CUET UG 2024 Chemistry Question Paper

COMMON UNIVERSITY ENTRANCE TEST

CUET UG (Chemistry)

19 July 2024

Question 1

Which among the following is super cooled liquid?

Options:

A. Diamond

B. Graphite

C. Copper

D. Glass

Answer: D

Solution:

CONCEPT:

Supercooled Liquid

- A supercooled liquid is a state of matter in which a liquid is cooled below its normal freezing point without solidifying.
- In this state, the substance remains liquid even at temperatures where it would usually become a solid.
- Supercooling occurs because the liquid does not have enough energy for the molecules to arrange themselves into a solid crystal structure.

EXPLANATION:

- Diamond: Diamond is a crystalline form of carbon and is a solid.
- Graphite: Graphite is another crystalline form of carbon and is a solid.
- Copper: Copper is a metal and is also a solid.
- Glass: Glass is an amorphous solid, meaning it lacks a long-range order or crystalline structure.
- Although glass appears to be solid, it is technically considered a supercooled liquid because it does not crystallize as it cools down and has a disordered molecular structure similar to that of a liquid.

Therefore, the supercooled liquid among the options is Glass.

Question 2

Dry ice is:

Options:

A. Lead monoxide

B. Silicon carbide

C. Solid carbon dioxide

D. Glacier ice

Answer: C

Solution:

CONCEPT:

Dry Ice

- Dry ice is the solid form of carbon dioxide (CO_2).
- It is called "dry ice" because it sublimates directly from a solid to a gas without passing through a liquid phase, thus it doesn't leave any residue or moisture.
- Dry ice is commonly used as a cooling agent due to its very low temperature of -78.5°C (-109.3°F).

EXPLANATION:

- Option 1 (Lead monoxide): This is a compound of lead and oxygen, not related to dry ice.
- Option 2 (Silicon carbide): This is a compound of silicon and carbon, used as an abrasive and in semiconductor electronics, not related to dry ice.
- Option 3 (Solid carbon dioxide): This is indeed dry ice, as dry ice is the solid form of CO_2.
- Option 4 (Glacier ice): This is just frozen water (H_2O), not dry ice.
- Therefore, the correct answer isSolid carbon dioxide

Therefore, dry ice is solid carbon dioxide.

Question 3

Which kind of defect is observed in AgBr?

Options:

A. Vacancy defect

B. Interstitial defect

C. Both Frenkel and Schottky defects

D. Only Schottky defect

Answer: C

Solution:

CONCEPT:

Defects in Crystals

- Crystalline solids can have different types of defects which affect their physical properties.
- The two main types of defects are:
    - **Schottky defect:** A type of point defect in a crystal where an equal number of cations and anions are missing from the lattice, maintaining overall electrical neutrality.
    - **Frenkel defect:** A type of defect where a cation leaves its normal lattice site and occupies an interstitial site, creating a vacancy at the original site and an interstitial defect at the new site.

EXPLANATION:

- Silver bromide (AgBr) is known to exhibit both types of defects:
    - **Frenkel defect:** In AgBr, the small silver ions (Ag^+) can leave their normal lattice positions and occupy interstitial sites due to their smaller size, creating Frenkel defects.
    - **Schottky defect:** AgBr also exhibits Schottky defects where both Ag^+ and Br^- ions are missing from the lattice, maintaining electrical neutrality.

Therefore, the kind of defect observed in AgBr is both Frenkel and Schottky defects.

Question 4

Which of the following is an example of solid solution?

Options:

A. Camphor in N_2gas

B. Oxygen gas in water

C. Ethanol in water

D. Amalgam of mercury with sodium

Answer: D

Solution:

CONCEPT:

Solid Solution

- A solid solution is a homogeneous mixture of two or more substances where the solute is dissolved in the solvent in the solid state.
- In a solid solution, the components mix at the atomic level, forming a single phase.

EXPLANATION:

- **Camphor in N_2 gas** is a solid dispersed in a gas, which is not a solid solution.
- **Oxygen gas in water** is a gas dissolved in a liquid, which is not a solid solution.
- **Ethanol in water** is a liquid-liquid solution, which is not a solid solution.
- **Amalgam of mercury with sodium** is a solid solution where mercury (liquid) dissolves sodium (solid) to form a solid solution.

Therefore, the correct answer is<u>Amalgam of mercury with sodium</u>.

Question 5

What is the formula of urea?

Options:

A. NH_2CONH_2

B. NH_4HSO_4

C. C_2H_5OH

D. NH_4OH

Answer: A

Solution:

<u>CONCEPT</u>:

Urea Structure and Formula

- Urea is an organic compound with the chemical formula NH_2CONH_2.
- It is also known as carbamide.
- Urea is widely used in fertilizers as a source of nitrogen and is an important raw material for the chemical industry.

<u>EXPLANATION</u>:

- NH_2CONH_2 - This is the correct formula of urea.
- NH_4HSO_4 - This is ammonium hydrogen sulfate.
- C_2H_5OH - This is ethanol.
- NH_4OH - This is ammonium hydroxide.
- Therefore, the correct answer is Option 1: NH_2CONH_2.

Therefore, the formula of urea is NH_2CONH_2.

Question 6

For $p = K_Hx$. Here K_H is:

Options:

A. Cryoscopic constant

B. Henry's Law constant

C. Boyle's constant

D. Rate constant

Answer: B

Solution:

CONCEPT:

Henry's Law Constant (K_H)

- Henry's Law states that the amount of dissolved gas in a liquid is proportional to its partial pressure above the liquid.
- The law is usually represented as:

  $p = K_H x$

- Here,
  - p is the partial pressure of the gas
  - K_H is the Henry's Law constant, which is specific to the gas and solvent at a given temperature
  - x is the mole fraction of the gas in the solution

EXPLANATION:

- In the given statement:

  For $p = K_H x$

  - p is the partial pressure of the gas above the solution.
  - K_H is the Henry's Law constant.
  - x is the mole fraction of the gas in the solution.
- Henry's Law constant (K_H) is a measure of the solubility of a gas in a liquid under a given set of conditions.
- The higher value of K_H, the less soluble the gas is in the liquid.

Therefore, in the context of the given statement, K_H is Henry's Law constant.

Question 7

What kind of problem arises when bubbles of nitrogen gas dissolves in blood?

Options:

A. Anoxia

B. Red fever

C. Sleeping sickness

D. Bends

Answer: D

Solution:

CONCEPT:

Bends (Decompression Sickness)

- The bends, also known as decompression sickness, is a condition that can arise when nitrogen bubbles form in the bloodstream due to rapid changes in pressure.
- This typically occurs in divers who ascend to the surface too quickly after being at depth, where the pressure is higher.
- At higher pressures, nitrogen gas dissolves more readily in the blood. When the pressure decreases rapidly, the dissolved nitrogen can form bubbles in the blood and tissues.

EXPLANATION:

- When a diver ascends too quickly:

  The rapid decrease in pressure causes the nitrogen gas, which was dissolved in the blood at higher pressures, to come out of solution and form bubbles.

- These nitrogen bubbles can cause various symptoms and complications:
  - Joint pain (the "bends")
  - Dizziness and confusion
  - Difficulty breathing
  - Nerve and muscle pain
- To avoid the bends:
  - Divers need to ascend slowly and make decompression stops as necessary to allow the nitrogen to be safely expelled from the body.
  - Proper training and adherence to diving tables or dive computers can help manage the risk.

Therefore, the correct answer isBends.

Question 8

A perfectly ideal solution is rare but some solution behave nearly ideal. Which of the following does not fall in this category?

Options:

A. n-hexane and n-heptane

B. Ethanol and acetone

C. Benzene and toluene

D. Bromoethane and chloroethane

Answer: B

Solution:

CONCEPT:

Ideal Solutions

- An ideal solution is a solution in which the enthalpy of mixing is zero, and the volume of mixing is also zero.
- This means the interactions between the molecules of the different components are similar to the interactions between the molecules of the same components.
- In an ideal solution, Raoult's law is obeyed throughout the entire range of concentration.

EXPLANATION:

- **n-Hexane and n-Heptane:** Both are non-polar hydrocarbons and their molecular interactions are similar, so they behave nearly ideal.
- **Ethanol and Acetone:** Ethanol is capable of hydrogen bonding, while acetone is a polar aprotic solvent. Their molecular interactions are quite different, leading to deviations from ideality.
- **Benzene and Toluene:** Both are non-polar aromatic hydrocarbons and their molecular interactions are similar, so they behave nearly ideal.
- **Bromoethane and Chloroethane:** Both are halogenated hydrocarbons with similar molecular interactions, so they behave nearly ideal.
- Therefore, the solution that does not behave nearly ideal is**Ethanol and Acetone**

Therefore, the answer is Ethanol and Acetone.

Question 9

Which among the following life processes is electrochemical in origin?

Options:

A. Breathing

B. Digestion

C. Transmission of sensory signals

D. Blood circulation

Answer: C

Solution:

CONCEPT:

Electrochemical Origin of Transmission of Sensory Signals

- Transmission of sensory signals involves the movement of ions across neuron membranes, creating electrical impulses that travel through the nervous system.
- These electrical impulses are generated and propagated by the movement of charged particles (ions), which is an electrochemical process.

EXPLANATION:

- In the process of transmitting sensory signals:
  - Neurons have specialized structures such as axons and dendrites that facilitate the transmission of electrical impulses.
  - When a sensory receptor is stimulated, it generates an action potential, which is an electrical signal that travels along the neuron's membrane.
  - This action potential is created by the movement of sodium (Na^+) and potassium (K^+) ions across the neuron's membrane, which changes the electrical charge inside and outside the neuron.
  - The movement of these ions is facilitated by ion channels and pumps, which are proteins embedded in the neuron's membrane.
- Therefore, the transmission of sensory signals is fundamentally an electrochemical process, relying on the movement of ions to generate and propagate electrical impulses.

Therefore, the life process that is electrochemical in origin is the transmission of sensory signals.

