(3 Hours) **[Total Marks: 80]**

Note:

1. Question number one is compulsory
2. Attempt any three of the remaining Questions
3. Each question carries equal marks
4. Figures to the right indicate marks
5. Make suitable assumptions when required and specify them.

Q1 Answer the Following (Attempt any four) **20**

(a) Explain principle of corresponding states

(b) Explain how fugacity of pure gas is calculated using compressibility factor

(c) What is the limitation of first law of thermodynamics? Explain Zeroth law

(d) Calculate the minimum work required to chill 2 kg of water from 25°C to 5°C.Derive the equation used Cp=4184 J/kg K

(e) Explain Open, Closed and Isolated System

Q2 (a) Derive expression for Lewis-Randall Rule. Under which conditions is it valid **10**

(b) Using Redlich – Kwong equation, calculate the pressure of 0.5 kg gaseous ammonia contained in a vessel of 0.03 m3 at constant temperature of 338 K. The critical temperature and pressure is 405.5 K & 112.8 bar respectively **10**

Q3 (a) Explain how Clausius- Clapeyron equation can be used to calculate the latent heat accompanying phase Change **10**

(b) Heat is transferred to 10 kg of air which is initially at 100 kPa and 300 K until its temperature reaches 600 K. Determine the change in internal energy, change in enthalpy, the heat supplied and the work done in the following process **10**

i. Constant volume process

ii. Constant Pressure Process

Q4 (a) Show that a gas obeying Vander Waals equation, a change in temperature is given by $dT = \frac{1}{Cp}\left(\frac{2a}{RT} - b\right) dp$ If gas undergoes Joule Thomson expansion **15**

(b) What is chemical potential? Effect of temperature and pressure on it **5**

Q5 (a) Explain any two types of Thermodynamic diagrams **10**

(b) Prove that $Cp - Cv = \frac{\beta^2 VT}{k}$ **10**

Q6 (a) Explain the terms **10**

i. Fugacity

ii. Fugacity Coefficient

iii. Activity

iv. Activity coefficient

v. Gibbs free energy

(b) A gas mixture containing 3 mole CO_2, 5 mole H_2 and 1 mole of H_2O is undergoing following reaction **10**

i. $CO_2 + 3H_2 \longrightarrow CH_3OH + H_2O$

ii. $CO_2 + H_2 \longrightarrow CO + H_2O$

Develop the expression for mole fraction of species in terms of extent of reaction

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