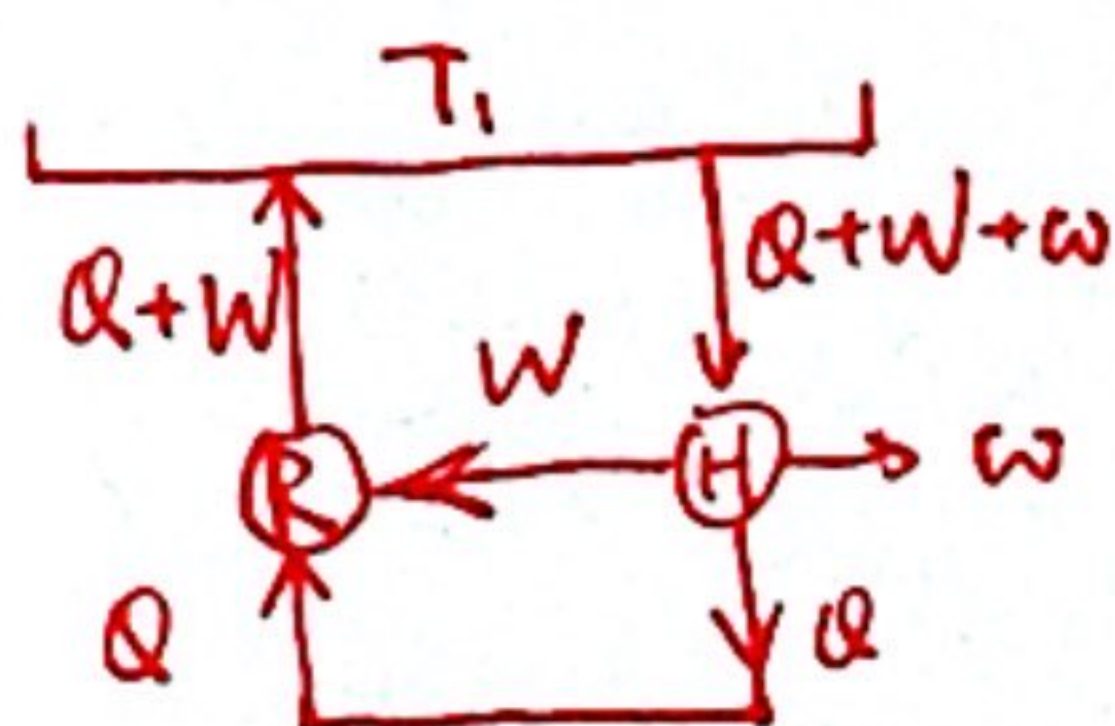# Carnot's Theorem

Carnot's Theorem: all reversible heat engines operating between given temperatures are equally efficient. and more efficient than non-reversible ones.

Reversible Heat Engine : a reversible heat engine is an idealised heat engine that operates in such a way that every step of its cycle can be reversed.

$$\Delta S_{universe} = 0.$$

(1)

$$\eta_R = \frac{W}{Q+W} \quad , \quad \eta_n = \frac{W+\omega}{Q+W+\omega}$$

Suppose there exists a hypothetical engine that has a greater efficiency than the reverse engine.

$$\eta_n > \eta_R.$$

$$1 - \eta_n < 1 - \eta_R \quad \Rightarrow \quad \frac{Q}{Q+W+\omega} < \frac{Q}{Q+W}$$

The net effect violates the Kelvin statement. as the entire system extracts ω amount of heat and put that into work.

(2) Suppose I itself is reversible. and swap the roles of I and R. From (1). we then know that R can't be more efficient than I. Since I can't be more efficient than R, we know reversible engines between the same reservoirs have the same efficiency.