Sample Paper 10 Solutions

Class XII 2023-24

Chemistry

Time: 3 Hours **Max. Marks: 70**

General Instructions:

1. There are 33 questions in this question paper with internal choice.
2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 5 very short answer questions carrying 2 marks each.
4. SECTION C consists of 7 short answer questions carrying 3 marks each.
5. SECTION D consists of 2 case-based questions carrying 4 marks each.
6. SECTION E consists of 3 long answer questions carrying 5 marks each.
7. All questions are compulsory.
8. Use of log tables and calculators is not allowed.

SECTION-A

Directions (Q. Nos. 1-16) : The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. Regarding criteria of catalysis which one of the following statements is not true?

   (a) The catalyst is unchanged chemically at the end of the reaction

   (b) A small quantity of catalyst is often sufficient to bring about a considerable amount of reaction

   (c) In a reversible reaction the catalyst alters the equilibrium position

   (d) The catalyst accelerates the reaction

   Ans : (c) In a reversible reaction the catalyst alters the equilibrium position

   Catalyst does not alter the position of equilibrium in a reversible reaction.

2. By increasing the temperature, the vapour pressure of substance:

   (a) always increases

   (b) does not depend on temperature

   (c) always decreases

   (d) partially depends on temperature

   Ans : (a) always increases

   By increasing the temperature the vapour pressure of a substance always increases because more vapour will be formed at higher temperature.

3. Benzyl alcohol is obtained from benzaldehyde by

   (a) Fitting's reaction   (b) Cannizzaro's reaction

   (c) Kolbe's reaction   (d) Wurtz's reaction

   Ans : (b) Cannizzaro's reaction

By heating benzaldehyde with conc. NaOH or KOH (Cannizzaro reaciton).

$$\underset{\text{Benzaldehyde}}{C_6H_5CHO} + NaOH \longrightarrow \underset{\text{Benzyl alcohol}}{C_6H_5CH_2OH} + \underset{\text{Sod. benzoate}}{C_6H_5COONa}$$

4. The best way to prevent rusting of iron is

   (a) Making it cathode   (b) putting in saline water

   (c) both of these   (d) none of these

   Ans (a) Making it cathode

   Cathodic protection is best method to prevent iron from rusting. In this method iron is made cathode by application of external current.

   Saline water is highly conducting and hence accelerates the formation of rust.

5. An example of double salt is

   (a) Bleaching powder   (b) $K_4\left[Fe(CN)_6\right]$

   (c) Hypo   (d) Potash alum

   Ans : (d) Potash alum

   Potash alum $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ is a double salt.

6. A zero order reaction is one whose rate is independent of

   (a) the concentration of the reactants

   (b) the temperature of reaction

   (c) the concentration of the product

   (d) the material of the vessel in which reaction is carried out

   Ans : (a) the concentration of the reactants

   For zero order reaction, $\frac{dx}{dt} = k\,[\text{reactant}]^\circ$.

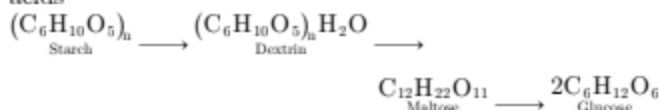   Thus the rate of zero order reaction is independent of concentration of reactants.

7. On hydrolysis of starch, we finally get

   (a) Glucose   (b) Fructose

   (c) Both a and b   (d) Sucrose

   Ans : (a) Glucose

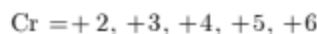   **Manufacture :** By hydrolysis of starch with hot dil. mineral acids

   $$\underset{\text{Starch}}{(C_6H_{10}O_5)_n} \longrightarrow \underset{\text{Dextrin}}{(C_6H_{10}O_5)_n} H_2O \longrightarrow$$

   $$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} \longrightarrow \underset{\text{Glucose}}{2C_6H_{12}O_6}$$

8. Of the following transition metals, the maximum numbers of oxidation states are exhibited by:

   (a) Chromium $(Z = 24)$

   (b) Manganese $(Z = 25)$

   (c) iron $(Z = 26)$

   (d) Titanium $(Z = 22)$

   Ans : (b) Manganese $(Z = 25)$

   Manganese shows max. no. of oxidation states $+2, +3, +4, +5, +6, +7$.

   $$Cr = +2, +3, +4, +5, +6$$
   $$Fe = +2, +3$$
   $$Ti = +2, +3, +4$$

9. Which of the following undergoes Cannizzaro's reaction?

   (a) CH_3CHO (b) CH_3CH_2CHO

   (c) $(CH_3)_2CHCHO$ (d) $HCHO$

   Ans : (d) $HCHO$

   Carbonyl compound having no α hydrogen undergo cannizzaro reaction. In HCHO, there is no alpha hydrogen present. So HCHO is expected to undergo Cannizzaro reaction.

