Name ______________________________

Section ____________ Date ___________

Physics 211 PreLab #8: Simple Harmonic Motion

Getting a Sense of Déjà Vu

Periodic motion is motion that repeats itself. Such motion generally results when a system is disturbed from its equilibrium position and the forces generated within the system as a result tend to restore the system back to its equilibrium position. The result is oscillatory motion of the system about its equilibrium position. The types of oscillatory motion you are perhaps most familiar with include such diverse phenomena as the motion of a child's swing and the motion of the moon around the earth. Also, oscillatory motion influences many lesser-known phenomena around you - for example, the timing mechanism in a watch relies upon oscillatory motion, and oscillations of water molecules cause food to cook in a microwave oven.

A special type of oscillatory motion, known as simple harmonic motion, occurs when the "restoring" force experienced by an object pushed away from equilibrium is proportional to the object's displacement from equilibrium, $F = -kx$, where k is a proportionality constant, and x is the displacement from equilibrium. In this laboratory, you will use the experimental setup shown in Figure 1 to study simple harmonic motion of a hanging mass.

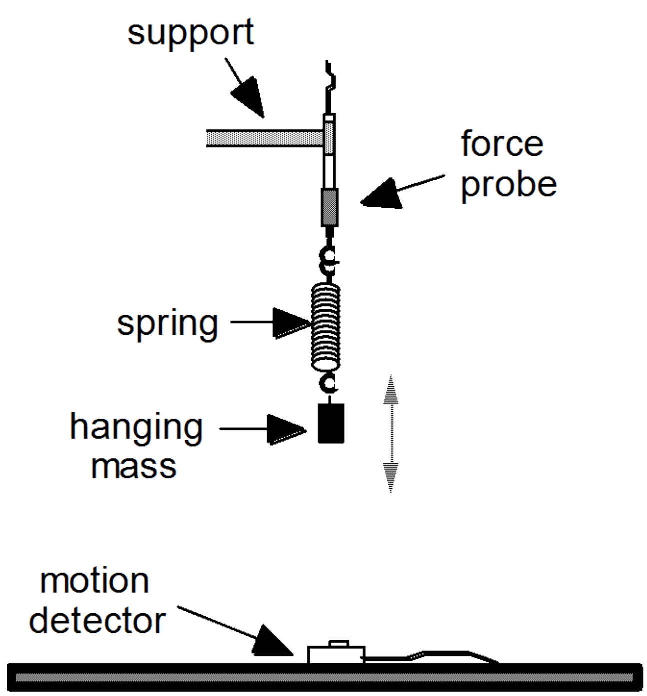

Figure 1. Experimental setup for Laboratory 8

In Activity 1, you will study the relationship among the displacement, velocity, acceleration of a mass experiencing simple harmonic motion.

Answer the following question concerning Activity 1.

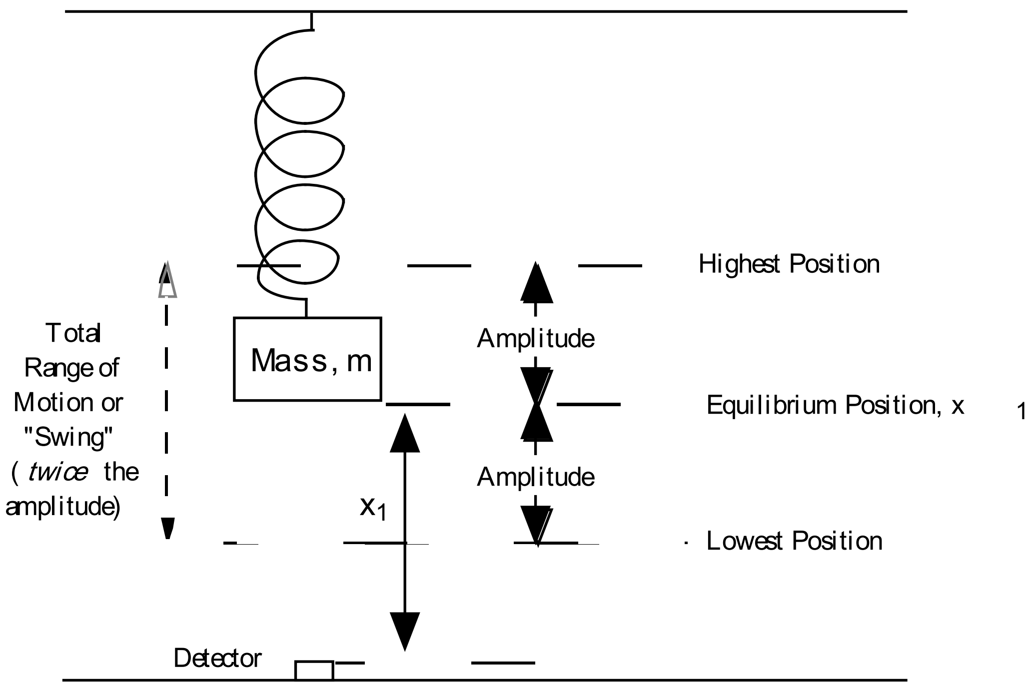

Figure 2. Experimental setup for Question 1

Q1 - A mass oscillates with simple harmonic motion according to the equation

$$x(t) = 6.0 \cos(3\pi t + \pi/3)$$

where *x* is the displacement from equilibrium in units of meters, *t* is in units of seconds, and the argument of the cosine function is in units of radians. What is (a) the displacement, (b) the velocity, and (c) the acceleration as a function of time. Also, what is (d) the phase at t = 2.0 seconds? Finally, determine (e) the frequency, *f*, (f) the period, and (g) the amplitude of the motion.

In Activities 2-4, you will explore the dependence of an object's period during simple harmonic motion on the displacement amplitude, the spring constant, and the object's mass.

Answer the following question related to Activities 2-4.

Q2 - A massless spring having a spring constant $k = 19$ N/m hangs vertically. An object of mass m = 0.2 kg is attached to the free end of the spring and then released. Assume that the spring was unstretched before the body was released. Find (a) the maximum distance the object descends below the initial position, and (b) the frequency and amplitude of the resulting simple harmonic motion.

In Activities 5 and 6, you will study the energetics of an object experiencing simple harmonic motion, and will investigate the influence of frictional damping on the object's energy.

Answer the following question related to Activity 5.

Q3 - An object attached to a spring experiences simple harmonic motion (define the potential energy of the object + spring system to be zero when it is in equilibrium). Question: (a) When the displacement of the object is one-half the maximum amplitude A, what fraction of the total energy is kinetic and what fraction is potential? (b) At what displacement x is the total energy half kinetic and half potential?