(Following Paper ID and Roll No. to be filled in your Answer Books)

PAPER ID :   **Roll No.**

B.TECH.

Theory Examination (Semester-IV) 2015-16

CHEMICAL ENGINEERING THERMODYNAMICS

Time : 3 Hours   *Max. Marks : 100*

SECTION A

Q1. Attempt all question parts: (10*2=20)

a)   What is absolute temperature?

b)   When two ideal gases are mixed the change in entropy is $\Delta S = -R \sum x_i \ln x_i$. Calculate the entropy change of 1g mol of air.

c)   Write two equations of state for a real fluid.

d)   Define Helmholtz free energy.

e)   What is the criterion of equilibrium in terms of fugacity?

f)   Derive activity (a_i) of a component 'i' is equal to the product of its activity coefficient (γ_i) and mole fraction (x_i).

g)   Distinguish Positive and Negative deviations from ideality.

h)   What is the zero area method for testing the consistency of VLE data?

i)   Write a note on the choice of Standard State in the study of chemical reactions.

j) What is the effect of Pressure on the degree of conversion at equilibrium, for a gas phase reaction?

SECTION B

Q2. Attempt any FIVE question parts-   (5*10=50)

a) Explain the following

i . Work required in the case of Isothermal and Adiabatic process.

ii. Calculate the work done when 65.38 gram of zinc dissolves in HCl in a open beaker and a closed beaker at 300 K.

b) 1 kmol of methane is stored in a container of 0.12 m^3 volume. What is the pressure using

i.   Ideal gas law

ii.   Redlich-Kwong equation

iii.   Vander Waals equation.

Given Z = 0.83, P_c = 46 bar, T_c = 190 K

c)   Describe the methods used for testing the thermodynamic consistency of experimentally determined vapor-liquid equilibrium data for binary systems

d)   An experimental determination of a VLE state for Ethanol-Toluene system gave the following results;

i.   Standard V.P. at 45°C, Ethanol=l73 mmHg; Toluene=75.4mmHg

ii. $X_1 = 0.3$, $y_1 = 0.634$ and $P_\gamma = 183$ mmHg.

Calculate the liquid phase Activity coefficient. Does the liquid phase exhibit positive or negative deviation from the ideality?

e)   Calculate the equilibrium percentage conversion of nitrogen to ammonia at 700 K and a pressure of 300 atm. If the gas enters the converter with a composition of 75 mole percent H_2 and 25 mole percent N_2. The reaction is given by,

i. $l/2N_2 + 3/2H_2 \rightleftharpoons NH_3$

ii.   It may be taken that at 300 atm and 700 K,

iii. $K = 0.0091$ and $K_y = 0.72$ where K is the reaction equilibrium constant and K_y is the correction term for fugacity coeffcients.

f) Derive the first law of thermodynamics for closed system.

g) One gram mole of an ideal gas ($C_p = 7$ cal/gmol.°K) is cooled at 10 atmosphere absolute pressure from 500 K to 300 K, and then expanded isothermally to 1 atmosphere absolute pressure and 300 K. Calculate the change in entropy.

h) Discuss with an example the concept of a reversible process.

SECTION C

Attempt any two questions   (2*15=30)

Q3-

a) Prove the following:

i. $C_p - C_v = R$ for ideal gas

ii. $\{\partial T/\partial P\}_H = 0$ for ideal gas

b) Derive Maxwell relations from the fundamentals of thermodynamics.

c) Derive the coexistence equation.

Q4. 30 litres of Ethanol and 70 lit of water are mixed. One engineer says that the total volume is 100 lit. Another engineer says it is not so. Prove who is right using the following data;

i) Density of EtOH and water are 0.789 and 0.997 g/cc.

ii) Partial molar volume of EEOH and water are 53.6×10^{-3} and 18×10^{-3} lit/mol.

Q5. Two components A and B form a maximum boiling azeotrope at 90°C and 760 mm Hg. The composition of azeotrope is 60 mole % A. The vapor pressure of A and B at 90°C are 600 and 300 mm Hg respectively. Calculate the Margules constants and plot In g_A Vs. x_A.