**Seat No.: _____** **Enrolment No._____**

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2017**

**Subject Code: 2163508** **Date: 03/05/2017**

**Subject Name: Basics of Thermodynamics & Kinetics**

**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.**

| | | | MARKS |
|---|---|---|---|
| **Q.1** | | **Short Questions** | 14 |
| | **1** | At a inversion temperature, the joule-thomson coefficient is<br>(a) Zero (b) positive<br>(c) negative (d) infinite | 01 |
| | **2** | Pure component molar volume is equal to partial molar volume in a binary mixture<br>(a) always false (b) always true<br>(c) true only for a mixture of ideal gases (d) cannot say | 01 |
| | **3** | A larger positive value of $\Delta G^0$ corresponds to which of these<br>(a) small positive K (b) large positive K<br>(c) small negative K (d) Large negative K | 01 |
| | **4** | The partial molar volume of a species in a liquid mixture becomes nearly equal to its pure component molar volume when the mole fraction($x_i$) of the species in the mixture<br>(a) $x_i \rightarrow 0$ (b) $x_i \rightarrow 1$<br>(c) $x_i \rightarrow$ infinity (d) cannot be predicted | 01 |
| | **5** | Chemical potential<br>(a) is an intensive property (b) is a force which drives the chemical system to equilibrium<br>(c) of a substance is equal to its partial molar properties (d) All of these | 01 |
| | **6** | Activity coefficient is measure of | 01 |

(a) Departure of a liquid from the ideal solution behavior
(b) Departure of gas phase from ideal law
(c) Tendency of a gas to achieve behaviour
(d) None of these

**7** During phase change which of the following state variable is continuous and remains unchanged at the transition point **01**

(a) Specific enthalpy
(b) Specific entropy
(c) Specific Gibbs free energy
(d) Molar volume

**8** The activity coefficient of benzene in benzene and toluene mixture can be assume to be equal to **01**

(a) Vapour pressure of benzene
(b) Critical temperature of benzene
(c) Mole fraction of benzene in the mixture
(d) unity

**9** For an ideal solution, which of the following equation(s) is not true **01**

(a) partial molar enthalpy of a species is equal to its pure molar enthalpy
(b) partial molar entropy of a species is equal to its pure molar entropy
(c) chemical potential of a species is equal to its pure molar gibbs free energy
(d) None of the above

**10** The molar extend of reaction is **01**

(a) Always greater than unity
(b) Always less than unity
(c) Can be greater than, equal to, or less than unity, depending on the reaction stochiometry
(d) None of these

**11** For an ideal gas mixture undergoing a reversible gaseous phase chemical reaction, the equilibrium constant **01**

(a) Is independent of pressure
(b) Increases with pressure
(c) Decreases with pressure
(d) Increase/decreases with pressure depending on the stochiometry coefficient of the reaction

**12** For a reversible exothermic gas phase reaction, $A + B \leftrightarrow C$, the equilibrium conversion will increase with **01**

(a) Increase in pressure and increase in temperature

(b) Decrease in pressure and increase in temperature

(c) Increase in pressure and decrease in temperature

(d) Decrease in pressure and decrease in temperature

**13** With dilute aqueous solution of two salts are mixed, the process is associated with **01**

(a) Decrease in temperature

(b) Increase in temperature

(c) No change in temperature

(d) Change in temperature which is a function of composition

**14** The Maxwell relation derived from the differential expression for the Helmholtz free energy is **01**

(a) $\left(\frac{\partial T}{\partial V}\right)_s = -\left(\frac{\partial P}{\partial S}\right)_V$

(b) $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$

(c) $\left(\frac{\partial T}{\partial P}\right)_s = -\left(\frac{\partial V}{\partial S}\right)_P$

(d) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

**Q.2** **(a)** Define (1) fugacity (2) fugacity coefficient (3) activity **03**

**(b)** Show that for ideal gas $C_p$-$C_v$ = R **04**

**(c)** Show that fugacity of a gas obeying the van der waals equation of state is given by **07**

$$\ln f = \frac{b}{v-b} - \frac{2a}{RTV} + ln\frac{RT}{V-b}$$

**OR**

**(c)** The equation of state of a certain substance is given by the expression $V = \frac{RT}{P} - \frac{C}{T^3}$ and the specific heat is given by the relation Cp = A + BT where A, B and C are constant. Derive expressions for change in internal energy, enthalpy and entropy for (i) An isothermal process (ii) An isobaric process **07**

**Q.3** **(a)** Define : (i) Henry law , (ii) Raoult' law , (iii) Henry' law **03**

**(b)** Write short note on effect of temperature on chemical potential **04**

**(c)** The volume of an aqueous solution of NaCl at 298 K was measured for a series of molalities(moles of solute per kg of solvent) and it was found that the volume varies with molality according to the following expression. **07**

$V = a + b\,m + c\,m^{1.5} + d\,m^2$ , where m is the volatility and a = 1.003 x $10^{-3}$ , b = 0.1662 x $10^{-4}$ , c = 0.177 x $10^{-5}$, d = 0.12 x $10^{-6}$, and V is in $m^3$. Calculate the partial molar volumes of the components at m = 0.1 mol/kg.

**OR**

**Q.3** **(a)** Write Gibbs-Duhem equations in terms of (i) fugacity (ii) activity (iii) activity coefficient **03**

**(b)** Write short note on effect of pressure on activity coefficient **04**

**(c)** Prove that if Henry's law is obeyed by component 1 in a binary system over certain concentration range , Lewis-Randall rule( Raoult's law) will be obeyed by component 2 over the same concentration range. **07**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Write down assumptions of Raolut's Law. | **03** |
| | **(b)** | An equimolar solution of benzene and toluene is totally evaporated at a constant temperature of 363 K. At this temperature, the vapour pressures of benzene and toluene are 135.4 and 54 kPa respectively. What are the pressure at the beginning and at the end of the vapourization. | **04** |
| | **(c)** | Derive van't Hoff equation | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Draw T-x-y and P-x-y diagram for binary ideal solution. | **03** |
| | **(b)** | Write a short note on determination of partial molar properties by graphical menthod. | **04** |
| | **(c)** | A compound M polymeries in the gas phase at low pressure to $M_n$ , where n > 1. (i) show that the mole fraction of the polymer at equilibrium increases with increase in pressure at constant temperature (ii) the mole fraction of the polymer in the equilibrium mixture at 300 K is 0.15 at 1 bar and 0.367 at 2 bar. Find the value of n. | **07** |
| **Q.5** | **(a)** | Differentiate Elementary and non-Elementary reactions | **03** |
| | **(b)** | Compare Integral method of analysis with differential method of analysis | **04** |
| | **(c)** | The rate of bimolecular reaction at 500 K is 10 times the rate at 400 K. Calculate the activation energy of reaction by Arrhenius law and collision theory | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Differentiate between Homogeneous reaction and Heterogeneous reaction | **03** |
| | **(b)** | Discuss various forms of rate equation. Also explain variables affecting rate of reaction | **04** |
| | **(c)** | On doubling the concentration of the reactants, the rate of reaction increase four times. Find the order of reaction | **07** |

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