ISC 2026 EXAMINATION
Sample Question Paper - 5
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(s) from the given brackets. **[4]**

[+3, -3, metal, ligand, homoleptic, 6, 9, heteroleptic, one, two, d^2sp^3, sp^3d^2, diamagnetic, paramagnetic]

i. The coordination number and oxidation state of the complex $[Cr(NH_3)_3(H_2O)_3]Cl_3$ are ________ and ________ respectively.

ii. In coordination complex, donation of electrons pair take place from the ________ to ________.

iii. In $[Co(NH_3)_6]^{3+}$ complex, a metal is bound to ________ type of donar group are known as ________.

iv. $[Co(NH_3)_6]^{3+}$ has ________ hybridisation and ________ in nature.

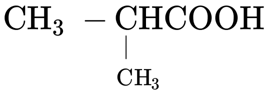
2. **Select and write the correct alternative from the choices given below.** **[7]**

(a) 0.76 g of glucose (molecular mass = 180 g mol^{-1}) is dissolved in 20 mL of aqueous solution at 298 K. (R = 0.0821 L-atm K^{-1} mol^{-1}) **[1]**

What is the osmotic pressure of solution at 298 K?

a) 5.16 atm
b) 8.41 atm
c) 0.48 atm
d) 4.89 atm

(b) An organic compound **A** on treatment with NH_3 gives **B** which on heating gives **C**, **C** when treated with Br_2 in the presence of KOH produces ethylamine. Compound **A** is: **[1]**

a) 
$CH_3-\underset{\underset{CH_3}{|}}{CH}COOH$
b) CH_3CH_2COOH
c) $CH_3CH_2CH_2COOH$
d) CH_3COOH

(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):** E_a of the forward reaction is higher than that of the backward reaction in a reversible endothermic reaction. **[1]**

Reason (R): Threshold energy of the forward reaction is more than that of backward reaction.

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) An equimolar solution of non-volatile solutes A and B, shows a depression in freezing point in the ratio of 2:1. If A remains in its normal state in the solution, the state of B in the solution will be **[1]**

a) normal
b) hydrolysed
c) associated
d) dissociated

(f) The correct statement about the $t_{\frac{1}{2}}$ for a first order reaction is **[1]**

a) independent of concentration of reactant
b) inversely proportional to concentration of reactants
c) inversely proportional to the square of the concentration of reactant
d) proportional to concentration of reactants

(g) When SO_2 gas is passed through acidified $K_2Cr_2O_7$ solution, the colour of the solution changes to: **[1]**

a) Black
b) Orange
c) Red
d) Green

3. i. The half-life period $\left(t_{\frac{1}{2}}\right)$ for decay of radioactive ^{14}C is 5730 years. An ancient piece of wood has only 80% of the ^{14}C found in a living tree. Calculate the age of the piece of wood. **[3]**

ii. The rate of most of the reactions becomes double when the temperature is raised from 298 K to 308 K . Calculate the activation energy.

($R = 8.314\ J\ K^{-1}\ mol^{-1}$)

Section B

4. A substance decomposes by following first order kinetics. If 50% of the compound is decomposed in 120 minutes, how long will it take for 90% of the compound to decompose? **[2]**

5. For the reaction $2H_2 + 2NO \rightleftharpoons 2H_2O + N_2$, the following rate data was obtained: **[2]**

S.No.	**[NO] $molL^{-1}$**	**[H_2] $molL^{-1}$**	**Rate: $mol\ L^{-1}\ s^{-1}$**
1.	0.40	0.40	4.6×10^{-3}
2.	0.80	0.40	18.4×10^{-3}
3.	0.40	0.80	9.2×10^{-3}

Calculate the following.

i. The overall order of reaction.

ii. The rate law.

iii. The value of rate constant (k).

6. Calculate the mole fraction of water in a sodium hydroxide solution which has 80 g of NaOH and 54 g of H_2O. (Relative atomic masses of Na = 23, O = 16 and H = 1) **[2]**

7. What role does the molecular interactions play in solution of alcohol and water? **[2]**

8. Why do gases always tend to be less soluble in liquids as the temperature is raised? **[2]**

9. Write the formula of the following compounds. **[2]**

i. Triamminetriaquachromium (III) chloride

ii. Potassiumhexacyanoferrate (III)

10. i. Write the IUPAC names of the following. **[2]**

a. $K_3[Fe(C_2O_4)_3]$

b. $[Co(NH_3)_5Cl]SO_4$

ii. $[Fe(CN)_6]^{4-}$ is a coordination complex ion.

a. Calculate the oxidation number of iron in the complex.

b. Write the IUPAC name of the complex ion.

