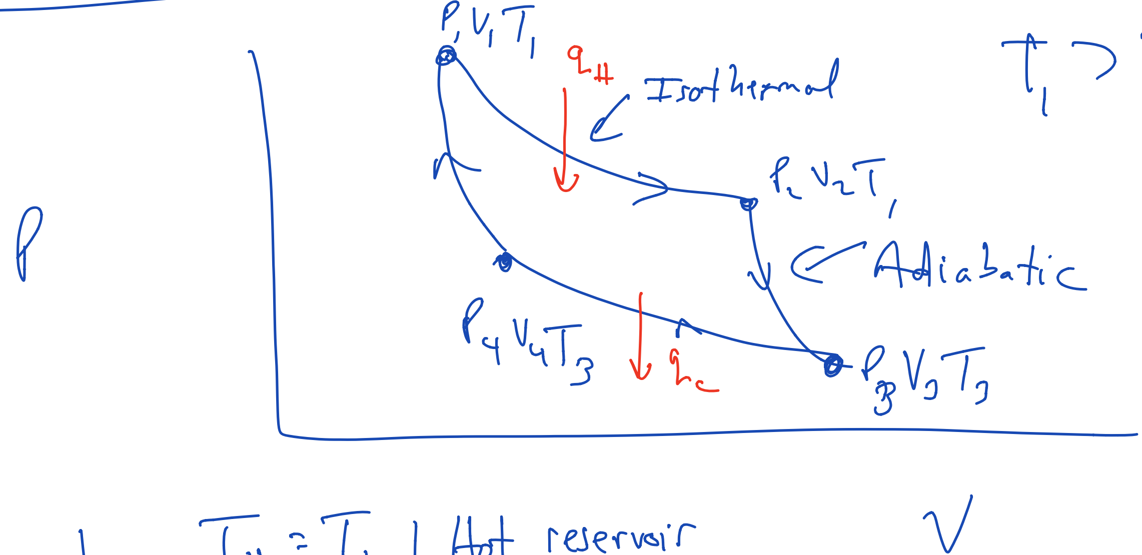
Isothermal

$dT = \Delta T = 0$

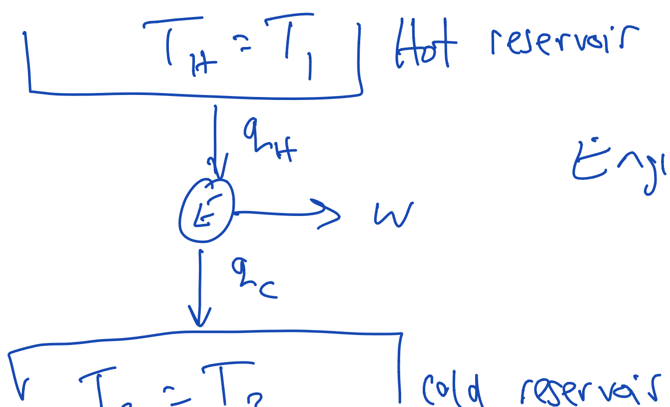
$dq \neq 0$

$dq = 0$

Adiabatic



$T_1 > T_3$



Engine system

* Reversible
* Ideal Gas
  Fluid

Question: What is efficiency?

$$\eta = \frac{-w}{q_H}$$

$$\eta > 0$$

Apply 1st "Law" $\rightarrow$ $\eta_{Carnot} = 1 + \frac{q_c}{q_H}$

$q_c < 0$ (negative)

$\eta_{Carnot} = 1 - \frac{|q_c|}{q_H}$

q is not practical

$\longrightarrow$ Temperatures

$\eta_{Carnot} \rightarrow \eta_{Carnot}(T)$

Need:

$$\frac{q_c}{q_H} =$$

1st "Law": I.G. IsoT

$$dU = đq + đW = 0 = C_v^{ig} dT$$

$$\therefore đq = -đW$$

$$= -(-P_{ext}\, dV)$$

$$đq = p\, dV$$

$\therefore$

$$q_H = \int_{V_1}^{V_2} p\,dV = \int_{V_1}^{V_2} nRT \frac{dV}{V}$$

$$q_H = nRT_1 \int_{V_1}^{V_2} d(\ln V)$$

$$\boxed{q_H = nRT_1 \ln\left(\frac{V_2}{V_1}\right)}$$

$$\boxed{q_C = nRT_3 \ln\left(V_4/V_3\right)}$$

$$\left(\frac{q_H}{q_C}\right)^{-1} = \left[\frac{nRT_1}{nRT_3} \frac{\ln(V_2/V_1)}{\ln(V_4/V_3)}\right]^{-1}$$

$$= \left[\frac{T_1}{T_3} \frac{\ln(V_2/V_1)}{\ln(V_4/V_3)}\right]^{-1}$$

$$\underline{pV^{\gamma} = \text{constant}}$$

Adiabatic, Reversible Process for I.G.

$$\gamma = C_p/C_v$$

$$\underline{P_2 V_2^{\gamma} = P_3 V_3^{\gamma}} \qquad \underline{P_4 V_4^{\gamma} = P_1 V_1^{\gamma}}$$

$$\frac{P_2 V_2^{\gamma} = P_3 V_3^{\gamma}}{P_1 V_1^{\gamma} = P_4 V_4^{\gamma}}$$

$$\frac{V_2^{\gamma}}{V_1^{\gamma}} = \left(\frac{V_2}{V_1}\right)^{\gamma} = \frac{P_3}{P_4}\left(\frac{V_3}{V_4}\right)^{\gamma} \frac{P_1}{P_2}$$

$$\left(\frac{V_2}{V_1}\right) = \left(\frac{P_3 P_1}{P_4 P_2}\right)^{\frac{1}{\gamma}} \left(\frac{V_3}{V_4}\right)^{\frac{\gamma}{\gamma}}$$

$$\left(\frac{V_2}{V_1}\right) = \left(\frac{P_3 P_1}{P_4 P_2}\right)^{\frac{1}{\gamma}} \left(\frac{V_3}{V_4}\right)$$

$$= \left(\frac{V_4 V_2}{V_3 V_1}\right)^{\frac{1}{\gamma}} \frac{V_3}{V_4}$$