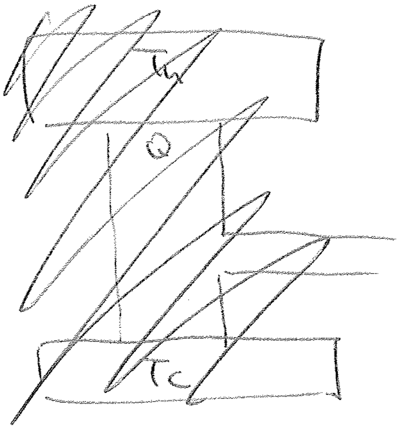
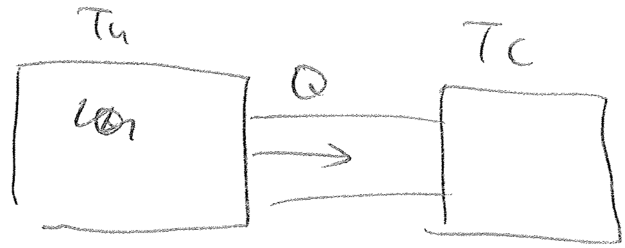
HEAT ENGINES



IF TEMPERATURE STAYS THEN

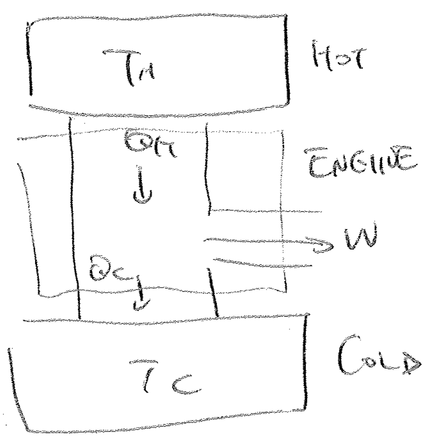


$$\Delta S_i = -\frac{Q}{T_H} + \frac{Q}{T_C}$$

$$= Q\left(\frac{1}{T_C} - \frac{1}{T_H}\right) > 0$$

$\Delta U = Q + W$

= MAYBE WE CAN EXTRACT WORK FROM Q



EFFICIENCY OF ENGINE IS

$$\varepsilon = \frac{W}{Q_H}$$

~~$Q_H + Q_C =$~~

$Q_H = Q_C + W$

$$\varepsilon = \frac{Q_H - Q_C}{Q_H} = 1 - \frac{Q_C}{Q_H}$$

SINCE $\Delta S \geq 0$

$$-\frac{Q_H}{T_H} + \frac{Q_C}{T_C} \geq 0$$

$$\frac{Q_C}{T_C} \geq \frac{Q_H}{T_H}$$

