

2026

## CHEMISTRY — HONOURS

Paper : DSCC-7

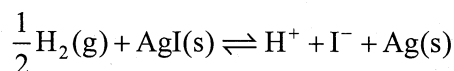
(Physical Chemistry - II)

Full Marks : 75

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*Answer **question nos. 1, 2, 3, 4** (Compulsory) and **any four** questions from the rest (**question nos. 5 to 10**).1. Answer **any ten** questions :

2×10

- Define surface energy. How is it related to surface tension?
- “Viscosity of a liquid decreases with increasing temperature.” — Justify or criticize.
- State Fick’s first law of diffusion and explain the meaning of diffusion coefficient.
- How many tetrahedral and octahedral voids are present in a FCC unit cell?
- Derive the relation between molar mass and unit cell dimension for a cubic system.
- Find the degree of freedom for the following equilibrium :  $\text{NH}_4\text{Cl(s)} \rightleftharpoons \text{NH}_3\text{(g)} + \text{HCl(g)}$  obtained by heating solid  $\text{NH}_4\text{Cl}$  in a closed container.
- Explain positive deviation from Raoult’s law with an example.
- Explain why ‘molality’ is used as concentration term while dealing with colligative properties, instead of molarity or normality.
- Set up an electrochemical cell where the following reaction takes place :



- How can EMF measurements be used to determine equilibrium constants?
- What is eutectic mixture? Give one example.
- Differentiate between an ideal solution and an ideally dilute solution.

2. Write short notes on :

- Poiseuille’s equation covering the following points :
  - Derivation of the equation mentioning at least two assumptions involved.
  - Calculation of the rate of flow of oil through a pipe of 1.3 cm inner diameter and 15 m length. [given the pressure difference between the two ends of the pipe is 4 atm and viscosity coefficient of oil is 0.40 Pa] 3+2

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*Or*

(b) Bragg's Equation covering the following points :

- (i) Derivation of equation using suitable diagram. (mentioning conditions of constructive interference and geometric considerations.)
- (ii) Calculation of the value of maximum lattice spacing that can be determined using X-ray radiation of wavelength  $\lambda$ . 3+2

3. Write short notes on :

- (a) Depression of freezing point of a solution of non-volatile, non-electrolyte solute covering the following points :
  - (i) Thermodynamic derivation mentioning the assumptions involved.
  - (ii) Conditions for elevation of freezing point. 3+2

*Or,*

(b) Phase equilibrium using the following points :

- (i) Definition of the number of components and the degrees of freedom with one example each.
- (ii) Ehrenfest classification of conditions of first order phase transitions.. 2+3

4. Write short notes on :

(a) Concentration cells on the basis of the following points :

- (i) Types of concentration cells with examples.
- (ii) Cell reactions for the following concentration cell with transference :

*Or,*

(b) Consolute temperature of liquid – liquid equilibria on the basis of the following points :

- (i) One example each for systems with upper/lower and both upper and lower consolute temperatures.
- (ii) Calculation of the degrees of freedom at consolute temperature for a two phase liquid system and effect of impurities on the consolute temperature. 2+3

- 5. (a) Find the change in surface energy when two identical mercury droplets of diameter 1.5 mm merge isothermally to form one drop. [Surface tension of Mercury = 490 dynes/cm]
- (b) The relative position of  $\text{Na}^+$  and  $\text{Cl}^-$  in NaCl structure was established on the basis of diffraction intensity data for the (111) planes of the crystal structure. — Justify.
- (c) The vapour pressure of pure water at  $0^\circ\text{C}$  is 4.579 Torr and that of a solution of non-volatile solute is 4.56 Torr. Find out the  $\Delta T_b$ ,  $\Delta T_f$  and osmotic pressure of the solution. 4+3+3

6. (a) X-ray powder diffraction angles of silver crystal are obtained at  $19.11^\circ$ ,  $22.18^\circ$ ,  $32.34^\circ$ ,  $38.84^\circ$  and  $40.89^\circ$ .

