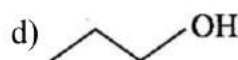
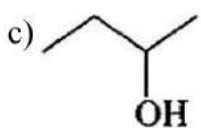
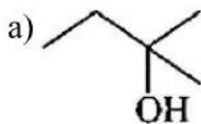


4. Which of the following has maximum pK_a value? [1]



5. For decolourization of 1 mole of $KMnO_4$, the moles of H_2O_2 required is (in acidic medium) [1]

a) $7/2$

b) $5/2$

c) $3/2$

d) $1/2$

6. Colligative properties are: [1]

a) none of these

b) intensive

c) extensive

d) additive

7. $CH_3COCl + C_2H_5OH \xrightarrow{\text{Pyridine}} CH_3COOC_2H_5 + HCl$ [1]
The function of pyridine in the above reaction is:

a) none of these

b) to catalyse the reaction

c) both to absorb liberated HCl and catalyse the reaction

d) to absorb liberated HCl

8. On dissolving sugar in water at room temperature solution feels cool to touch. Under which of the following cases dissolution of sugar will be most rapid? [1]

a) Powdered sugar in hot water

b) Sugar crystals in hot water

c) Powdered sugar in cold water

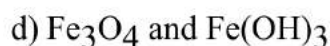
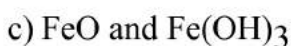
d) Sugar crystals in cold water

9. Rust is a mixture of: [1]

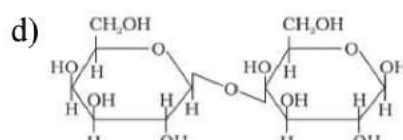
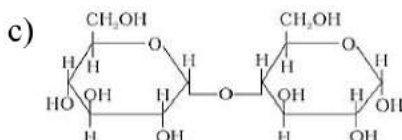
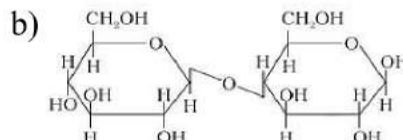
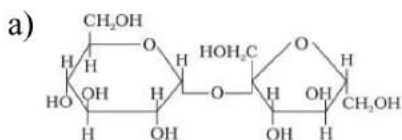
a) Fe_2O_3 and $Fe(OH)_3$

b) FeO and $Fe(OH)_2$

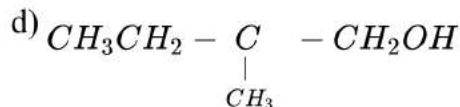
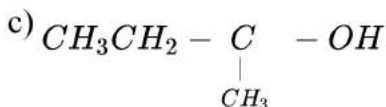
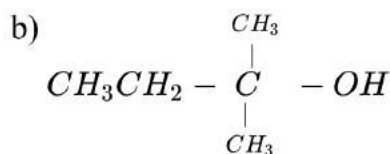
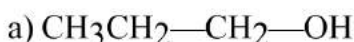




10. In disaccharides, if the reducing groups of monosaccharides i.e. aldehydic or ketonic groups are bonded, these are non-reducing sugars. Which of the following disaccharide is a non-reducing sugar? [1]



11. Which of the following alcohols will yield the corresponding alkyl chloride on reaction with concentrated HCl at room temperature? [1]



12. A reduction in atomic size with increase in atomic number is a characteristic of elements of: [1]

a) f-block

b) radioactive series

c) d-block

d) high atomic masses

13. During the passage of some charge through acidified water using Pt electrode, total 168 mL of H₂ (g) and O₂ (g) were evolved at STP. The total charge passed during electrolysis is: [1]

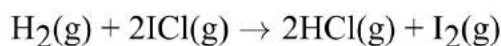
a) 965 C

b) 1443 C

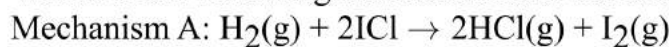
c) 350 C

d) 482.5 C

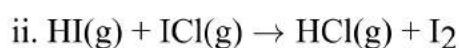
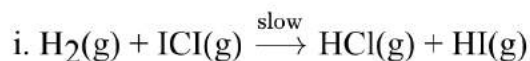
14. The reaction obeys I order with respect to H₂ and ICl both: [1]



Which of the following mechanism is in consistent with the given fact?



Mechanism B:

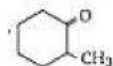


20. Using the valence bond approach, deduce the shape and magnetic character of $[Co(NH_3)_6]^{3+}$. [Atomic number of Co = 27] [2]

OR

Write the formula of the following complexes: (i) Pentaamminechlorocobalt (III) ion
(ii) Lithium tetrahydro aluminate (III)

21. Write IUPAC name of the following : [2]



OR

Arrange the following compounds in increasing order of their reactivity in nucleophilic addition reactions.

