

## 2<sup>nd</sup> Law of Thermodynamics

### Statements

#### Kelvin Statement

*No process is possible in which the sole result is the absorption of heat ( $Q_h$ ) from a reservoir ( $T_h$ ) and its complete conversion into work ( $W$ ).*

#### Clausius Statement

*No process is possible in which the sole result is the transfer of energy ( $Q_c$ ) from a cooler ( $T_c$ ) to a hotter body ( $T_h$ ).*

### Carnot Engines

#### Works on a Carnot Cycle

$$\begin{aligned}\epsilon &= \frac{|W|}{Q_h} \\ &= \frac{T_h - T_c}{T_h}\end{aligned}$$

$Q_h$  and  $Q_c$  can't have the same sign.

$$\epsilon_{\text{irrev}} < \epsilon_{\text{CarEng}}$$

$$\epsilon_{\text{rev}} = \epsilon_{\text{CarEng}}$$

### Entropy

$$\begin{aligned}dS &= \frac{\delta Q_{\text{rev}}}{T} \\ dS &> \frac{\delta Q_{\text{irrev}}}{T}\end{aligned}$$

### Stability Consequences

$$\begin{aligned}C_V &> 0 \\ \kappa &> 0\end{aligned}$$