11. Give reason for the following. **[2]**

i. Transition metals form large number of complex compounds.

ii. Transition elements show variable oxidation states.

OR

Justify: Mn^{2+} is more stable than Fe^{2+} towards +3 oxidation state. (At. No. of Mn = 25, Fe = 26)

12. How can you convert benzene to phenol? **[2]**

13. Give the balanced equations for the following name reactions. **[2]**

i. Rosenmund reaction

ii. Formaldehyde is treated with ammonia

Section C

14. i. Give a reason for each of the following: **[3]**

a. Formaldehyde does not undergo aldol condensation, but acetaldehyde does.

b. Chloroacetic acid is stronger acid than acetic acid.

c. Both aldehydes and ketones undergo a number of nucleophilic addition reactions.

ii. An organic compound with the molecular formula C_7H_6O gets oxidised by Tollen's reagent. It does not respond to Fehling test but can undergo the Cannizzaro reaction. Identify the compound. Show how you used the above information to identify the compound.

15. i. Write a chemical test to distinguish between **[3]**

a. chlorobenzene and benzyl chloride

b. chloroform and carbon tetrachloride

ii. Why is methyl chloride hydrolysed more easily than chlorobenzene?

16. i. Write the formula of each of the following compounds. **[3]**

a. Potassium trioxalatoaluminate (III)

b. Triammine triaquachromium (III) chloride

ii. For the complex ion $[Co(NH_3)_6]^{3+}$, state the oxidation state of central metal atom and the coordination number of the complex ion.

17. A cell is constructed by dipping a zinc rod in 0.1 M zinc nitrate solution and a lead rod in a 0.2 M lead nitrate solution. **[3]**

$E^\circ_{Pb^{2+}/Pb} = -0.13\ V$ and $E^\circ_{Zn^{2+}/Zn} = -0.76\ V$

i. Write the spontaneous cell reaction.

ii. Calculate standard emf and emf of the cell.

OR

Calculate the emf and ΔG° for the cell reaction at $25^\circ C$.

$$\mathrm{Zn(s)|\underset{(0.1\ M)}{Zn^{2+}(aq)^{2+}}||\underset{(0.01\ M)}{Cd^{2+}(aq)}|Cd(s)}$$

Given, $E^\circ_{Zn^{2+}/Zn} = -0.763$ and $E^\circ_{Cd^{2+}/Cd} = -0.403\ V$

18. i. Write the structural difference between starch and cellulose. **[3]**

ii. What type of linkage is present in nucleic acids?

iii. Give one example each for fibrous protein and globular protein.

19. A first order reaction is 50% completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction. **[3]**

20. The initial rate of a reaction, A + B $\longrightarrow$ products, is doubled when the initial concentration of A is doubled and increases eight fold when the initial concentration of both A and B were doubled. State the order of the reaction with respect to A and with respect to B. Write the rate equation. **[3]**

Section D

21. An aliphatic unsaturated hydrocarbon [A] when treated with $HgSO_4/H_2SO_4$ yieids a compound [B] having molecular formula C_3H_6O. [B] on oxidation with concentrated HNO_3 gives two **[5]**

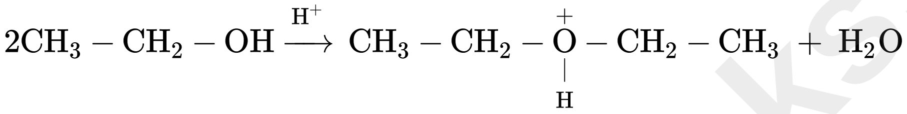
compounds [C] and [D]. Compound [C] when treated with PCl_5 gives compound [E]. [E] when reacts with ethanol gives a sweet smelling liquid [F]. Compound [F] is also formed when [C] reacts with ethanol in the presence of concentrated H_2SO_4,

i. Identify the compound A, B, C, D, E and F.
ii. Give the chemical equation for the reaction of (C) with chlorine in the presence of red phosphorus and name the reaction.