- Ethanol, Propanal, Propanone, Butanone
- Benzaldehyde, p-Tolualdehyde, p-Nitrobenzaldehyde, Acetophenone.

Hint: Consider steric effect and electronic effect.

22.  [2]

- What is the order of the reaction?
- What is the slope of the curve?

23. Using the valence bond approach, deduce the shape and magnetic character of $[Cr(CO)_6]$. [Atomic number of Cr = 24] [2]
24. Write the disease caused by deficiency of vitamins A, B₂, B₆, B₁₂, C, D E and K. [2]
25. Mention an industrial product manufactured from methanal. [2]

Section C

26. An organic compound A on heating with NH_3 and cuprous oxide at high pressure gives compound B. The compound B on treatment with ice-cold solution of $NaNO_2$ and HCl gives C, which on heating with copper turning and HCl gives A again. Identify A, B & C. compound. [3]
27. The thermal decomposition of $HCOOH$ is a first order reaction with a rate constant of $2.4 \times 10^{-3} s^{-1}$ at a certain temperature. How long will it take for three fourth of initial quantity of $HCOOH$ to decompose? ($\log 0.25 = -0.6021$) [3]

28. Write the equation of the reaction of hydrogen iodide with: [3]
- 1-propoxypropane
 - Methoxybenzene
 - Benzyl ethyl ether

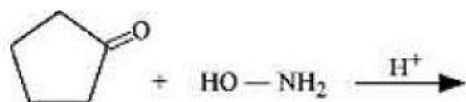
29. Carbohydrates are essential for life in both plants and animals. Name the carbohydrates that are used as storage molecules in plants and animals, also name the carbohydrate which is present in wood or in the fibre of cotton cloth. [3]

OR

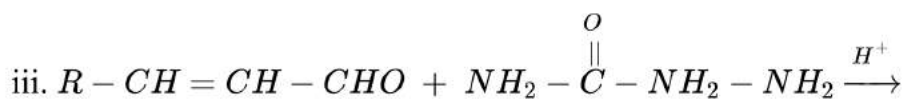
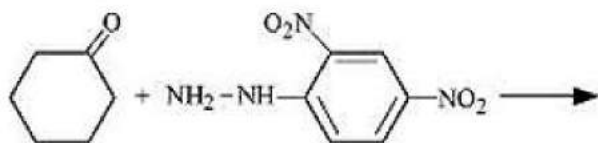
30. Explain what is meant by:
- a peptide linkage
 - a glycosidic linkage

Predict the products of the following reactions: [3]

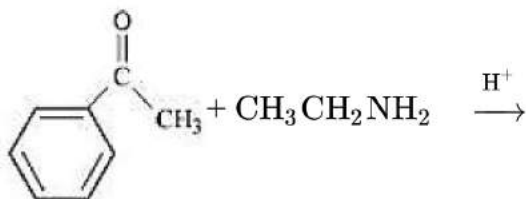
i.



ii.



iv.



Section D

31. **Read the text carefully and answer the questions:** [4]

The boiling point elevation and the freezing point depression of solutions have a number of practical applications. Ethylene glycol ($\text{CH}_2\text{OH}\cdot\text{CH}_2\text{OH}$) is used in automobile radiators as an antifreeze because it lowers the freezing point of the coolant. The same substance also helps to prevent the radiator coolant from boiling away by elevating the boiling point. Ethylene glycol has a low vapour pressure. We can also use glycerol as an antifreeze. In order for boiling point elevation to occur, the solute must be non-volatile, but no such restriction applies to freezing point depression. For example, methanol (CH_3OH), a fairly volatile liquid that boils only at 65°C is sometimes used as antifreeze in automobile radiators.

- (i) Out of the CH_3OH and $\text{C}_6\text{H}_{12}\text{O}_6$, which is a better reagent for depression in freezing point but not for elevation in boiling point?
- (ii) Will the depression in freezing point be same or different, if 0.1 moles of sugar or 0.1 moles of glucose is dissolved in 1 L of water?
- (iii) 124 g each of the two reagents glycerol and glycol are added in 5 kg water of the radiators in the two cars. Which one is better for a car? Justify your answer.

