Candidacy Exam

Spring 2005

Statistical Physics

(30 pts) 1. A cube has its sides uniquely numbered with the numbers one to six. When the cube is rolled, each side is equally likely to be face up.

a) For a single roll, what is the average value of the face-up number?

b) What is the standard deviation for the value of the face-up number for a single roll?

c) In an experiment, the cube is rolled 1,000 times, and an average value of the face-up number is calculated. Call this result $\overline{n}$. Obtain the probability distribution for the value of $\overline{n}$.

(40 pts) 2. A system consists of N atoms located on N lattice sites, and is at a temperature, T (N large). Each atom behaves like an independent quantum harmonic oscillator. Write down an expression for the partition function. Calculate the Helmholtz Free energy, F, the entropy, S, and energy, E, of the system.

Graph $\frac{S(T)}{N}$ and $\frac{E(T)}{N}$

(30 pts)3. Consider an ideal Fermi gas, and an ideal Bose gas. For each of them, calculate the temperature, T_0, at which the chemical potential, μ, goes to zero. You may treat integrals such as $\int_0^\infty dx \frac{x^{\frac{1}{2}}}{e^x \pm 1}$ as constants: You do not need to determine the value of these constants.

Draw a graph of $\mu(T)$ for each gas.