Class XII
CHEMISTRY (Theory)
(CBSE 2019)

Time : 3 Hrs.

Max. Marks : 70

GENERAL INSTRUCTIONS :

(i) All questions are compulsory.

(ii) Section A : Q. no. 1 to 5 are very short-answer questions and carry 1 mark each.

(iii) Section B : Q. no. 6 to 12 are short-answer questions and carry 2 marks each.

(iv) Section C : Q. no. 13 to 24 are also short-answer questions and carry 3 marks each.

(v) Section D : Q. no. 25 to 27 are long-answer questions and carry 5 marks each.

(vi) There is no overall choice. However, an internal choice has been provided in **two** questions of **one** mark, **two** questions of **two** marks, **four** questions of **three** marks and all the **three** questions of **five** marks weightage. You have to attempt only one of the choices in **such** questions.

(vii) Use log tables if necessary. Use of calculators is **not** allowed.

Section-A

1. Out of NaCl and AgCl, which one shows Frenkel defect and why? [1]

2. Arrange the following in increasing order of boiling points : [1]

   $(CH_3)_3N$, C_2H_5OH, $C_2H_5NH_2$

3. Why are medicines more effective in colloidal state? [1]

   OR

   What is difference between an emulsion and a gel?

4. Define ambident nucleophile with an example. [1]

5. What is the basic structural difference between glucose and fructose? [1]

   OR

   Write the products obtained after hydrolysis of lactose.

6. Write balanced chemical equations for the following processes : **[2]**

   (i) XeF_2 undergoes hydrolysis.

   (ii) MnO_2 is heated with conc. HCl.

OR

   Arrange the following in order of property indicated for each set :

   (i) H_2O, H_2S, H_2Se, H_2Te – increasing acidic character

   (ii) HF, HCl, HBr, HI   – decreasing bond enthalpy

7. State Raoult's law for a solution containing volatile components. Write two characteristics of the solution which obeys Raoult's law at all concentrations. **[2]**

8. For a reaction **[2]**
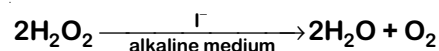
   $$2H_2O_2 \xrightarrow[\text{alkaline medium}]{I^-} 2H_2O + O_2$$

   the proposed mechanism is as given below:

   (1) $H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)

   (2) $H_2O_2 + IO^- \rightarrow H_2O + I^- + O_2$ (fast)

   (i) Write rate law for the reaction.

   (ii) Write the overall order of reaction.

   (iii) Out of steps (1) and (2), which one is rate determining step?

9. When MnO_2 is fused with KOH in the presence of KNO_3 as an oxidizing agent, it gives a dark green compound (A). Compound (A) disproportionates in acidic solution to give purple compound (B). An alkaline solution of compound (B) oxidises KI to compound (C) whereas an acidified solution of compound (B) oxidises KI to (D). Identify (A), (B), (C), and (D). **[2]**

10. Write IUPAC name of the complex $[Pt(en)_2Cl_2]$. Draw structures of geometrical isomers for this complex. **[2]**

OR

   Using IUPAC norms write the formulae for the following :

   (i) Hexaamminecobalt(III) sulphate

   (ii) Potassium trioxalatochromate(III)

11. Out of $[CoF_6]^{3-}$ and $[Co(en)_3]^{3+}$, which one complex is **[2]**
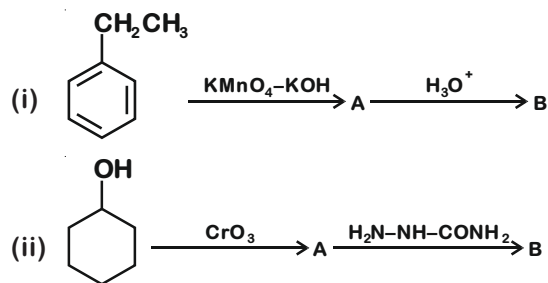
   (i) paramagnetic

   (ii) more stable

   (iii) inner orbital complex and

   (iv) high spin complex

   (Atomic no. of Co = 27)

12. Write structures of compounds A and B in each of the following reactions : **[2]**

(i)

CH_2CH_3 (on benzene ring)

$\xrightarrow{KMnO_4-KOH} A \xrightarrow{H_3O^+} B$

(ii)

OH (on cyclohexane ring)

$\xrightarrow{CrO_3} A \xrightarrow{H_2N-NH-CONH_2} B$

Section-C

13. The decomposition of NH_3 on platinum surface is zero order reaction. If rate constant (k) is 4×10^{-3} Ms^{-1}, how long will it take to reduce the initial concentration of NH_3 from 0.1 M to 0.064 M.

[3]

14. (i) What is the role of activated charcoal in gas mask? **[3]**

(ii) A colloidal sol is prepared by the given method in figure. What is the charge on hydrated ferric oxide colloidal particles formed in the test tube? How is the sol represented?

FeCl$_3$
Solution

NaOH
Solution
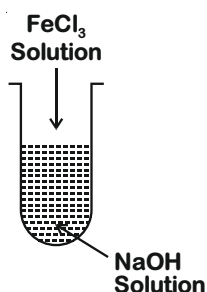
(iii) How does chemisorption vary with temperature?

15. An element crystallizes in fcc lattice with a cell edge of 300 pm. The density of the element is 10.8 g cm^{-3}. Calculate the number of atoms in 108 g of the element. **[3]**

16. A 4% solution(w/w) of sucrose (M = 342 g mol^{-1}) in water has a freezing point of 271.15 K. Calculate the freezing point of 5% glucose (M = 180 g mol^{-1}) in water.

(Given: Freezing point of pure water = 273.15 K) **[3]**

17. (a) Name the method of refining which is **[3]**

   (i) Used to obtain semiconductor of high purity.

   (ii) Used to obtain low boiling metal.

(b) Write chemical reactions taking place in the extraction of copper from Cu_2S.

18. Give reasons for the following: **[3]**

(i) Transition elements and their compounds act as catalysts.

(ii) E° value for (Mn^{2+}|Mn) is negative whereas for (Cu^{2+}|Cu) is positive.

(iii) Actinoids show irregularities in their electronic configuration.

19. Write the structures of monomers used for getting the following polymers: [3]
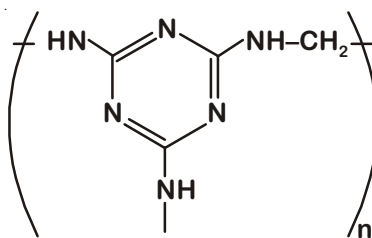
    (i) Nylon-6, 6

    (ii) Glyptal

    (iii) Buna-S

OR

(i) Is $+CH_2-\overset{\overset{\displaystyle CH_3}{|}}{CH}\,]_n$ a homopolymer or copolymer? Give reason.

(ii) Write the monomers of the following polymer :

(iii) What is the role of Sulphur in vulcanization of rubber?

20. (i) What type of drug is used in sleeping pills? [3]

    (ii) What type of detergents are sued in toothpastes?

    (iii) Why the use of alitame as artificial sweetener is not recommended?