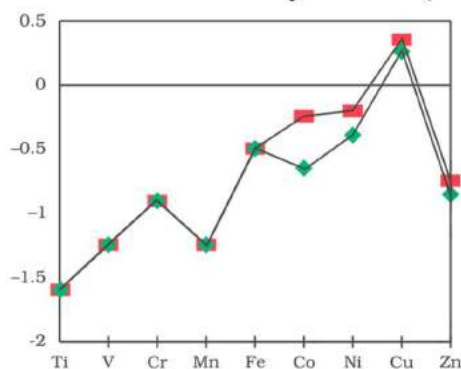
OR

If the cost of glycerol, glycol and methanol are the same, then what would be the sequence of the economy to use these compounds as antifreeze?

32. **Read the text carefully and answer the questions:** [4]

The unique behaviour of Cu, having a positive E° accounts for its inability to liberate H_2 from acids. Only oxidising acids (nitric and hot concentrated

sulphuric) react with Cu, the acids being reduced. The stability of the half-filled d sub-shell in Mn^{2+} and the completely filled d^{10} configuration in Zn^{2+} are related to their E° values, whereas E° for Ni is related to the highest negative $\Delta_{hyd}H^\circ$. An examination of the $E^\circ_{(M^{3+}/M^{2+})}$ values the low value for Sc reflects the stability of Sc^{3+} which has a noble gas configuration. The comparatively high value for Mn shows that $Mn^{2+}(d^5)$ is particularly stable, whereas a comparatively low value for Fe shows the extra stability of $Fe^{3+}(d^5)$. The comparatively low value for V is related to the stability of V^{2+} (half-filled t_{2g} level).



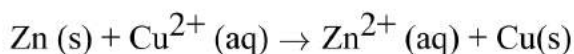
- Why Zn has high value for M^{3+}/M^{2+} Standard Electrode Potentials?
- Transition metals, despite high E° oxidation, are poor reducing agents. Justify.
- Why is Cr^{2+} reducing and Mn^{3+} oxidising when both Cr and Mn have d^4 configuration?

OR

Why Cu^{2+} is more stable than Cu^+ ?

Section E

33. i. Calculate ΔG° for the reaction



Given: E° for $Zn^{2+}/Zn = -0.76$ V and E° for $Cu^{2+}/Cu = +0.34$ V

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$F = 96500 \text{ C mol}^{-1}$$

- ii. Given two advantages for fuel cells.

OR

The resistance of a conductivity cell when filled with 0.05 M solution of an electrolyte X is 100 ohms at 40°C . The same conductivity cell filled with 0.01 M solution of electrolyte Y has a resistance of 50 ohms. The conductivity of 0.05 M solution of electrolyte X is $1.0 \times 10^{-4} \text{ S cm}^{-1}$ calculate.

- Cell constant
- Conductivity of 0.01 M Y solution



iii. Molar conductivity of 0.01 M solution.

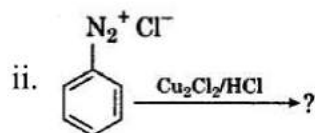
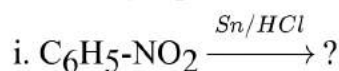
34. Answer the following questions:

[5]

- Decomposition of a substance with initial concentration 'a' follows zero order kinetics with the rate constant ' k ' $\text{mol L}^{-1} \text{s}^{-1}$. How much time it will take for completion of the reaction?
- What type of isomerism is shown by the complex $[\text{Co}(\text{NH}_3)_5 \text{NO}_2]\text{Cl}_2$?
- How will you convert bromobenzene to 1-phenylethanol?
- Why is benzene diazonium chloride not stored and is used immediately after its preparation?
- Why first ionisation enthalpy of Cr is lower than that of Zn?

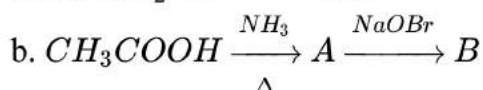
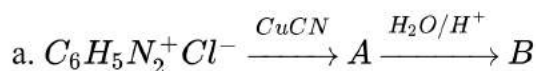
35. Write major product(s) in the following reactions:

[5]



OR

i. Write the structures of A and B in the following reactions:



ii. Write the chemical reaction of methyl amine with benzoyl chloride and write the IUPAC name of the product obtained.

iii. Arrange the following in the increasing order of their pK_b values: $\text{C}_6\text{H}_5\text{NH}_2$, NH_3 , $\text{C}_2\text{H}_5\text{NH}_2$, $(\text{C}_2\text{H}_5)_2\text{NH}$



SOLUTION

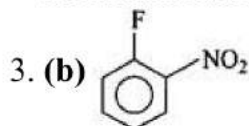
Section A

1. (c) Mn^{2+}

Explanation: $\text{MnO}_4^- + 5e \rightarrow \text{Mn}^{2+}$; E_{RP}^0 is maximum and thus reduction will predominate.

