an alcohol



secondary

44. (d)vicinal dibromide
$CH_2=CH_2 + Br_2 \rightarrow BrCH_2 - CH_2Br$

45**. (c)**
Assertion: Electron gain enthalpy of oxygen is less than that of Flourine but greater than Nitrogen. (correct)
Reason: Ionisation enthalpies of the elements follow the order Nitrogen > Oxygen > Fluorine (incorrect)
Ionisation enthalpies of the elements follow the order Fluorine >Nitrogen > Oxygen

46. (b) **Assertion:** Alkyl halides are insoluble in water. (correct)
Reason: Alkyl halides have halogen attached to sp^3 hybrid carbon. (correct)
Alkyl halides are insoluble in water because they are unable to form hydrogen bonds with water or break pre-existing hydrogen bonds.

47. (c)**Assertion:** Molarity of a solution changes with temperature. (correct)
Reason: Molarity is a colligative property. (incorrect)
Molarity is a means to express concentration. It is not a physical property.

48. (a) **Assertion:** SO_2 is reducing while TeO_2 is an oxidising agent. (correct)
Reason: Reducing property of dioxide decreases from SO_2 to TeO_2 (correct and reason for Assertion)

49. (c) **Assertion:** Cryoscopic constant depends on nature of solvent. (correct)
Reason: Cryoscopic constant is a universal constant (incorrect)
Cryoscopic constant various with type of solvent

SECTION C

50. (b) i-D, ii-C, iii- A, iv-B
Amino acids form proteins and exist as zwitter ion , Thymine is a nitrogenous base in DNA, Insulin is a protein , phosphodiester linkage is found in nucleic acids so also in DNA and Uracil is nitrogenous base found in RNA which is a nucleic acid.

51. (d)Helium: meteorological observations :: Argon: metallurgical processes
Nitrogen: $1s^2 2s^2 2p^3$ :: Argon: $1s^2 2s^2 2p^6$ is configuration of Neon not Argon
Carbon: maximum compounds :: Xenon: no compounds , Xenon forms compounds
XeF_2: Linear :: ClF_3: Trigonal planar , ClF_3 is T shaped not trigonal planar

52. (a) A : Isomers B: Enantiomer
Isomers have Same molecular formula but different structure
Enantiomers are Non superimposable mirror images

Q53. (c)6
The radius of Ag+ ion is 126pm and of I- ion is 216pm. The coordination number of Ag+ ion is:
$\rho = r_{cation}/r_{anion} = 126/216 = 0.58$
Radius ratio lies in the range 0.414 – 0.732, so has coordination number 6 or 4 according to the table.
Since none of the options is 4, so the answer is 6

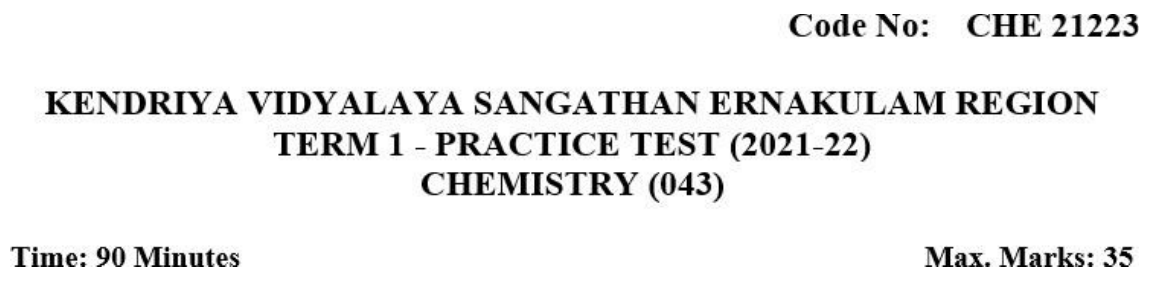
Q54. (d)290 pm
Square planar means ratio ratio is between 0.414 – 0.732
If radius of cation is 120 pm then anion should be in the range $\rho = r_{cation}/r_{anion}$
$0.414 = 120/x$ so $x = 289.8 = 290$ pm
$0.732 = 120/x$ so $x = 163.9 = 164$ pm

Q55. (a)all of its nearest neighbour anions

TERM-1 PRACTICE TEST (XII Chemistry)

The respondent's email (**null**) was recorded on submission of this form.
*Required

1. Email *

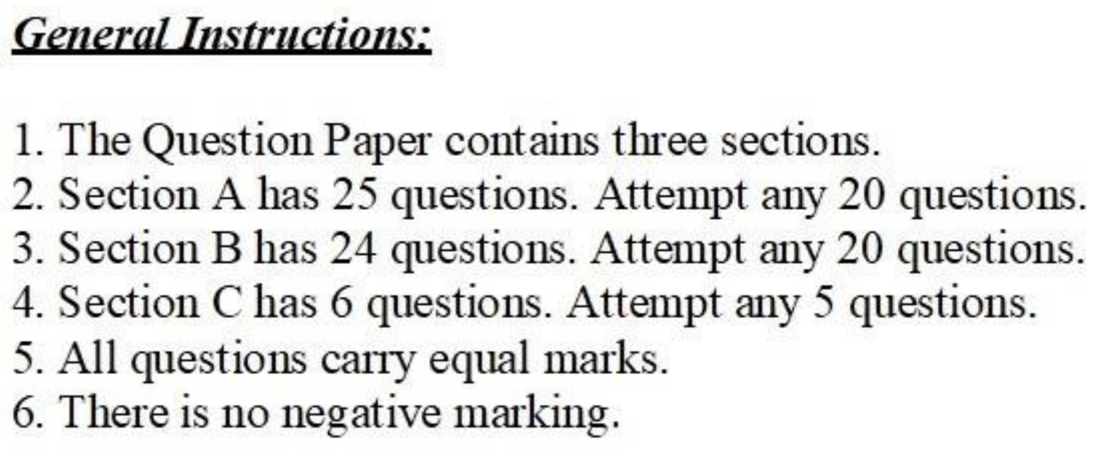


Code No: CHE 21223

KENDRIYA VIDYALAYA SANGATHAN ERNAKULAM REGION
TERM 1 - PRACTICE TEST (2021-22)
CHEMISTRY (043)

Time: 90 Minutes **Max. Marks: 35**

General Instructions



General Instructions:

1. The Question Paper contains three sections.
2. Section A has 25 questions. Attempt any 20 questions.
3. Section B has 24 questions. Attempt any 20 questions.
4. Section C has 6 questions. Attempt any 5 questions.
5. All questions carry equal marks.
6. There is no negative marking.

2. Name *

3. Roll Number

____

Section-A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLYfirst 20 will be considered for evaluation

4. 1. When glucose reacts with bromine water, the main product is

Mark only one oval.

○ (a) gluconic acid
○ (b) glyceraldehyde
○ (c) saccharic acid
○ (d) acetic acid

5. 2. When Phenyl methyl ether is heated with excess HI, it yields

Mark only one oval.

○ (a) Iodobenzene and Methanol
○ (b) Phenol and Methylodide
○ (c) Benzene and Ethanol
○ (d) Benzene and Methanol

6. 3. Aquatic animals are more comfortable in cold water rather than in warm water because

Mark only one oval.

