BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: IMSC **SEMESTER: II**
BRANCH: CHEMISTRY **SESSION: SP/2019**

SUBJECT: CH107 PHYSICAL CHEMISTRY II (CHEMICAL THERMODYNAMICS & ITS APPLICATIONS)

TIME: 2 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates may attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.

Q1 (a) State 1st law of thermodynamics and derive the internal energy function from it. [2]

(b) 5 mole of an ideal gas at 300 K and 10 bar expands isothermally against a constant pressure of 1 bar. Find out the values of W, Q, ΔU and ΔH. [3]
What would be the values of W and ΔH if same state change occurs isothermally and reversibly?

Q2 (a) Show that Joule-Thomson experiment is an isoenthalpic process. [2]

(b) For the reaction [3]

$$H_2O\ (g) \longrightarrow H_2\ (g) + \frac{1}{2}O_2\ (g)$$

ΔH° = 242 kJ/mol at 290 K. Find ΔH° at 310 K.
Assume C_P values remains constant over the temperature range and are given by C_P (H_2O, g) = 35.5; C_P (H_2, g) = 28.8 and C_P (O_2, g) = 29.1 all in units of J/K/mol

Q3 (a) Show that a cyclic process must consist of isothermal and adiabatic processes to produce net work in the surrounding. [2]

(b) Calculate the entropy change of 5 mol of water for the following changes [3]

$$H_2O\ (\text{liq, } 110\ ^oC) \longrightarrow H_2O\ (\text{vapor, } 110\ ^oC)$$

(Given, $C_{P,\text{liq}}$ = 75.291 J/K/mol, $C_{P,\text{ vap}}$ = 33.57 J/K/mol and heat of vaporization is 40.69 kJ/mol)

Q4 (a) What is Clausius inequality and proves it. [2]

(b) Proves that, [3]

$$\left[\frac{d(\Delta G/T)}{dT}\right]_P = -\frac{\Delta H}{T^2}$$

Q5 (a) Isothermal free expansion of an ideal gas must be adiabatic- Justify or criticize. [2]

(b) Prove that $\left(\frac{dS}{dV}\right)_T = \frac{\alpha}{\beta}$ where α is the coefficient of expansion and β is the coefficient of compressibility. [3]

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