* Second law of thermodynamics:-

A heat engine is chiefly concerned with the conversion of heat. A refrigerator is a device to cool a certain space below the tempr. of its surroundings. The ~~first~~ first law of thermodynamics is a qualitative statement of which doesn't preclude the possibility of the existence of either a heat engine or a refrigerator. The first law doesn't contradict the existence of a 100% efficient heat engine or a self acting refrigerator.

In practice, these two are not attainable. These phenomena are recognized and this led to the formulation of a law governing these two devices. It is called second law of thermodynamics.

A new term reservoir is used to explain the second law. A reservoir is a device having infinite thermal capacity and which can absorb, retain or reject unlimited quantity of heat without any change in its tempr.

Kelvin-Planck statement of the second law is as follows:-

"It is impossible to get a continuous supply of work from a body (or engine) which can transfer heat with a single heat reservoir. This is negative statement. According to this statement a single reservoir at a single tempr. can't continuously transfer heat into work. It means that there should be two reservoirs for any heat engine. One reservoir (called source) is taken at a higher tempr. and the other reservoir (called Sink) is taken at a lower temperature.

According to this statement, zero degree absolute temper. is not attainable because no heat is rejected to the sink at 0°K. If an engine works between any temper. higher than 0 Kelvin and zero degree kelvin; it means it uses a single reservoir which contradicts Kelvin-Plank's statement of the second law. Similarly, no engine can be 100% efficient.

In a heat engine, the engine draws heat from the source and after doing some external work, it rejects the remaining heat to the sink. The source and sink are of infinite thermal capacity and they maintain constant temper.

First Part: According to Kelvin, the second law can also be stated as follows:—

"It is impossible to get a continuous supply of work from a body by cooling it to a temper. lower than that of its surroundings."

In a heat engine the working substance does some work and rejects the remaining heat to the sink. The temper. of the source must be higher than the surroundings and engine will not work when the temper. of the source and the sink are the same. Take the case of steam engine. The steam at high pressure is introduced into the cylinder of engine. Steam expands and it does external work. The contents remaining behind after doing work are rejected to the surroundings. The temper. of the working substance rejected to the surroundings is higher than the temper. of surroundings.

If this working rejected by the first engine is used in another engine, it can do work

and the temp. of the working substance will fall further. It means that the working substance can do work only if its temp. is higher than that of surroundings.

Second law: According to Clausius:
"It is impossible to make heat flow from a body at a lower temp. to a higher temp. without doing external work on the working substance."

This law is applicable in the case of ice plants and refrigerators. Heat itself can't flow from a body at a lower temp. to a body at a higher temp. But it is possible, if some external work is done on working substance. Take the case of ammonia ice plants. Ammonia is the working substance. Liquid ammonia is at low pressure takes heat from the brine solution in the brine tank and it is converted to pressure vapour. External work is done to compress the ammonia vapours to high pressure. This ammonia at high pressure is passed to coil over which water at room temp. is poured. Ammonia vapour gives heat to water at room temp. and gets itself converted into liquid again. This high pressure liquid ammonia is throttled to low pressure liquid ammonia. In the whole process ammonia takes heat from brine solution and gives heat to water at room temp. This is possible only due to the external work done on ammonia by the piston in compressing it. The only work of electricity in the ammonia ice plants is more to the piston to do external work on ammonia. If external work is not done

no ice plant or refrigerator is work. Hence it is possible to make heat flow from a body at a lower temperature to a body at a higher temp. by doing external work on the working substance.

Thus, the second law of thermodynamics plays an important part for practical devices e.g. heat engines and refrigerators. The first law of thermodynamics only gives the relation between the work done and the heat produced. But the second law of thermodynamics gives the conditions under which heat can converted into work.