Sample Question Paper-5

CHEMISTRY (862)

Class-12

SOLVED

Time Allowed : 3 Hours   **Maximum Marks : 70**

This paper is divided into four sections – A, B, C and D.

Answer all questions.

Section A consists of one question having sub-parts of one mark each.

Section B consists of ten questions of two marks each.

Section C consists of seven questions of three marks each, and

Section D consists of three questions of five marks each.

Internal choices have been provided in one question each in Section B, Section C and Section D.

All working, including rough work, should be done on the same sheet as, and

adjacent to the rest of the answer.

The intended marks for questions or parts of questions are given in brackets [ ].

Balanced equations must be given wherever possible and diagrams where they

are helpful.

When solving numerical problems, all essential working must be shown.

In working out problems, use the following data:

Gas constant $R = 1.987$ cal deg^{-1} mol^{-1} = 8.314 JK^{-1} mol^{-1}

= 0.0821 dm^3 atm K^{-1} mol^{-1}

1 l atm = 1 dm^3 atm = 101.3 J. 1 Faraday = 96500 coulombs.

Avogadro's number = 6.022×10^{23}.

Section - A   (14 Marks)

Question 1

(A) Fill in the blanks by choosing the appropriate word(s) from those given in the brackets.   **[4 × 1]**

   (i) _____ is formed on heating an aliphatic primary amine with chloroform and alcoholic potassium hydroxide. (alkyl isocyanide/alkanol)

   (ii) IUPAC name of complex coordination compound $[Co(NCS)(NH_3)_5][Zn(CN)_4]$ is _____.

   (Pentaamminethiocyanato-S-cobalt (III) tetracyanidozincate (II)/ Pentaamminethiocyanato-N-cobalt (III) tetracyanidozincate(II)

   (iii) Toluene reacts with halogen in the presence of iron (III) chloride giving ortho and para halo compounds. This is known as _____ reaction.

   (electrophilic substitution / nucleophic substitution)

   (iv) Lucas reagent is the mixture of _____. ($ZnCl_2$ + HCl/$ZnCl_2$ + HCN)

(B) Select and write the correct alternative from the choices given below: **[7 × 1]**

   (i) The quantity of electricity required to deposit 1.15 g of sodium from molten NaCl (Na = 23, Cl = 35.5) is :

   (A) 1 F   (B) 0.5 F   (C) 0.05 F   (D) 1.5 F

   (ii) The hybridisation of the iron atom in $[Fe(CN)_6)]^{3-}$ complex is:

   (A) sp^3 (B) d^2sp^3 (C) sp^3d^2 (D) dsp^2

(iii) Which of the following ions exhibits colour in aqueous solution?

(A) Sc^{3+} (B) Ni^{2+} (C) Ti^{4+} (D) Zn^{2+}

(iv) Reaction of which among the following ethers with HI in cold leads to the formation of methyl alcohol?

(A) ethyl methyl ether   (B) methyl propyl ether

(C) isopropyl methyl ether   (D) tert-butyl methyl ether

(v) At a given temperature, osmotic pressure of a concentrated solution of a substance:

(A) is higher than that of a dilute solution

(B) is lower than that of a dilute solution

(C) is same as that of a dilute solution

(D) cannot be compared with osmotic pressure of a dilute solution.

(vi) **Assertion:** The conductivity of cell decreases on dilution.

Reason: The number of ions increases when the solution is diluted.

Self made

(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(B) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

(C) Assertion is true but Reason is false.

(D) Assertion is false but Reason is true.

(vii) **Assertion:** In Hoffmann Bromide reaction, nitro benzene is converted into primary amine.

Reason: The reaction takes place in presence of bromine water and potassium hydroxide.

(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(B) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

(C) Assertion is true but Reason is false.

(D) Assertion is false but Reason is true.

(C) Read the passage given below carefully and answer the questions that follow: [3 × 1]

Solution plays a very important role in our daily life. Alloys, a homogeneous mixture of metal are solutions of solid in solid. All intravenous injections must be isotonic with our body fluids. Diabetic patients are more likely to have a heart attack and high blood pressure due to the higher glucose levels in the blood.

(i) What will happen if blood cells are kept in hypertonic solution?

(ii) Name the process when solvent and solution are separated by semi-permeable membrane, and the pressure applied on the solution side is more than the osmotic pressure.

(iii) Calculate the molarity of 30 g of $Co(NO_3)_2.6H_2O$ in 4.3 l of solution.
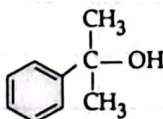
Section - B   (20 Marks)

Question 2   [2]

(i) Give one chemical test to distinguish between the following pair of compounds: Ethanol and 2-propanol.

(ii) Write the IUPAC name of the following compound:

Question 3   [2]

Explain the following observations about the transition/inner transition elements:

(i) There is in general an increase in density of element from titanium (Z = 22) to copper (Z = 29).

(ii) There occurs much more frequent metal-metal bonding in compounds of heavy transition elements.

Question 4   [2]

(i) Among Benzene, chlorobenzene, fluoro benzene and iodobenzene which has highest boiling point.

(ii) Show the different resonating structures of chlorobenzene.

Question 5 [2]

(i) Mn^{2+} is much more resistant than Fe^{2+} towards oxidation.

(ii) Zr (Z = 40) and Hf (Z = 72) have almost identical radii.

