

CASE STUDY / PASSAGE BASED QUESTIONS

1

Read the passage given below and answer the following questions :

Molar conductivity of ions are given as product of charge on ions to their ionic mobilities and Faraday's constant.

$$\lambda_{A^{n+}} = n\mu_{A^{n+}} F \text{ (here } \mu \text{ is the ionic mobility of } A^{n+}\text{).}$$

For electrolytes say A_xB_y , molar conductivity is given by

$$\lambda_{m(A_xB_y)} = x_n\mu_{A^{n+}} F + y_m\lambda_{A^{m-}} F$$

Ions	Ionic mobility
K^+	7.616×10^{-4}
Ca^{2+}	12.33×10^{-4}
Br^-	8.09×10^{-4}
SO_4^{2-}	16.58×10^{-4}

The following questions are multiple choice questions. Choose the most appropriate answer :

- (i) At infinite dilution, the equivalent conductance of $CaSO_4$ is
 (a) 256×10^{-4} (b) 279 (c) 23.7 (d) 2.0×10^{-8}
- (ii) If the degree of dissociation of $CaSO_4$ solution is 10% then equivalent conductance of $CaSO_4$ is
 (a) 3.59 (b) 36.9 (c) 27.9 (d) 30.6

OR

The correct order of equivalent conductance at infinite dilution of LiCl, NaCl, KCl is

- (a) LiCl = NaCl = KCl (b) LiCl > NaCl > KCl
 (c) KCl > LiCl > NaCl (d) KCl > NaCl > LiCl
- (iii) What is the unit of equivalent conductivity?
 (a) $ohm^{-1} cm^2 eq^{-1}$ (b) $ohm cm^2 eq^{-1}$
 (c) $ohm^{-1} cm eq^{-1}$ (d) $ohm cm^{-2} eq^{-1}$
- (iv) If the molar conductance value of Ca^{2+} and Cl^- at infinite dilution are $118.88 \times 10^{-4} m^2 mho mol^{-1}$ and $77.33 \times 10^{-4} m^2 mho mol^{-1}$ respectively then the molar conductance of $CaCl_2$ (in $m^2 mho mol^{-1}$) will be
 (a) 120.18×10^{-4} (b) 135×10^{-4}
 (c) 273.54×10^{-4} (d) 192.1×10^{-4}

Syllabus

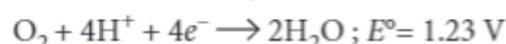
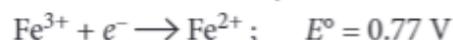
Redox reactions, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, Relation between Gibbs energy change and EMF of a cell, conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's Law, electrolysis.

Read the passage given below and answer the following questions :

Standard electrode potentials are used for various processes :

- It is used to measure relative strengths of various oxidants and reductants.
- It is used to calculate standard cell potential.
- It is used to predict possible reactions.

A set of half-reactions (in acidic medium) along with their standard reduction potential, E° (in volt) values are given below :



The following questions are multiple choice questions. Choose the most appropriate answer :

(i) Which of the following statements is correct?

- | | |
|------------------------------------|----------------------------------------|
| (a) Cl^- is oxidised by O_2 . | (b) Fe^{2+} is oxidised by iodine. |
| (c) I^- is oxidised by chlorine. | (d) Mn^{2+} is oxidised by chlorine. |

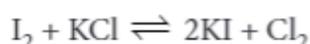
(ii) Mn^{3+} is not stable in acidic medium, while Fe^{3+} is stable because

- (a) O_2 oxidises Mn^{2+} to Mn^{3+}
- (b) O_2 oxidises both Mn^{2+} to Mn^{3+} and Fe^{2+} to Fe^{3+}
- (c) Fe^{3+} oxidises H_2O to O_2
- (d) Mn^{3+} oxidises H_2O to O_2 .

(iii) The strongest reducing agent in the aqueous solution is

- | | | | |
|-----------|------------|---------------|---------------|
| (a) I^- | (b) Cl^- | (c) Mn^{2+} | (d) Fe^{2+} |
|-----------|------------|---------------|---------------|

(iv) The emf for the following reaction is



- | | | | |
|-----------------------|-----------------------|-----------------------|-----------------------|
| (a) -0.82 V | (b) $+0.82 \text{ V}$ | (c) -0.73 V | (d) $+0.73 \text{ V}$ |
|-----------------------|-----------------------|-----------------------|-----------------------|

OR

Which of the following statements is correct for the following reaction?



