

**ISC 2026 EXAMINATION**  
**Sample Question Paper - 4**  
**Chemistry**

**Time Allowed: 3 hours and 15 minutes**

**Maximum Marks: 70**

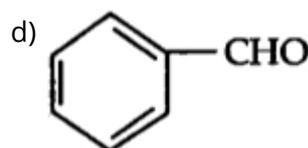
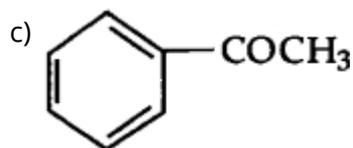
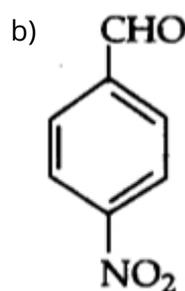
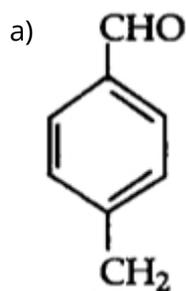
**General Instructions:**

1. You are allowed additional 15 minutes for only reading the question paper.
2. You must NOT start writing during the reading time.
3. This question paper has 11 printed pages.
4. It is divided into four sections and has 21 questions in all.
5. All questions are compulsory. Answer all questions.
6. Section A has fourteen subparts. Each question carries 1 mark.
7. While attempting Multiple Choice Questions in Section A, you are required to write only ONE option as the answer.
8. Section B has ten questions. Each question carries 2 marks.
9. Section C has seven questions. Each question carries 3 marks.
10. Section D has three questions. Each question carries 5 marks.
11. Internal choices have been provided in one question each in Sections B, C and D.
12. The intended marks for questions are given in brackets [ ].
13. All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.
14. Balanced equations must be given wherever possible and diagrams where they are helpful.
15. When solving numerical problems, all essential workings must be shown.

**Section A**

1. **Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:** [4]
  - (a) Fill in the blanks by choosing the appropriate word! words from those given in the brackets: [4]  
(cerium, lanthanoids, very, presence, f-f, lanthanoids, actinoids, lanthanoids)
    - i. Actinoids are \_\_\_\_\_ reactive in nature and combine with oxygen and halogens like \_\_\_\_\_.
    - ii. Misch metal is an alloy of \_\_\_\_\_ and other \_\_\_\_\_ elements.
    - iii. The \_\_\_\_\_ and \_\_\_\_\_ form the f-block of the periodic table.
    - iv. Actinoids ions are coloured because of the \_\_\_\_\_ of unpaired electrons and \_\_\_\_\_ transitions.
2. **Select and write the correct alternative from the choices given below.** [7]
  - (a) Which of the following aqueous solution has lowest vapour pressure? [1]
    - a) 1 M Glucose
    - b) 1 M Sucrose
    - c) 1 M  $K_2SO_4$
    - d) 1 M NaCl

(b) Which one is most reactive towards Nucleophilic addition reaction? [1]



(c) **Assertion (A):** Aldehydes and ketones both react with Tollen's reagent to form silver mirror. [1]

**Reason (R):** Both aldehydes and ketones contain a carbonyl group.

- 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.

(d) **Assertion (A):** The rate law may not depend on the concentration of every reactant. [1]

**Reason (R):** With increase in temperature, the rate of reaction increases.

- 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.

(e) Colligative properties depend on [1]

- a) the physical properties of solute particles in solution      b) the number of solute particles in solution  
c) the nature of solute particles in solution      d) the nature of solute and solvent particles

(f) In the presence of a catalyst the heat evolved or absorbed during the reaction [1]

- a) increases      b) decreases  
c) may increase or decrease      d) remains unchanged

(g) Phosphine is not obtained by the reaction when: [1]

- a)  $P_4O_6$  is boiled with water.      b)  $Ca_3P_2$   
c) Red P is heated with NaOH      d) White P is heated with NaOH

3. The rate constant for a first order reaction becomes six times when the temperature is increased from 350 K to 410 K. Calculate activation energy ( $E_a$ ) for the reaction. [3]

### Section B

4. 25% of a first order reaction is completed in 30 minutes. Calculate the time taken in minutes for the reaction to go to 90% completion. [2]

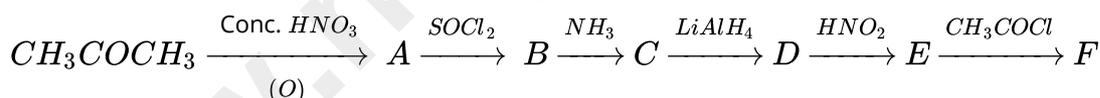
5. What is the difference between order of a reaction and the molecularity of a reaction? [2]

