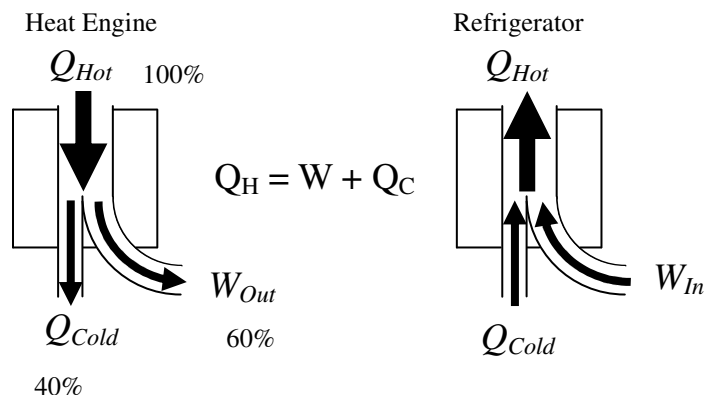


These two diagrams are key to solving many cyclic process problems. Notice that in BOTH CASES (engines and refrigerators) that $Q_H = W + Q_C$. The difference is whether work is added or removed.

Efficiency problems, the Q_C is the inefficiency, the lost energy, of the heat engine. Q_H is always 100% - if all of Q_H became work, then the engine would be 100% efficient, but remember some must be lost at Q_C . You can easily use proportions to find unknowns. Ex. An engine is 60% efficient and does 25 J of work. Therefore: $25/60 = Q_C/40 = Q_H/100$.



1. Q_H , Q_C , W or ΔU ?

- A. ____ Heat removed by the coils outside of a refrigerator.
- B. ____ When the refrigerant passes thru the expansion valve of a refrigerator.
- C. ____ Heat absorbed by the refrigerant inside the refrigerator.
- D. ____ Changes inside the compressor of a refrigerator.

1500 J of energy is added at the boiler of a heat engine. 600 J is lost when the steam is cooled. 900 J of useful energy is produced by the engine.

- E. ____ 1500 J
- F. ____ 600 J
- G. ____ 900 J
- H. ____ Is 0 for a cyclic process.

2. Adiabatic, isovolumetric, or isothermal?

- A. ____ In the compressor of a refrigerator.
- B. ____ In the boiler of a heat engine.
- C. ____ In the piston of a heat engine.
- D. ____ When heat is absorbed by the refrigerant while inside the refrigerator.
- E. ____ When heat is dissipated in the coils at the back of the refrigerator.
- F. ____ Steam is cooled after the piston of a heat engine.
- G. ____ At the expansion valve of a refrigerator.

3. +, -, or 0?

- A. ____ Q for the refrigerant inside the refrigerator compartment.
- B. ____ W by the gas at the refrigerator's expansion valve.
- C. ____ Q for the refrigerant when outside the refrigerator compartment.
- D. ____ ΔU for the refrigerant during one entire cycle.
- E. ____ W by the gas in a heat engine's piston.
- F. ____ ΔU for any cyclic process.
- G. ____ Q in the boiler of a heat engine.
- H. ____ W for the refrigerant inside the refrigerator compartment.
- I. ____ Q in the radiator of a steam engine (after the piston).

NOTE: "by the gas" is the same as "by the system".

4. Write the First Law of Thermodynamics for the compressor stage of a refrigerator. Be exact as for +'s or -'s.

5. A heat engine does 55 J of work each cycle and expels 29 J of heat in the radiator.

- A. How much heat was added at the boiler?
- B. How efficient is the engine?

6. A heat engine has an efficiency of 84%. If 3500J of work is done by the engine, how much heat is lost in the cycle?