OR

Define the following terms with a suitable example in each :

(i) Broad-spectrum antibiotics

(ii) Disinfectants

(iii) Cationic detergents

21. (i) Out of $(CH_3)_3C-Br$ and $(CH_3)_3C-I$, which one is more reactive towards S_N1 and why? [1]

    (ii) Write the product formed when p-nitrochlorobenzene is heated with aqueous NaOH at 443 K followed by acidification? [1]

    (iii) Why dextro and laevo-rotatory isomers of Butan-2-ol are difficult to separate by fractional distillation? [1]
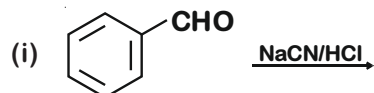
22. An aromatic compound 'A' on heating with Br_2 and KOH forms a compound 'B' of molecular formula C_6H_7N which on reacting with $CHCl_3$ and alcoholic KOH produces a foul smelling compound 'C'. Write the structures and IUPAC names of compounds A, B and C. [3]

23. Complete the following reactions :   **[3]**

(i)

benzaldehyde with CHO group $\xrightarrow{\text{NaCN/HCl}}$

(ii) $(C_6H_5CH_2)_2Cd + 2CH_3COCl \rightarrow$

(iii)

$$CH_3-\underset{\underset{CH_3}{|}}{CH}-COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } Br_2 / \text{Red } P_4}$$

O R

Write chemical equations for the following reactions :

(i) Propanone is treated with dilute $Ba(OH)_2$.

(ii) Acetophenone is treated with Zn(Hg)/Conc.HCl.

(iii) Benzoyl chloride is hydrogenated in presence of $Pd/BaSO_4$.

24. Differentiate between the following   **[3]**

(i) Amylose and Amylopectin

(ii) Peptide linkage and Glycosidic linkage
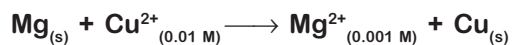
(iii) Fibrous proteins and Globular proteins

OR

Write chemical reactions to show that open structure of D-glucose contains the following :

(i) Straight chain

(ii) Five alcohol groups

(iii) Aldehyde as carbonyl group

Section-D

25. $E°_{cell}$ for the given redox reaction is 2.71 V   **[5]**

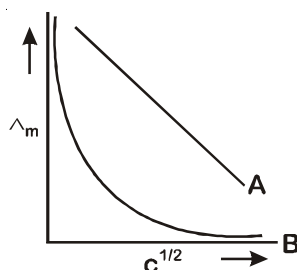$$Mg_{(s)} + Cu^{2+}_{(0.01 \text{ M})} \longrightarrow Mg^{2+}_{(0.001 \text{ M})} + Cu_{(s)}$$

Calculate E_{cell} for the reaction. Write the direction of flow of current when an external opposite potential applied is

(i) less than 2.71 V and

(ii) greater than 2.71 V

OR

(a) A steady current of 2 amperes was passed through two electrolytic cells X and Y connected in series containing electrolytes $FeSO_4$ and $ZnSO_4$ until 2.8 g of Fe deposited at the cathode of cell X. How long did the current flow? Calculate the mass of Zn deposited at the cathode of cell Y.

(Molar mass : Fe = 56 g mol^{-1}, Zn = 65.3 g mol^{-1}, 1 F = 96500 C mol^{-1})

(b) In the plot of molar conductivity ($\wedge_m$) vs square root of concentration ($c^{1/2}$) following curves are obtained for two electrolytes A and B :

Answer the following :

(i) Predict the nature of electrolytes A and B.

(ii) What happens on extrapolation of $\wedge_m$ to concentration approaching zero for electrolytes A and B ?

26. (a) How do you convert the following :   [5]

    (i) Phenol to Anisole

    (ii) Ethanol to Propan-2-ol

(b) Write mechanism of the following reaction :

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

(c) Why phenol undergoes electrophilic substitution more easily than benzene?

OR

(a) Account for the following :

    (i) o-nitrophenol is more steam volatile than p-nitrophenol.

    (ii) t-butyl chloride on heating with sodium methoxide gives 2-methylpropene instead of t-butylmethylether.

(b) Write the reaction involved in the following :

    (i) Reimer-Tiemann reaction

    (ii) Friedal-Crafts Alkylation of Phenol

(c) Give simple chemical test to distinguish between Ethanol and Phenol.

27. (a) Give reasons for the following: [5]

   (i)   Sulphur in vapour state shows paramagnetic behaviour.

   (ii) N-N bond is weaker than P-P bond.

   (iii) Ozone is thermodynamically less stable than oxygen.

(b) Write the name of gas released when Cu is added to

   (i)   dilute HNO_3 and

   (ii) conc. HNO_3

<p align="center">OR</p>

(a) (i)   Write the disproportionation reaction of H_3PO_3.

   (ii) Draw the structure of XeF_4.

(b) Account for the following :

   (i)   Although Fluorine has less negative electron gain enthalpy yet F_2 is strong oxidizing agent.

   (ii) Acidic character decreases from N_2O_3 to Bi_2O_3 in group 15.

(c) Write a chemical reaction to test sulphur dioxide gas. Write chemical equation involved.

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Class XII
CHEMISTRY (Theory)
(CBSE 2019)
SOLUTION

Section-A

1. Out of NaCl and AgCl, which one shows Frenkel defect and why?   [1]

Sol. AgCl shows Frenkel defect.   [½]

Due to large difference in size of cation (Ag^+) and anion (Cl^-), AgCl shows Frenkel defect.   [½]

2. Arrange the following in increasing order of boiling points :   [1]

$(CH_3)_3N$, C_2H_5OH, $C_2H_5NH_2$

Sol. Boiling point : $(CH_3)_3N < C_2H_5NH_2 < C_2H_5OH$ [1]

3. Why are medicines more effective in colloidal state?   [1]

OR

What is difference between an emulsion and a gel?

Sol. Medicines are more effective in colloidal state because colloids have larger surface area and hence their absorption, assimilation and digestion become easier. [1]

OR

[1]

	Dispersed phase	Dispersion medium
Emulsion	liquid	liquid
Gel	liquid	solid

4. Define ambident nucleophile with an example. [1]

Sol. Nucleophiles which have more than one donor site (nucleophilic centre) are called ambident nucleophiles. [½]
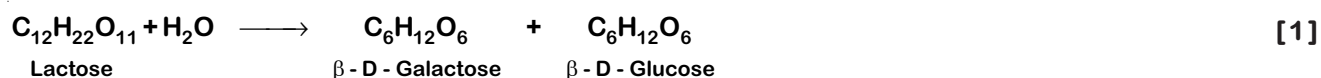
For example : $^-$CN, $^-$SCN [½]

5. What is the basic structural difference between glucose and fructose? [1]

OR

Write the products obtained after hydrolysis of lactose.

Sol. Glucose is an aldohexose and fructose is a ketohexose. [1]

OR

$$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$ [1]

Lactose   β - D - Galactose   β - D - Glucose

Section-B

6. Write balanced chemical equations for the following processes : [2]

   (i) XeF_2 undergoes hydrolysis.

   (ii) MnO_2 is heated with conc. HCl.