10. Which one is most reactive towards S_N1 reaction?

    (a) $C_6H_5CH(C_6H_5)Br$

    (b) $C_6H_5CH(CH_3)Br$

    (c) $C_6H_5C(CH_3)(C_6H_5)Br$

    (d) $C_6H_5CH_2Br$

    Ans : (c) $C_6H_5C(CH_3)(C_6H_5)Br$

    S_N1 reactions involve the formation of carbocations, hence higher the stability of carbocation, more will be reactivity of the parent alkyl halide. Thus tertiary carbocation formed from (c) is stabilized by two phenyl groups and one methyl group, hence most stable.

11. The correct order of increasing basic nature for the bases NH_3, CH_3NH_2 and $(CH_3)_2NH$ is :

    (a) $(CH_3)_2NH < NH_3 < CH_3NH_2$

    (b) $NH_3 < CH_3NH_2 < (CH_3)NH$

    (c) $CH_3NH_2 < (CH)_3NH < NH_3$

    (d) $CH_3NH_2 < NH_3 < (CH_3)_2NH$

    Ans : (b) $NH_3 < CH_3NH_2 < (CH_3)NH$

    The alkyl groups are electron releasing group $(+I)$, thus increases then electron density around the nitrogen thereby increasing the availability of the lone pair of electrons to proton or lewis acid and making the more basic. Hence more the no. of alkyl group more basic is the amine. Therefore the correct order is
    $$NH_3 < CH_3NH_2 < (CH_3)_2N$$

12. Which of the following concentration unit is independent of temperature?

    (a) Normality   (b) Molarity

    (c) Formality   (d) Molality

    Ans : (d) Molality

    Volume is temperature dependent, hence expression involving volume term (normality, molarity and formality) varies with temperature.

    $$\text{Normality} = \frac{\text{geq of solute}}{\text{vol. of solution in L}}$$

    $$\text{Molarity} = \frac{\text{moles of solute}}{\text{vol. of solution in L}}$$

    $$\text{Formality} = \frac{\text{formula mass}}{\text{vol. of solution in L}}$$

    $$\text{Molality} = \frac{\text{moles of solute}}{\text{mass of solvent in Kg}}$$

    Since molality does not include the volume term, it is independent of temperature.

Directions (Q. Nos. 13-16) : Each of the following questions consists of two statements, one is Assertion and the other is Reason. Give answer :

13. **Assertion :** Maltose is a reducing sugar which gives two moles of D-glucose on hydrolysis.
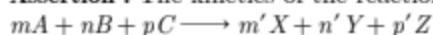   **Reason :** Maltose has 1, 4-β-glycosidic linkage.

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

    (b) Both Assertion and Reason are correct but Reason is not the a correct explanation of the Assertion.

    (c) Assertion is correct but Reason is incorrect.

    (d) Both the Assertion and Reason are incorrect.

    Ans : (c) Assertion is correct but Reason is incorrect.

    The two glucose units of maltose are linked through α - glycosidic linkage between C-1 of one glucose unit and $C-4$ of the other.

14. **Assertion :** The kinetics of the reaction :
$$mA + nB + pC \longrightarrow m'X + n'Y + p'Z$$

Obey the rate expression as $\frac{dx}{dt} = k[A]^m[B]^n$.

Reason : The rate of the reaction does not depend upon the concentration of C.

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

(b) Both Assertion and Reason are correct but Reason is not the a correct explanation of the Assertion.

(c) Assertion is correct but Reason is incorrect.

(d) Both the Assertion and Reason are incorrect.

Ans : (a) Both Assertion and Reason are correct and Reason is a correct explanation of the Assertion.

Rate expression $\frac{dX}{dt} = k[A]^m[B]^n$ shows that the total order of reaction is $m + n + 0 = m + n$.
As the rate of reaction is independent of concentration of C, i.e., the order with respect to C is zero. This is the reason that C does not figure in the rate expression.

15. **Assertion :** SN^2 reactions always proceed with inversion of configuration.
Reason : SN^2 reaction of an optically active aryl halide with an aqueous solution of KOH always gives an alcohol with opposite sign of rotation.

