[Time: 3 Hours] **[Total Marks: 80]**

Instructions to the candidates if any: -

1. Question No 1 is compulsory
2. Attempt any three questions from the remaining five questions
3. Assume suitable data wherever necessary
4. Figures to the right indicates full marks

Q. No. 1

a. Derive relation between $K-type$ and $F-type$ mass transfer coefficients for equimolal counter diffusion of gas A and gas B, when the driving force is partial pressure difference **[05]**

b. A thin film of liquid is flowing past a vertical surface, inclined at an angle of 38^O with the vertical. The density of the liquid is $994\ kg/m^3$, viscosity is $8.94 \times 10^{-2}\ kg/ms$. The thickness of the liquid film is $2.25\ mm$. Find the bulk average velocity with which the film is coming down**.** **[05]**

c. In a mixture of benzene vapor and nitrogen gas at a total pressure of $850\ mm\ of\ Hg$ and a temperature of 60^OC, the partial pressure of benzene is $120\ mm\ of\ Hg$. Calculate mass and molal absolute humidity. **[05]**

d. Discuss the requirements for a solvent that can be used in gas absorption **[05]**

Q. No. 2

a. Derive the equation for calculating steady state molar flux for equimolar counter diffusion of gas A and gas B. [**08**]

b. Ammonia is diffusing through a stagnant gas mixture consisting of two third nitrogen and one third of hydrogen by volume. The total pressure is $2\ atm$ absolute and the temperature is 53^OC. Calculate the rate of diffusion of ammonia through a film of gas, $0.6\ mm$ thick when the concentration change across the film is 12 % to 6 % by volume.
The given data is: -
Diffusivity of ammonia in nitrogen is $0.196\ cm^2/s$.
Diffusivity of ammonia in hydrogen is $0.63\ cm^2/s$. **[08]**

c. Write a short note on Height Equivalent to a Theoretical Plate [**04**]

Q. No. 3

a. Derive an equation between overall and individual mass transfer coefficients in interphase mass transfer between a gas and a liquid. [**10**]

b. The air pressure in a tyre reduces from $2\ bar$ to $1.98\ bar$ in four days. The volume of the air in the tube is $0.025\ m^3$, the surface area is $0.5\ m^2$ and the wall thickness is $0.01\ m$. The solubility of air in the rubber is $0.07 m^3/m^3$. Estimate the diffusivity of air in the rubber at 30^OC. [**10**]

Q. No. 4

a. Derive the equation for adiabatic saturation curves [**08**]

b. $6000\ kg/hr$ of a $SO_2 - air$ mixture containing 4 % by volume of SO_2 is to be scrubbed with $150000\ kg/hr$ of water in a packed tower. The exit concentration of SO_2 is reduced to 0.18 %. The tower operates at $1\ atm$. The equilibrium relationship is $Y = 29X$. If the packed height of tower is $400\ cm$, estimate the height of transfer unit. X and Y are the mole ratios in liquid and gas phase respectively. [**12**]

Q. No. 5

a. Discuss the comparison between packed and tray towers. [**08**]

b. A batch of solids for which the following table of data applies is to be dried from 28 % to 8 % moisture content under conditions identical to those for which the data was collected. The initial weight of the wet solid is $350\ kg$ and the drying surface is $1 m^2/$ $9\ kg\ dry\ weight$. Determine the time of drying. [**12**]

X	0.35	0.25	0.20	0.18	0.16	0.14	0.12	0.10	0.09	0.08	0.064
N	0.35	0.35	0.35	0.3	0.26	0.239	0.20	0.18	0.15	0.097	0.07

Q. No. 6 **[20]**

Write a short note on the following **[Any four]**

a. Diffusion through crystalline solids.

b. Problems associated with operation of a packed column.

c. Classification of cooling towers.

d. Two film theory

e. Diffusion coefficients for liquids.

****