GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (NEW) – • EXAMINATION – SUMMER 2016 t Code : 2721604 Date: 31/05/ 2016

Subject Code : 2721604

Subject Name: Property Prediction of Mixtures

Time: 10:30 am to 01:00 pm

Total Marks: 70

- Instructions: 1. Attempt all questions.
 - 2. Make suitable assumptions wherever necessary.
 - 3. Figures to the right indicate full marks.
- Q.1 (a) Explain the concept of Hypothetical Ideal Gas State. Hence, derive the 07 generalized equations for the calculations of $\Delta H'_{T'P}$ or $\Delta S'_{T'P}$ in terms of reduced parameters using equation of state PV = ZRT.
- Q-1 (b) Derive any one of the Maxwelløs Relationship by using two different approaches 07 / methods.
- Q.2 (a) Starting with following two equations;

$$\mathbf{T} \cdot \mathbf{ds} = \mathbf{C}\mathbf{p} \cdot \mathbf{dT} - \mathbf{T}\frac{\delta \mathbf{V}}{\delta \mathbf{T}} \bigg|_{\mathbf{P}} \mathbf{dP} \text{ and } \mathbf{T} \cdot \mathbf{ds} = \mathbf{C}\mathbf{v} \cdot \mathbf{dT} + \mathbf{T}\frac{\delta \mathbf{P}}{\delta \mathbf{T}} \bigg|_{\mathbf{V}} \mathbf{dV}$$

Prove the following equation:

$$Cp \circ Cv = \circ T \left(\frac{\delta V}{\delta T}\right)_{P}^{2} \cdot \left(\frac{\delta p}{\delta v}\right)_{T}$$

Q-2 (b) Starting from the first principles, derive following property Equations:

(i)
$$\frac{\partial C_{P}}{\partial P} = -T \frac{\partial^{2} V}{\partial T^{2}} \Big|_{P} \& \frac{\partial C_{V}}{\partial V} = T \frac{\partial^{2} P}{\partial T^{2}} \Big|_{V}$$

(ii) $dH = C_{P} \cdot dT + \left[V - T \frac{\partial V}{\partial T} \right]_{P} dP$
OR

Q-2 (b) Starting from first principles, derive following property equations:

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(i)
$$\frac{C_{v}}{T} \cdot \frac{\partial T}{\partial P} \Big|_{v} \cdot dP + \frac{Cp}{T} \cdot \frac{\partial T}{\partial V} \Big|_{p} \cdot dV$$

(ii) $Cp = \frac{[-V]}{\left[\frac{\partial T}{\partial P}\right]_{H} - \frac{\partial T}{\partial P} \Big|_{s}}$

- Q.3 (a) Explain concept of Partial Molal Quantities (PMQ) with special reference to 07 energy function ó Enthalpy (H).
 - (b) Discuss various methods for determination of critical properties of a pure 07 component.

OR

- Q.3 (a) Evaluation of temperature effect on enthalpy under isobaric conditions (ΔH) 07 using three different methods.
 - (b) Describe different techniques for estimation of pure liquid densities.
- Q.4 (a) Outline stepwise procedure in detail with relevant equations for calculations of 07 H and S at any temperature (T) and any pressure (P) under ideal gas conditions.

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Q-4 (b) A wild gasoline contains 15% CH₄, 10% C₂H₆, 30% C₃H₈, 5% i-C₄H₁₀, 07 10% C₄H₁₀, 15% C₅H₁₂ and 15% C₆H₁₂⁺(heavier) as feed. Vaporization is carried out at 232 psia (15.78 atm) and 50 °C. What is the composition of residue gasoline and that of the gas that is vaporized ? Also show that $\left(\frac{V}{L}\right)$ ratio of 0.429 is the suitable ratio.

Use following data of vapor pressures at 50 °C for different components: i-C₄H₁₀, Component CH₄, C_2H_6 , C_3H_8 , C_4H_{10} , C_5H_{12} , $C_6H_{14}^+$ 4100, V.P. (psia) 750, 194, 78, 56, 19, 04 OR

- Q.4 (a) Discuss estimation technique of low pressure gas viscosity based on Chapman- 07 Enskog theory.
 - (b) Estimate the viscosity of SO₂ gas at atmospheric pressure and 300° C using 07 Chung et al method. Take Tc= 430.8 K, Vc= 122 cm³/mol , ω =0.256, M = 64.063 , Dipole moment=1.6 debyes , Assume κ = 0
 - Q.5 (a) Using concept of Hypothetically Ideal Component (Carlson and Coulburn 07 Method) how constants of Van Laarøs Equations could be determined conveniently?
 - (b) A ternary mixture containing molar 10% propane, 65%, n-butane and 25% npentane is vaporized at t=5°c and P=600 mmHg. The value of equilibrium constants for phase equilibrium are K_1 =6.34, K_2 =1.37 and K_3 =0.32 respectively. Show that the degree of vaporization (e) is 0.665.

OR

- Q.5 (a) Enlist various methods to calculate thermal conductivity of pure liquids and 07 discuss any one in detail.
 - (b) Discuss different methods for determination of surface tension of pure liquid. 07