Question 10

The standard electrode potential for Daniell cell is 1.1 V. The standard Gibbs free energy for the reaction Zn(s) + Cu^2+ (aq)→ Zn^{2+}(aq) + Cu(s) is approximately:

Options:

A. -212.27J/mol

B. -21.22J/mol

C. -212271.4J/mol

D. -2.1227J/mol

Answer: C

Solution:

CONCEPT:

Standard Gibbs Free Energy (ΔG^o)

- The standard Gibbs free energy change (ΔG^o) is related to the standard cell potential (E^o_{cell}) by the equation:

  $\Delta G^o = -nFE^o_{cell}$

- Where:

  - n = number of moles of electrons transferred in the balanced equation
  - F = Faraday's constant, approximately 96485 C/mol
  - E^o_{cell} = standard cell potential (in volts)

EXPLANATION:

- $IZn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
  - Zinc (Zn) is oxidized to Zn^{2+}, so Zn is the anode.
  - Copper (Cu^{2+}) is reduced to Cu, so Cu is the cathode.
- $E^o_{cell} = 1.1$ V
- Number of moles of electrons transferred (n) in the reaction is 2.
- Using the equation for standard Gibbs free energy change:
  - $\Delta G^o = -nFE^o_{cell}$
  - = - (2 mol) (96485 C/mol) (1.1 V)
  - = - 212267 J/mol
  - = - 212.27 kJ/mol

Therefore, the standard Gibbs free energy (ΔG^0) for the reaction is approximately -212.27 kJ/mol, which corresponds to -212271.4 J/mol.

Question 11

Which metal is the most powerful reducing agent in aqueous solution?

Options:

A. Potassium

B. Sodium

C. Barium

D. Lithium

Answer: D

Solution:

CONCEPT:

Reducing Agent Strength

- The strength of a reducing agent in aqueous solution is determined by its standard reduction potential (E^o).
- The lower (more negative) the standard reduction potential, the stronger the reducing agent.

EXPLANATION:

- Given standard reduction potentials for the metals in question:
  - $E^o_K = -2.93$ V (for $K^+ + e^- \rightarrow K$)

  - E^o_{Na} = -2.71 V (for $Na^+ + e^- \rightarrow Na$)
  - E^o_{Ba} = -2.92 V (for $Ba^{2+} + 2e^- \rightarrow Ba$)
  - E^o_{Li} = -3.04 V (for $Li^+ + e^- \rightarrow Li$)
- The most powerful reducing agent is the one with the most negative reduction potential:
  - Comparing the values: -2.93 V, -2.71 V, -2.92 V, -3.04 V
  - Lithium (Li) has the most negative reduction potential (-3.04 V).

Therefore, Lithium (Li) is the most powerful reducing agent in aqueous solution.

Question 12

What is the over all order of reaction which has the following rate expression?

Rate = $k[A]^{1/2}[B]^{3/2}$

Options:

A. One

B. Two

C. Zero

D. Three

Answer: B

Solution:

CONCEPT:

Order of Reaction

- The order of a reaction is the sum of the powers of the concentration terms in the rate equation.
- For a given rate expression:

  Rate = $k[A]^m[B]^n$

  - The order with respect to A is m.
  - The order with respect to B is n.
  - The overall order of the reaction is m + n.

EXPLANATION:

- In the given rate expression:

  Rate = $k[A]^{1/2}[B]^{3/2}$

  - The order with respect to A is 1/2.
  - The order with respect to B is 3/2.
  - The overall order of the reaction is:

    1/2 + 3/2 = 2

Therefore, the overall order of the reaction is Two.

Question 13

Inversion of cane sugar is a:

Options:

A. Zero order reaction

B. Pseudo first order reaction

C. Second order reaction

D. Third order reaction

Answer: B

Solution:

CONCEPT:

Pseudo First Order Reactions

- A pseudo first order reaction is a reaction that is not truly first order but can be approximated as such under certain conditions.
- This occurs when the concentration of one of the reactants is much higher than the other, so its concentration remains nearly constant during the reaction.
- As a result, the reaction appears to depend on the concentration of only one reactant, mimicking a first order reaction.

EXPLANATION:

- In the inversion of cane sugar:

  $C_{12}H_{22}O_{11}$ (sucrose) + $H_2O \rightarrow C_6H_{12}O_6$ (glucose) + $C_6H_{12}O_6$ (fructose)

  - This reaction is catalyzed by an acid, and water is in large excess.
  - The concentration of water remains practically constant during the reaction.
- Because the concentration of water does not change significantly, the reaction rate can be expressed as:
  - Rate = k' [sucrose], where k' is the effective rate constant.
- This makes the reaction appear to be first order with respect to sucrose, even though it is actually second order (first order with respect to sucrose and first order with respect to water).

Therefore, the inversion of cane sugar is a pseudo first order reaction.

Question 14

Which term from the following is not related to adsorption?

Options:

A. Adsorbent

B. Effluent

C. Adsorbate

D. Desorption

Answer: B

Solution:

CONCEPT:

Adsorption

- Adsorption is the process in which atoms, ions, or molecules from a substance (such as a gas, liquid, or dissolved solid) adhere to a surface of the adsorbent.
- The substance that is adsorbed on the surface is called the adsorbate.
- The substance on whose surface the adsorption occurs is called the adsorbent.
- Desorption is the process in which adsorbed molecules detach from the surface of the adsorbent.

EXPLANATION:

- From the given options:
    - **Adsorbent**: The material on which the adsorption takes place.
    - **Adsorbate**: The substance that is adsorbed on the adsorbent.
    - **Desorption**: The process in which adsorbed molecules leave the surface of the adsorbent.
    - **Effluent**: Typically refers to wastewater or other outflows of liquid waste, which is not related to the process of adsorption.

Therefore, the term *Effluent* is not related to adsorption.

Question 15

Which statement is not true for physisorption?

Options:

A. It is not specific in nature.

B. It is reversible in nature.

C. Enthalpy of adsorption is low.

D. Chemical bond is responsible.

Answer: D

Solution:

CONCEPT:

Physisorption (Physical Adsorption)

- Physisorption is the adsorption of gas molecules onto the surface of a solid through weak van der Waals forces.
- It is generally characterized by low enthalpy changes (typically in the range of 20-40 kJ/mol).
- Physisorption is reversible, meaning the adsorbed gas can be easily desorbed by decreasing the pressure or increasing the temperature.
- It is not specific in nature, as it can occur between any gas and solid due to the non-specific van der Waals forces.

EXPLANATION:

- "It is not specific in nature." -
  This is true as physisorption can occur between any gas and solid due to van der Waals forces.
- "It is reversible in nature." -
  This is true as physisorption can be reversed by changing the pressure or temperature.
- "Enthalpy of adsorption is low." -
  This is true as the enthalpy change for physisorption is typically low.
- "Chemical bond is responsible." -
  This is not true as physisorption involves weak van der Waals forces, not chemical bonds.

Therefore, the statement that is not true for physisorption isChemical bond is responsible.

Question 16

Which among the following chemicals is used for control of humidity?

Options:

A. Charcoal

B. Silica gel

C. Ammonia gas

D. Sodium chloride

Answer: B

Solution:

CONCEPT:

Control of Humidity

- Humidity control in a given environment can be achieved by using substances that can absorb or release moisture as needed.
- One of the most common substances used for this purpose is silica gel, which is a desiccant.

EXPLANATION:

- Silica gel is a highly porous form of silicon dioxide (SiO_2) that can adsorb water vapor and other substances.
- It has a high surface area, which allows it to absorb moisture efficiently.
- When placed in a humid environment, silica gel can absorb water molecules, reducing the humidity level.
- It can also be regenerated by heating, which drives off the absorbed water and allows it to be reused.
- Other substances listed, such as charcoal, ammonia gas, and sodium chloride, are not typically used for controlling humidity.

Therefore, the chemical used for control of humidity is Silica gel.

Question 17

Which among the following chemicals is used as catalytic promoter in Haber's process?

Options:

A. Ni

B. MnO_2

C. Fe

D. Mo

Answer: D

Solution:

CONCEPT:

Haber's Process

- Haber's process is an industrial method for the synthesis of ammonia (NH_3) from nitrogen (N_2) and hydrogen (H_2) gases.
- The process requires specific conditions such as high temperature and pressure, and the presence of a catalyst to increase the rate of reaction.

EXPLANATION:

- In Haber's process, iron (Fe) is used as the main catalyst.
- Molybdenum (Mo) is used as a catalytic promoter to enhance the efficiency of the iron catalyst.
- The role of the catalytic promoter is to increase the activity and lifespan of the catalyst, making the process more efficient.

- Other options like Ni (Nickel) and MnO_2 (Manganese dioxide) are not used as promoters in this specific process.

Therefore, Molybdenum (Mo) is used as a catalytic promoter in Haber's process.

Question 18

Which of the following metal's ore can be concentrated by magnetic separation method?

Options:

A. Aluminium

B. Cadmium

C. Iron

D. Zinc

Answer: C

Solution:

CONCEPT:

Magnetic Separation Method

- Magnetic separation is a process in which magnetically susceptible material is extracted from a mixture using a magnetic force.
- This separation technique can be useful in mining iron as it is attracted to a magnet.

EXPLANATION:

- Aluminium ore is not magnetic.
- Cadmium ore is not magnetic.
- Iron ore is magnetic, making it suitable for magnetic separation.
- Zinc ore is not magnetic.
- Magnetic separation is specifically used to concentrate iron ore because of its magnetic properties.

Therefore, the metal's ore that can be concentrated by the magnetic separation method is Iron (Option 3).

Question 19

Which of the following is a polyhydric alcohol?

Options:

A.

Ethanol

B.

Glycerol

C.

Propanol

D.

Phenol

Answer: B

Solution:

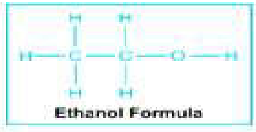
CONCEPT:

Polyhydric Alcohols

- Polyhydric alcohols are alcohols that contain more than one hydroxyl (-OH) group in their molecular structure.
- These compounds are also known as polyols.
- Polyhydric alcohols have multiple hydroxyl groups which make them highly soluble in water and give them the ability to form hydrogen bonds.

EXPLANATION:

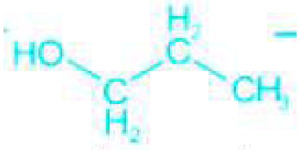
- Among the given options:
  - **Ethanol** (Option 1) has one hydroxyl group (-OH), so it is a monohydric alcohol.


Ethanol Formula

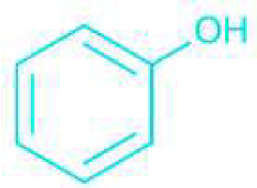
- **Glycerol** (Option 2) has three hydroxyl groups (-OH), so it is a polyhydric alcohol.


Glycerol Formula

- **Propanol** (Option 3) has one hydroxyl group (-OH), so it is a monohydric alcohol.


1-propanol

- **Phenol** (Option 4) has one hydroxyl group (-OH) attached to an aromatic ring, so it is a monohydric alcohol.



- Therefore, the polyhydric alcohol among the given options is **Glycerol** (Option 2).

Therefore, the correct answer is Option 2: Glycerol.

Question 20

What is the other term used for thermal reductions?

