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SF-7023

B. E. - III (Sem. VI) (Chem.) Examination

May / June – 2011

Chemical Engg. Thermodynamics - II

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. - III (Sem. VI) (Chem.)**

Name of the Subject :

☛ **Chemical Engg. Thermodynamics - II**

☛ Subject Code No. : **7 0 2 3** ☛ Section No. (1, 2,.....) : **1, 2**

Seat No. :

Student's Signature

(2) Answer each section in **separate** answerbook.

(3) Figures to the **right** indicate full marks.

(4) Assume suitable data wherever required.

(5) Use steam table and graph paper wherever **necessary**.

SECTION - I

1 (a) Answer the following : **1×10=10**

(1) What is residual Gibbs' free energy ?

(2) Write down Henry's law.

(3) What is ideal solution ?

(4) Give the summability relation.

(5) Which excess property gives activity coefficient ?

(6) Which extensive property do change if two pure components are mixed to form an ideal solution?

(7) All property changes of mixing are zero for ideal solution. True/False.

(8) What is Dew point and Bubble point ?

(9) Write down Gibbs-Duhem equation.

(10) Define chemical potential.

(b) Estimate the fugacity and fugacity coefficient for ethylene at 339.7 K and 1 bar using the virial coefficient correlation for ethylene : $T_c = 283.1$ K, $P_c = 51.17$ bar and W = 0.089 **6×1=6**

2 Attempt any **two** : **8×2-16**

(a) Carbon tetrachloride (1) - ethanol (2) forms an azeotrope at 760 torr where x_1=0.613 and T = 64.95^{0}C. Using the van Laur model predict the p-x-y data at 64.95^{o}C.

	A	*B*	*C*
CCl_4	6.84083	1177.91	220.576
Ethanol	8.11220	1592.864	226.184

(b) The following p-x-y data for a system is experimentally measured at 45^{0}C. Assuming that these data can be represented by van Laur equation, predict van Laur parameters. The Antoine constants of the components are given by :

Component	*A*	*B*	*C*
1	7.11714	1210.595	229.664
2	6.84083	1177.910	220.576

P(Torr)	397.77	448.88	472.84	498.07	512.32
x_1	0.2152	0.3970	0.530	0.7128	0.909
y_1	0.4495	0.5832	0.6621	0.7718	0.9141

(c) Benzene (1) and Toluene (2) form an ideal solution. The vapor pressures of benzene and toluene are adequately represented by the Antione equation. Prepare p-x-y diagram at 95^{0}C. The Antoine constants are given by :

Component	*A*	*B*	*C*
Benzene	6.87987	1196.76	219.161
Toluene	6.95087	1342.31	219.187

3 Attempt any **three** : **6×3=18**

(1) Short note on ideal gas mixture.

(2) Define partial property and derive the equations for partial molar properties for binary system.

(3) Excess Gibbs' free energy models.

(4) Fugacity and Fugacity coefficients.

SECTION - II

4 (a) Answer in brief : **10**

(i) Define reaction coordinate.

(ii) What is the criteria and chemical equilibrium ?

(iii) Define law of mass action.

(iv) Define phase rule.

(v) Define $\left(dG^t\right)_{T,\,p} = 0$

(b) Develop a relation for equilibrium constant to composition for a gas phase reaction. **6**

5 Answer any **two** of the following : **18**

(a) What is LCST and UCST in liquid-liquid equilibrium ? Explain with liquid-liquid solubility diagram.

(b) Develop relation between mole fraction (y_i) and reaction coordinate for a single reaction and multiple reaction.

(c) Estimate the standard Gibbs' free energy of formation of $CH_3OH_{(g)}$ from $\Delta G^0 f_{298}$ for $CH_3OH_{(l)}$, given that the saturation pressure of CH_3OH at 298.15° K is 0.16716 bar. Reaction is as follows :

$$C_{(s)} + 2H_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow CH_3OH_{(l)} \quad \Delta G_1^0 = -166.215\,kJ$$

$$CH_3OH_{(l)} \rightarrow CH_3OH_{(g)} \quad \Delta G_2^0 = \_\_\_\_\_$$

$$C_{(s)} + 2H_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow CH_3OH_{(g)} \quad \Delta G_1^0 = \Delta G_2^0 - 166.215\,kJ$$

6 Answer any **four** of the following : **16**

(a) Effect of temp. on the equilibrium constant.

(b) Discuss equilibrium conversion for single reaction.

(c) Multireaction equilibria.

(d) T-x-y diagram at constant pressure.

(e) P-x-y diagram at constant temperature for two partially miscible liquids.