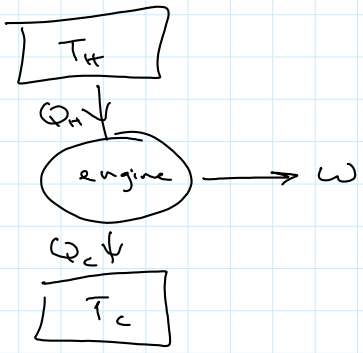
Phy 4C 1/27

Friday, January 27, 2017 10:44 AM

Goals for the Lecture:

1) Understand the Second Law of Thermodynamics and how it applies to heat engines
2) Understand the efficiency of a heat engine and how to solve problems using this concept
3) Understand heat pumps, refrigerators, and their coefficient of performance (COP) and how to use COP in solving problems
4) Understand the difference between reversible and irreversible processes

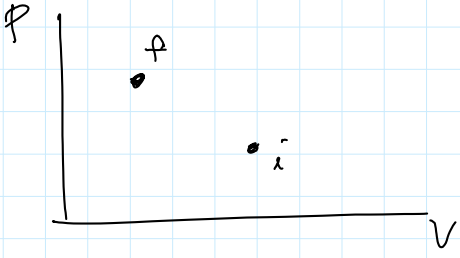
Heat engine:



$$|Q_H| = W + |Q_c|$$

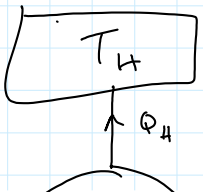
efficiency: $$e = \frac{W}{|Q_H|}$$

Reversible Process: very slow and frictionless (quasi-static)

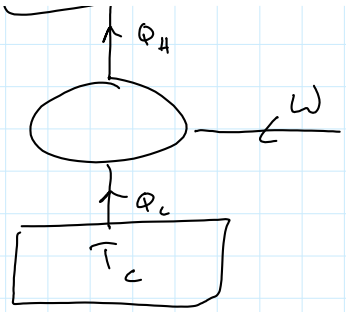


Refrigerators and Heat Pumps:

Refrigerator



$$|Q_c| = W + |Q_H|$$



$$|Q_c| = W + |Q_H|$$

Coefficient of Performance (COP)

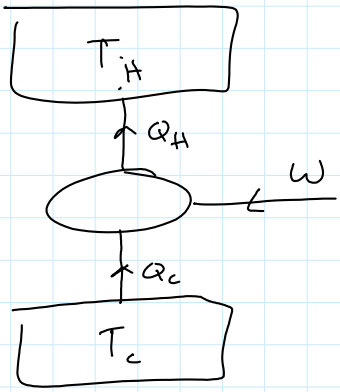
$$COP = \frac{|Q_c|}{W} = \frac{|Q_c|}{|Q_H| - |Q_c|} = \frac{1}{\left|\frac{Q_H}{Q_c}\right| - 1}$$

if reversible:

$$COP = \frac{1}{\frac{T_H}{T_c} - 1}$$

must be in kelvin

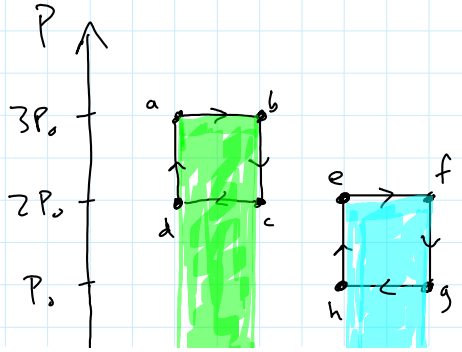
Heat Pump

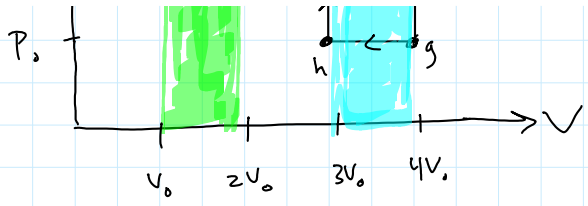


$$COP = \frac{|Q_H|}{W}$$

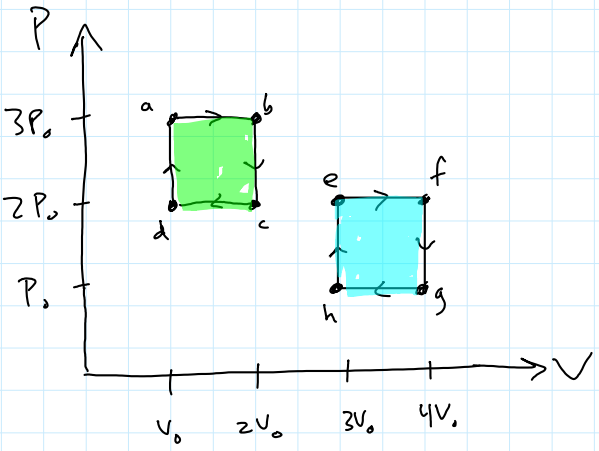
Worksheet p.274

a) $W_{a \to b} > W_{e \to f}$





b) $W_{b\to c} = W_{f\to g} = 0$



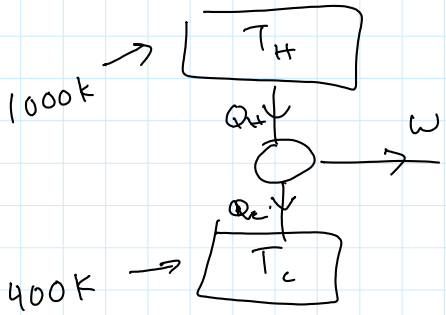
c) $W_{a\to b\to c\to d} = W_{e\to f\to g\to h}$

d) equal

same as c

since $W_{d\to a} = 0$

Worksheet p. 275



$W + |Q_c| = |Q_H|$

$e = \dfrac{W}{|Q_H|}$

Find W and e

efficiency of any heat engine: $e = 1 - \left|\dfrac{Q_c}{Q_H}\right|$

efficiency of a Carnot engine: $e = 1 - \dfrac{T_c}{T_H}$

$W = |Q_H| - |Q_c| = 2000\ J - 800\ J = 1200\ J$

$e = 1 - \dfrac{800}{2000} = 0.6$

should also be $e = 1 - \dfrac{T_c}{T_H} = 0.6$

a) $e = 1 - \frac{T_c}{T_H}$ increases

T_H ↑ in Kelvin

b) decreases

c) increases (Q_c stays same, Q_H increases)

d) decreases

$e = 1 - \frac{T_c}{T_H}$

this increases

so, e decreases

e) increase

Entropy: S

$\Delta S = \frac{Q}{T}$ for reversible processes