○ (a) Solubility of O2 gas in liquid changes with pressure
○ (b) They are cold blooded animals
○ (c) Solubility of O2 gas in liquid increases with decrease in temperature
○ (d) Concentration of O2 gas increases with increase in temperature

7. 4. The correct statement regarding defects in crystalline solid is

Mark only one oval.

○ (a) Frenkel defect does not change the density of solid

○ (b) Frenkel defect is found in the halides of Alkali metals.

○ (c) Schottky defect does not change the density of solid

○ (d) Schottky defect is a dislocation defect.

8. 5. Among the 15th group elements, as we move from nitrogen to bismuth, the pentavalency becomes less pronounced and trivalency becomes more pronounced due to

Mark only one oval.

○ (a) Non-metallic character

○ (b) Inert pair effect

○ (c) High electronegativity

○ (d) Large ionization energy

9. 6. Which of the following is chiral in nature?

Mark only one oval.

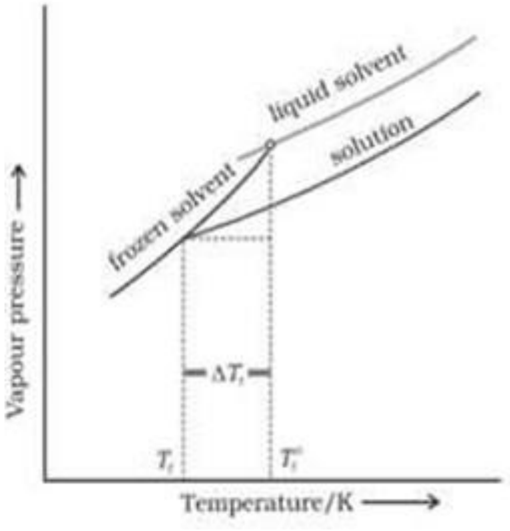
○ (a) 2-Bromobutane

○ (b) 1-Bromobutane

○ (c) 2-Bromopropane

○ (d) 2-Bromopropan-2-ol

7. Observe the following graph



10. 7. Which colligative property is represented in the above graph?

Mark only one oval.

- ○ (a) Osmotic pressure
- ○ (b) Relative lowering of vapour pressure
- ○ (c) Elevation in boiling point of the solvent
- ○ (d) Depression in freezing point of the solvent

11. 8. The IUPAC name of CH3-CH(Cl)-CH2-CH2-CH(OH)-CH3 is

Mark only one oval.

- ○ (a) 2-Chloro-5-hydroxyhexane
- ○ (b) 2-Hydroxy-5-chlorohexane
- ○ (c) 5-Chlorohexan-2-ol
- ○ (d) 2-Chlorohexan-5-ol

12. 9. Proteins are found to have two different types of secondary structures, viz. α-helix and ß-pleated sheet structure. α -helix structure of protein is stabilised by:

Mark only one oval.

- ○ (a) Peptide bonds
- ○ (b) van der Waals forces
- ○ (c) Hydrogen bonds
- ○ (d) Dipole-dipole interactions

13. 10. H2 molecules are held in the crystal lattice by

Mark only one oval.

- ○ (a) Dipole-Dipole interactions
- ○ (b) Covalent bond
- ○ (c) Ionic bond
- ○ (d) London forces

14. 11. Read the following statements carefully and choose the correct option. (i) Different gases have different KH values at the same temperature. (ii) Higher the value of KH at a given temperature, lower is the solubility of the nature of gas in the liquid. (iii) Henry's constant (KH) is a function of the nature of the gas. (iv) Solubility of gases increases with increase of temperature.

Mark only one oval.

- ○ (a) (i), (ii) and (iv) are correct.
- ○ (b) (ii) and (iv) are correct.
- ○ (c) (i), (ii) and (iii) are correct.
- ○ (d) and (iv) are correct

15. 12. The percentage of empty space in a face centred cubic arrangement is

Mark only one oval.

○ (a) 74 %
○ (b) 68 %
○ (c) 32 %
○ (d) 26 %

16. 13. Which of the following options are not in accordance with the property mentioned against them?

Mark only one oval.

○ (a) F2>Cl2>Br2>I2 (Oxidisng power)
○ (b) HI>HBr>HCl>HF (Acidic character)
○ (c) F2>Cl2>Br2>I2 (Bond dissociation enthalpy)
○ (d) HI<HBr<HCl<HF (Bond strength)

17. 14. Select the Grignard reagent that can be used to prepare propan-1-ol from Methanal

Mark only one oval.

○ (a) CH3Br
○ (b) CH3MgBr
○ (c) C3H7MgBr
○ (d) C2H5MgBr

18. 15. Complete the following reaction: XeF6 + 3H2O→ A+ B

Mark only one oval.

○ (a) XeO2F2 + HF
○ (b) XeOF4 + HF
○ (c) XeO3+HF
○ (d) XeO3+HF + O2

19. 16. Which of the following is an essential amino acid?

Mark only one oval.

○ (a) Glycine
○ (b) Alanine
○ (c) Valine
○ (d) Glutamic acid

20. 17. Hybridisation of S in SF4 and geometry of SF4 are

Mark only one oval.

○ (a) sp3d, trigonal pyramidal
○ (b) sp3d, see saw
○ (c) sp3, tetrahedral
○ (d) dsp2, square planner

21. 18. The backbone of DNA is

Mark only one oval.

○ (a) phosphate-purine
○ (b) phosphate-sugar
○ (c) pyrimidines-sugar
○ (d) purine-pyrimidine

22. 19. Which one of the following colligative properties of solution is the best method for the determination of the molecular masses of Proteins and polymers.

Mark only one oval.

○ (a) Osmotic pressure method
○ (b) Lowering in vapour pressure
○ (c) Depression in freezing point
○ (d) Elevation in boiling point

23. 20. The correct decreasing order of basic strength is:

Mark only one oval.

○ (a) NH3 >PH3> AsH3 > SbH3
○ (b) SbH 3 > AsH3 >PH3> NH3
○ (c) AsH3 > SbH3> PH3 > NH3
○ (d) PH3> AsH3 > SbH3 >NH3

24. 21. The ortho and para isomers of Nitrophenol can be separated by steam distillation because

Mark only one oval.

○ (a) o-Nitrophenol is less volatile due to intramolecular hydrogen bonding
○ (b) p-nitrophenol is more volatile due to intermolecular hydrogen bonding
○ (c) o-Nitrophenol is more volatile due to intramolecular hydrogen bonding
○ (d) p-nitrophenol is less volatile due to intramolecular hydrogen bonding

25. 22. On heating ammonium dichromate and barium azide separately we get

Mark only one oval.

- ○ (a) N_2 in both cases
- ○ (b) N_2 with ammonium dichromate and NO with barium azide
- ○ (c) N_2O with ammonium dichromate and N_2 with barium azide
- ○ (d) N_2O with ammonium dichromate and NO_2 with barium azide

26. 23. Name the reagent that can be used in the following reaction:
$CH_3CH_2CH=CH\,CH_2CH_2OH \rightarrow CH_3CH_2CH=CHCH_2CHO$

Mark only one oval.

- ○ (a) Alk $KMnO_4$
- ○ (b) $Na_2Cr_2O_7/H_2SO_4$
- ○ (c) PCC
- ○ (d) $LiAlH_4$

27. 24. The equation for Finkelstein reaction is

Mark only one oval.

