U.G. 3rd Semester Examination-2024

CHEMISTRY

[HONOURS]

Course Code : CHEM-H-CC-T-05

[CBCS]

Full Marks : 40 Time : $2\frac{1}{2}$ 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: $2\times5=10$

   a) Discuss the factors affecting ionic mobility of ions in solutions.

   b) Calculate the de-Broglie wavelength of an electron ($m_e = 9.1\times10^{-31}$ kg) having kinetic energy equal to 1000 eV. [Electronic charge = 1.6×10^{-19}C]

   c) Define specific and equivalent conductance and state their relationship.

   d) Write down the time independent Schrodinger wave equation explaining the meaning of each term.

   e) 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.

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: 5×2=10

a) i) An 0.02 (N) aqueous solution of KCl placed in a conductivity cell at 25°C shows a resistance of 380 Ω. Specific conductance of the 0.02(N) aqueous solution of KCl at 25°C is 0.00276 $\Omega^{-1}cm^{-1}$. The same cell filled with 0.01 (N) acetic acid (HAc) shows a resistance of 6434 Ω. 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 $\Omega^{-1}cm^2$ eqv^{-1} respectively]

ii) The mobility of an acetate ion in aqueous solution at 25°C is 4.24×10^{-8} $m^2s^{-1}v^{-1}$. 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: 10×2=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 5.7×10^{-4} cm^2 $volt^{-1}s^{-1}$. 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 $\Delta_{mix}G$. What would be the value of $\Delta_{mix}G$ 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. ($m_e = 9.1\times10^{-31}$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. Justify. 4+4+2

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 ($m^2v^{-1}s^{-1}$) 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) $sin^{-1}\times[-1,1]$

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
