Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2015

Subject Code:2140502 **Date: 01/06/2015**

Subject Name: Chemical Engineering Thermodynamics-I

Time: 10:30am-1.00pm **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)** Discuss the important properties of a refrigerant. **07**

(b) Show the relation between temperature, pressure and volume in case of reversible adiabatic process for an ideal gas. **07**

Q.2 **(a)** Define extensive and intensive properties. State whether the following properties are extensive or intensive: (a) density, (b) volume, (c) specific volume, (d) heat capacity, (e) specific heat, (f) potential energy, (g) pressure, (h) temperature. **07**

(b) Discuss strength and limitations of thermodynamics in chemical engineering. **07**

OR

(b) A vapour-compression cycle using ammonia as refrigerant is employed in an ice manufacturing plant. Cooling water at 288 K enters the condenser at a rate of 0.25 kg/s and leaves at 300 K. Ammonia at 294 K condenses at a rate of 0.5 kg/minute. Enthalpy of liquid ammonia at 294 K is 281.5 kj/kg. The compressor efficiency is 90%. Saturated ammonia vapour at 258 K and enthalpy of 1426 kj/kg enters the compressor. What is the power requirement of the compressor and refrigeration capacity in tons? **07**

Q.3 **(a)** Explain about principle of corresponding states. **07**

(b) Explain Cubic equations of state and derive expressions of constants 'a' and 'b' of Vanderwaal's EOS in terms of critical properties of a substance. **07**

OR

Q.3 **(a)** Discuss PVT behavior of pure substances. **07**

(b) Reported values for the virial coefficients of isoproponal vapor at 200 ^{0}C are: B = - 388 cm^3 / mol and C = - 26000 cm^6 / mol^2. Calculate V and Z for isoproponal vapor at 200 ^{0}C and 10 bar by the following equations. **07**

(i) Ideal gas equation (ii) the truncated virial equation of state considering three terms on right hand side.

Q.4 **(a)** (i) Write down the equation for prediction of the heat of vaporization at normal boiling point. **04**

(ii) Define the standard heat of reaction and the standard heat of combustion.

(b) Ammonia is synthesized according to the following reaction: **10**

$0.5\ N_2 + 1.5H_2 = NH_3$; $\Delta H^o_{298} = 46.222$ kJ

The specific heats of the components are represented by $C_p = a + bT + cT^2$

Where C_p is in J/mol K and constants a, b and c are :

Component	a	b	c
N_2	27.31	5.2335×10^{-3}	-4.1868×10^{-9}
H_2	29.09	-8.374×10^{-4}	2.0139×10^{-6}
NH_3	25.48	36.89×10^{-3}	-6.305×10^{-6}

Express the heat of reaction as function of temperature.

OR

Q.4 **(a)** State mathematically the principle of the increase in entropy and hence show that "the entropy of the universe is increasing". **07**

(b) A block of copper at a temperature of 825 K and weighting 5 kg is dropped into 50 kg water at 300 K. If there are no heat losses what is the change in entropy of (a) copper, (b) water, and (c) copper and water both considered together? Cp of copper is 0.4 kJ/kg K and that of water is 4.2 kJ/kg K. **07**

Q.5 **(a)** Discuss about thermodynamic diagrams. **04**

(b) Using Maxwell's equation prove that : **10**

$dH = CpdT + V(1 - \beta T)dP$

$dS = CpdT/T - \beta VdP$

Where β = Volume expansivity

OR

Q.5 **(a)** Discuss the Linde process for gas liquefaction. **07**

(b) Write short note on Multistage compression. **07**

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