6. Which of the following solutions will have a lower vapour pressure and why? [2]  
 i. A 5% solution of cane sugar ( $C_{12}H_{22}O_{11}$ ).  
 ii. A 5% solution of urea ( $NH_2CONH_2$ ).  
 (Relative atomic masses of H = 1, C = 12, O = 16, N = 14)
7. A solution of urea in water has boiling point  $100.128^\circ C$ . Calculate the freezing point of the same solution. Molal constants for water are  $K_b = 0.512 \text{ K kg mol}^{-1}$  and  $K_f = 1.86 \text{ K kg mol}^{-1}$  respectively. [2]
8. A 0.15 M aqueous solution of KCl exerts an osmotic pressure of 6.8 atm at 310 K. Calculate the degree of dissociation of KCl. ( $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$ ) [2]
9. Write the IUPAC name of  $[Co(en)_2Cl_2]^+$  ion and draw the structures of its geometrical isomers. [2]
10. Write the IUPAC name of the following: [2]  
 i.  $[Co(NH_3)_6]Cl_3$   
 ii.  $[NiCl_4]^{2-}$   
 iii.  $K_3[Fe(CN)_6]$
11. Why do the transition elements have higher enthalpies of atomisation? In 3d-series (Sc to Zn), which element has the lowest enthalpy of atomisation and why? [2]

OR

Give a reason for the following.

- i.  $Cu^{+2}$  salts are paramagnetic while  $Cu^+$  salts are diamagnetic.  
 ii.  $Mn^{+2}$  compounds are more stable than  $Fe^{+2}$  compounds.
12. Give one good chemical test to distinguish between the following pair of compounds. [2]  
 Propan-1-ol and propan-2-ol
13. Identify compounds A to F, by completing the equation: [2]



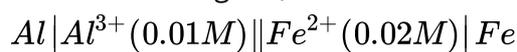
### Section C

14. Identify A to F: [3]  
 $A \xrightarrow{LiAlH_4} C_2H_5OH \xrightarrow{PBr_3} B \xrightarrow{KCN} C \xrightarrow{D} C_3H_7NH_2 \xrightarrow{HNO_2} E \xrightarrow[\text{K}_2Cr_2O_7/H^+]{[O]} F$
15. How do you convert the following? [3]  
 i. Chlorobenzene to biphenyl  
 ii. Propene to 1-iodopropane  
 iii. 2-bromobutane to but-2-ene
16. For the complex ion of  $[Fe(CN)_6]^{3-}$ . [3]  
 i. Show hybridisation diagrammatically.  
 ii. Is it an inner orbital complex or an outer orbital complex?  
 iii. State its magnetic property.
17. Calculate the emf and  $\Delta G$  for the cell reaction at 298 K. [3]  
 $Mg(s) | Mg^{2+}(0.1M) || Cu^{2+}(0.01M) | Cu(s)$

Given,  $E_{\text{cell}}^{\circ} = 2.71 \text{ V}$ ,  $1 F = 96500 C$

OR

For the following cell, calculate the emf.



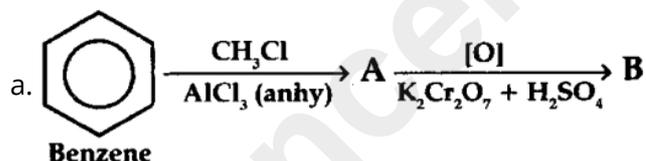
Given:  $E_{\text{Al}^{3+}/\text{Al}}^{\circ} = -1.66 \text{ V}$ ,  $E_{\text{Fe}^{2+}/\text{Fe}}^{\circ} = -0.44 \text{ V}$

18. Define the following: [3]
- Peptide linkage
  - Primary structure
  - Denaturation
19. 20% of a first order reaction is completed in five minutes. How much time will the 60% reaction take to complete? Calculate the half-life period ( $t_{\frac{1}{2}}$ ) for the above reaction. [3]
20. i. Define molecularity of a reaction. Give one difference between the order of reaction and its molecularity. [3]
- ii. The rate constant (k) of a first order reaction is  $4.5 \times 10^{-2} \text{ s}^{-1}$ . What will be the time required for the initial concentration of 0.4 M of the reactant to be reduced to 0.2 M?

