S.E. (Chem)/ Sem IV / Choice Bas / CET – II

Q. P. Code: 40652

(3 Hours) Total Marks: 80

23/05/18

N.B. (1) Question No 1 is compulsory
(2) Attempt any three questions out of remaining six questions
(3) Assumption made, if any should be clearly stated
(4) Figures to the right indicate full marks.

Q1 **Explain Any four**

(a) Difference between ideal and non-ideal solution 05
(b) Derive Gibbs Duhem equation 05
(c) Explain various properties of refrigerant used in Refrigeration system 05
(d) Short note on Phase rule for reacting and non-reacting system 05
(e) Show that in a binary solution, if the molar volume of one of the components increases with concentration, the molar volume of the other must decrease. 05

Q2 (a) The volume of an aqueous solution of NaCl at 298 K was measured for a series of molalities (moles of solute per kg of solvent) and it was found that the volume varies with molality according to the following expression. 10

$V = 1.003 \times 10^{-3} + 0.1662 \times 10^{-4}\, m + 0.177 \times 10^{-5}\, m^{1.5} + 0.12 \times 10^{-6}\, m^2$

where m is the molality and V is in m^3. Calculate the partial molar volumes of the components at m= 0.1 mol/kg

(b) Show that the Chemical Potential of a component i in the liquid equal to chemical potential of the same component in vapour when the two phases are in equilibrium. i.e $\mu_i^L = \mu_i^V$ 10

Q3 (a) The following equation have been proposed to represent the activity coefficient for a system at fixed temperature and pressure condition 12

$Ln\gamma_1 = A\, x_2^2 + Bx_2^2\,(3x_1 - x_2)$ $\ln\gamma_2 = A\, x_1^2 + Bx_1^2\,(x_1 - 3x_2)$ do the equation satisfy Gibbs Duhem equation and determine the equation G^E/RT

(b) Prove that if Raoults law is valid for one constituent of a binary solution over the whole concentration , it must also apply to the other constituent. 08

Q4 (a) The vapour pressure of acetone (1) and acetonitrile (2) can be evaluated by the Antoine equation 12

$$\ln P_1^s = 14.5463 - \frac{2940.46}{T - 35.93}$$

$$\ln P_2^s = 12.0586 - \frac{2945.47}{T - 49.15}$$

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 65kPa and $x_1 = 0.4$

iii) P and y_1 at 327 k and $x_1 = 0.4$

iv) T and x_1 at 65 kPa and $y_1 = 0.4$

v) P and x_1 at 327 K and $y_1 = 0.4$

(b) For binary solution at constant temperature show that 08

$$\int \ln \frac{r1}{r2}\, dx_1 = 0$$

Q5 (a) A gas mixture containg 25 % CO , 55% H_2 and 20 % inert gas is to be used for methanol synthesis. The gases uses from the catalyst chamber in chemical equilibrium with respect to the reaction. $CO_{(g)} + 2H_{2(g)} \rightarrow CH_3OH_{(g)}$ At a pressure of 300 bar and temperature of 625 K. Assume that the equilibrium mixture forms an ideal solution and k_f and k_Φ are 4.9×10^{-5} and 0.35 respectively. What is the percent conversion of CO? 10

(b) For a binary system of component A & B, the activity coefficient are given by 10

$\ln \gamma_A = 0.9761 x_B^2$

Vapour pressure data are given as

$$\ln PA^\circ = 9.7321 - \frac{2866.6}{t + 217.88}$$

$$\ln PB^\circ = 12.0586 - \frac{3667.7}{t + 226.18}$$

Does this system form an azeotrope at 71.1°C if so at what composition it forms an azeotrope

Q6 (a) Ammonia refrigeration system works between 266 K and 300K. The vapour is dry at the end of compression and there is no undercooling. The expansion is through a throttle valve Find 12

1. Coefficient of performance
2. Power required to remove 120 kW $H_2 - H_1$

Properties of Ammonia

Ps , kPa	Ts , K	Vg , m^3/kg	H_l kJ/kg	Hv kJ/kg	Entropy of liquid(kJ/kg.K)	Entropy of vapour (kJ/kg.K)
328.3	266	0.374	148.64	1435.136	0.5862	5.4297
1066	300	0.121	308.12	1466.41	1.1544	5.0139

(b) Consider the following reactions 08

$A + 3B \rightarrow R + 5S$

$A + 5B \rightarrow T + 2S$

If feed contains 4 moles of A and 10 moles of B, express the mole fraction in terms of reaction coordinates.

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