B.Sc. 3rd Semester (Honours) Examination, 2022 (CBCS)

Subject : Chemistry

Course : CC-V

(Physical Chemistry)

Full Marks: 40

Time: 2 Hours

The figures in the margin indicate full marks.

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

2×5=10

1. Answer *any five* questions of the following:

(a) Explain why specific conductance of a solution of NaCl in water decreases with dilution while the equivalent conductance increases with dilution. 2

(b) Define chemical potential. Explain whether it is an extensive property. 1+1=2

(c) Starting from Van't Hoff isotherm establish the condition for equilibrium of a chemical reaction. 2

(d) Show that in a rectangular box with sides $L_x = L$ and $L_y = 2L$, there is an accidental degeneracy between the states (1, 4) and (2, 2). 2

(e) Define coefficient of viscosity. Find its dimension. 1+1=2

(f) Explain whether partition coefficient depends on temperature. 2

(g) Explain whether the function $\psi = \frac{x^2+14x+45}{x^2-4x-45}$ behaves well within the range $-8 \leq x \leq 8$. 2

(h) Depict diagrammatically the variation of ΔS_{mix} during preparation of an ideal mixture. 2

5×2=10

2. Answer *any two* questions of the following:

(a) Arrive at the equation for the determination of coefficient of viscosity of a liquid by falling sphere model. 5

(b) (i) if $\Psi_n = \sqrt{\frac{2}{L}} sin\frac{n\pi x}{L}$ for a particle in an one dimensional box of length L, evaluate $\bar{x}$.

(ii) If $\hat{M}$ is a linear operator and if $\hat{M}\Psi_1 = b\Psi_1$ and $\hat{M}\Psi_2 = b\Psi_2$, prove that $C_1\Psi_1 + C_2\Psi_2$ is also an eigenfunction of $\hat{M}$ with eigenvalue b. 3+2=5

(c) (i) Discuss the principle behind determination of equilibrium constant of the reaction $KI + I_2 \rightleftharpoons KI_3$ utilizing Nernst's distribution law.

(ii) State Ostwald's dilution law. 4+1=5

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(d) (i) Define ionic mobility. Derive a relation between ionic mobility and ionic conductance.

(ii) Establish the relation between molar conductance and equivalent conductance of Aluminium phosphate. 3+2=5

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

(a) (i) Find an expression for ΔG_{mix} when n_A moles of A is mixed with n_B moles of B to prepare an ideal solution. From it find the value of ΔH_{mix} during ideal mixing.

(ii) At 1000K, K_p = 3·5 for the reaction $2SO_2(g) + O_2(g) \leftrightharpoons 2SO_3(g)$ when pressure is expressed in atmosphere unit. Find ΔG°_p and ΔG°_c for the reaction at 1000K and explain the reason behind the difference. (3+2)+(4+1)

(b) (i) For the reaction $2A(g) \leftrightharpoons 2B(g) + C(g)$, the value of K_p of the reaction increases by 2% per degree celsius rise in temperature at 227°C. Calculate ΔH° and ΔG° for the reaction at this temperature.

(ii) Show that $\left(\frac{\partial \mu_i}{\partial P}\right)_{T,N} = \overline{V}_i$, where the terms have their usual significance.

(iii) State Fick's law and hence identify the terms 'flux' and 'force'.

(iv) What are phenomenological relations? 3+2+3+2

(c) (i) For the photoelectric effect of sodium metal, $K_{max} = 3 \cdot 41 \times 10^{-19} J$ for a radiation of wavelength 3125Å and $K_{max} = 1 \cdot 95 \times 10^{-19} J$ for a radiation of wavelength 4047Å. Find Planck's constant and the work function for sodium metal if K_{max} represents the maximum kinetic energy of emitted electrons.

(ii) Find the average potential energy and average kinetic energy using the ground state wave function of the harmonic oscillator.

(iii) Name two experiments which proved particle have wave character. 3+5+2

(d) (i) What is fugacity? Write down it's significance.

(ii) How can we determine Λ_0 and dissociation constant of a weak electrolyte graphically?

(iii) Show that the temperature coefficient of the viscosity coefficient of a gas is opposite in sign to that of a liquid.

(iv) Draw and explain the conductometric curve for the titration of KCl vs $AgNO_3$. 2+3+3+2
