Notes for
B.Sc. Part-I
Paper - 2nd

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"Second law of thermodynamics"

This law is a generalization of certain experiences and observations and is concerning with the direction in which energy transfer takes place. The laws have been stated in number of ways, we shall refer to only some of them.

(1) Kelvin-Plank statement of the second law :-

The working substance in a heat engine extracts heat from a source, converts a part of it in to work and rejects the rest to a sink at lower temperature. The steam which enters the cylinder of a steam engine from boiler is hotter than the steam which is rejected by the cylinder to the surroundings. The heat lost by steam is utilized in doing work in the engine. Thus the mechanical energy obtained from the engine is the out come of heat flow from a hotter to a colder body. If any how the boiler and surroundings would have been the same temperature No heat flow would occur and hence no mechanical energy would be obtained. Hence to convert heat in to work, a difference of Temperature is essential. NO engine has ever been constructed which converts all the heat absorbed from the source in to work without rejecting a part of it to the cold body. As the engine absorbs more and more heat from the hot body the later suffers a continuous fall in Temperature and if a continuous supply of work is desired; the hot body will in the long run become as cold as its surroundings. Then no heat flow will be possible, the engine will stop working and hence no mechanical

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⇒ work will be obtained. It means that we can not obtain a continuous supply of work from a single supply of heat. ie the Presence of colder body is a must for the continuous conversion of heat in to work. Such considerations led Lord Kelvin to state that -

" It is impossible by means of inanimate material agency to derive mechanical effect from any Person of matter by cooling it below the temperature of the coldest of the surrounding object. In the words of Planck -

" It is impossible to construct an engine which working in a complete cycle, will Produce no effect other than the raising of weight and the cooling of a heat reservoir.

These two statements can be combined in to one equivalent statement of the second law which is -

" It is impossible to construct a device which operating in a cycle, has the sole effect of extracting heat from a reservoir and performing an equivalent amount of work."

According to this statement, a single reservoir at a single temperature can not be continuously Transfer heat in to work.

(2) Clausius statement of Second Law :-

" It is impossible for a self-acting machine working in a cycle process, unaided by any external agency to transfer heat from a body at a lower temperature to a body at a heighur temperature."

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