OR

Arrange the following in order of property indicated for each set :

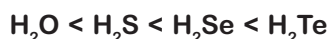   (i) H_2O, H_2S, H_2Se, H_2Te – increasing acidic character

   (ii) HF, HCl, HBr, HI – decreasing bond enthalpy

Sol. (i) $2XeF_2(s) + 2H_2O(l) \rightarrow 2Xe(g) + O_2(g) + 4HF(aq)$ [1]

   (ii) $MnO_2 + 4HCl_{\text{conc.}} \rightarrow MnCl_2 + Cl_2 + 2H_2O$ [1]

OR

   (i) Acidic character

   $H_2O < H_2S < H_2Se < H_2Te$

   Down the group, bond dissociation enthalpy decreases, so acidic character increases. [1]

   (ii) Bond enthalpy H–F > H–Cl > H–Br > H–I

   As size of halogen increases, bond length increases, bond strength decreases. [1]

7. State Raoult's law for a solution containing volatile components. Write two characteristics of the solution which obeys Raoult's law at all concentrations. **[2]**

Sol. Raoult's law states that for a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution. **[1]**

Let us consider two volatile components 1 and 2 having mole fraction x_1 and x_2 in the solution.

For component 1

$p_1 = p_1^{\circ} x_1$

Similarly for component 2

$p_2 = p_2^{\circ} x_2$

p_1° and p_2° are the pressure of the two components in the pure state

Therefore, $P_{Tot} = p_1 + p_2 = p_1^{\circ} x_1 + p_2^{\circ} x_2$

Characteristics of the solution which obeys Raoult's law at all concentrations

(1) The total vapour pressure of the solution always lies between the vapour pressures of pure components. **[½]**

(2) Total vapour pressure over the solution varies linearly with mole fraction of component 1 or 2. **[½]**
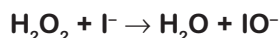
8. For a reaction **[2]**
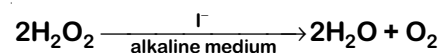
$$2H_2O_2 \xrightarrow[\text{alkaline medium}]{I^-} 2H_2O + O_2$$

the proposed mechanism is as given below:

(1) $H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)

(2) $H_2O_2 + IO^- \rightarrow H_2O + I^- + O_2$ (fast)

(i) Write rate law for the reaction.

(ii) Write the overall order of reaction.

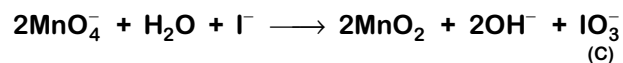(iii) Out of steps (1) and (2), which one is rate determining step?

Sol. Slowest step is

$H_2O_2 + I^- \rightarrow H_2O + IO^-$

(i) Rate law; $r = k[H_2O_2][I^-]$ **[1]**

(ii) Overall order of reaction = 2 **[½]**

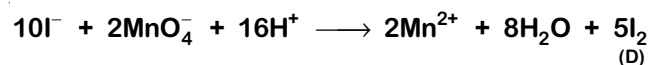(iii) Since 1st step is the slow step so, it is the rate determining step. **[½]**

9. When MnO_2 is fused with KOH in the presence of KNO_3 as an oxidizing agent, it gives a dark green compound (A). Compound (A) disproportionates in acidic solution to give purple compound (B). An alkaline solution of compound (B) oxidises KI to compound (C) whereas an acidified solution of compound (B) oxidises KI to (D). Identify (A), (B), (C), and (D). **[2]**

Sol. $2MnO_2 + 4KOH + \underset{\text{(from KNO}_3\text{)}}{O_2} \longrightarrow \underset{\substack{\text{(dark green)} \\ \text{(A)}}}{2K_2MnO_4} + 2H_2O$

$\underset{\text{(acidic medium)}}{3MnO_4^{2-} + 4H^+} \longrightarrow \underset{\substack{\text{(purple)} \\ \text{(B)}}}{2MnO_4^-} + MnO_2 + 2H_2O$
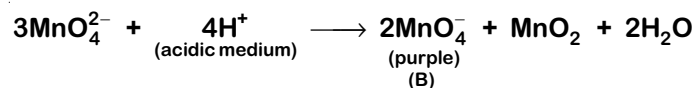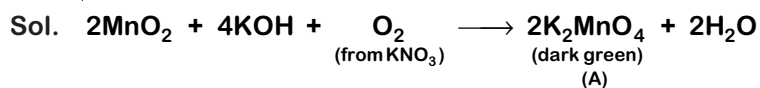
B in basic medium converts I^- to IO_3^-

$2MnO_4^- + H_2O + I^- \longrightarrow 2MnO_2 + 2OH^- + \underset{\text{(C)}}{IO_3^-}$

B in acidic medium converts I^- to I_2

$10I^- + 2MnO_4^- + 16H^+ \longrightarrow 2Mn^{2+} + 8H_2O + \underset{\text{(D)}}{5I_2}$

[A] = K_2MnO_4 = Potassium manganate	[½]
[B] = $KMnO_4$ = Potassium permanganate	[½]
[C] = KIO_3 = Potassium iodate	[½]
[D] = I_2 = Iodine	[½]

10. Write IUPAC name of the complex $[Pt(en)_2Cl_2]$. Draw structures of geometrical isomers for this complex. **[2]**
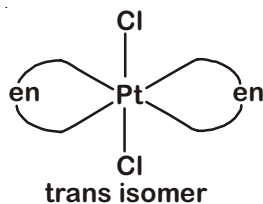
OR

Using IUPAC norms write the formulae for the following :
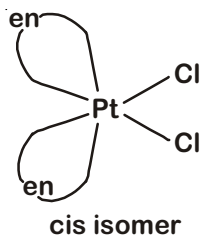(i) Hexaamminecobalt(III) sulphate
(ii) Potassium trioxalatochromate(III)

Sol. $[Pt(en)_2Cl_2]$ – Dichloridobis(ethane-1,2-diammine)platinum (II) **[1]**

Geometrical isomer :

trans isomer **[½]**

cis isomer **[½]**

OR

(i) $[Co(NH_3)_6]_2 (SO_4)_3$ **[1]**
(ii) $K_3[Cr(C_2O_4)_3]$ **[1]**

11. Out of $[CoF_6]^{3-}$ and $[Co(en)_3]^{3+}$, which one complex is   [2]
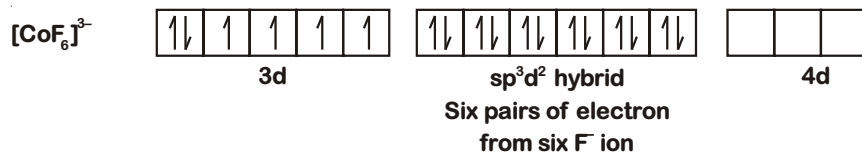
   (i)   paramagnetic

   (ii) more stable

   (iii) inner orbital complex and
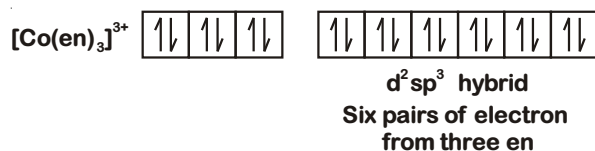
   (iv) high spin complex

   (Atomic no. of Co = 27)

Sol. Co(Z = 27) = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$

   Co^{+3} = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$

   F⁻ is weak field ligand

   $[CoF_6]^{3-}$

   3d   sp³d² hybrid   4d
               Six pairs of electron
               from six F⁻ ion

   en is strong field ligand

   $[Co(en)_3]^{3+}$

               d²sp³ hybrid
           Six pairs of electron
               from three en

   (i) $[CoF_6]^{3-}$ is paramagnetic due to presence of four unpaired electrons   [½]

   (ii) $[Co(en)_3]^{3+}$ is more stable due to chelation   [½]

   (iii) $[Co(en)_3]^{3+}$ forms inner orbital complex (d^2sp^3)   [½]