- ○ (a) $CH_3\,CH_2\,CH_2\,I + NaCl \rightarrow CH_3\,CH_2CH_2Cl + NaI$
- ○ (b) $CH_3\,CH_2\,CH_2\,Cl + NaI \rightarrow CH_3\,CH_2CH_2I + NaCl$
- ○ (c) $CH_3\,CH_2\,CH_2\,Cl + NaBr \rightarrow CH_3\,CH_2CH_2Br + NaCl$
- ○ (d) $CH_3\,CH_2\,CH_2\,Cl + AgF \rightarrow CH_3\,CH_2CH_2F + AgCl$

28. 25. The correct order of increasing acidity of the following compounds: A-> Phenol , B-> 4-Nitrophenol C-> Propan-1-ol D-> 4-Methylphenol

Mark only one oval.

- ○ (a) C<D<A<B
- ○ (b) A<C<D<B
- ○ (c) C<A<B<D
- ○ (d) A<D<C<B

Section-B

This section consists of 24multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

29. 26. An unknown alcohol is treated with “Lucas reagent” to determine whether the alcohol is primary, secondary or tertiary. Which alcohol reacts fastest and by what mechanism?

Mark only one oval.

- ○ (a) Tertiary alcohol by SN2
- ○ (b) Secondary alcohol by SN1
- ○ (c) Tertiary alcohol by SN1
- ○ (d) Secondary alcohol by SN2

30. 27. Tungsten crystallises in body centred cubic unit cell. If the edge length of the unit cell is 316.5 pm, what is the radius of tungsten atom?

Mark only one oval.

- ○ (a) 137pm
- ○ (b) 1.37pm
- ○ (c) 13.7pm
- ○ (d) 0.137pm

31. 28. Which among the following statements is correct, if two liquids A and B form minimum boiling azeotrope at some specific composition.

Mark only one oval.

○ (a) A–B interactions are stronger than those between A–A or B–B.

○ (b) A–B interactions are more or less same as those between A–A or B–B.

○ (c) vapour pressure of solution decreases because a smaller number of moleculesof only one of the liquids escape from the solution.

○ (d) A–B interactions are weaker than those between A–A or B–B

32. 29. A solid is made of two elements X and Y. The atoms Y are in CCP arrangement while the atom X occupy 2/3 rd of the tetrahedral sites. What is the formula of the compound?

Mark only one oval.

○ (a) X3Y4

○ (b) X4Y3

○ (c) X2Y3

○ (d) X3Y2

33. 30. When cold and dilute Sodium Hydroxide reacts with Chlorine, it produces a mixture of

Mark only one oval.

○ (a) NaCl and H2O

○ (b) NaCl ,HCl and H2O

○ (c) NaCl , NaOCl and H2O

○ (d) NaCl , NaClO3 and H2O

34. 31. Consider the reaction

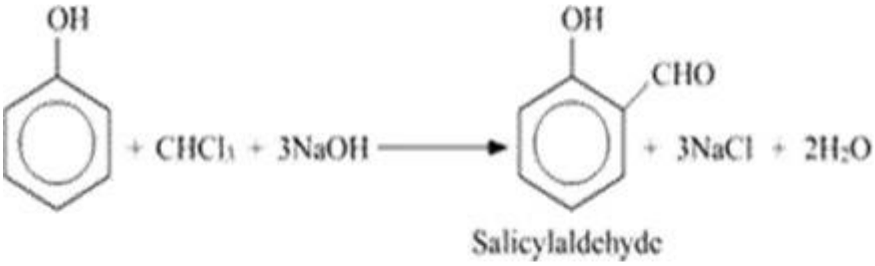
CH3-CH2-OH + PBr3 ------------→ X

X + alc KOH → Y, the product Y is

Mark only one oval.

- ○ (a) CH3 CH2OH
- ○ (b) CH3 CH2 Br
- ○ (c) CH2=CH2
- ○ (d) CH3 CH2 O CH2 CH3

32. Consider the reaction:



35. 32.Identify the name of the reaction

Mark only one oval.

- ○ (a) Sandmeyer's reaction
- ○ (b) Reimer Tiemann reaction
- ○ (c) Swarts reaction
- ○ (d) Kolbe’s reaction

36. 33. Dilute HNO3 reacts with copper to form Cu(NO3)2 and a gas A. Dilute HNO3 reacts with zinc to form Zn(NO3)2 and a gas B.

Mark only one oval.

○ (a) Gas A is NO2 and Gas B is NO
○ (b) Gas A is NO and Gas B is N2O
○ (c) Gas A is N2O and Gas B is NO
○ (d) Gas A is N2O and Gas B is NO2

37. 34. The most suitable reagent that can be used for converting Aniline to Chlorobenzene is

Mark only one oval.

○ (a) HCl and Cu2Cl2
○ (b) Cl2 in presence of Al Cl3
○ (c) Nitrous acid and HCl
○ (d) Nitrous acid and then with Cu2Cl2

38. 35. Assume three samples of juices A, B and C having glucose as the only sugar present in them. The concentration of sample A, B and C are 0.1M, 0.5M and 0.2 M respectively. Melting point will be highest for the fruit juice:

Mark only one oval.

○ (a) A
○ (b) B
○ (c) C
○ (d) All have same freezing point

39. 36. When the vapours of alcohol P is passed over heated copper at 573K, Propanone is obtained. Identify P and the type of reaction.

Mark only one oval.

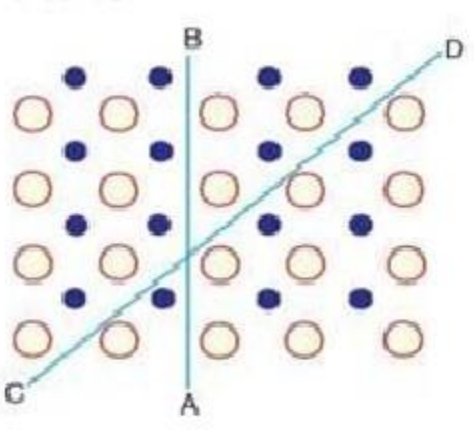
○ (a) Propan-2-ol, Dehydration reaction
○ (b) Propan-2-ol, Dehydrogenation reaction
○ (c) Propan-1-ol , Elimination reaction
○ (d) 2-Methylpropan-2-ol, Dehydrogenation reaction

40. 37. The conversion of an alkyl halide into an alcohol by aqueous NaOH is classified as

Mark only one oval.

○ (a) Nucleophilic substitution reaction
○ (b) Elimination reaction
○ (c) addition reaction
○ (d) Electrophilic substitution reaction

38. Study the figure of the solid given below depicting the arrangement of particles.



41. 38. What is the most appropriate term used for the figure?

Mark only one oval.

○ (a) Isotropy
○ (b) Anisotropy
○ (c) Amorphous nature
○ (d) Irregular shape

42. 39. Chlorine water on standing loses its yellow colour due to the formation of

Mark only one oval.

○ (a) Cl and HOCl
○ (b) HCl and HOCl2
○ (c) HOCl and HOCl2
○ (d) HCl and HOCl

43. 40. The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of the solute. Kb for benzene is 2.53 K kg mol–1

Mark only one oval.