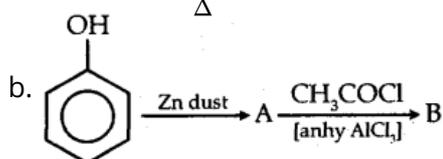
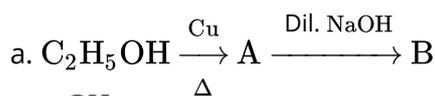
#### Section D

21. i. Write chemical equations to illustrate the following name reactions: [5]
- Aldol condensation.
  - Cannizzaro's reaction.
  - Benzoin condensation.

ii. Identify the compounds A and B in the given reactions:



22. i. Write chemical equations to illustrate the following name reactions: [5]
- Williamson's synthesis
  - Esterification reaction
  - Reimer-Tiemann reaction
- ii. Identify the compounds A and B in the given reactions:



23. i. A solution containing 0.5 g of KCl dissolves in 100 g of water and freezes at  $-0.24^\circ\text{C}$ . Calculate the degree of dissociation of the salt. (K) for water =  $1.86^\circ\text{C}$ . (Atomic weights of K = 39, Cl = 35.5) [5]

- ii. If 1.71 g of sugar (molar mass = 342 g/mol) are dissolved in 500 mL of an aqueous solution at 300 K, what will be its osmotic pressure?
- iii. 0.70 g of an organic compound when dissolved in 32 g of acetone produces an elevation of  $0.25^{\circ}\text{C}$  in the boiling point. Calculate the molecular mass of organic compound. ( $K_b$  for acetone =  $1.72 \text{ K kg mol}^{-1}$ )

OR

- i. Determine the freezing point of a solution containing 0.625 g of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) dissolved in 102.8 g of water. (Freezing point of water = 273K,  $K_f$  for water =  $1.87 \text{ K kg mol}^{-1}$ , at. wt. of C = 12, H = 1 and O = 16)
- ii. A 0.15 M aqueous solution of KCl exerts an osmotic pressure of 6.8 atm at 310 K. Calculate the degree of dissociation of KCl. ( $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$ ).
- iii. A solution containing 8.44 g of sucrose in 100 g of water has a vapour pressure 4.56 mm of Hg at 273K. If the vapour pressure of pure water is 4.58 mm of Hg at the same temperature, calculate the molecular weight of sucrose.

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# Solution

## Section A

1. Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:

- (a) i. very, lanthanoids
- ii. cerium, lanthanoids
- iii. lanthanoids, actinoids
- iv. presence, f-f

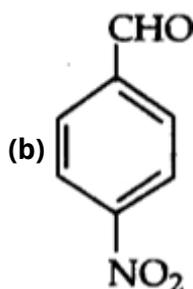
2. Select and write the correct alternative from the choices given below.

- (a) **(c)** 1 M  $K_2SO_4$

**Explanation:**

1 M  $K_2SO_4$  has maximum number of ions, hence have lowest vapour pressure.

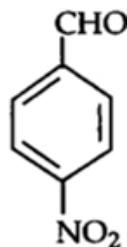
- (b)



**Explanation:**

Any substituent in the carbonyl compound that increases the positive charge on the carbonyl carbon will increase reactivity towards nucleophilic addition.

$-NO_2$  shows -M effect hence



is most reactive towards nucleophilic addition reaction.

- (c) **(d)** A is false but R is true.

**Explanation:**

A is false but R is true.

- (d) **(b)** Both A and R are true but R is not the correct explanation of A.

**Explanation:**

Both A and R are true but R is not the correct explanation of A.

- (e) **(b)** the number of solute particles in solution

**Explanation:**

Colligative properties depend on the total number of solute particles in the solution. It does not depend on the chemical nature of its components.

- (f) **(d)** remains unchanged

**Explanation:**

remains unchanged

- (g) **(c)** Red P is heated with NaOH

**Explanation:**

Red P is heated with NaOH

3. Let  $k_1 = k$  and  $k_2 = 6k$

Given,  $T_1 = 350$  K,  $T_2 = 410$  K

$$\log \frac{k_2}{k_1} = \frac{E_a}{2303R} \left[ \frac{T_2 - T_1}{T_1 \cdot T_2} \right]$$

$$\log \frac{6k}{k} = \frac{E_a}{2.303 \times 8314} \left[ \frac{410 - 350}{410 \times 350} \right]$$

