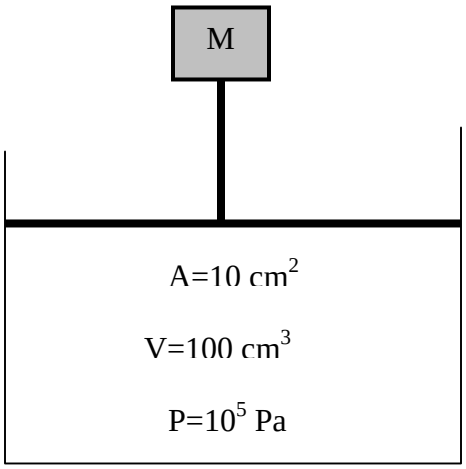
Physics 206b

Homework Assignment III
due September 7, 2007

As announced in class, Exam #1 has been rescheduled. It will be administered on Friday, September 14th. Please let me know as soon as possible if this causes any conflicts.



1. (This problem was originally assigned as problem #10 on assignment #2.) Consider the sample of ideal, monatomic gas in a cylinder sealed by a piston shown above. Neglect any pressure of atmosphere outside of the cylinder. If the mass is $m = 10.2\,kg$, how much heat must flow into the gas to raise the mass a distance of 2 cm? What will be the temperature of the gas when this is achieved?

2. Again consider the system above. If the monatomic ideal gas were replaced by a diatomic ideal gas, how much heat would need to be added to the system to achieve the same result? Will the final temperature be different in this case?

3. One hundred moles of an ideal, monatomic gas fills a cylinder at a pressure of $1\times10^5\,Pa$ at 300 K. The sample then undergoes the following set of processes:

    a. The sample's pressure is kept constant (as in the problem above) but heat is added to it to increase its volume by 500 ml.

    b. Next, the piston is clamped in place so that the volume is fixed while the gas is cooled down. Its temperature is reduced until its pressure is reduced by $2.5\times10^4\,Pa$.

c. The mass sitting on the piston is reduced to maintain the new pressure and the gas is compressed by 500 ml (back to its original volume). This may require the addition or removal of heat.

d. Finally, the volume of the gas is fixed and then heat is added or removed from the gas to increase its temperature back to $1\times10^5\,Pa$. Note that this returns the system back to its original configuration.

i. How much net work is done *by* or *on* the piston in this cycle?

ii. For each of the four steps, determine how much heat must be added to or removed from the system.

iii. Assuming that any heat removed from the system is lost, what is the efficiency of the process? This is the ratio of net work done by the system to total energy added to the system.

4. Heat is added to a system consisting of a cylinder filled with a monatomic ideal gas and a piston that is *not* constrained to have a constant pressure. The pressure is (somehow) continuously adjusted so that the volume increases as heat is added to the system without the temperature changing. The temperature is maintained at 500 K. The system begins with a pressure of $3\times10^5\,Pa$ and a volume of 2 liters. At the end of this isothermal process, its volume is 3.5 liters. How much work was done in this process? How much heat had to be added to the system to achieve this work?

5. If a refrigerator has a coefficient of performance ("efficiency") of 2.5, how long will it take your refrigerator to cool $1\,\mathrm{L}$ of boiling water to one degree above freezing if the refrigerator draws 1 kW?

6. You see advertised a motor that claims that for every Joule of energy it gets out of burning fuel at $700\,^\circ\mathrm{C}$, given the world average temperature of 15 °C, it can on average do 0.85 Joules of work. Is such a motor feasible?