Motion of a Simple Pendulum

As you work through the steps in the lab procedure, record your experimental values and the results on this worksheet. Use the exact values you record for your data to make later calculations.

Pendulum Lab - Simulation

Open the pendulum apparatus simulation to do this lab. You will need to use the VPL Grapher to complete this lab.

Hypothesis

What do you think might affect the period of a pendulum? Suggest at least three possibilities. State these choices as hypotheses using direct or inverse proportions.

I. Amplitude, θ - Maximum Angle of the String from the Vertical

Record the volume of the sphere.

Record the mass of the gold bob.

Record the length of the pendulum.

What do you think will happen to the period when you increase the amplitude? Why? Explain your reasoning carefully. (This is an introductory lab. Just do your best to come up with an explanation for these predictions.)

Complete the table.

Table 1: Period vs. Amplitude

Trial	**Amplitude** (°)	**Time for 10 Swings** (s)	**Period, *T*** (s)
1	5		
2	10		
3	15		
4	20		
5	25		
6	30		
7	35		
8	40		
9	45		

Trial	**Amplitude** (°)	**Time for 10 Swings** (s)	**Period, *T*** (s)
10	50		
11	55		
12	60		
13	65		
14	70		
15	75		
16	80		
17	85		
18	90		

Upload your graph of period versus amplitude as "Pend_I.png". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

For a horizontal graph, how do we describe the relation between the two variables?

II. Mass

What do you think will happen to the period when you increase the mass? Why? Explain your reasoning carefully.

Record the length of the pendulum. (The amplitude of the pendulum = 10.0°.)

Complete the table.

Table 2: Period vs. Mass

Trial	Material	Mass (kg)	Time for 10 Swings (s)	Period, T (s)
1	**Wood**			
2	**Glass**			
3	**Iron**			
4	**Brass**			

Upload your graph of period versus mass as Pend_II.png". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

Describe the relation between the two variables.

Why do you think that (within error) you found the mass to have no effect on the period of the pendulum? Explain your reasoning after discussion with your lab partners.

III. Length

What do you think will happen to the period when you increase the length? Explain your reasoning carefully.

Record the mass of the pendulum. (The amplitude of the pendulum = 10.0°.)

Complete the table.

Table 3: Period vs. Length

Trial	**Length (m)**	**Time for 10 Swings (s)**				**Period, T (s)**
		t_1	t_2	t_3	t_{avg}	
1						
2						
3						
4						
5						
6						
7						
8						
9						

Why do you think that you found the length to have an effect on the period of the pendulum? Explain your reasoning.

Is the period directly proportional to the length?

Assuming that the period versus length graph does fall dramatically to (0, 0), which graph type does this illustrate?

Give the equation describing your data in $y = mx + b$ form. (Be sure to substitute T^2 for y, etc.)

List your values of the y-intercept b and your RMSE for your T^2 vs. L graph.

Is your graph within experimental uncertainty of being equal to zero?

Give your new equation below in $y = mx$ form.

Select the data set that you will use to compare your experimental T value with the theoretical value.

Calculate the theoretical T value using the new equation.

Do the theoretical and experimental values agree? (Your experimental value should be within 10% of the theoretical value to agree.)

If you quadrupled the length of a certain pendulum, the period should do which of the following?

Upload your graphs as "Pend_IIIa.png" and "Pend_IIIb.png". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

IV. One Last Factor, *g*

Suppose you took your pendulum to the top of a high mountain or, better still, to Earth's moon. What effect would you expect to find? Specifically, where would the period of a pendulum have its greatest value, on the Earth or on the Moon?

Explain what you think is happening as you change the location of the pendulum.

What would be the period of a pendulum in deep space where the force of gravity is zero? (Let T_E represent the period of the same pendulum here on Earth.)

V. The Mathematical Relationship Among *T*, *L*, and *g*

What value did you find for the theoretical acceleration due to gravity on Earth's moon?

Show your data and calculations for the values of g.

Table 4

	Earth's moon	**Brian**
$\boldsymbol{L}$ **(m)**		
θ (°)		
$\boldsymbol{T}$ **(s)**		
$\boldsymbol{g}$ **(m/s^2)**		
% error		