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

(b) Both Assertion and Reason are correct but Reason is not the a correct explanation of the Assertion.

(c) Assertion is correct but Reason is incorrect.

(d) Both the Assertion and Reason are incorrect.

Ans : (c) Assertion is correct but Reason is incorrect.

Assertion is true, because aryl halides do not undergo nucleophilic substitution under ordinary conditions. This is due to resonance, because of which the carbon halogen bond acquires partial double bond character, hence, it becomes shorter and stronger and thus, cannot be replaced by nucleophiles. However, Reason is false.

16. **Assertion :** Vitamin D cannot be stored in our body.
Reason : Vitamin D is fat soluble vitamin and is excreted from the body in urine.

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

(b) Both Assertion and Reason are correct but Reason is not the a correct explanation of the Assertion.

(c) Assertion is correct but Reason is incorrect.

(d) Both the Assertion and Reason are incorrect.

Ans : (d) Both the Assertion and Reason are incorrect.

Vitamin D is a fat soluble vitamin and can be stored in the body since it is not excreted out of the body.

SECTION-B

Directions (Q. Nos. 17-21) : This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. What is the trend in melting point of transition metals when we move left to right in a series?

Ans :

On moving left to right in a series the melting points of these metals rise to a maximum at d^5 then fall as the atomic number increases.

18. For what reason transition metals have high melting points?

Ans :

The high melting point of these metals are due to the involvement of greater number of electrons from $(n-1)d$ in addition to the ns electrons in the inter-atomic metallic bonding.

19. What is rate law? Illustrate with an example.

Ans :

The equation that describes mathematically the dependence of the rate of a reaction on the concentration terms of the reactions is known as the rate equation (or) rate law.
Example : $2A + 3B \longrightarrow 3C$

Rate of the given reaction $\propto [A]^2[B]^3$

20. Give one test from which methyl alcohol and ethyl alcohol are distinguished.
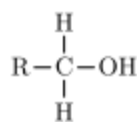
Ans :

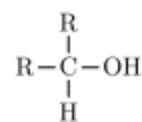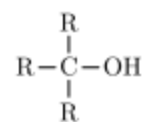| Test	Methyl alcohol	Ethyl alcohol
Iodo form test On heating I_2 and NaOH	No yellow compound is formed	Yellow compound with characteristic odour is formed.

or

How are alcohols classified?

Ans :

Alcohols are classified as primary, secondary, or tertiary according to the $1°$, $2°$, or $3°$ carbon that bears the hydroxy (–OH) group.

Primary (1°)   Secondary (2°)   Tertiary (3°)
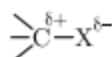
21. Give the reason of dipole in $C - X$ bond.

Ans :

Since halogen atoms are more electronegative than carbon, the carbon halogen bond is polarised; the carbon atom bears a positive charge whereas the halogen atom bears a partial negative charge.

$$\underset{}{\overset{\delta+}{\underset{}{C}}} - \overset{\delta-}{X}$$

SECTION-C

Directions (Q. Nos. 22-28) : This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22. Explain Raoult's Law.

Ans :

Raoult's law for the solutions of liquids in liquids: "The equilibrium vapour pressure of a volatile solute is linearly proportional to the mole fraction of that component in liquid phase".

$$p_A = X_A p_A^\circ \quad \text{and} \quad p_B = X_B p_B^\circ$$

where, A and B are volatile solute and solvent respectively. P_A° and P_B° are the vapour pressures in pure state.

If X_A and X_B are the mole fraction of the components A and B respectively in the vapour phase then,

$$P_A = X_A \cdot p_{\text{total}}$$
$$P_B = X_B \cdot p_{\text{total}}$$

Raoult's law for solutions of solids in liquid i.e., for non-volatile solutes,

$$p_{\text{solution}} = X_{\text{solvent}} p^\circ{}_{\text{solvent}}$$

23. Mention a reaction for which the exponents of concentration terms are not the same as their stoichiometric coefficients in the rate equation.

Ans :

The following are the reactions for which the exponents of concentration terms are not the same as their stoichiometric coefficients in the rate equation.

$$CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$$
$$\text{Rate} = K[CHCl_3][Cl_2]^{1/2}$$

$$CH_3COOC_2H_5 + H_2O \longrightarrow CH_3COOH + C_2H_5OH$$
$$\text{Rate} = K[CHCOOC_2H_5][H_2O]$$

24. Define specific conductance and equivalent conductance.

Ans :

Specific Conductance : The reciprocal of specific resistance (resistivity) is called the specific conductance or conductivity.

$$\kappa = \frac{1}{\rho}$$
$$\kappa = \frac{1}{R} \cdot \frac{l}{A}$$
$$\kappa = G \cdot \frac{l}{A}$$

where, l = distance between the electrodes

          A = their cross-sectional area

Equivalent Conductance:

It is defined as the conducting power of all the ions produced by dissolving one gram equivalent of an electrolyte in solution.