22. i. Write the formula of reagents used in the following reactions: **[5]**
   a. Bromination of phenol to 2,4,6-trlbromophenol
   b. Hydroboration of propene and then oxidation to propanol.

ii. Arrange the following compound groups in the increasing order of their property indicated:
   a. p-nitrophenol, ethanol, phenol (acidic character)
   b. Propanol, Propane, Propanal (boiling point)

iii. Write the mechanism (using curved arrow notation) of the following reaction:



$$2CH_3 - CH_2 - OH \xrightarrow{H^+} CH_3 - CH_2 - \underset{\underset{H}{|}}{\overset{+}{O}} - CH_2 - CH_3 + H_2O$$

23. 100 g of liquid A (molar mass 140 g mol^{-1}) was dissolved in 1000 g of liquid B (molar mass 180 g mol^{-1}). The vapour pressure of pure liquid B was found to be 500 torr. Calculate the vapour pressure of pure liquid A and its vapour pressure in the solution if the total vapour pressure of the solution is 475 torr. **[5]**

OR

i. An aqueous solution of a non-volatile solute freezes at 272.4 K, while pure water freezes at 273.0K. Determine the following: (Given, K_f = 1.86 K kg mol^{-1}, K_b = 0.512 K kg mol^{-1} and vapour pressure of water at 298 K = 23.756 mm of Hg)
   a. The molality of solution.
   b. Boiling point of solution.
   c. The lowering of vapour pressure of water at 298K.

ii. A solution containing 1.23 g of calcium nitrate in 10 g of water, boils at 100.975^{o}C at 760 mm of Hg. Calculate the van't Hoff factor for the salt at this concentration. (K_b for water = 0.52 K kg mol^{-1}, molecular weight of calcium nitrate = 164 g mol^{-1})

Solution

Section A

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

(a) i. 6, +3
ii. ligand, metal
iii. one, homoleptic
iv. d^2sp^3, diamagnetic

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

(a) **(d)** 4.89 atm

Explanation:

π = CRT
where, π = osmotic pressure
R = gas constant = 0.082 dm^3 atm mol^{-1} K^{-1}
T = temperature = 298 K
C = molarity $= \frac{n}{V} = \frac{w}{M \times V}$
where, n = no. of moles
w = weight of solute glucose = 0.76 g
M = molecular weight of solute glucose = 180 g
V = volume of solution
= 2011 mL = 0.02 L
$\pi = 0.2 \times 0.0821 \times 298$ = 4.89 atm

(b) **(b)** CH_3CH_2COOH

Explanation:

Since, C when heated with Br_2 in presence of KOH produces ethylamine, hence it must be propanamide and hence the organic compound (A) will be propanoic acid. The reactions follows:

$$\underset{\text{(A)}}{CH_3 - CH_2 - COOH} \xrightarrow{NH_3}$$

$$\underset{\text{(B)}}{CH_3 - CH_2 - CO\overset{-}{O}\overset{+}{N}H_2} \xrightarrow{\Delta}$$

$$\underset{\text{(C)}}{CH_3 - CH_2 - CONH_2} \xrightarrow[\text{Hoffmann bromamide reaction}]{KOH+Br_2} \underset{\text{(Ethylamine)}}{CH_3 - CH_2 - NH_2}$$

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

Explanation:

A is false but R is true.

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

Explanation:

A is true but R is false.

(e) **(d)** dissociated

Explanation:

Dissociated

(f) **(a)** independent of concentration of reactant

Explanation:

independent of concentration of reactant

(g) **(d)** Green

Explanation:

Green

3. i. Decay constant

$k = \frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{5730\text{year}}$ = 1.209 × 10^{-4}/year

The rate of counts is proportional to the number of C-14 atoms in the sample.

N_0 = 100, N = 80

The age of the sample $t = \frac{2.303}{k}\log\left(\frac{N_0}{N}\right)$

$t = \frac{2.303}{1.209\times10^{-4}} \times \log\left(\frac{100}{80}\right)$

= 1846 years

ii. Using Arrhenius equation, $k = A_0 e^{-\frac{E_a}{RT}}$

$log\frac{k_2}{k_1} = \frac{E_a}{2.303}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

Given, rate of reaction doubles when temperature is raised from 208 to 308 K.

$\frac{k_2}{k_1}$ = 2

$E_a = \frac{2.303\times8.314\times298\times308\times0.3014}{1000}$

= 52.89 kJ/mol

Section B

4. Given, first order reaction complete 50% in 120 minutes,

Let, $[x]_0$ = 100 M, $[x]_{120}$ = 100 - 50 = 50 M and t = 120 min.

