F(4th Sm.)-Chemistry-II/DSCC-7/CBCS

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

(a) Define surface energy. How is it related to surface tension?

(b) "Viscosity of a liquid decreases with increasing temperature." — Justify or criticize.

(c) State Fick's first law of diffusion and explain the meaning of diffusion coefficient.

(d) How many tetrahedral and octahedral voids are present in a FCC unit cell?

(e) Derive the relation between molar mass and unit cell dimension for a cubic system.

(f) Find the degress of freedom for the following equilibrium : $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$ obtained by heating solid NH_4Cl in a closed container.

(g) Explain positive deviation from Raoult's law with an example.

(h) Explain why 'molality' is used as concentration term while dealing with colligative properties, instead of molarity or normality.

(i) Set up an electrochemical cell where the following reaction takes place :

$$\frac{1}{2}H_2(g) + AgI(s) \rightleftharpoons H^+ + I^- + Ag(s)$$

(j) How can EMF measurements be used to determine equilibrium constants?

(k) What is eutectic mixture? Give one example.

(l) Differentiate between an ideal solution and an ideally dilute solution.

2. Write short notes on :

(a) Poiseuille's equation covering the following points :

(i) Derivation of the equation mentioning at least two assumptions involved.

(ii) 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

Please Turn Over

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 λ.

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.

Or,

3+2

(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 :

$Pb \mid PbSO_4(Satd) \mid CuSO_4(m_1) \vdots CuSO_4(m_2) \mid PbSO_4(Satd) \mid Pb$

3+2

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 Na^+ and 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^oC is 4.579 Torr and that of a solution of non-volatile solute is 4.56 Torr. Find out the ΔT_b, ΔT_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°, 22.18°, 32.34°, 38.84° and 40.89°.

(i) Find the types of unit cell.

(ii) What is the radius of Ag atom if λ of X-ray is 154.43. 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 $E^{\circ}_{Fe^{3+}/Fe}$ [given = $E^{\circ}_{Fe^{2+}/Fe} = -0.44$ V and $E^{\circ}_{Fe^{3+}/Fe^{2+}} = 0.77$ 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 :

$$Ag^{+}(aq) + I^{-}(aq) = AgI(s)$$

and find out the solubility product of AgI.

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

(b) A mixture of quinoline and water boils at 98.9°C under a pressure of 740 mm Hg. The distillate contains 78 g of quinoline and 1000 g of water. The vapour pressure of quinoline is 8 mm Hg at 98.9°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 cm falling through air of viscosity coefficient = 1.85×10^{-4} 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 gm of benzene lowers the freezing point by 1.28°C. The same mass of solute dissolved in 100 gm water lowers the freezing point of the later by 1.40°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(water) = 1.86, K_f(benzene) = 5.12 in K kg mol^{-1} 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

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^{-3})	7.86	12.16
molar mass (gm mol^{-1})	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_2B 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_2B > m.p. of A > m.p. of B].

(c) For a solution of $AgNO_3$ 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