Options:

A. Hydrometallurgy

B. Leaching

C. Froth floatation

D. Pyrometallurgy

Answer: D

Solution:

CONCEPT:

Pyrometallurgy

- Pyrometallurgy is a branch of extractive metallurgy. It involves high-temperature processes where chemical reactions take place to extract metals from their ores.
- Thermal reductions, which involve the reduction of metal oxides using heat, are a fundamental part of pyrometallurgical processes.

EXPLANATION:

- In pyrometallurgy, the thermal reduction process typically involves heating metal oxides with a reducing agent such as carbon (coke) or hydrogen.

  Example: $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$

    - Iron oxide (Fe_2O_3) is reduced by carbon (C) to produce iron (Fe).
    - Carbon monoxide (CO) is produced as a byproduct.
- Pyrometallurgy also includes other high-temperature processes such as smelting, roasting, and refining.
    - Smelting involves melting ores to extract metals.
    - Roasting involves heating ores in the presence of oxygen to remove impurities.
    - Refining involves purifying extracted metals using heat.

Therefore, the other term used for thermal reductions is pyrometallurgy.

Question 21

Which member of 15 group elements does not show allotropy?

Options:

A. Nitrogen

B. Phosphorus

C. Arsenic

D. Antimony

Answer: A

Solution:

CONCEPT:

Allotropy in Group 15 Elements

- Allotropy refers to the existence of an element in more than one form, in the same physical state.
- Allotropes have different physical properties but the same chemical properties.
- In group 15 elements, allotropy is commonly observed in elements like phosphorus, arsenic, and antimony.

EXPLANATION:

- Nitrogen, Phosphorus, Arsenic, and Antimony are elements of Group 15.
- Phosphorus shows allotropy with several forms such as white phosphorus, red phosphorus, and black phosphorus.
- Arsenic exists in multiple allotropes including yellow arsenic and grey arsenic.
- Antimony also has several allotropes such as metallic antimony and explosive antimony.
- Nitrogen, however, does not exhibit allotropy and exists primarily as diatomic nitrogen (N_2).

Therefore, the member of the Group 15 elements that does not show allotropy is Nitrogen.

Question 22

What is the colour of product when ammonia reacts with a solution of Cu^{2+}?

Options:

A. Orange

B. Green

C. Deep blue

D. Yellow

Answer: C

Solution:

CONCEPT:

Complex Formation with Ammonia

- When ammonia (NH_3) is added to a solution containing Cu^{2+} ions, a complex ion is formed.
- The copper ion (Cu^{2+}) reacts with ammonia to form the complex ion $[Cu(NH_3)_4]^{2+}$.
- This complex ion formation changes the color of the solution.

EXPLANATION:

- In the given reation:

  $Cu^{2+}(aq) + 4NH_3(aq) \rightarrow [Cu(NH_3)_4]^{2+}(aq)$

- The color change that occurs when Cu^{2+} reacts with ammonia is due to the formation of the $[Cu(NH_3)_4]^{2+}$ complex.
- The original Cu^{2+} solution is typically blue in color.
- Upon forming the $[Cu(NH_3)_4]^{2+}$ complex, the color changes to a deep blue.

Therefore, the color of the product when ammonia reacts with a solution of Cu^{2+} is deep blue.

Question 23

What is the co-ordination number of metal in $[Fe(C_2O_4)_3]^{3-}$?

Options:

A. Two

B. Three

C. Six

D. Four

Answer: C

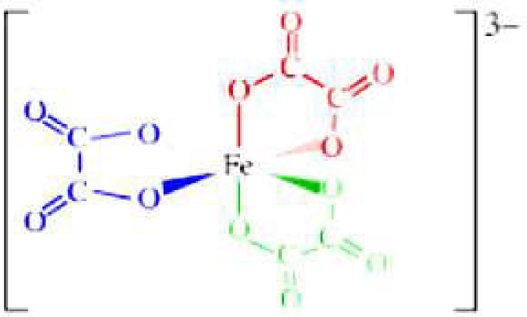
Solution:

CONCEPT:

Coordination Number

- The coordination number of a metal ion in a complex is the number of ligand donor atoms to which the metal is directly bonded.
- In coordination complexes, each ligand can donate a pair of electrons to the metal ion to form a coordinate bond.

EXPLANATION:



- In the given complex: $[Fe(C_2O_4)_3]^{3-}$
- The ligand $C_2O_4^{2-}$ (oxalate) is a bidentate ligand, meaning it can donate two pairs of electrons to the metal ion.
- Therefore, each oxalate ligand forms two coordinate bonds with the Fe^{3+} ion.
- Since there are three oxalate ligands in the complex, the total number of coordinate bonds is:
  - 3 ligands × 2 donor atoms per ligand = 6 coordinate bonds.

Therefore, the coordination number of the metal in $[Fe(C_2O_4)_3]^{3-}$ is 6.

Question 24

Which among the following compounds is most soluble in water?

Options:

A. Ethanol

B. Ethane

C. Phenol

D. Ethylene glycol

Answer: D

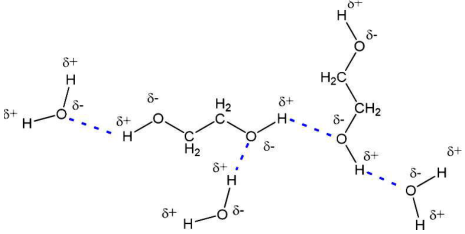
Solution:

CONCEPT:

Solubility of Organic Compounds in Water

- Solubility in water depends on the ability of the compound to form hydrogen bonds with water molecules.
- Compounds that can form multiple hydrogen bonds with water are usually more soluble.

EXPLANATION:

- Let's analyze the given compounds:
  - **Ethanol (CH_3CH_2OH)**:
    - Has an -OH group which can form hydrogen bonds with water.
  - **Ethane (C_2H_6)**:
    - Is a nonpolar molecule with no ability to form hydrogen bonds with water.
  - **Phenol (C_6H_5OH)**:
    - Has an -OH group that can form hydrogen bonds, but the large nonpolar benzene ring reduces its overall solubility in water.
  - **Ethylene glycol ($HOCH_2CH_2OH$)**:
    - Has two -OH groups that can form multiple hydrogen bonds with water, making it highly soluble.
- 

- Considering the hydrogen bonding capability, **ethylene glycol** is expected to be the most soluble in water due to the presence of two -OH groups.

Therefore, the most soluble compound in water is Ethylene glycol.

Question 25

Which important compound is prepared by using cumene?

Options:

A. Ethanol

B. Phenol

C. Propanone

D. Propene

Answer: B

Solution:

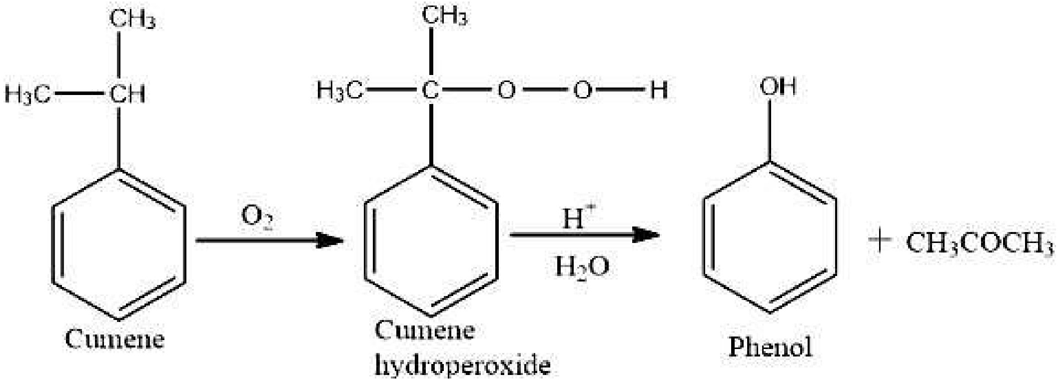
CONCEPT:

Cumene Process

- The cumene process, also known as the Hock process, is an industrial method for synthesizing phenol and acetone from benzene and propylene.
- The process involves the following main steps:
  - Alkylation of benzene with propylene to form cumene (isopropylbenzene).
  - Oxidation of cumene to cumene hydroperoxide.
  - Acid-catalyzed cleavage of cumene hydroperoxide to yield phenol and acetone.

EXPLANATION:

- In the cumene process:
    - Cumene (isopropylbenzene) is first produced by the alkylation of benzene with propylene.
    - Cumene is then oxidized to form cumene hydroperoxide.
    - Finally, cumene hydroperoxide is cleaved in the presence of an acid to produce phenol and acetone.



- Phenol is the primary product of this process, and it is an important industrial chemical used in the production of plastics, resins, and other chemicals.
- Acetone is also produced as a valuable byproduct and is used as a solvent and in the production of various chemicals.

Therefore, the important compound prepared by using cumene is phenol.

Question 26

Which of the following reaction is shown by aldehydes that do not have alpha H-atom?

Options:

A.

Aldol condensation

B.

Cross aldol condensation

C.

Cannizzaro reaction

D.

Kolbe's reaction

Answer: C

Solution:

CONCEPT:

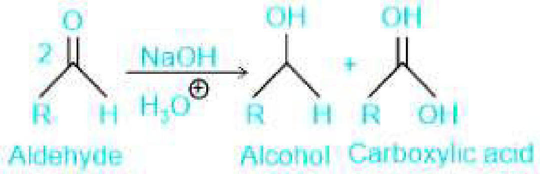
Reactions of Aldehydes without Alpha Hydrogen

- Aldehydes that do not have an alpha hydrogen atom undergo a specific type of reaction known as the Cannizzaro reaction.
- The Cannizzaro reaction is a redox reaction where one molecule of the aldehyde is reduced to an alcohol while another molecule is oxidized to a carboxylic acid.
- This reaction is typical for aldehydes like formaldehyde (HCHO) and benzaldehyde (C_6H_5CHO).

EXPLANATION:

- Aldehydes without alpha hydrogen atoms cannot undergo reactions like:
  - Aldol condensation
  - Cross aldol condensation
  - Kolbe's reaction
- Instead, they undergo the Cannizzaro reaction. For example:

  $2\ C_6H_5CHO + NaOH \rightarrow C_6H_5CH_2OH + C_6H_5COONa$



Here, benzaldehyde (C_6H_5CHO) is converted into benzyl alcohol ($C_6H_5CH_2OH$) and sodium benzoate (C_6H_5COONa).

Therefore, the reaction shown by aldehydes that do not have alpha hydrogen atoms is the Cannizzaro reaction.

Question 27

What is the measurement of C - O - C bond angle in methoxymethane?

