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3 (Sem-4/CBCS) CHE HC 3

2024

**CHEMISTRY**

(Honours Core)

Paper : CHE-HC-4036

**(Physical Chemistry-IV)**

Full Marks : 60

Time : Three hours

**The figures in the margin indicate full marks for the questions.**

1. Answer the following questions :  $1 \times 7 = 7$

(a) The molar conductance  $\Lambda_{NaOAC}^{\circ}$  and  $\Lambda_{HCl}^{\circ}$  at infinite dilution in water at  $25^{\circ}C$  are  $91.0$  and  $426.2 \text{ Scm}^2 \text{ mol}^{-1}$  respectively. To calculate  $\Lambda_{HOAC}^{\circ}$ , the additional value required is

(i)  $\Lambda_{NaOH}^{\circ}$

(ii)  $\Lambda_{NaCl}^{\circ}$

(iii)  $\Lambda_{H_2O}^{\circ}$

(iv)  $\Lambda_{KCl}^{\circ}$

(Choose the correct answer)

Contd.

- (b) Define specific conductance.
- (c) What is Ostwald's Dilution Law ?
- (d) The pH of an aqueous solution is 4. Its  $[OH^-]$  is
- (i) 10
  - (ii)  $10^{-4}$
  - (iii)  $10^{-10}$
  - (iv)  $10^{-14}$

*(Choose the correct answer)*

- (e) Define Debye-Falkenhagen effect.
- (f) Which of the following molecule would have zero dipole moment ?
- (i)  $NH_3$
  - (ii) *m*-dichlorobenzene
  - (iii)  $CH_3Cl$
  - (iv) *p*-dichlorobenzene

*(Choose the correct answer)*

- (g) The relative permeability  $\mu_r > 1$  stands for
- (i) Paramagnetic solids
  - (ii) Diamagnetic solids
  - (iii) Ferromagnetic solids
  - (iv) None of the above

*(Choose the correct answer)*

2. Answer the following questions :  $2 \times 4 = 8$

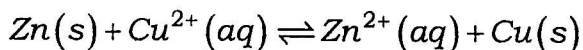
- (a) Explain the variation of molar conductance with dilution for weak electrolyte.
- (b) Name *two* types of concentration cells.
- (c) How can dissociation constant of weak acid be determined from the measurement of conductance ?
- (d) Differentiate between paramagnetic and diamagnetic substances in terms of magnetic permeability and magnetic susceptibility.

3. Answer **any three** questions from the following :  $5 \times 3 = 15$

- (a) What is meant by transport number of an ion ? How is it determined by moving boundary method ?  $1 + 4 = 5$
- (b) Explain saturated calomel electrode with the reactions when it is acting as anode and cathode as well.

(c) At 25 °C, the specific conductance of carefully distilled water is  $58.0 \times 10^{-7} \text{ Sm}^{-1}$  and  $\lambda_m^\circ$  values for  $H^+$  and  $OH^-$  ions are  $349.8 \times 10^{-4}$  and  $198.5 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$  respectively. Calculate the ionic product of water at 25°C. [Assume that  $\lambda_m$  differs very little from  $\lambda_m^\circ$ ]

(d) Derive the relation between standard EMF and equilibrium constant of a cell reaction. The standard EMF of the cell



is 1.10 volts. Calculate the equilibrium constant of the cell reaction. Prove whether the reaction is feasible or not.

$$2+2+1=5$$

(e) What is magnetic susceptibility? Explain Gouy's method for the measurement of magnetic susceptibility. 1+4=5

4. Answer **any three** questions from the following :  $10 \times 3 = 30$

(a) Discuss Debye-Hückel theory of strong electrolytes. Explain relaxation effect and electrophoretic effect. How can Debye-Hückel-Onsager equation be utilized in the determination of equivalent conductance at infinite dilution for strong electrolytes.

$3+4+3=10$

(b) Write the principle of conductometric titrations. Draw and explain the titration curves obtained in the conductometric titration of

(i)  $HCl$  with  $NaOH$

(ii)  $CH_3COOH$  with  $NaOH$

(iii)  $CH_3COOH$  with  $NH_4OH$  and

(iv)  $AgNO_3$  with  $KCl$

$2+2+2+2+2=10$

(c) Explain the construction and working of glass electrode for the determination of  $pH$  of a solution using this electrode. What are the limitations of a glass electrode ?

$8+2=10$

- (d) Derive Nernst equation for the measurement of EMF of an electrochemical cell.

Consider an electrochemical cell



- (i) Write the cell reaction
- (ii) Calculate the EMF of the cell
- (iii) Calculate  $\Delta G^\circ$  value of the cell reaction.

Given that  $E^\circ_{Cd^{2+}|Cd} = -0.40V$

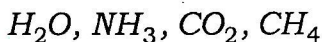
$$E^\circ_{Fe^{2+}|Fe} = -0.44V$$

why does a cell stops working after some time ? Explain with an example.

$$3+1+2+2+2=10$$

- (e) (i) What is molecular polarizability ?
- (ii) Derive the Clausius-Mossotti equation.
- (iii) Define induced molar polarization.

(iv) Which of the following molecules obey Clausius-Mossotti equation ?



$$2+5+1+2=10$$

(f) (i) How can you apply dipole moment of a molecule to calculate percentage ionic character of the molecule and to predict the shapes of molecules ?

(ii) The dipole moment of  $NH_3(g)$  is 1.46D and the bond angle  $HNH$  is  $108^\circ$ . Calculate the bond moment of the  $N-H$  bond.

(iii) How do you explain that the dipole moment of ethylchloride is considerably larger than that of chlorobenzene ?

$$6+2+2=10$$