○ (a) 68 g mol–1
○ (b) 58 g mol–1
○ (c) 70 g mol–1
○ (d) 83 g mol–1

44. 41. Hot conc. H_2SO_4 acts as moderately strong oxidising agent. It oxidises both metals and nonmetals. Which of the following element can give two gaseous products upon oxidation by conc. H_2SO_4?

Mark only one oval.

○ (a) Cu
○ (b) S
○ (c) C
○ (d) Zn

45. 42. How many octahedral voids are there in 1 mole of a compound having ccp structure?

Mark only one oval.

○ (a) 6.02×10^{23} (b)
○ 12.04×10^{23}
○ (c) 1
○ (d) 2

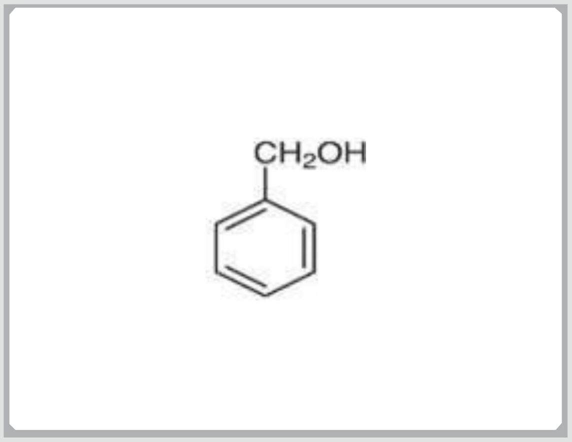
46. 43. Each polypeptide in protein has amino acids linked with each other in a specific sequence. This sequence of amino acids is said to be-

Mark only one oval.

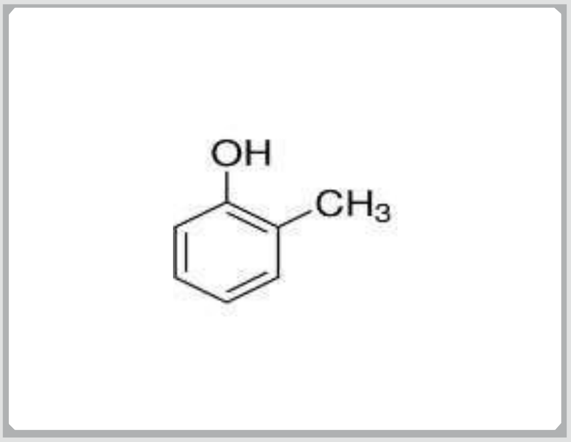
○ (a) primary structure of proteins.
○ (b) secondary structure of proteins.
○ (c) tertiary structure of proteins.
○ (d) quaternary structure of proteins

47. 44. In which of the following structures, hydroxyl group is attached to sp2 hybridized carbon atom

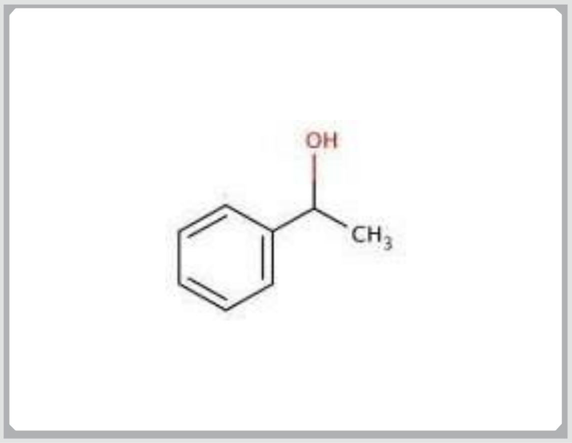
Mark only one oval.



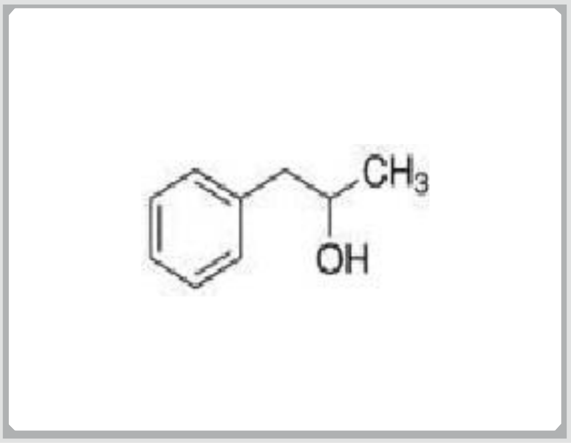
○ (a)



○ (b)



○ (c)



○ (d)

48. 45. Assertion(A): The correct order of decreasing SN2 reactivity of Alkyl halides is R3CX > R2CHX > RCH2X Reason (R): SN2 mechanism follows second order kinetics and take place in one step with no intermediate formation. Select the most appropriate answer from the options given below:

Mark only one oval.

○ (a) Both A and R are true and R is the correct explanation of A

○ (b) Both A and R are true but R is not the correct explanation of A.

○ (c) A is true but R is false.

○ (d) A is false but R is true.

49. 46. Assertion (A): Benzene-toluene mixture forms ideal solution at low concentrations. Reason (R): Intermolecular forces between two benzene molecules are nearly of same strength as those between two toluene molecules Select the most appropriate answer from the options given below:

Mark only one oval.

- ○ (a) Both A and R are true and R is the correct explanation of A
- ○ (b) Both A and R are true but R is not the correct explanation of A.
- ○ (c) A is true but R is false.
- ○ (d) A is false but R is true.

50. 47. Assertion (A): ICl is more reactive than I2. Reason (R): I-Cl bond is stronger than I-I bond.

Mark only one oval.

- ○ (a) Both A and R are true and R is the correct explanation of A
- ○ (b) Both A and R are true but R is not the correct explanation of A.
- ○ (c) A is true but R is false.
- ○ (d) A is false but R is true.

51. 48. Assertion (A): NaCl reacts with concentrated H2SO4 to give colourless fumes with pungent smell. But on adding MnO2 the fumes become greenish yellow. Reason (R) : MnO2 oxidizes HCl to chlorine gas which is greenish yellow

Mark only one oval.

- ○ (a) Both A and R are true and R is the correct explanation of A
- ○ (b) Both A and R are true but R is not the correct explanation of A.
- ○ (c) A is true but R is false.
- ○ (d) A is false but R is true.

52. 49. Assertion (A): Boiling points of alcohols are greater than ethers of same molar mass. Reason (R) : Ethers can form intermolecular hydrogen-bonding with each other.

Mark only one oval.

○ (a) Both A and R are true and R is the correct explanation of A

○ (b) Both A and R are true but R is not the correct explanation of A.

○ (c) A is true but R is false.

○ (d) A is false but R is true.

Section-C

This section consists of 6 multiple choice questions with an overall choice to attempt any5. In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.

50. Match the following:

I	II
(i) Proteins	(A) Pyranose structure
(ii) Single stranded	(B) Carbohydrates
(iii) Glucose	(C) Peptide linkage
(iv) Poly hydroxy aldehydes or ketones	(D) RNA
(v) Double stranded	

53. 50. Which of the following is correctly matched?

Mark only one oval.

○ (a) (i) – A, (ii) – D, (iii) – C, (v)-B

○ (b) (i) – D, (ii) – A, (iii) – C, (iv)-B

○ (c) (i) – C, (ii) – D, (iii) –A, (iv)-B

○ (d) (i) – C, (iii) – A, (iv) – B, (v)-D

54. 51. Which of the following analogies is correct?

