Today

I. Our Stamina Breaks for the Semester: We will take Friday Oct 23rd off, Wed Nov 25th, and Fri Nov 27th.
II. Summary of Midterm feedback for the Course
III. Last Time
IV. Refrigerators
V. Real Heat Engines

III. Talked about cyclones as Carnot engines. Starts with the ocean as a high temperature reservoir and the gas absorbs heat along an isotherm. Then the gas quickly rises along the wall of the storm in an adiabatic expansion. Then it goes through an isothermal compression in the high atmosphere and dumps heat. Finally it goes through an adiabatic compression as it quickly descends.

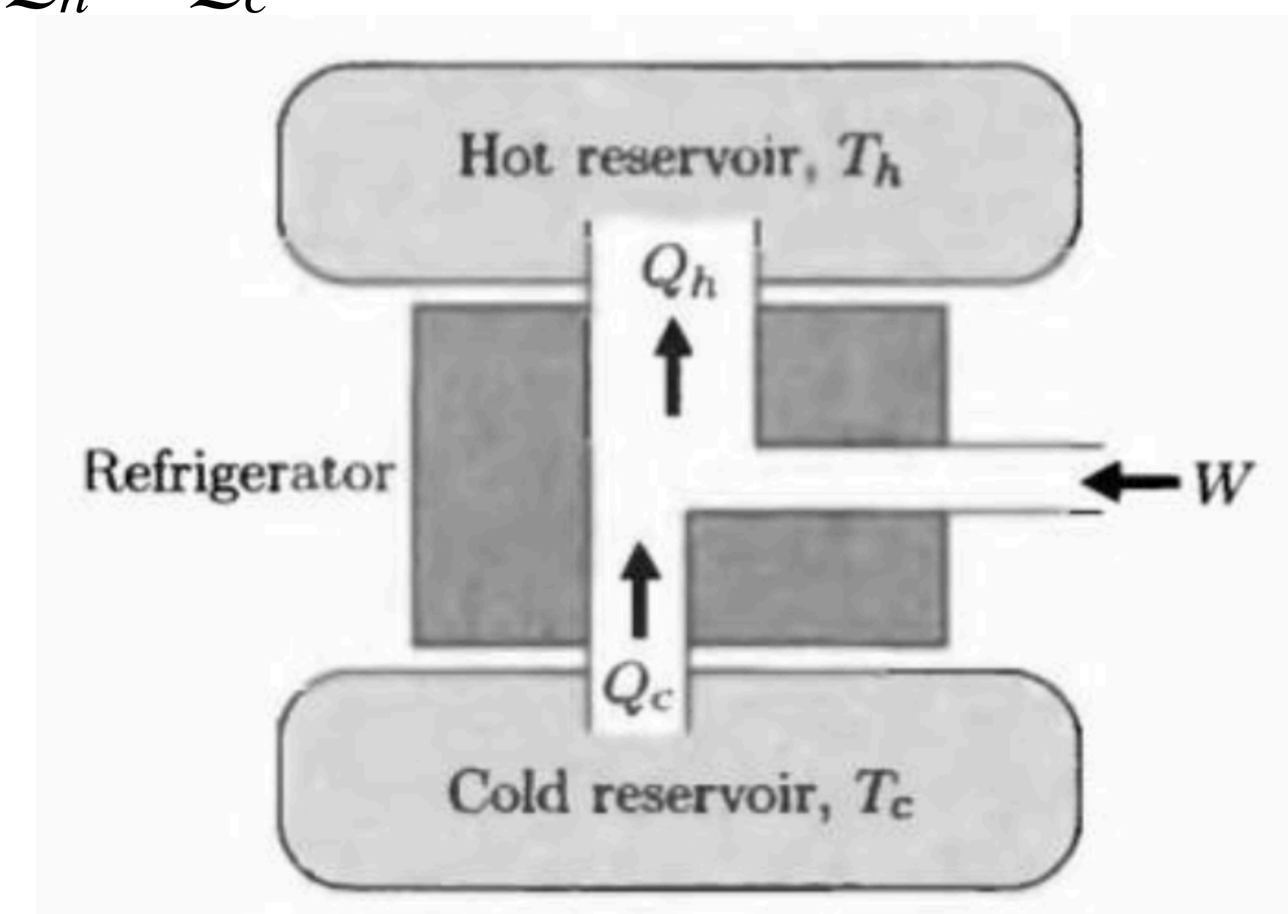
IV. We can consider refrigerators in a similar vein:\

$$\text{COP} = \frac{Q_c}{W}.$$

From the diagram, and specifically the 1st law $Q_h = Q_c + W$, then $W = Q_h - Q_c$ and we have

$$\text{COP} = \frac{Q_c}{Q_h - Q_c}, \text{ or}$$

$$\text{COP} = \frac{1}{Q_h/Q_c - 1}.$$



Let's bring in entropy

$$\frac{Q_h}{T_h} \geq \frac{Q_c}{T_c} \implies \frac{Q_h}{Q_c} \geq \frac{T_h}{T_c}.$$

This gives

$$\text{COP} \leq \frac{1}{T_h/T_c - 1} = \frac{T_c}{T_h - T_c}$$

IV. Real Heat Engines

Josh highlighted a problem with the Carnot engine: to get heat to flow you need the reservoirs and the working substance to have different temperatures, but this decreases the efficiency.

In practice real engines don't even try for the Carnot process.

A nice model for a real internal combustion engine is the "Otto cycle"