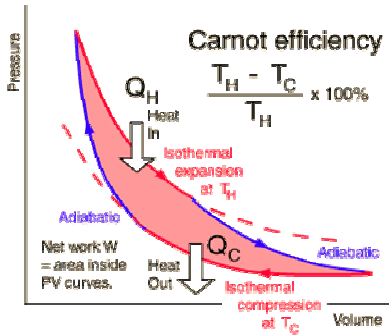


Carnot cycle.



Efficiency $\eta = 1 - \frac{Q_C}{Q_H} = 1 - \frac{T_C}{T_H}$

Efficiency of the Carnot cycle is

1. Independent of the 'working substance'.
2. A function only of the reservoir temperatures.
3. The maximum possible efficiency of any heat engine.
4. Equal to the efficiency of any other reversible heat engine.

Since $\frac{|Q_C|}{T_C} = \frac{|Q_H|}{T_H}$ and Q_C & Q_H have opposite signs, we have

$$\sum_{\text{Carnot cycle}} \frac{\Delta Q}{T} = 0$$

Any reversible cycle can be split into an infinite number of infinitesimal Carnot cycles, hence

$\oint \frac{d'Q}{T} = 0$ for ANY closed path. This implies that the quantity $\frac{d'Q}{T}$ is the exact differential of some underlying quantity, the ENTROPY, S .

Hence, for an infinitesimal reversible step, we have

$$dS = \frac{d'Q}{T}$$

In general, we have

$$\boxed{dS \geq \frac{d'Q}{T}} \quad (\text{The Clausius's inequality}).$$

Where the inequality applies to an irreversible step.

The importance of entropy:

ENTROPY IS A VARIABLE OF STATE THAT IS SENSITIVE TO THE NATURE OF CHANGE.

1. Changes compatible with the 1st law but never observed in practice are forbidden by the principle that **THE TOTAL ENTROPY OF THE UNIVERSE NEVER DECREASES.**
2. Entropy distinguishes between reversible and irreversible changes. $\Delta S)_{\text{universe}} = 0$ for reversible changes, $\Delta S)_{\text{universe}} > 0$ for irreversible changes.