$$\frac{0.77 \times 2.303 \times 8.314 \times 410 \times 350}{60} = E_a$$

$$E_a = 35.2 \text{ kJ mol}^{-1} = 3563433 \text{ J mol}^{-1}$$

### Section B

4. Given, time for 25% completion of reaction = 30 min

Let, [initial concentration] = 100

Then, [a - x],

$$= 100 - 25 = 75\%$$

and t = 30 min

$$\text{Therefore, } k = \frac{2.303}{t} \log \frac{a}{a-x}$$

$$= \frac{2.303}{30} \log \frac{100}{75}$$

$$= 0.0767 \log 1.333$$

$$= 0.0767 \times 0.1250 = 0.00958k$$

$$= 0.0096 \text{ min}^{-1}$$

∴ Time taken to complete 90% of reaction will be

$$t = \frac{2.303}{k} \log \frac{100}{10}$$

$$= \frac{2.303}{0.0096} \log 10$$

$$= \frac{2.303}{0.0096} \times 1 = 239.89 \approx 240 \text{ min}$$

5. **Differences between order and molecularity of a reaction**

Order of a reaction	Molecularity of a reaction
It is the sum of the powers of concentration terms on which the rate of reaction actually depends or it is the sum of the exponents of the concentrations in the rate law equation.	It is the number of atoms, ions or molecules that must collide with one another simultaneously so as to result into a chemical reaction.
It can be fractional as well as zero.	It is always a whole number.
It can be determined experimentally only and cannot be calculated theoretically.	It can be calculated by adding the molecules of the slowest step. Therefore, it is a theoretical concept.
It tells us about slowest step in the mechanism and hence, gives some clue about mechanism of the reaction.	It does not tell us anything about the mechanism of the reaction.
Even the order of a simple reaction may not be equal to the number of molecules of the reactants as seen from the balanced equation.	For simple reactions, the molecularity can usually be obtained from the stoichiometry of the equation.

6. Vapour pressure of solution  $\propto$  Mole fraction of solvent. Let, 5 g of cane sugar be dissolved in 100 g of water.

Mole fraction of water in (i)

$$= \frac{N}{N+n} = \frac{\frac{W}{M}}{\frac{w}{M'} + \frac{W}{M}}$$

$$= \frac{\frac{100}{18}}{\frac{100}{18} + \frac{5}{342}} = \frac{5.55}{5.55 + 0.0146} = 0.9973$$

$$\left( \text{where, } N = \frac{W}{M} = \frac{100}{18} \text{ and } n = \frac{w}{M'} = \frac{5}{342} \right)$$

Mole fraction of water in (ii),

$$\frac{N}{N+n'} = \frac{\frac{100}{18}}{\frac{100}{18} + \frac{5}{60}} = 0.98526 \left( \text{where, } n' = \frac{5}{60} \right)$$

Vapour pressure of 5% solution of urea will be lower because mole fraction of water is lower than that of 5% solution of cane sugar.

7. Boiling point of solution = 100.128°C

$$K_b = 0.512 \text{ K kg mol}^{-1}$$

$$K_f = 1.86 \text{ K kg mol}^{-1}$$

$$\Delta T_b = 100.128^\circ\text{C} - 100^\circ\text{C} = 0.128^\circ\text{C}$$

$$\Delta T_b = K_b \times \text{molality}$$

$$\text{Molality} = \frac{0.128}{0.512} = 0.25$$

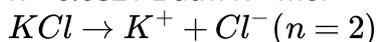
$$\text{Now, } \Delta T_{\text{freezing}} = K_f \times \text{molality}$$

$$= 1.86 \times 0.25 = 0.465$$

$$\text{Freezing point of solution} = 0 - 0.46 = -0.46^\circ\text{C}$$

8.  $C = 0.15 \text{ M}$ ,  $\pi = 6.8 \text{ atm}$ ,  $T = 310 \text{ K}$ ,

$$R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$$



$$\pi = iCRT$$

$$6.8 = i \times 0.15 \times 0.0821 \times 310$$

$$i = \frac{6.8}{0.15 \times 0.0821 \times 310}$$

$$= 1.7812$$

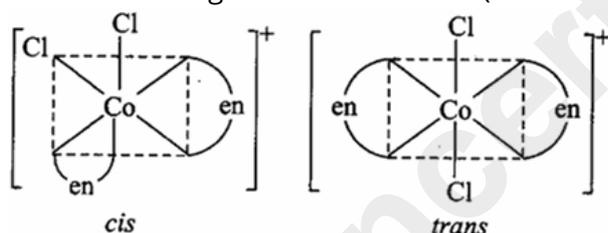
$$\text{Degree of dissociation } (\alpha) = \frac{i-1}{n-1} = \frac{1.7812-1}{2-1}$$

$$= 0.7812 \text{ or } = 78.12\%$$

9.  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$

**IUPAC name** Dichloro bis-(ethane-1, 2-diamine) cobalt (III) ion.

Structure of its geometrical isomers (cis and trans) are given below.



10. i. Hexaamminecobalt(III) chloride

ii. Tetrachloridonickelate(II) ion

iii. Potassium hexacyanoferrate(III)

11. The transition metals have high enthalpy of atomisation. It can be explained on the basis of strong inter-atomic interaction due to unpaired electrons. Greater the number of unpaired electrons, stronger is the resultant bonding.

In 3d-series Zn has the least enthalpy of atomisation because it has stable ground state configuration due to its completely filled d-orbital.

Thus, zinc has least tendency to form metallic bonds in the series.

OR

i. The electronic configuration of  $\text{Cu}^+ = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^{10}$  and  $\text{Cu}^{2+} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^9$

In  $\text{Cu}^+$  ion, all electrons are paired. Hence,  $\text{Cu}^+$  is diamagnetic in nature. Whereas,  $\text{Cu}^{2+}$  has one unpaired electron thus, shows paramagnetic character.

ii. Magnesium in +2 oxidation state form stable compounds than iron in +2 oxidation state.