It is expressed as Λ_e and is related to specific conductance as,

$$\Lambda_e = \frac{\kappa \times 1000}{C_{eq}}$$

where C_{eq} is the concentration in gram equivalent per litre (or normality).

25. What may be the stable oxidation state of the transition element with the following d electrons configurations in the ground state of their atoms : $3d^3$, $3d^5$, $3d^8$ and $3d^4$?

Ans :

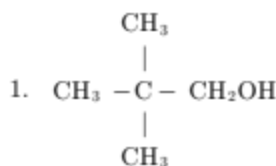Stable oxidation states are :
$3d^3$ (Vanadium) : +3, +4 and +5
$3d^5$ (Chromium) : +3, +4, +6
$3d^5$ (Manganese) : +2, +4, +6, +7
$3d^8$ (Cobalt) : +2,+3(in complexes)
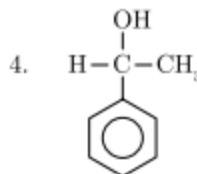$3d^4$ No element has d^4 configuration in the ground state.

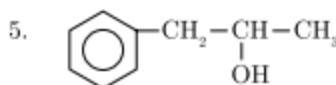**26.** Classify the following as primary, secondary and tertiary alcohols :

1. $$CH_3 - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - CH_2OH$$

2. $H_2C = CH - CH_2OH$

3. $CH_3CH_2CH_2OH$

4. $$H - \underset{\underset{\bigcirc}{|}}{\overset{\overset{OH}{|}}{C}} - CH_3$$

5. $$\bigcirc - CH_2 - \underset{\underset{OH}{|}}{CH} - CH_3$$

6.

Ans :
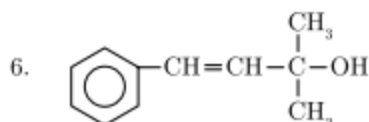
1. S.NO. 1, 2 and 3 are Primary alcohols : because given molecule has $-CH_2OH$.
2. S.NO. 4, and 5 are Secondary alcohols : because given molecule has $>CHOH$.
3. S.No. 6 is Tertiary alcohols : because given molecule has $>COH$.

27. Discuss the structures of Carbonyl group.

Ans :

Structure of Carbonyl group : According to M. O theory, the carbonyl carbon make use of three sp^2 hybrid orbitals in forming the three σ bonds. As such these bonds lie in the same plane with an angle approximately $120°$. The π bond between C and O is formed by the sidewise overlaping of remaining half filled p-orbital of each atom Further since oxygen atom is more electronegative than C, it tends to attract the electron cloud of the double bond towards itself and as such oxygen acquires some negative charged. While C-becomes some positive charge.

or

Why aldehydes are generally more reactive than Ketones in nucleophilic addition reactions?

Ans :

Aldehydes are generally more reactive than ketones in nucleophilic addition reactions due to steric and electronic reasons. Sterically the presence of two relatively large substituents in ketones hinders the approach of nucleophile to carbonyl carbone than in aldehydes having only one substituent. Electronically, aldehydes are more reactive than ketones because two alkyl groups reduces the electrophilicity of the carbonyl in ketones.

28. Why do the gases always tend to be less soluble in liquids as the temperature is raised?

Ans :

Dissolution of gases in liquids is exothermic process

$$Gas + Liquid \rightleftharpoons Solution + Heat$$

or $Gas + Liquid \rightleftharpoons Solution, \Delta H = -ve$

Therefore, in accordance with Le chatelier's principle, an increase in temperature will shifts the equilibrium towards left i.e. the solubility of gas in liquid will decrease.

SECTION-D

Directions (Q. Nos. 29-30) : The following questions are case-based questions. Each question has an internal choice and carries 4 marks each. Read the passage carefully and answer the questions that follow.

