Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– VI • EXAMINATION – SUMMER 2016

Subject Code: 2163508 Date:11-05-2016

Subject Name: Basics of Thermodynamics and Kinetics

Time: 10:30 AM to 1:00 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)**	Show that the Joule-Thomson coefficient is zero for ideal gases.	**07**
	(b)	Derive the mathematical expression for the effect of volume and pressure on C_p and C_v.	**07**
Q.2	**(a)**	At 300 K and 1 bar, the volumetric data for a liquid mixture of benzene and cyclohexane are represented by $V = 109.4 \times 10^{-6} - 16.8 \times 10^{-6} X - 2.64 \times 10^{-6} X^2$,where X is the mole fraction of benzene and V has the units of m^3/mol. find expression for the partial molar volume of benzene and cyclohexane.	**07**
	(b)	Show that the rate of change of chemical potential of a substance with pressure is equal to its partial molar volume in the solution.	**07**
		OR	
	(b)	Derive Lewis-Randall rule	**07**
Q.3	**(a)**	Derive phase rule for non reactive systems	**07**
	(b)	Deduce the Clapeyron equation using the criteria of equilibrium.	**07**
		OR	
Q.3	**(a)**	Write a note on P-x,y diagram for binary system.	**07**
	(b)	The vapour pressures of acetone (1) and acetonitrile (2) can be evaluated by the Antoine equation $\ln P_1^s = 14.5463 - \frac{2940.46}{T - 35.93}$, $\ln P_1^s = 14.2724 - \frac{2945.47}{T - 49.15}$ Where T is K and P is in kPa. Assuming that the solution formed by these are ideal, calculate (a) T and y_1 at 65 kPa and $x_1 = 0.4$ (b) P and y_1 at 327 K and $x_1 = 0.4$	**07**
Q.4	**(a)**	Write a short note on Arrhenius' law.	**07**
	(b)	State the various methods of analysis of kinetic data and explain any one of them in brief	**07**
		OR	
Q.4	**(a)**	Differentiate between (1) single reaction and multiple reaction (2) elementary and non elementary reaction	**07**
	(b)	In the synthesis of ammonia , stoichiometric amounts of nitrogen and hydrogen are sent to a reactor where the following reaction occurs $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ The equilibrium constant for the reaction at 675 K may be taken equal to 2×10^{-4}. (1) Determine the per cent conversion of nitrogen to ammonia at 675 K and 20 bar. (2) What would be the conversion at 675 K and 200 bar?	**07**

Q.5 **(a)** A gas mixture containing 2 moles nitrogen , 7 moles hydrogen and 1 mol ammonia initially, is undergoing the following reaction **07**

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$$

(1) Derive expression for the mole fraction of various components in the reaction mixture in terms of the extent of reaction

(2) Explain how the conversion of limiting reactant is related to the extent of reaction.

(b) Derive from first principle $G^0 = -RT \ln K$. **07**

OR

Q.5 **(a)** The standard heat of formation and standard free energy of formation of ammonia at 298 K are -46,000 J/mol and -16,500 J/mol respectively. Calculate the equilibrium constant for the reaction. **07**

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$$

At 500 K assuming that the standard heat of reaction is constant in the temperature range 298 K to 500 K.

(b) Discuss the criteria of chemical reaction equilibria. **07**

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