   (iv) $[CoF_6]^{3-}$ forms high spin complex (sp^3d^2)   [½]
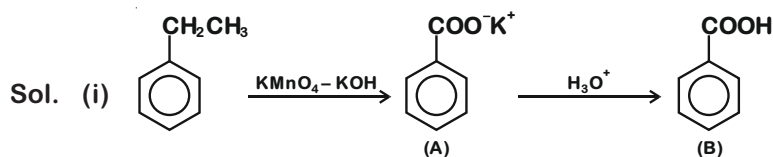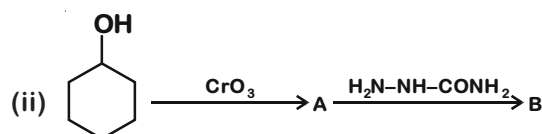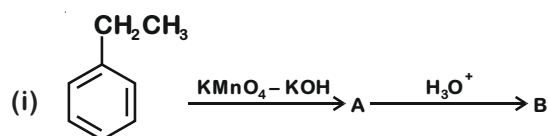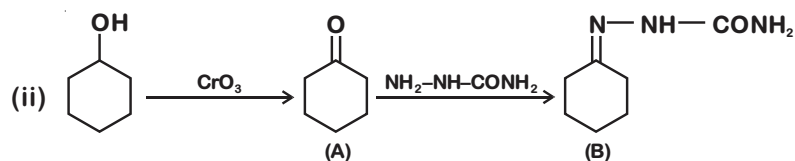
12. Write structures of compounds A and B in each of the following reactions :   [2]

Sol. (i)

             [1]

   (ii)

             [1]

13. The decomposition of NH_3 on platinum surface is zero order reaction. If rate constant (k) is 4×10^{-3} Ms^{-1}, how long will it take to reduce the initial concentration of NH_3 from 0.1 M to 0.064 M. **[3]**

Sol. For zero order reaction

$A_t = A_0 - kt$ **[½]**

$k = 4 \times 10^{-3}$ Ms^{-1}

$A_t = 0.064$ M

$A_0 = 0.1$ M **[½]**

$\therefore$ $t = \dfrac{A_0 - A_t}{k}$ **[½]**

$= \dfrac{0.1 - 0.064}{4 \times 10^{-3}}$ **[½]**
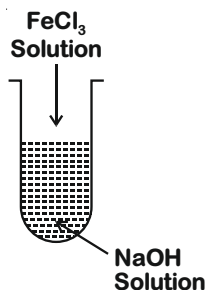
$= \dfrac{36 \times 10^{-3}}{4 \times 10^{-3}}$

$= 9$ second **[1]**

14. **(i)** What is the role of activated charcoal in gas mask? **[3]**

(ii) A colloidal sol is prepared by the given method in figure. What is the charge on hydrated ferric oxide colloidal particles formed in the test tube? How is the sol represented?

FeCl$_3$
Solution

NaOH
Solution

(iii) How does chemisorption vary with temperature?

**Sol.** **(i)** In gas mask activated charcoal is used to adsorb poisonous gases in coal mines. **[1]**

(ii) If $FeCl_3$ is added to NaOH, a negatively charged sol is obtained with adsorption of OH^- ions.

Sol is represented as $Fe_2O_3 \cdot xH_2O/OH^-$.
(negatively charged) **[1]**

(iii) With increase in temperature chemisorption first increases as molecules get activation energy for adsorption. After certain temperature, chemisorption decreases. **[1]**
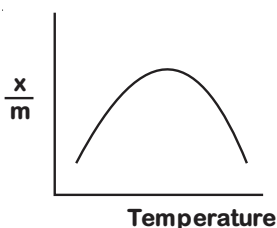
$\dfrac{x}{m}$

Temperature

15. An element crystallizes in fcc lattice with a cell edge of 300 pm. The density of the element is 10.8 g cm^{-3}. Calculate the number of atoms in 108 g of the element. **[3]**

Sol. Volume of unit cell = (300 pm)^3

$$= (3.00 \times 10^{-8} \text{ cm})^3$$

$$= 2.7 \times 10^{-23} \text{ cm}^3 \quad \text{[½]}$$

Volume of 108 g of element $= \dfrac{\text{mass}}{\text{density}} = \dfrac{108 \text{ g}}{10.8 \text{ g cm}^{-3}} = 10 \text{ cm}^3$ **[½]**

Number of unit cells in this volume $= \dfrac{10 \text{ cm}^3}{2.7 \times 10^{-23} \text{ cm}^3 / \text{unit cell}} = \dfrac{10^{24}}{2.7} \text{ unit cells}$ **[1]**

Since each FCC unit cell contains 4 atoms, therefore the total number of atoms in 108 g

$= 4 \text{ atoms / unit cell} \times \dfrac{10^{24}}{2.7} \text{ unit cells}$

$= 1.48 \times 10^{24} \text{ atoms}$ **[1]**

16. A 4% solution(w/w) of sucrose (M = 342 g mol^{-1}) in water has a freezing point of 271.15 K. Calculate the freezing point of 5% glucose (M = 180 g mol^{-1}) in water.

(Given: Freezing point of pure water = 273.15 K) **[3]**

Sol. Molality(m) $= \dfrac{n}{W_{\text{solvent(kg)}}}$ **[½]**

For Sucrose solution :

$m = \dfrac{\frac{4}{342}}{\frac{96}{1000}} = \dfrac{4}{342} \times \dfrac{1000}{96} = 0.122 \text{ m}$ **[½]**

$(\Delta T_f)_1 = (273.15 - 271.15) \text{ K} = 2 \text{ K}$

$(\Delta T_f)_1 = K_f m = K_f \times 0.122$ **[½]**

$2 = K_f \times 0.122 \qquad \ldots(1)$

For glucose solution :

$m = \dfrac{\frac{5}{180}}{\frac{95}{1000}} = \dfrac{5}{180} \times \dfrac{1000}{95} = 0.292 \text{ m}$ **[½]**

$(\Delta T_f)_2 = K_f \times 0.292 \qquad \ldots(2)$

Dividing eqn. (2) by (1)

$\dfrac{(\Delta T_f)_2}{2} = \dfrac{K_f \times 0.292}{K_f \times 0.122}$

$(\Delta T_f)_2 = \dfrac{0.292}{0.122} \times 2 = 4.79$ **[½]**

$T_f = 273.15 - 4.79 = 268.36 \text{ K}$

Freezing point of glucose solution will be 268.36 K **[½]**

17. (a) Name the method of refining which is [3]

    (i)   Used to obtain semiconductor of high purity.

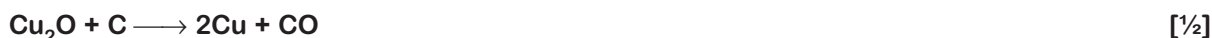   (ii) Used to obtain low boiling metal.

  (b) Write chemical reactions taking place in the extraction of copper from Cu_2S.

Sol. (a) (i) Zone refining [1]

     (ii) Distillation [1]

  (b) •   The sulphide ores are roasted to give oxides

      $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$ [½]

     •   The oxide can easily be reduced to metallic copper using coke

      $Cu_2O + C \longrightarrow 2Cu + CO$ [½]

18. Give reasons for the following: [3]

  (i) Transition elements and their compounds act as catalysts.

  (ii) E° value for $(Mn^{2+}|Mn)$ is negative whereas for $(Cu^{2+}|Cu)$ is positive.