$k = \frac{2.303}{t}\log\frac{[x_0]}{[x]} = \frac{2.303}{120}\log\frac{100}{50}$

= 0.019 log 2 = 5.78 × 10^{-3} min^{-1}

Time taken to complete 90% reaction = ?

$[x]_0$ = 100 M, $[x]_{90\ min}$ = 100 - 90 = 10 M

k = 5.78 × 10^{-3} min^{-1}

$t = \frac{2.303}{k}\log\frac{[x_0]}{[x]} = \frac{2.303}{5.78\times10^{-3}}\log\frac{100}{10}$

= 0.3984 × 10^{+3} × log 10 = 398.4 min [∵ log 10 = 1]

5. Given, $2H_2 + 2NO \rightleftharpoons 2H_2O + N_2$

Let, the given reaction is of order q with respect to H_2 and p with respect to NO.

The rate of formation of H_2O and N_2 can also be written as,

$4.6\times10^{-3} = k[A]^p[B]^q = k[0.4]^p[0.4]^q$ ...(i)

$18.4\times10^{-3} = k[0.8]^p[0.4]^q$ ...(ii)

$9.2\times10^{-3} = k[0.4]^p[0.8]^q$ ...(iii)

From Eqs. (i) and (ii), we get

$\frac{18.4\times10^{-3}}{4.6\times10^{-3}} = \frac{k(0.8)^p(0.4)^q}{k(0.4)^p(0.4)^q}$

$4 = (2)^p \Rightarrow (2)^2 = (2)^p$

Hence, p = 2

From Eqs. (i) and (iii), we get

$\frac{9.2\times10^{-3}}{4.6\times10^{-3}} = \frac{k(0.4)^p(0.8)^q}{k(0.4)^p(0.4)^q} \Rightarrow 2 = (2)^q$

∴ q = 1

i. Overall order of reaction is (2 + 1) = 3

ii. Rate law equation, r = k $[NO]^2$ $[H_2]$

iii. r = k $[H_2]^2$ [NO]

Rate constant, k

$= \frac{r}{[H_2][NO]^2} = \frac{4.6\times10^{-3}}{[0.4][0.4]^2}$

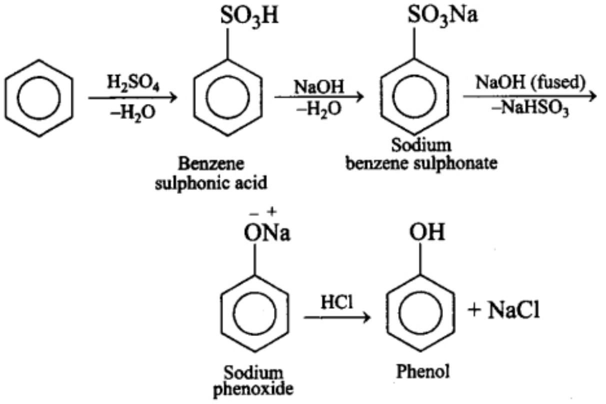
$= 7.18\times10^{-2}\ mol^{-2}\ L^2\ s^{-1}$

6. Molecular mass of NaOH
$= 23 + 16 + 1 = 40\ g\ mol^{-1}$
Number of moles of NaOH in 80 g
$(n) = \frac{\text{Mass of } NaOH}{\text{Molecular mass of } NaOH}$
$= \frac{80}{40} = 2\ mol$
Molecular mass of water $= 2 + 16 = 18\ g\ mol^{-1}$
Number of moles of water in 54 g,
$(N) = \frac{54}{18} = 3\ mol$
Total number of moles in solution = n + N
= 2 + 3 = 5 mol
Mole fraction of water in solution
$= \frac{\text{Number of moles of water}}{\text{Total number of moles present in solution}}$
$= \frac{N}{n+N} = \frac{3}{5} = 0.6$
7. There are strong hydrogen bonding in alcohol molecules as well as water molecules. On mixing alcohol and water, the molecular interactions become weak. Therefore, they show positive deviation from ideal behaviour. As a result, the solution will have higher vapour pressure and lower boiling point than that of alcohol and water.
8. The dissolution of a gas in a liquid exothermic process. Therefore, in accordance with LeChatelier's principle, with increase in temperature, the equilibrium shifts in the backward direction.
Liquid + Gas $\rightarrow$ Dissolved gas, ΔH = -ve
Therefore, the solubility of gas in solution decreases with rise in temperature.
9. i. $[Cr(NH_3)_3(H_2O)_3]Cl_3$
   ii. $K_3[Fe(CN)_6]$
10. i. a. $K_3[Fe(C_2O_4)_3]$
   Potassiumtrioxalato ferrate (III)
   b. $[Co(NH_3)_5Cl]SO_4$
   Pentaamminechlorocobalt (lll) sulphate
   ii. $[Fe(CN)_6]^{4-}$ ion
   a. Let the oxidation number of iron in the complex, $[Fe(CN)_6]^{4-}$ be x.
   $\therefore$ x + 6(-1) = -4, $\Rightarrow$ x - 6 = -4
   x = 6 - 4 = 2
   b. Hexacyanoferrate(II)
11. i. Transition elements form a large number of complex compounds due to the comparatively smaller sizes of the metal ions, their high charge density and the availability of vacant d-orbitals for bond formation.
   ii. Transition elements show variable oxidation states in their compounds because there is a very small energy difference in between (n - 1) d and ns-orbitals.
   As a result, electrons of (n - 1) d-orbitals as well as ns-orbitals take part in bond formation.

