Time: 3hour **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

Q.1 Solve any Four **20**

a) Chemical potential

b) Method for determination of Partial molar properties.

c) Gibbs Duhem equation

d) Principle of vapor absorption cycle

e) Criteria of reaction equilibria

Q.2

a) A vessel is divided into two compartments. One contains 100 moles nitrogen at 298K and 1 bar and the other contains 100 moles of oxygen at the same conditions. The barrier separating them is removed and the gases are allowed to reach equilibrium under adiabatic conditions. What is the change in entropy of the contents of the vessel? **10**

b) Explain activity and activity coefficient in detail **10**

Q.3

a) Explain phase rule for reacting system. **10**

b) The molar enthalpy of a binary mixture is given by **10**
$H = x_1 (a_1 + b_1 x_1) + x_2(a_2 + b_2 x_2)$
Derive expression for $\bar{H}_1$

Q.4

a) Derive the relationship between mole fractions of the species in multiple reactions and the extent of reactions. **08**

b) The azeotrope of the ethanol-benzene system has a composition of 44.8% (mole) ethanol with a boiling point of 341.4 K and 101.3kPa. at this temperature the vapour pressure of the benzene is 68.9 kPa and the vapour pressure of ethanol is 67.4 kPa. Find the activity coefficients in a solution containing 10% alcohol? **12**

Q.5

a) Determine the degree of freedom in a gaseous system consisting of H_2O, HCl,O_2 and Cl_2 in chemical equilibrium. **10**

b) Sketch and label vapour compression refrigeration system with P-H and T-S diagram **10**

Q.6

a) 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 0.25 kg/s and leaves at 300K. Ammonia at 294K condenses at a rate of 0.50 kg/min. Enthalpy of liquid ammonia at 294K is 281.5 kJ/kg. The compressor efficiency is 90%. Saturated ammonia vapour at 258 K and enthalpy of 1426 kJ/kg enters the compressor. Evaluate the power requirement of the compressor and refrigeration capacity in tons. **10**

b) Derive Van't Hoff Equation **10**
