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WORK SHEET

CH. 2
ELECTROCHEMISTRY

LONG ANSWER TYPE QUESTIONS (5 MARKS)

1. (a) Explain with example the terms weak and strong electrolytes.

   (b) Calculate the emf of the cell

$$Mg\,|\,Mg^{2+}\,(0.001M\,\|\,Cu^{2+}\,(0.001M)\,|\,Cu$$

$$E^{\circ}_{Cu^{2+}/Cu} = 0.34V;\ E^{\circ}_{Mg^{2+}/Mg} = -2.375V$$

[**Ans. :** 2.651 V]

2. (a) Explain Kohlrausch law of independent migration of ions. Mention two applications of this law.

   (b) The conductivity of 0.001M CH_3COOH is 4.95×10^{-5} Scm^{-1}. Calculate its dissociation constant. Given for acetic acid Λ°_m is 390.5 S cm^2 mol^{-1}. [**Ans. :** = 0.126]

3. (i) Define molar conductivity. Draw the plots showing the variation of molar conductivity for strong and weak electrolyte with square root of concentation.

   (ii) Resistance of a solution (A) is 50 ohm and that of solution (B) is 100 ohm, both solutions being taken in the same conductivity cell, if equal volumes of solutions (A) and (B) are mixed, what will be the resistance of the mixture, using the same cell? Assume that there is no increase in the degree of dissociation of (A) and (B) on mixing. [**Ans. :** 66.66 ohm]

[**Hint. :** k = Conductivity, y = Cell constant]

$k_1 = \frac{1}{50}\, y,\ k_2 = \frac{1}{100}\, y$: and specific conductance of mixture is given by

$$= \frac{k_1 + k_2}{2}$$

$$\frac{k_1 + k_2}{2} = \frac{1}{R} \times y,\ \frac{1}{2}\left[\frac{y}{50} + \frac{y}{100}\right] = \frac{1}{R} \times y \Rightarrow R = 66.66 \text{ ohm}$$

4. (a) State Faraday's first and second laws of electrolysis.

   (b) Silver is deposited on a metallic vessel of surface area 800 cm^2 by passing current of 0.2 ampere for 3 hours. Calculate the thickness of silver deposited.

   (Density of silver = 10.47 g cm^{-3}, Molar atomic mass of silver = 107.924 g mol^{-1}] [**Ans. :** 2.9×10^{-4} cm]

5. (a) Draw the diagram of standard hydrogen electrode. Write the electrode reaction.

   (b) Calculate the equilibrium constant for the reaction :

   $Fe^{2+} + Ce^{4+} \rightleftharpoons Ce^{3+} + Fe^{3+}$

   Given $E^{\circ}_{Ce^{4+}/Ce^{3+}} = 1.44V;\ E^{\circ}_{Fe^{3+}/Fe^{2+}} = 0.68V$

   [**Ans. :** 7.6×10^{12}]

NUMERICAL PROBLEMS

*1. The emf of the following cells are:

$Ag\,|\,Ag^+\,(1M\,\|\,Cu^{2+}\,(1M)\,|\,Cu,\ E^{\circ} = 0.46V$

$Zn\,|\,Zn^{2+}\,(1M\,\|\,Cu^{2+}\,(1M)\,|\,Cu,\ E^{\circ} = 1.1V$

Calculate emf of the cell :

$An\,(s)\,|\,Zn^{2+}\,(1M\,\|\,Ag^{2+}\,(1M)\,|\,Ag\,(s)$

2. For concentration cell

$$Cu\,(s)\,|\,Cu^{2+}\,(0.01M\,\|\,Cu^{2+}\,(0.1M)\,|\,Cu\,(s)$$

(a) Calculate the cell potential.

(b) Will the cell generate emf when concentration becomes equal?

[**Ans. :** (a) 0.295V, (b) No.]

3. Calculate the equilibrium constant for the reaction at 25°C.

$$Cu(s) + 2Ag^{+}\,(aq) \rightleftharpoons Cu^{2+}\,(aq) + 2Ag\,(s)$$

The standard cell potential for the reaction at 25°C is 0.46V.