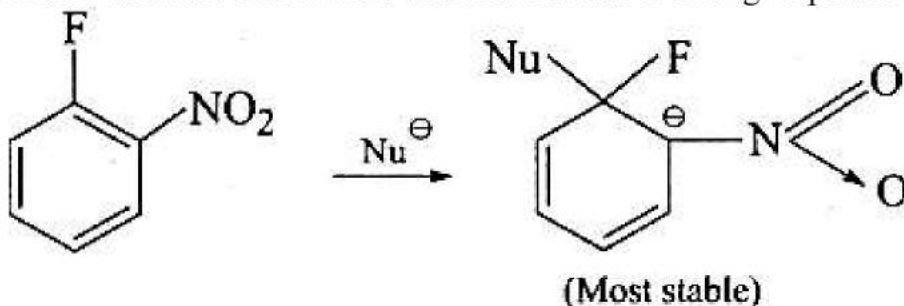
2. (d) 3

Explanation: A monosaccharide is a single polyhydroxy aldehyde (aldose) or ketone (ketose) unit. Glucose is a single polyhydroxy aldehyde, while fructose is a single polyhydroxy ketone. A monosaccharide contains a skeleton, of carbon atoms. The minimum number of carbon atoms is three and it can go up to seven.

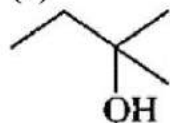


Explanation:

Fluoro derivative form more stable anion due to strong -I power.



4. (a)



Explanation: $pK_a \propto \frac{1}{\text{Acidity}}$

5. (b) 5/2

Explanation: $\text{Eq. of } \text{MnO}_4^- = \text{Eq. of } \text{H}_2\text{O}_2$
($n=5$) ($n=2$)

$$\frac{1}{5} \text{mol} = \frac{1}{2} \text{mol}$$

$$1 \text{mol of } \text{MnO}_4^- = \frac{5}{2} \text{mol of } \text{H}_2\text{O}_2$$

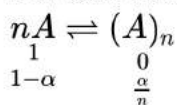
6. (c) extensive

Explanation: $A_x B_y \rightleftharpoons xA^+ + yB^-$
 $\frac{1}{1-\alpha}$ $\frac{0}{x\alpha}$ $\frac{0}{y\alpha}$

For dissociation:

Colligative properties ($\Delta P, \Delta T_b, \Delta T_f$) $\propto \frac{w}{m} \times \frac{1}{V} \times (1 - \alpha + x\alpha + y\alpha)$

For association:



$$CP \propto \frac{w}{m} \times \frac{1}{V} \times \left(1 - \alpha + \frac{\alpha}{n}\right)$$

7. (d) to absorb liberated HCl

Explanation: to absorb liberated HCl

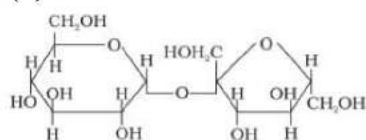
8. (a) Powdered sugar in hot water

Explanation: Dissolution of sugar in water is endothermic and thus favoured by heat. Also surface area of powdered sugar is more which favours dissolution.

9. (a) Fe_2O_3 and $\text{Fe}(\text{OH})_3$

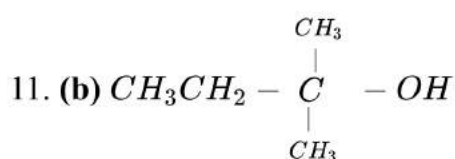
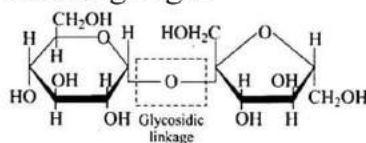
Explanation: Rust is $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ or a mixture of $\text{Fe}_2\text{O}_3 + \text{Fe}(\text{OH})_3$

10. (a)



Explanation:

This structure represents sucrose (disaccharides) in which α -D glucose and β -D-fructose is attached to each other by C_1 - C_2 glycosidic linkage. Since reducing groups of glucose and fructose are involved in glycosidic bond formation, this is considered as a non-reducing sugar.



