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Total No. of Questions : 09

B.Tech.(Petroleum Refinary Engineering) (2013 Batch) (Sem.–4)

CHEMICAL ENGINEERING THERMODYNAMICS

Subject Code : BTPC-404/BTCH-305

M.Code : 72427

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Answer briefly :

a) Write the van der Waals equation of state for 5 moles of gas.

b) State 3rd law of thermodynamics. What is its significance?

c) What is throttling process? Give an example.

d) What is the significance of mollier diagram?

e) What do you understand by fugacity and activity?

f) What is chemical potential? What is its significance?

g) What are the criteria of chemical reaction equilibrium?

h) What is the effect of pressure on equilibrium constant in a gas phase reaction?

i) Write two major applications of Gibb's Duhem equation.

j) What is the physical significance of partial molar volume?

SECTION-B

2. Calculate the change in internal energy, change in enthalpy, work done and the heat supplied in process when an ideal gas is expanded from 5 bar to 4 bar isothermally at 600 K.

3. Describe Linde's cycle of liquefaction of gases.

4. Prove that the efficiency of Carnot's cycle depends only upon two extreme temperatures in which the engine works.

5. An ideal gas is compressed adiabatically from 1.5 bar, 338 K to 9 bar. The process is reversible and $\gamma = 1.23$ is constant over the entire range of conditions.

   Calculate :

   a) The temperature at the end of compression.

   b) The work of compression.

6. If the partial molar volumes of species 1 in a binary liquid solution at constant temperature and pressure is given by $\bar{V}_1 = V_1 + \alpha x_2^2$; derive the equation for $\bar{V}_2$.

SECTION-C

7. Derive an expression for fugacity coefficient of a gas obeying the equation of state $\frac{PV}{RT} = a + bP + cP^2$, where P is in bar. Determine fugacity of oxygen at 293 K and 100 bar, given that $a = 1.0$; $b = -0.753 \times 10^{-3}$ and $c = 0.15 \times 10^{-5}$.

8. The enthalpy at 300 K and 1 bar of a binary liquid mixture is

   $H = 400\ x_1 + 600\ x_2 + x_1x_2(40\ x_1 + 20\ x_2)$

   Where H is in J/mol. For the stated temperature and pressure, determine :

   a) Expressions for H_1 and H_2 in terms of x_1.

   b) Numerical values for the pure component enthalpies H_1 and H_2.

   c) Numerical values for the partial molar enthalpies at infinite dilution.

9. A mixture of 1 mol CO & 1 mol water vapour is undergoing the water-gas shift reaction at a temperature of 1100 K and a pressure of 1 bar.

   $CO\ (g) + H_2O\ (g) \rightarrow CO_2\ (g) + H_2\ (g)$

   The equilibrium constant for the reaction is K = 1. Assume that the gas mixture behaves as ideal gas. Calculate :

   a) The fractional dissociation of steam.

   b) The fractional dissociation of steam if the reactant steam is diluted with 2 mol nitrogen.

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.