Options:

A. 108°

B. 111.7°

C. 90°

D. 60°

Answer: B

Solution:

CONCEPT:

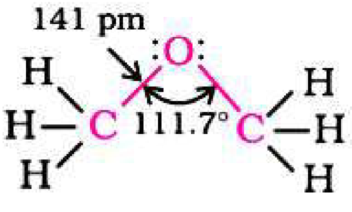
Bond Angles in Methoxymethane (Dimethyl Ether)

- Methoxymethane, also known as dimethyl ether, has the chemical formula CH_3OCH_3.
- The central oxygen atom in methoxymethane is bonded to two carbon atoms and has two lone pairs of electrons.
- The electron geometry around the oxygen atom is tetrahedral due to the four regions of electron density (two bonding pairs and two lone pairs).
- However, the bond angle is slightly less than the ideal tetrahedral angle (109.5°) because lone pairs repel more strongly than bonding pairs.

<u>**EXPLANATION**</u>:

- In methoxymethane:

  The oxygen atom has two lone pairs and two bonding pairs.

- 

  Methoxymethane

- The ideal tetrahedral bond angle is 109.5°, but due to the presence of lone pairs, the bond angle is slightly reduced.
- The actual C-O-C bond angle in methoxymethane is approximately 111.7°.
- This increase in bond angle from the ideal tetrahedral angle is due to the larger repulsive effect of the lone pairs compared to bonding pairs.

Therefore, the measurement of the C-O-C bond angle in methoxymethane is 111.7°.

Question 28

Which among the following compounds is not an artificial sweetener?

Options:

A. Aspartame

B. Alitame

C. Sucralose

D. Sodium benzoate

Answer: D

Solution:

<u>CONCEPT</u>:

Artificial Sweeteners

- Artificial sweeteners are substances used to sweeten food and beverages without the calories or carbohydrates of sugar.
- They are often much sweeter than sugar, so only a small amount is needed.
- Common artificial sweeteners include Aspartame, Alitame, and Sucralose.

EXPLANATION:

- Among the given options:
  - **Aspartame** (option 1) is a widely used artificial sweetener.
  - **Alitame** (option 2) is another type of artificial sweetener.
  - **Sucralose** (option 3) is also a common artificial sweetener, known for being calorie-free.
  - **Sodium benzoate** (option 4) is not an artificial sweetener. It is a preservative commonly used in food and beverages to prevent spoilage.

Therefore, the compound that is not an artificial sweetener is Sodium benzoate (option 4).

Question 29

What is Aspirin chemically?

Options:

A.

Salicylic acid

B.

Ethyl Salicylic acid

C.

Methyl Salicylic acid

D.

Acetyl Salicylic acid

Answer: D

Solution:

CONCEPT:

Aspirin Chemical Structure

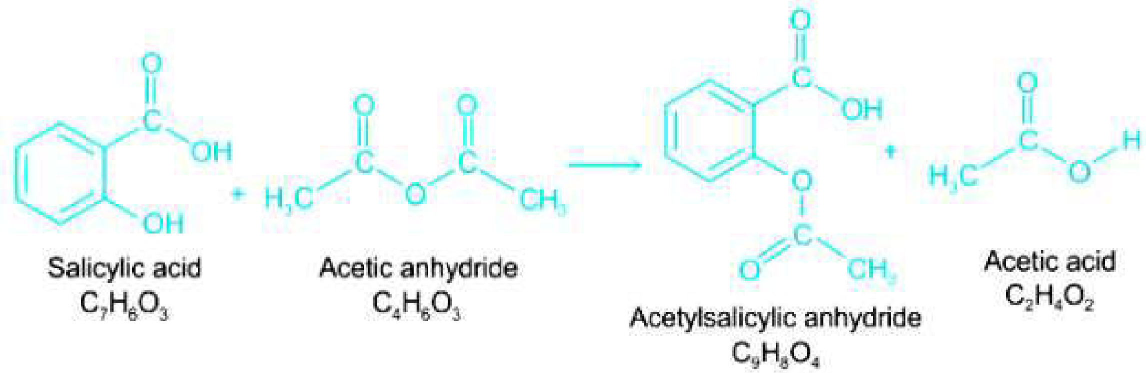
- Aspirin, also known as acetylsalicylic acid, is a medication used to reduce pain, fever, or inflammation.
- Chemically, aspirin is an ester of salicylic acid. The chemical formula for aspirin is $C_9H_8O_4$.

  It is synthesized by the acetylation of salicylic acid using acetic anhydride.

EXPLANATION:

- In the synthesis of aspirin:

  $C_7H_6O_3$ (salicylic acid) + $C_4H_6O_3$ (acetic anhydride) → $C_9H_8O_4$ (aspirin) + $C_2H_4O_2$ (acetic acid)



Salicylic acid undergoes acetylation, where an acetyl group (CH_3CO) from acetic anhydride is transferred to the hydroxyl group (-OH) of salicylic acid, forming acetylsalicylic acid (aspirin).

- This reaction forms aspirin (acetylsalicylic acid) and acetic acid as a byproduct.

Therefore, the chemical name of Aspirin is acetylsalicylic acid.

Question 30

Match List-I with List-II.

	List-I Ions		List-II No. of unpaired electrons
(A)	Zn^{2+}	(I)	0
(B)	Cu^{2+}	(II)	4
(C)	Ni^{2+}	(III)	1
(D)	Fe^{2+}	(IV)	2

Choose the correct answer from the options given below:

Options:

A. (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

B. (A) - (I), (B) - (III), (C) - (II), (D) - (IV)

C. (A) - (I), (B) - (III), (C) - (IV), (D) - (II)

D. (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Answer: C

Solution:

CONCEPT:

Unpaired Electrons in Transition Metal Ions

- Transition metal ions often have unpaired electrons in their d-orbitals.
- The number of unpaired electrons can be determined from the electronic configuration of the ion.

EXPLANATION:

- For Zn^{2+}:
  - Zinc has the electronic configuration [Ar] $3d^{10}$ $4s^2$.
  - Zn^{2+} loses two electrons, resulting in [Ar] $3d^{10}$.
  - All electrons are paired in Zn^{2+}, so it has 0 unpaired electrons.
- For Cu^{2+}:
  - Copper has the electronic configuration [Ar] $3d^{10}$ $4s^1$.
  - Cu^{2+} loses two electrons, resulting in [Ar] $3d^9$.
  - There is 1 unpaired electron in Cu^{2+}.
- For Ni^{2+}:
  - Nickel has the electronic configuration [Ar] $3d^8$ $4s^2$.
  - Ni^{2+} loses two electrons, resulting in [Ar] $3d^8$.
  - There are 2 unpaired electrons in Ni^{2+}.
- For Fe^{2+}:
  - Iron has the electronic configuration [Ar] $3d^6$ $4s^2$.
  - Fe^{2+} loses two electrons, resulting in [Ar] $3d^6$.
  - There are 4 unpaired electrons in Fe^{2+}.

Therefore, the correct matching is(A) - (I), (B) - (III), (C) - (IV), (D) - (II)

Question 31

Increasing order of ionic radii of the followings :

(A) Eu^{3+}

(B) Lu^{3+}

(C) Y^{3+}

(D) La^{3+}

Choose the correct answer from the options given below:

Options:

A. (A)<(B)<(C)<(D)

B. (A)<(C)<(B)<(D)

C. (B)<(C)<(A)<(D)

D. (C)<(B)<(D)<(A)

Answer: C

Solution:

CONCEPT:

Ionic Radii

- The ionic radius is the measure of an atom's ion in a crystal lattice. It is the distance from the nucleus to the outermost electron of the ion.
- When comparing the ionic radii of ions with the same charge, the radius generally increases with increasing atomic number (moving down a group in the periodic table).
- For the same period, the ionic radius decreases with an increase in atomic number due to the increase in nuclear charge which pulls the electrons closer to the nucleus.

EXPLANATION:

- La^{3+} has the largest ionic radius because it is at the beginning of the lanthanide series.
- Y^{3+} has a smaller radius than La^{3+} because it is in the same group but has a smaller atomic number.
- Eu^{3+} and Lu^{3+} are in the lanthanide series, with Lu^{3+} having the smallest radius due to the lanthanide contraction (the decrease in ionic radii across the lanthanide series).
- Therefore, the increasing order of ionic radii is $Lu^{3+} < Eu^{3+} < Y^{3+} < La^{3+}$

Therefore, the correct answer is (B) < (C) < (A) < (D).

Question 32

Match List-I with List-II.

	List-I Types of hybridisation		List-II Distribution of hybrid orbitals in space
(A)	sp^3	(I)	Trigonal bipyramidal
(B)	dsp^2	(II)	Octahedral
(C)	sp^3d	(III)	Tetrahedral
(D)	sp^3d^2	(IV)	Square Planar

Choose the correct answer from the options given below:

Options:

A. (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

B. (A) - (I), (B) - (III), (C) - (II), (D) - (IV)

C. (A) - (I), (B) - (II), (C) - (IV), (D) - (III)

D. (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Answer: D

Solution:

CONCEPT:

Hybridization and Distribution of Hybrid Orbitals

- Hybridization is the concept of mixing atomic orbitals to form new hybrid orbitals that can form covalent bonds with other atoms.
- Different types of hybridization correspond to specific geometric arrangements in space.

EXPLANATION:

- For sp^3 hybridization:
  - The hybrid orbitals are arranged in a **tetrahedral** geometry.
- For dsp^2 hybridization:
  - The hybrid orbitals are arranged in a **square planar** geometry.
- For sp^3d hybridization:
  - The hybrid orbitals are arranged in a **trigonal bipyramidal** geometry.
- For sp^3d^2 hybridization:
  - The hybrid orbitals are arranged in an **octahedral** geometry.

Matching List-I with List-II:

- (A) sp^3 - (III) Tetrahedral
- (B) dsp^2 - (IV) Square Planar
- (C) sp^3d - (I) Trigonal bipyramidal
- (D) sp^3d^2 - (II) Octahedral

Therefore, the correct answer is(A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Question 33

Increasing order of crystal field splitting power of following ligands will be:

(A) CN^-

(B) Cl^-

(C) F^-

(D) H_2O

Choose the correct answer from the options given below:

Options:

A. (A)<(B)<(C)<(D)

B. (A)<(C)<(B)<(D)

C. (A)<(D)<(C)<(B)

D. (B)<(C)<(D)<(A)

Answer: D

Solution:

CONCEPT:

Crystal Field Splitting Power of Ligands

- Crystal Field Theory (CFT) explains the effect of ligands on the d-orbitals of a metal ion in a coordination complex.
- The ability of a ligand to split the d-orbitals is known as its **Crystal Field Splitting Power**.
- The **Spectrochemical Series** ranks ligands based on their field strength:

  Weak field ligands → Strong field ligands

- General trend in the increasing field strength:

  $I^- < Br^- < Cl^- < F^- < H_2O < NH_3 < CN^-$

EXPLANATION:

- Arranging based on increasing field strength:
  - **Cl^-**: A weak field ligand with low splitting power.
  - **F^-**: Slightly stronger than Cl^-, but still a weak field ligand.
  - **H_2O**: A neutral ligand with moderate field strength.
  - **CN^-**: A strong field ligand with the highest splitting power.
- Thus, the increasing order of crystal field splitting power is $Cl^- < F^- < H_2O < CN^-$

The correct option is **(B) < (C) < (D) < (A)**.

