

Total No. of Questions :10]

SEAT No. :

P3552

[Total No. of Pages : 3

[5560]-205

T. E. (Chemical)

CHEMICAL ENGINEERING THERMODYNAMICS - II

(2012 Pattern) (Semester - I)

Time : 2 ½ Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8, Q.9 or Q.10
- 2) Neat diagrams must be drawn whenever necessary.
- 3) Assume suitable data, if necessary.
- 4) Figures to the right indicate full marks.

Q1) For a binary system show that any thermodynamic solution property is related with its component partial molar properties as **[10]**

$$M_1 = M + x_2 \frac{dm}{dx_1} \quad \text{and} \quad M_2 = M - x_1 \frac{dm}{dx_1}$$

OR

Q2) What is ideal solution Derive Equation for G^{id} , S^{id} , V^{id} , H^{id} **[10]**

Q3) a) Derive the Equation for Excess Gibbs Energy. **[4]**

b) Define the following terms : **[6]**

- i) Fugacity and Fugacity Coefficient
- ii) Activity Coefficient

OR

Q4) A liquid mixture of cyclohexane (a) phenol (b) for which $x_1 = 0.60$ is in equilibrium with its vapor at 417.15 K. Determine the equilibrium pressure P and vapor composition y_1 from the following information. **[10]**

$\ln \gamma_1 = Ax_1^2$, $\ln \gamma_2 = Ax_1^2$ at 417.15 K, $P_1^{\text{sat}} = 1.24$ bar, $P_2^{\text{sat}} = 0.89$ bar. The system forms an azeotrope at 417.15 K for which $x_1^{a2} = y_1^{a2} = 0.294$.

P.T.O.

- Q5) a)** The vapour pressure of acetone Acetonitrile and Nitromethane can be represented by Antoine equation as [10]

$$\ln p_1^{\text{sat}} = 14.3916 - \frac{2795.82}{T + 230}$$

$$\ln p_2^{\text{sat}} = 14.2724 - \frac{2945.47}{T + 224}$$

$$\ln p_3^{\text{sat}} = 14.2043 - \frac{2972.64}{T + 209}$$

Where p_1^{sat} , p_2^{sat} and p_3^{sat} are KP_a and T is in $^{\circ}\text{C}$. Assuming that the system follow Raoult's law calculate

- i) P and y_1 at $T = 75^{\circ}\text{C}$, $x_1 = 0.30$, $x_2 = 0.40$
 - ii) P and x_1 at $T = 80^{\circ}\text{C}$, $y_1 = 0.45$, $y_2 = 0.35$
- b) Explain liquid - liquid equilibrium diagram. [6]

OR

- Q6) a)** Explain any two method of consistency test for VLE data [10]
- b) Derive various criteria for phase equilibrium. [6]

Q7) Define and derive the Equation for Following Terms :

- i) Reaction Coordinate [6]
- ii) Application of Equilibrium Criteria [5]
- iii) Effect of Temperature on Equilibrium Constant [5]

OR

- Q8) a)** Derive the relation $\Delta G = -RT \ln K$ [8]
- b) Consider a reaction $\text{H}_2\text{O} \rightarrow \text{H}_2 + 1/2\text{O}_2$ occurring in a closed vessel with n_0 moles of water vapor initially. Derive an expression for the mole fractions of all the components and the fractional decomposition of water in terms of the reaction coordinate. [6]
- c) Define the term Fugacity [2]

Q9) a) Derive the Relation of Equilibrium Constant to Composition for gas Phase and Liquid Phase Reaction. [12]

b) Write a short note on [6]

i) Phase Rule for Reaction System.

ii) Fuel Cell

OR

Q10) The water gas Shift reaction is carried out under the different set of conditions. Calculate fraction of stream reacted in each case. [18]

a) The reactant consists of 1 mol of H_2O and One mole of CO . The Temp is 1100K and Pressure 1 bar

b) The reactant consists of 2 mol of H_2O and One mole of CO . The Temp is 1100K and Pressure 1 bar

c) The Initial Mixture consist of 1 mol of H_2O , 2 Mol of CO other conditions are same as above.

d) The Initial Mixture consist of 1 mol of H_2O , 1 Mol of CO and 1 mol of CO_2 other conditions are same as above
