Name: ID:

General Physics I (151)

Discussion Questions #1

Measurement and Motion

1. Dimensional Analysis & Similarity

a) One end of a spring is attached to a sturdy block, and a mass m is attached to the other end of the spring. Let Δx = the displacement of the mass from its rest position.

If the mass is displaced, the spring exerts a force on the mass, which makes it oscillate back and forth. The acceleration of the mass is given by the formula

$$a = \frac{k}{m}\Delta x$$

where k is called the spring constant. What are the dimensions of k?

b) Two masses M and m are separated by a distance r. The magnitude of the gravitational force between them is given by

$$F_{\text{grav}} = G\frac{Mm}{r^2}$$

where G is Newton's constant. Suppose M is changed by a factor A and r is changed by a factor B, that is, $M \to AM$, $r \to Br$. Then the gravitational force between the masses changes, $F_{\text{grav}} \to CF_{\text{grav}}$. Find C in terms of A and B.

2. Colliding Particles with Constant Velocities in One Dimension

Initially, at time $t = 0$, two marbles A and B are separated by a distance L and are moving towards each other at constant speeds v_{A0} and v_{B0} respectively. Let's take A moving to the right, B to the left. You can take the position of A to be $x_A = 0$ at t = 0.

a) In this part of the problem, assume that you are given L, v_{A0} and v_{B0} (initial data).

i) By $x_A(t)$, we mean the position of A as a function of time. Write out an expression for $x_A(t)$ in terms of the initial data.

ii) Write out an expression for $x_B(t)$ in terms of initial data.

iii) Let t_{hit} = the amount of time until the marbles collide. Find t_{hit} in terms of the initial data.

iv) How far has A traveled?

b) In this part of the problem, assume that you know v_{A0}, v_{B0} and t_{hit}.

Find the initial separation L.

3. Estimation

Estimate the number of drops of water in the ocean. Here "drop" is a precise volume measure, where there would be a fixed number of metric drops in a milliliter. Since this is an estimate, you can make fairly drastic approximations about the shape of the ocean bed, for example, that the ocean has a constant depth D.

Suggestion: First give your answer in terms of D, and other parameters you use in making the estimate. Then substitute in numbers as a last step. State your approximations clearly!