Mark only one oval.

○ (a) Diamond: Covalent solid : : Cu : ionic solid

○ (b) BCC Unit cell : 1 atom : : FCC Unit cell : 4 atoms

○ (c) ccp : ABAB… Pattern arrangement : : hcp : ABCABC….Pattern arrangement

○ (d) ccp structure : Coordination number of atom is 12 : : bcc structure: Coordination number is 8

55. 52. Complete the following analogy: The carbon atom to which different atoms or substituents attached : A : : The process of conversion of enantiomer into a mixture with zero optical rotation : B

Mark only one oval.

○ (a) A: Achiral carbon B: Optical rotation

○ (b) A: Symmetric carbon B: Inversion of configuration

○ (c) A: Asymmetric Carbon B: Retention

○ (d) A: Chiral carbon B: Racemisation

CASE1: Read the passage given below and answer the following questions 53-55

Group 18 consists of elements helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn) (radioactive). All of these are gases and chemically unreactive. Their general electronic configuration is ns2 np6 except He(1s 2).

They have highest ionization enthalpy and positive electron gain enthalpy due to stable electronic configuration. Noble gases have low boiling points due to weak van der Waals' forces of attraction. Group 18 elements are called noble gases and not inert gases because compounds of Kr, Xe and Rn have been prepared. In March 1962, Bartlett prepared world's first noble gas compound, i.e., XePtF6. Bartlett's experiment opened the door to a better understanding of the oxidation states of atoms and their possible reactions.
More than 100 noble gas compounds are known today. Noble gases and their compounds have already made an impact in our daily lives. Helium is found in sun and stars. Xenon forms XeF2, XeF4, XeF6, XeOF4, XeO3, XeO2F2, their structures can be drawn on the basis of VSEPR theory. Helium is mixed with oxygen by deep sea divers to avoid pain. Helium gas is used as a heat transfer agent in gas nuclear reactors. Neon is used in coloured advertising lights. Argon is used in bulbs as inert gas. Kr and Xe are used in high efficiency lamps, head light of cars. XeF2 has been used to convert uracil to 5-fluorouracil one of the first anti-tumour agent.
Researchers recently succeed combining noble gases with hydrocarbons, a development that could lead to a new and better synthetic approach to some organic materials.

56. 53. Helium -Oxygen mixture is used by deep sea divers in preference to Nitrogen-Oxygen mixture because

Mark only one oval.

○ (a) Helium is much less soluble in blood than Nitrogen

○ (b) Nitrogen is much less soluble in blood than Helium

○ (c) Nitrogen is highly soluble in water

○ (d) Due to high pressure deep under the sea, Nitrogen and Oxygen react to give poisonous nitric oxide.

57. 54. The idea that promoted to Bartlett to prepare first ever compound of Noble gases was

Mark only one oval.

○ (a) Low bond dissociation enthalpy of F-F bond in F2

○ (b) High bond enthalpy of Xe-F bond

○ (c) Ionization enthalpies of O2 and Xe are almost same

○ (d) None of the above

58. 55. Noble gases have very low boiling point because of

Mark only one oval.

○ (a) Weak Van der Waal’s forces

○ (b) chemically inert

○ (c) High ionization enthalpy

○ (d) Positive electron gain enthalpy

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Class XII-Chemistry

General Instructions:

1. The Question Paper contains three sections.
2. Section A has 25 questions. Attempt any 20 questions.
3. Section B has 24 questions. Attempt any 20 questions.
4. Section C has 6 questions. Attempt any 5 questions.
5. All questions carry equal marks.
6. There is no negative marking.

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*Required

1. Email *

2. Exam Roll Number *

3. Name of the Student *

SECTION A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

4. 1. Only carbon is obtained when con H_2SO_4 is added to — 1 point

Mark only one oval.

○ Formic acid
○ Cane sugar
○ Oxalic acid
○ Ethyl alcohol

5. 2. Three elements A,B,C crystallize into a cubic solid lattice . Atoms of A occupy the corners , B atoms occupy the cube centres and atoms of C occupy the edges. The formula of the compound is 1 point

Mark only one oval.

○ ABC
○ ABC2
○ ABC3
○ ABC4

6. 3. Relative lowering of vapour pressure is equal to the molefraction of the non volatile solute. The statement was given by 1 point

Mark only one oval.

○ Raoult
○ Henry
○ Dalton
○ Joule

7. 4. Frenkel defect is also known as 1 point

Mark only one oval.

○ Vacancy defect
○ Dislocation defect
○ Impurity defect
○ Non stoichiometric defect

8. 5. 1 point


Which is most reactive towards Br_2 in the presence of $FeBr_3$?

Mark only one oval.

○ Anisole Benzene
○ Bromobenzene
○ Nitrobenzene
○

9. 6. Which of the following base is not present in RNA 1 point

Mark only one oval.

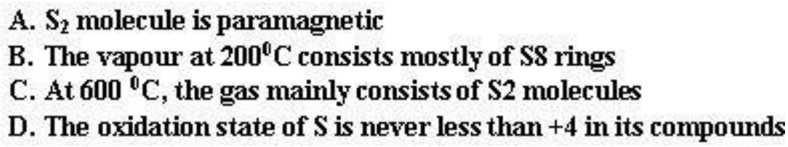
○ Adenine
○ Uracil
○ Thymine
○ Cytosine

10. 7. Which of the following cannot convert RCHO into RCH2OH 1 point

Mark only one oval.

○ H2/Pd
○ LiAlH4
○ NaBH4
○ Reaction with RMgX followed by hydrolysis

11. 8. Which of the following statements regarding Sulphur is incorrect 1 point



A. S_2 molecule is paramagnetic
B. The vapour at 200^0C consists mostly of S8 rings
C. At 600 ^{0}C, the gas mainly consists of S2 molecules
D. The oxidation state of S is never less than +4 in its compounds

Mark only one oval.

○ A

○

○ B

○ C

D

12. 9. Phenol is less acidic than 1 point

Mark only one oval.

○ Ethanol

○ o-nitrophenol

○ o-methylphenol o-

○ methoxyphenol

13. 10. Which of the following statements is not true about hexagonal close packing? 1 point

Mark only one oval.

○ Co-ordination number is 12

○ It has 74% packing efficiency

○ Tetrahedral voids of the second layer are covered by spheres of the third layer

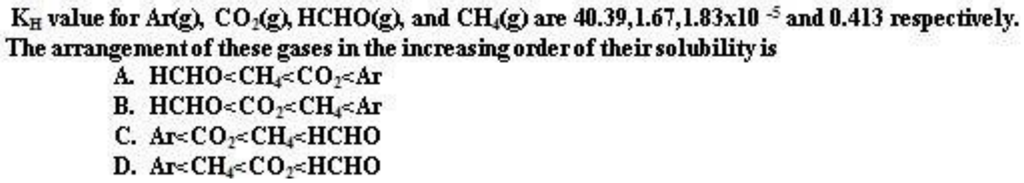
○ In this arrangement spheres of the fourth layer are exactly aligned with those of thefirst layer

14. 11. Arrange the following compounds in increasing order of boiling points: Propan-1-ol, butan-1-ol,butan-2-ol,pentan-1-ol 1 point

Mark only one oval.