- | | |
|--------------------------------------|------------------------------------|
| (a) The emf of the cell is positive. | (b) Fe^{3+} oxidises Mn^{2+} . |
| (c) The reaction does not occur. | (d) All are correct. |

Read the passage given below and answer the following questions :

All chemical reactions involve interaction of atoms and molecules. A large number of atoms/molecules are present in a few gram of any chemical compound varying with their atomic/molecular masses. To handle such large number conveniently, the mole concept was introduced. All electrochemical cell reactions are also based on mole concept. For example, a 4.0 molar aqueous solution of NaCl is prepared and 500 mL of this solution is electrolysed. This leads to the evolution of chlorine gas at one of the electrode. The amount of products formed can be calculated by using mole concept.

The following questions are multiple choice questions. Choose the most appropriate answer :

- (i) The total number of moles of chlorine gas evolved is
(a) 0.5 (b) 1.0 (c) 1.5 (d) 1.9
- (ii) If cathode is a Hg electrode, then the maximum weight of amalgam formed from this solution is
(a) 300 g (b) 446 g (c) 396 g (d) 296 g

OR

The total charge (coulomb) required for complete electrolysis is

- (a) 186000 (b) 24125 (c) 48296 (d) 193000
- (iii) In the electrolysis, the number of moles of electrons involved are
(a) 2 (b) 1 (c) 3 (d) 4
- (iv) In electrolysis of aqueous NaCl solution when Pt electrode is taken, then which gas is liberated at cathode?
(a) H₂ gas (b) Cl₂ gas (c) O₂ gas (d) None of these

4

Read the passage given below and answer the following questions :

The concentration of potassium ions inside a biological cell is at least twenty times higher than the outside. The resulting potential difference across the cell is important in several processes such as transmission of nerve impulses and maintaining the ion balance. A simple model for such a concentration cell involving a metal M is $M_{(s)} | M^+(aq; 0.05 \text{ molar}) || M^+(aq; 1 \text{ molar}) | M_{(s)}$

The following questions are multiple choice questions. Choose the most appropriate answer :

- (i) For the above cell,
(a) $E_{\text{cell}} < 0; \Delta G > 0$ (b) $E_{\text{cell}} > 0; \Delta G < 0$ (c) $E_{\text{cell}} < 0; \Delta G^\circ > 0$ (d) $E_{\text{cell}} > 0; \Delta G^\circ < 0$

OR

If the 0.05 molar solution of M^+ is replaced by a 0.0025 molar M^+ solution, then the magnitude of the cell potential would be

- (a) 130 mV (b) 185 mV (c) 154 mV (d) 600 mV
- (ii) The value of equilibrium constant for a feasible cell reaction is
(a) < 1 (b) $= 1$ (c) > 1 (d) zero
- (iii) What is the emf of the cell when the cell reaction attains equilibrium?
(a) 1 (b) 0 (c) > 1 (d) < 1
- (iv) The potential of an electrode change with change in
(a) concentration of ions in solution (b) position of electrodes
(c) voltage of the cell (d) all of these.

5

Read the passage given below and answer the following questions :

The electrochemical cell shown below is concentration cell.



The emf of the cell depends on the difference in concentrations of M^{2+} ions at the two electrodes. The emf of the cell at 298 K is 0.059 V.

The following questions are multiple choice questions. Choose the most appropriate answer :

- (i) The solubility product (K_{sp} , $\text{mol}^3 \text{dm}^{-9}$) of MX_2 at 298 K based on the information available for the given concentration cell is (take $2.303 \times R \times 298/F = 0.059$)
- (a) 2×10^{-15} (b) 4×10^{-15} (c) 3×10^{-12} (d) 1×10^{-12}
- (ii) The value of ΔG (in kJ mol^{-1}) for the given cell is (take $1 \text{ F} = 96500 \text{ C mol}^{-1}$)
- (a) 3.7 (b) -3.7 (c) 10.5 (d) -11.4
- (iii) The equilibrium constant for the following reaction is
- $$\text{Fe}^{2+} + \text{Ce}^{4+} \rightleftharpoons \text{Ce}^{3+} + \text{Fe}^{3+}$$
- (Given, $E^\circ_{\text{Ce}^{4+}/\text{Ce}^{3+}} = 1.44 \text{ V}$ and $E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.68 \text{ V}$)
- (a) 7.6×10^{12} (b) 6.5×10^{10} (c) 5.2×10^9 (d) 3.4×10^{12}

