B.Sc. 3rd Semester (Honours) Examination 2021 (CBCS)
(Physical Chemistry II)
Paper: CC-5

Time: 2 hrs **Full Marks: 40**

Candidates are required to give their answers in their own words as far as practicable.

Answer any *eight* questions of the following **8 x 5 = 40**

1. Write the phenomenological relation for the flow of a fluid against a pressure gradient. Identify the flux and force term in this relation. A droplet of water (r = 10^{-2} cm) is falling in air at 25^0C (η= 1.8 x 10^{-4}Poise). What will be the velocity of fall? Density of water = 1 g/cc.

2. What should be the nature of the plot of conductance values of strong electrolytes of varying concentration measured in a particular cell against respective specific conductance? Does this plot give any information about the cell? Calculate the ionic mobility of the cation in KCl at 25^0C, mentioning proper unit, given that its transport number is 0.49 and the equivalent conductance of KCl at infinite dilution is 150.

3. "Debye-Huckel theory is applicable only to slightly contaminated distilled water": - Justify the statement with proper arguments. Why should equivalent conductance of an electrolyte at finite concentration be less than that at infinite dilution?

4. Using necessary equation, predict the slope ($\partial G/\partial \varepsilon$) and thus direction of reaction, if,(a) $Q_P > K_P$(b) $Q_P = K_P$ (c) $Q_P < K_P$ [ε= extent of reaction; Q_P = pressure quotient].

5. (i) Using Heisenberg uncertainty principle, derive an expression for the approximate ground state energy of a particle of mass 'm' moving in a one-dimensional box of length "L"

   (ii) If, $\left[-\frac{h^2}{8\pi^2 m}\frac{d^2}{dx^2} + \frac{h^2\alpha^2x^2}{2\pi^2 m}\right]\exp(-\alpha x^2) = C\,.\frac{h^2}{4\pi^2}\exp(-\alpha x^2)$

   where h, π, m, α are constants. Find the value of C.

6. The ground state wavefunction of a harmonic oscillator can be written as $\Phi_0(x) = (\beta/\pi)^{1/4}\exp(-\beta x^2/2)$, where β is a constant for a given system and '*x*' is the displacement that can vary from - ∞ to + ∞.
   (i) Find the average position < x > of the oscillator in the ground state.
   (ii) Plot $\varphi_0(x)$ versus '*x*'.

7. (i) Using energy-time uncertainty relation define 'stationary state' in quantum mechanics.
   (ii) If two operators α and β are Hermitian, then find out the condition for αβ to be Hermitian.

8. The solubility of a solute is three times as high in ether as in water. Compare the amounts extracted from 100 ml of the aqueous solution by (i) 100 ml of ether in one step (ii) successive extractions by two steps each with 50 ml of ether.

9. (i) The chemical potential μ and standard chemical potential μ^0 of an ideal gas are related as: $\mu = \mu^0 + RT \ln P$. Comment on the temperature and pressure dependence of μ and μ^0.
   (ii) Show that if equation of state for a gas is $P (V_m - b) = RT$ (where 'b' is a constant) the fugacity of the gas is given by $\ln (f/P) = (bP/RT)$.

10. (i) Find the first excited state wave function for a particle in a 1-d box that spans from -a to +a.
    (ii) In a moving boundary experiment with 0.01 mol. LiCl, the boundary in a tube having cross sectional area of 5 cm^2 moves through 7.3 cm in 1490 s when a current of 1.80×10^{-3} ampere is used. Calculate t_+ .