Question 6 [2]

(i) $[Fe(H_2O)_6]^{3+}$ is strongly paramagnetic while $[Fe(CN)_6]^{3-}$ is weakly paramagnetic.

(ii) A solution of $[Ni(H_2O)_6]^{2+}$ is green but a solution of $[Ni(CN)_4]^{2-}$ is colourless. 🔖

Question 7 [2]

(i) A current of 10 A is passed for 80 min and 27 seconds through a cell containing dilute sulphuric acid.

    (a) Calculate the charge on the cell.

    (b) Calculate the moles of oxygen liberated at anode.

(ii) The standard electrode potential (E°) for Daniel cell is + 1.1 V. Calculate the $\Delta G°$ for the given reaction (1 F = 96500 C mol^{-1})

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Question 8 [2]

Give one good chemical test to distinguish between the following pair of compounds:

(a) 1-propanol and 2-propanol.

(b) ethanol and phenol

OR

✓ An organic compound C_6H_6 (A) is treated with conc. sulphuric acid to form an organo sulphur compound with the formula $C_6H_6O_3S$ (B) which on dehydration gives (C). The resulting salt (C) is mixed with base NaOH and fused at high temp and further undergo acidic hydrolysis to gives a compound in which H group of A is replace with OH group(D).Write the reaction involved and identify A,B,C and D.

Question 9 [2]

The cryoscopic constant of water is 1.86 K kg mol^{-1}. An aqueous solution of cane sugar freezes at – 0.327°C. Calculate molality of the solution.

Question 10 [2]

How will you bring about the following conversions:

(i) Propanone to propane

(ii) Ethanal to but-2-enal

Question 11 [2]

Explain the following giving reasons:

(i) Copper (I) ion is not known in aqueous solution.

(ii) Actinoids exhibit greater range of oxidation states than lanthanoids

Section - C
                           (21 Marks)

Question 12 [3]

For the reaction: $2H_2 + 2NO \rightleftharpoons 2H_2O + N_2$, the following rate data was obtained:

S. No.	[NO] mol L^{-1}	[H_2] mol L^{-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:

(a) The overall order of reaction.

(b) The rate law.

(c) The value of rate constant (k).

Question 13 [3]

(i) Give balanced equation to show the conversion of ethyl amine to methyl amine?

(ii) Explain the following:

    (a) NH_3 act as a ligand but NH_4^+ does not.

    (b) CN^- is a ambidentate ligand. 🔖

Question 14   [3]

Explain why:

(i) Glucose is soluble in water but cyclohexane is not.

(ii) Aldehyde group is absent in the pentaacetate of D-glucose

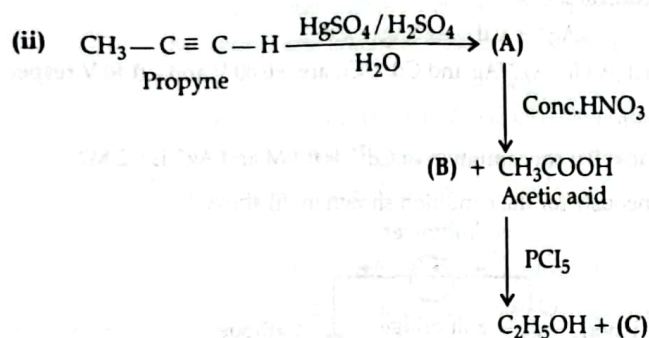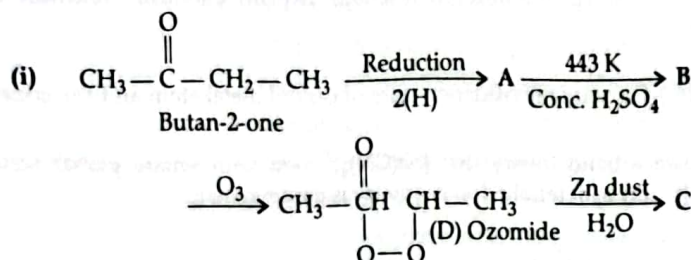(iii) Glucose when heated with red P and HI gives *n*-hexane   🄰🄸

Question 15   [3]

(i) A solution containing 1.23 g of calcium nitrate in 10 g of water, boils at 100.975 °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}, mol. wt. of calcium nitrate = 164 g mol^{-1})

(ii) State any two limitations of Henry's law.

Question 16   [3]

(i)
$$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3 \xrightarrow[2(H)]{\text{Reduction}} A \xrightarrow[\text{Conc. } H_2SO_4]{443 K} B$$

Butan-2-one

$$\xrightarrow{O_3} CH_3-\overset{\overset{O}{\|}}{C}H\underset{\underset{O-O}{|\ \ \ \ |}}{\ \ \ \ }CH-CH_3 \xrightarrow[H_2O]{\text{Zn dust}} C$$
(D) Ozomide

(ii)
$$CH_3-C\equiv C-H \xrightarrow[H_2O]{HgSO_4/H_2SO_4} (A)$$
Propyne

↓ Conc.HNO$_3$

(B) + CH$_3$COOH
Acetic acid   🄰🄸

↓ PCl$_5$

C$_2$H$_5$OH + (C)

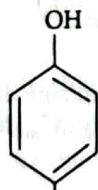## Question 17   [3]
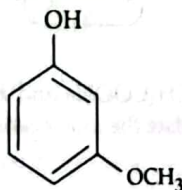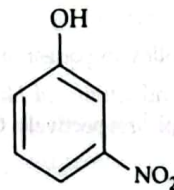
(a) Write down the decreasing order of reactivity of sodium metal towards primary, secondary and tertiary alcohols.   2

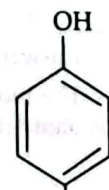(b) Mark the correct order of decreasing acid strength of the following compounds.   1

(A)   (B)   (C)   (D)   (E)

OR

✔ C$_6$H$_7$O (A) when reacts with chloroform in the presence of a base, an unstable product is formed (B). This unstable product is hydrolysed in presence of alkali and introduce an aldehyde group at ortho position to C$_6$H$_7$O to form C.