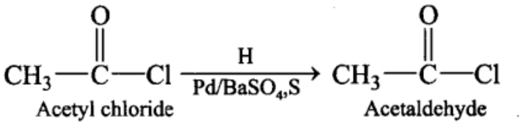
OR

   i. Electronic configuration of Mn^{+2} is $3d^5$, which is half filled and hence stable. Hence it cannot lose third electron easily. In case of Fe^{+2} electronic configuration is $3d^6$. Hence, it can lose one electron easily to give stable configuration $3d^5$.
   ii. It is due to d-d transition by absorbing part of visible light.
   iii. Due to Lanthanoid contraction they have same atomic and ionic size or they have same general electronic configuration.

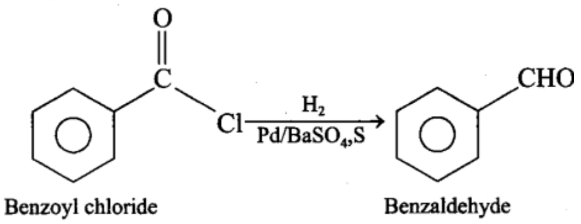
12. Conversion of benzene to phenol is as follows



13. i. **Rosenmund reduction** Acyl chloride or acid chloride is hydrogenated in the presence of palladium catalyst supported over and partially poisoned by the addition of sulphur or barium sulphate. This reaction is called Rosenmund reduction.



$$\mathrm{CH_3-\overset{\overset{O}{\|}}{C}-Cl \xrightarrow[Pd/BaSO_4,S]{H} CH_3-\overset{\overset{O}{\|}}{C}-Cl}$$



ii. Formaldehyde reacts with ammonia to form hexamethylene tetraamine. Also, known as urotropine.

$$\underset{\text{Formaldehyde}}{6\mathrm{HCHO}} + 4\mathrm{NH_3} \xrightarrow{\Delta} \underset{\substack{\text{(Urotropine)}\\ \text{Hexamethylenetetraamine}}}{(\mathrm{CH_2})_6\mathrm{N_4}} + 6\mathrm{H_2O}$$

Section C

14. i. a. Aldehydes having atleast one α-H undergo aldol condensation in the presence of a base to give α-hydroxyaldehydes (aldol).
Since, acetaldehyde CH_3CHO has no α-H whereas, formaldehyde HCHO has no α-H, therefore HCHO do not undergo aldol condensation.

b. Chloroacetic acid $Cl\text{-}CH_2\text{-}COOH$ is strongest acid than acetic acid $CH_3\text{-}COOH$-Cl is electron withdrawing group. It increases the acidity of acetic acid by dispersing negative charge by inductive effect and stabilise the acetate anion.

c. Carbon, the C atom of the C=O group acquires a partial positive charge in aldehydes and ketones and hence readily undergo nucleophilic addition reactions.