Question 34

Match List-I with List-II.

	List-I Vitamins		List-II Deficiency Diseases
(A)	VitaminB_6	(I)	Cheilosis
(B)	VitaminB_2	(II)	Osteomalacia
(C)	Vitamin D	(III)	Anaemia
(D)	Vitamin B_{12}	(IV)	Convulsions

Choose the correct answer from the options given below:

Options:

A. (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

B. (A) - (I), (B) - (III), (C) - (II), (D) - (IV)

C. (A) - (I), (B) - (II), (C) - (IV), (D) - (III)

D. (A) - (IV), (B) - (I), (C) - (II), (D) -(III)

Answer: D

Solution:

CONCEPT:

Vitamin Deficiency Diseases

- Vitamins are essential micronutrients required by the body for various biochemical and physiological functions.
- A deficiency in any vitamin can lead to specific diseases or health conditions.
- For example:
  - Vitamin B6 is crucial for enzyme function and protein metabolism.
  - Vitamin B2 (Riboflavin) is important for energy production and skin health.
  - Vitamin D is essential for calcium absorption and bone health.
  - Vitamin B12 is vital for red blood cell formation and neurological function.

EXPLANATION:

- Vitamin B6 deficiency can lead to convulsions due to its role in neurotransmitter synthesis.
- Vitamin B2 (Riboflavin) deficiency can cause cheilosis, which is characterized by cracked lips and inflammation at the corners of the mouth.
- Vitamin D deficiency leads to osteomalacia, a condition where bones become soft due to impaired bone metabolism.
- Vitamin B12 deficiency can result in anaemia, a condition where the body lacks enough healthy red blood cells.

Therefore, the correct answer is(A) - (IV), (B) - (I), (C) - (II), (D) - (III).

Question 35

Reactivity order of following towards nucleophilic substitution reactions will be:

(A) 4-Nitro-1-chlorobenzene

(B) 2, 4-Dinitro-1-chlorobenzene

(C) Chlorobenzene

(D) 2, 4, 6-Trinitro-1-chlorobenzene

Choose the correct answer from the options given below:

Options:

A. (A)<(B)<(C)<(D)

B. (A)<(C)<(B)<(D)

C. (B)<(A)<(D)<(C)

D. (C)<(A)<(B)<(D)

Answer: D

Solution:

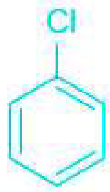
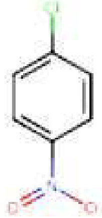
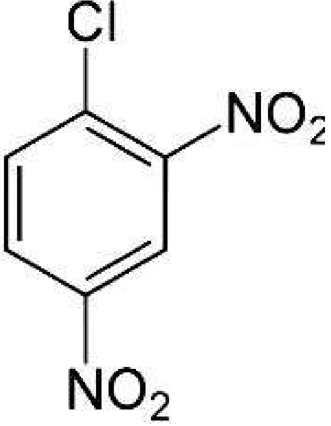
CONCEPT:

Reactivity in Nucleophilic Substitution Reactions of Aryl Halides

- Aryl halides (such as chlorobenzene) undergo **nucleophilic aromatic substitution (SNAr)** under special conditions.
- The presence of **electron-withdrawing groups (-NO_2)** at the ortho and para positions stabilizes the intermediate **Meisenheimer complex**, facilitating nucleophilic attack.
- The order of activation towards nucleophilic substitution increases with:
  - The number of -NO_2 groups (more -NO_2 → more reactivity).
  - The position of -NO_2 groups (ortho & para positions enhance reactivity more than meta).

EXPLANATION:

- **(C) Chlorobenzene:**
  - No electron-withdrawing groups (-NO_2).
  - Highly unreactive towards nucleophilic substitution due to the lack of resonance stabilization for the intermediate.

  - 
    Chlorobenzene
- **(A) 4-Nitro-1-chlorobenzene:**
  - Has one -NO_2 at the para position.
  - Activates the ring slightly towards nucleophilic substitution.
  - 
- **(B) 2,4-Dinitro-1-chlorobenzene:**
  - Has two -NO_2 groups (at ortho & para positions).
  - Stronger activation due to additional stabilization of the intermediate.
  - 
- **(D) 2,4,6-Trinitro-1-chlorobenzene:**
  - Has three -NO_2 groups (at ortho, para, and another ortho position).
  - Highest activation towards nucleophilic substitution due to maximum stabilization.
  - 
    1-Chloro-2, 4, 6-trinitrobenzene

Conclusion:-

Chlorobenzene (C) < 4-Nitro-1-chlorobenzene (A) < 2,4-Dinitro-1-chlorobenzene (B) < 2,4,6-Trinitro-1-chlorobenzene (D).

Question 36

Which of the following gives positive Tollens test?

(A) Phenylethanal

(B) Acetophenone

(C) Formic acid

(D) Benzene carbaldehyde

Choose the correct answer from the options given below:

Options:

A. (A), (B) and (D) only

B. (A), (B) and (C) only

C. (A), (B), (C) and (D)

D. (A), (C) and (D) only

Answer: D

Solution:

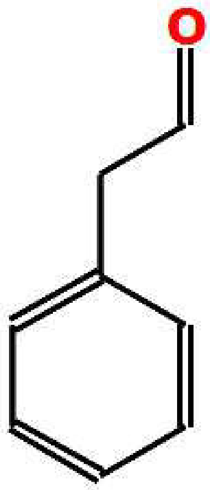
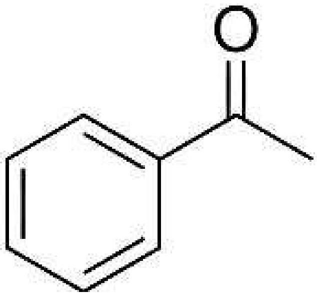
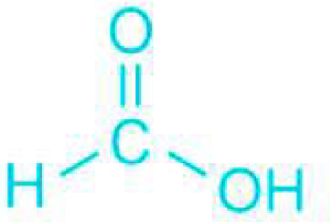
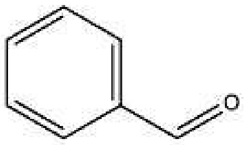
CONCEPT:

Tollens' Test

- Tollens' test is a qualitative test used to identify aldehydes and alpha-hydroxy ketones.
- The reagent used in the test is Tollens' reagent, which contains silver nitrate ($AgNO_3$) in ammonia (NH_3).
- When an aldehyde or alpha-hydroxy ketone is present, the Tollens' reagent is reduced to metallic silver, forming a silver mirror on the inner surface of the test tube.

EXPLANATION:

- Phenylethanal (A): It is an aldehyde and will give a positive Tollens' test.

- 
- Acetophenone (B): It is a ketone and will not give a positive Tollens' test.
- 
- Formic acid (C): It contains an aldehyde group (-CHO) in its structure and will give a positive Tollens' test.
- 
- Benzene carbaldehyde (D): It is an aldehyde and will give a positive Tollens' test.
- 
  Benzene carbaldehyde

Therefore, the correct answer is(A), (C) and (D) only.

Question 37

Match List-I with List-II.

	List-I Compound		List-II Product in Basic Medium

			(inNaOH+ Heat)
(A)	Ethanal	(I)	Benzoic acid + Phenylmethanol
(B)	Methanal	(II)	3-Hydroxybutanal + But-2-enal
(C)	Benzenecarbaldehyde	(III)	4-Hydroxy-4-methylpentan-2-one +4 -Methylpent-3-en-2-one
(D)	Acetone	(IV)	Formic acid+Methanol

Choose the correct answer from the options given below:

Options:

A. (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

B. (A) - (II), (B) - (IV), (C) - (I), (D) - (III)

C. (A) - (I), (B) -(II), (C) - (IV), (D) - (III)

D. (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Answer: B

Solution:

CONCEPT:

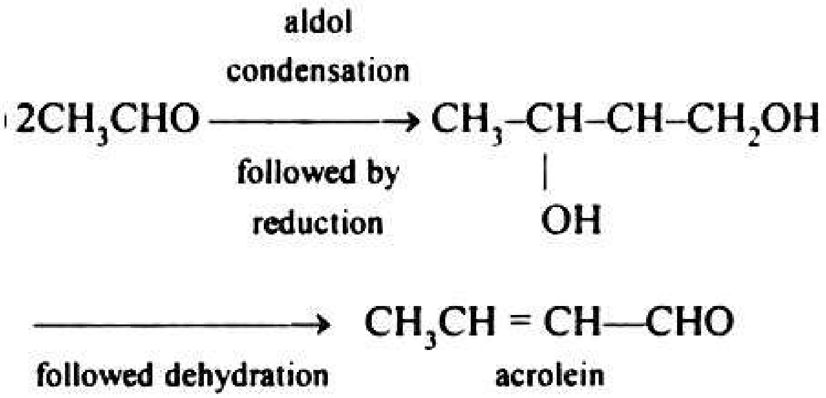
Aldol Condensation in Basic Medium

- Aldol condensation is a reaction between aldehydes or ketones, catalyzed by a base, leading to the formation of β-hydroxy aldehydes (aldols) or β-hydroxy ketones.
- On heating, these β-hydroxy compounds often dehydrate to give α,β-unsaturated carbonyl compounds.

