



WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 3rd Semester Examination, 2020, held in 2021

CEMACOR05T-CHEMISTRY (CC5)

PHYSICAL CHEMISTRY-II

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.*

Answer any *three* questions taking *one* from each unit

UNIT-I

1. (a) What is a Newtonian fluid? Polymer solutions are often non-Newtonian. — Explain. 2
- (b) Define ionic mobility. Does it depend on concentration? Give reasons in support of your answer. How is it related with conductivity of solution? 1+1+2
- (c) What is viscosity activation energy for laminar flow of a liquid? How is it related to the viscosity coefficient of the liquid? 1+2
- (d) The equivalent conductances at infinite dilution (Λ_0) of KNO_3 and KCl solutions are 144.96 and 149.86 $\text{ohm}^{-1} \text{cm}^2 \text{equiv}^{-1}$ at 25°C respectively. Calculate the quantity $[\Lambda_0(\text{NaCl}) - \Lambda_0(\text{NaNO}_3)]$. State the law used. 1+2
2. (a) Establish an expression for the ratio of equivalent conductance and molar conductance of a given electrolytic solution. 3
- (b) The increase in equivalent conductance of a strong electrolyte with dilution is due to increase in velocity of the ions in the solution. Comment on the statement. 2
- (c) At 25°C , the equivalent conductance of a 0.02 M AgNO_3 solution is $128.7 \text{ohm}^{-1} \text{cm}^2 \text{equiv}^{-1}$, while the transport number of Ag^+ is 0.477. Calculate (i) the ionic mobility of Ag^+ in the solution and (ii) velocity of Ag^+ if 6.0 volts are applied across the electrodes 4.0 cm apart. 3
- (d) Discuss the effect of temperature on the viscosity of a liquid. How does it differ from that of a gas? 2+2

UNIT-II

3. (a) If volume and density of a solution containing n_1 moles of solvent of molecular weight M_1 and 1 mole of solute of molecular weight M_2 , at a certain temperature and pressure are V litres and $\rho \text{g cm}^{-3}$ respectively then show that 4

$$\bar{V}_1 = \frac{M_1}{1000 \left[\rho + V \left(\frac{d\rho}{dV} \right) \right]} \quad (\bar{V}_1 = \text{partial molar volume of the solvent})$$

- (b) Show that in a mixture of ideal gases $\left(\frac{\partial \mu_i}{\partial P}\right)_{T, n_i} = \frac{RT}{P_i}$, 2
 where the terms have their usual significances.
- (c) The relation $K_p = K_c(RT)$ for the equilibrium $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ implies that (K_p/K_c) has the dimension of energy. — Criticize. 3
- (d) Show that at constant temperature and pressure $\sum n_i d\bar{Y}_i = 0$, where \bar{Y}_i is any partial molar quantity and n_i is its mole number. 4
- (e) At 25°C, the standard free energy of formation (ΔG_f^0) of gaseous C_2H_4 and C_2H_2 are 68.1 and 209.2 kJ/mol respectively. Calculate K_n at 25°C for the reaction: 3



4. (a) What is the degree of advancement of a reaction? Derive an expression to show its variation with temperature at a given pressure. 2+3
- (b) Define fugacity coefficient of a gas. Under what condition(s) fugacity of a gas is greater than its pressure? 1+2
- (c) For a gaseous reaction, $A(g) \rightarrow B(g)$ if the standard reaction Gibbs energy, $\Delta_r G^0$, is greater than 1, then reactant $A(g)$ is favoured in the equilibrium. — Justify/ criticise. 3
- (d) Calculate the change in chemical potential of a gas obeying the equation of state $P(\bar{V} - b) = RT$ at 300 K due to isothermal compression from a pressure of 2 to 5 atm. Given: $b = 0.043$ L/mol. 3
- (e) Calculate the entropy of mixing when 3 mol of hydrogen is mixed with 1 mol of nitrogen. Assume ideal behaviour of the gases. 2

UNIT-III

5. (a) The Schrödinger equation for a particle of mass m free to move parallel to the x -axis with zero potential energy is $-\frac{h^2}{2m} \frac{d^2\psi}{dx^2} = E\psi$ 3
 The solution of this equation has the form $\psi = Ae^{ikx} + Be^{-ikx}$ (A , B and k are constants). Using the solution find E .
- (b) Show that two eigenfunctions belonging to different eigenvalues of an Hermitian operator are orthogonal. 3
- (c) State and explain Stefan-Boltzmann law with the help of a schematic diagram. 3
- (d) The work function for metallic caesium is 2.14 eV. Calculate the kinetic energy and the speed of the electrons ejected by light of wavelength, 300 nm. 3
 [Given: 1 eV = 1.602×10^{-19} J]
6. (a) If Ψ_1 and Ψ_2 are two degenerate states with an eigenvalue a_1 for a linear operator then any linear combination of Ψ_1 and Ψ_2 is also an eigenfunction of the operator with the eigenvalue a_1 . — Justify. 3

- (b) If $\hat{D} = \frac{d}{dx}$, then find $(\hat{D} + \hat{x})(\hat{D} - \hat{x})$. 3
- (c) Find the zero-point energy of a particle of mass 1×10^{-28} kg confined in a rectangular box of sides $L_x = L$ and $L_y = 2L$, where L is 10 nm. 3
- (d) For a free particle in a one-dimensional box with impenetrable walls when potential energy is zero inside the box, find the probability of finding the particle in the central third of the box (from $a/3$ to $2a/3$, a = dimension of the box) in its ground state. 3

N.B. : *Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within 1 hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.*

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