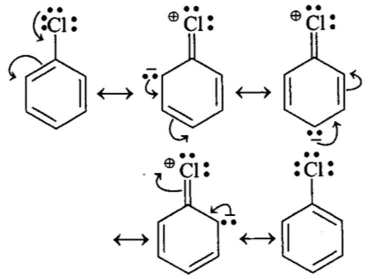
ii. An organic compound (A) is not reduced by Fehling solution but undergoes Cannizzaro reaction (A) is benzaldehyde.

$$C_6H_5CHO + C_6H_5CHO \xrightarrow{\text{NaOH}} C_6H_5COONa + C_6H_5CH_2OH$$

15. i. a. Benzyl chloride when treated with $AgNO_3$ solution, will give a white ppt. while chlorobenzene will not.

b. Chloroform when treated with 1° amine and KOH, gives offensive smelling isocyanides while CCl_4 does not give this test.

ii. Chlorobenzene is stabilised by resonance so, has a double bond character between C and Cl. Secondly, C is sp^2-hybridised so, more electronegative, thus Cl^- is not replaced easily.



While in methyl chloride, C-Cl has a single bond character which can be cleaved easily and hence, it is hydrolysed more easily than chlorobenzene.

16. i. a. $K_3[Al(C_2O_4)_3]$

b. $[Cr(NH_3)_3(H_2O)_3]Cl_3$

ii. Let, the oxidation state of Co in the complex $[Co(NH_3)_6]^{3+}$ be x.

$\therefore$ x + 6 × 0 = +3

x = +3

As six ammonia molecule is attached to Co (central metal). Thus, coordination number is 6.

17. i. Since, $E^\circ_{Pb^{2+}/Pb} > E^\circ_{Zn^{2+}/Zn}$

Hence, Pb will reduce and zinc will oxidise, i.e. Pb^{2+} will move towards cathode and Zn towards anode.

At anode, $Zn \longrightarrow Zn^{2+} + 2e^-; E^\circ = -0.76\ V$

At cathode, $Pb^{2+} + 2e^- \longrightarrow Pb; E^\circ = -0.13\ V$

Cell reaction, $Zn + Pb^{2+} \longrightarrow Pb + Zn^{2+}$

Cell representation is

$Zn\left|Zn^{2+}(0.1M)\right|\left|Pb^{2+}(0.2M)\right|Pb$

ii. $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$

$= E^\circ_{Pb^{2+}/Pb} - E^\circ_{Zn^{2+}/Zn}$

= -0.13 - (-0.76) = -0.13 + 0.76

$E^\circ_{\text{cell}} = +0.63\ V$

$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{n}\log\frac{[\text{[Product]}]}{[\text{Reactant}]}$(Here, $n = 2$)

$= 0.63 - \frac{0.059}{2}\log\frac{(0.1)}{(0.2)}$

= 0.63 - 0.0295 log (0.5)

= 0.63 - 0.0295(-030) $= 0.63 + 8.85 \times 10^{-3}$

$E_{\text{cell}} = 0.6388\ V$

OR

The cell reaction is

$Zn(s) + Cd^{2+}(aq) \longrightarrow Cd(s) + Zn^{2+}(aq)$

E°_{cell} of the cell is given by

$E^\circ_{\text{cell}} = E^\circ_{\text{right}} - E^\circ_{\text{left}}$

= -0.403 - (-0.763) = 0.36 V

Applying Nernst equation to the cell reaction

$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{n}\log\frac{[Zn^{2+}(aq)]}{[Cd^{2+}(aq)]}$

$E_{\text{cell}} = 0.36 - \frac{0.059}{2}\log\frac{0.1}{0.01}$

$E_{\text{cell}} = 036 - 0.0295\log 10$

$= 0.36 - 0.0295 \times 1 = 03305\ V$

Now,

$\Delta_r G^\circ = -nFE^\circ_{\text{cell}}$

$= -2 \times 96500 \times 0.33$

$= -63690\ J\ mol^{-1}$

$= -63.69\ kJ\ mol^{-1}$

18. i. In starch, the glucose monomers are in alpha configuration while in cellulose the glucose monomers are in beta configuration. Starch is a polymer consisting of amylase and amylopectin while cellulose is a long chain composed only of β-D-glucoseunits.

ii. Phosphodiester linkage between the 5' and 3' atoms is present in nucleic acids.

iii. Example of fibrous protein- Collagen, keratin, myosin. **(Any one)**
Example of globular protein-
Insulin, haemoglobin, egg albumin.

