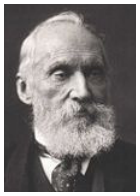
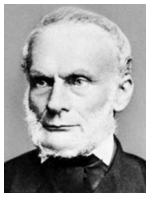
THE SECOND LAW OF THERMODYNAMICS



Lord Kelvin
(1824-1907)

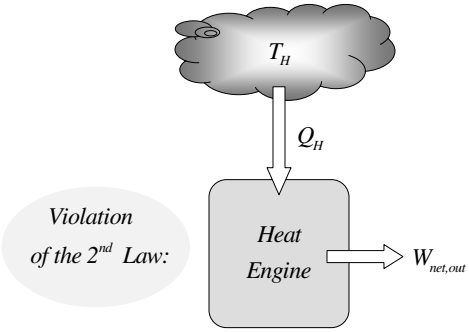
Max Planck
(1858-1947)



Rudolf Clausius
(1822-1888)

Kelvin – Planck Statement:

It is impossible for any device that operates on a cycle to receive heat from a single reservoir and produce a net amount of work



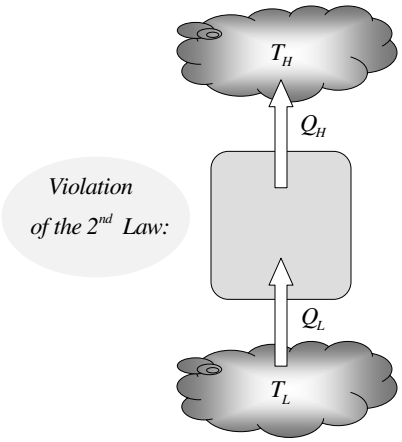
For heat engine to operate, the working fluid has to exchange heat with heat sink as well with the heat source.

If $Q_L = 0$, *then* $\eta_{th} = 1 - \frac{Q_L}{Q_H} = 1$, *therefore, the 2nd Law claims that no heat engine can be 100% efficient:*

$$\eta_{th} < 1$$

Clausius Statement:

No device can operate on a cycle and produce effect that is solely the heat transfer from a lower-temperature body to a higher-temperature body

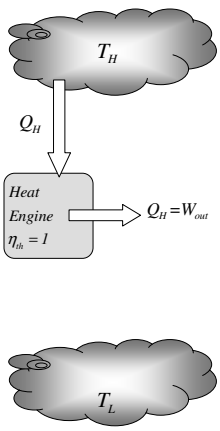


There are devices that can transfer heat from lower-temperature reservoirs to higher-temperature reservoirs but they have also to consume some energy W_{in}

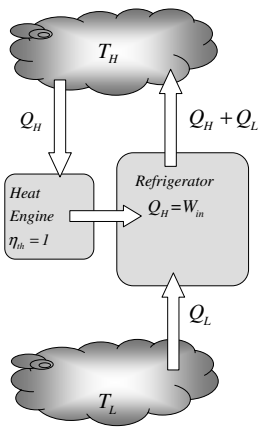
Equivalence of two statements:

If some device violates one statement, it also violates the other statement, and vice versa.

1) Assume that Kelvin-Planck statement is violated



2) Attach heat engine to refrigerator



3) Violation of Clausius statement