PHY307 HWK ASSIGNMENT Monte Carlo #2, due by the start of class Nov. 19, 2002:

You will apply random walks to bacteria and financial markets.

Problems:

1. Tumbling Bacteria. Lowly bacteria get kicked around a lot. They get shoved side to side by vibrating water molecules and they also get turned around in direction. They can't swim straight for long distances. Download the code **EColi.py** from the course web page. Trust that it works properly. When you run it, how long does it take for buffeting molecules to cause the E. Coli bacteria to lose its original direction, defined as pointing roughly down, when it starts moving by pointing up? Run the simulation several times to estimate the average time for the E. Coli to be turned by Brownian motion.

2. Tumbling Markets. Random walks have applications in many areas. One is in the stock market. Write a code similar to your **walk1d.py**. You want it to simulate the price of a stock over time, rather than the position of a random walker. You don't want the frame or the cylinder or the sphere or any 3D visualizations, just the 2D plot. (Import only **visual.graph** and **random**.)

   Assume that the stock starts at price $100.00. (Assign a variable **price** with this initial value.) Have a loop over 50 weeks. Each time step (one week), multiply the stock's price by a random number between 0.9 and 1.15, representing that it can go up by up to 15% or down by 10% each week and plot the new price, with the week number as the *x*-axis. After the **for** loop, simply print out the stock price.

   Include a sample plot of price versus time.

   Then run your simulation 10 times and use your results to estimate the average price of the stock after 50 weeks.

3. [FOR PHY607 STUDENTS] Finding the value of an option. Carry the previous simulation further. There are all kinds of options, where you essentially make a bet on the future price of a stock. You might buy an option to purchase a stock at a particular price at a particular time, for example. That is, you can purchase the option to buy a share of stock at a particular price, the strike price, 50 weeks in the future. For a stock with the behavior in problem 2, what is the fair value of an option to purchase a share at a strike price of $250.00 after 50 weeks (assuming no inflation and that the interest rate is zero, so that alternative investments make no money)? That is, you pay some money up front and after 50 weeks, if you wish, you can purchase the share for the price of $250.00 from person B. How much money will person B want, under the assumptions here and in problem 2? To compute this, you will want to run the stock simulation a number of times, each time computing the value of the option at 50 weeks. The value of the option at that time will be zero if you won't want to exercise your option, but will be worth the profit if you do want to exercise your option. You will want to exercise your option if the stock is worth more than the strike price at the end of 50 weeks. Find the expected or average value of the option over a number of random histories. How does the value of the option change for different strike prices, say for strike prices from $200.00 to $600.00, in steps of $50.00? You won't need graphics to solve this problem and if you abandon them, your code will run faster.