PHY 540 **Statistical Mechanics** Spring 2007

Homework 02

(due Tuesday Feb. 13)

Problem 2.1. (To be graded of 30 points.) Find all thermodynamic properties of an ideal classical gas of $N >> 1$ identical atoms contained in volume V at temperature T, starting from the microcanonical distribution (rather than from the Gibbs distribution), neglecting the internal energies of the atoms.

Hints:

(i) Try to make a more accurate calculation than has been done in class for the system of N harmonic oscillators. For that you will need to know the volume of an n-dimensional hypersphere of the unit radius. To avoid being too cruel, I am giving it to you:

$$v_n = \frac{\pi^{n/2}}{\Gamma\left(\frac{n}{2}+1\right)},$$

where $\Gamma(x)$ is the gamma-function. (For its definition and properties, see, e.g., Abramowitz and Stegun, Ch. 6.)

(ii) One more piece of math which you will need (and should know!) is the so-called Stirling formula whose crudest form (sufficient for the purposes of our course) is

$$\ln(n!)_{|n\to\infty} \to n\ln n - n.$$

(iii) Think how to account for the exact similarity of the atoms. This will set a good background for our future discussion of the gas-mixing ("Gibbs") paradox.