19. $t_{\frac{1}{2}}$ for first order reaction is given by, $t_{\frac{1}{2}} = \frac{0.693}{k}$

At 300 K, $k_1 = \frac{0.693}{40}$

At 320 K, $k_2 = \frac{0.693}{20}$

From Arrhenius equation,

$\log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$\log\left(\frac{40}{20}\right) = \frac{E_a}{2.303 \times 8.314\ \text{J mol}^{-1}\ \text{K}^{-1}}\left[\frac{1}{300} - \frac{1}{320}\right]$

$\log 2 = \frac{E_a}{19.147\ \text{J mol}^{-1}\ \text{K}^{-1}}\left[\frac{320-300}{300 \times 320}\right]$

$0.3010 = \frac{E_a}{19.147\ \text{J mol}^{-1}\ \text{K}^{-1}} \times 0.0002083\ \text{K}^{-1}$

$E_a = 27668$ J/mol

20. Given, $A + B \longrightarrow$ Products

According to law of mass action,

Rate $\propto [A]^m[B]^n$ if the reaction is of order m with respect to [A] and n with respect to [B].

Hence, rate $= k[A]^m[B]^n$ ...(i)

(where, k = Rate constant)

In case I, i.e. when concentration of A is doubled.

$2 \times \text{ Rate } = k[2A]^m[B]^n$ ...(ii)

In case II, i.e. when concentrations of A and B are doubled.

$8 \times \text{ Rate } = k[2A]^m[2B]^n$ ...(iii)

On dividing Eq. (iii) by Eq. (ii), we get

$\frac{8 \times \text{ Rate}}{2 \times \text{ Rate}} = \frac{k[2A]^m[2B]^n}{k[2A]^m[B]^n}$

$\Rightarrow (2)^2 = [2]^n \Rightarrow n = 2$

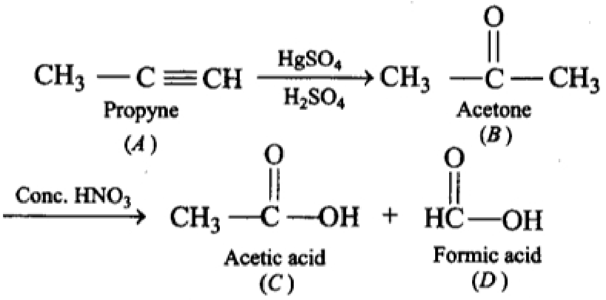
Similarly, on dividing Eq. (ii) by Eq. (i), m comes out to be 1, thus m = 1, n = 2

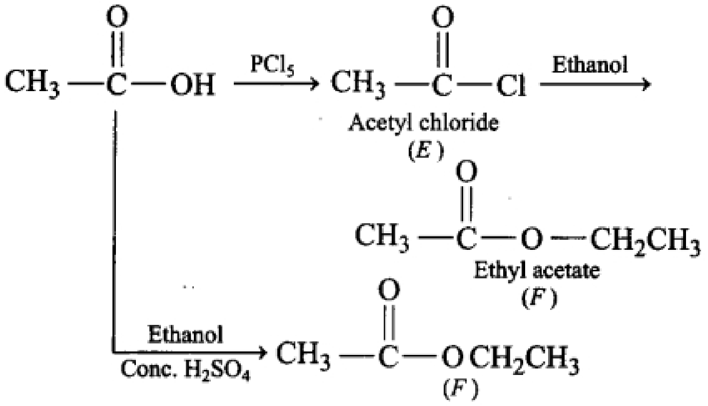
Hence, reaction is of first order with respect to A and of second order with respect to B.