OR

The solubility product of a saturated solution of Ag_2CrO_4 in water at 298 K if the emf of the cell $\text{Ag}|\text{Ag}^+ (\text{satd. Ag}_2\text{CrO}_4 \text{ soln}) || \text{Ag}^+ (0.1 \text{ M}) | \text{Ag}$ is 0.164 V at 298 K, is

- (a) $3.359 \times 10^{-12} \text{ mol}^3 \text{L}^{-3}$ (b) $2.287 \times 10^{-12} \text{ mol}^3 \text{L}^{-3}$
 (c) $1.158 \times 10^{-12} \text{ mol}^3 \text{L}^{-3}$ (d) $4.135 \times 10^{-12} \text{ mol}^3 \text{L}^{-3}$
- (iv) To calculate the emf of the cell, which of the following options is correct?
- (a) $\text{emf} = E_{\text{cathode}} - E_{\text{anode}}$ (b) $\text{emf} = E_{\text{anode}} - E_{\text{cathode}}$
 (c) $\text{emf} = E_{\text{anode}} + E_{\text{cathode}}$ (d) None of these

6

Read the passage given below and answer the following questions :

The potential of each electrode is known as electrode potential. Standard electrode potential is the potential when concentration of each species taking part in electrode reaction is unity and the reaction is taking place at 298 K. By convention, the standard electrode potential of hydrogen (SHE) is 0.0 V. The electrode potential value for each electrode process is a measure of relative tendency of the active species in the process to remain in the oxidised/reduced form. The negative electrode potential means that the redox couple is stronger reducing agent than H^+/H_2 couple. A positive electrode potential means that the redox couple is a weaker reducing agent than the H^+/H_2 couple. Metals which have higher positive value of standard reduction potential form the oxides of greater thermal stability.

In these questions (Q. No. i-iv), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 (c) Assertion is correct statement but reason is wrong statement.
 (d) Assertion is wrong statement but reason is correct statement.
- (i) **Assertion :** An electrochemical cell can be set-up only if the redox reaction is spontaneous.
Reason : A reaction is spontaneous if the free energy change is negative.
- (ii) **Assertion :** The standard electrode potential of hydrogen is 0.0 V.
Reason : It is by convention.

OR

Assertion : The more negative is the standard reduction potential, greater is its ability to displace H_2 from acid.

Reason : Strength of reducing agent increases with the increase in negative value of the standard reduction potential.

(iii) **Assertion :** The negative value of standard reduction potential means that reduction takes place on this electrode with reference to hydrogen electrode.

Reason : The standard electrode potential of a half cell has a fixed value.

(iv) **Assertion :** The absolute value of electrode potential cannot be determined experimentally.

Reason : The electrode potential values are generally determined with respect to SHE.

7

Read the passage given below and answer the following questions :

Two types of conductors are generally used, metallic and electrolytic. Free electrons are the current carrier in metallic and in electrolytic conductors, free ions. Specific conductance or conductivity of an electrolytic solution is given by

$$\kappa = C \times \frac{l}{A}$$

where, $C = 1/R$ and $l/A = G^*$ (cell constant)

Molar conductance (Λ_m) and equivalent conductance (Λ_e) of an electrolyte solution are calculated as

$$\Lambda_m = \frac{\kappa \times 1000}{M} \quad \text{or} \quad \Lambda_e = \frac{\kappa \times 1000}{N}$$

where, M = molarity of solution and N is normality of solution. Molar conductance of strong electrolyte depends on the concentration.

$$\Lambda_m = \Lambda_m^\circ - b\sqrt{C}$$

Λ_m° = molar conductance at infinite dilution, b = constant, C = conc. of solution

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(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

(i) **Assertion :** The molar conductivity of strong electrolyte decreases with increase in concentration.

Reason : At high concentration, migration of ions is slow.

OR

Assertion : The molar conductance of weak electrolyte at infinite dilution is equal to the sum of molar conductance of cations and anions.

Reason : Kohlrausch's law is applicable for strong electrolytes.

