Physics 224A **Problem Set 5** May 2007

Due Wednesday, May 9, 2007

Questions for grading:

1. What is the root mean square velocity of sodium atoms (^{23}Na) at 1.0 μK (1.0×10^{-6} K)?

If sodium atoms are held in a trap at this temperature and then suddenly released, so that they are only subject to the gravitational force, how far will an atom going at the root mean square velocity in a horizontal direction have dropped by the time it has traveled 5 mm horizontally from the trap?

2. (Giancoli, problem 18-55) The temperature of an ideal gas is increased from 120 C to 290 C, while the volume and number of moles stay constant. By what factor does the pressure change? By what factor does $v_{\rm rms}$ change?

3. (Giancoli problem 19-57) A sample of 770 mol of nitrogen gas is maintained at a constant pressure of 1.00 atm. in a flexible container. The gas is heated from 40 C to 180 C. Calculate (a) the heat added to the gas, (b) the work done by the gas, and (c) the change in internal energy.

4. (From Giancoli, problem 18-58) At room temperature it takes about 2450 J to evaporate 1 gram of water.

(a) What speed should the molecules have had before they escape from the water, if you assume that this energy loss comes from a potential energy that holds the molecules in the liquid phase?

(b) What is the ratio of this speed needed to escape to the root mean square speed of the molecules in the water?

Remember that latent heat of vaporization largely represents an increase of the average internal energy of the molecules as they escape from the attractive forces of their neighbors. Therefore only those molecules with the most energy can escape at all.

Other questions:

5. (Giancoli problem 19-54) The specific heat at constant volume of a particular gas is 0.762 kJ/kg K at room temperature, and its molecular mass is 34.

(a) What is its specific heat at constant pressure?

(b) What do you think might be the molecular structure of the gas?

6. What is the root mean square of the x component of the velocity of the center of mass of N atoms, each of mass m, if the system is in thermal equilibrium?

Does this agree with what you have been told about the root mean square velocity of molecules like nitrogen or ozone, with several identical atoms?

7. If hydrogen atoms in the center of a star have a temperature of 2.0×10^7 K, what is their root mean square velocity? I have changed the temperature in this question to match a star like the sun.