4.2) Theoretical Performance of Cycles

Carnot Corollaries

1.) The performance of a reversible cycle is better than that of an irreversible cycle
2.) All reversible processes operating between the same thermal reservoirs have the same performance value

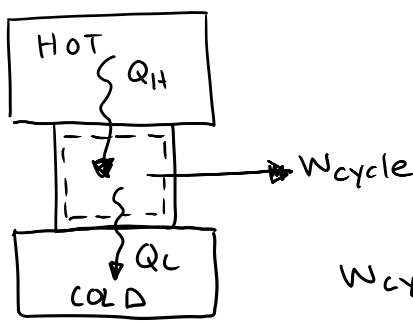
Kelvin Temperature Scale

$$\boxed{\left(\frac{Q_C}{Q_H}\right)_{\text{rev cycle}} = \underbrace{\frac{T_C}{T_H}}_{\text{Kelvin}}}$$

=> selected such that the temperature ratios are the same as the heat transfer ratios

$T_H = 273.16\,K$ => Triple Point of Water
=> Used to establish the scale

Power Cycle



$$W_{cycle} = Q_H - Q_C$$

Thermal Efficiency

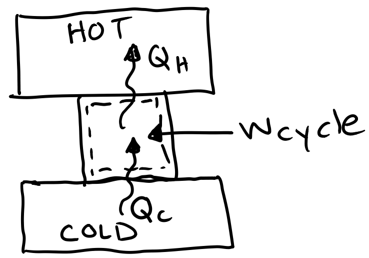
$$\eta = \frac{W_{cycle}}{Q_H} = \frac{Q_H - Q_C}{Q_H} = 1 - \frac{Q_C}{Q_H}$$

$$\eta < 100\%$$

η_{max} => reversible cycle => use $\left(\frac{Q_C}{Q_H}\right)_{\text{rev cycle}} = \frac{T_C}{T_H}$

$$\boxed{\eta_{max} = 1 - \frac{T_C}{T_H}}$$

Refrigeration and Heat Pump Cycles



$$W_{cycle} = Q_H - Q_C$$

Refrigeration Cycle

$$\beta = \frac{Q_C}{W_{cycle}} = \frac{Q_C}{Q_H - Q_C}$$

$$\beta_{max} = \frac{T_C}{T_H - T_C}$$

Heat Pump Cycle

$$\gamma = \frac{Q_H}{W_{cycle}} = \frac{Q_H}{Q_H - Q_C}$$

$$\gamma_{max} = \frac{T_H}{T_H - T_C}$$