Name____Date____________Per___

The Simple Pendulum

OBJECTIVE:

To investigate the properties of a simple pendulum.

THEORY:

The **period** of a pendulum is the time it takes for the bob of a pendulum to make one complete swing. This is the time required for the pendulum to return to the place from which it starts. In this exercise we will attempt to determine the factors that affect the period. This will be done by keeping fixed all factors except one variable and doing controlled experiments on that factor. The three factors that will be investigated are the effect of mass, length, and displacement on the period.

APPARATUS:

Mass set, string, pendulum clamp, timing device, a metric ruler, and a protractor.

PROCEDURE:

PART I: The Effect of Changing the Displacement

1. Tie a 50 - 100 gram mass to the end of a string about 80 centimeters long and attach it to the pendulum clamp.
2. Record the mass and the measured length (from the pivot to the center of the bob) in DATA TABLE I.
3. Displace the bob from the center line about 5 degrees and proceed to time 50 complete swings (back and forth).
4. Record the FREQUENCY in swings per second by dividing 50 by this time.
5. Calculate the reciprocal of the frequency and record this **PERIOD** in seconds per swing.
6. Repeat steps 3 through 6 but displace the bob 10 and 15 degrees.
7. For additional consideration, repeat steps 3 through 6 but displace the bob 60 and 90 degrees.
8. **Graph the results of the period vs. displacement.**
9. Comment on the results.

PART II: The Effect of Changing the Mass

1. Measure the mass of the bob.
2. Make sure that the length of the pendulum is the same as before.
3. Displace the pendulum 10 degrees and repeat the timing procedure to determine the frequency and period.
4. Record all data in DATA TABLE II.
5. Add mass. Repeat steps 2 through 4.
6. **Graph the results of the period vs. mass.**
7. Comment on the results.

PART III: The Effect of Changing the Length

1. Reduce the length of the pendulum to about 60 centimeters, attach a 50 - 100 gram weight as the bob, and displace the pendulum about 10 degrees.
2. Determine the period of the pendulum and record your data in DATA TABLE III. Note that you can use the PART I data for 80 centimeters here also.
3. Repeat steps 1 and 2 for 40 and 20 centimeters.
4. **Graph the results of the period vs. length.**
5. Comment on the results.

DATA TABLE I - CHANGING THE DISPLACEMENT OF A PENDULUM

Mass of Pendulum (grams)	Length of Pendulum (centimeters)	Displacement of Pendulum (degrees)	Time (seconds)	Frequency of Pendulum (swings/second)	Period of Pendulum (seconds/swing)
		5			
		10			
		15			
		60			
		90			

Analysis Question: How does changing the displacement of a pendulum affect the frequency and period?

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DATA TABLE II - CHANGING THE MASS OF A PENDULUM

Mass of Pendulum (grams)	Length of Pendulum (centimeters)	Displacement of Pendulum (degrees)	Time (seconds)	Frequency of Pendulum (swings/second)	Period of Pendulum (seconds/swing)
	80	10			
	80	10			
	80	10			
	80	10			
	80	10			

Analysis Question: How does changing the mass of a pendulum affect the frequency and period?

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DATA TABLE III - CHANGING THE LENGTH OF A PENDULUM

Mass of Pendulum (grams)	Length of Pendulum (centimeters)	Displacement of Pendulum (degrees)	Time (seconds)	Frequency of Pendulum (swings/second)	Period of Pendulum (seconds/swing)	$g = \frac{4\pi^2 L}{T^2}$
	80	10				
	60	10				
	40	10				
	20	10				

Analysis Question: How does changing the length of a pendulum affect the frequency and period?

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ANALYSIS:

Assuming that the theoretical formula ($T = 2\pi\sqrt{\frac{L}{g}}$) for the period of a simple pendulum is correct, calculate the experimental acceleration of gravity, g, in table III and find the relative error using 9.81 m/s^2 as the theoretical value. **<u>Show your work for this calculation on the back side of this page.</u>** What does this value tell you about the accuracy of your data and the formula for the period?

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ERROR ANALYSIS & CONCLUSION:

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