$$\frac{Q_C}{Q_H} \geq \frac{T_C}{T_H}$$

$$e = \frac{Q_H - Q_C}{Q_H} = 1 - \frac{Q_C}{Q_H} \leq 1 - \frac{T_C}{T_H}$$

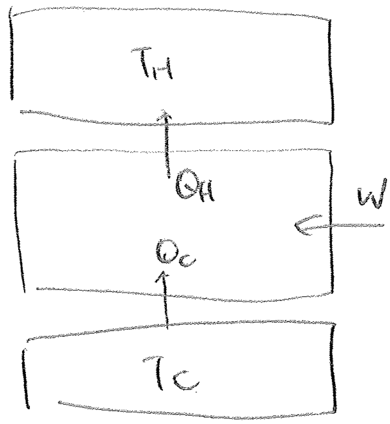
$$\boxed{e \leq 1 - \frac{T_C}{T_H}}$$

SO $T_H = 500\,K$ $T_C = 300\,K$ THEN

$$\varepsilon \leq 1 - \frac{3}{5} =$$

$$\boxed{\varepsilon \leq 40\%}$$

REFRIGERATORS



COEFFICIENT OF PERFORMANCE

$$COP = \frac{Q_C}{W} \qquad W + Q_C = Q_H$$

$$W = Q_H - Q_C$$

$$COP = \frac{Q_C}{Q_H - Q_C}$$

$$= \frac{1}{Q_H/Q_C - 1}$$

$$\frac{Q_H}{T_H} \geq \frac{Q_C}{T_C}$$

$$\boxed{\frac{Q_H}{Q_C} \geq \frac{T_H}{T_C}}$$

$$COP = \frac{1}{\frac{Q_H}{Q_C} - 1} \leq \frac{1}{\frac{T_H}{T_C} - 1}$$