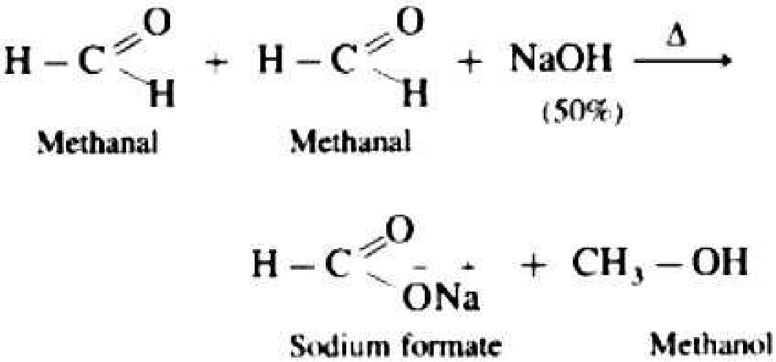
EXPLANATION:

- In the given reaction:

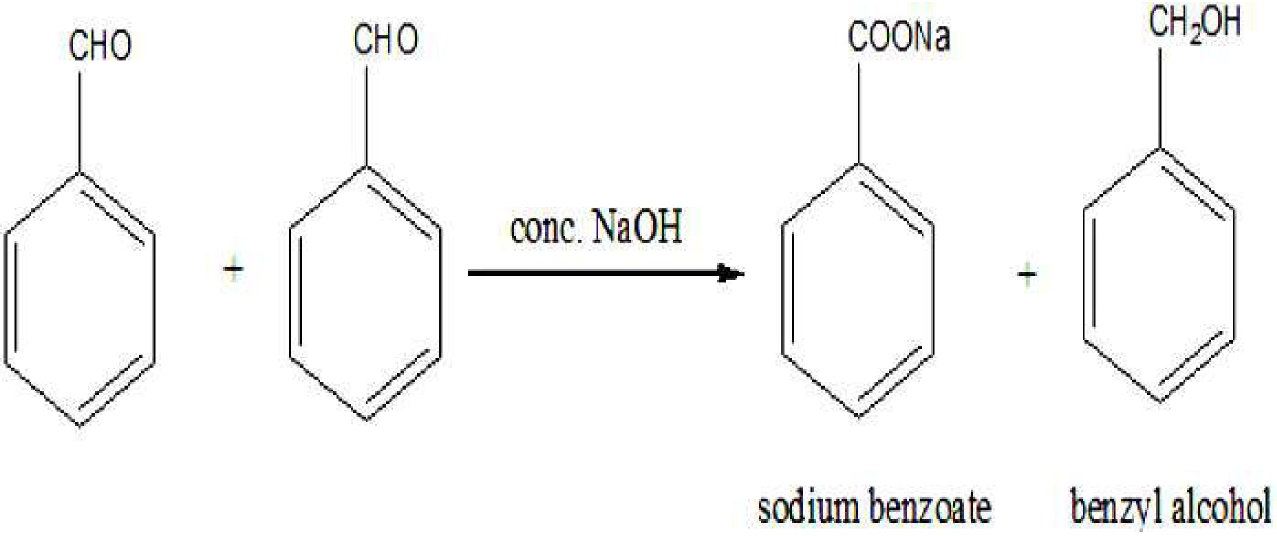
  (A) Ethanal (CH_3CHO) undergoes aldol condensation to form 3-Hydroxybutanal, which further dehydrates to But-2-enal.



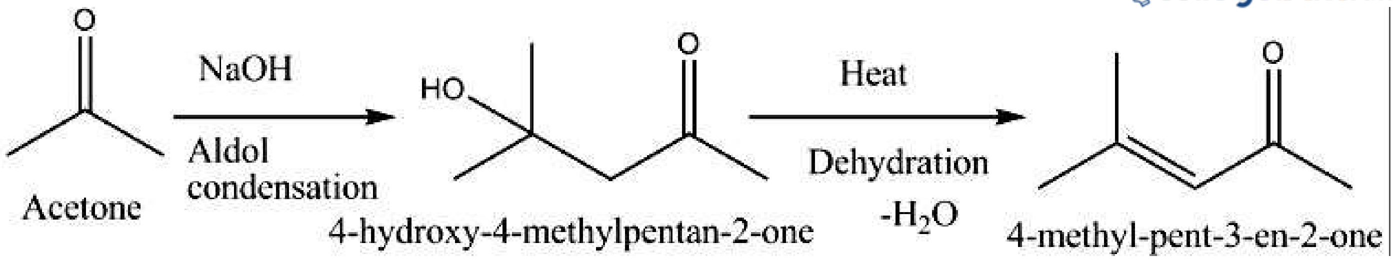
- (B) Methanal (HCHO) undergoes Cannizzaro reaction in basic medium to form Formic acid and Methanol.



- (C) Benzenecarbaldehyde (C_6H_5CHO) undergoes Cannizzaro reaction in basic medium to form Benzoic acid and Phenylmethanol.



- (D) Acetone (CH_3COCH_3) undergoes aldol condensation to form 4-Hydroxy-4-methylpentan-2-one, which further dehydrates to 4-Methylpent-3-en-2-one.

- 

Therefore, the correct matching is:

- (A) - (II) 3-Hydroxybutanal + But-2-enal
- (B) - (IV) Formic acid + Methanol
- (C) - (I) Benzoic acid + Phenylmethanol
- (D) - (III) 4-Hydroxy-4-methylpentan-2-one + 4-Methylpent-3-en-2-one

Thus, the correct answer is Option 2.

Question 38

Which of the following on reaction with NaOI will give yellow precipitates?

(A) Phenylethanone

(B) Sec-Butyl alcohol

(C) Phenylethanal

(D) Methyl n-propylketone

Choose the correct answer from the options given below:

Options:

A.

(A), (B) and (D) only

B.

(A), (B) and (C) only

C.

(A), (B), (C) and (D)

D.

(B), (C) and (D) only

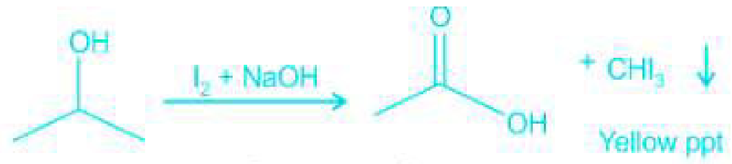
Answer: A

Solution:

CONCEPT:

Iodoform Test

- The iodoform test is used to identify the presence of a methyl ketone group (CH_3CO-) or a secondary alcohol with at least one methyl group ($CH_3CH(OH)$-).
- When compounds containing these functional groups react with sodium hypoiodite (NaOI), they form a yellow precipitate of iodoform (CHI_3).



Iodoform Test of Propan-2-ol

EXPLANATION:

- The presence of the methyl ketone group or secondary alcohol with a methyl group in each compound:
  - **(A) Phenylethanone (acetophenone)** has the structure $C_6H_5COCH_3$. It contains a methyl ketone group and will give a yellow precipitate of iodoform with NaOI.
  - **(B) Sec-Butyl alcohol** has the structure $CH_3CH(OH)CH_2CH_3$. It is a secondary alcohol with a methyl group and will give a yellow precipitate of iodoform with NaOI.
  - **(C) Phenylethanal (phenylacetaldehyde)** has the structure $C_6H_5CH_2CHO$. It does not contain a methyl ketone group or a secondary alcohol with a methyl group, so it will not give a yellow precipitate of iodoform with NaOI.
  - **(D) Methyl n-propylketone** has the structure $CH_3COCH_2CH_2CH_3$. It contains a methyl ketone group and will give a yellow precipitate of iodoform with NaOI.
- Based on the above analysis, the compounds that will give yellow precipitates with NaOI are (A), (B), and (D).

Therefore, the correct answer is(A), (B), and (D) only.

Question 39

The correct order of increasing pK_a values of the compounds :

(A) CH_3COOH

(B) CH_3OCH_2COOH}$

(C) Cl_3COOH

(D) $(CH_3)_3CCOOH$

Choose the correct answer from the options given below:

Options:

A.

(A)<(B)<(C)<(D)

B.

(A)<(C)<(B)<(D)

C.

(B)<(A)<(C)<(D)

D.

(C) <(B) <(A) <(D)

Answer: D

Solution:

CONCEPT:

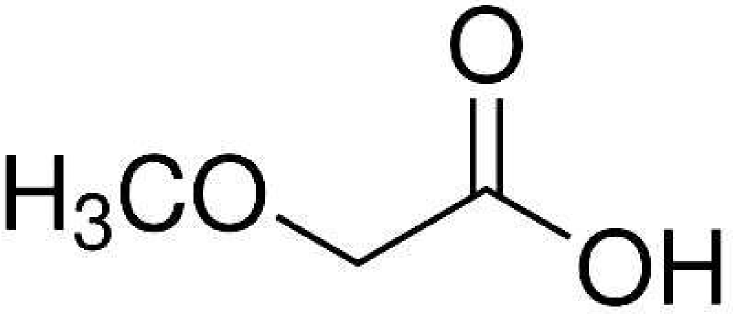
pKa and Acid Strength

- The pKa value is a measure of the strength of an acid in solution. It is the negative logarithm of the acid dissociation constant (Ka).
- A **lower pKa value indicates a stronger acid**, which dissociates more completely in solution.
- Conversely, a higher pKa value indicates a weaker acid.

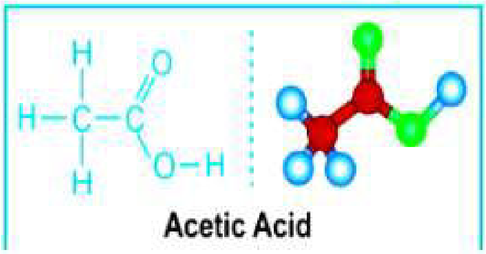
EXPLANATION:

- Trichloroacetic acid (C) is the strongest acid among the given options because the three chlorine atoms are highly electronegative and stabilize the conjugate base by inductive effect, leading to a very low pKa value.

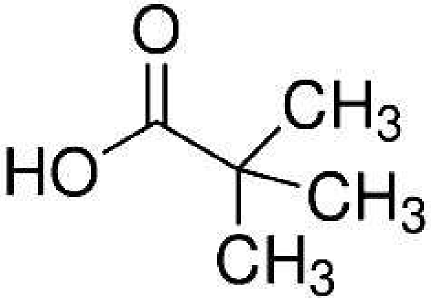
- Methoxyacetic acid (B) is next, as the methoxy group has an electron-withdrawing effect through both inductive and resonance effects, making the acid stronger than acetic acid.



Acetic acid (A) comes next, with a moderate pKa value.



- Pivalic acid (D) is the weakest acid among the given options because the bulky tert-butyl group is electron-donating, which destabilizes the conjugate base, leading to a higher pKa value.