○ Propan-1-ol, butan-2-ol, butan-1-ol,pentan-1-ol Propan-1-
○ ol, butan-1-ol, butan-2-ol,pentan-1-ol Pentan-1-ol, butan-
○ 2-ol, butan-1-ol, Propan-1-olPentan-1-ol butan-1-
○ ol,butan-2-ol, Propan-1-ol

15. 12. 1 point


K_H value for Ar(g), CO_2(g), HCHO(g), and CH_4(g) are 40.39,1.67,1.83x10 $^{-5}$ and 0.413 respectively. The arrangement of these gases in the increasing order of their solubility is

A. HCHO<CH_4<CO_2<Ar
B. HCHO<CO_2<CH_4<Ar
C. Ar<CO_2<CH_4<HCHO
D. Ar<CH_4<CO_2<HCHO

Mark only one oval.

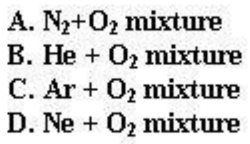
○ A
○
○ B
○ C
D

16. 13. IUPAC name of quinol is 1 point

Mark only one oval.

○ 3- methylphenol
○ Benzene-1,3-diol 3-
○ methoxyphenol
○ Benzene-1,4-diol

17. 14. The gaseous mixture used by deep sea divers for respiration is 1 point



A. N_2+O_2 mixture
B. He + O_2 mixture
C. Ar + O_2 mixture
D. Ne + O_2 mixture

Mark only one oval.

○ A

○

○ B

○ C

D

18. 15. α-(+) glucose and β-(+) glucose are 1 point

Mark only one oval.

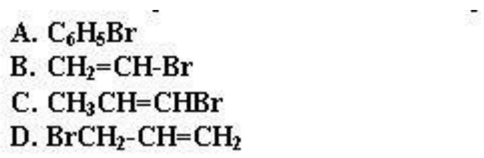
○ enantiomers

○ conformers

○ epimers

○ anomers

19. 16. Which of the following is most reactive towards nucleophilic substitution reaction? 1 point



A. C_6H_5Br
B. $CH_2=CH-Br$
C. $CH_3CH=CHBr$
D. $BrCH_2-CH=CH_2$

Mark only one oval.

○ A

○

○ B

○ C

D

20. 17. Which of the following cannot be used for the preparation of iodoform? 1 point

Mark only one oval.

○ Acetone Methanol
○ Ethanol
○ Acetaldehyde
○

21. 18. Bleaching powder is a mixture of 1 point

Mark only one oval.

○ Calcium hypochlorite and calcium hydroxideCalcium
○ chlorate and calcium chloride
○ Calcium hypochlorite and basic calcium chlorideCalcium
○ chlorate and calcium hydroxide

22. 19. Which of the following pair will form an ideal solution? 1 point

Mark only one oval.

○ Ethanol- acetone
○ Benzene-toluene
○ Acetone-chloroform
○ Water-HCl

23. 20. Reducing property of halogen acids are in the order 1 point

Mark only one oval.

○ HF>HCl>HBr>H
○ I
○ HF<HCl<HBr<H
○ I
HCl>HF>HBr>H
I
HCl>HBr>HF<H
I

24. 21. During acetylation , glucose needs x moles of acetic anhydride. The value of x would be

1 point

Mark only one oval.

○ 3
○ 5
○ 4
○ 1

25. 22. Catalyst used in Deacon’s process for manufacture of chlorine is

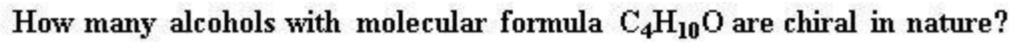
1 point

Mark only one oval.

○ Cu
○ An alloy of Cu
○ CuCl2
○ CuS

26. 23.

1 point



How many alcohols with molecular formula $C_4H_{10}O$ are chiral in nature?

Mark only one oval.

○ 1
○ 2
○ 3
○ 4

27. 24. How many lone pairs of electrons are present on chlorine in ClF3 molecule? 1 point

Mark only one oval.

○ 0
○ 1
○ 2
○ 3

28. 25. The boiling point of an azeotropic mixture of water and ethyl alcohol is less than that of the theoretical value of water and alcohol mixture. Hence the mixture shows 1 point

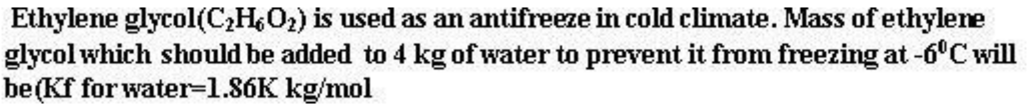
Mark only one oval.

○ Positive deviation from Raoult's Law Negative
○ deviation from Raoult's Law Neither positive
○ nor negative deviationCan't be predicted
○

SECTION B

This section consists of 24multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation

29. 26. 1 point

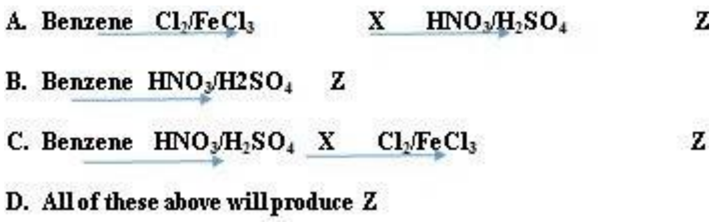


Ethylene glycol($C_2H_6O_2$) is used as an antifreeze in cold climate. Mass of ethylene glycol which should be added to 4 kg of water to prevent it from freezing at -6^{0}C will be(Kf for water=1.86K kg/mol

Mark only one oval.

○ 204.3g
○ 400g
○ 304.6g
○ 800 g

30. 27. Which of the following sequences would yield m-nitrochlorobenzene (Z) from benzene? 1 point



A. Benzene $\xrightarrow{Cl_2/FeCl_3}$ X $\xrightarrow{HNO_3/H_2SO_4}$ Z

B. Benzene $\xrightarrow{HNO_3/H2SO_4}$ Z

C. Benzene $\xrightarrow{HNO_3/H_2SO_4}$ X $\xrightarrow{Cl_2/FeCl_3}$ Z

D. All of these above will produce Z

Mark only one oval.

○ A

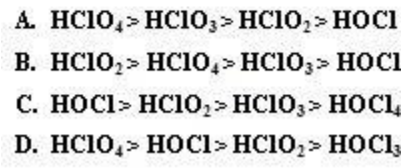
○

○ B

○ C

D

31. 28. Among the following oxoacids, the correct decreasing order of acid strength is 1 point



A. $HClO_4 > HClO_3 > HClO_2 > HOCl$

B. $HClO_2 > HClO_4 > HClO_3 > HOCl$

C. $HOCl > HClO_2 > HClO_3 > HOCl_4$

D. $HClO_4 > HOCl > HClO_2 > HOCl_3$

Mark only one oval.

○ A

○

○ B

○ C

D

32. 29. Which reagent is used to convert glucose into saccharic acid 1 point

Mark only one oval.

