Homework #7 Phys 711 Fall 2008

1. Review example 7.1 on page 166 in the book. Do this in preparation for hand-in problem #1.

2. Work through example 7.9 in the book, filling in the missing details. Do this in preparation for hand-in problem #2.

Hand in

1. Work through exercise 7.2 on page 168 in the book, filling in the missing details. Compare this method (using the canonical ensemble) to example 6.2 on page 153 in the book (which uses the microcanonical ensemble).

2. Consider a classical system of N noninteracting diatomic molecules enclosed in a box of volume V at temperature T. The Hamiltonian for a single molecule is

$$H\left(\vec{r}_1, \vec{r}_2, \vec{p}_1, \vec{p}_2\right) = \frac{1}{2m}\left(\left|\vec{p}_1\right|^2 + \left|\vec{p}_2\right|^2\right) + \frac{1}{2}L\left|\vec{r}_1 - \vec{r}_2\right|^2$$

where $\vec{r}_1, \vec{r}_2, \vec{p}_1, \vec{p}_2$ are the coordinates and momenta of the two atoms in a molecule.

   a. Find the Helmholtz free energy of the system.

   b. Show that the specific heat at constant volume is $\frac{9}{2}Nk$.

   c. Find U/N, and compare your result to what the equipartition theorem suggests.

   d. Show that the mean-square molecular diameter $\left\langle\left|\vec{r}_1 - \vec{r}_2\right|^2\right\rangle$ is $\frac{3kT}{L}$.