29. Pentose and hexose undergo intramolecular hemiacetal or hemiketal formation due to combination of the –OH group with the carbonyl group. The actual structure is either of five or six membered ring containing an oxygen atom. In the free state all pentoses and hexoses exist in pyranose form (resembling pyran). However, in the combined state some of them exist as five membered cyclic structures, called furanose (resembling furan).
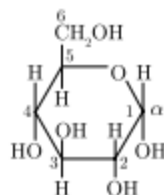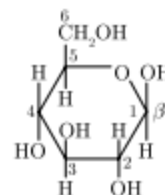

The cyclic structure of glucose is represented by Haworth structure :

$\alpha-$ and $\beta-D$ glucose have different configuration at anomeric $(C-1)$ carbon atom, hence are called anomers and the $C-1$ carbon atom is called anomeric carbon (glycosidic carbon). The six membered cyclic structure of glucose is called pyranose structure.

Answer the following questions :

(a) Give the difference between $\alpha-D(+)$-glucose and $\beta-D(+)$ glucose ?

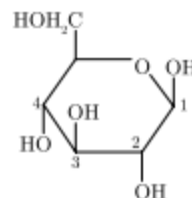(b) The given carbohydrate is
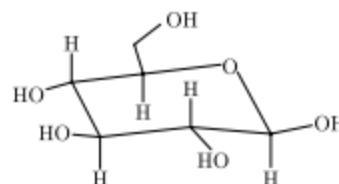
an α-furanose or a β-pyranose ?

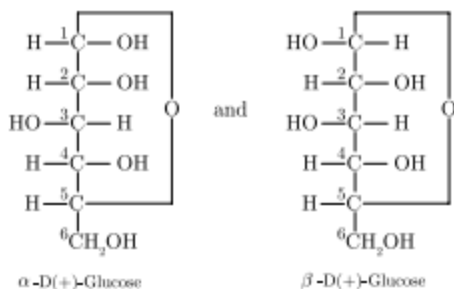(c) What is the structural difference between starch and cellulose?

or

(d) What is the anomers ? Find anomeric carbon in given structure.

Ans :

(a) $\alpha - D - (+)$-glucose and $(3 - D - (+))$-glucose differ in configuration at C_1 (i.e., anomeric or glycosidic carbon) and hence are called anomers.

α -D(+)-Glucose β -D(+)-Glucose

(b) This structure is an example of pyranose and aldohexose. Here, the carbohydrate's structure is of the (3-pyranose form.

(c) The basic structural difference between starch and cellulose is of linkage between the glucose units. In starch, there is $\alpha - D$-glycosidic linkage. Both the components of starch-amylose and amylopectin are polymer of $\alpha - D$-glucose. On the other hand, cellulose is a linear polymer of $\beta - D$-glucose in which C_1 of one glucose unit is connected to C_4 of the other through $\beta - D$-glycosidic linkage.

or

(d) Anomers are cyclic monosaccharides or glycosides that are epimers, differing from each other in the configuration at $C-1$, if they are aldoses or in the configuration at $C-2$ if they are ketoses. $C-1$ is the anomeric carbon.

30. Elevation in boiling point is the increase in boiling point when a non volatile solute is added to the solvent.
Addition of the solute lowers the vapour pressure of solvent, hence more heat is required to increase the vapour pressure upto the atmospheric pressure. The addition of 3 g of a substance to 100 g CCl_4 $(M = 154 \text{ g mol}^{-1})$ raises the boiling point of CCl_4 by $0.60°C$. $K_b(CCl_4)$ is 5.03 K kg mol^{-1}.
Given : $K_f(CCl_4) = 31.8$ K kg mol^{-1} and ρ (solution) $= 1.64 \text{ g cm}^{-3}$.

Answer the following questions :
(a) Determine the relative lowering of vapour pressure of the solution.
(b) Determine the molar mass of the substance.
(c) What will be the freezing point depression of the solution ?

or

(d) Define molal elevation constant for a solvent. Why is elevation of boiling point a colligative property ?

Ans :

(a) If M_2 is the molar mass of the substance, then using the expression

$$\frac{\Delta P}{P^\circ} = \frac{\frac{3}{250}}{\frac{100}{154} + \frac{3}{250}} = 0.01814$$

(b) From the molality of the solution, we get

$$\text{Molality} = \frac{n_2 \times 1000}{m_1} = \frac{\frac{m_2}{M_2} \times 1000}{m_1}$$

Now, $\Delta T_f = K_f \times m$

or $m = \frac{\Delta T_f}{K_f} = \frac{3.793}{31.8} = 0.12$

$$0.12 = \frac{\frac{3}{M_2} \times 1000}{100};$$

$$M_2 = 250$$

(c) $\frac{\Delta T_f}{\Delta T_b} = \frac{K_f}{K_b}$

$\Delta T_f \frac{K_f}{K_b} \times \Delta T_b$

$$= \frac{31.8}{5.03} \times 0.6 = 3.793°C$$

or

(d) Molal elevation constant may be defined as the elevation in boiling point when the molality of the solution is unity (i.e., 1 mole of the solute is dissolved in 1 kg (1000 g) of the solvent). The units of K_b are therefore, degree/molality i.e., K/m or °C/m or K kg mol^{-1}. Elevation of boiling point is a colligative property because it depends on number of solute particles present in a solution.

