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D_1 (H & S) Paper-II

Change of entropy in a reversible cycle

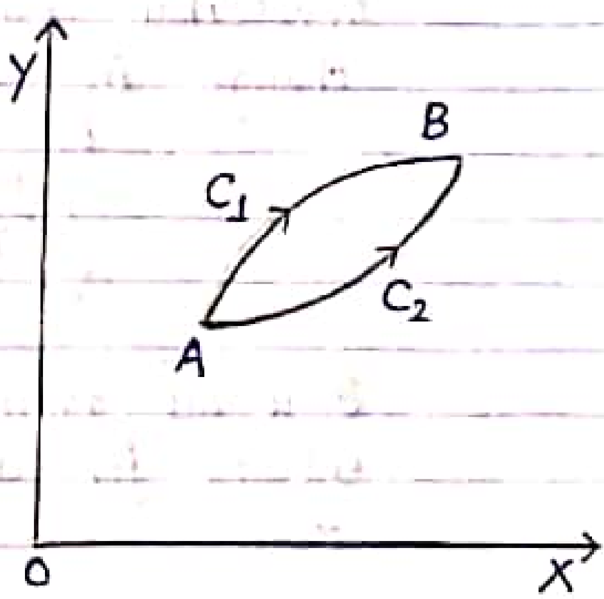
A reversible is one in which the system successively changes from one equilibrium state to the next equilibrium state, differing only infinitesimally from the previous state.

The value of change in entropy δS for the equilibrium state is zero. Therefore as the system changes from one equilibrium state to another equilibrium state infinitesimally close to it, the change in entropy δS approaches zero. Hence the system can go from one equilibrium state to another in infinitesimally small steps, for an infinitely long period of time. Such infinitely slow process are known as quasi-static. Hence for a reversible process, δS is zero as it is zero for each of its infinitesimally small steps.

This is explained in detail as under. We consider a system which passes from the state A to state B along a reversible path C_1. The change in entropy during an infinitesimal change of state is given by

$$dS = \frac{dQ}{T}.$$

∴ Total change in entropy of the system during the change of state from A to B along path C_1 is given by,



$$\int_A^B dS = \int_A^B \frac{dQ}{T} \quad \text{or}$$

$$S_B - S_A = \int_A^B \frac{dQ}{T}$$

Now, we suppose the system passes from the state A to the state B via the path C_2. As entropy is path independent and depends only on the initial and final values of state variable, we have also for path C_2.

$$S_B - S_A = \int_A^B \frac{dQ}{T}.$$

Now,

$$\int_A^B \frac{dQ}{T} = -\int_B^A \frac{dQ}{T}.$$

If, therefore the system passes from the state A to state B along the path C_1 and comes back to the state via the reversible path C_2, then the total change in entropy is,

$$\int_A^B \frac{dQ}{T} + \int_B^A \frac{dQ}{T} = -\int_B^A \frac{dQ}{T} + \int_B^A \frac{dQ}{T} = 0$$

Thus we again find that the change in entropy for a reversible cycle is always zero.