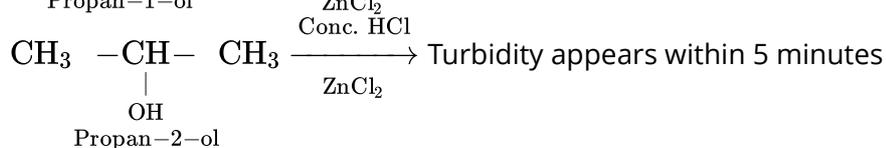
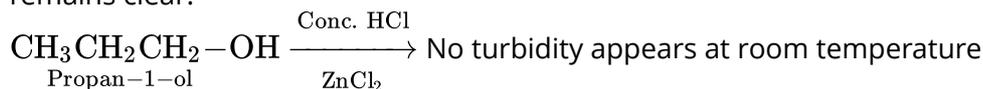
$$\text{Mn}^{2+} = 1s^2 2s^2 2p^6 3p^6 3d^5 \text{ (half-filled d-orbital)}$$

$$\text{Fe}^{2+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$$

$\text{Mn}^{2+}$  compounds are more stable due to half-filled d-orbitals.  $\text{Fe}^{2+}$  compounds are comparatively less stable as they have six electrons in their 3d-orbitals.

12. Propan-1-ol and propan-2-ol can be distinguished by Lucas test. When Lucas reagent (solution of HCl and ZnCl<sub>2</sub>) is added to propan-2-ol, cloudiness (turbidity) appears within 5 min.

When Lucas reagent is added to propan-1-ol, no turbidity appears at room temperature and solution remains clear.



13. A - CH<sub>3</sub>COOH

B - CH<sub>3</sub>COCl

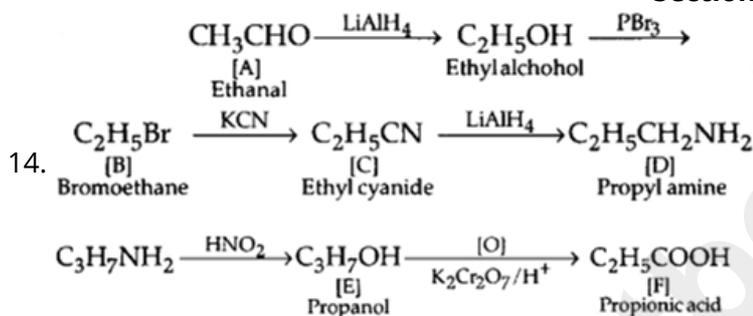
C - CH<sub>3</sub>CONH<sub>2</sub>

D - CH<sub>3</sub>CH<sub>2</sub>NH<sub>2</sub>

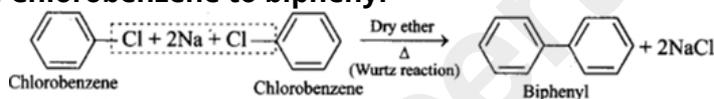
E - CH<sub>3</sub>CH<sub>2</sub>OH

F - CH<sub>3</sub>COOC<sub>2</sub>H<sub>5</sub>

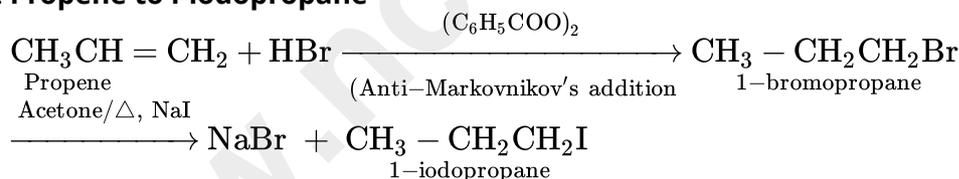
### Section C



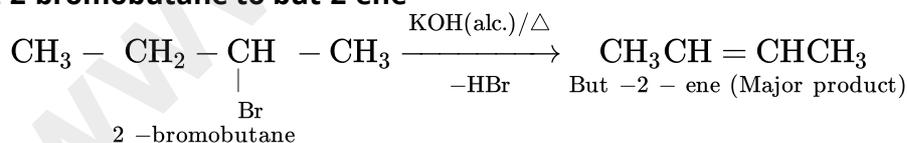
15. i. **Chlorobenzene to biphenyl**



ii. **Propene to 1-iodopropane**



iii. **2-bromobutane to but-2-ene**



16. i. Let the oxidation number of Fe in the complex ion [Fe(CN)<sub>6</sub>]<sup>3-</sup> be x.

