Physics 123 section 2 CID ____________

Homework 5

Score ________ / 30

1. (5 pts) An ideal gas is held in a thin-walled elastic container which can stretch and increase its volume as the gas is heated. It stretches in such a way that the pressure of the gas is always equal to $AV^{1/2}$ where V is the volume of the gas and A is a constant. The gas has an initial volume of 0.1 m^3 and a pressure of 1.013×10^5 Pa. The gas is then slowly heated until its pressure is 2.211×10^5Pa. (a) What is the constant A? (b) How much work is done by the gas as it expands? (c) How much work is done by the atmosphere around the container as the gas inside the container expands? (hint, the work done by the atmosphere should be negative, since the volume of the atmosphere is decreasing as the container expands) (d) You should have found that the gas did more work than the atmosphere absorbed. Where did the rest of the energy go?

2. (5 pts) An ideal gas is contained inside a cylinder with a moving piston on the top. The piston has a mass m which keeps the gas at a pressure P_0. The initial volume of the gas is V_0. For this whole problem give your answers in terms of P_0 and V_0.

- **(a)** The gas is heated until the volume has expanded to twice its initial volume. How much work is done on the gas do during this process?
- **(b)** By what factor does the temperature increase during this expansion?
- **(c)** The piston is then locked in place and the gas is cooled back to its original temperature. What is the pressure of the gas after it is cooled?
- **(d)** How much work is done on the gas as it is cooled?
- **(e)** The cylinder is then placed in a bucket of water which keeps the temperature constant (at the original temperature), and the piston is released and allowed to slowly drop until the gas returns to its initial pressure P_0. How much work is done on the gas during this process?
- **(f)** Draw a $P-V$ diagram of this sequence of processes. Label the initial state of the gas A, the state after expanding B, and the state after it is cooled C.

3. (5 pts) An ideal gas is initially at atmospheric pressure with a volume of $0.3\,\mathrm{m}^3$.

- **(a)** The gas is then heated at constant volume until the pressure doubles. During this process 1,200 Joules of heat flow into the gas. How much work does the gas do? (Note, unlike the last problem, I've asked you how much work the gas does rather than how much work is done on the gas. Remember that the two quantities differ by a minus sign.)
- **(b)** What is the change in the internal energy of the gas as it is heated?
- **(c)** Now the pressure of the gas is kept at 2 atmospheres and the gas is heated while it's volume increases to twice its initial volume. In the process the internal energy of the gas increases by 1,000 Joules. How much work does the gas do?
- **(d)** How much heat flows into the gas during the expansion?
- **(e)** Draw a $P-V$ diagram of this sequence of processes. Label the initial state of the gas A, the state after the constant volume process B, and the state after the constant pressure process C.
- **(f)** Show that the total work done by the gas through both processes is equal to the area under the curve in the $P-V$ diagram.

4. (5 pts) A $10\,\mathrm{cm}^3$piece of copper is heated from a temperature of $25\,^\circ\mathrm{C}$ to a temperature of $35\,^\circ\mathrm{C}$. (a) How much work does the copper do on the atmosphere as it is heated? (b) How much heat does the copper absorb? (c) How much has the internal energy of the copper changed by?

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

- Work a bunch of the section 20.5 and 20.6 problems from the textbook.