(ii) **Assertion :** Equivalent conductance of all electrolytes increases with increasing concentration.

Reason : More number of ions are available per gram equivalent at higher concentration.

(iii) **Assertion :** Specific conductance decreases with dilution whereas equivalent conductance increases.

Reason : On dilution, number of ions per millilitre decreases but total number of ions increases considerably.

(iv) **Assertion** : The ratio of specific conductivity to the observed conductance does not depend upon the concentration of the solution taken in the conductivity cell.

Reason : Specific conductivity decreases with dilution whereas observed conductance increases with dilution.

8

Read the passage given below and answer the following questions :

Electrical work done in unit time is equal to electrical potential multiplied by total charge passed. In order to obtain maximum work from a cell, the charge has to be passed reversibly. The reversible work done by a cell is equal to decrease in its Gibbs energy. Hence, Gibbs energy of reaction is given by

$$\Delta G = -nFE_{\text{cell}}$$

Hence, E is the emf of the cell and nF is the amount of energy.

In these questions (Q. No. i-iv), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

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(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

(i) **Assertion** : $\Delta G^\circ = -nFE^\circ$

Reason : E° should be positive for a spontaneous reaction.

(ii) **Assertion** : An electrochemical cell can be set up only if the redox reaction is spontaneous.

Reason : A reaction is spontaneous if free energy change is negative.

OR

Assertion : For an electrochemical cell, $\Delta G < 0$ and $E_{\text{cell}} > 0$.

Reason : The given cell is non-spontaneous.

(iii) **Assertion** : Current stops flowing when $E_{\text{cell}} = 0$.

Reason : Equilibrium of the cell reaction is attained.

(iv) **Assertion** : E_{cell} should have a positive value for the cell to function.

Reason : $E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}}$

9

Read the passage given below and answer the following questions :

Nernst equation relates the reduction potential of an electrochemical reaction to the standard potential and activities of the chemical species undergoing oxidation and reduction.

Let us consider the reaction, $M^{n+}_{(aq)} \longrightarrow nM_{(s)}$

For this reaction, the electrode potential measured with respect to standard hydrogen electrode can be given as

$$E_{(M^{n+}/M)} = E^\circ_{(M^{n+}/M)} - \frac{RT}{nF} \ln \frac{[M]}{[M^{n+}]}$$

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(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

(i) **Assertion** : For concentration cell, $\text{Zn}_{(s)}|\text{Zn}^{2+}_{(aq)} \parallel \text{Zn}^{2+}_{(aq)}|\text{Zn}$
 $C_1 \quad C_2$

For spontaneous cell reaction, $C_1 < C_2$

Reason : For concentration cell, $E_{\text{cell}} = \frac{RT}{nF} \log \frac{C_2}{C_1}$

For spontaneous reaction, $E_{\text{cell}} = +ve \Rightarrow C_2 > C_1$

(ii) **Assertion** : For the cell reaction. $\text{Zn}_{(s)} + \text{Cu}^{2+}_{(aq)} \longrightarrow \text{Zn}^{2+}_{(aq)} + \text{Cu}_{(s)}$
voltmeter gives zero reading at equilibrium.

Reason : At the equilibrium, there is no change in concentration of Cu^{2+} and Zn^{2+} ions.

(iii) **Assertion** : The Nernst equation gives the concentration dependence of emf of the cell.

Reason : In a cell, current flows from cathode to anode.

(iv) **Assertion** : Increase in the concentration of copper half cell in a cell, increases the emf of the cell.

Reason : $E_{\text{cell}} = E_{\text{cell}}^{\circ} + \frac{0.059}{2} \log \frac{[\text{Cu}^{2+}]}{[\text{Zn}^{2+}]}$

OR

Assertion : Electrode potential for the electrode Mn^+/Mn with concentration is given by the expression under STP conditions.

$E = E^{\circ} + \frac{0.059}{n} \log [\text{Mn}^+]$

Reason : STP conditions require the temperature to be 273 K.

ASSERTION & REASON

In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

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(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

10. **Assertion** : Substances like glass, ceramics, etc. having very low conductivity are known as insulators.

Reason : They do not allow the passage of electric current through them.

11. **Assertion** : The observed conductance depends upon the nature of the electrolyte and the concentration of the solution.

Reason : The cell constant of a cell depends upon the nature of the material of the electrodes.

