GUJARAT TECHNOLOGICAL UNIVERSITY BE – SEMESTER – VI (NEW).EXAMINATION – WINTER 2016

Subject Code: 2163611Date: 25/10/2016Subject Name: Chemical Engineering Thermodynamics & KineticsTime: 10:30 AM to 01:00 PMInstructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- **3.** Figures to the right indicate full marks.

Q.1(a) i.Write a short note on thermodynamic properties of a system04ii.Explain thermodynamic characteristics of an ideal gas?03(b) i.Differentiate reversible and irreversible process.03

- (b) i. Differentiate reversible and irreversible process.
 ii. Derive the expression for work done by a gas in an isothermal process.
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- Q.2 (a) State first law of thermodynamics. Starting from fundamentals derive a 07 mathematical expression of the first law of thermodynamics for a steady state flow process.
 - (b) A balloon which was initially empty is filled with hydrogen. The atmospheric 07 pressure is 1.01325 bar. Estimate the work done by balloon cylinder system when the balloon attains a spherical shape of 6 m in diameter.

OR

- (b) Write about i) Phase ii) Internal Energy iii) Reversible process iv) Joule 07 Thomson coefficient v) Compressibility factor vi) Entropy vii) Work function
- Q.3 (a) Explain second law of thermodynamics? Prove that violation of Kelvin Plank 07 statement results in the violation of Clausius statement
 - (b) Calculate the pressure developed by 1 kmol of ammonia gas contained in a 07 vessel of 0.6m³ volume at a constant pressure of 200 °C by using
 - i. Ideal gas equation
 - ii. Van der Waals Equation. Van der Waals constants a and b are 0.4233 Nm^4/mol^2 and $3.73 \times 10^{-5} m^3/mol$ respectively

OR

- **Q.3** (a) Describe the classification of thermodynamic properties?
 - (**b**) Establish the following Maxwell's relations

$$\frac{\partial T}{\partial V}\Big|_{S} = -\left[\frac{\partial P}{\partial S}\right]_{V} \left[\frac{\partial T}{\partial P}\right]_{S} = \left[\frac{\partial V}{\partial S}\right]_{P}$$

- Q.4 (a) Write a short note on Partial molar Properties.
 - (b) Laboratory alcohol containing 96% alcohol and 4% water is to be diluted to a solution containing 56% alcohol and 44% water. All percentages are on a weight basis. The partial specific volumes are as follows: In 96% alcohol solution $\bar{V}_W = 0.816 \times 10^{-3} \text{ m}^3/\text{kg}$ $\bar{V}_E = 1.273 \times 10^{-3} \text{ m}^3/\text{kg}$. In 56% alcohol solution $\bar{V}_W = 0.953 \times 10^{-3} \text{ m}^3/\text{kg}$ $\bar{V}_E = 1.243 \times 10^{-3} \text{ m}^3/\text{kg}$. The density of water can be taken as $0.997 \times 10^3 \text{ kg/m}^3$. How much water is to be added to $2 \times 10^3 \text{ m}^3$ of laboratory alcohol.

OR

(a) What is Clapeyron Equation? How criterion of equilibrium is used in the 07 derivation of Clapeyorn Equation?

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- (b) A container is divided into two compartments. One contains 3 moles of Hydrogen at 298 K and 1 bar and other contain 1 mole of nitrogen at 298 K and 3 bar. Calculate the free energy of mixing when the partition is removed.
- Q.5 (a) Describe an ideal solution and classification of solutions based on their non 07 idealities.
 - (b) Liquid A and B form an azeotrope containing 46.1 mole% A at 101.3kPa and 07 345 K. At this temperature vapor pressure of A is 84.4 kPa and that of B is 78.2 kPa. Calculate Van laar constants

OR

- Q.5 (a) How criteria of Chemical Reaction Equilibrium is used in the estimation of free 07 energy change of a reaction?
 - (b) Calculate the equilibrium constant at 298 K of the reaction 07

$N_2O_4(g) \rightarrow 2NO_2(g)$

Given the standard free energy change of formation at 298 K are 97540 J/mol for N_2O_4 and 51,350 J/mol for NO_2