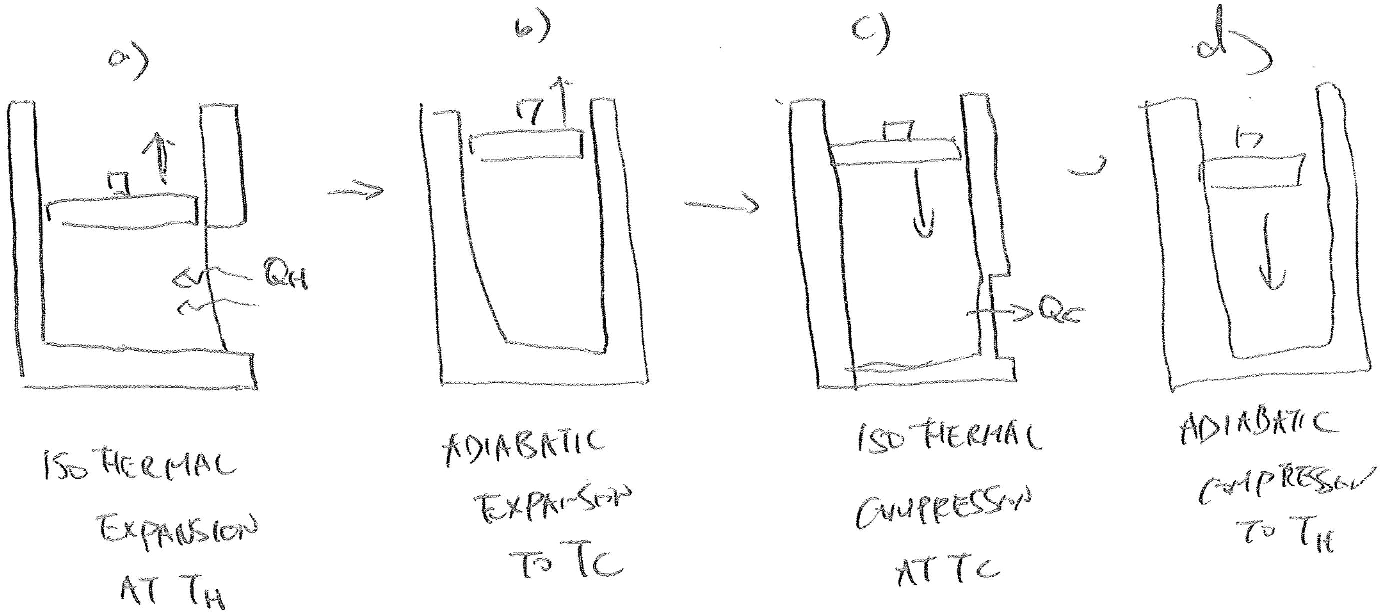
$$\leq \frac{T_C}{T_H - T_C}$$

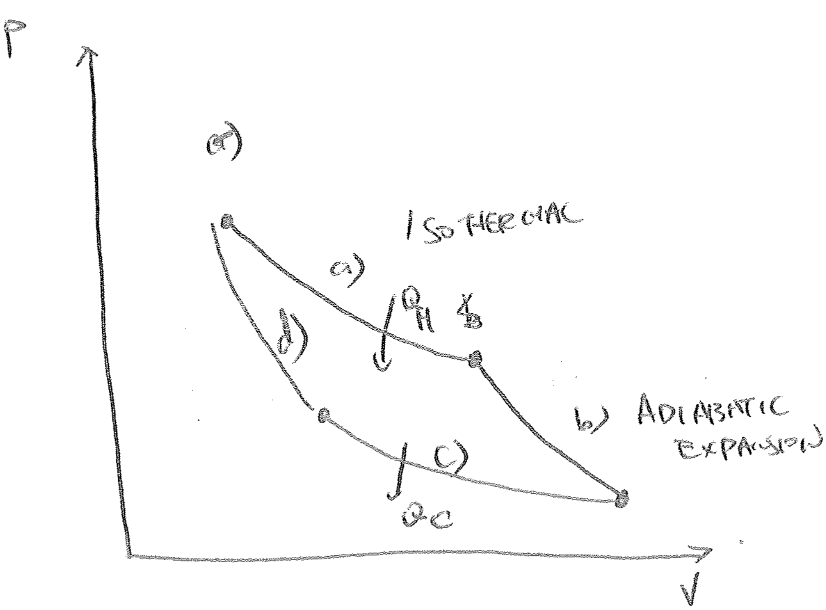
So IF $T_C = 255K$ AND $T_H = 298K$

$$COP \leq \frac{255K}{298 - 255K} \doteq 5.9$$

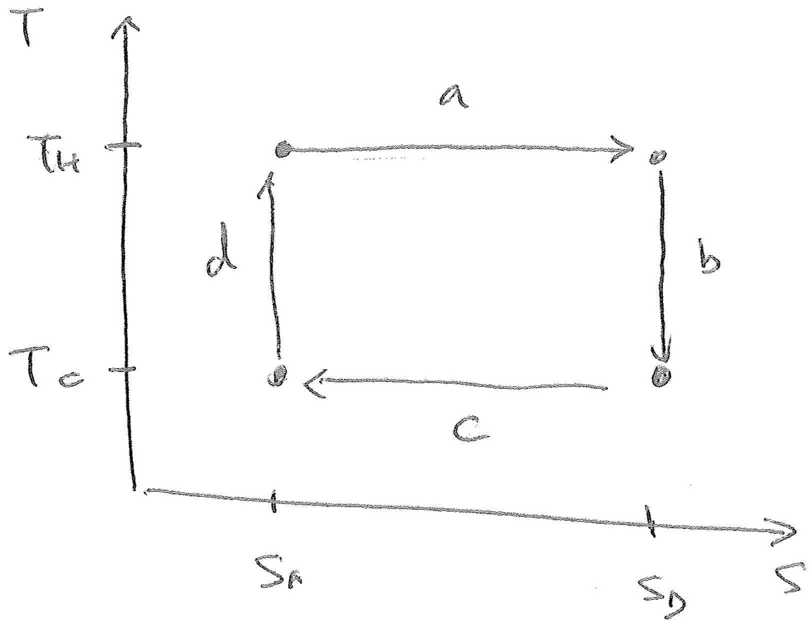
So how do we achieve max efficiency?

Carnot cycle





OK LETS TRY DRAWING TEMPERATURE ENTROPY DIAGRAM



~~DISSAW~~ W =

WHAT CAN WE DO NOW? <u>PPT</u>

SAY YOU FIND $T_H = 1000K$

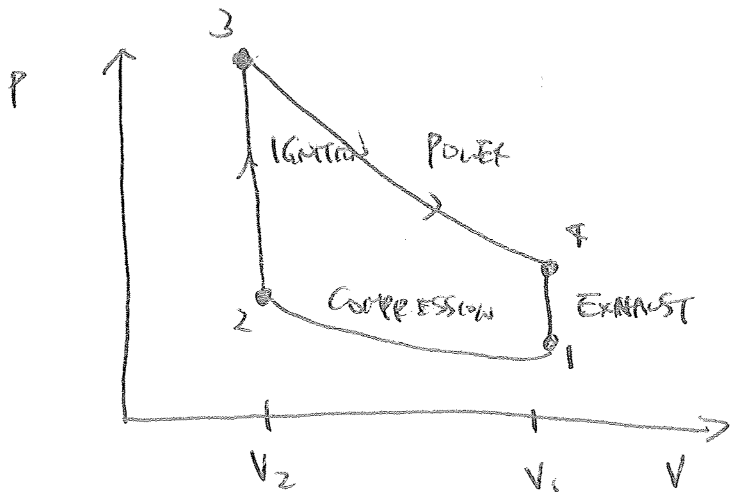
$T_C = 500K$

MAX EFFICIENCY IS 50%

SO IF SOME ONE SAYS 49.5% EFFICIENCY THEN NOT MUCH ROOM FOR IMPROVEMENT

INTERNAL COMBUSTION ENGINES.

