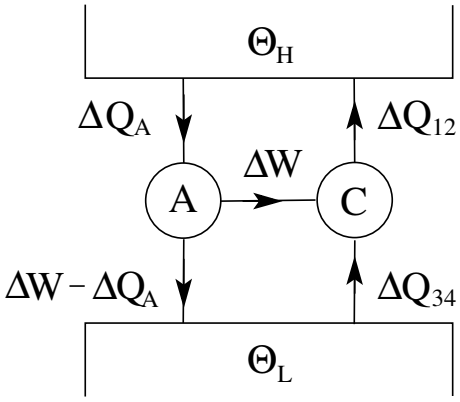
Maximum efficiency [tln12]

Is it possible to construct a heat engine A which is more efficient than the Carnot engine C?

Use engine A to drive engine C in the reverse i.e. as a refrigerator.



Heat transfers: $\Delta Q_A > 0,\ \Delta Q_{12} < 0,\ \Delta Q_{34} > 0.$

Work performance: $\Delta W = \Delta W_{out}^{(A)} = \Delta W_{in}^{(C)} > 0.$

Efficiencies: $\eta_A = \dfrac{\Delta W}{\Delta Q_A}, \quad \eta_C = \dfrac{\Delta W}{|\Delta Q_{12}|}$

Since engine C operates reversibly, η_C is the same in the forward and reverse directions. Note: η_C is not an *efficiency* in the reverse mode.

$\eta_A > \eta_C$ would imply $\Delta Q_A < |\Delta Q_{12}|$.

The two engines combined would then cause heat to flow from low to high temperature without work input, which is a violation of the second law.

Conclusions:

- Engine A cannot be more efficient than engine C.
- All Carnot engines operating between Θ_H and Θ_L must have the same efficiency.