  (iii) Actinoids show irregularities in their electronic configuration.

Sol. (i) Transition elements and their compounds act as catalysts. This is because of their ability to adopt multiple oxidation states and to form complexes. [1]

  (ii) E° value for $(Mn^{2+}|Mn)$ is negative whereas for $(Cu^{2+}|Cu)$ is positive as the hydration enthalpy of Cu^{2+} ion is not sufficient to compensate the sum of sublimation as well as first and second ionisation enthalpy of copper. [1]

  (iii) Actinoids show irregularities in their electronic configuration are related to their stabilities of the f^0, f^7 and f^{14} occupancies of the 5f orbital. [1]
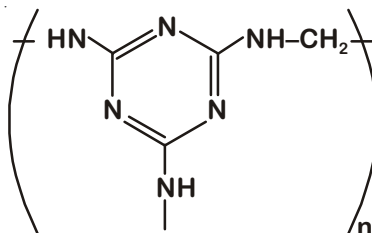
19. Write the structures of monomers used for getting the following polymers: [3]

  (i) Nylon-6, 6

  (ii) Glyptal
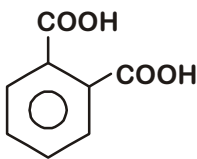
  (iii) Buna-S

<div align="center">**OR**</div>

  (i) Is $\left(CH_2-\underset{\underset{CH_3}{|}}{CH}\right)_n$ a homopolymer or copolymer? Give reason.

  (ii) Write the monomers of the following polymer :

  (iii) What is the role of Sulphur in vulcanization of rubber?

Sol. (i) Nylon-6,6 : $HOOC(CH_2)_4COOH$ + $H_2N(CH_2)_6NH_2$ [1]
  Adipic acid   Hexamethylenediamine

(ii) Glyptal : $HOH_2C–CH_2OH$ +

  Ethylene glycol   Phthalic acid [1]

(iii) Buna-S : $CH_2\text{=}CH–CH\text{=}CH_2$ + $C_6H_5CH\text{=}CH_2$ [1]
  1,3-Butadiene   Styrene

OR

(i) $\text{---}(CH_2–CH)_n$ is homopolymer because only one type of monomer is used in its formation which is
  CH_3

$CH_3–CH\text{=}CH_2$. [1]

(ii)

    +   HCHO
        Formaldehyde [1]

  Melamine

(iii) In vulcanization, sulphur forms cross links at the reactive sites of double bonds of natural rubber so the rubber gets stiffened. [1]

20. (i) What type of drug is used in sleeping pills? [3]

(ii) What type of detergents are used in toothpastes?

(iii) Why the use of alitame as artificial sweetener is not recommended?

OR

Define the following terms with a suitable example in each :

(i) Broad-spectrum antibiotics

(ii) Disinfectants

(iii) Cationic detergents

Sol. (i) Tranquilizers are used in sleeping pills. [1]

(ii) Anionic detergents are used in toothpastes. [1]

(iii) The control of sweetness of food is difficult while using alitame, hence its use as artificial sweetener is not recommended. [1]

OR

(i) Broad-spectrum antibiotics – Antibiotics which kill or inhibit a wide range of gram-positive and gram-negative bacteria are called broad-spectrum antibiotics. [½]

e.g. – Chloramphenicol / Vancomycin / Ofloxacin [½]

(ii) Disinfectants – The chemicals which either kill or prevent the growth of microorganisms are called disinfectants. [½]

e.g. Chlorine or SO_2 [½]

(iii) Cationic detergents – They are quaternary ammonium salts of amines with acetates, chlorides or bromides as anions. [½]

e.g. Cetyltrimethylammonium bromide [½]

21. (i) Out of $(CH_3)_3C–Br$ and $(CH_3)_3C–I$, which one is more reactive towards S_N1 and why? **[1]**

(ii) Write the product formed when p-nitrochlorobenzene is heated with aqueous NaOH at 443 K followed by acidification? **[1]**

(iii) Why dextro and laevo-rotatory isomers of Butan-2-ol are difficult to separate by fractional distillation? **[1]**

Sol. (i) $(CH_3)_3C–I$ **[½]**

Reason: Reactivity towards S_N1 depends upon the ease of formation of carbocation. Since C – I bond is weaker than C–Br bond, hence in case of $(CH_3)_3C–I$, carbocation will be formed easily.

[½]

(ii) **[1]**

(iii) Dextro and laevo rotatory isomers of Butan-2-ol are enantiomers of each other and both have same boiling point and hence they cannot be separated by fractional distillation. **[1]**

22. An aromatic compound 'A' on heating with Br_2 and KOH forms a compound 'B' of molecular formula C_6H_7N which on reacting with $CHCl_3$ and alcoholic KOH produces a foul smelling compound 'C'. Write the structures and IUPAC names of compounds A, B and C. **[3]**
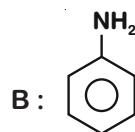
Sol.
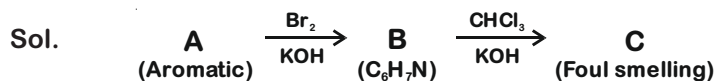
Structure   IUPAC Name
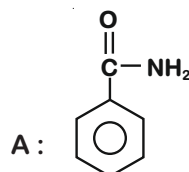
A :   Benzamide   **[½ + ½]**

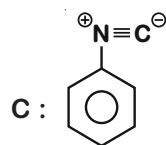B :   Aniline or Benzenamine   **[½ +½]**

