

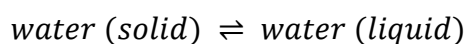
SL No of QP : 5695
Unique Paper Code : 2173012009
Name of the Paper : DSE/GE: Solutions, Colligative Properties, Phase Equilibria and Adsorption
Name of the Course : B.Sc. (H)
Semester : IV
Duration : 3 hours
Maximum Marks : 90

Instructions for candidates:

1. Write your Roll Number on top of the question paper immediately on receipt of the question paper.
2. **Q. No. 1 is compulsory.**
3. Attempt **SIX** questions in all.
4. All questions carry equal marks.
5. Use of scientific calculators is allowed.

1. Attempt **any five** (3 marks each) (3 x 5 = 15)
 - a. How does the addition of succinic acid affect the C.S.T of phenol-water system? Explain.
 - b. The slope of the sublimation curve in the phase diagram of water is greater than that of the vapourization curve. Explain.
 - c. State the Nernst Distribution Law along with a suitable formula.
 - d. Azeotropic mixtures have definite compositions and definite boiling points but they are not compounds. Explain.
 - e. Write the expressions for Gibbs Phase Rule and Reduced Gibbs Phase Rule. Name the various terms used.
 - f. Chemisorption results in decrease in entropy of the gas, still it is a spontaneous process. Why? Explain in terms of ΔG , ΔH and ΔS ?
 - g. What do you mean by the triple point of water?
2. Write short notes on (**any three**) (5 x 3 = 15)
 - a. Difference between physisorption and chemisorption.
 - b. Steam distillation.
 - c. van't Hoff factor and abnormal molecular masses.

- d. Phase diagram of phenol-water system.
 - e. Langmuir Adsorption Isotherm.
3. a. What are colligative properties? Explain *osmosis* and *osmotic pressure* with a suitable diagram. (5)
- b. 1.50 g of a non-volatile organic substance was dissolved in 140 g of acetone at 20°C. The vapour pressure of the solution was found to be 181.5 torr. Calculate the molar mass of the substance, given that the vapour pressure of pure acetone at 20°C is 186 torr. (5)
- c. Define “*degree of freedom*”. Find the number of components, number of phases and degrees of freedom for the following system (5)



4. a. Draw a well-labelled phase diagram of the Sulphur system and explain the different areas, curves and points. Also calculate the degrees of freedom corresponding to the areas, curves and points. (5)
- b. Derive the following equation starting from the Duhem-Margules Equation. (5)

$$\frac{dp}{d\chi_A} = \frac{dp_B}{d\chi_A} \left[1 - \frac{\chi_B p_A}{\chi_A p_B} \right]$$

- c. Derive the Gibbs phase rule for a non-reactive system at equilibrium containing C components and P phases. (5)
5. a. Using the phase diagrams, compare the slopes of the fusion curve of H₂O and CO₂ systems. Explain using Clausius-Clapeyron equation. (5)
- b. State the Konowaloff Rule. (5)
- On distillation of each of the following mixtures, find which component will be obtained in the residue and which one in the distillate. The vapour pressures of the components are given within brackets:
- (i) *n*-hexane (45.5 mm Hg) and *n*-heptane (11.4 mm Hg)
 - (ii) benzene (51.3 kPa) and toluene (18.5 kPa)

- c. Metals X and Y exhibit a *simple eutectic* diagram. Following table gives the break and halt points for various mixtures of X and Y. Draw the phase diagram and find the eutectic composition and temperature. (5)

Mass percent of Y	0	20	40	50	70	85	100
Break Temperature/ °C	800	600	400	-	415	500	600
Halt Temperature/ °C	350	350	350	350	350	350	350

6. a. State and derive the lever rule for a 2-component system. (5)
- b. To 100 mL of an aqueous solution containing 0.3 g of aspirin, 50 mL of ether were added. The mixture was shaken and allowed to equilibrate at 293 K. The distribution coefficient of aspirin *between ether and water* is 5.9. (5)
- How much aspirin remains **unextracted** in the aqueous phase?
 - If instead of 50 mL ether, the extraction is carried out with 2 successive 25 mL portions of ether, how much aspirin remains **unextracted**?
- c. Find the number of components (C) in the following systems with suitable explanation: (5)
- An aqueous solution of KCl and NaCl
 - $MgCO_3(s) \rightleftharpoons MgO(s) + CO_2(g)$
 - $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$ on starting with pure NH_4Cl
 - A mixture of ethanol, water and ice
 - $I_2(s) \rightleftharpoons I_2(v)$
7. a. With a suitable diagram, explain isobaric fractional distillation of an ideal binary solution. (5)
- b. Discuss how the extent of physical adsorption depends on the following (5)
- surface area per unit mass of the adsorbent
 - increasing temperature of the system
 - critical temperature (T_c) of the gas
- c. Draw and explain the phase diagram of a 3-component system of **acetic acid - chloroform - water**. (5)
