B.Tech. Fourth Semester (Chemical Engineering) (CGS)

10992 : Chemical Engineering Thermodynamics-II : 4 CH 02

P. Pages : 3 | AW - 3066

Time : Three Hours | Max. Marks : 80

Notes :
1. Answer **three** question from Section A and **three** question from Section B.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and chemical equations should be given wherever necessary.
5. Illustrate your answer necessary with the help of neat sketches.
6. Discuss the reaction, mechanism wherever necessary.
7. Mobile phones are strictly prohibited.
8. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION – A

1. a) An ideal gas (1mole) is allowed to expand in a single step from an initial pressure of 10 atm and at 300 to a final state of 1 atm and 300K. The gas is compressed in a single step to bring it to the initial state. Calculate W_{exp} and W_{comp} & interpret the result. **6**

b) Define coefficient of thermal expansion (α) & compressibility (β). Derive the relation bet^n the α & β. **7**

OR

2. a) An ideal gas ($C_{pm} = 29.1 Jk^{-1}mol^{-1}$) is expanded reversibly and adiabatically from a volume of $1.43dm^3$ at a pressure of 303975 P_a and temp. 298K, until the volume is $2.86dm^3$. Calculate **7**

i) The final temp & pressure of the gas
ii) q, w, ΔE & ΔH for the process.

b) Prove that Isothermal reversible work of expansion is always greater in magnitude than that of irreversible expansion of on ideal gas. **6**

3. a) Derive the expression for Gibbs-Duhem Margules equation and explain its application in detail. **14**

OR

4. a) 100g of ethanol & methanol are mixed at 20°C to prepare an ideal mixture the vapour pressure of the pure methanol is 88.7mm and that of ethanol is 44.5mm at 20°C. Calculate **6**

i) The vapour pressure of solution
ii) The partial vapour pressure of ethanol & methanol in solution
iii) The vapour phase composition.

b) Calculate the enthalpy, entropy and free-energy of mixing of one mole toluene and two moles of benzene at 25°C. **4**

c) Calculate the fugacity of ammonia at 50atm and 298K, given that the gas obeys the equation of state $P(V_m - b) = RT$, and $b = 0.037\,dm^3 mol^{-1}$. 4

5. a) Two g of cytochrome $(M_2 = 12400)$ is dissolved in 100g of water at 25°C. Calculate the freezing point depression, boiling point elevation, lowering of vapour pressure and osmotic pressure of the solution at 25°C. ($K_f = 1.86$, $K_b = 0.52$, vapour pressure of water at 25°C = 24mm Hg) 6

b) Calculate the osmotic pressure of an aqueous solution containg 2g of protein $(M_2 = 69000\,g\,mol^{-1})$ per 100ml at 27°C 7

i) in centimeters of mercury
ii) in centimeters of water

(Take density of solution = $1g/cm^3$ and 1 atm = 1013250 dync cm^{-2})

OR

6. a) Prove that the Freezing point depression is an colligative properties. 7

b) Calculate the mass of methyl alcohol which when dissolved in 100g of water, would just prevent the formation of ice at $-10°C$, (k_f of water is $1.86\,K\,molal^{-1}$) 6

SECTION – B

7. a) State the Gibbs-phase rule and explain the meaning of the terms and symbol used. 6

b) Derive the conditions of thermal, mechanical and chemical equilibria for a two-phase system. 7

OR

8. a) Construct a phase diagram for water showing the three phases. 7

b) Explain in detail the term critical solution temperature (CST) & state the effect of impurity of CST. 6

9. a) Define the term statical thermodynamic & explain the quantum mechanical aspect of thermodynamics in detail. 7

b) What is the probability that 2 moles of water originally at 50°C will spontaneously separate into 1 mole water at 49°C & 1 mole water at 51°C ($C_{pm} = 75\,J\,k^{-1}mol^{-1}$). 7

OR

10. a) Explain and illustrate the following terms: 4

i) Assembly ii) Ensemble
iii) Configuration iv) Probability

b) Define thermodynamic probability & derive the expression for thermodynamic probability. 5

c) 10 molecules of a gas are present in a container maintained at 298K. What is the probability that all ten molecules will be found simultaneously in one half of the container? 5

11. a) Derive the expression for chemical affinity (A_f) and explain how it is useful to decide the feasibility of the chemical reaction. 7

b) The equilibrium constant for the reaction $A \rightleftharpoons M$ is 0.10 at 300K calculate 6

a) ΔG and

b) $\Delta G°$ for the production of 1mole of M at a pressure of 1 atm from A at a pressure of 20 atm.

c) Predict the nature of the reaction under the latter conditions.

OR

12. a) For the reaction represented by $SO_2(g) + H_2O_2(g) \rightarrow SO_3(g)$, $k_p = 1.7 \times 10^{12}$ at 300K. Calculate k_p for the following reactions at 300K. 6

i) $SO_3(g) \rightarrow SO_2(g) + H_2O_2(g)$

ii) $2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$

iii) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

b) 3.176 g of N_2O_4 when take in a 1 lit vessel at 25°C gives a total pressure of 760 torr on dissociation. Calculate the degree of dissociation α, and equilibrium constant k_p. What would be the value of α, if the total pressure is only 0.5atm? 7

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