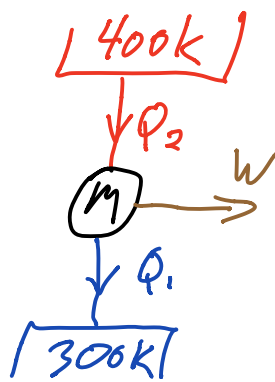


Carter, Problem 3-6  
Carnot engine

a.)  $Q_2 = 1200 \text{ kCal}$   
 $Q_1 = ?$



Carnot efficiency:

$$\eta = \frac{W}{Q_2} = \frac{Q_1 + Q_2}{Q_2} = 1 - \frac{T_1}{T_2}$$

solve for  $Q_1$

$$Q_1 = Q_2 \left(1 - \frac{T_1}{T_2}\right) - Q_2$$

$$Q_1 = \cancel{Q_2} - Q_2 \frac{T_1}{T_2} - \cancel{Q_2} = -Q_2 \frac{T_1}{T_2}$$

$$= -1200 \text{ kCal} \cdot \frac{300 \text{ K}}{400 \text{ K}} = -900 \text{ kCal}$$

b.)  $Q_1 = +1200 \text{ kCal}$   
 $Q_2 = ?$

Solve  $Q_1 = -Q_2 \frac{T_1}{T_2}$  for  $Q_2$

$$\Rightarrow Q_2 = -Q_1 \frac{T_2}{T_1} = -1200 \text{ kCal} \cdot \frac{400 \text{ K}}{300 \text{ K}} = -1600 \text{ kCal}$$

c.) Energy conservation:

$$Q_2 = W - Q_1 \Rightarrow W = Q_2 + Q_1$$

in a.)  $W = 1200 \text{ kCal} - 900 \text{ kCal} = 300 \text{ kCal}$

in b.)  $W = -1600 + 1200 = -400 \text{ kCal}$

$$d.) \text{ in a.) } \eta = \frac{W}{Q_2} = \frac{300 \text{ kcal}}{1200 \text{ kcal}} = \frac{1}{4} = 25\%$$

$$\text{in b.) } C_{ref} = -\frac{Q_1}{W} \quad \text{Eq 5.22}$$

$$C_{ref} = \frac{-1200 \text{ kcal}}{-400 \text{ kcal}} + 3$$