Simple Pendulum *10/10*

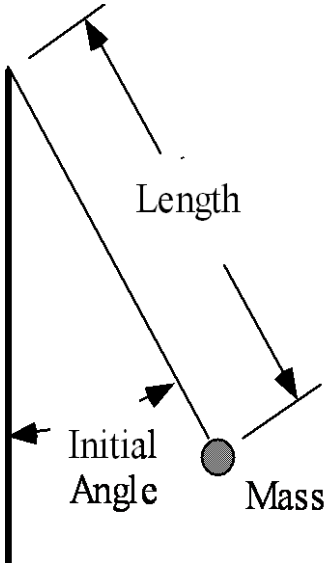
Physical Science 101

Name _____

Partner's Name _____

Purpose

In this lab you will study the motion of a simple pendulum. A simple pendulum is a pendulum that has a small amplitude of swing, i.e., initial angle less than 20 degrees from the vertical.



Simple Pendulum

Equipment

right angle table clamp, right angle clamp, metal post, pendulum support, various masses, protractor, meter stick, stop watch

Procedure

The period of a pendulum is the time required for the pendulum to make *one full back and forth swing*. You will study the effect that changing each of the individual aspects of the pendulum has on the pendulum's period.

First you will vary the initial angle, then the mass of the bob, and finally the length of the string of the pendulum. To measure the period you will record the time it takes to make 10 full swings, back and forth, and then divide by 10.

Example

If it takes 20.1 sec for 10 swings, back and forth, the period is 2.01 sec.

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Start with a pendulum of length between 80 to 100 cm and mass 50 to 200 gm. (*Note:* the length is measured from where the string attaches to the stand to the *center* of the mass.)

Part 1 Collecting Pendulum Data

1. Variation of period with angle.

Keeping the same mass and same length measure the period of the pendulum for the three initial angles in the table below. Fill in the rest of the table.

Mass (g)	Length (cm)	Initial Angle (deg)	Time (sec)	Period (sec)
		5		
		10		
		15		

Does changing the initial angle significantly change the period of the pendulum? Explain.

2. Variation of period with mass.

Keeping a constant length and the same initial angle measure the period for the various masses listed in the table below. Fill in the rest of the table.

N*ote:* In order to maintain the same length the different masses you may have to adjust the string a little so the distance from the top of the string to the center of the mass is constant.

Mass (g)	Length (cm)	Initial Angle (deg)	Time (sec)	Period (sec)
50				
100				
200				

Does changing the mass significantly change the period of the pendulum? Explain.

3. Variation of period with length.

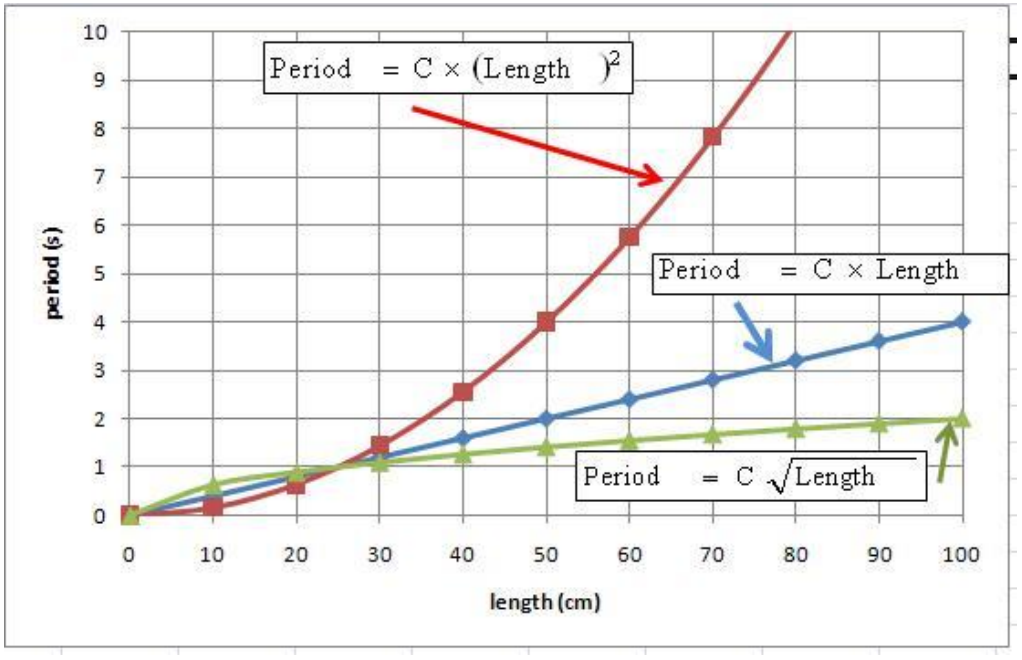
Keeping the same mass and same initial angle measure the period of the pendulum for three different lengths. Fill in the table below.