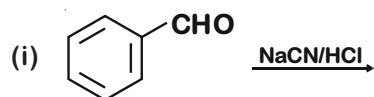C :   Benzene isonitrile   **[½ + ½]**

or Isocyanobenzene or Phenylisocyanide

23. Complete the following reactions : **[3]**
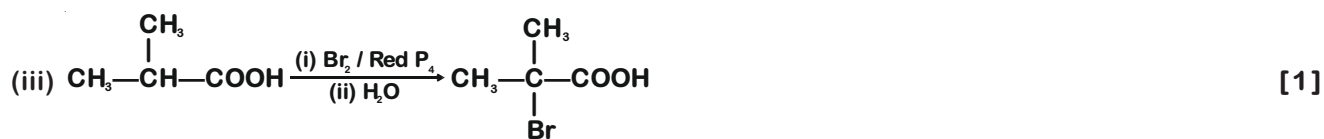
(i)

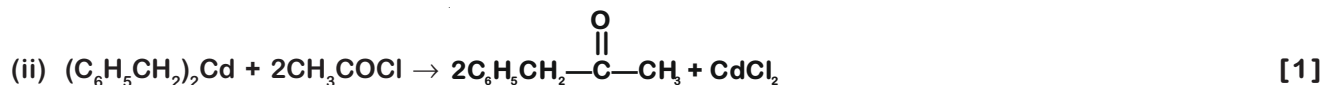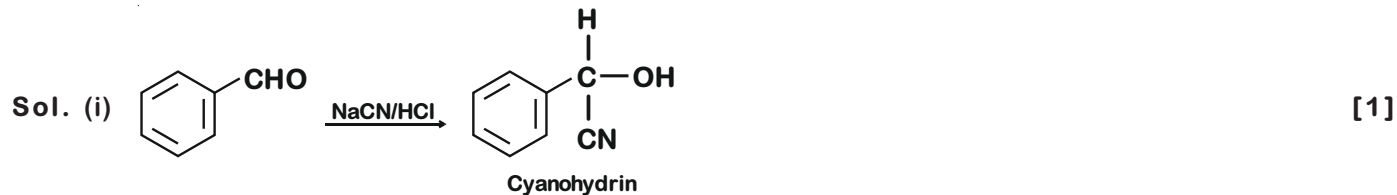(ii) $(C_6H_5CH_2)_2Cd + 2CH_3COCl \rightarrow$
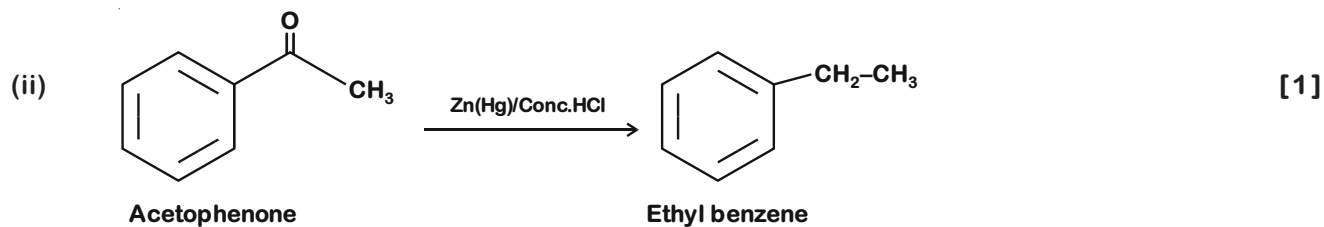
(iii)

OR

Write chemical equations for the following reactions :

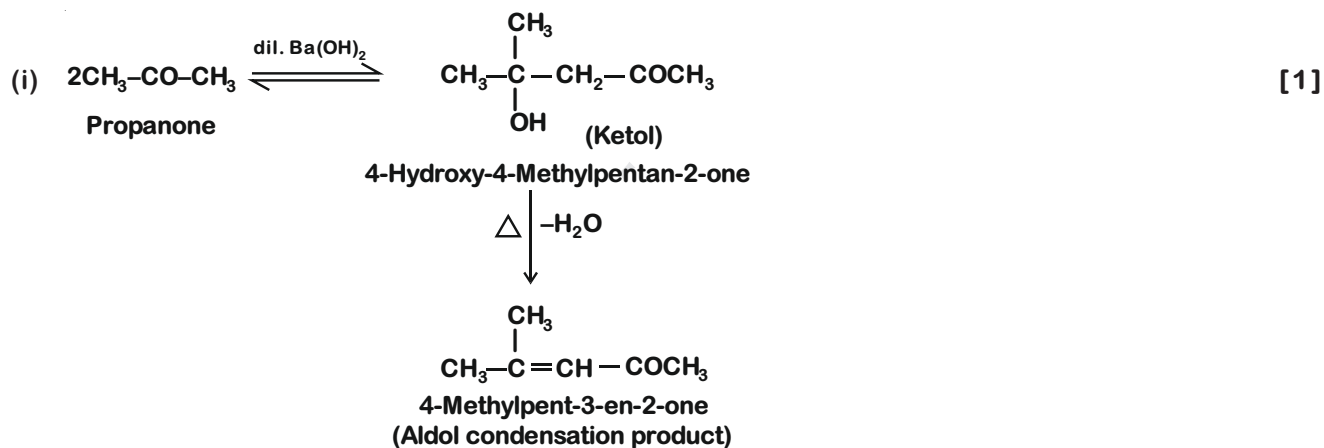(i) Propanone is treated with dilute $Ba(OH)_2$.

(ii) Acetophenone is treated with Zn(Hg)/Conc.HCl.

(iii) Benzoyl chloride is hydrogenated in presence of $Pd/BaSO_4$.

Sol. (i)

Cyanohydrin   [1]

(ii) $(C_6H_5CH_2)_2Cd + 2CH_3COCl \rightarrow 2C_6H_5CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 + CdCl_2$ [1]

(iii)

$$CH_3-\underset{\underset{\displaystyle CH_3}{|}}{CH}-COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } Br_2 \text{ / Red } P_4} CH_3-\underset{\underset{\displaystyle Br}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}-COOH$$ [1]

OR

(i) $2CH_3-CO-CH_3 \underset{\xleftarrow{\hspace{1cm}}}{\overset{\text{dil. } Ba(OH)_2}{\xrightarrow{\hspace{1cm}}}}$ [1]

Propanone

4-Hydroxy-4-Methylpentan-2-one

$\triangle \downarrow -H_2O$

4-Methylpent-3-en-2-one
(Aldol condensation product)

(ii)

Acetophenone   Ethyl benzene   [1]

Clemmensen reduction

(iii)

Benzoyl chloride   Benzaldehyde   [1]

24. Differentiate between the following   [3]

   (i) Amylose and Amylopectin

   (ii) Peptide linkage and Glycosidic linkage

   (iii) Fibrous proteins and Globular proteins

<div align="center">OR</div>

Write chemical reactions to show that open structure of D-glucose contains the following :

   (i) Straight chain

   (ii) Five alcohol groups
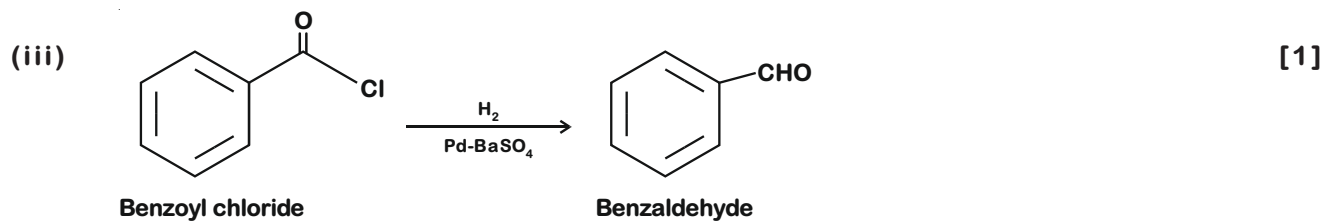
   (iii) Aldehyde as carbonyl group

Sol. (i) [1]

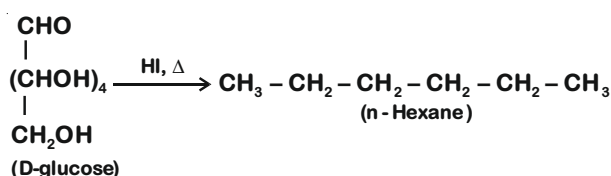|	Amylose		Amylopectin
(a)	Only C1–C4 glycosidic linkage	(a)	C1–C4 glycosidic linkage but, branching occurs by C1–C6 glycosidic linkage
(b)	Water soluble component of starch (15-20%)	(b)	Water insoluble component of starch (80-85%)

(ii) [1]

Peptide linkage	Glycosidic linkage
It is –CONH– linkage which exists in proteins formed by condensation of amino acids.	It is –O– linkage. In disaccharide two monosaccharide units are joined through oxygen atom i.e. glycosidic linkage.