12. **Assertion** : The conductivity of solution is greater than pure solvent.

Reason : Conductivity depends upon number of the ions present in solution.

13. **Assertion** : The electrical resistance of any object decreases with increase in its length.

Reason : The electrical resistance of any object decreases with increase in its area of cross-section.

14. **Assertion** : Conductance of a substance increases with decrease in resistance.

Reason : The inverse of resistance is called conductance.

15. **Assertion** : The conductivity depends on the charge and size of the ions in which they dissociate, the concentration of ions or ease with which the ions move under potential gradient.

Reason : The conductivity of solutions of different electrolytes in the same solvent and at a given temperature is same.

16. **Assertion :** Molar conductivity of a weak electrolyte at infinite dilution cannot be determined experimentally.
Reason : Kohlrausch law helps to find the molar conductivity of a weak electrolyte at infinite dilution.
17. **Assertion :** Electrolysis of an aqueous solution of KI gives I_2 at the anode but that of KF gives O_2 at the anode not F_2 .
Reason : I^- ions have much higher oxidation potential than water while F^- ions have much lower oxidation potential than water.
18. **Assertion :** If $\lambda^\circ_{Na^+}$ and $\lambda^\circ_{Cl^-}$ are molar limiting conductivities of the sodium and chloride ions respectively, then the limiting molar conductivity for sodium chloride is given by the equation, $\Lambda^\circ_{NaCl} = \lambda^\circ_{Na^+} + \lambda^\circ_{Cl^-}$
Reason : This is according to Kohlrausch law of independent migration of ions.
19. **Assertion :** The potential difference between the two electrodes of a galvanic cell is called the cell potential.
Reason : Cell potential is equal to the emf of a cell.
20. **Assertion :** KCl, NaCl and NH_4Cl cannot be used in the salt bridge of a cell containing silver.
Reason : A salt bridge contains concentrated solution of an inert electrolyte like KCl, KNO_3 , K_2SO_4 or solidified solution of such an electrolyte in agar-agar and gelatine.
21. **Assertion :** Auric chloride ($AuCl_3$) solution cannot be stored in a vessel made of copper, iron, nickel, chromium, zinc or tin.
Reason : Gold is a very precious metal.
22. **Assertion :** If standard reduction potential for the reaction, $Ag^+ + e^- \rightarrow Ag$ is 0.80 volt, then for the reaction, $2Ag^+ + 2e^- \rightarrow 2Ag$, it will be 1.60 volt.
Reason : If concentration of Ag^+ ions is doubled, the standard electrode potential remains same.
23. **Assertion :** Identification of cathode and anode is done by the use of a thermometer.
Reason : Higher the value of reduction potential, greater would be its oxidising power.
24. **Assertion :** Zinc displaces copper from copper sulphate solution.
Reason : E° of zinc is -0.76 V and that of copper is $+0.34$ V.
25. **Assertion :** At the end of electrolysis using platinum electrodes, an aqueous solution of copper sulphate turns colourless.

HINTS & EXPLANATIONS

1. (i) (b): Equivalent conductance of $CaSO_4$:

$$\Lambda^\circ_{CaSO_4} = \lambda^\circ_{Ca^{2+}} + \lambda^\circ_{SO_4^{2-}}$$

$$\lambda^\circ_{Ca^{2+}} = (\mu_{Ca^{2+}})F; \lambda^\circ_{SO_4^{2-}} = (\mu_{SO_4^{2-}})F$$

$\mu_{Ca^{2+}}$ and $\mu_{SO_4^{2-}}$ are ionic mobilities.

$$\Lambda^\circ_{CaSO_4} = F(12.33 + 16.58) \times 10^{-4} \\ = 96500 \times 10^{-4} \times 28.91 = 279$$

$$(ii) (c) : \alpha = \frac{\Lambda_C}{\Lambda^\circ} \Rightarrow 0.1 = \frac{\Lambda_C}{279} \Rightarrow \Lambda_C = 27.9$$

OR

(d) : The ions formed are Li^+ , Na^+ and K^+ , the hydration is maximum in case of Li^+ because of which

its mobility is least and has least conductance.

Therefore, the correct order is $KCl > NaCl > LiCl$.