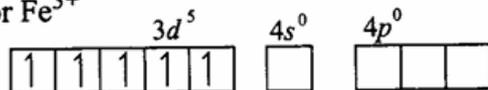
$$\text{Then, } x + 6(-1) = -3$$

$$\Rightarrow x = +3$$

Electronic configuration

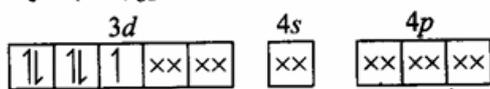


For  $\text{Fe}^{3+}$



$\text{CN}^-$  being strong field ligand, paired up the  $d$ -electrons of the metal

For  $[\text{Fe}(\text{CN})_6]^{3-} =$



$d^2sp^3$ -hybridisation

Six pairs of electrons from six  $\text{CN}^-$  ions

ii. It is an inner orbital complex as inner  $d$ -orbitals take part in hybridisation.

iii. It is paramagnetic due to the presence of unpaired electron.

17.  $\Delta G^\circ = -nFE_{\text{cell}}^\circ$

where,  $n$  = no. of electrons participate = 2

Given,  $E_{\text{cell}}^\circ = 2.71 \text{ V} = emf$  of cell

$F = 96500 \text{ C}$

$\therefore \Delta G = -2 \times 96500 \times 2.71$

$= -523030 \text{ J mol}^{-1}$

$\Delta G = -523.030 \text{ kJ/mol}$

Now,

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.0591}{n} \log \frac{[Mg^{2+}]}{[Cu^{2+}]}$$

$$= 2.71 - \frac{0.0591}{2} \log \frac{[0.1]}{[0.01]}$$

$$= 2.71 - 0.02955$$

$$= 2.68045$$

$\therefore \text{EMF of cell} = 2.68045$

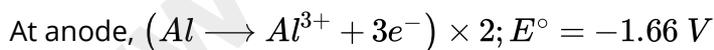
OR

Given:  $E_{\text{Al}^{3+}/\text{Al}}^\circ = -1.66 \text{ V}$ ,  $E_{\text{Fe}^{2+}/\text{Fe}}^\circ = -0.44 \text{ V}$

For the cell,



$E^\circ = -0.44 \text{ V}$



Hence,  $n = 6$

According to Nernst equation,

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.0591}{n} \log_{10} \frac{[\text{Product}]}{[\text{Reactant}]}$$

$$= E_{\text{cell}}^\circ - \frac{0.0591}{6} \log \frac{[\text{Al}^{3+}]^2}{[\text{Fe}^{2+}]^3}$$

$$E_{\text{cell}}^\circ = E_{\text{cathode}}^\circ - E_{\text{anode}}^\circ = -0.44 - (-1.66)$$

$$= -0.44 + 1.66 = 1.22$$

Given,  $[\text{Al}^{3+}] = 0.01 \text{ M}$ ,  $[\text{Fe}^{2+}] = 0.02 \text{ M}$

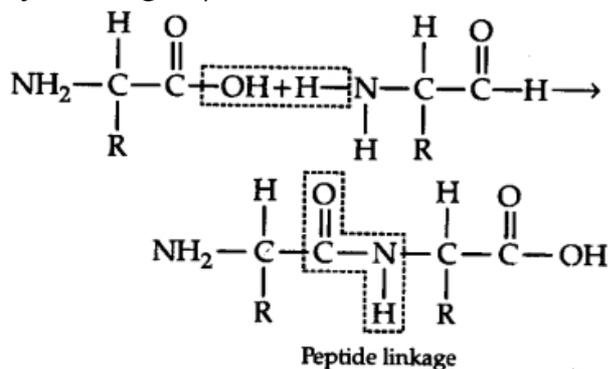
$$E_{\text{cell}} = 1.22 - \frac{0.0591}{6} \log \frac{(0.01)^2}{(0.02)^3}$$

$$= 1.22 - 9.85 \times 10^{-3} \log(125)$$

$$= 1.22 - 9.85 \times 10^{-3} \times 1.097$$

$$= 1.22 - 0.012 = 1.208 \text{ V}$$

18. i. Peptide linkage is the linkage that exists between the monomeric amino acids in a polypeptide chain by -COOH group of one amino acid and the -NH<sub>2</sub> group of next amino acid by condensation.



- ii. Primary structure depicts the way amino acids are linked to each other by peptide bond in a polypeptide chain, e.g., Val, Ala, Gly, Ala.

