U.G. 3rd Semester Examination-2021
CHEMISTRY
[HONOURS]
Course Code : CHEM-H-CC-T-05

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: 2×5=10

a) Write down the units of viscosity coefficient.

b) What do you mean by specific conductance?

c) State the Kohlrausch's law of independent migration of ions.

d) What is the value of the enthalpy of mixing ($\Delta_{mix}H$) for perfect gases?

e) State the Nernst's distribution law.

f) Write down the de Broglie relation.

g) What do you mean by Hamiltonian operator?

h) What is the general form of the Heisenberg uncertainty principle?

2. Answer any **two** questions: 5×2=10

a) i) What is the Poiseuille's law?

ii) Explain the variation of viscosity of liquids and that of gases with temperature. 2+3

b) i) Define the transport number. What is the relation between the limiting transport number and the mobility of ion?

ii) The molar conductivity and the limiting molar conductivity of 0.0100M CH_3COOH (aq) at 298 K are $\Lambda_m = 1.65$ mS m^2mol^{-1} and $\Lambda_m = 39.05$ mS cm^2mol^{-1} respectively. Calculate pKa of the acid. 2+3

c) i) Explain the variation of chemical potential (μ) with temperature and pressure.

ii) Derive the van't Hoff equation related to the chemical equilibrium. 2+3

d) i) Show that e^{ax} is an eigenfunction of the operator d/dx and find the corresponding eigenvalue. Show that e^{ax^2} is not an eigenfunction of d/dx.

ii) Is the function cos ax an eigenfunction of (a) d/dx, (b) d^2/dx^2? 3+2

3. Answer any **two** questions: 10×2=20

a) i) State the Ostwald's dilution law with proper expression.

ii) How the limiting value of the molar conductivity of a solution is determined using Ostwald's dilution law? Explain with graphical representation.

iii) The limiting molar conductivities of KCl, KNO_3, and $AgNO_3$ are 14.99 mS $m^2 mol^{-1}$, 14.50 mS m^2 mol^{-1}, and

13.34 mS m^2 mol^{-1}, respectively (all at 25°C). What is the limiting molar conductivity of AgCl at this temperature? 2+4+4

b) i) What is the mean activity coefficient?

ii) Derive an expression of the Gibbs energy of mixing of two liquids that form an ideal solution.

iii) The excess Gibbs energy of solutions of methylcyclohexane (MCH) and tetrahydrofuran (THF) at 303.15 K was found to fit the expression:

$G^E = RTx(1-x)\{0.4857-0.1077(2x-1)+0.0191(2x-1)^2\}$

where x is the mole fraction of the methylcyclohexane. Calculate the Gibbs energy of mixing when a mixture of 1.00 mol of MCH and 3.00 mol of THF is prepared. 1+3+6

c) i) What is the standard enthalpy of a reaction for which the equilibrium constant is (a) doubled, (b) halved when the temperature is increased by 15 K at 310 K?

ii) The equilibrium constant of a reaction is found to fit the expression $\ln K = A + B/T + C/T^3$ between 400 K and 500 K with A = –2.04, B = –1176 K, and $C = 2.1 \times 107\ K^3$, Calculate the standard reaction enthalpy and standard reaction entropy at 450 K. 5+5

d) i) Suppose the speed of a projectile of mass 1.0 g is known to within $1 \mu m\ s^{-1}$. Calculate the minimum uncertainty in its position.

ii) Show that the operators for position and momentum do not commute.

iii) The ground-state wavefunction for a particle confined to a one-dimensional

box of length L is

$$\psi = \left(\frac{2}{L}\right)^{1/2} \sin\left(\frac{\pi x}{L}\right)$$

Suppose the box is 10.0 nm long. Calculate the probability that the particle is

a) between x=4.95 nm and 5.05 nm,

b) between x= 1.95 nm and 2.05 nm,

c) between x=9.90 nm and 10.00 nm,

d) in the right half of the box,

e) in the central third of the box. 3+2+5

———————————