(iii) (a)

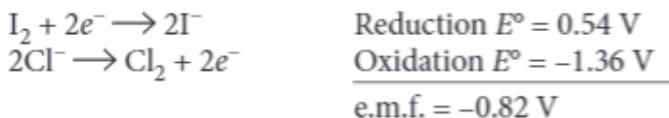
$$(iv) (c) : \Lambda^\circ_{m(CaCl_2)} = \lambda^\circ_{Ca^{2+}} + 2\lambda^\circ_{Cl^-} \\ = (118.88 \times 10^{-4}) + 2(77.33 \times 10^{-4}) \\ = 273.54 \times 10^{-4} \text{ m}^2 \text{ mho mol}^{-1}$$

2. (i) (c) : The half cell having the higher reduction potential will undergo reduction process.

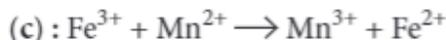
(ii) (d): Electrode potential of Mn^{3+} is higher than O_2 .

(iii) (a) : Due to least electrode potential value.

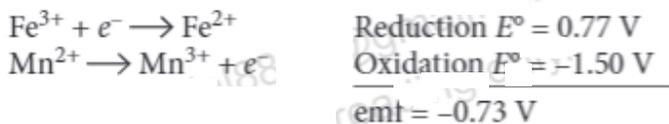
(iv) (a): Half reactions :



OR



Two half reactions :



Since, emf is negative, the reaction does not occur i.e., Fe^{3+} does not oxidise Mn^{2+} .

$$3. (i) (b) : n_{NaCl} = \frac{4 \times 500}{1000} = 2 \text{ mol}$$

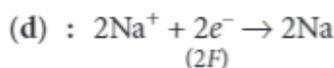
$$\therefore n_{Cl_2} = 1 \text{ mol}$$

$$(ii) (b) : n_{Na} \text{ deposited} = 2 \text{ mol}$$

$$\therefore n_{Na-Hg} \text{ formed} = 2 \text{ mol}$$

$$\therefore \text{Mass of amalgam formed} = 2 \times 223 = 446 \text{ g}$$

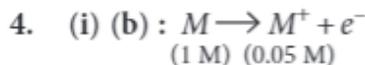
OR



$$\text{Total charge required} = 2F = 2 \times 96500 = 193000 \text{ C}$$

(iii) (a)

(iv) (a)



$$\text{For concentration cell, } E_{\text{cell}} = -\frac{0.059}{1} \log \frac{0.05}{1}$$

$$E_{\text{cell}} = -\frac{0.059}{1} \log(5 \times 10^{-2})$$

$$\begin{aligned} E_{\text{cell}} &= -\frac{0.059}{1} [(-2) + \log 5] = -0.059(-2 + 0.698) \\ &= -0.059(-1.302) = 0.0768 \end{aligned}$$

$$\Delta G = -nFE_{\text{cell}}$$

If E_{cell} is positive, ΔG is negative.

OR

$$(c) : \frac{E_1}{E_2} = \frac{\log 0.05}{\log 0.0025}$$

$$\frac{E_1}{E_2} = \frac{\log 5 \times 10^{-2}}{\log 25 \times 10^{-4}}$$

$$E_1 = 0.0768$$

$$\frac{0.0168}{E_2} = \frac{-1.3}{-2.6} = \frac{1}{2} \quad \text{or } E_2 = 154 \text{ mV}$$

$$(ii) (c) : K = \text{antilog} \left(\frac{nE^\circ}{0.0591} \right)$$

For feasible cell, E° is positive, hence from the above equation, $K > 1$ for a feasible cell reaction.

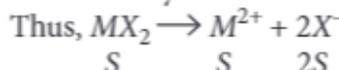
(iii) (b)

(iv) (a)

$$5. (i) (b) : 0.059 = \frac{+0.059}{2} \log \frac{0.001}{[M^{2+}]}$$

$$\log \frac{0.001}{[M^{2+}]} = 2 \quad \text{or } [M^{2+}] = 10^{-5}$$

Let solubility of salt be S mol/litre.