Explanation: Alkyl halides can be obtained by treating alcohol with haloacids. The reactivity of tertiary alcohols with the haloacids is the highest and primary alcohols are the lowest. Formation of alkyl chloride using primary and secondary alcohols requires the usage of a catalyst ZnCl_2 , where dry hydrogen chloride gas is passed through a solution of alcohol or by heating a mixture of alcohol and concentrated aqueous halogen acid. Reaction with tertiary alcohols does not require a catalyst and can be carried out by using tertiary alcohols. the reaction is conducted by simply shaking with concentrated HCl at room temperature

12. (a) f-block

Explanation: f-block

13. (a) 965 C

Explanation: $2\text{H}^+ + 2\text{e} \rightarrow \text{H}_2$

$2\text{OH}^- \rightarrow \frac{1}{2}\text{O}_2 + \text{H}_2\text{O} + 2\text{e}$

eq. formed of H_2 and O_2 are in the ratio 2 : 1

Total eq. formed = $\frac{168}{11200} = 0.015$ (n-factor for H_2 and O_2 is 2)

\therefore Eq. of $\text{H}_2 = 0.010$

\therefore Eq. of $\text{O}_2 = 0.005$

\therefore Total charge passed = $0.010 \times 96500 = 965 \text{ C}$

14. (d) B only

Explanation: I step of mechanism B shows I order in both reactants.

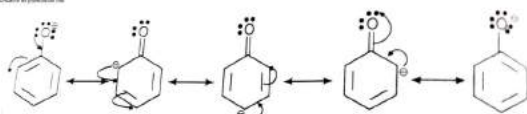
15. (d) If both Assertion and Reason are false statements.

Explanation: The given assertion and its reason both are incorrect.

EtOH is a weaker acid than phenol because it is tough to remove H^+ ion

from EtOH whereas phenol readily gives H^+ to form phenoxide ion (highly stable due to resonance).

The correct reason is that phenoxide ion is stabilized by resonance but ethoxide ion is not stabilized by resonance.



16. (c) A is true but R is false.

Explanation: A is true but R is false.

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

Explanation: Depression in freezing point is a colligative property which depends upon the number of the particles.

The number of particles is different in the case of benzene and water because acetic acid undergoes association in benzene and dissociation in water. That is why the molecular weight of acetic acid determined by depression in freezing point method is also different.

18. (d) A is false but R is true.

Explanation: Mercury cell gives a steady potential because in the cell reaction ions are not involved in the solution.

Section B

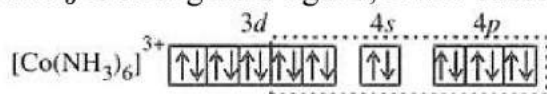
19. a. **Analytical chemistry:** (i) EDTA is used for the estimation of Ca^{2+} and Mg^{2+} in hard water.

b. **Extraction of metals :** (i) Silver and gold are extracted by treating zinc with their cyanide complexes.

20. Electronic configuration of Co : $[\text{Ar}]4s^23d^7$

Electronic configuration of Co^{3+} : $[\text{Ar}]4s^03d^6$

NH_3 is strong field ligand, it will cause pairing of electrons. Hence,



d^2sp^3 hybridisation

It has octahedral shape and is diamagnetic due to the absence of unpaired electrons.

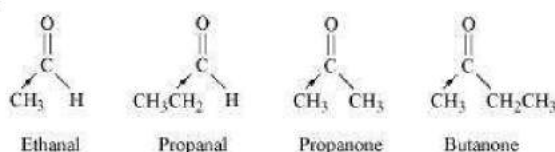
OR

i. $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$

ii. $\text{Li} [\text{AlH}_4]$

21. The IUPAC name is 2-Methylcyclohexanone

i. OR

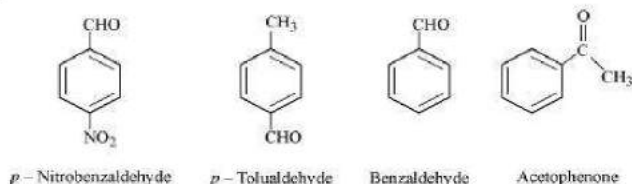


The +I effect of the alkyl group increases in the order: Ethanal < Propanal < Propanone < Butanone

The electron density at the carbonyl carbon increases with the increase in the +I effect of the alkyl group. As a result, the chances of attack by a nucleophile decrease. Hence, the increasing order is:

Butanone < Propanone < Propanal < Ethanol

ii.



The +I effect is more in ketone than in aldehyde. Hence, acetophenone is the least reactive in nucleophilic addition reactions.

