Various Formulations of
the Second Law of Thermodynamics

The Kelvin-Planck statement:

*It is impossible to construct a process that, operating in a cycle, will produce no effect other than extraction of heat from a reservoir at one temperature and the performance of an equivalent amount of work.*

The Clausius statement:

*It is impossible to have a cyclic process whose sole result is a heat flow from a cooler body to a warmer body.*

It is relatively easy to show that the Kelvin statement leads to the Clausius statement and vice versa. The relation with the next formulation may be a bit less obvious.

The Carathéodory statement:

*Arbitrary close to any given thermodynamic state there exists states which cannot be reached from it solely by means of adiabatic processes.*

These statements have mainly historical significance. We will add to these statements the one we will use:

*There exists a STATE function S of the extensive variables for which holds: (for closed systems)*

\[
\frac{dS}{T} \geq \frac{\delta Q}{T}
\]

*For a reversible process the equality sign holds:*

\[
\frac{dS}{T} = \frac{\delta Q}{T}
\]