PHYSICS 126 EXPERIMENT NO. 5
SIMPLE HARMONIC MOTION

The phenomenon of simple harmonic motion will be studied for masses on springs and suspended pendulums. Such motion occurs in any system for which the force exerted on a mass is linearly proportional (by a negative constant) to its displacement from equilibrium. The relationship may be written in general as $\mathbf{F} = -m\omega^2\mathbf{x}$, where **m** is the mass, ω is the angular frequency, and **x** is the displacement from equilibrium.

A. Equipment

1 air track, 1 glider with “flag”, 1 photo-gate and timer, audio tape, small masses, 1 simple pendulum.

B. Method

Throughout the experiment, a system (either a glider between springs, or a pendulum) will be displaced from equilibrium. The period, τ, of the resulting motion will be measured. The dependence of the period on the amplitude of the motion will be assessed. For true simple harmonic motion, there should be no dependence of the period on the amplitude.

C. Procedure

I. Measurement of the Spring Constant.

1. Your glider is held between two springs. Record its equilibrium position.
2. Attach a piece of audio tape to the glider and lay it across the "air pulley" with a small mass suspended on the end of the tape.
3. Measure the displacement of the glider from equilibrium for 4 different hanging masses.
4. Graph the weight of the hanging mass (y axis) vs. the measured displacement.

Q1. Is your weight-displacement curve linear? Comment.

5. Determine the spring constant, **k**, from your graph.

II. Measurement of the Period of the Motion.

1. Remove the audio tape and place the photo-gate so that it is centered over the flag on the glider when the glider is at equilibrium. Measure the mass of the glider.
2. Set the Pasco Timer to "two-pulse" mode. This will measure the time interval between two successive times at which the flag blocks the photo-gate.
3. Start the system oscillating. Measure the time between successive blockages of the photo-gate using the Pasco timer. This time is 1/2 of the system period.

Q2. Present an argument proving that the timer measures only 1/2 of the system period.

4. Measure the 1/2 period several times using the "reset" button on the timer.

5. Compare your results to the theoretical value $\tau = \sqrt{(m/k)}$.

6. Repeat the measurement for 2 other masses by taping extra mass to your glider.

III. Maximum velocity and position.

1. Measure and record the width of the flag atop your glider.

2. Set the Pasco Timer to pulse width mode. In this mode the timer will measure the time interval during which the light is blocked.

3. Start the oscillator by pulling it back a measured distance from equilibrium and releasing.

4. Record the time interval for which the gate is blocked and calculate from this the glider's velocity as it passes through equilibrium.

5. Check conservation of energy by calculating both $\mathbf{1/2kA^2}$ (maximum potential energy) and $\mathbf{1/2\ mv_{max}^2}$ (maximum kinetic energy)

Q3. Do the energies measured in part 5 agree within error?

6. Repeat the measurement for several amplitudes.

IV. Simple Pendulum.

1. Measure and record the length of the simple pendulum.

2. Place the timer in two pulse mode. Operate the timer manually and measure the time required for 20 swings. Repeat several times.

3. Compare the measured period to the theoretical value. Repeat for a different length of the pendulum.

4. Measure the period as a function of amplitude of the swing.

    Q4. It it independent? Why or why not?