OTTO CYCLE



$$\varepsilon = 1 - \left(\frac{V_2}{V_1}\right)^{\gamma-1}$$

ADIABATIC STEPS

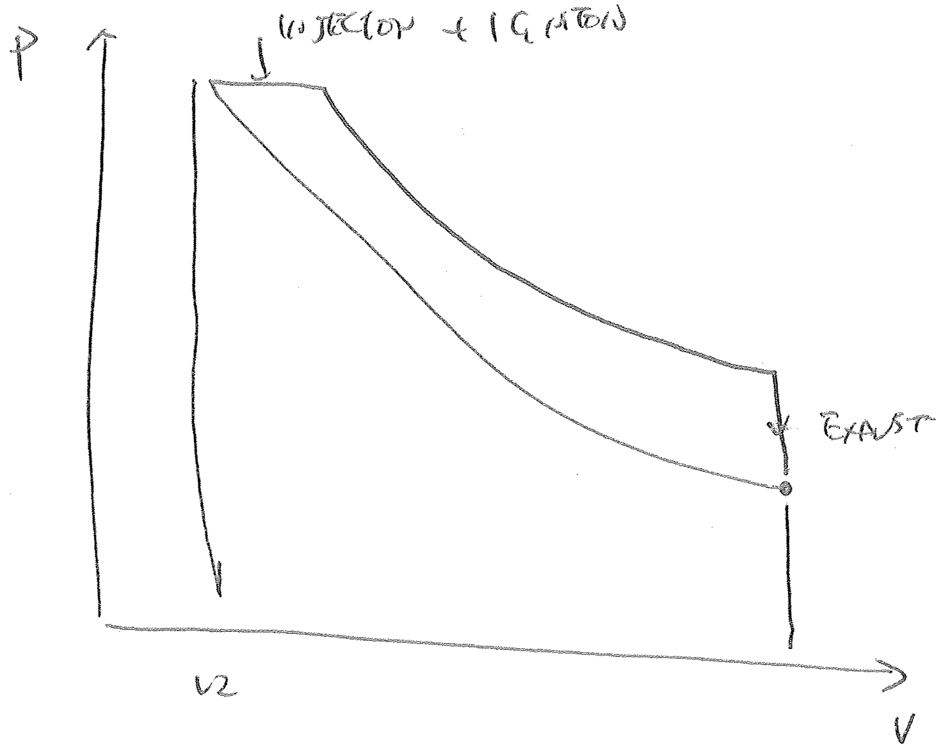
SINCE $TV^{\gamma-1}$ IS CONST

ε = < CARNOT

$$= 1 - \frac{T_1}{T_2}$$

REAL 20% - 30%

DIESEL PROCESS



OTTO CYCLE

~~M~~ $\varepsilon = \dfrac{Q_{23} - Q_{41}}{Q_{23}}$

$Q_{23} = C_V(T_3 - T_2)$

$Q_{41} = C_V(T_4 - T_1)$

$$\varepsilon = 1 - \frac{Q_{41}}{Q_{23}} = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$

ADIABATIC SO $TV^{\gamma-1} = \text{CONST}$ $\quad T_4 V_4^{\gamma-1} = T_3 V_3^{\gamma-1}$

$$\frac{T_4}{T_3} = \left(\frac{V_3}{V_4}\right)^{\gamma-1} = \left(\frac{V_2}{V_1}\right)^{\gamma-1} \qquad \frac{T_4}{\ } =$$

$$\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma-1}$$

$$\frac{T_4}{T_3} = \frac{T_1}{T_2}$$

$$\varepsilon = 1 - \frac{T_4 - T_1}{T_3 - T_2} = 1 - \frac{T_4\left(1 - \frac{T_1}{T_4}\right)}{T_3\left(1 - \frac{T_2}{T_3}\right)}$$

$$= 1 - \frac{T_4}{T_3} = 1 - \left(\frac{V_2}{V_1}\right)^{\gamma-1}$$