

GUJARAT TECHNOLOGICAL UNIVERSITY
BE III SEMESTER VI – EXAMINATION – SUMMER 2016

Subject Code: 2163611**Date: 11/5/2016****Subject Name: Chemical Engineering Thermodynamics & Kinetics****Time: 10.30 AM to 1.00 PM****Total Marks: 70****Instructions:**

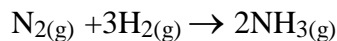
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Starting from fundamentals, Derive a mathematical expression of the first law of thermodynamics for a steady state flow process. **07**
- (b) Nitrogen gas is confined in a cylinder and the pressure of the gas is maintained by a weight placed on the piston. The mass of the piston and the weight together is 50 kg. The acceleration due to gravity is 9.81 m/s^2 and the atmospheric pressure is 1.01325 bar. Assume frictionless piston. Determine:
- i) The force exerted by the atmosphere, the piston and the weight on the gas if the piston is 100 mm in diameter. **07**
 - ii) The pressure on the gas.
 - iii) If the gas is allowed to expand pushing up the piston and the weight by 400 mm, what is the work done by the gas in kJ?
- Q.2** (a) Differentiate with suitable examples
- (1) State function vs. path function **03**
 - (2) Intensive property vs. extensive property **04**
- (b) Derive Constant T_c , P_c , and V_c , in terms of a & b in Van Der Waal's Equation of State. **07**
- OR**
- (b) One kilo mol CO_2 occupies a volume of 0.381 m^3 at 313°K . Compare the pressures given by a). Ideal gas equation b). van der Waals equation. Take the van der Waals constants to be $a = 0.365 \text{ Nm}^4/\text{mol}^2$ and $b = 4.28 \times 10^{-5} \text{ m}^3/\text{mol}$. **07**
- Q.3** (a) Write the various representational forms of second law of thermodynamics establishing the equivalency of Kelvin and Clausius Statements. **07**
- (b) Oil at 500 K is to be cooled at a rate of 5000Kg/h in a counter- current exchanger using cold water available at 295 K. A temperature approach of 10 K is to be maintained at both ends of the exchanger. The specific heats of oil and water are respectively 3.2 and 4.2 KJ/Kg K. Determine the total entropy change in the process. **07**
- OR**
- Q.3** (a) Describe the various thermodynamic diagrams. **03**
- (b) a) Explain the characteristics of an ideal solution? **03**
 b) Explain $P - x - y$ diagram. **04**
- Q.4** (a) Write a short note on the classification of thermodynamic properties. **07**
- (b) Establish the following Maxwell's relations **07**
- $$\left[\frac{\partial T}{\partial V} \right]_S = - \left[\frac{\partial P}{\partial S} \right]_V \quad \left[\frac{\partial S}{\partial V} \right]_T = \left[\frac{\partial P}{\partial T} \right]_V$$
- OR**
- Q.4** (a) Explain the significance of Clapeyron and Clausius Clapeyron Equations **07**

- (b) A 30% by mole methanol – water solution is to be prepared. How many cubic meters of pure methanol (molar volume $40.727 \times 10^{-6} \text{ m}^3/\text{mol}$) and pure water (molar volume $18.068 \times 10^{-6} \text{ m}^3/\text{mol}$) are to be mixed to prepare 2 m^3 of desired solution? The partial molar volume of methanol in water in a 30% solution are $38.632 \times 10^{-6} \text{ m}^3/\text{mol}$ and $17.765 \times 10^{-6} \text{ m}^3/\text{mol}$ respectively. **07**

Q.5 (a) Derive the criteria for chemical reaction equilibrium for the reaction represented by the scheme $aA + bB \rightarrow lL + mM$ **07**

- (b) The standard heat of formation and standard free energy of formation of ammonia at 298 K are -46100 J/mol and -16500 J/mol respectively. Calculate the equilibrium constant for the reaction **07**



at 500 K assuming standard heat of reaction constant in the temperature range 298 to 500 K.

OR

Q.5 (a) Express the relationship between Equilibrium constant relating to partial pressure and concentration. **07**

- (b) Discuss the effect of temperature and pressure on Equilibrium. **07**