Among aldehydes, the +I effect is the highest in *p*-tolualdehyde because of the presence of the electron-donating $-\text{CH}_3$ group and the lowest in *p*-nitrobenzaldehyde because of the presence of the electron-withdrawing $-\text{NO}_2$ group. Hence, the increasing order is:

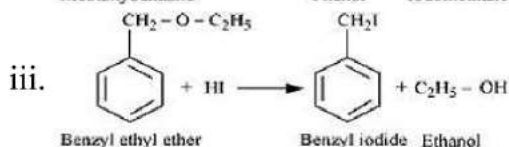
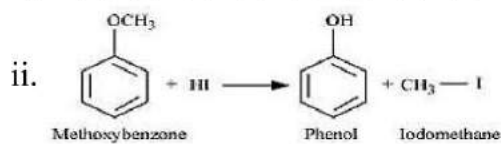
Acetophenone < *p*-Tolualdehyde < Benzaldehyde < *p*-Nitrobenzaldehyde

22. i. Zero order reaction.

ii. $[\text{R}] = [\text{R}_0] - kt \therefore \text{Slope} = -k$

23. Electronic configuration of Cr





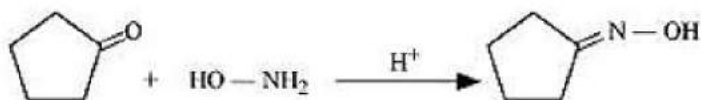
29. Carbohydrate is essential for life and also used as storage molecules in plants and animals are as follows:

- i. The plant contains mainly starch, cellulose, sucrose, etc.
- ii. Animal contains glycogen in their body. So, glycogen is also known as animal starch. Glycogen is present in the liver, muscles, and brain when the body needs glucose, the enzyme breaks glycogen down to glucose.
- iii. Cellulose is present in the wood, and the fibre of clothes. Cell wall of bacteria is made up of cellulose.

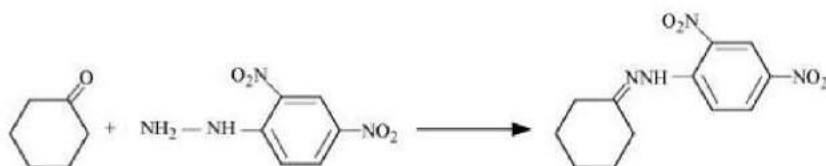
OR

- i. **Peptide linkage.** Polymers of α -amino acids are connected to each other by peptide bond or peptide linkage. Chemically peptide linkage is an amide formed between - COOH group and -NH₂ group.
- ii. **Glycosidic linkage.** The two monosaccharides are joined together by an oxide linkage formed by the loss of a water molecule. Such a linkage between two monosaccharide units through oxygen atom is called glycosidic linkage.

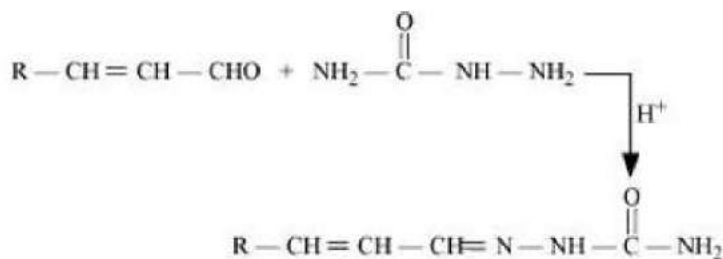
30. i.



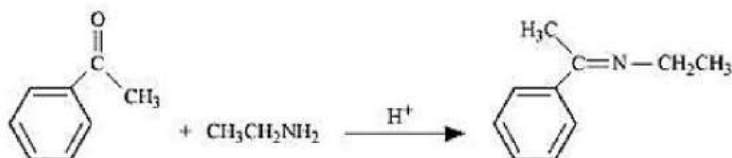
ii.



iii.



iv.



Section D

31. Read the text carefully and answer the questions:

The boiling point elevation and the freezing point depression of solutions have a number of practical applications. Ethylene glycol ($\text{CH}_2\text{OH}\cdot\text{CH}_2\text{OH}$) is used in automobile radiators as an antifreeze because it lowers the freezing point of the coolant. The same substance also helps to prevent the radiator coolant from boiling away by elevating the boiling point. Ethylene glycol has a low vapour pressure. We can also use glycerol as an antifreeze. In order for boiling point elevation to occur, the solute must be non-volatile, but no such restriction applies to freezing point depression. For example, methanol (CH_3OH), a fairly volatile liquid that boils only at 65°C is sometimes used as antifreeze in automobile radiators.

