T.E- CHEM/IV/CBGS/CET-I

QP Code : 3397

Chemical Engg Thermodynamics - II

ation: 03 Hrs Marks: 80

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 indicate full marks.

a	Discuss in brief estimation methods for critical properties	05
b	Write short note on entropy change of mixing.	05
c	Prove that chemical potential as criteria for phase equilibrium.	05
d	Write short note on Vapor Compression Refrigeration Cycle.	05
a	For synthesis of Ammonia stichometric amount of N_2 & H_2 are sent to a rector where the following reaction occurs. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$. Equilibrium constant for reaction at 675K is 2×10^{-4}. Determine: - i. Percentage conversion of N_2 to NH_3 at 675 K and 20 bar. ii. Percentage conversion of N_2 to NH_3 at 675 K and 200 bar.	10
b	Enthalpy at 300K and 1 bar of a binary mixture is $H = 400 X_1 + 600 X_2 + X_1 X_2 (40 X_1 + 20 X_2)$ Where H is in J/mole for stated temperature and pressure. Obtain expression for $\overline{H_1}$ and $\overline{H_2}$ in terms of X_1.	10
a	Water(1) – Hydrazine(2) system forms an azeotrope containing 58.5 mole % Hydrazine at 393 K and 101.3kPa. Calculate the equilibrium vapor composition for a solution containing 20 % mol hydrazine. The relative volatility of water with reference to hydrazine is 1.6 and may be assumed to remain constant in temperature range involved. The vapor pressure of hydrazine at 393K is 124.76kPa. Use Vanlaar equation.	10
b	20 moles of Nitrogen is mixed with 20 moles of Oxygen. This process is carried out at atmospheric temperature and pressure. The gases can be assumed to be ideal. Find the Gibbs free energy of the resulting mixture? The value of Cp is 29.1 kJ/kmol-K.	10
a	The following equations have been proposed to represent the activity coefficient data for a system at a fixed temperature and pressure. $\ln\gamma_1 = Ax_2^2 + Bx_2^2(3x_1 - x_2)$ $\ln\gamma_2 = Ax_1^2 + Bx_1^2(x_1 - 3x_2)$ Does the system satisfy Gibbs Duhem equation? Determine the expression for $\frac{G^E}{RT}$ for the system.	10

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b The vapor compression unit using Freon – 12 operated between 151 kPa and 746 kPa. The fluid leaving the evaporator is saturated vapor and leaves the condenser at 303 K. Calculate: a. Refrigeration effect. b. Power required. c. Coefficient of performance. 10

P_s, kPa	T_s, K	$V_s m^3/kg$	Enthalpy(kJ/Kg)		Entropy of vapor(kJ/kg.K)
			H_l	H_v	
151	253	0.1093	17.81	179.63	0.7123
746.6	303	0.0236	64.77	201.10	0.6703

C_{pv} = 0.74 kJ/kg.K

Q.5 a Discuss the heat of reaction in detail. 10

b The vapor pressures of acetone(1) and acetonitrile(2) can be evaluated by the Antoine equations- 10

$$\ln P_1^S = 14.5463 - 2940.46/(T - 35.93)$$
$$\ln P_2^S = 14.2724 - 2945.47/(T - 49.15)$$

where T is in K and P is in kPa. Assuming that the solution formed by these are ideal, calculate-

i) x_1 and y_1 at 327 K and 65 kPa.
ii) T and y_1 at 65 kPa and $x_1 = 0.4$
iii) T and x_1 at 65 kPa and $y_1 = 0.4$
iv) P and y_1 at 327K and $x_1 = 0.4$

Q.6 a Describe the graphical method for determination of partial molar properties. 05

b Define excess property. Under what circumstances the property change of mixing and excess properties are identical? 05

c UNIQUAC equation 05

d Calculate the enthalpy of fusion of ice at -10 ^{0}C from the following data: ΔH_f = 6.02kJ/mol at 0 ^{0}C; C_p(ice)= 37.66 J/K.mol ; C_p(water)= 75.31 J/K.mol. 05