(iii) [1]

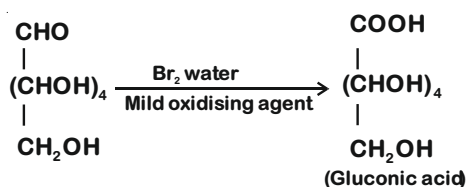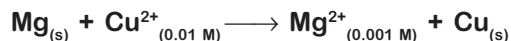|	Fibrous proteins		Globular proteins
(a)	Polypeptide chains run parallel to give fibre-like structure	(a)	Polypeptide chains coil around to give spherical shape
(b)	Generally insoluble in water such as keratin, myosin	(b)	Usually soluble in water such as insulin, albumins

<div align="center">OR</div>

(i) [1]

$$\underset{\text{(D-glucose)}}{\begin{array}{c}CHO\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{array}} \xrightarrow{\text{HI, }\Delta} \underset{\text{(n-Hexane)}}{CH_3-CH_2-CH_2-CH_2-CH_2-CH_3}$$

(ii) Formation of pentaacetate.

$$\begin{array}{c}CHO\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{array} \xrightarrow{\text{Acetic anhydride}} \underset{\text{(Glucose pentaacetate)}}{\begin{array}{c}CHO\\ |\\ (CH-O-\overset{O}{\overset{||}{C}}-CH_3)_4\\ |\\ CH_2-O-\overset{O}{\overset{||}{C}}-CH_3\end{array}}$$ [1]

(iii) [1]

$$\begin{array}{c}CHO\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{array} \xrightarrow[\text{Mild oxidising agent}]{\text{Br}_2\text{ water}} \underset{\text{(Gluconic acid)}}{\begin{array}{c}COOH\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{array}}$$

25. $E°_{cell}$ for the given redox reaction is 2.71 V **[5]**

$Mg_{(s)} + Cu^{2+}_{(0.01 M)} \longrightarrow Mg^{2+}_{(0.001 M)} + Cu_{(s)}$
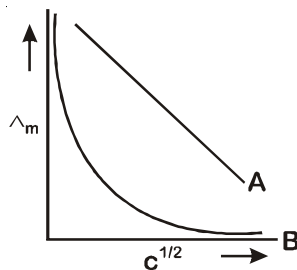
Calculate E_{cell} for the reaction. Write the direction of flow of current when an external opposite potential applied is
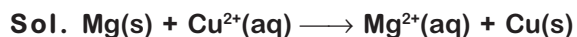
(i) less than 2.71 V and

(ii) greater than 2.71 V

OR

(a) A steady current of 2 amperes was passed through two electrolytic cells X and Y connected in series containing electrolytes $FeSO_4$ and $ZnSO_4$ until 2.8 g of Fe deposited at the cathode of cell X. How long did the current flow? Calculate the mass of Zn deposited at the cathode of cell Y.

(Molar mass : Fe = 56 g mol^{-1}, Zn = 65.3 g mol^{-1}, 1 F = 96500 C mol^{-1})

(b) In the plot of molar conductivity ($\wedge_m$) vs square root of concentration ($c^{1/2}$) following curves are obtained for two electrolytes A and B :

Answer the following :

(i) Predict the nature of electrolytes A and B.

(ii) What happens on extrapolation of $\wedge_m$ to concentration approaching zero for electrolytes A and B ?

Sol. $Mg(s) + Cu^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Cu(s)$

$$Q = \frac{[Mg^{2+}][Cu]}{[Mg][Cu^{2+}]} = \frac{(0.001)(1)}{(1)(0.01)} = 0.1$$ **[½]**

Using Nernst equation,

$$E_{cell} = E°_{cell} - \frac{0.0591}{n}\log Q$$ **[1]**

$$= 2.71 - \frac{0.0591}{2}\log 0.1$$ **[½]**

$$= 2.74 \text{ V}$$ **[1]**

(i) Since the voltage applied externally is less than E_{cell} then the direction of flow of current is from cathode to anode **[1]**

(ii) When the external voltage applied exceeds E_{cell}, the direction of flow of current is from anode to cathode. **[1]**

*If voltage is applied is greater than 2.74 V, the direction of current is from anode to cathode.

OR

(a) I = 2 A

W$_1$ = 2.8 g

$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$

96500 × 2 C of charge is required to deposit = 56 g of Fe   [½]

9650 C of charge is required to deposit = 2.8 g of Fe   [½]

$\because$ Q = It or t $= \dfrac{9650}{2} = 4825$ s   [½]

Using Faraday's second law of electrolysis

$$\dfrac{W_1 \text{ (Weight of Fe deposited)}}{W_2 \text{ (Weight of Zn deposited)}} = \dfrac{E_1 \text{ (Equivalent weight of Fe)}}{E_2 \text{ (Equivalent weight of Zn)}}$$ [½]

$$\dfrac{2.8}{W_2} = \dfrac{56/2}{65.3/2} = \dfrac{56}{65.3}$$ [½]

or   W$_2$ = 3.265 g   [½]

(b) Electrolyte A is strong electrolyte   [½]

& Electrolyte B is weak electrolyte   [½]

On extrapolation of $\wedge_m$ to concentration approaching zero for strong electrolytes, we get the value of $\wedge^\circ_m$ *i.e.* molar conductance at infinite dilution
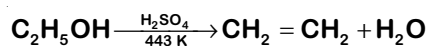
In the case of weak electrolytes, $\wedge_m$ increases steeply on dilution. Therefore, $\wedge^\circ_m$ cannot be obtained by extrapolation.   [1]

26. (a) How do you convert the following :   [5]

    (i)   Phenol to Anisole

    (ii)   Ethanol to Propan-2-ol

  (b) Write mechanism of the following reaction :

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

  (c) Why phenol undergoes electrophilic substitution more easily than benzene?

OR

(a) Account for the following :

    (i)   o-nitrophenol is more steam volatile than p-nitrophenol.

    (ii)   t-butyl chloride on heating with sodium methoxide gives 2-methylpropene instead of t-butylmethylether.
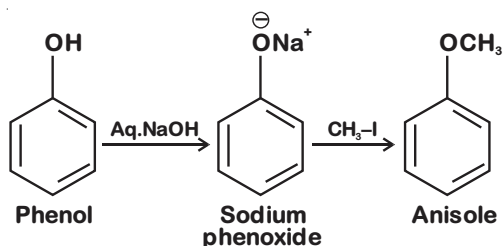
(b) Write the reaction involved in the following :
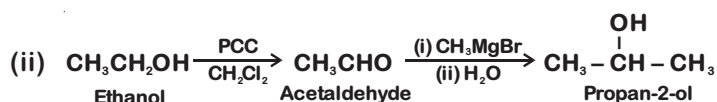
    (i)   Reimer-Tiemann reaction

    (ii)   Friedal-Crafts Alkylation of Phenol

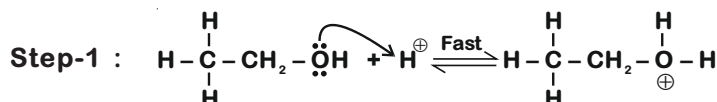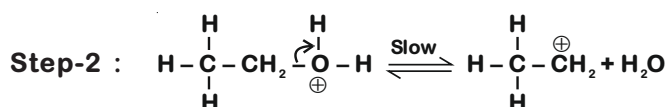(c) Give simple chemical test to distinguish between Ethanol and Phenol.
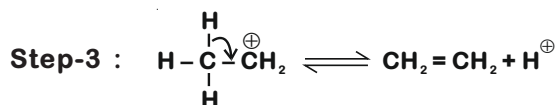
Sol. **(a)** **(i)**

[1]

