



Indian Association for the Cultivation of Science
(Deemed to be University under *de novo* Category)
Integrated Bachelor's-Master's Program
Mid-Semester Examination-Autumn 2023

Subject: Energetics and Bonding
Full Marks: 25

Subject Code(s): CHS1101
Time Allotted: 2 hrs

Answer all questions
All questions carry equal marks

1. (a) Establish the thermodynamic equation of state from the two laws of thermodynamics.
(b) Show that for a van der Waals gas $\frac{\partial E}{\partial V} = a/V^2$ at constant T.
2. One mole of a van der Waals gas at a temperature T expands isothermally and reversibly from the volume V_1 to V_2 . For the given values of van der Waals gas constants 'a' and 'b' calculate q, ΔE and ΔH
3. (a) Express the change in entropy of a thermodynamic system as a function of temperature and pressure.
(b) Calculate the change in entropy of a liquid having molar volume 100 cc when the pressure is increased by 1 atm at a constant temperature. Given the coefficient of thermal expansion $\alpha = 10^{-3} \text{ K}^{-1}$.
4. (a) Use two laws of thermodynamics to prove $\frac{\partial V}{\partial T_P} = -\frac{\partial S}{\partial P_T}$
(b) Calculate the entropy of a binary mixture of 'A' and 'B' relative to its pure components. If x_a and x_b are the respective mole fractions, show that entropy is maximum when $x_a = x_b = 1/2$.
5. If the energy density u of a photon gas is related to its pressure p as $p=u/3$, show that u is proportional to T^4 .