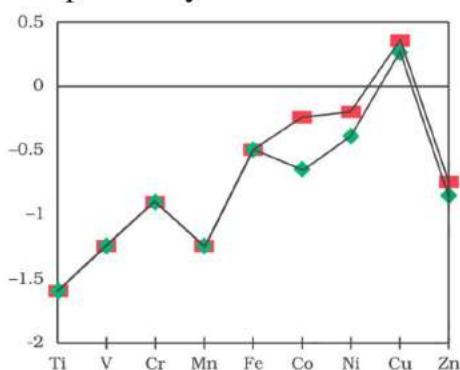
- (i) CH_3OH is a better reagent for depression in freezing point but not for elevation in boiling point.
- (ii) The depression in freezing point will be the same in both the solutions because both are non-electrolytes and gives the same number of solutes.
- (iii) Glycol will be better than glycerol because it is more volatile than glycerol.

OR

The sequence of the economy to use these compounds as antifreeze is Methanol > Glycol > Glycerol.

32. Read the text carefully and answer the questions:

The unique behaviour of Cu, having a positive E° accounts for its inability to liberate H_2 from acids. Only oxidising acids (nitric and hot concentrated sulphuric) react with Cu, the acids being reduced. The stability of the half-filled d sub-shell in Mn^{2+} and the completely filled d^{10} configuration in Zn^{2+} are related to their E° values, whereas E° for Ni is related to the highest negative $\Delta_{hyd}H^\circ$. An examination of the $E^\circ_{(M^{3+}/M^{2+})}$ values the low value for Sc reflects the stability of Sc^{3+} which has a noble gas configuration. The comparatively high value for Mn shows that $Mn^{2+}(d^5)$ is particularly stable, whereas a comparatively low value for Fe shows the extra stability of $Fe^{3+}(d^5)$. The comparatively low value for V is related to the stability of V^{2+} (half-filled t_{2g} level).

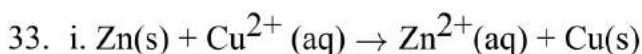


- Due to the removal of an electron from the stable d^{10} configuration of Zn^{2+} .
- Transition metals despite having high E° oxidation, are poor reducing agents because of their high heat of vaporization, high ionisation energies and low heats of hydration.
- Cr^{2+} is reducing as its configuration changes from d_4 to d_3 , the having a half-filled t_{2g} level. On the other hand, the change from Mn^{3+} to Mn^{2+} results in the half-filled (d_5) configuration which has extra stability.

OR

The Stability of Cu^{2+} is more than Cu^+ as stability depends on the hydration energy of the ions when they bond to the water molecules. The Cu^{2+} ion has a greater charge density than Cu^+ ion and thus forms much stronger bonds releasing more energy.

Section E



$$E^\circ_{Zn^{2+}/Zn} = -0.076 \text{ V}$$

$$E^\circ_{Cu^{2+}/Cu} = +0.034 \text{ V}$$

$$F = 96500 \text{ C mol}^{-1}$$

from the reaction $n = 2$

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

$$E^\circ_{cell} = 0.34 - (-0.076) = 1.10 \text{ V}$$

The value of ΔG° for the reaction = nFE°

$$= -2 \times 96500 \times 1.10$$

$$= -212300 \text{ KJmol}^{-1} = -212.3 \text{ kJmol}^{-1}$$

ii. Two advantages of fuel cells.

- Fuel cells have a higher efficiency than diesel or gas engines and are pollution-free.
- Most fuel cells operate silently, compared to internal combustion engines. They are therefore ideally suited for use within buildings such as hospitals.

OR

For electrolyte X

Molarity = 0.05 M

Resistance = 100Ω

Conductivity = $1.0 \times 10^{-4} \text{ S cm}^{-1}$

For electrolyte Y

Molarity = 0.01 M

Resistance = 50Ω

Conductivity = ?

i. Cell constant = Conductivity (K) × Resistance (R)

$$G^* = 1.0 \times 10^{-4} \times 100$$

$$= 10^{-2} \text{ cm}^{-1}$$

ii. Conductivity of solution Y is

$$K = \frac{G^*}{R} = \frac{10^{-2}}{50}$$

$$= 0.02 \times 10^{-2}$$

$$= 2 \times 10^{-4} \text{ S cm}^{-1}$$

iii. Concentration C = 0.01 M

$$= 0.01 \text{ mol L}^{-1}$$

$$= 0.01 \times 1000 \text{ mol ml}^{-3}$$

$$= 10 \text{ mol cm}^{-3}$$

∴ Molar concentration

$$\lambda_m = \frac{K}{C} = \frac{2 \times 10^{-4}}{10}$$

$$= 0.2 \times 10^{-4} \text{ S cm}^2 \text{ mol}^{-1}$$

34. Answer the following questions:

(i) For the reaction

A → products

The reaction follows zero order kinetics and the concentration of A = a mol/L

Integrating both sides, $\int d[a] = -k \int dt \implies [a] = -k t + C \dots (i)$

where, C is the constant of integration

At t = 0, the concentration of the reactant = a₀, where a₀ is initial concentration of the reactant.