Phenol → (Aq.NaOH) → Sodium phenoxide → (CH₃–I) → Anisole

(ii) $CH_3CH_2OH \xrightarrow[CH_2Cl_2]{PCC} CH_3CHO \xrightarrow[(ii)\,H_2O]{(i)\,CH_3MgBr} CH_3-\overset{\overset{\displaystyle OH}{|}}{CH}-CH_3$ **[1]**

Ethanol   Acetaldehyde   Propan-2-ol

(b) Mechanism of elimination reaction

Step-1 :

[½]

Step-2 :

[1]

Step-3 :

[½]

(c) –OH group of phenol is activating group which increases the electron density at ortho/para position within the benzene ring so that electrophile can easily attack at ortho/para position in phenol than in benzene. **[1]**
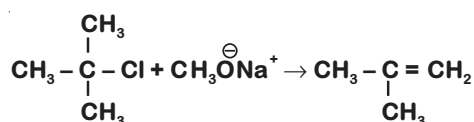
<div align="center">OR</div>

(a) **(i)** o-Nitrophenol is steam volatile due to intramolecular hydrogen bonding while p-nitrophenol is less volatile due to intermolecular hydrogen bonding **[1]**
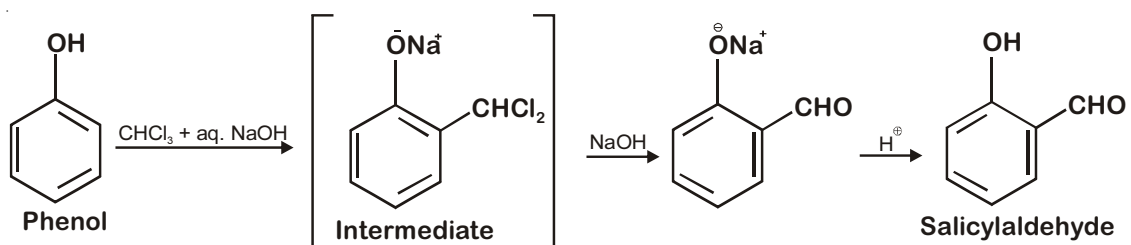

o-Nitrophenol
(Intramolecular
H-bonding)

p-Nitrophenol
(Intermolecular H-bonding)
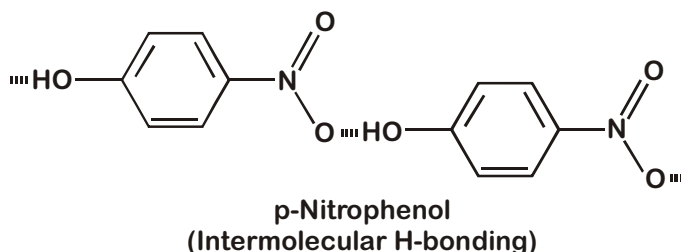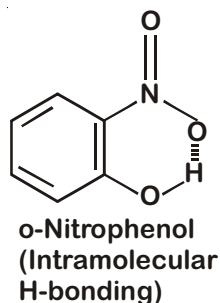
(ii) Sodium methoxide is a strong base hence elimination pre-dominates over substitution

[1]

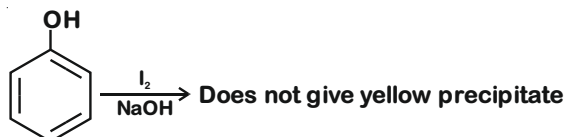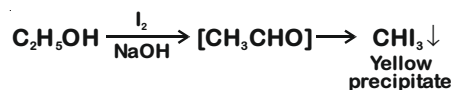**(b)** **(i)** Reimer-Tiemann reaction

[1]

Phenol → (CHCl₃ + aq. NaOH) → Intermediate → (NaOH) → → (H⁺) → Salicylaldehyde

(ii) Friedel Craft's reaction of phenol

Phenol   o-cresol   p-cresol
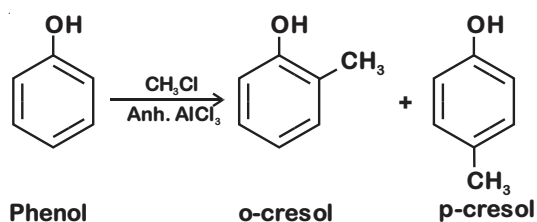
[1]

(c) Ethanol and phenol can be chemically distinguished by Iodoform test   [1]

$$C_2H_5OH \xrightarrow[NaOH]{I_2} [CH_3CHO] \longrightarrow CHI_3 \downarrow$$
$$\underset{\substack{\text{Yellow} \\ \text{precipitate}}}{}$$

$$\xrightarrow[NaOH]{I_2}$$ **Does not give yellow precipitate**

27. (a) Give reasons for the following :   [5]

(i) Sulphur in vapour state shows paramagnetic behaviour.

(ii) N-N bond is weaker than P-P bond.

(iii) Ozone is thermodynamically less stable than oxygen.

(b) Write the name of gas released when Cu is added to

(i) dilute HNO_3 and

(ii) conc. HNO_3

OR

(a) (i) Write the disproportionation reaction of H_3PO_3.

(ii) Draw the structure of XeF_4.

(b) Account for the following :

(i) Although Fluorine has less negative electron gain enthalpy yet F_2 is strong oxidizing agent.

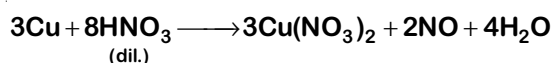(ii) Acidic character decreases from N_2O_3 to Bi_2O_3 in group 15.

(c) Write a chemical reaction to test sulphur dioxide gas. Write chemical equation involved.

Sol. (a) (i) Sulphur in vapor state exists as S_2 which has two unpaired electrons in the pi-antibonding molecular orbital and is paramagnetic   [1]

(ii) Due to small size of N, there is strong interelectronic repulsion of the non-bonding electrons and as a result the N–N single bond is weaker than P–P single bond.   [1]
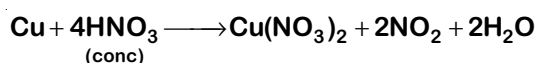
(iii) Decomposition of ozone into oxygen results in the liberation of heat ($\Delta H < 0$) and an increase in entropy ($\Delta S > 0$) resulting in a large negative Gibb's energy change. Hence, ozone is thermodynamically less stable than oxygen   [1]

(b) (i) With dil. $HNO_3 \longrightarrow$ Nitrogen monoxide (NO)

$$\underset{\text{(dil.)}}{3Cu + 8HNO_3} \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

[1]

(ii) With $Conc.HNO_3 \longrightarrow$ Nitrogen dioxide (NO_2)

$$\underset{\text{(conc)}}{Cu + 4HNO_3} \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

[1]

OR

(a) (i) $4H_3PO_3 \longrightarrow 3H_3PO_4 + PH_3$ [1]

(ii) [1]

(b) (i) Due to small size, fluorine has less negative electron gain enthalpy. The oxidizing power is dependent upon hydration energy, bond dissociation energy as well as electron gain enthalpy. Due to small size, fluorine has very high hydration energy, therefore F_2 acts as strong oxidising agent. [1]

(ii) As electronegativity of atom decreases, acidic strength of oxide decreases, hence acidic character decreases from N_2O_3 to Bi_2O_3 [1]

(c) $5SO_2 + 2MnO_4^- + 2H_2O \rightarrow 5SO_4^{2-} + 4H^+ + 2Mn^{2+}$. [1]

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