PHYX 106 Lab

Experiment 5 — The Conical Pendulum

Objective: To examine the physics of the conical pendulum.

Preparation:

You will be provided with a wire and bolt device as well as a lead ball to be attached to the device. As a preparatory procedure, measure the length of the wire and the mass of the lead ball.

Procedure, Part I:

Your objective is to experimentally determine the period of a conical pendulum at three different radii.

In the hall outside the lab are a set of holes in the ceiling. You will be given a wire with a bolt attached to one end and a lead ball on the other. Screw the bolt into the hole in the ceiling. The ball should come quite close to the floor but not touch. Locate the point on the floor which is directly under the center of the suspended ball when it is at rest. Attach a sheet of brown paper to the floor beneath the pendulum on which to record measurements. Using this point as the center, draw three concentric guide circles on the butcher paper with radii of about 25 cm, 55 cm, and 85 cm. Start the ball swinging in a circle, and use the guide circles to confirm circular (as opposed to elliptical) motion. One student may then observe the time for the pendulum to make about 20 complete revolutions while another may observe the mean value of the radius of revolution during the timing interval. You may want to use a flat steel rule to aid you in this. Do this a total of three times, once at 25, once at 55 and once at 85 cm.

Draw a Free-Body Diagram for your conical pendulum. Using this diagram, it is possible (although you are not required to do this) to find the horizontal component of the tension, set that equal to centripetal force, and obtain

$$T^2 = 4\pi^2 L \cos\theta / g \tag{1}$$

as the period of the motion.

Question 1. Use Equation (1) to compute the expected period P at each radius, and **compare** the theoretical with the experimental results.

Procedure, Part II:

Figure 1: Pulley Apparatus to be used in Part II.

Construct a system of pulleys as shown in Figure 1, and use it to measure the **horizontal** force necessary to pull the mass out to each mean radius you have used above. This force should balance the horizontal component of tension at each radius, and thus give you a direct measurement of centripetal force at each radius.

Question 2. Compare these forces with the centripetal force at each radius, given by Equation 4:

$$F_c = M\frac{v^2}{r} \tag{2}$$

$$= M\frac{\left[\frac{2\pi r}{T}\right]^2}{r} \tag{3}$$

$$= M\frac{4\pi^2 r}{T^2} \tag{4}$$

Question 3. Find the percent difference between your measured and calculated (from equation 4) F's (one for each radius). To what are these differences due?

Question 4. Examining your data, discuss the dependence of the period of the pendulum on the radius of the motion. Be very careful, and consider theory as well in your discussion. Do you find this result surprising? Calculate the period for $\theta = 89.9°$. Also find the tension in the cable and the value of the centripetal force at this angle and comment on the results.