

## 3.1 SECOND LAW OF THERMODYNAMICS

When we bring two bodies at different temperatures in thermal contact, we always find that the hotter body loses energy to the colder body. This experience turns out to be universal and places restrictions on the direction of energy flow in naturally occurring processes when thermal processes are involved. The second law of thermodynamics codifies this experience in a number of equivalent ways.

One of first observations suggesting the special nature of thermal processes was made in the inability to make a 100% efficient heat engine. The theoretical considerations concerning heat engines led to the following statement of the second law of thermodynamics by William Thomson, also known as Lord Kelvin.

**Kelvin-Planck statement:** No device is possible whose sole effect is to convert a given amount of heat completely into work.

Rudolf Clausius proposed another statement of the second law of thermodynamics in 1850. He utilized the natural tendency of heat to flow from a hot object to a cold object more directly. Clausius's statement of the second law of thermodynamics states the following.

**Clausius's statement:** There is no process whose sole effect is a net transfer of heat from a cold object to a hot object.

Clausius introduced a new property, called entropy, into an analysis of thermodynamic systems. Using the property of entropy, Clausius stated second law of thermodynamics in 1865 in yet another way. We will discuss entropy in the next chapter.