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Second law of thermodynamics.
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Q. Give Kelvin-Planck statement and Clausius statement of second law of thermodynamics and explain its significance. Show that both these statements are equivalent.

Ans.- Second law of thermodynamics : It can be stated in a number of ways. We give below Kelvin Planck and Clausius statement of this law.

Kelvin-Planck statement : It is impossible to get a continuous supply of work from a body by cooling it to a temp. lower than the coldest of its surroundings.

Clausius statement: It is impossible for a self-acting machine unaided by any external agency to convey heat from a body at a lower temp to a body at a higher temp.

Explanation : It is clear from the above definitions that heat cannot flow from a body at a lower temp to a body at a higher temp unless work is done by an external agency.

This is in accordance with our experience in other branches of Physics.

(i) A body cannot move from a lower to a higher level unless work is done on it by an external agency.

(ii) Electric current does not flow from a lower to a higher potential unless work is done on it. Heat can flow from a higher temp to a lower temp. A heat engine may absorb a certain amount of heat at higher temp to a lower temp, convert a part of it into mechanical work and give out the rest of its at a lower temp. Thus we see that a heat engine works essentially by destroying the temp difference between the source and the sink. This led Lord Kelvin to state the second law of thermodynamics in the following manner.

It is impossible to derive continuous supply of work by cooling a body to a temp lower than that of the coldest of its surroundings. The two statements are equivalent. ~~The This statement of second law may also be put~~ is explained as under.

The rate at which heat is conducted is given by $Q = K \cdot \frac{dT}{dz}$, where K = Coeff. of Conduction

$\frac{dT}{dz}$ = Temp. gradient.

In the third case the molecules of the gas move from region to higher concentration to the region of lower concentration to destroy the density gradient. This gives rise to diffusion. The rate of diffusion of molecules is given by

$v = -D \frac{dn}{dz}$, where D = Coeff. of diffusion

$\frac{dn}{dz}$ = Concentration gradient.

Thus viscosity, conduction and diffusion represent the transport of momentum, energy and mass respectively. These phenomena are collectively called transport phenomena.