# Today

I. Our Stamina Breaks for the Semester: We will take Friday Oct 23rd off, Wed Nov 25th, and Fri Nov 27th.
II. Midterm feedback for the Course…I'd still love to hear more
III. Last Time
IV. Tropical Cyclones as Carnot Engines

III. Josh introduced us to heat engines, in particular, the Carnot engine, and he proved for us that it is as efficient as an engine can be.

$$e = \frac{W_{out}}{Q_{in}} = \frac{Q_h - Q_c}{Q_h} = 1 - \frac{Q_c}{Q_h} \leq 1 - \frac{T_c}{T_h}.$$ (many texts use $\eta$ for efficiency)

A Carnot cycle is made up of 4 pieces:

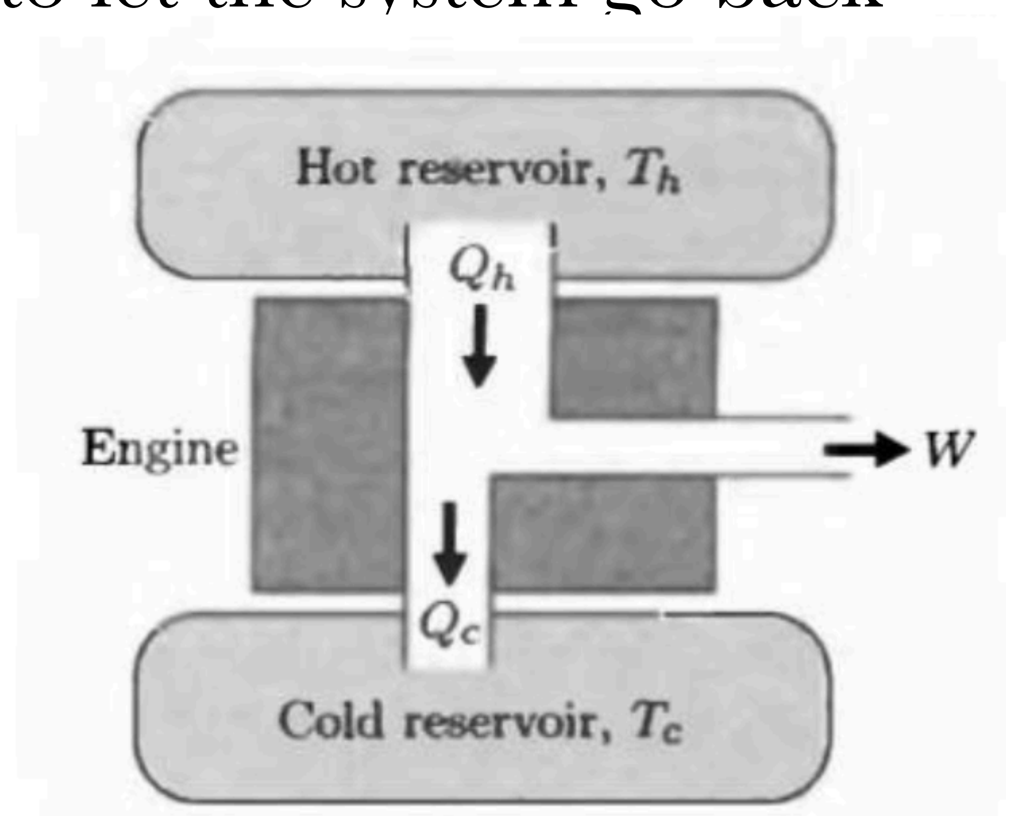
(i) Start with a high temperature reservoir and add heat isothermally.

(ii) Do an adiabatic expansion of the gas. This continues to do work on the environment, but no heat comes or out.

(iii) Dump heat into the cold reservoir via an isothermal compression.

(iv) Finally we do an adiabatic compression to let the system go back up to the high temperature.

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



IV. The Earth is heated by the sun. About 30% of the incoming sunlight is reflected back out into space. Much is absorbed, raises the surface temperature and cause two things re-radiation by the Earth in the infrared and convection of the atmosphere. The infrared radiation is more absorbed by the atmosphere and causes a second phase radiation down to the Earth, the so-called green house effect. This stabilizes with the Earth some 35K above the black-body temperature in space.

The convection causes cumulus and cumulonimbus clouds…

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Cumulus clouds

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Cumulonimbus clouds or Anvil clouds