

- N.B :** (1) Question No. 1 is compulsory.
 (2) Attempt any three out of remaining five questions.
 (3) Assume suitable data if necessary with justification.

1. (a) For binary diffusion of A in B show that $D_{AB} = D_{BA}$. 4
 (b) Define mass transfer coefficient and derive relation between K-type and F-type mass transfer coefficient for gas A diffusing in non-diffusing gas B. 4
 (c) Write a short note on two film theory for interphase transfer. 4
 (d) Write a short note on packings used in packed towers. 4
 (e) Discuss requirements of a good solvent that can be used for gas absorption. 4
2. (a) Derive steady state flux equation for molecular diffusion of liquid A in non-diffusing liquid B. 10
 (b) Ammonia is diffusing through a stagnant gas mixture consisting of one third nitrogen and two third of hydrogen by volume. The total pressure is 2.25 atm absolute and the temperature is 53° C. Calculate the rate of diffusion of ammonia through a film of gas 0.6 mm thick when concentration change across the film is 12 to 6 percent ammonia by volume. 10
 Data:-
 Diffusivity of ammonia in nitrogen is 0.196 m²/s
 Diffusivity of ammonia in hydrogen is 0.63 m²/s
3. (a) Derive relation between individual and overall mass transfer coefficient when 10
 (i) Gas phase resistance is controlling
 (ii) Liquid phase resistance is controlling
 (b) Gaseous carbon dioxide is flowing up a vertical metal tube 1.5 m long, as the water flows down in the form of thin film wetting inner wall of the tube. The up flowing gas is pure CO₂ whose pressure is 1 std atm. Mass flow rate of water per meter width of the film is 4.5 kg/min. Calculate thickness of the film, rate of absorption of CO₂ by water film at 298 K. At 298 K and 1 std atm, the solubility of CO₂ in water is 1.4784 kg/m³ of solution. 10
 Diffusivity of CO₂ in water is 1.96 X 10⁻⁹ m²/s. Density of water at the prevailing conditions is 997 kg/m³ and viscosity of water is 902.75 x 10⁻⁶ kg/ms.
4. (a) Compare tray towers with packed towers. 7
 (b) Discuss various problems associated with operation of tray towers. 7
 (c) Discuss different types of packings. 6

5. (a) A gas absorber has to be designed to handle 900 cubic meters per hour of coal gas containing 2 % [by volume] benzene. Coal gas enters at a temperature of 300 K and 805 mm Hg. 95 % of benzene should be removed by the solvent. The solvent enters at 300 K containing 0.005 mole fraction of benzene and has an average molecular weight of 260. Calculate the circulation rate of solvent per second, if the column is to be operated at 1.5 times the minimum. Equilibrium data is given by $y = 0.125x$ x and y are mole fractions in liquid and gas respectively. 10
- (b) It is desired to dry sheet material from 55% to 4 % moisture content. The sheets are 125 cm x 140 cm x 5 cm. The drying rate during the constant rate period is 1.5 gm/hr cm^2 . The critical moisture content is 25% on wet basis. If the material is dried from both the sides and has bone dry density of 4000 kg/m 3 calculate the time required for drying assuming the falling rate period to be linear. Neglect equilibrium moisture content. 10
6. Write short note on the following (Any 4) 20
- (a) Wet bulb temperature theory
 - (b) Typical Rate of drying curve
 - (c) Adiabatic Saturation Curves
 - (d) Dimensionless numbers in mass transfer
 - (e) Minimum Liquid to gas ratio in gas absorption.