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

(i) Λ_{NaOH}°

(ii) Λ_{NaCl}°

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

(iv) Λ_{KCl}°

(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 λ_m° values for H^+ and OH^- ions are 349.8×10^{-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 λ_m differs very little from λ_m°]

(d) Derive the relation between standard EMF and equilibrium constant of a cell reaction. The standard EMF of the cell $\text{Zn(s)} + \text{Cu}^{2+}(\text{aq}) \rightleftharpoons \text{Zn}^{2+}(\text{aq}) + \text{Cu(s)}$ 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 : 10×3=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

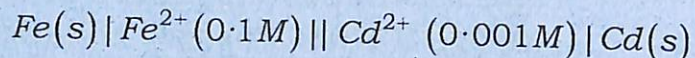
2+2+2+2+2=10

(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 ΔG° value of the cell reaction.

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

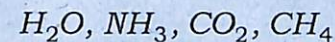
$$E^\circ_{\text{Fe}^{2+}|\text{Fe}} = -0.44V$$

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 $\text{NH}_3(g)$ is 1.46D and the bond angle H-N-H is 108° . 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 ?

$$6+2+2=10$$