

(3 Hours)

Total Marks: 80

N.B. (1) Question No 1 is compulsory

(2) Attempt any three questions out of remaining five questions

(3) Assumption made, if any should be clearly stated

(4) Figures to the right indicate full marks.

- Q.1** Attempt any four. 20
- Define activity and activity coefficient
 - Explain Tangent intercept method
 - Explain Van Laar method
 - Derive Van't Hoff Equation
 - Chemical Potential
- Q.2** a. At 300K and 1 bar, the volumetric data for a liquid mixture of benzene and cyclohexane are represented by 12
- $$V = 109.4 \times 10^{-6} - 16.8 \times 10^{-6} x_1 - 2.64 \times 10^{-6} x_1^2$$
- Where x is the mole fraction of benzene and V has the units of m^3/mol . Find expressions for the partial molar volumes of benzene and cyclohexane.
- b. Determine the number of degree of freedom in a gaseous system consisting of H_2O , HCl , O_2 & Cl_2 8
- Q.3** a. The excess Gibbs free energy is given by 10
- $$\frac{G^E}{RT} = -3x_1x_2 (0.4x_1 + 0.5x_2)$$
- Find expressions for $\ln \gamma_1$ and $\ln \gamma_2$
- b. Explain VLE in ideal and non-ideal solutions. 10
- Q.4** a. The azeotrope of the ethanol-benzene system has a composition of 44.8% (mol) ethanol with a boiling point of 341.4 K at 101.3 kPa. At this temperature the vapour pressure of benzene is 68.9 kPa and the vapour pressure of ethanol is 67.4 kPa. What are the activity coefficients in a solution containing 10% alcohol? 10
- b. Explain phase diagrams for Binary solution. 10
- Q.5** a. A gas mixture containing 2 mole of nitrogen, 7 moles hydrogen and 1 mole ammonia initially, is undergoing following reaction 10
- $$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$$
- Derive expression for mole fraction of various component in the reaction mixture in terms of extent of reaction
 - Explain how the conversion of limiting reactant is related to extent of reaction
- b. Derive Gibbs Duhem equations 10

- Q.6 a. Explain Vapour absorption refrigeration cycle with its principle. **10**
- b. A vapour compression cycle using ammonia as refrigerant is employed in an ice manufacturing plant. Cooling water at 288K enters the condenser at a rate of 0.25kg/s and leaves at 300K. Ammonia at 298K condenses at a rate of 0.50 kg/min. enthalpy of liquid ammonia at 294 K is 281.5 kJ/kg. The compressor efficiency is 90%. Saturated ammonia vapour at 258K and enthalpy of 1426 kJ/kg enters the compressor. What is the power requirement of the compressor and refrigeration capacity in tons? **10**
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