B-Day Due Tues., Tues 23 A-Day: Due Wed., Wed 24

2009-10 PreAP Thermo 3

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. $__\Delta U$ for the refrigerant during one entire cycle.
 - E. _____W by the gas in a heat engine's piston.
 - F. $__\Delta U$ 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).
- 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?

NOTE: "by the gas" is the same as

"by the system".

More notes: A hot object is placed inside a refrigerator. As the object cools it heats the air inside the refrigerator. This heat them moves to the walls of the refrigerator and is eventually absorbed by the actual refrigerant inside metal coils that are inside the walls. So, each of these is equivalent: heat is removed from inside the refrigerator; heat is absorbed by the coils in the walls of the refrigerator; heat is absorbed by the refrigerant inside the refrigerator.

- 7. What are the units for power?
- 8. What do the units for power break into?
- 350g of water at 15° is placed inside a refrigerator. The water is cooled to 4°C in 12 minutes. 25 kJ of heat is dissipates into the room from the coils behind the refrigerator.
 A. Calculate the heat removed from the water.
 - B. Remembering that 1 kJ = 1000 J, how much work was done by the compressor?

C. What is the power used by the compressor during the 12 minutes?

- 10. A piston circular cross sectional area with a diameter of 12 cm. The piston rises 8 cm in each stroke.62 kJ of work is done and 84 kJ of heat is ejected into a river with each power stroke.A. Calculate the pressure in the piston.
 - B. How much heat was added at the boiler?

C. How efficient is the engine?

AND DO THE TAKS HOMEWORK.