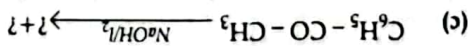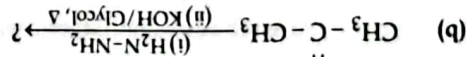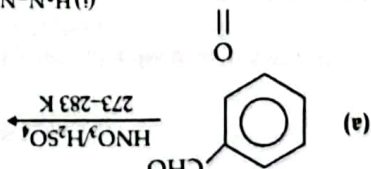## Question 18   [3]

(i) Write the mathematical expression relating the variation of rate constant of a reaction with temperature.   1

(ii) In a first order reaction,10% reactant is consumed in 25 minutes. Calculate:

(a) The half-life period of the reaction.

(b) The time required for completing 87.5% of the reaction.   2 🄰🄸

Section - D   (15 Marks)

Question 19   [5]

(i) Complete the following reactions: 3 [A]

(a)

CHO⟨benzene ring⟩ $\xrightarrow[\text{273-283 K}]{\text{HNO}_3/\text{H}_2\text{SO}_4}$

(b) $CH_3 - C - CH_3$
$\qquad\qquad \|$
$\qquad\qquad O$ $\xrightarrow[\text{(ii) KOH/Glycol, }\Delta]{\text{(i) }H_2N-NH_2}$?

(c) $C_6H_5 - CO - CH_3 \xrightarrow{\text{NaOH/}I_2} ?+?$

(ii) Which type of aldehyde can undergo Cannizaro reaction? Explain Cannizaro reaction using an equation to justify your answer.   2

Question 20   [5]

(i) 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.   3

(ii) Explain on the basis of valence bond theory that $[Ni(CN)_4]^{2-}$ ion with square planar structure is diamagnetic and the $[NiCl_4]^{2-}$ ion with tetrahedral geometry is paramagnetic.   2

Question 21   [5]

(a) Consider the following cell reaction at 298 K:

$$2Ag^+ + Cd \longrightarrow 2Ag + Cd^{2+}$$
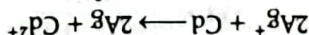
The standard reduction potential (E°) for Ag^+/Ag and Cd^{2+}/Cd are +0.80 V and −0.40 V respectively.
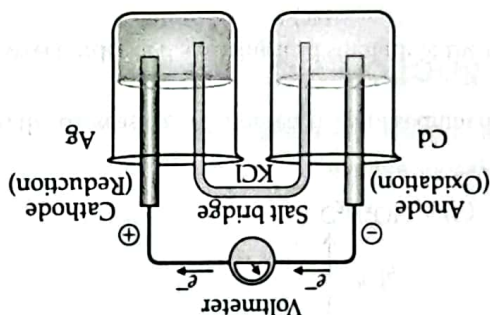
(i) Give the cell representation.

(ii) What will be the emf of the cell if concentration of Cd^{2+} is 0.1 M and Ag^+ is 0.2 M?

(iii) Will the cell work spontaneously for the condition shown in (ii) above?   3

Voltmeter

Anode
(Oxidation)
⊖

Cathode
(Reduction)
⊕

Salt bridge
KCl

Cd   Ag

(b) Answer the following question:

The molar conductivity of NaCl, CH_3COONa and HCl at infinite dilution is 126.45, 91.0 and 426.16 ohm^{-1} cm^2 mol^{-1} respectively. Calculate the molar conductivity (Λ°_m) for CH_3COOH at infinite dilution.   2

OR

(a) The specific conductance of a 0.01 M solution of acetic acid at 298 K is 1.65×10^{-4} ohm^{-1} cm^{-1}. The molar conductance at infinite dilution for H^+ ion and CH_3COO^- ion are 349.1 Ω^{-1} cm^2 mol^{-1} and 40.9 Ω^{-1} cm^2 mol^{-1} respectively.   4 [A]

Calculate:

(i) Molar conductance of the solution.

(ii) Degree of dissociation of CH_3COOH.

(iii) Dissociation constant for acetic acid.

(b) Why is alternating current used in place of direct current in measuring the electrolytic conduction?   1 [U]

ANSWERS
Sample Question Paper-5

CHEMISTRY (862)

Section - A

1. (A) (i) Alkyl isocyanide

(ii) Pentaamminethiocyanato-N-cobalt (III) tetracyanidozincate(II)

(iii) electrophilic substitution

(iv) $ZnCl_2 + HCl$

(B) (i) Option (C) is correct.

Explanation:

$$= \frac{(1 \times 1.15)}{23} = 0.05 \text{ F}$$

(ii) Option (B) is correct.

Explanation: CN^- is a strong field and low spin complex which forms inner d-orbitals. Hence, show d^2sp^3 hybridisation.

(iii) Option (B) is correct.

Explanation: Only Ni^{2+} has incomplete d-orbitals. Hence, exhibits colour in aqueous solution.