SECTION-E

Directions (Q. Nos. 31-33) : The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.

31. Write the chemistry of recharging the lead storage battery, highlighting all the material that are involved during recharging.
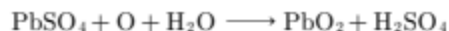
Ans :

Chemical Changes During Recharging : Consider a discharged lead-acid cell having both the plates converted to lead sulphate ($PbSO_4$). In order to recharge the cell, direct current is passed through the cell in the reverse direction to that in which the cell provided current. To do so, the anode is connected to the positive terminal of the dc source and cathode to the negative terminal of the source as shown in Figure 26.3. The electrolyte (H_2SO_4) splits into hydrogen ions ($2H^+$) and sulphate ions (SO_4^{--}). Hydrogen ions move towards cathode and sulphate ions move towards anode causing the following chemical reactions:
At anode

$$SO_4^{--} - 2e^- \longrightarrow SO_4 \ (\text{Radical})$$

$$SO_4 + H_2O \longrightarrow H_2SO_4 + O$$

The oxygen in the atomic state (i.e., O) is very active and reacts chemically with anode material ($PbSO_4$) to produce the following chemical change:

$$PbSO_4 + O + H_2O \longrightarrow PbO_2 + H_2SO_4$$

At cathode $2H^+ + 2e^- \longrightarrow 2H$

$$PbSO_4 + 2H \longrightarrow Pb + H_2SO_4$$
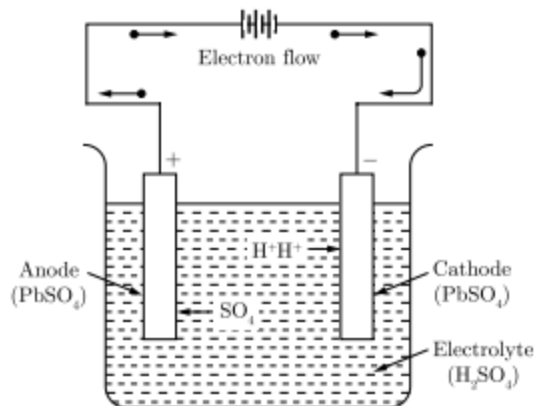
Figure : Recharging of a Lead-acid Cell

As the charging process goes on, the anode is converted into PbO_2 and cathode into Pb. The H_2SO_4 produced in the above chemical reactions increases the specific gravity of the electrolyte. The chemical change that occur during recharging can be summed up as under:

1. The positive plate (anode) is converted into PbO_2 and the negative plate (cathode) into Pb.
2. H_2SO_4 is formed in the reactions. Therefore, specific gravity of the electrolyte (H_2SO_4) is raised. When the cell is fully charged, the specific gravity of H_2SO_4 rises to about 1.28.
3. The emf of the cell rises. The emf of a fully charged cell is about 2.1 V.
4. Electrical energy supplied is converted into chemical energy which is stored in the cell.

or

What is the function of salt bridge in an electrochemical cell?

Ans :

Some important functions of a salt bridge are described below.

1. A salt bridge acts as an electrical contact between the two half-cells. When in a galvanic cell two solutions are kept in separate containers, an electrical contact between the two is needed to complete the circuit. A salt bridge completes the circuit by allowing the migration of anions from the cathodic half-cell into the salt bridge and from the salt bridge into the anodic half-cell.
2. A salt bridge prevents the transference/diffusion of the electrolytes from one half-cell to the other. the agar-agar gel does not allow any physical transfer of electrolyte from one half-cell to another.