○ Br2/H2O
○ Nitric acid
○ Alkaline solution of iodineAmmonium
○ hydroxide

33. 30. Match the correct entries 1 point

Mark only one oval per row.

	heated Cu at 573K	Conversion of phenol to salicyclaldehyde	Conversion of phenol to salicylic acid	Reaction of alkyl halide with sodium alkoxide
Kolbe’s reaction	○	○	○	○
Williamson’s synthesis	○	○	○	○
Conversion of secondary alcoholto ketone	○	○	○	○
Reimer Tiemann reaction	○	○	○	○

34. 31. Nitrogen is relatively an inactive element because 1 point

Mark only one oval.

○ its atom has a stable electronic configurationit has
○ low atomic radius
○ its electronegativity is fairly high
○ dissociation energy of its molecule is fairly high

35. 32. An excess of potassium ions makes KCl crystal appear violet or lilac in colour shows 1 point

Mark only one oval.

○ Some of the cationic sites are occupied by an unpaired electronSome

○ of the anionic sites are occupied by a pair of electrons There are

○ vacancies at some anionic sites

○ F-centres are created which impart colour to the crystals

36. 33. In the following sequence of reactions, Y is 1 point

Mark only one oval.

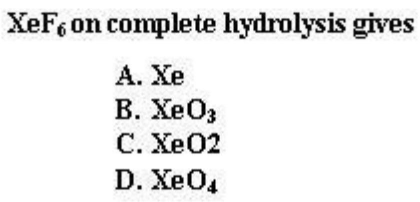
○ Ethene

○ Bromoethane

○ Ethanol

○ Methanol

37. 34. 1 point



XeF_6 on complete hydrolysis gives

A. Xe
B. XeO_3
C. XeO2
D. XeO_4

Mark only one oval.

○ A

○

○ B

○ C

D

38. 35. The use of common salts, eg: NaCl or CaCl2 anhydrous, is made to clear snow on the roads. This causes 1 point

Mark only one oval.

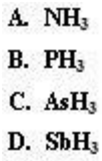
○ A lowering in the freezing point of waterA
○ lowering in the melting point of ice
○ Ice melts at the temperature of atmosphere present at that timeAll of
○ these
○ Other: ______________________________

39. 36. Which of the following is not an essential amino acid 1 point

Mark only one oval.

○ Lysine
○ Phenyl alanine
○ Valine
○ Glycine

40. 37. Which one has the lowest boiling point? 1 point

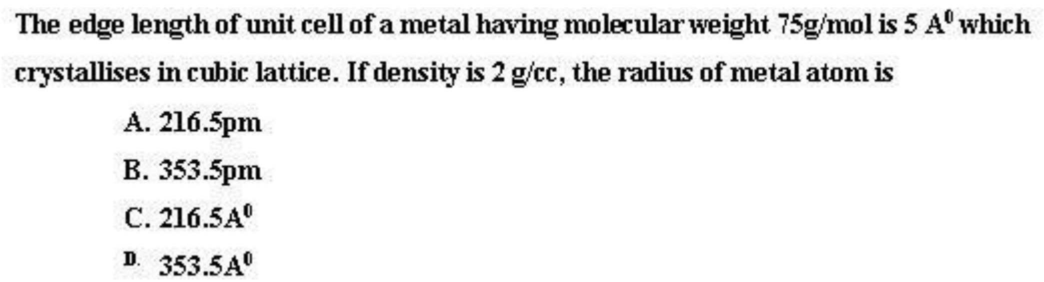


A. NH_3
B. PH_3
C. AsH_3
D. SbH_3

Mark only one oval.

○ A
○
○ B
○ C
D

41. 38. 1 point



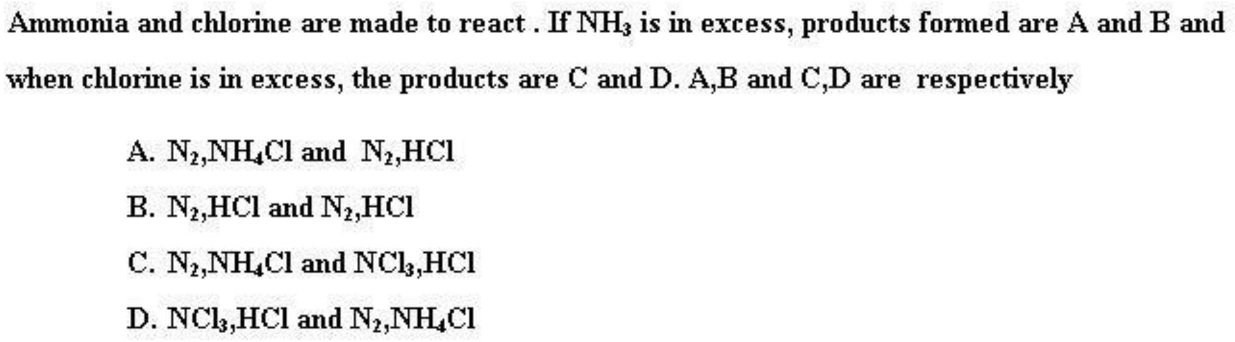
The edge length of unit cell of a metal having molecular weight 75g/mol is 5 A^0 which crystallises in cubic lattice. If density is 2 g/cc, the radius of metal atom is

A. 216.5pm
B. 353.5pm
C. 216.5A^0
D. 353.5A^0

Mark only one oval.

○ A
○
○ B
○ C
D

42. 39. 1 point



Ammonia and chlorine are made to react . If NH_3 is in excess, products formed are A and B and when chlorine is in excess, the products are C and D. A,B and C,D are respectively

A. N_2,NH_4Cl and N_2,HCl
B. N_2,HCl and N_2,HCl
C. N_2,NH_4Cl and NCl_3,HCl
D. NCl_3,HCl and N_2,NH_4Cl

Mark only one oval.

○ A
○
○ B
○ C
D

43. 40. The compound obtained by the reaction of propene with diborane followed by hydrolysis with alkaline H2O2 is 1 point

Mark only one oval.

○ ethanol

○ propan-1-ol

○ propan-2-ol

○ methanol

44. 41. The compound which reacts fastest with Luca's reagent at room temperature is 1 point

Mark only one oval.

○ Butan-1-ol

○ Butan-2-ol

○ 2-methylpropan-1-ol 2-

○ methylpropan-2-ol

45. 42. The catalytic promoter used in Haber's process is 1 point

Mark only one oval.

○ Mo

○ Ni

○ Pt

○ V2O5

46. 43. On distilling phenol with Zn dust, one gets 1 point

Mark only one oval.

○ Toluene

○ Benzaldehyde+ZnO

○ ZnO+Benzene

○ Benzoic acid

47. 44. In order to prepare fluorobenzene from benzene diazonium chloride, which of the following reagents is used? 1 point

Mark only one oval.

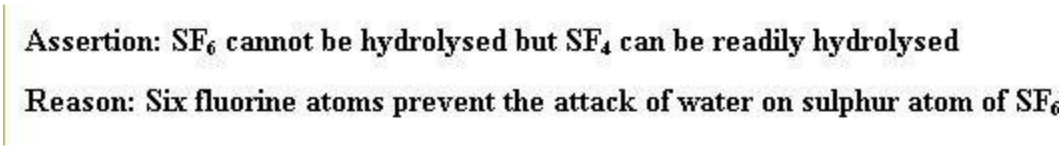
○ Fluorine

○ HF

○ Hydrofluorosilicic acidFluoroboric

○ acid

45. Given below are two statements labelled as Assertion and Reason (R)



Assertion: SF_6 cannot be hydrolysed but SF_4 can be readily hydrolysed

Reason: Six fluorine atoms prevent the attack of water on sulphur atom of SF_6

48. Select the most appropriate answer from the options given below: 1 point

Mark only one oval.