(iv) Option (D) is correct.

Explanation: when ether react with HI in cold methyl alcohol is formed.

(v) Option (A) is correct.

Explanation: At a given temperature, osmotic pressure of a concentrated solution of a substance is higher than that of a dilute solution.

(vi) Option (C) is correct.

Explanation: The number of ions decreases on dilution, thus conductivity decreases on dilution.

(vii) Option (d) is correct.

Explanation: In Hoffmann Bromide reaction, primary amide is converted into primary amine using halogen, bromine water and a base (potassium hydroxide).

(C) (i) They shrink.

(ii) Reverse osmosis

(iii) No. of moles of $Co(NO_3)_2 \cdot 6H_2O$

$$= \frac{30}{290.7} = 0.103 \text{ mol.}$$

$$\text{Molarity} = \frac{0.103}{4.3}$$

$$= 0.239 \text{ M}$$

Section - B

2. (i) Lucas test– with concentrated HCl + $ZnCl_2$ and ethanol, no turbidity is formed whereas with 2-propanol turbidity appears within five minutes.

(ii) 2-Phenylpropan-2-ol **2**

3. (i) As we move along a transition series from left to right, the atomic radii decrease due to increase in nuclear charge. Hence, the atomic volume decreases. At the same time, atomic mass increases from Ti to Cu, therefore density increases.

(ii) It is due to their low ionization energies and variable oxidation state. **2**

4. (i) The boiling point of iodobenzene is higher than chlorobenzene because iodine atom is larger than chlorine atom and Van der waal's force of attraction is more in iodine. Thus, greater will be the boiling point.

(ii) In chlorobenzene the lone pair of electrons present on chlorine atom migrate towards the aromatic ring.

The electron density of the ring increases due to donation of pair of electrons.   **2**
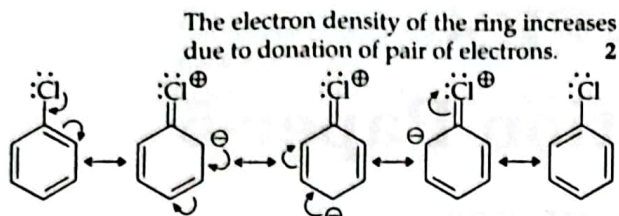
5.   (i) Mn^{2+} is quite stable because it possesses half-filled d^5 electrons in its electronic configuration and therefore, cannot be easily oxidised whereas, Fe^{2+} has a less stable d^6 electronic configuration and can be easily oxidised to a stable d^5 configuration.

    (ii)   Due to lanthanoid contraction, the increase in radii from the second to third transition series vanishes. Therefore, Zr and Hf have almost the same radii.   **2**

6.   (i)   In both cases, Oxidation state of Fe is +3.

      In the presence of strong field ligand CN, the 3d-electron pair up and leave only one unpaired electron. Due to one unpaired electron, it is weakly paramagnetic.

      In the presence of H_2O (a weak ligand), 3d-electrons do not pair up.. As it contains five unpaired electrons, it is strongly paramagnetic in nature.

    (ii)   In $[Ni(H_2O)_6]^{2+}$ and $[Ni(CN)_4]^{2-}$ Ni is in +2 state with the configuration $3d^8$.

      In $[Ni(H_2O)_6]_{2+}$ it has two unpaired electrons which do not pair up in presence of the weak H_2O ligand. Hence, it is coloured.

      In d–d transition, red light is absorbed and complementary light emitted is green.

      In case of $[Ni(CN)_4]^{2-}$ in presence of the strong CN ligand, the two unpaired electrons in the 3d orbitals pair up. Thus, there is no unpaired electron present. Hence, it is colourless.   **2**

⚠️ Examiner's Comments

- ➤ Some students got confused with para and diamagnetic nature.
- ➤ Some students could not relate the relation between configuration, para/di magnetism and colour of the compound.

💡 Answering Tip

- ➤ Understanding the concept will help to write the proper answer.

7.   (i)   (a)   I = 10 A, t = 80 min 27 s

         = 80 × 60 = 4800 + 27 = 4827 s

         Q = I × t = 10 × 4827 = 48270 C

         Equivalent weight of oxygen = 8

Weight of O_2 liberated

$$= \frac{8 \times 48270}{96500} = 4g$$

  (b)   Moles of oxygen

$$= \frac{\text{Weight}}{\text{Molecular weight}} = \frac{4}{32}$$

$$= 0.125 \text{ moles of Oxygen}$$

  (ii) $\Delta G° = -nFE°_{cell}$

      $E°cell = 1.1$ volt

   ∴ $\Delta G° = -2 \times 96500 \text{ C mol}^{-1} \times 1.1$ Volt

         $= -212300 \text{ CV mol}^{-1}$

         $= -212300 \text{ J mol}^{-1}$

         $= -212.3 \text{ kJ mol}^{-1}$ **2**

8.   (a)   **Lucas test :** When Lucas reagent (conc. HCl + $ZnCl_2$) is added to 2-propanol, turbidity appears within five minutes whereas with 1 – propanol, no turbidity appears and solution remains clear.

  (b)   Phenol decolourises bromine solution as it is an unsaturated compound whereas ethanol does not decolourise bromine solution as it is a saturated compound.