(i) Find the types of unit cell.

(ii) What is the radius of Ag atom if  $\lambda$  of X-ray is  $154.43 \text{ pm}$ ?

- (b) Explain the principle of the Ostwald Viscometer. Derive the relation viscosity and flowtime of liquid.

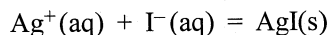
- (c) Draw and explain the phase diagram of sulphur. 4+3+3

7. (a) Starting from the appropriate form of Duhem-Margules equation, obtain Konowaloff's rule and explain the significance of the rule.

- (b) Find out  $E^\circ_{\text{Fe}^{3+}/\text{Fe}}$  [given  $= E^\circ_{\text{Fe}^{2+}/\text{Fe}} = -0.44 \text{ V}$  and  $E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.77 \text{ V}$ ].

- (c) Explain temperature variation of surface tension of a liquid and write down the Ramsay Shields expression defining all terms involved. 4+3+3

8. (a) Construct the cell with the following reaction :



and find out the solubility product of AgI.

[given  $E^\circ_{\text{Ag}^+/\text{Ag}} = 0.799 \text{ V}$  and  $E^\circ_{\text{I}^-/\text{AgI}/\text{Ag}} = -0.152 \text{ V}$ ].

- (b) A mixture of quinoline and water boils at  $98.9^\circ\text{C}$  under a pressure of  $740 \text{ mm Hg}$ . The distillate contains  $78 \text{ g}$  of quinoline and  $1000 \text{ g}$  of water. The vapour pressure of quinoline is  $8 \text{ mm Hg}$  at  $98.9^\circ\text{C}$ . Calculate the molar mass of quinoline. [Assume that the two liquids are immiscible pair].

- (c) Find out the terminal velocity of a drop of a certain material of radius  $0.01 \text{ cm}$  falling through air of viscosity coefficient  $= 1.85 \times 10^{-4} \text{ poise}$ . Neglect the density of air compared to that of the material of the drop. Will the terminal velocity change when pressure changes? 4+3+3

9. (a) A certain mass of a substance when dissolved in  $100 \text{ gm}$  of benzene lowers the freezing point by  $1.28^\circ\text{C}$ . The same mass of solute dissolved in  $100 \text{ gm}$  water lowers the freezing point of the later by  $1.40^\circ\text{C}$ . If the substance has a normal molecular weight in Benzene and is completely dissociated in water, into how many ions does it dissociate in water? [given :  $K_f(\text{water}) = 1.86$ ,  $K_f(\text{benzene}) = 5.12 \text{ in K kg mol}^{-1} \text{ unit}$ ].

- (b) State the law of rational indices. Determine the Miller indices of the planes that intersects the crystal axes at (i)  $a$ ,  $2b$ ,  $3c$  and (ii)  $a$ ,  $b$ ,  $-c$ .

- (c) Starting from Clapeyron equation, deduce the Clausius-Clapeyron equation for a liquid-vapour equilibrium mentioning the necessary assumptions. 4+3+3

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10. (a) From the following data, evaluate the types of cubic lattice to which the two systems belong :

|                                    | X     | Y      |
|------------------------------------|-------|--------|
| edge length (pm)                   | 286   | 388    |
| density (gm cm <sup>-3</sup> )     | 7.86  | 12.16  |
| molar mass (gm mol <sup>-1</sup> ) | 55.85 | 106.40 |

- (b) Draw the phase diagram (T vs mole% of B) of a system consisting of solids A and B forming a stable compound A<sub>2</sub>B with congruent melting point. Show the different phases present in the different regions of the diagram. State the degrees of freedom at eutectic point.  
[given : m.p. of A<sub>2</sub>B > m.p. of A > m.p. of B].

- (c) For a solution of AgNO<sub>3</sub> being titrated with KCl, what are the half-cells that will be combined to form the electrochemical cell to be used for the experiment? Discuss how the half-cell used for titration changes after equivalence point and give Nernst equation for the reduction potential of each form (before and after equivalence point). 4+3+3
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