Physics 123 section 2 CID ____________

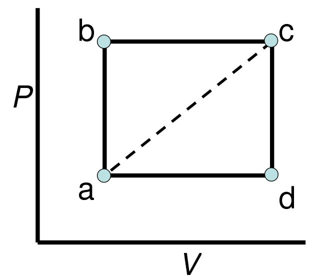
Homework 9

Score ________ / 30

1. (4 pts) (a) Can a given amount of thermal energy be converted completely into mechanical energy? Why/why not? (b) Can a given amount of mechanical energy be converted completely into thermal energy? Why/why not?

2. (4 pts) A heat engine absorbs 1000 J of heat and puts out 210 J of work each cycle. The engine goes through 2 cycles each second. (a) How much heat is exhausted per cycle? (b) How much heat is exhausted each second? (c) What is the efficiency of this engine?

For the next two problems, consider n moles of an ideal gas with $\gamma = 5/3$ which is taken through the cycle shown and described below. Give all answers in terms of n, P_0, V_0, and fundamental constants.



We start with n moles at and pressure P_0 and volume V_0. The pressure is then increased to $3P_0$ while keeping the volume constant. Then, at constant pressure, the volume is increased to $(7/2)V_0$. The pressure is then reduced back to P_0 at constant volume. Finally, while maintaining the pressure at P_0, the volume is reduced back to V_0.

3. (8 pts) (a) What is the work performed by the gas as it undergoes one cycle? (b) What is Q_h for this cycle? (c) What is the highest and lowest temperatures that the gas reaches during this cycle? (d) What is the efficiency of this cycle?

4. (4 pts) Now I change the cycle to eliminate point d by going from c to a along the dotted line in the $P-V$ diagram. (a) What are the highest and lowest temperatures that the gas reaches during this modified cycle? (b) What is the efficiency of the modified cycle?

5. (6 pts) An single cylinder ideal gasoline engine (no friction, etc.) is going through the Otto cycle. The maximum volume of the cylinder is 1.5×10^{-3} m^3, the compression ratio is 7.21:1, and the output power of the engine (work done per unit time) is 75 kW. Assuming that the air in the cylinder behaves like an ideal gas with $\gamma = 7/5$, (a) What is the efficiency of the engine? (b) How much heat is exhausted by the engine second?

6. (4 pts) I found a table on the web that claims that for a car engine with a 7:1 compression ratio, gasoline with an octane of 87 should be used. Use this information to estimate the temperature at which 87 octane gasoline vapors will spontaneously ignite. Assume an ambient air temperature of 25 °C and a γ of 7/5.

Extra problems I recommend you work (not to be turned in)

- Check out problem 22.6 in your text.

- (a) If you increased the γ for the air in the engine in problem 6, how would this change the maximum compression ratio you could use with 87 octane gas? (b) How would this combination of increased γ and altered maximum compression ratio change the efficiency of the engine?