Time : 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	Explain	20
(a)	Criteria of Phase Equilibria	05
(b)	Equlibrium conversion	05
(c)	Excess Properties	05
(d)	Tonn of Refrigeration	05

Q 2 (a) The molar enthalpy of a binary mixture is given by   10
$H = x_1(a_1 + b_1x_1) + x_2 (a_2+b_2x_2)$ derive expression for H_1

(b) The activity coefficient data for a binary solution at fixed temperature and pressure are correlated as   10

$ln\gamma_1 = x_2^2 (0.5 +2x_1)$ $ln\gamma_2 = x_1^2(1.5- 2x_2)$ Do these equations satisfy Gibbs Duhem equatios.

Q 3 (a) The azeotrope of the ethanol benzene system has a composition of 44.8% (mol) ethanol with a boiling point   12
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.

(b) Explain in detail criteria of Chemical Reaction equilibrium   08

Q 4 (a) A mixture of 1 mol CO, and 1 mol water vapour is undergoing the water gas shift reaction at a temperature   12
of 1100 K and a pressure of 1 bar. Calculate
$CO (g) + H_2O (g) \rightarrow CO_2 (g) + H_2(g)$
The equilibrium constant for the reaction is K=1 . Assume that the gas mixture behaves as ideal gas
calculate
i)   The fractional dissociation of steam
ii)   The fractional dissociation of steam if the reactant stream is diluted with 2 mol nitrogen

(b) What do u understand by the number of degrees of freedom? How is it determined using the phase rule for a   08
non reacting system?

Q 5 (a) R-12 is condensed at 30^0C. It is then throttled to -5^0C. Find the refrigerant flow rate that enters the compressor for 1 T of refrigerant. 12

T_{sat}	Psat	H_g KJ/Kg	H_f KJ /Kg
-5^0C	0.2619 MPA	31.42	185.243
30^0C	0.7449 MPA	64.539	199.475

It is assumed that compressor discharged is at the saturated vapour conditions. Find work done by compressor and COP.

(b) A gas mixture containing 2 moles nitrogen , 7 moles hydrogen and 1 mole ammonia initially is undergoing the following reaction 08

$N_2 + 3H_2 \rightarrow 2NH_3$

Derive expression for the mole fraction of various components in the reaction mixture.

Q 6 (a) Vapor liquid equilibrium data for the binary system ethyl acetate (1) and methyl isobutyl ketone (2) is obtained at 760 mmHg pressure and $x_1 = 0.20$ find i) the boiling temperature and y1 ii) If P= 760 and $y_1 = 0.8$ find t and x1 12

Vanlaar constant A= 0.5713, B= 0.1951 vapor pressure in mmHg

$$log_{10} \, P1° = 7.09808 - \frac{1238.71}{t + 217}$$
$$log_{10} \, P2° = 8.0590 - \frac{2009.5}{t + 273.15}$$

(b) Explain effect of temperature and pressure on chemical Potential 08

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