OR
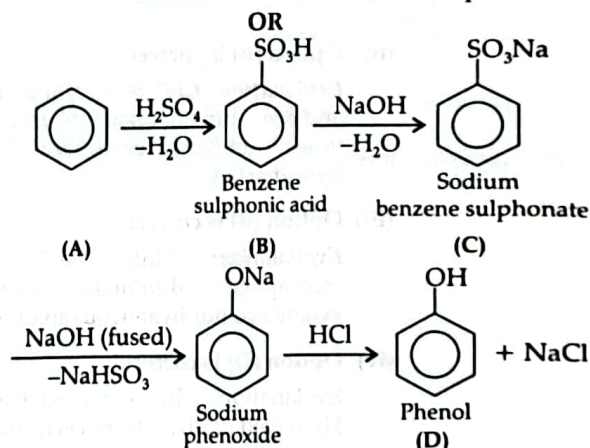
9. $K_f = 1.86$ K kg mol^{-1}

Freezing point of solution, $T_f = -0.327°C$

$$= [273 + (-0.327)]$$

$$= 272.673 \text{ K}$$

Freezing point of pure water, $T°_f = 0°C = 273$ K

Depression in freezing point, $T_f = T_f° - T_f$

$$= (273 - 272.673) \text{ K} = 0.327 \text{ K}$$

$T_f = i \times K_f \times m$

Since, cane sugar is a non-electrolyte, thus i (Van't Hoff factor) is equal to 1.

    $0.327 = 1 \times 1.86 \times m$

     m = 0.327 / 1.86
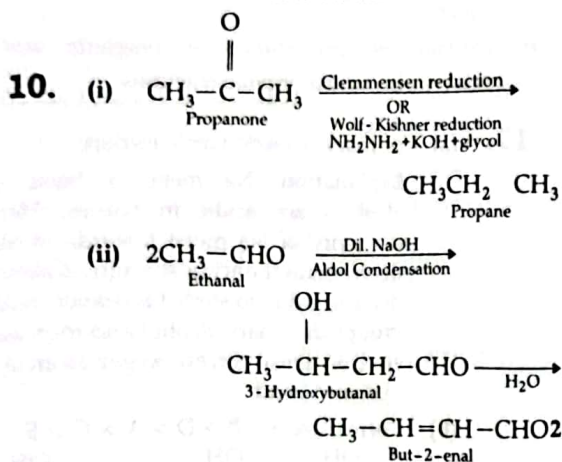
        = 0.17 molal ≈ 0.2 molal

⚠️ Examiner's Comments

- ➤ Students make mistake in using correct formula.
- ➤ Some wrote wrong units.

💡 **Answering Tips**

- Practice numerical using correct formula and units.
- Understand how to write Von't Hoff factor.

10. **(i)**

$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 \xrightarrow[\substack{\text{OR} \\ \text{Wolf - Kishner reduction} \\ NH_2NH_2 + KOH + glycol}]{\text{Clemmensen reduction}}$$

Propanone

$$CH_3CH_2 \quad CH_3$$
Propane

(ii) $2CH_3-CHO \xrightarrow[\text{Aldol Condensation}]{\text{Dil. NaOH}}$

Ethanal

$$CH_3-\underset{\underset{\displaystyle \text{3-Hydroxybutanal}}{}}{\overset{\overset{\displaystyle OH}{|}}{CH}}-CH_2-CHO \xrightarrow{H_2O}$$

$$CH_3-CH=CH-CHO2$$
But–2–enal

11. **(i)** $Cu^{2+}(aq)$ is more stable than $Cu^+(aq)$ because although second ionization enthalpy of copper is large but Δ_{hyd} (hydration enthalpy) for $Cu^{2+}(aq)$ is much more negative than that for $Cu^+(aq)$ and hence it compensates more for the second ionization enthalpy of copper. Therefore, many copper (I) compounds are unstable in aqueous solution and undergo disproportionation as follows:

$$2\,Cu^+ \longrightarrow Cu^{2+} + Cu$$

(ii) Actinoids exhibit greater range of oxidation states than lanthanoids because of very small energy gap between $5f$, $6d$ and $7s$ subshells all their electrons can take part in bonding and shows variable oxidation states. **2**

Section - C

12. **(a)** Rate = $k\,[NO]^p[H_2]^q$

$r_1 = 4.6 \times 10^{-3} = k[0.40]^p[0.40]^q$ ...1

$r_2 = 18.4 \times 10^{-3} = k[0.80]^p[0.40]^q$ ...2

$r_3 = 9.2 \times 10^{-3} = k[0.40]^p[0.80]^q$ ...3

On dividing eq 1 by 2

$$\frac{4.6 \times 10^{-3}}{18.4 \times 10^{-3}} = \frac{k[0.40]^p}{k[0.80]^p}$$

$$p = 2$$

Similarly, divide eq 1 by 3

$$\frac{4.6 \times 10^{-3}}{9.2 \times 10^{-3}} = \frac{k[0.40]^q}{k[0.80]^q}$$

$$q = 1$$

Order of the reaction = $p + q = 2+1 = 3$

(b) Rate law, Rate = $k\,[NO]^2[H_2]$

(c) Rate constant, $k = \dfrac{\text{Rate}}{[NO]^2[H_2]}$

Placing the values

$$k = \frac{4.6 \times 10^{-3}}{[0.40]^2[0.40]} = 0.072 \text{ mol}^{-2}L^{-2}s^{-1} \quad 3$$

13. **(i)** $C_2H_5NH_2 \xrightarrow{HNO_2} C_2H_5OH$

$$\xrightarrow{K_2Cr_2O_7/Conc.H_2SO_4} CH_3CHO$$

$$\xrightarrow{[O]} CH_3COOH$$

$$CH_3COOH \xrightarrow{NH_3} CH_3COONH_4 \rightarrow$$

$$CH_3CONH_2 \xrightarrow{Br/KOH} CH_3NH_2$$

(ii) **(a)** NH_3 has one lone pair of electron to donate while NH_4^+ does not have. That's why it does not behave as ligand.