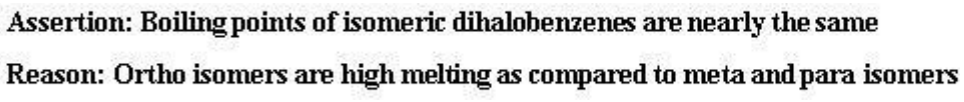
○ Both A and R are true and R is the correct explanation of A Both A

○ and R are true but R is not the correct explanation of A.A is true but

○ R is false.

○ A is false but R is true

46. Given below are two statements labelled as Assertion and Reason (R)



Assertion: Boiling points of isomeric dihalobenzenes are nearly the same

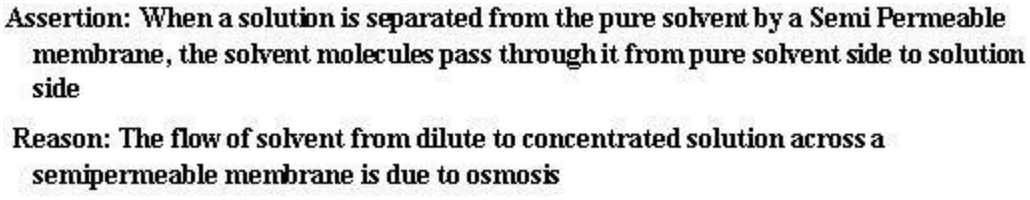
Reason: Ortho isomers are high melting as compared to meta and para isomers

49. Select the most appropriate answer from the options given below: 1 point

Mark only one oval.

○ Both A and R are true and R is the correct explanation of A Both A
○ and R are true but R is not the correct explanation of A.A is true but
○ R is false.
○ A is false but R is true

47. Given below are two statements labelled as Assertion and Reason (R)



Assertion: When a solution is separated from the pure solvent by a Semi Permeable membrane, the solvent molecules pass through it from pure solvent side to solution side

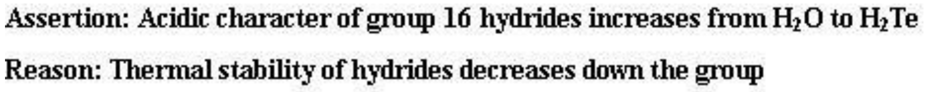
Reason: The flow of solvent from dilute to concentrated solution across a semipermeable membrane is due to osmosis

50. Select the most appropriate answer from the options given below: 1 point

Mark only one oval.

○ Both A and R are true and R is the correct explanation of A Both A
○ and R are true but R is not the correct explanation of A.A is true but
○ R is false.
○ A is false but R is true

48. Given below are two statements labelled as Assertion and Reason (R)



Assertion: Acidic character of group 16 hydrides increases from H_2O to H_2Te

Reason: Thermal stability of hydrides decreases down the group

51. Select the most appropriate answer from the options given below: 1 point

Mark only one oval.

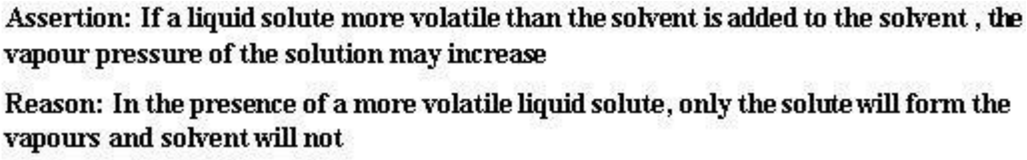
○ Both A and R are true and R is the correct explanation of A Both A

○ and R are true but R is not the correct explanation of A.A is true but

○ R is false.

○ A is false but R is true

49. Given below are two statements labelled as Assertion and Reason (R)



Assertion: If a liquid solute more volatile than the solvent is added to the solvent , the vapour pressure of the solution may increase

Reason: In the presence of a more volatile liquid solute, only the solute will form the vapours and solvent will not

52. Select the most appropriate answer from the options given below: 1 point

Mark only one oval.

○ Both A and R are true and R is the correct explanation of A Both A

○ and R are true but R is not the correct explanation of A.A is true but

○ R is false.

○ A is false but R is true

SECTION C

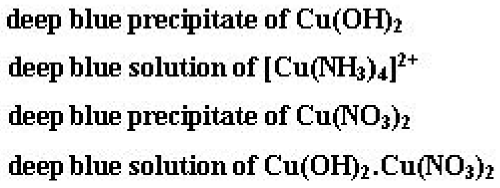
This section consists of 6multiple choice questions with an overall choice to attempt any5. In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.

53. 50. Match the following 1 point

Mark only one oval per row.

	Monomeric units of nucleic acids	sugar-heterocyclic base combination	linkage between two amino acid units	linkage between two monosaccharide units
Glycosidic linkage	○	○	○	○
Peptidebond	○	○	○	○
NucleosideNucleotide	○	○	○	○
	○	○	○	○

54. 51. In qualitative analysis,when H2S is passed through an aqueous solution of salt acidified with dil HCl, a black precipitate is obtained. On boiling the precipitate with dil HNO3, it forms a solution of blue colour. Addition of excess of aqueous solution of ammonia to this solution gives 1 point



deep blue precipitate of $Cu(OH)_2$

deep blue solution of $[Cu(NH_3)_4]^{2+}$

deep blue precipitate of $Cu(NO_3)_2$

deep blue solution of $Cu(OH)_2.Cu(NO_3)_2$

Mark only one oval.

○ A

○

○ B

○ C

D

55. 52. Ethyl alcohol is obtained when ethyl chloride is boiled with 1 point

Mark only one oval.

- ○ alcoholic KOH
- ○ aqueous KOH
- ○ water
- ○ aqueous KMnO4

CASE 1: Read the passage given below and answer the following questions 53-55

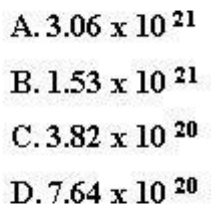
X ray diffraction is the first exact method for the study of the structure of matter. The present study of gold and silver items outlines the first steps in a new fields- analyzing the line profile of objects in order to obtain information about the microstructural properties of materials: sizes of coherently diffracting domains in crystals(crystalline sizes) and micro strains in the lattice. The packing of atoms in a crystal of gold is found to be in layers such that starting from any layer, every fourth layer is found to be exactly identical. The density of gold is found to be 19.4 g/cc and its atomic mass is 197 amu

56. 53. The co-ordination number of gold atom in the crystal is 1 point

Mark only one oval.

- ○ 4
- ○ 6
- ○ 8
- ○ 12

57. 54. The appropriate number of unit cells present in one gram of gold is 1 point


A. 3.06×10^{21}

B. 1.53×10^{21}

C. 3.82×10^{20}

D. 7.64×10^{20}

Mark only one oval.

○ A

○

○ B

○ C

D

58. 55. The fraction occupied by gold atoms in the crystal is 1 point

Mark only one oval.

○ 0.52

○ 0.68

○ 0.74

○ 1.0

****


Best wishes!