Assignment #1

due Feb. 10

1. Make an order of magnitude estimate of the following:

(a) The thickness of a page in your book.

(b) The number of pennies you can fit into a jar that is 6 inches in diameter and 8 inches high.

(c) The number of copies of a 200 page paperback novel that can be stored on an 80 GB hard drive. (In case you didn't know, a GB = 10^9 bytes, and each byte can represent a number from 0 to 255.)

2. An astronaut in zero gravity swings a ball on the end of a string in a circle over her head with constant speed. This problem concerns the tension, which is equal to the force exerted by the string on the ball. Do this problem using only dimensional analysis.

(a) What quantities do you need to know in order to determine the tension of the string? Make sure that these quantities are independent, *i.e.* you cannot determine any one from all the others.

(b) What are the dimensions of tension in terms of M, L, and T?

(c) Find a formula in terms of the quantities in part (a) that has the same dimensions as the tension. Is it unique?

(d) If the astronaut doubles the speed at which the ball is moving, what happens to the tension?

3. Sketch a graph of position as a function of time, velocity as a function of time, and acceleration as a function of time for each of the following situations. For each situation, draw the three graphs above each other, so that equal times correspond to the same position on the horizontal axis.

(a) A car is initially going at a constant speed on a highway. It then speeds up to pass a truck, and then slows down to its original speed.

(b) A raindrop falls from a cloud. It initially experiences only the force of gravity, but air resistance eventually causes it to approach a constant final velocity ('terminal velocity').

(c) A rubber ball is dropped from rest. It hits the floor and bounces several times. Each time it bounces, it goes slightly less high than the previous bounce.

More soon...