(b) CN^- has two donor atoms in a mono-dentate ligand and these may coordinate to the metal ion through either of the two atoms. These types of ligands are called ambidentate ligands. **3**

14. **(i)** Glucose has five —OH groups which form hydrogen bond with water. Due to this extensive intermolecular hydrogen bonding, glucose is soluble in water. Cyclohexane is a non-polar molecule with no —OH group, hence it does not dissolve in polar solvent water.

(ii) Pentaacetate of D-Glucose does not contain any free aldehyde group as it is a cyclic structure of glucose. Glucose on acetylation forms pentaacetate of D-glucose

(iii) As it contains straight chain of six carbon atoms. **3**

15. **(i)** Given : $w = 1.23$ g, $W = 10$ g

$$\Delta T_b = 100.975 - 100 = 0.975$$
$$K_b = 0.52 \text{ K kg mol}^{-1}$$

$$M(\text{observed}) = \frac{1000\,K_b\,w}{W\Delta T_b}$$

$$= \frac{1000 \times 0.52 \times 1.23}{10 \times 0.975}$$

$M(\text{observed}) = 65.6$

Van't Hoff factor (i)

$$= \frac{M(\text{calculated})}{M(\text{observed})}$$

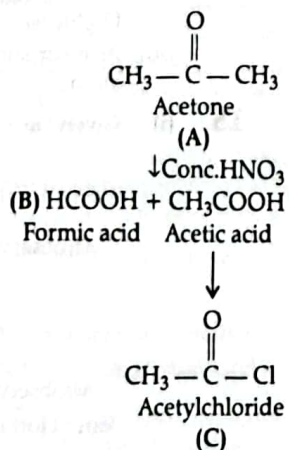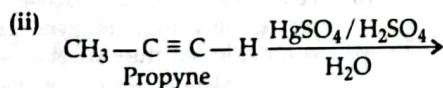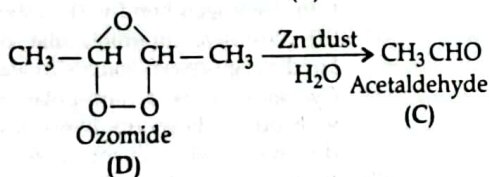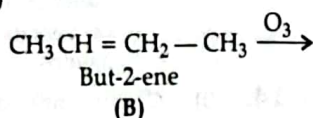$$= \frac{164}{65.6}$$

$$i = 2.5$$

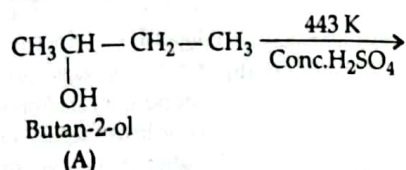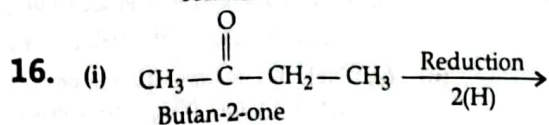**Alternate method :**

$$i = \frac{M(\text{calculated}) \times \Delta T_b \times W}{1000 \times K_b \times w}$$

or $= \dfrac{164 \times 0.975 \times 10}{1000 \times 0.52 \times 1.23}$

$= \dfrac{1599}{639.6} = 2.5$

(ii) **Limitations of Henry's law:** This law is applicable only when:

  (a) The pressure of gas is not too high and a temperature is not too low.

  (b) The gas should not undergo any chemical change.

  (c) The gas should not undergo association or dissociation in the solution. **3**

16. (i)

$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-CH_3 \xrightarrow[2(H)]{\text{Reduction}}$
Butan-2-one

$CH_3\underset{\underset{\displaystyle OH}{|}}{CH}-CH_2-CH_3 \xrightarrow[\text{Conc.H}_2SO_4]{443\ K}$
Butan-2-ol
(A)

$CH_3CH = CH_2-CH_3 \xrightarrow{O_3}$
But-2-ene
(B)

$CH_3-\underset{\underset{\displaystyle O-O}{|}}{\overset{\overset{\displaystyle O}{\diagdown}}{CH}}\ \underset{}{CH}-CH_3 \xrightarrow[\text{H}_2O]{\text{Zn dust}} CH_3CHO$
Ozomide   Acetaldehyde
(D)   **(C)**

(ii)

$CH_3-C\equiv C-H \xrightarrow[\text{H}_2O]{\text{HgSO}_4/\text{H}_2SO_4}$
Propyne

$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$
Acetone
(A)
$\downarrow$Conc.HNO$_3$
(B) HCOOH + CH$_3$COOH
Formic acid   Acetic acid
$\downarrow$