Substituting in equation (i)

$$a_0 = -k \times 0 + C$$

$$a_0 = C$$

Substituting the value of C in the equation (i)

$$a = -kt + a_0 \dots (ii)$$

$$-kt = a - a_0 \implies kt = a_0 - a$$

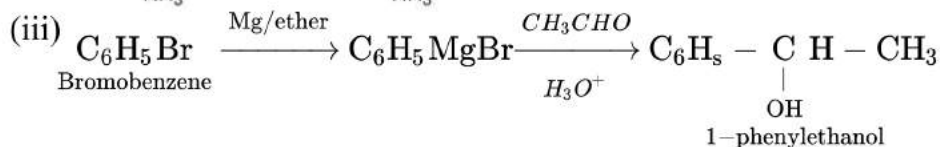
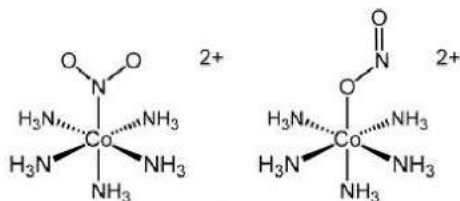
∴ The time required for the reactant concentration to reach a is $t = \frac{a_0 - a}{k} \text{ s}$



The reaction gets completed when $[A]=a=0$

The time required for the completion of the reaction is $t = \frac{a_0 - 0}{k} = \frac{a_0}{k}$ s

(ii) Linkage isomerism is shown by the complex $[\text{Co}(\text{NH}_3)_5 \text{NO}_2]\text{Cl}_2$.

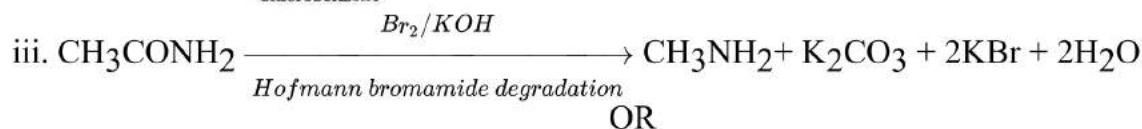
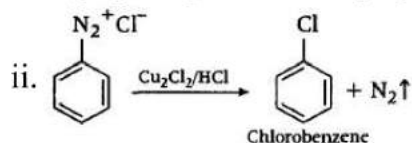
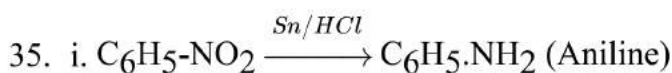


(iv) Benzene diazonium chloride is very unstable. Therefore, it cannot be generally stored and is used immediately after its preparation.

(v) The electronic configuration of chromium and zinc are respectively:

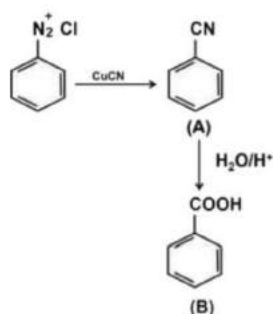


It is easy to remove electron from $4s^1$ -orbital (unpaired) rather than from $4s^2$ -orbital (paired). Therefore, first ionisation enthalpy of Cr is less than Zn.

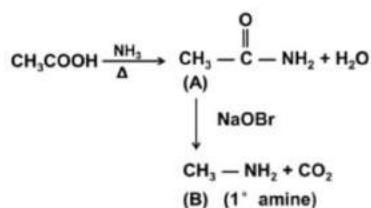


i. The structure of A and B on following reaction is:

a.

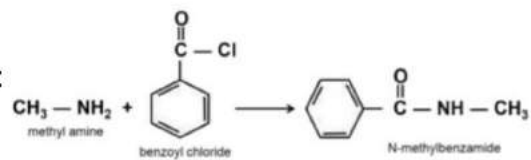


b.



ii. The chemical reaction of methyl amine with benzoyl chloride and IUPAC name of the

product form is as follows:



iii. Increasing order of pK_b values

