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Roll No .....

CM-501 (GS)

B.E. V Semester Examination, June 2020

Grading System (GS)

Advanced Chemical Engineering Thermodynamics

Time : Three Hours

Maximum Marks : 70

Note : i) Attempt any five questions.
ii) All questions carry equal marks.

1. Explain how Debye and Huckel derive an expression that allows calculation of activity coefficients. Calculate the activity coefficients for K+ and SO_4^{2-} in a 0.20m solution of K_2SO_4. Assume α_{K+}=0.3nm and α_{SO4} = 4.0nm.

2. When 25 g of Naphthalene ($C_{10}H_8$, M=128) is placed in 500 g of benzene (K_f = 5.12 °C/m. T_{fo} = 5.5 °C), the freezing point of the solution is 3.9 °C. What is the activity coefficient of naphthalene in this solution?

3. Use the Van't Hoff equation for the temperature dependence of the equilibrium constant to estimate the equilibrium constant for the following reaction at 700 K I_2 (*gas*) $\rightarrow$ 2*I* (*gas*)

   Assume that ΔH_{rxn}^{Θ} for this process is independent of temperature.

   Data: $\Delta H_f^{\Theta}(I.gas) = 106.8\frac{kJ}{mol}, \Delta H_f^{\Theta}(I_2.gas) = 62.4\frac{kJ}{mol}$

4. Define grand canonical ensemble and statistical ensemble.

5. Define Gibbs energy of reaction. Explain by van't Hoff equation how the temperature variation of the equilibrium constant K(T) can be related to the enthalpy of reaction.

6. Derive expression for free energy change of mixing in terms of activity.

   OR

   A container is divided into two equal compartments, one containing 3.0 mol H_2 and the other 1.0 mol N_2 both at 25°C. Calculate the Gibbs energy of mixing when the partition is removed.

7. What is significance of thermodynamics in chemical engineering field?

   OR

   Calculate the fugacity and the fugacity coefficient of steam at 2 MPa and 500 C.

8. Answer any two of the following:
   a) Explain the concept of fugacity and how fugacity and fugacity coefficients are utilized in gas-phase reactions.
   b) What is a Barotropic effect?
   c) Explain the Conditions for Highest COP.
   d) What is the physical significance of chemical potential?

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