$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-Cl$
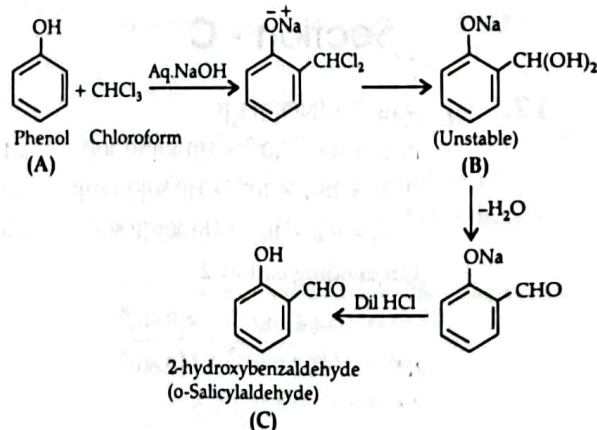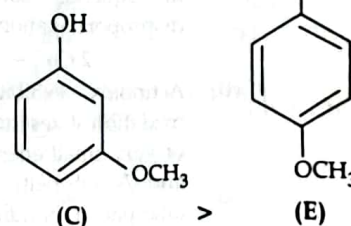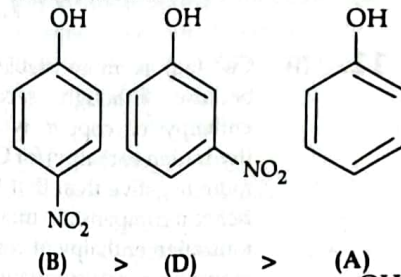Acetylchloride
(C)

3

💡 **Answering Tips**

➤ Students to practice adequately in writing organic reactions.
➤ Lay emphasis on writing correct balanced equations.
➤ Explain the importance of reagents and catalysts in named organic reactions.

17. (a) primary > secondary > tertiary

Explanation: Na metal is basic and alcohols are acidic in nature. Hence, reactivity of Na metal towards alcohols decreases as the acidic strength of alcohols decreases due to steric hindrance of alkyl groups in tertiary alcohol and increase in electron density on an oxygen atom in the hydroxyl bond.

(b) Correct order is B > D > A > C > E

(B) > **(D)** > **(A)**

(C) > **(E)**

OR

Phenol + CHCl$_3$ $\xrightarrow{\text{Aq.NaOH}}$ (A)
o-CHCl$_2$ (B, Unstable) $\xrightarrow{-\text{H}_2O}$
ONa–CHO $\xrightarrow{\text{Dil HCl}}$ 2-hydroxybenzaldehyde (o-Salicylaldehyde) **(C)**

18. (i) $k = Ae^{-Ea/RT}$

Where, k = Rate constant
A = Arrhenius or collision factor
Ea = Activation energy
R = Gas constant

(ii) $t = 100$ s, $[A]^0 = 1.0$ mol^{-1}

(a) Since the unit k is s^{-1}, the given reaction is a first order reaction. Therefore,

$$k = \frac{2.303}{t} \log \frac{a_0}{(a-x)}$$

$$k = \frac{2.303}{25} \log \frac{100}{(100-10)}$$

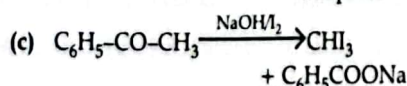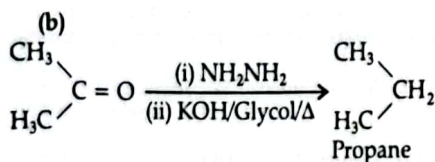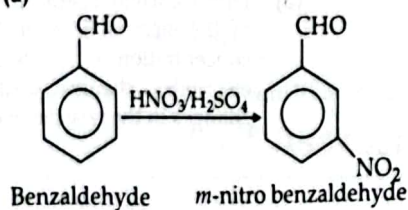$$= 4.215 \times 10^{-3} \text{ min}^{-1}$$

Half life $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{4.215 \times 10^{-3}}$

$$t_{1/2} = 164.45 \text{ min}$$

(b) $t = \frac{2.303}{k} \log \frac{a}{a-x}$

$$= \frac{2.303}{4.215 \times 10^3} \log \frac{100}{100-87.5}$$

$$= 493.38 \text{ min}$$

$$= \frac{100}{2.303}$$

Section - D

19. (i) (a)

Benzaldehyde → HNO$_3$/H$_2$SO$_4$ → m-nitro benzaldehyde

(b)

$$\text{(i) NH}_2\text{NH}_2 \quad \text{(ii) KOH/Glycol/}\Delta \rightarrow \text{Propane}$$

(c) C_6H_5–CO–CH$_3$ $\xrightarrow{\text{NaOH/I}_2}$ CHI$_3$ + C_6H_5COONa
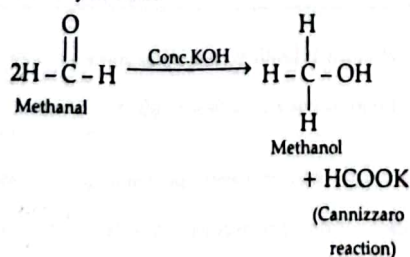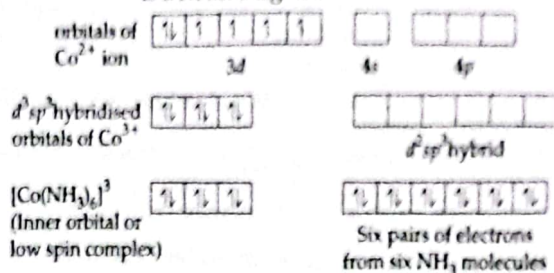
(ii) Aromatic and aliphatic aldehydes which do not contain alpha hydrogen.