3. A salt bridge helps in maintaining the charge balance in the two half-cells. A salt bridge helps in maintaining the charge balance in the two half-cells by releasing counter ions into the solution as shown in Figure.
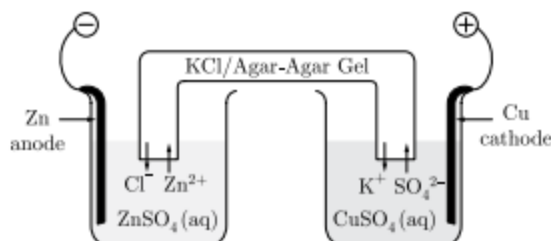

Figure : Salt Bridge

4. A salt bridge minimises/eliminates the liquid junction potential. A direct liquid-liquid junction is thermodynamically unstable state. The unequal rates of migration of the cations and anions across a liquid-liquid junction gives rise to a potential difference across the junction. This potential difference across the liquid-liquid junction is called liquid junction potential. A salt bridge eliminates a direct contact between the two solutions, and thus minimises the liquid junction potential.

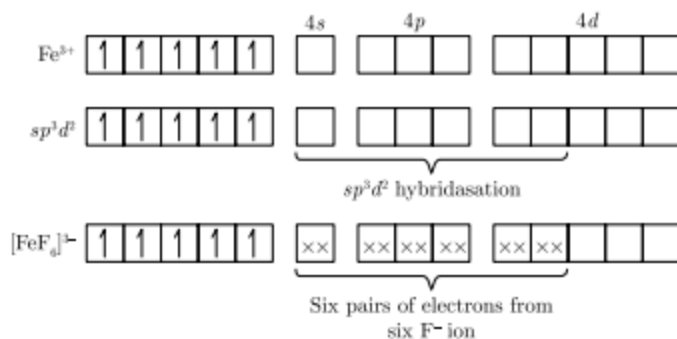**32.** Discuss the nature of bonding in the following coordination entities on the basis of valence bond theory.

(i) $[Fe(CN)_6]^{4-}$

(ii) $[FeF_6]^{3-}$

(iii) $[Co(C_2O_4)_3]^{3-}$

(iv) $[CoF_6]^{3-}$
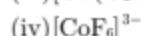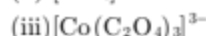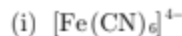
Ans :
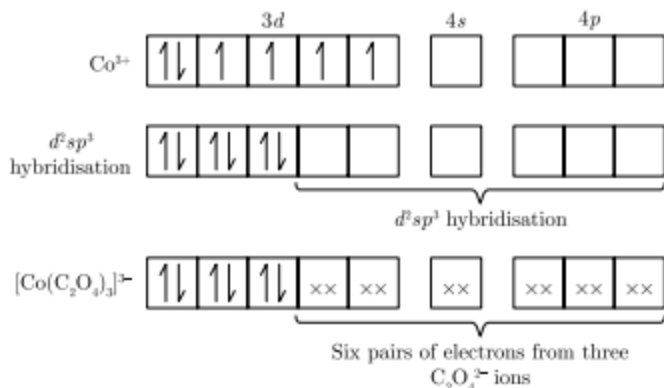
(i) $[Fe(CN)_6]^{4-}$: Iron is in $+2$ oxidation state ($3d^6$), Hybridisation is d^2sp^3, octahedral and diamagnetic.

(ii) $[FeF_6]^{3-}$: Iron is in $+3$ oxidation state ($3d^5$), hybridisation sp^3d^2, octahedral.

Six pairs of electrons from six F$^-$ ion

$[FeF_6]^{3-}$ is strongly paramagnetic due to presence of five unpaired electrons.

(iii) $[Co(C_2O_4)_3]^{3-}$: Cobalt is in +3 oxidation state, $(3d^6)$ hybridisation is d^2sp^3, octahedral.

Six pairs of electrons from three $C_2O_4^{2-}$ ions

$[Co(C_2O_4)_3]^{3-}$ is diamagnetic due to absence of unpaired electron.

(iv) $[CoF_6]^{3-}$: Cobalt is in +3 oxidation state $(3d^6)$, hybridisation sp^3d^2, octahedral.

Six electron pairs donated by six F⁻ ions
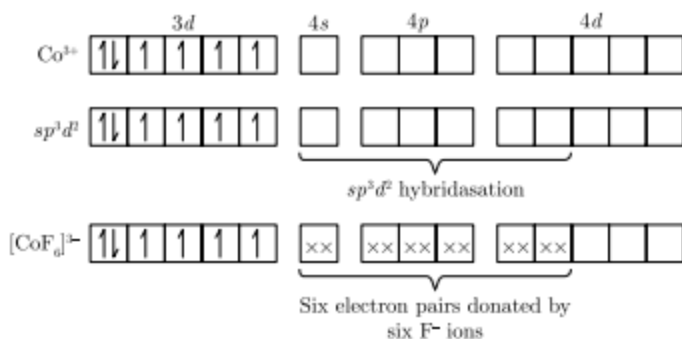
$[CoF_6]^{3-}$ is strongly paramagnetic due to presence of four unpaired electrons.

