

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.

Q1 Solve any Four out of Five 20

- a) Derive the relationship between the mole fraction of the components taking part in the reaction and the extent of reaction
- b) Short note on Partial Molar Properties
- c) State Raoult's law. Show that it is simplified form of Lewis Randall Rule
- d) Short Note on UNIFAC Method
- e) Describe important properties of refrigerants

Q2 a) For a system excess free energy is given by the relation 10

$$\frac{G^E}{RT} = (-2.6x_1 - 1.8x_2)x_1x_2$$

Find the expression for $\ln\gamma_1$ and $\ln\gamma_2$

b) Explain different methods of determination partial molar property. 10

Q3 a) Explain Boiling point diagram (T-x- y plot) and equilibrium diagram (x-y plot) for binary solution 10

b) The following simultaneous reaction occurs in a mixture 10



Estimate the equilibrium conversion at 1 bar if 1 kmol of A is fed to a reactor for producing D. The reaction mixture can be assumed as an ideal gas mixture

Q4 a) Water hydrazine system forms an azeotrope containing 58.5 % (mol) hydrazine at 393 K and 101.3 KPa. Calculate the equilibrium vapour composition for a solution containing 20 % (mol) hydrazine. The relative volatility of water with reference to hydrazine is 1.6 may be assumed to remain constant in the temperature range involved. The vapour pressure of hydrazine at 393 K is 124.76 kPa. 10

b) Discuss the phase rule for non reacting and reacting systems .Determine the number of degrees of freedom in a gaseous system consisting of CO,CO₂, H₂,H₂O and CH₄ in chemical equilibrium. 10

Q5

- a) At 300 K and 1 bar, the volumetric data for a liquid mixture of benzene and cyclohexane are represented by **10**

$$V = 109.4 \times 10^{-6} - 16.8 \times 10^{-6}x_1 - 2.64 \times 10^{-6}x_1^2$$

where x is mole fraction of benzene and V has units of m^3/mol .

Find the expression for partial molar volumes of benzene and cyclohexane also determine the expression for volume change of mixing for the standard state based on Lewis Randall Rule

- b) Explain refrigeration cycle diagram P-V and T-S **10**

Q6

- a) A refrigerating unit using Freon -12 (R-12) as the working fluid operates between 18°C and 37°C . The rate of circulation of refrigerant is 2 kg/min and the efficiency of the compressor is 0.85. Using the following data of enthalpy, calculate **10**

- i) The capacity of the plant in tons of refrigeration
- ii) The power required to run the unit
- iii) The COP of the unit

Data : The enthalpies of R-12 liquid at 37°C is 455 kJ/kg. The enthalpies of R-12 entering and leaving the compressor are 563.15 kJ/kg and 595.4 kJ/kg respectively.

- b) Derive various forms of Gibbs-Duhem equation **10**