Cannizaro reaction: Two molecules of aldehydes on heating with conc. alkali undergoes self oxidation and reduction. One molecule of aldehyde is reduced to alcohol and another is oxidised to carboxylic acid.


2H–C–H $\xrightarrow{\text{Conc.KOH}}$ H–C–OH + HCOOK

Methanal → Methanol
(Cannizzaro reaction)

(Any other correct reaction)

20. (i) The oxidation number of cobalt in the complex ion is +3. In [Co(NH$_3$)$_6$]$^{+3}$, the oxidation state of cobalt is +3, as ammine is a neutral ligand.

orbitals of Co^{2+} ion

d^2sp^3 hybridised orbitals of Co^{3+}

[Co(NH$_3$)$_6$]^3 (Inner orbital or low spin complex)
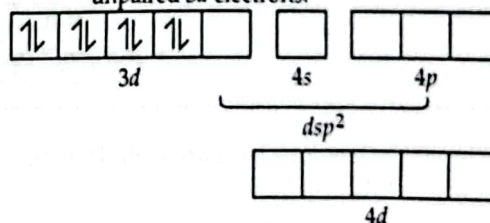
Six pairs of electrons from six NH$_3$ molecules

Coordination number of Co^{3+} is 6. So, its geometry is octahedral.

(ii) Ni is in the +2 oxidation state i.e., in d^8 configuration.

d^8 configuration
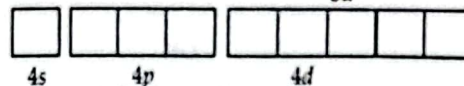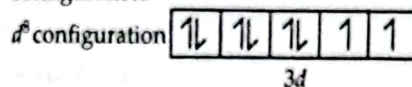
There are 4 CN$^-$ ions. Thus, it can either have tetrahedral geometry or square planar geometry. Since, CN$^-$ ion is a strong field ligand, it causes the pairing of unpaired 3d electrons.

dsp^2

It now undergoes dsp^2 hybridisation. Since all electrons are paired, it is diamagnetic. In case of [NiCl$_4$]$^{2-}$, Cl$^-$ ion is a weak field ligand. Therefore, it does not lead to the pairing of unpaired 3d electrons. Therefore, it undergoes sp^3 hybridisation.

sp^3
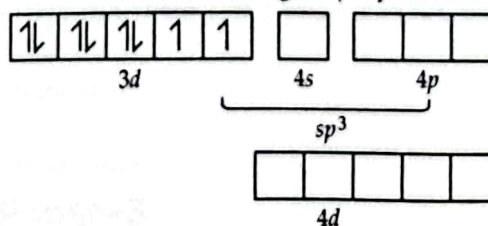
Since, there are 2 unpaired electrons therefore, it is paramagnetic.

21. (a) (i) Cell representation is
$$\text{Cd}_{(s)} | \text{Cd}^{2+}_{(aq)} || \text{Ag}^+_{(aq)} | \text{Ag}$$
(ii) $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$
$$= 0.80 - (-0.40) = 1.2 \text{ V}$$

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{n} \log \frac{[\text{Cd}^{2+}][\text{Ag}]^2}{[\text{Ag}^+]^2[\text{Cd}]}$$

$$= 1.2 - \frac{0.0591}{2} \log \frac{[0.1]}{[0.2]^2}$$

$$= 1.18 \text{ V}$$

(iii) $\Delta G^\circ = -n\, FE^\circ$

Since E° is positive, ΔG will be negative, so the cell will work spontaneously.

[ISC Marking Scheme, 2016]

(b) Given $\lambda^-_{CH_3COOH} = 126.45 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

$\lambda^-_{CH_3COONa} = 91.0 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

$\lambda^\infty_{HCl} = 426.16 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

$\lambda^-_{CH_3COOH} = ?$

$\lambda^-_{CH_3COOH} = \lambda^-_{CH_3COONa} + \lambda^\infty_{HCl} - \lambda^-_{NaCl}$

$= 91.0 + 426.16 - 126.45$

$= 390.7 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

[ISC Marking Scheme, 2020]

OR

(a) **(i)** Molar conductance,

$$\Lambda_m = \frac{\kappa \times 1000}{C}$$

$$= \frac{1.65 \times 10^{-4} \times 1000}{0.01}$$

$$= 16.5 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

(ii) Degree of dissociation,

$$\alpha = \frac{\Lambda^c_m}{\Lambda^\infty_m}$$

$\Lambda_m = 16.5 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

$\Lambda_{m(CH_3COOH)} = \lambda_{(H^+)} + \lambda_{(CH_3COO^-)}$

$= 349.1 + 40.9$

$= 390 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

$\alpha = \frac{16.5}{390} = 0.0423$

(iii) $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

                                         0.01M

$0.01(1-\alpha)$ 0.01α $+ 0.01\alpha$

Dissociation constant K_d

$= [CH_3COO-][H^+]/[CH_3COOH]$

$= 0.01\alpha \times 0.01\alpha / 0.01(1-\alpha)$

$= 0.01\alpha^2/1-\alpha$

considering $1-\alpha$ as 1, α, being very small.

$= 0.01 \times (0.0423)2$

$= K_d = 1.86 \times 10^{-5}$

(b) Direct current results in the electrolysis of the electrolytic solution. As a result, concentration of the electrolyte near the electrodes changes and these results changes in the resistance of the solution.

□□