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 2022

Subject: Energetics and Bonding ***Subject Code(s): CHS1101***
Full Marks: 25 ***Time Allotted: 2 h***

Answer any FIVE questions

1. (a) Show that for one mole of a non-ideal gas obeying

$$(P + a/V^2)(V - b) = RT, \quad \frac{\partial E}{\partial V_T} = {}^{a}/_{V^2}$$

where a and b are constants.

(b) One mole of the same gas undergoes adiabatic free expansion. Calculate the change of entropy from (V_1, T_1) to (V_2, T_2). (2+3)

2. (a) For a metal with $C_P = 20 + 0.00063T$ (Joules/mole) calculate the change in enthalpy when 5 moles of the metal is heated from 25^0C to 900^0 C under 1 atmosphere pressure.

(b) Show that for the same change of state the two-stage expansion produces more work than that for one-stage expansion. (2+3)

3. Consider the following stages of a reversible cycle with one mole of an ideal gas.
   (1) Isothermal compression of volume from V_1 to V_2 ,
   (2)Isochoric pressure increase at volume V_2 ,
   (3) Isothermal expansion of volume V_2 to V_1 ,
   (4) Isochoric pressure decrease at volume V_1 .

Plot the P-V diagram. Calculate the change in internal energy, heat and work for each stage and calculate the efficiency of the engine. (1+4)

4. (a) Test to decide which of the following are exact differentials

$ydx + xdy$, $y^2dx + x^2dy$, VdP

(b) Show that

$\frac{\partial H}{\partial P_T}$ = V(1-Tα), where α is the coefficient of thermal expansion. (1.5+3.5)

5. (a) Calculate $\frac{\partial S}{\partial V_T}$ for one mole of a gas obeying P(V-b) = RT, where b is a constant.

(b) Show that the entropy of mixing per mole of an equi-molar mixture of two gases is 5.76 Joule/K (2.5 + 2.5)

6. (a) Elucidate a method to determine the standard entropy change ΔS^0 of a chemical reaction..

(b) Show that the triple point of a substance is a unique point in phase diagram. (3+2)