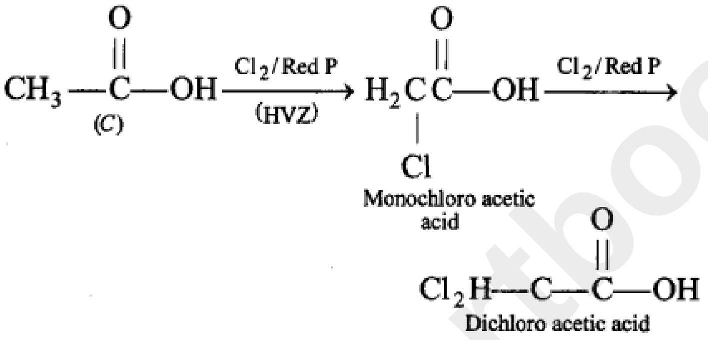
So, rate = k[A] $[B]^2$

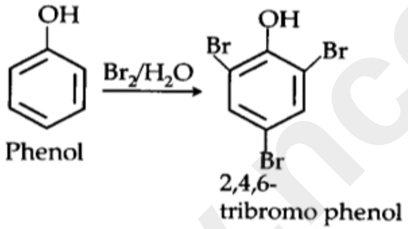
Section D

21. The reaction takes place as follows



- 

- 

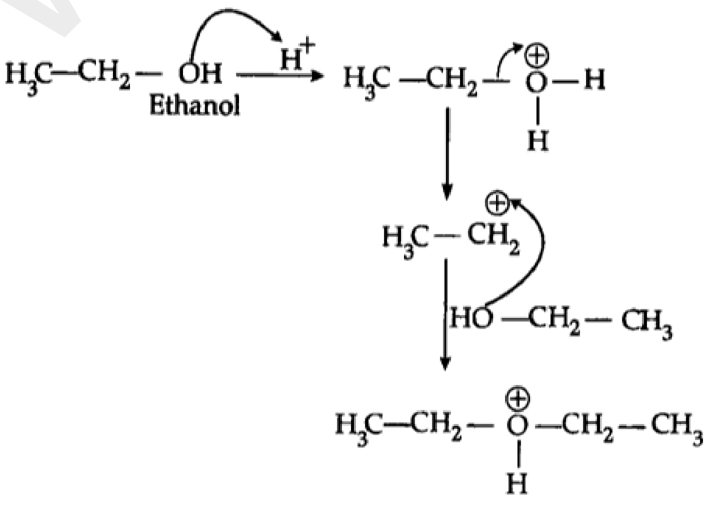
22. i. a. 

$$3CH_3-CH=CH_2 \xrightarrow{B_2H_6} (CH_3-CH_2-CH_2)_3-B \xrightarrow[H_2O_2/3OH]{} 3CH_3-CH_2-CH_2OH$$

ii. a. ethanol < phenol < p-nitrophenol

b. Propane < Propanal < propanol

iii.



23. Moles of A $= \frac{100}{140} = 0.714$

Moles of B $= \frac{1000}{180} = 5.556$

Mole of fraction of A $= \frac{0.714}{0.714+5.556} = 0.114$

Mole fraction of B = 1 - 0.114

= 0.886

$p_{\text{total}} = p_A + p_B$

$= p_A{}^{\circ} x_A + p_B{}^{\circ} x_B$

$475 = p_A{}^{\circ} \times 0.114 + 500 \times 0.886$

$475 = 0.114 p_A{}^{\circ} + 443$

$0.114 p_A{}^{\circ} = 32$

$p_A{}^{\circ} = 280.7$ torr

$\therefore$ Vap. pressure of pure A = 280.7 torr

Vap. pressure of A in solution = 280.7 × 0.114 = 32 torr

OR

i. a. Given: $T_f = 272.4\ K, T_f^{\circ} = 273.0\ K$

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

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

Vapour pressure of water at 298 K

= 23.756 mm Hg

m = ?

As we know, $\Delta T_f = K_f \times m$

$\therefore 0.6 = 1.86 \times m$ or $m = \frac{0.6}{1.86}$

Thus, molality of solution $= 0.323\ m$

b. T_b (Boiling point of solution) = ?

We know, $\frac{\Delta T_f}{\Delta T_b} = \frac{K_f}{K_b}$

$\therefore \frac{0.6}{\Delta T_b} = \frac{1.86}{0.512}$

or $\Delta T_b = \frac{0.6 \times 0.512}{1.86} = 0.17\ K$

Also, $\Delta T_b = T_b - T_b^{\circ}$

$\Rightarrow 0.17 = T_b - 273$

$\therefore 0.17 + 273 = T_b\ 273.17\ K = T_b$

c. Lowering of vapour pressure at 298 K = ?

we know, $\frac{p^{\circ}-p}{p^{\circ}} = \frac{(760-23.756) mmHg}{760\ mmHg}$

$\therefore \frac{p^{\circ}-p}{p^{\circ}} = 0.969$

ii. Given, mass of calcium nitrate = 1.23 g

Mass of water = 109 Tb for solution = 100975$^{\text{o}}$C

K_b for water = 0.52K kg mol^{-1}

Molecular weight of calcium nitrate = 164 g mol^{-1}

As we know,

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

$\Rightarrow \Delta T_b = i \times K_b \times \frac{w_B}{M_B} \times \frac{1000}{W_A}$

$100.975 - 100^{\circ}C = i \times 0.52 \times \frac{1.23}{164} \times \frac{1000}{10}$

or $0.975 = i \times 0.52 \times 0.75$

$\therefore$ i = 2.5