

UG/3rd Sem/H/20(CBCS)

2020

CHEMISTRY (Honours)

Paper : CEMH-DC-T5

**(Physical)
(CBCS)**

Full Marks : 25

Time : Two Hours

The figures in the margin indicate full marks.

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

1. Answer any five questions (Choose the correct answer) : $1 \times 5 = 5$

- (a) If K_1 and K_2 are equilibrium constants for a given exothermic reaction at temperature T_1 and T_2 the relation between K_1 and K_2 is —
- (i) $K_1 < K_2$
 - (ii) $K_1 > K_2$
 - (iii) $K_1 = K_2$
 - (iv) $K_1 \leq K_2$
- (b) The velocity of Li^+ ion in water is 2×10^{-2} cm/sec when $100V$ applied between two electrodes separated by 2cm. The mobility of Li^+ ion in water is —
- (i) $1 \times 10^{-4} s^{-1} V^{-1}$
 - (ii) $4V \text{ cm}^2 s^{-1}$
 - (iii) $4 \times 10^{-4} \text{ cm}^2 s^{-1} V^{-1}$
 - (iv) $2.5 \times 10^5 V s \text{ cm}^2$

- (c) The unit of Planck's constant is that of —
- (i) position
 - (ii) angular momentum
 - (iii) linear momentum
 - (iv) energy
- (d) A particle is confined to a 1 D box of length $2a$ extending from $x = -a$ to $x = a$ along the x -axis. The average value of position and momentum, for the particle, if it is in the ground state is —
- (i) $\langle x \rangle = 0$ and $\langle p_x \rangle = 0$
 - (ii) $\langle x \rangle = a/2$ and $\langle p_x \rangle = 0$
 - (iii) $\langle x \rangle = 0$ and $\langle p_x \rangle = -i\hbar$
 - (iv) $\langle x \rangle = 0$ and $\langle p_x \rangle = \hbar$
- (e) Consider a container of volume 5.0 L that is divided into two compartments of equal size. In the left compartment there is nitrogen at 1.0 atm and 25°C; in the right compartment there is hydrogen at the same temperature and pressure. What will happen when the partition is removed? (Assume ideal behaviour)
- (i) The entropy decreases, and the free energy decreases
 - (ii) The entropy increases, and the free energy decreases
 - (iii) The entropy increases, and the free energy increases
 - (iv) The entropy decreases, and the free energy increases
- (f) Reynold's number for laminar flow for a liquid through a pipe is approximately equal to —
- (i) 2000
 - (ii) 2500
 - (iii) 3000
 - (iv) 4500

(g) For the equilibrium $2N_2O(g) + N_2H_4(g) \rightleftharpoons 3N_2(g) + 2H_2O(g)$; $\frac{K_p}{K_c}$ is —

- (i) RT
- (ii) $(RT)^2$
- (iii) $(RT)^{-1}$
- (iv) 1

(h) If η and φ are viscosity and fluidity of a liquid then —

- (i) $\eta = 1/\varphi$
- (ii) $\eta = 1/\varphi^2$
- (iii) $\eta = 1/\varphi^3$
- (iv) none of these

2. Answer any *four* questions : $2 \times 4 = 8$

- (a) What is Reynold's number? What does it indicate?
- (b) For weak electrolytes increases indefinitely with dilution and hence there is no Λ^0 — Comment on the statement.
- (c) Express the fugacity of a real gas in terms of its pressure and compressibility factor.
- (d) If ϕ_1 and ϕ_2 are two eigenfunctions of the operator H have the same eigenvalue E , show that any linear combination of ϕ_1 and ϕ_2 is also an eigenfunction of H .
- (e) For mixing of ideal gases at constant T and P show that $\Delta H_{mix} = 0$ and $\Delta V_{mix} = 0$.

- (f) In the Compton effect, photons scattered from metal foils exhibit two wavelengths. Comment on their nature of shift in the wavelength.
- (g) Calculate the change in chemical potential of an ideal gas at 300K when its pressure is changed from 2 atm to 5 atm .
- (h) If standard free energy change of a reaction is positive, can it proceed in a forward direction?

3. Answer any *two* questions : $6 \times 2 = 12$

- (a) (i) Using Gibbs-Duhem equation show that if one component in a solution follows Raoult's law over the entire range, the second component must also follow Raoult's law.
- (ii) A AgNO_3 solution containing 0.00739 g of AgNO_3 per gram of water is electrolyzed between Ag electrodes. During the experiment 0.078 g silver was deposited on the cathode. At the end of the experiment anode solution contains 23.14 g of silver nitrate. What is the transport number of silver ion? Atomic weight of silver and molecular weight silver nitrate are 108 and 170 respectively. 3+3
- (b) (i) Cd^{2+} ion shows abnormal transport number in conc. CdI_2 solution. Why?
- (ii) Show that for dilute aqueous solutions of the weak acid HA , $\frac{1}{\Lambda}$ vs Λc plot is a straight line with positive intercept .
- (iii) Show that eigenvalues of a Hermitian operator are real. 2+2+2
- (c) (i) Comment on the pressure and temperature dependence of viscosity coefficients of gases and liquids.

(ii) A steel ball ($\rho = 7.86 \text{ gm cm}^{-3}$) 0.2 cm in diameter falls 10 cm through a viscous liquid ($\rho_0 = 1.50 \text{ gm cm}^{-3}$) in 25s. What is the viscosity coefficient of the liquid? 3+3

(d) (i) Assuming π electrons of a butadiene molecule moving freely along a straight line of length 578 pm. Calculate the energy changes associated with the HOMO-LUMO transition in this molecule.

(Given $m_e = 9.019 \times 10^{-31} \text{ Kg}$, $h = 6.626 \times 10^{-31} \text{ J.s}$)

(ii) Using Uncertainty principle or de Broglie relation, estimate the ground state energy of a particle of mass m confined in a one-dimension box of length L . 3+3