19. Given,  $t_{20\%} = 5$  min

Let, [A] be initial concentration = 100

After 5 min, [A] = 100 - 20 = 80

For 1<sup>st</sup> order reaction,

$$k = \frac{2.303}{t} \log_{10} \frac{[A]_0}{[A]}$$

$$k = \frac{2.303}{5} \log_{10} \frac{100}{80}$$

$$= 0.0446 \text{ min}^{-1}$$

For 60% completion of reaction, the time will be

$$t = \frac{2.303}{k} \log_{10} \frac{[A]_0}{[A]}$$

Here, [A]<sub>0</sub> = 100 and [A] = 100 - 60 = 40

$$\text{So, } t = \frac{2.303}{0.0446} \times \log_{10} \frac{100}{40}$$

$$= \frac{2.303}{0.0446} \log_{10} 2.5$$

$$t = 20.5 \text{ min}$$

$t_{\frac{1}{2}}$  for this reaction is

$$t_{\frac{1}{2}} = \frac{0.693}{k} = \frac{0.693}{0.0446 \text{ min}^{-1}}$$

$$= 15.538 \text{ min}$$

20. i. Molecularity is defined as the number of reacting species undergoing simultaneous collisions in the elementary or simple reactions.

Order of a reaction	Molecularity of reaction
It is the sum of powers raised on concentration term in the rate expression.	It is the number of molecules of reactants taking part in elementary step of a reaction.

- ii. Given,  $k = 4.5 \times 10^{-2} \text{ s}^{-1}$

Since the initial concentration is to be reduced to one half, the time required will be equal to half life period,  $t_{0.5}$ . For a first order reaction,

$$t_{0.5} = \frac{0.693}{k}$$

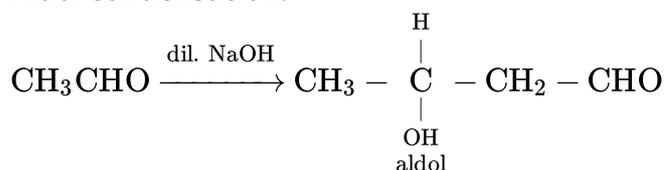
$$= \frac{0.693}{4.5 \times 10^{-2}}$$

$$= 15.4 \text{ s}$$

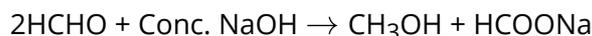
Therefore, time required to reduce the initial concentration of 0.4 M to 0.2 M is 15.4 s.

#### Section D

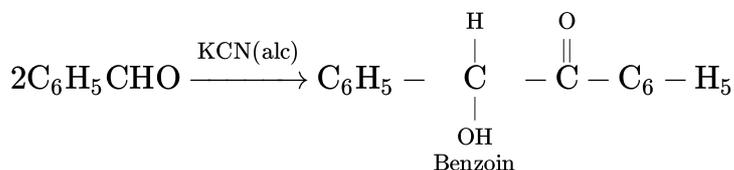
21. i. a. **Aldol condensation:**



b. **Cannizzaro's reaction:**



c. **Benzoin condensation:**



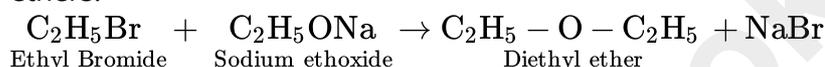
ii. a. A  $\Rightarrow$  Toluene or  $\text{C}_6\text{H}_5\text{CH}_3$

B  $\Rightarrow$  Benzoic acid or  $\text{C}_6\text{H}_5\text{COOH}$

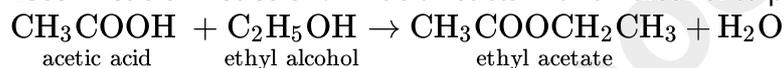
b. A  $\Rightarrow$  Acetic acid or  $\text{CH}_3\text{COOH}$

B  $\Rightarrow$  Ethanoyl chloride or  $\text{CH}_3\text{COO}$

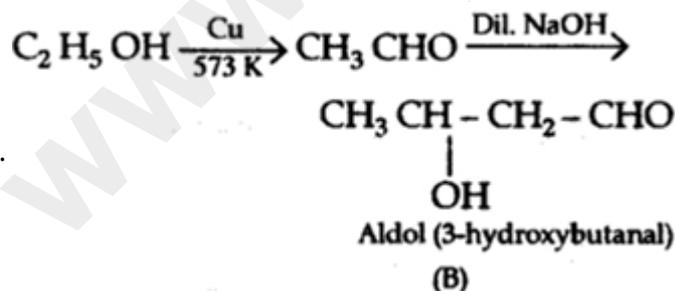
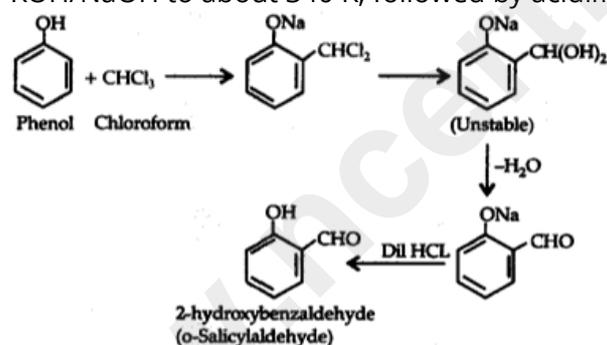
22. i. a. **Williamson's synthesis:** It is the best laboratory method for the preparation of simple and mixed ethers.



b. **Esterification reaction:** An acid reacts with an alcohol to produce ester, is called esterification.



c. **Reimer-Tiemann reaction:** In this reaction phenol is heated with chloroform along with aqueous KOH/NaOH to about 340 K, followed by acidification, aldehyde is form.



