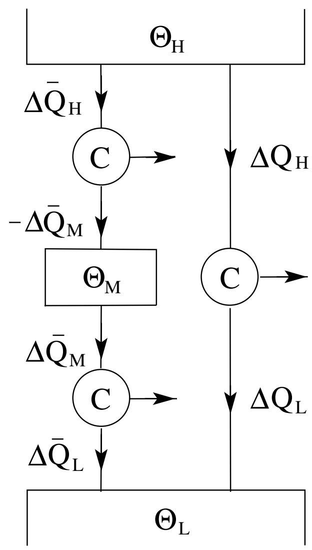
Absolute temperature [tln13]

Reservoir temperatures: $\Theta_H, \Theta_M, \Theta_L$.

Efficiency: $\eta = 1 - \dfrac{|\Delta Q_L|}{\Delta Q_H} = 1 - f(\Theta_L, \Theta_H)$.

Likewise: $\dfrac{\Delta \bar{Q}_M}{\Delta \bar{Q}_H} = f(\Theta_M, \Theta_H), \quad \dfrac{|\Delta \bar{Q}_L|}{\Delta \bar{Q}_M} = f(\Theta_L, \Theta_M)$.



Second law implies: If $\Delta \bar{Q}_L = \Delta Q_L$ then $\Delta \bar{Q}_H = \Delta Q_H$.

$\Rightarrow \dfrac{|\Delta \bar{Q}_L|}{\Delta \bar{Q}_M} \dfrac{\Delta \bar{Q}_M}{\Delta \bar{Q}_H} = \dfrac{|\Delta Q_L|}{\Delta Q_H} \Rightarrow f(\Theta_L, \Theta_M) f(\Theta_M, \Theta_H) = f(\Theta_L, \Theta_H)$

Functional form: $f(\Theta_L, \Theta_H) = \dfrac{g(\Theta_L)}{g(\Theta_H)} \equiv \dfrac{T_L}{T_H} \Rightarrow \eta = 1 - \dfrac{T_L}{T_H}$.

Definition of absolute temperature: $\dfrac{T_L}{T_H} = \dfrac{|\Delta Q_L|}{\Delta Q_H}$.

Kelvin scale is fixed by triple point of water: $T_{trp} = 273.16\text{K}$.

Note: $\eta = 1$ implies $T_L = 0$. However, the third law states $\delta Q = TdS = 0$ at $T = 0$. Hence, all reversible processes at $T = 0$ are adiabatic. Heat cannot be absorbed reversibly at $T = 0$.