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Entropy

Q. Explain what do you mean by the entropy of a substance.

Ans:- Entropy literally means 'transformation'. The concept of entropy was introduced by Clausius in 1854, while working on derivation and application of second law of thermodynamics. The temp. of a body remains constant in an adiabatic process. When a gas is compressed adiabatically work is done by the gas, the heat energy as well as its temp increases. On the other hand when work is done by the gas, the heat energy as well as temp decreases. This shows that in an adiabatic process neither the heat energy nor the temp remains constant. These two increase or decrease together, but there is something which remains constant, just as temperature remains constant in isothermal process.

The thermal property of a body which remains constant during an adiabatic process, when no heat energy is given to or removed from it is called entropy.

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• Entropy plays a very vital role in the study of thermodynamics.

We consider a no. of isothermals T_1, T_2, T_3 etc, drawn at small but equal temperatures differences. We draw two adiabatics A and B, such that these cut the isothermal T_1 at a and b, T_2 at c and d and T_3 at e and f as shown in fig.

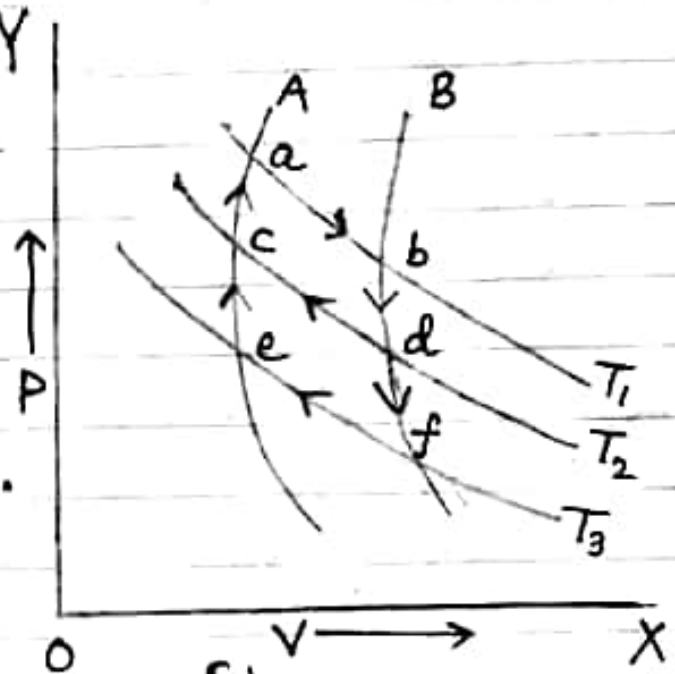

Fig.

We consider the Carnot cycle abcd. In going from the point a to b certain amount of heat say Q_1 is absorbed at a temp T_1, in going from d to c, an amount of heat, say Q_2, is given out at a temp T_2, then

According to Carnot's Theorem,

$$\frac{Q_1 - Q_2}{Q_1} = \frac{T_1 - T_2}{T_1}$$

$$\therefore \frac{Q_2}{Q_1} = \frac{T_2}{T_1} \quad \text{or} \quad \frac{Q_1}{T_1} = \frac{Q_2}{T_2}.$$

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If we consider the Carnot cycle cdfe, an amount of heat Q_2 is absorbed at a temp T_2 and Q_3 will be given out a temp T_3, then similarly, we have

$$\therefore \frac{Q_2}{T_2} = \frac{Q_3}{T_3} \quad \therefore \frac{Q_1}{T_1} = \frac{Q_2}{T_2} = \frac{Q_3}{T_3} = \text{constant}$$

In general if Q is the quantity of heat absorbed at a temp T in going from adiabatic A to the adiabatic B, then

$$\frac{Q}{T} = \text{constant}$$

If the two adiabatic lie very close to each other and δQ is the quantity of heat absorbed at a temp T in going from one adiabatic to the other the change in entropy δS is given by,

$$\delta S = \frac{\delta Q}{T}$$

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