23. i. Given: Weight of KCl (solute) = 0.5g

Weight of solvent (water) = 100 g

Freezing point ( $T_f$ ) =  $-0.24^\circ\text{C}$

$K_f = 1.86^\circ\text{C}$

Molecular mass of KCl = 39 + 35.5 = 74.5

From depression in freezing point

$$T_f = i \times K_f \times m$$

$$0.24^\circ\text{C} = i \times 1.86^\circ\text{C} \times \frac{0.5}{74.5} \times \frac{1000}{100} \Rightarrow i = 1.92$$

For KCl,  $i = 1 + \alpha$

(where  $\alpha$  is the degree of dissociation)

$$\alpha = 192 - 1 \Rightarrow \alpha = 92 \text{ or } 92\%$$

ii. Given: Weight of sugar = 1.71 g

Molar mass of sugar = 342 g/mol

Volume of solvent = 500 mL

Temperature = 300 K

Osmotic pressure,  $\pi = CRT$

$$C = \frac{1.71}{342} \times \frac{1000}{500}$$

$$\pi = 0.01 \times 0.0821 \text{ L atm/K/mol} \times 300 \text{ K}$$

$$C = 0.01 \text{ mol/L}, \pi = 0.2463 \text{ atm}$$

iii. Given  $\Delta T_b = 0.25^\circ$ , or 0.25 K,  $K_b = 1.72 \text{ kg mol}^{-1}$

$$\Rightarrow \Delta T_b = K_b \times m$$

$$0.25 = 1.72 \times \frac{0.70}{\text{molecular weight}} \times \frac{1000}{32 \text{ g}}$$

$$\text{Molecular weight} = 150.5 \text{ g}$$

OR

i. Given: Freezing point of water = 273 K

Weight of solute (glucose)  $w = 0.625 \text{ g}$

Weight of solvent,  $W = 102.8 \text{ g}$

Molecular weight of solute,  $m = (C_6H_{12}O_6)$

$$= 12 \times 6 + 1 \times 12 + 16 \times 6 = 180 \text{ g mol}^{-1}$$

$K_f$  for water =  $1.87 \text{ K kg mol}^{-1}$

For glucose as solute,  $i = 1$

$$\Delta T_f = \frac{1000 \times K_f \times w}{m \times W}$$

$$= \frac{1000 \times 1.87 \times 0.625}{180 \times 102.8}$$

$$= 0.063 \text{ K}$$

$$\therefore \text{Freezing point of solution} = T_f + \Delta T_f$$

(where,  $T_f$  is freezing point of water =  $0^\circ \text{C} = 273 \text{ K}$ )

$$= 273 + 0.063 = 273.063 \text{ K}$$

ii. Osmotic pressure ( $\pi$ ) = CRT

Given,  $C = 0.15 \text{ M}$ ,  $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$

$T = 310 \text{ K}$

$$\therefore \pi = CRT$$

$$= 0.15 \text{ M} \times 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1} \times 310 \text{ K}$$

$$= 3.82 \text{ atm}$$

Observed  $\pi = 6.8 \text{ atm}$

$\therefore$  van't Hoff Factor,

$$i = \frac{\text{Observed magnitude of } \pi}{\text{Normal magnitude of } \pi} = \frac{6.8}{3.82} = 1.78$$

If degree of dissociation is  $\alpha$ , then for KCl,  $n = 2$  as the number of solute particles in its aqueous solution is almost double the number of NaCl molecules.

$$\therefore \alpha = \frac{i-1}{n-1} = \frac{1.78-1}{2-1} = 0.78 = 78\%$$

iii.  $P_A^o = 4.58 \text{ mm of Hg}$

$P_A = 4.56 \text{ mm of Hg}$

$$\frac{P_A^o - P_A}{P_A^o} = X_B = \frac{n_B}{n_B + n_A}$$

$$\frac{4.58 - 4.56}{4.58} = \frac{\frac{8.44}{M_s}}{\frac{100}{18} + \frac{8.44}{M_s}}$$

$$\frac{0.02}{4.58} = \frac{8.44}{M_B} \times \frac{18M_B}{(100M_B+151.92)}$$

$$\frac{0.02}{4.58} = \frac{8.44 \times 18}{100M_B+151.92}$$

$$100M_B + 151.92 = \frac{8.44 \times 18 \times 4.58}{0.02}$$

$$M_B = 346.38 \text{ amu}$$

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