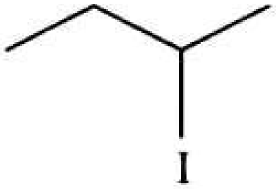


Therefore, the correct order of increasing pKa values (stronger to weaker acid) (C) < (B) < (A) < (D)

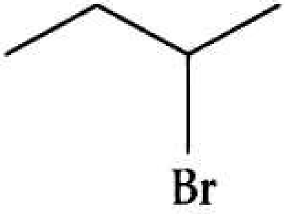
Question 40

Reactivity order of the following alkyl halides towards dehydrohalogenation is:

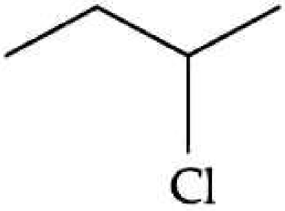
(A)



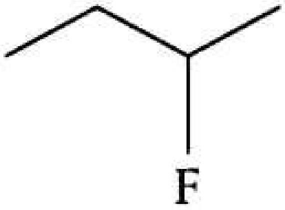
(B)



(C)



(D)



Choose the correct answer from the options given below:

Options:

A. (A)>(B)>(C)>(D)

B. (A)>(C)>(B)>(D)

C. (D)>(B)>(C)>(A)

D. (D)>(C)>(B)>(A)

Answer: A

Solution:

CONCEPT:

Reactivity of Alkyl Halides in Dehydrohalogenation

- **Dehydrohalogenation** is an elimination reaction where an alkyl halide reacts with a strong base to form an alkene by removing a halogen and a β-hydrogen.
- The ease of dehydrohalogenation depends on:
  - **Bond strength (C-X)**: Weaker bonds break more easily.
  - **Leaving group ability**: A better leaving group facilitates the reaction.
- The **leaving group ability** of halogens follows the order:

$I^- > Br^- > Cl^- > F^-$

EXPLANATION:

- **(A) 2-Iodopropane (C_4H_9I)**:
  - Iodine (I^-) is the best leaving group due to its large size and weak bond strength.
  - Highest reactivity in dehydrohalogenation.
- **(B) 2-Bromopropane (C_4H_9Br)**:
  - Bromine (Br^-) is a good leaving group but slightly less effective than iodine.
  - Moderate reactivity.
- **(C) 2-Chloropropane (C_4H_9Cl)**:
  - Chlorine (Cl^-) is a weaker leaving group than Br^- and I^-.
  - Lower reactivity in elimination.
- **(D) 2-Fluoropropane (C_4H_9F)**:
  - Fluorine (F^-) forms the strongest C-F bond, making it the worst leaving group.
  - Least reactive in dehydrohalogenation.

2-Iodopropane (A) > 2-Bromopropane (B) > 2-Chloropropane (C) > 2-Fluoropropane (D)

Therefore, the correct reactivity order for the given alkyl halides towards dehydrohalogenation is (A) > (B) > (C) > (D)

Question 41

When NaOH reacts with R-X, what is the major product?

When NaOH reacts with R-X, what is the major product?

Options:

A. Alcohol

B. Ether

C. Ester

D. Acid

Answer: A

Solution:

CONCEPT:

Reaction of NaOH with Alkyl Halide (R-X)

- When sodium hydroxide (NaOH) reacts with an alkyl halide (R-X), a nucleophilic substitution reaction occurs.
- The hydroxide ion (OH^-) from NaOH acts as a nucleophile and attacks the carbon atom bonded to the halide (X).

- This reaction typically follows an S_N2 mechanism, where the nucleophile attacks the carbon atom from the opposite side of the leaving group, leading to inversion of configuration.

EXPLANATION:

- In the given reaction:

  R-X + NaOH → R-OH + NaX
-
  - 

    The alkyl halide (R-X) reacts with sodium hydroxide (NaOH).
  - The hydroxide ion (OH^-) replaces the halide ion (X^-), forming an alcohol (R-OH) and a sodium halide (NaX).
- The major product of this reaction is an alcohol (R-OH).

Therefore, the major product when NaOH reacts with R-X is an alcohol.

Question 42

When KCN reacts with R-X, what is the major product?

When KCN reacts with R-X, what is the major product?

Options:

A. Alcohol

B. Ether

C. Isonitrile

D. Nitrile

Answer: D

Solution:

CONCEPT:

SN_2 Reaction Mechanism

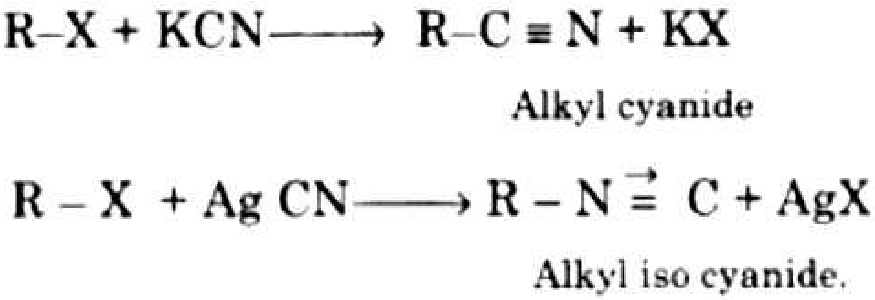
- The SN_2 reaction is a type of nucleophilic substitution reaction mechanism.
- In this mechanism, the nucleophile attacks the electrophilic carbon from the opposite side of the leaving group, resulting in the inversion of configuration at the carbon center.

- Potassium cyanide (KCN) provides the nucleophile CN^- which attacks the carbon atom bonded to the halogen (X) in the alkyl halide (R-X).

EXPLANATION:

- In the given reaction:

  R-X + KCN → R-CN + KX

- 

  - The alkyl halide (R-X) undergoes nucleophilic substitution.
  - The cyanide ion (CN^-) from KCN acts as the nucleophile and replaces the halogen (X) in R-X.
  - This results in the formation of a nitrile (R-CN).

Therefore, the major product when KCN reacts with R-X is a nitrile (R-CN).

Question 43

When AgCN reacts with R-X, what is the major product?

When AgCN reacts with R-X, what is the major product?

Options:

A. Alcohol

B. Ether

C. Isonitrile

D. Nitrile

Answer: C

Solution:

CONCEPT:

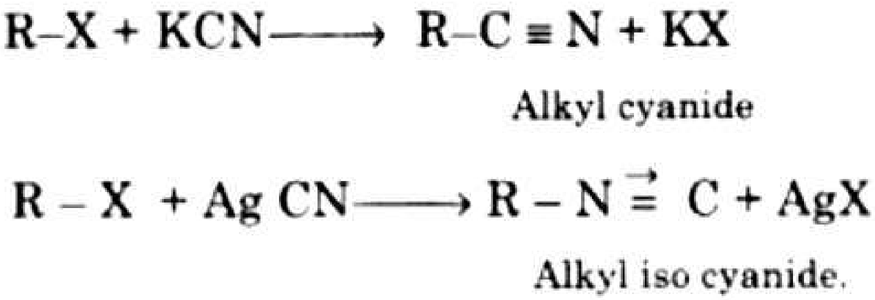
AgCN Reaction with Alkyl Halides (R-X)

- When silver cyanide (AgCN) reacts with alkyl halides (R-X), the reaction proceeds through the formation of isonitrile (R-NC) rather than the expected nitrile (R-CN).
- This is because AgCN is a covalent compound and the carbon atom is more nucleophilic than the nitrogen atom, leading to the formation of isonitriles.

EXPLANATION:

- In the given reaction:

  R-X + AgCN → R-NC + AgX

- 
  - The alkyl halide (R-X) reacts with silver cyanide (AgCN).
  - The carbon atom in the cyanide group (CN) of AgCN acts as the nucleophile and attacks the alkyl halide (R-X).
  - This results in the formation of isonitrile (R-NC) and silver halide (AgX).
- Since the carbon atom of the cyanide group is more nucleophilic, the major product is isonitrile (R-NC).

Therefore, the major product of the reaction between AgCN and R-X is isonitrile (R-NC).

Question 44

When KNO_2 reacts with R-X, what is the major product?

When KNO_2 reacts with R-X, what is the major product?

Options:

A. Alcohol

B. Nitroalkane

C. Isonitrile

D. Alkyl nitrite

Answer: D

Solution:

CONCEPT:

Reaction of KNO_2 with Alkyl Halides (R-X)

- KNO_2 (potassium nitrite) reacts with alkyl halides (R-X) to form alkyl nitrites (R-ONO).
- The nucleophilic substitution reaction involves the attack of the nitrite ion (NO_2^-) on the alkyl halide.
- The nitrite ion can behave as an ambident nucleophile, where it can attack through either the oxygen or the nitrogen atom.
- In this reaction, the nitrite ion predominantly attacks through the oxygen atom, forming an alkyl nitrite.

EXPLANATION:

- In the given reaction:

  $R\text{-}X + KNO_2 \rightarrow R\text{-}ON{=}O + KX$

  - R-X represents an alkyl halide.
  - KNO_2 is potassium nitrite.
  - The major product formed is an alkyl nitrite (R-ONO).
  - KX is the by-product, where X is the halide ion.
- As the nitrite ion (NO_2^-) attacks through the oxygen atom, the major product is an alkyl nitrite rather than a nitroalkane or any other compound.

Therefore, the major product when KNO_2 reacts with R-X is an alkyl nitrite.

Question 45

When NH_3 reacts with R-X, what is the major product?

When NH_3 reacts with R-X, what is the major product?

Options:

A. Nitroalkane

B. Isonitrile

C. Alkyl nitrite

D. Primary amine

Answer: D

Solution:

CONCEPT:

Reaction of Ammonia (NH_3) with Alkyl Halides (R-X)

- When ammonia (NH_3) reacts with an alkyl halide (R-X), a nucleophilic substitution reaction occurs.
- Ammonia acts as a nucleophile and attacks the electrophilic carbon atom bonded to the halide (X).
- This reaction typically proceeds via an S_N2 mechanism, where the halide ion (X^-) is displaced by the ammonia molecule.

EXPLANATION:

- In the given reaction:

  $NH_3 + R\text{-}X \rightarrow R\text{-}NH_2 + HX$

- 

  - Ammonia (NH_3) attacks the alkyl halide (R-X), leading to the formation of a primary amine ($R\text{-}NH_2$).
  - Hydrogen halide (HX) is produced as a byproduct.
- This reaction is a straightforward nucleophilic substitution where NH_3 replaces the halide ion (X^-).

Therefore, the major product of the reaction between NH_3 and R-X is a primary amine.

Question 46

Which among the following amines is most basic in aqueous medium?

Which among the following amines is most basic in aqueous medium?