$$\therefore K_{sp} = 4S^3 = 4 \times (10^{-5})^3 = 4 \times 10^{-15}$$

$$(ii) (d) : \Delta G = -nFE = -2 \times 96500 \times 0.059 = -11387 \text{ J mol}^{-1} = -11.4 \text{ kJ mol}^{-1}$$

$$(iii) (a) : E_{\text{cell}}^\circ = \frac{0.059}{1} \log K_C$$

$$\begin{aligned} E_{\text{cell}}^\circ &= E_{Fe^{2+}/Fe^{3+}}^\circ + E_{Ce^{4+}/Ce^{3+}}^\circ \\ &= -0.68 + 1.44 = 0.76 \text{ V} \end{aligned}$$

$$\log_{10} K_C = \frac{0.76}{0.059} = 12.88$$

$$K_C = 7.6 \times 10^{12}$$

OR

$$(b) : E_{\text{cell}} = \frac{0.059}{1} \log \frac{[Ag^+]_{\text{RHS}}}{[Ag^+]_{\text{LHS}}}$$

$$0.164 = \frac{0.059}{1} \log \frac{0.1}{[Ag^+]_{\text{LHS}}}$$

$$[Ag^+]_{\text{LHS}} = 1.66 \times 10^{-4} \text{ M}$$

$$\text{So, } [CrO_4^{2-}] = \frac{1.66 \times 10^{-4}}{2}$$

$$\begin{aligned} K_{sp} (Ag_2CrO_4) &= [Ag^+]^2 [CrO_4^{2-}] \\ &= (1.66 \times 10^{-4})^2 \left(\frac{1.66 \times 10^{-4}}{2} \right) \\ &= 2.287 \times 10^{-12} \text{ mol}^3 \text{ L}^{-3} \end{aligned}$$

(iv) (a)

6. (i) (b)

(ii) (a)

OR

(a) : More negative is the standard reduction potential, greater is its ability to displace hydrogen from acid.

(iii) (d): A negative value of standard reduction potential means that oxidation takes place on the electrode with reference to SHE.

(iv) (a)

7. (i) (a)

OR

(c) : $\Lambda_{AB}^{\infty} = \lambda_{A^+}^{\infty} + \lambda_{B^-}^{\infty}$

Kohlrausch's law is applicable for weak electrolytes.

(ii) (d): At higher concentration, mobility of ions decreases. Hence, conductance decreases.

(iii) (c): Total number of ions will increase slightly on dilution (not considerably).

(iv) (b)

8. (i) (b)

(ii) (b): If redox reaction is spontaneous, ΔG is -ve and hence, E° is positive.

$-\Delta G^{\circ} = nFE^{\circ}_{\text{cell}}$

OR

(c) : $\Delta G < 0$ and $E_{\text{cell}} > 0$; spontaneous.

(iii) (a)

(iv) (b)

9. (i) (a) : $\log\left(\frac{C_1}{C_2}\right) < 0$ for spontaneity.

$\therefore C_1 < C_2$

(ii) (a)

(iii) (b)

(iv) (a)

OR

(d) : Nernst equation is measured at 298 K. At STP conditions, temperature to be 273 K.

10. (a): The substances which do not allow the flow of electric current through them are termed as insulators.

11. (c): The cell constant depends upon the distance between the electrodes and their area of cross section.

12. (a): When electrolytes are dissolved in solvent they furnish their own ions in the solution hence, its conductivity increases.

13. (d): The electrical resistance of any object is directly proportional to its length, l , and inversely proportional to its area of cross-section, A . So, it increases with increase in length of object and decreases with increase in area of cross-section of object.

14. (a): The conductance is the property of the conductor which facilitates the flow of electricity through it however resistance resists the flow of electricity.

15. (c): The conductivity of solutions of different electrolytes in the same solvent and at a given temperature is different.

Effect of concentration on electrode potential is found by Nernst equation.

16. (b): In the plot of molar conductivity versus concentration, the extrapolation to zero concentration is not possible.

17. (a)

18. (a): According to Kohlrausch law, "limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and cation of the electrolyte."

19. (c): The cell potential is called the emf of the cell when the cell is used in such a manner that no current is drawn through the cell.

20. (b): KCl, NaCl and NH_4Cl cannot be used as salt bridge in a cell containing silver as one of the electrodes because they react to form a precipitate of AgCl.

21. (b): Gold has higher reduction potential than the given metals. Hence, AuCl_3 will react with these metals.

22. (d): Standard reduction potential of an electrode has a fixed value.

23. (d): Identification of cathode and anode is done by the use of ammeter/voltmeter. Higher is the value of reduction potential greater would be its oxidising power.

24 (a)

25. (c) : Cu^{2+} ions are deposited as Cu.