

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 : 1×7=7

(a) The molar conductance Λ_{NaOAc}° and Λ_{HCl}° at infinite dilution in water at 25°C are 91.0 and 426.2 $S\ cm^2\ mol^{-1}$ 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 : 2×4=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 : 5×3=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.

Contd.

- (c) At 25 °C, the specific conductance of carefully distilled water is $58 \cdot 0 \times 10^{-7} \text{ Sm}^{-1}$ and λ_m° values for H^+ and OH^- ions are $349 \cdot 8 \times 10^{-4}$ and $198 \cdot 5 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ 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 $\text{Zn}(s) + \text{Cu}^{2+}(aq) \rightleftharpoons \text{Zn}^{2+}(aq) + \text{Cu}(s)$ 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. $1+4=5$

3 (Sem-4/CBCS) CHE HC 3/G 4

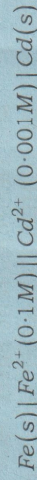
3 (Sem-4/CBCS) CHE HC 3/G 5

Contd.

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 $2+2+2+2=10$
- (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.

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

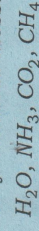
$$E_{\text{Fe}^{2+}|\text{Fe}}^\circ = -0.44V$$

- why does a cell stop 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 HNH 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?

$$6+2+2=10$$

3 (Sem-4/CBCS) CHE HC 3/G 6

3 (Sem-4/CBCS) CHE HC 3/G 7

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