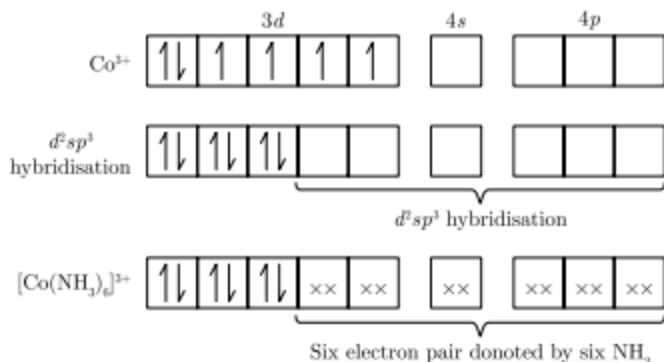**or**

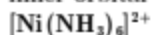Explain $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{2+}$ is an outer orbital complex.

Ans :

$[Co(NH_3)_6]^{3+}$
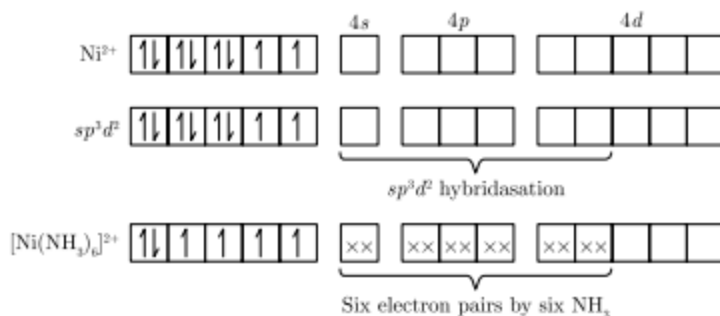
Co is in +3 state $(3d^6)$, hybridisation is d^2sp^3.

Six electron pair donoted by six NH₃

Hybridisation involves $(n-1)d$ or $3d$ orbitals, hence it is inner orbital complex.

$[Ni(NH_3)_6]^{2+}$

Ni is in +2 oxidation state $(3d^8)$ hybridisation is sp^3d^2.


Six electron pairs by six NH₃

Hybridisation involves nd or $4d$ orbitals, hence it is outer orbital complex.
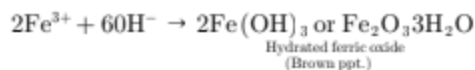
33. Accounts of the following
    (i) Methylamine in water reacts with ferric chloride to precipitate hydrated ferric oxide.
    (ii) Aniline does not undergo Friedel-Crafts reaction.
    (iii) Diazonium salts of aromatic amines are more stable than those of aliphatic amines.

Ans :

(i) Methylamine is more basic than water and accepts a proton from water giving OH^- ions.

$$CH_3\ddot{N}H_2 + H{-}OH \longrightarrow CH_3{-}\overset{+}{N}H_3 + OH^-$$
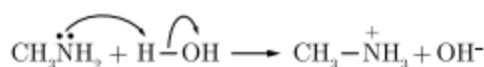
These OH^- ions combine with Fe^{3+} ions present in H_2O to form brown ppt. of hydrated ferric oxide.

$$FeCl_3 \rightarrow Fe^{3+} + 3Cl^-$$

$$2Fe^{3+} + 6OH^- \rightarrow 2Fe(OH)_3 \text{ or } Fe_2O_3 3H_2O$$
Hydrated ferric oxide (Brown ppt.)

(ii) Aniline being a Lewis base reacts with Lewis acid $AlCl_3$ to form a salt.

$$C_6H_5\ddot{N}H_2 + AlCl_3 \rightarrow \underset{\text{Salt}}{C_6H_5\overset{+}{N}H_2 AlCl_3^-}$$
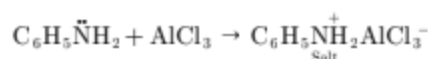
Due to the presence of a positive charge on N atom in the salt, the group $-\overset{+}{N}H_2AlCl_3^-$ acts as a strongly deactivating group which reduces the electron density in the benzene ring and hence aniline does not undergo Friedel-Crafts reaction (alkylation or acylation).

(iii) Due to the dispersel of the positive charge on the benzene ring the diazonium salts of aromatic amines are more stable than those of aliphatic amines.