

U.G. 3rd Semester Examination-2024**CHEMISTRY****[HONOURS]****Course Code : CHEM-H-CC-T-05****[CBCS]**

Full Marks : 40

Time : 2½ Hours

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*

1. Answer any five questions from the following:

 $2 \times 5 = 10$

- Discuss the factors affecting ionic mobility of ions in solutions.
- Calculate the de-Broglie wavelength of an electron ($m_e = 9.1 \times 10^{-31}$ kg) having kinetic energy equal to 1000 eV. [Electronic charge = 1.6×10^{-19} C]
- Define specific and equivalent conductance and state their relationship.
- Write down the time independent Schrodinger wave equation explaining the meaning of each term.
- The work function of metallic Cesium is 2.14 eV. Calculate the kinetic energy of the electrons ejected by the incident light of wavelength 300 nm.

[Turn over]

- f) How can one characterize a liquid flow as turbulent or laminar?
- g) For a strong electrolyte like KCl, depict graphically the variation of specific conductance and equivalent conductance with concentration.
- h) Write down the postulates of quantum mechanics.

2. Answer any two questions: $5 \times 2 = 10$

- a) i) An 0.02 (N) aqueous solution of KCl placed in a conductivity cell at 25°C shows a resistance of 380Ω . Specific conductance of the 0.02(N) aqueous solution of KCl at 25°C is $0.00276 \Omega^{-1}\text{cm}^{-1}$. The same cell filled with 0.01 (N) acetic acid (HAc) shows a resistance of 6434Ω . Calculate the degree of dissociation (α) of 0.01(N) HAc at 25°C. [The equivalent conductivity of NaAc, HCl and NaCl at infinite dilution at 25°C are given as 91.0, 426.2 and $126.5 \Omega^{-1}\text{cm}^2 \text{eqv}^{-1}$ respectively]
- ii) The mobility of an acetate ion in aqueous solution at 25°C is $4.24 \times 10^{-8} \text{ m}^2\text{s}^{-1}\text{V}^{-1}$. Calculate the molar ionic conductions.

3+2

- b) i) "Transference number of Cl^- ion in aqueous solution of HCl is 0.16 and it is 0.62 in aqueous solution of NaCl"—Explain the difference.
- ii) Deduce an expression for the variation of the chemical potential of the i^{th} component with pressure.
- iii) An ideal solution need not to be a dilute solution — Comment. $2+2+1$
- c) i) Define eigen function.
- ii) Identify which of the following functions are eigenfunctions of the operator (d/dx) —
 A) $\cos(kx)$
 B) kx
 C) e^{-ikx}
 Give the corresponding eigenvalue where appropriate. $2+3$
- d) i) The fugacity coefficient of a certain gas at 200 K temperature and 50 bar pressure is 0.72. Calculate the difference of its chemical potential from that of a perfect gas in the same state.
- ii) Show that the linear combination $A+ic$ and $A-ic$ are not Hermitian if A and C are Hermitian operators. $(1+2)+2$

3. Answer any two questions: $10 \times 2 = 20$

- a) i) State the Raoult's law. Based on the law, characterize an ideal solution.

- ii) At 18°C, the mobilities of NH_4^+ and ClO_4^- ions are 6.6×10^{-4} and $5.7 \times 10^{-4} \text{ cm}^2 \text{ volt}^{-1} \text{ s}^{-1}$. Calculate the transport number of two ions and equivalent conductance of ammonium chlorate.
- iii) 2 mol H_2 at 2 atm and 25°C and 4 mol N_2 at 3 atm and 25°C are mixed at constant volume. Calculate $\Delta_{\text{mix}} G$. What would be the value of $\Delta_{\text{mix}} G$ had the pressures been identical initially?
- iv) State the law of mass action. 3+2+4+1
- b) i) Light with a wavelength of 300 nm is incident on a potassium surface for which the work function is 2.26 eV. Calculate the kinetic energy and speed of the ejected electrons. ($m_e = 9.1 \times 10^{-31} \text{ kg}$)
- ii) Assuming Raoult's Law for ideal solution deduce an expression for ΔG_{mix} for an ideal binary liquid mixture.
- iii) Chemical potential of a solvent in solution is less than that of the pure solvent. 4+4+2 Justify.
- c) i) For conductometric titrations, the concentration of the titre should be at least 10 times greater than that of the solution to be titrated—justify.

- ii) The ionic mobilities ($\text{m}^2 \text{ v}^{-1} \text{ s}^{-1}$) of the OH^- , F^- and Cl^- ions are 20.50, 5.70 and 7.90, respectively—justify.
- iii) Solve the time independent Schrödinger equation for a particle in a one dimensional box and derive the energy expression.
- iv) Prove that the ideal mixing is not accompanied with a volume change.
- 2+2+(2+2)+2
- d) i) Write down equation which shows variation of equilibrium constant with temperature at constant pressure. Under what conditions, plot of $\log K_p$ vs $1/T$ will be straight line. Discuss.
- ii) Determine whether each of the following function is acceptable or not as a wavefunction over the indicated intervals:
- A) $\frac{1}{x} [0, \infty]$
- B) $\sin^{-1} x [-1, 1]$
- iii) Show from the reaction isotherm that a reaction can be made to occur to a considerable extent even if the standard free energy change ΔG° is positive.
- 4+4+2