Options:

A. $(C_2H_5)_2NH$

B. $(C_2H_5)_3N$

C. $C_2H_5NH_2$

D. NH_3

Answer: A

Solution:

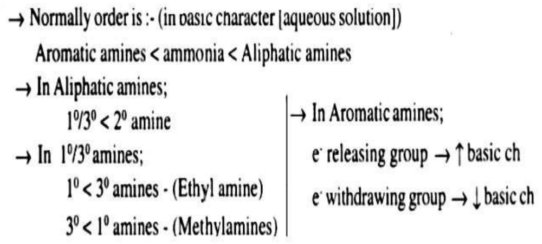
CONCEPT:

Basicity of Amines in Aqueous Medium

- The basicity of amines depends on:
    - **Inductive effect (+I):** Alkyl groups donate electron density to nitrogen, increasing basicity.
    - **Solvation effect:** The ability of water molecules to stabilize the protonated amine (RNH_3^+).
    - **Steric hindrance:** Bulky groups around nitrogen reduce solvation, lowering basicity.
- The general basicity order of **aliphatic amines** in aqueous solution is:

  Secondary amine > Primary amine > Tertiary amine > Ammonia

<u>**EXPLANATION**</u>:



→ Normally order is :- (in basic character [aqueous solution])

Aromatic amines < ammonia < Aliphatic amines

→ In Aliphatic amines;

$1^0/3^0 < 2^0$ amine

→ In $1^0/3^0$ amines;

$1^0 < 3^0$ amines - (Ethyl amine)

$3^0 < 1^0$ amines - (Methylamines)

→ In Aromatic amines;

e^- releasing group → ↑ basic ch

e^- withdrawing group → ↓ basic ch

- **$(C_2H_5)_2NH$ (Diethylamine) → Most Basic**
    - It is a **secondary amine**, which has a strong **+I effect** from two ethyl groups.
    - It is also well-solvated in aqueous medium, enhancing basicity.
- **$(C_2H_5)_3N$ (Triethylamine) → Less Basic**
    - It is a **tertiary amine**, with a stronger **+I effect** due to three ethyl groups.
    - However, steric hindrance reduces hydration, making it **less basic than secondary amines**.
- **$C_2H_5NH_2$ (Ethylamine) → Less Basic than Secondary Amine**
    - It is a **primary amine**, which has a weaker **+I effect** than secondary amines.
    - It is well-hydrated but **less basic than secondary amines**.
- **NH_3 (Ammonia) → Least Basic**
    - No alkyl groups, so it has **no +I effect** to enhance basicity.
    - It is the **least basic** in aqueous solution.

Diethylamine $(C_2H_5)_2NH$ > Ethylamine ($C_2H_5NH_2$) > Triethylamine $(C_2H_5)_3N$ > Ammonia (NH_3)

The correct answer is $(C_2H_5)_2NH$ (Diethylamine)

Question 47

Which base among the following is least basic in aqueous medium?

Which base among the following is least basic in aqueous medium?

Options:

A. $(CH_3)_2NH$

B. CH_3NH_2

C. $(CH_3)_3N$

D. NH_3

Answer: D

Solution:

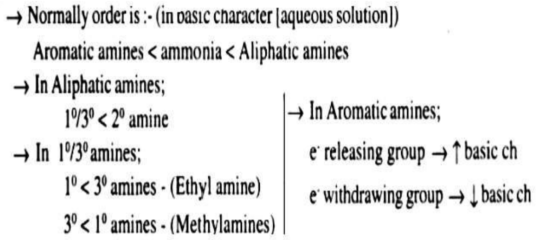
CONCEPT:

Basicity of Amines in Aqueous Medium

- The basicity of amines depends on:
    - **Inductive effect (+I):**Alkyl groups donate electron density to nitrogen, increasing basicity.
    - **Solvation effect:**The ability of water molecules to stabilize the protonated amine (RNH_3^+).
    - **Steric hindrance:**Bulky groups around nitrogen reduce solvation, lowering basicity.
- The general basicity order of**aliphatic amines**in aqueous solution is:

  Secondary amine > Primary amine > Tertiary amine > Ammonia

EXPLANATION:



→ Normally order is :- (in basic character [aqueous solution])

Aromatic amines < ammonia < Aliphatic amines

→ In Aliphatic amines;

$1^0/3^0 < 2^0$ amine

→ In $1^0/3^0$ amines;

$1^0 < 3^0$ amines - (Ethyl amine)

$3^0 < 1^0$ amines - (Methylamines)

→ In Aromatic amines;

e^- releasing group → ↑ basic ch

e^- withdrawing group → ↓ basic ch

- **$(C_2H_5)_2NH$ (Diethylamine) → Most Basic**
    - It is a**secondary amine**, which has a strong**+I effect**from two ethyl groups.
    - It is also well-solvated in aqueous medium, enhancing basicity.
- **$(C_2H_5)_3N$ (Triethylamine) → Less Basic**
    - It is a**tertiary amine**, with a stronger**+I effect**due to three ethyl groups.
    - However, steric hindrance reduces hydration, making it**less basic than secondary amines**.
- **$C_2H_5NH_2$(Ethylamine) → Less Basic than Secondary Amine**
    - It is a**primary amine**, which has a weaker**+I effect**than secondary amines.
    - It is well-hydrated but**less basic than secondary amines**.
- **NH_3(Ammonia) → Least Basic**
    - No alkyl groups, so it has**no +I effect**to enhance basicity.
    - It is the**least basic**in aqueous solution.

Diethylamine $(C_2H_5)_2NH$ > Ethylamine $(C_2H_5NH_2)$ > Triethylamine $(C_2H_5)_3N$ > Ammonia (NH_3)

Theleast basic in aqueous medium is NH_3.

Question 48

The most basic amine in gaseous medium is:

The most basic amine in gaseous medium is:

Options:

A. $(CH_3)_2NH$

B. CH_3NH_2

C. $(CH_3)_3N$

D. NH_3

Answer: A

Solution:

CONCEPT:

Basicity of Amines in Gaseous Medium

- In the gaseous phase, the basicity of amines is determined mainly by the **+I (Inductive Effect)**.
- More alkyl groups attached to nitrogen increase electron density, making the amine more basic.
- Unlike in aqueous solution, **solvation effects do not play a role in the gaseous phase**, so steric hindrance does not significantly reduce basicity.

EXPLANATION:

- **$(C_2H_5)_3N$ (Triethylamine) → Most Basic**
    - It is a **tertiary amine** with three ethyl groups.
    - Strongest **+I effect**, making nitrogen highly electron-rich.
    - Since solvation is absent in the gas phase, steric hindrance does not reduce basicity.
- **$(C_2H_5)_2NH$ (Diethylamine) → Less Basic**
    - It is a **secondary amine** with two ethyl groups.
    - Has a strong **+I effect**, but less than triethylamine.
- **$C_2H_5NH_2$ (Ethylamine) → Less Basic**
    - It is a **primary amine** with only one ethyl group.
    - Has the weakest **+I effect** among ethyl-substituted amines.
- **NH_3 (Ammonia) → Least Basic**
    - No alkyl groups, so it has no **+I effect**.
    - Weakest base in the gaseous phase.

Final Order of Basicity in Gaseous Phase:

Triethylamine $(C_2H_5)_3N$ > Diethylamine $(C_2H_5)_2NH$ > Ethylamine $(C_2H_5NH_2)$ > Ammonia (NH_3)

Correct Answer is $(C_2H_5)_3N$ (Triethylamine)

Question 49

Which factor is not responsible for basic strength of amines?

Which factor is not responsible for basic strength of amines?

Options:

A. Conjugation factor

B. Inductive effect

C. Solvation effect

D. Steric hinderance

Answer: A

Solution:

CONCEPT:

Factors Affecting the Basic Strength of Amines

- The basicity of amines depends on several factors that influence the availability of the lone pair on nitrogen for protonation.
- The major factors affecting amine basicity are:
    - **Inductive Effect (+I Effect):** Alkyl groups donate electron density to nitrogen, increasing basicity.
    - **Solvation Effect:** In aqueous solution, smaller protonated amines are better stabilized by hydrogen bonding, increasing basicity.
    - **Steric Hindrance:** In bulky amines, steric crowding around nitrogen reduces its ability to accept protons, decreasing basicity.

EXPLANATION:

- **Conjugation Factor → Not Responsible(Correct Answer)**
    - Conjugation refers to the delocalization of electrons through resonance.
    - In aromatic amines (e.g., aniline), the lone pair on nitrogen participates in resonance with the benzene ring, decreasing availability for protonation.
    - However, **conjugation is only relevant in aromatic amines** and does not generally affect all amines.
- **Inductive Effect → Responsible**
  Alkyl groups push electron density toward nitrogen (+I effect), enhancing its basicity.
    - More alkyl groups increase basicity, as seen in aliphatic amines.
- **Solvation Effect → Responsible**
    - In aqueous solution, the stability of the protonated amine (RNH_3^+) influences basicity.
    - Smaller amines (primary & secondary) are well-solvated, increasing their basic strength.
- **Steric Hindrance → Responsible**
    - Bulky groups around nitrogen reduce its ability to interact with protons.
    - Tertiary amines, despite having a strong +I effect, have lower basicity due to steric hindrance in aqueous solution.

Final Answer: Conjugation Factor is **not responsible** for the basic strength of amines.

Correct Answer: Conjugation Factor

Question 50

Hinsberg's reagent is:

Options:

A.

2, 4-dinitrophenol

B.

$NaNO_2$+HClmixture

C.

HNO_3+ H_2SO_4mixture

D.

Benzenesulphonyl chloride

Answer: D

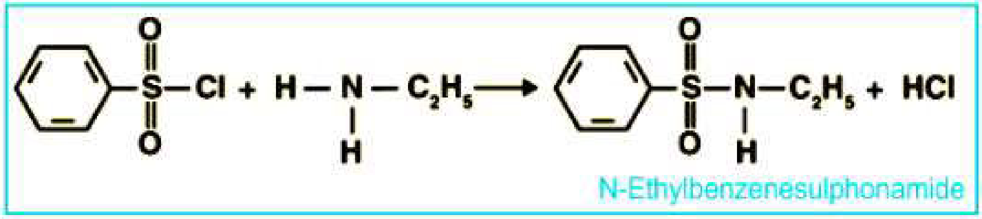
Solution:

CONCEPT:

Hinsberg's Reagent

- Hinsberg's reagent is used in organic chemistry to differentiate between primary, secondary, and tertiary amines.
- The reagent reacts differently with each type of amine, allowing for their identification.

EXPLANATION:



- Hinsberg's reagent is benzenesulphonyl chloride (C6H5SO2Cl).
- When benzenesulphonyl chloride reacts with a primary amine, it forms a sulfonamide which is soluble in alkali.
- When it reacts with a secondary amine, it forms a sulfonamide that is insoluble in alkali.
- Tertiary amines do not react with benzenesulphonyl chloride as there are no hydrogen atoms attached to the nitrogen atom to form a sulfonamide.

Therefore, Hinsberg's reagent is benzenesulphonyl chloride.
