**PROBLEM SET 1**

Due:

1. Consider a one dimensional random walk. Starting with the binomial distribution for the number of ways, , to move from the origin to  in N steps,



and using the Stirling Approximation for large x,



show that

 .

1. Using the Gaussian approximation for an ideal long polymer,



directly compute

, , and .

1. An ideal chain of N monomers has positive charges (+Ze) at each end. Calculate the average end-to-end distance if the chain is immersed in a solvent of dielectric constant ε. Use cgs units where the force between two charges separated by a distance r is (+Ze) is (Ze)2/ εr2.
2. A four step polymer in one dimension consists of left- and right-directed bonds of unit length. a) How many configurations of the chain have the end four units to the right of the beginning? How many have the end three steps to the right? Two? One ? Zero? b) Find <r4>/<r2> for this polymer and compare with the corresponding ratio for a one-dimensional Gaussian chain.
3. The radius of gyration, Rg, of a distribution of N point masses located at positions **rm,** is defined by

Rg2 = N-1Σm (**rm** - **r**cm)**2**

where **r**cm is the position of the center of mass of the distribution. For a Gaussian polymer chain, show that

<Rg2> = (1/6)R02

where R0 is the rms end-to-end distance.

1. An "elongational flow" field may be made by aiming two round nozzles at each other underwater, then sucking water out through both nozzles at the same rate. Any polymers at the center of this contraption are pulled towards both nozzles at once. The effect is roughly equivalent to a force pulling on each end, of the form bz2, where z is the distance from the center along the nozzle axis. The coefficient b is proportional to the flow rate. One can detect the amount of elongation <z> induced in the polymers by the flow. Treating the polymer as a spring how does <z> vary with b when b is small? As b is increased beyond a certain point, an abrupt change happens to the polymer. Describe this change and determine the value of b at which it occurs.
2. Using the Gaussian distribution for an ideal polymer (Problem 2), calculate <x> for an applied force, f, in the x direction.