[Given R = 8.314 $JK^{-1}\,mol^{-1}$] [**Ans. :** 4.0×10^{15}]

4. Calculate $\Delta G°$ for the reaction.

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

$E^{\varnothing}_{Cu^{2+}/Cu} = +0.34\,V; E^{\varnothing}_{Fe^{2+}/Fe} = -0.44\,V$ [**Ans. :** –150, 540 kJ]

6. Write the Nernst equation and calculate the emf of the following cell at 298K.

$$Cu(s)\,|\,Cu^{2+}\,(0.130M)\,||\,Ag+\,(10^{-2}\,M)\,|\,Ag(s)$$

Given $E^{\varnothing}_{Cu^{2+}/Cu} = +0.34\,V;\ E^{\varnothing}_{Ag^{+}/Ag} = +0.80\,V$ [**Ans. :** 0.37V]

7. A zinc rod is dipped in 0.1M solution of $ZnSO_4$. The salt is 95% dissociated at this dilution at 298K. Calculate the electrode potential

$\left(E^{\varnothing}_{Zn^{2+}/Zn} = -0.76\,V\right)$. [**Ans. :** –0.7902V]

8. For the electrode Pt, H_2 (1 atm) | $H^{+}_{(aq)}$ (*xM*), the reduction electrode potential at 25°C is – 0.34V. Write the electrode reaction and calculate the value of x. and the pH of solution.

[**Ans. :** $x = 1.807 \times 10^{-6}$, pH = 5.743]

9. For what concentration of Ag^{+} (aq) will the emf of the given cell be zero at 25°C if concentration of Cu^{2+} (aq) is 0.1M?

Given $E^{\circ}_{Ag^+/Ag} = 0.80\,V$; $E^{\circ}_{Cu^{2+}/Cu} = +0.34\,V$.

Cell : Cu (s) | Cu^{2+} (aq) || Ag^+ (aq) | Ag(s) [**Ans. :** 5.3×10^{-9}]

10. Zinc granules are added in excess to 500 mL of 1.0 M nickel nitrate solution at 25°C until the equilibrium is reached. If the standard reduction potential of Zn^{2+} | Zn and Ni^{2+} | Ni are –0.75 V and – 0.24 V respectively, find out the concentration of Ni^{2+} in solution at equilibrium.

[**Ans. :** 5.88×10^{-18}M]

11. The molar conductivity of 0.1M CH_3COOH solution is 4.6 S cm^2 mol^{-1}. Calculate the conductivity and resistivity of the solution.

[**Ans. :** .00046 S cm^{-1}, 2174 Ω cm]

12. The molar conductivities of NH^+_4 ion and Cl^- ion are 73.5 S cm^2 mol^{-1} and 76.255 cm^2 mol^{-1} respectively. The specific conductivity of 0.1 M NH_4Cl is 1.288×10^{-2} S cm^{-1}. Calculate the dissociation constant of NH_4Cl.

[**Ans. :** 7.396×10^{-2}]

13. Molar conductivity at infinite dilution for NH_4Cl, NaOH and NaCl solution at 298K are respectively 129.8, 218.4 and 108.9 Scm^2 mol^{-1} and m for 10^{-2} M solution of NH_4OH is 9.33 S cm^2 mol^{-1}. Calculate the degree of dissociation of NH_4OH. [**Ans. :** 0.039]

14. Write the Nernst equation and emf of the following cell at 298 K; Pt(s)/ Br_2(l)| Br^-(0.010M) || H^+(0.030M) | H_2(g) (0.9 bar) | Pt(s). E° Br_2 / Br^- / Pt = 1.09V.

[**Ans. :** –1.297V]

15. In the button cells widely used in watches and other derices, the following reaction takes place :

$Zn(s) + Ag_2O(s) + H_2O(l) \rightarrow Zn^{2+}(ag) + 2Ag(s) + 2OH^-(aq)$

Determine $\Delta_r G^{\circ}$ and E° for the reaction.

Given $E^{\circ}_{Zn^{2+}/Zn} = -0.76V$; $E^{\circ}_{Ag^+/Ag} = 0.8V$

[**Ans.:** –301.08 kJ / mol., $E^{\theta}_{cell} = 1.56V$]

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