Total No. of Questions :10]

SEAT No. :

P2899

[Total No. of Pages :4

[4958] - 1092

T.E. (Chemical Engineering)

CHEMICAL ENGINEERING THERMODYNAMICS - II

(2012 Course) (Semester - I) (309345)

Time : 2½ Hours] *[Max. Marks :70*

Instructions to the candidate:

1) ***Answer five questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicates full marks.***
4) ***Use of logarithmic tables, slide rule, Mollier Charts, Electronic pocket calculator and steam table is allowed.***
5) ***Assume suitable data, if necessary.***

Q1) a) Explain the property changes of mixing for various thermodynamic properties. **[6]**

b) Explain and derive Chemical Potential as a criterion for phase equilibrium. **[4]**

OR

Q2) a) Derive the equation for Lawis/Randall Rule. **[6]**

b) Estimate a value for the fugacity of 1Butene vapor at 200°C and 70 bar. Where, $T_r = 1.13$, $P_r = 7.74$, $\omega = 0.187$, $\varphi^{\circ} = 0.620$ and $\varphi^{1} = 1.095$. **[4]**

P.T.O.

Q3) A Vapor-liquid equilibrium data for Chloroform **[10]**

a) and 1-4 Dioxane

b) at 50°C is given below

P (kN/m^2)	15.79	17.51	18.50	19.30	19.89	21.37	24.95	29.82	34.80	42.10	60.38	65.39	69.36
X_1	0	0.093	0.125	0.176	0.200	0.263	0.361	0.475	0.555	0.672	0.878	0.940	1.00
Y_1	0	0.179	0.238	0.330	0.369	0.463	0.418	0.755	0.838	0.914	0.986	0.994	1.00

Calculate γ_1, γ_2, G^E/RT, G^E/RTx_1x_2 and plot $\ln\gamma_1$, $\ln\gamma_2$, GE/RT, G^E/RTx_1x_2 vs x_1. Find the values of $\ln\gamma_1^{\infty}, \ln\gamma_2^{\infty}$.

OR

Q4) a) Explain the procedure for bubble temperature calculations. **[5]**

b) For the binary system we have Wilsons constants A_{12}" =0.1258 & A_{21}" =0.7292

The Antonie equation is

$\ln P_1^{sat} = 16.68-(3640.2/(T - 53.54))$

$\ln P_2^{sat} = 16.29 - (3816.44/(T -46.13))$

Where T is in K and P is in kN/m^2

Assuming validity of modified Raoults Law, Calculate pressure and vapor phase composition at T = 353 K and $x_1 = 0.25$. **[5]**

Q5) a) Explain the criteria of stability. **[8]**

b) Derive Clausius Clapeyron equation. **[8]**

OR

Q6) a) Explain Osmotic pressure and derive the equation for osmotic pressure. **[8]**

b) Explain criteria of phase equilibrium at constant parameters. **[8]**

Q7) a) For the following reactions obtain the relation between mole fraction & reaction coordinate.

$CH_4 + H_2O = CO + 3H_2$

$CH_4 + 2H_2O = CO_2 + 4H_2$

Assume 2 moles of CH_4, 2 moles of H_2O and 3 moles of H_2 initially present. **[6]**

b) Derive the equation for equilibrium constant and effect of temperature on it. **[10]**

OR

Q8) a) n-Butane is isomerised to i-Butane by the action of catalyst at moderate temperature, it is found that the equilibrium is attend at the following compositions. **[8]**

Temp (k)	mole % of n-Butane
317	31.00
319	43.00

Assuming that, activities are equal to the mole function. Calculate the standard free energy of the reaction at 317 k and 319 K and average value of heat reaction over this temperature range.

b) Derive the equation for relation between composition and reaction coordinate for multireaction system. **[8]**

Q9) a) Explain and derive the relation between equilibrium constant and composition in case of gas phase reactions. **[6]**

b) Explain the Duhem's Theorem for reacting systems. **[6]**

c) Explain in detail fuel cell with its types. **[6]**

OR

Q10)a) Explain and derive the relation between equilibrium constant and composition in case of liquid phase reactions. **[6]**

b) Acetic acid is esterified in the liquid phase with ethanol at 100°C & at atmospheric pressure to produce ethyl acetate & water according to the reaction **[8]**

$$CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$$

If initially there is 1 mole of each acetic acid and ethanol. Estimate the mole fraction of ethyl acetate in the reacting mixture at equilibrium with the help of following data

Component	$\Delta H°f_{298}$ (j/mol)	$\Delta G°_{298}$ (J/mole)
CH_3COOH	-484500	-389900
C_2H_5OH	-277690	-174780
$CH_3COOC_2H_5$	-463250	-318280
H_2O	-285830	-237130

c) Explain the phase rule for reacting systems. **[4]**