DAY 28

Homework Assignment (see syllabus for homework collection information)

1. If an engine takes in 100 J of energy in a cycle and exhausts 30 J of energy in a cycle, what is its efficiency? What is its work power output if the engine runs at a rate of 100 cycles/minute?

2. Explain in your own words why heat energy flows from hotter objects to colder ones and does not flow from cold to hot.

3. For an ideal gas in an isothermal process, there is no change in internal energy (the total energy of all the molecules in the gas). Suppose the gas does 1000 J of work during such as process. How much energy was transported by heat?

4. A steam-driven turbine is one major component of an electric power plant. Why is it advantageous to increase the temperature of the steam as much as possible?

5. Define the following and sketch each on a P-V diagram-- Adiabatic process; Isothermal process; Isobaric process; Isochoric process.

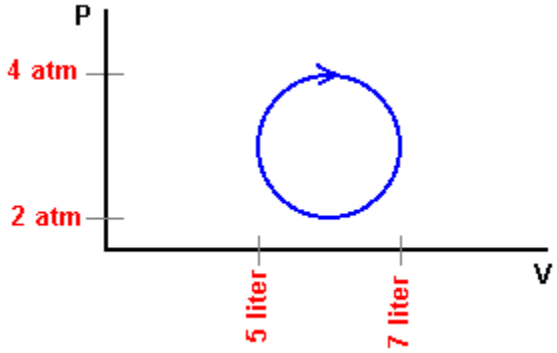
6. In the boiler of a steam engine water is converted to steam at a rate of 1 liter/minute. The boiler is pressurized to three times atmospheric pressure, which raises the temperature in the boiler and changes the latent heat of the water as shown in the table.

   The steam passes through a piston & cylinder, doing work, and is exhausted into the air which is at 20°C. Calculate the Carnot efficiency of the engine, and the power output of the engine if it is operating at Carnot efficiency. What will happen to the efficiency and power output if the pressure in the boiler is increased or decreased?

Pressure Atmos	Temp °C	Latent kJ/Kg
1	100	2257
2	120.42	2201.1
3	133.69	2163.3
4	143.7	2133.4

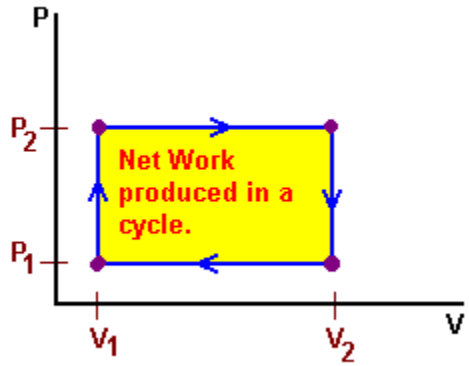
(Believe it or not I got these data from a "brew-your-own-beer" web page -- brewery.org! -- and confirmed it with a visit to Uconn: www.aes.uconn.edu/tools/steam.htm.)

7. Calculate the power output of an engine that operates in the cycle shown here if it runs at a rate of 1000 cycles per minute. If the engine's efficiency is 20%, at what rate does it take in heat?



8. If a heat engine were to use the Sun (5000 K) as a hot source, and space (3 K) as a cold source, what would be its Carnot Efficiency?

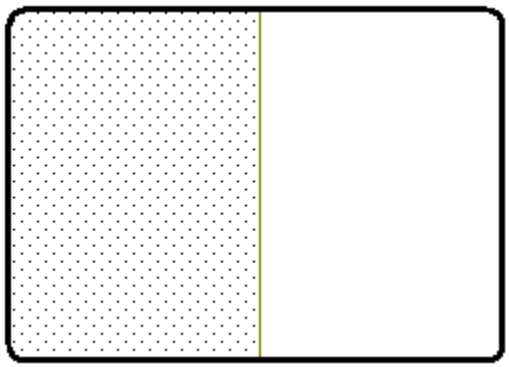
9. Suppose that a 5.0 liter engine operates on a simple rectangular cycle such as is shown at right. The compression ratio for the engine is 10:1. What is the engine's power output if it runs at 5000 RPM? What would be the engine's power output if the compression ratio were increased to 11:1?



Note: "5.0 liter with 10:1 compression" means that the pistons of the engine sweep out a volume of 5.0 liters, and compress the air in that volume by a factor of 10. Assume the air enters the engine at a pressure of P_1 = 1 atm.

10. A video camera records a superball and a glass Christmas tree ornament striking a tile floor. Discuss which of these could possibly pass the "time reverse" test and which would not and why. Mention entropy in your discussions.

11. The container shown has a volume of 1 m^3. The left half is filled with a gas whose pressure is 1 atm and whose temperature is 20°C. The barrier that divides the container is broken. Calculate the probability that the random motions of the gas molecules will cause them to end up on one side of the container again. Is the gas in the container likely to return to its ordered, half-and-half state any time in the next few billion billion years?



HINT – figure out how many gas molecules there are, first, using the Ideal Gas Law. Then, after the barrier is broken, the chance that any one molecule will be found on the left side is 50% or ½.