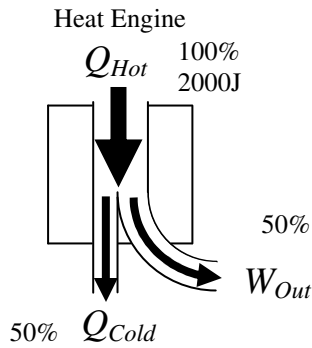


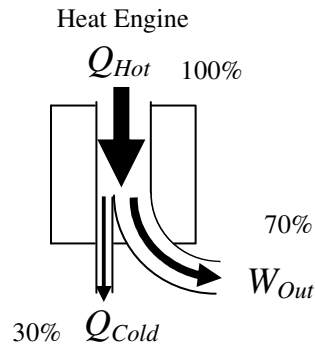
# Heat and Thermo 10



Notice that the  $Q_H$  arrow is equal to the  $Q_C$  and  $W$  arrows. So  $Q_H$  is the whole and the others are the parts.  $W$  is the useful work done by the engine.  $Q_C$  is the heat that is not used, so is “wasted” and is the inefficiency of the engine. This engine is 50% efficient.

$$\text{In general: } \text{Eff} = \frac{W_{\text{out}}}{W_{\text{in}}} \times 100$$

$$\text{For heat engines: } \text{Eff} = \frac{W_{\text{out}}}{Q_H} \times 100$$



This engine is more efficient because less heat is lost at  $Q_C$  and the useful work is a greater percentage of the absorbed heat ( $Q_H$ ). This engine is 70% efficient. Only 30% is lost to the environment.

- A heat engine does 55 J of work each cycle and expels 29 J of heat in the radiator.
  - How much heat was added at the boiler?
  - How efficient is the engine?
- A heat engine absorbs 4500 J per second from its fuel source. It gives up 3000 J to a cold reservoir each second.
  - How much work is done each second?
  - Calculate the engine’s efficiency?
- Adiabatic, isovolumetric, or isothermal?
  - \_\_\_ In the compressor of a refrigerator.
  - \_\_\_ In the boiler of a heat engine.
  - \_\_\_ In the piston of a heat engine.
  - \_\_\_ \* When heat is absorbed by the refrigerant while inside the refrigerator.
  - \_\_\_ When heat is dissipated in the coils at the back of the refrigerator.
  - \_\_\_ Steam is cooled after the piston of a heat engine.
  - \_\_\_ At the expansion valve of a refrigerator.
- +, -, or 0?
  - \_\_\_ \* Q for the refrigerant (the gas) inside the refrigerator compartment.
  - \_\_\_ W by the gas at the refrigerator’s expansion valve.
  - \_\_\_ Q for the refrigerant when outside the refrigerator compartment.
  - \_\_\_  $\Delta U$  for the refrigerant during one entire cycle.
  - \_\_\_ W by the gas in a heat engine’s piston.
  - \_\_\_  $\Delta U$  for any cyclic process.
  - \_\_\_ Q in the boiler of a heat engine.
  - \_\_\_ W for the refrigerant inside the refrigerator compartment.
  - \_\_\_ Q in the radiator of a steam engine (after the piston).

$$\text{A. } 55+29 = 84\text{J}$$

$$\text{B. } W/Q_H = 55/84 = 65\%$$

$$\begin{aligned} \text{A. } Q_H &= Q_C + W \\ W &= Q_H - Q_C \\ W &= 4500 - 3000 \\ W &= 1500 \text{ J} \end{aligned}$$