Mass (g)	Length (cm)	Initial Angle (deg)	Time (sec)	Period (sec)
	25			
	50			
	100			

Does changing the length significantly change the period of the pendulum? Explain.

Part 2 Predicting from Data

Scientists often look at ratios of numbers, square roots of number, etc. in their search for patterns. Look for patterns in your data to find an equation (or relation) between the Period of the pendulum and the Length. The three curves below show three possible functional relations between the Period and Length, i.e. period is proportional to Length squared, Length, or square root of Length. The constant **C** is just a constant of proportionality. By carefully plotting your data from experiment 3 on the axes below, decide which functional form best fits your observations. After deciding which functional form is correct, use your data to figure out which single value of **C** works best for all your data.



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What value of C seems to work best for all three length,period data pairs?

What is your equation for the period of the Pendulum of a given length?

In the front corner of the room is a large pendulum of length 300 cm, mass 100 g, and initial angle of 10 degrees. Use your equation to predict the period of this pendulum, without actually measuring it. Data about the pendulum will be given on the side blackboard. Show your Calculations here.

Predicted Period = _____ sec

Once everyone has made a prediction then the large pendulum's actual period will be measured. ****If there is not a pendulum available use the virtual pendulum at**

http://www.atmosedu.com/PHSC101/Flash/Pendulum/Pendulum.html . and adjust it for 300 cm to obtain the actual period. Otherwise measure the large pendulum in the lab.

Actual Period _____ sec

Compare your prediction to the actual period by calculating the percent difference between the two.

$$\text{Percent Difference} = \frac{\text{Prediction} - \text{Actual}}{\text{Actual}} \times 100 = \_\_\_\_\_$$

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Questions

The theoretical formula for the period of a simple pendulum is,

$$T = 2\pi\sqrt{\frac{Length}{g}} \qquad (\pi=3.142)$$

The length corresponds to the sluggishness (or inertia) of the pendulum and the acceleration of gravity corresponds to the strength of the force restoring the pendulum back to the bottom of its swing. All oscillators have inertia and a restoring force which combine to make them oscillate at a certain frequency.

1. What is the period of a 1.0 m (100cm) long pendulum?

How does this compare with the value recorded in your data table? (give % difference)

2. The acceleration of gravity on Jupiter is 2.53 times that of gravity on the Earth. Would the period of a 1.0 m long pendulum be longer or shorter on Jupiter than on Earth?

3. The acceleration of gravity gets smaller as you increase your distance from the center of the Earth. For example, if you go to a height that is one earth radius above the surface of the earth the acceleration of gravity is 2.45 m/s^2 (g/4.0). Is the period of a pendulum longer or shorter when it's in Denver compared to when its in Vancouver?

4. The frequency of a pendulum is (1/Period). That is, if the period is the number of second per cycle the frequency is the number of cycles per second. Another name for cycles per second is Hertz (Hz). What is the frequency of a pendulum that has a period of 0.5 sec.

5. A little girl is sitting on a swing and swings back and forth with a period of 3.0 seconds. If she stands up on the swing the period of her swing will be.

a) longer b) shorter c) unaffected.