1.

- **Heat engine:-** It is a device used to convert heat into mechanical energy

  (a) **Work done**, $W = Q_1 - Q_2$

  (b) **Efficiency:-** Efficiency η of an engine is defined as the fraction of total heat, supplied to the engine which is converted into work.

  $\eta = W/ Q_1 = [Q_1 - Q_2]/ Q_1 = 1-[Q_2/Q_1]$

- **Carnot engine – Carnot's reverse cycle:-**

  (a) **First stroke (isothermal expansion):-** $W_1 = RT_1 \log_e[V_2/V_1]$

  (b) **Second stroke (adiabatic expansion):-** $W_2 = R/\gamma\text{-}1\ [T_1 - T_2]$

  (c) **Third stroke (isothermal compression):-** $W_3 = RT_2 \log_e V_3/V_4$

  (d) **Fourth stroke (adiabatic compression):-** $W_4 = R/\gamma\text{-}1\ [T_1 - T_2]$

  (e) **Total work done in one cycle,** $W = W_1 + W_2 + W_3 + W_4 = R\,(T_1 - T_2) \log_e (V_2/V_1)$

- **Efficiency of Carnot engine:-** Efficiency η of an engine is defined as the ratio between useful heat (heat converted into work) to the total heat supplied to the engine.

  $\eta = W / Q_1 = [Q_1 - Q_2]/ Q_1 = 1-[Q_2/Q_1] = 1 - T_2/T_1$

- ## Second law of thermodynamics:-

  (a) Clausius statement:- Heat cannot flow from a cold body to a hot body without the performance of work by some external agency.

  (b) Kelvin's statement:- It is impossible to obtain a continuous supply of energy by cooling a body below the coldest of its surroundings.

  (c) Planck's statement:- It is impossible to extract heat from a single body and convert the whole of it into work.

- **Refrigerator:-** It is a device which is used to keep bodies at a temperature lower than that of surroundings.
- **Coefficient of performance (β):-** Coefficient of performance of a refrigerator is defined as the amount of heat removed per unit work done on the machine.

  β = Heat removed/work done = $Q_2/W = Q_2/[Q_1 - Q_2] = T_2/[T_1 - T_2]$

  Coefficient of performance of a refrigerator is not a constant quantity since it depends upon the temperature of body from which the heat is removed.

  For a perfect refrigerator, $W = 0$ or $Q_1 = Q_2$ or $\beta = \infty$

- **Heat added or removed:-**

  (a) For isobaric process:- $Q = n C_p \Delta T$

  (b) For isochoric process:- $Q = n C_v \Delta T$

  (c)For isothermal process:- $Q = nRT \log_e (V_2/V_1)$

  (d) For adiabatic process: $Q = 0$

- **Change in internal energy:-**

  (a) For isobaric process, $\Delta U = n C_p \Delta T$

  (b) For isobaric process, $\Delta U = n C_v \Delta T$

  (c) For isothermal process, $\Delta U = 0$

  (d) For adiabatic process, $\Delta U = -W = [nR(T_2 - T_1)]/(\gamma - 1)$

2. Clear all the basic concepts and practice more numerical problem.