Subject: *Energetics and Bonding*   Subject Code(s): CHS 1101

Full marks: 25   Time allotted: 2 h

1. (i) Show that for any real gas:

$$C_p - C_v = \left[p + \left(\frac{\partial U}{\partial V} \right)_T \right] \left(\frac{\partial V}{\partial T} \right)_p$$

where $C_p = \left(\frac{\partial H}{\partial T} \right)_p$ and $C_v = \left(\frac{\partial U}{\partial T} \right)_v$.

(ii) Briefly explain the physical meaning of $p \left(\frac{\partial V}{\partial T} \right)_p$ and $\left(\frac{\partial U}{\partial V} \right)_T \left(\frac{\partial V}{\partial T} \right)$.

(iii) Find out the corresponding expression for an ideal gas.   **[3+2+1=6]**

2. Derive the expression for the net work done by a Carnot engine with graphical (p-V-T) representation.   **[5]**

3. (i) What are the criteria on dU, dH, dA, dG for spontaneity of a chemical process?

(ii) Which of the above conditions is most practical and why?   **[2+2=4]**

4. (i) Derive an expression for the variation of entropy with T and V as well as with T and p.

(ii) Find out the entropy change for an

   (a) isothermal process

   (b) isobaric process

   (c) isochoric process

                                                                                [3+3=6]

5. Water is heated to the boiling point under a pressure of 1.0 atm. When an electric current of 0.50 A from a 12V supply is passed for 300 s through a resistance in thermal contact with it, it is found that 0.798 g of water is vaporized. Calculate the molar internal energy and enthalpy changes at the boiling point (373.15 K). Given: $R=8.314\ JK^{-1}mol^{-1}$. [4]