Name: _____ Partners: _____ _____ Period: ___ Score: ___

Pendulum Investigation Report to be handed in. Extra copies: http://teach.kralsite.com/ *Dr. Fred Kral, v. 1.1*

Materials: 80cm string, hex nut, measuring tape, stopwatch, tape, calculator.

Goals: Investigate the period of a pendulum depends on the length of the string. Find a best fit function to the recorded data and investigate transformations of the function.

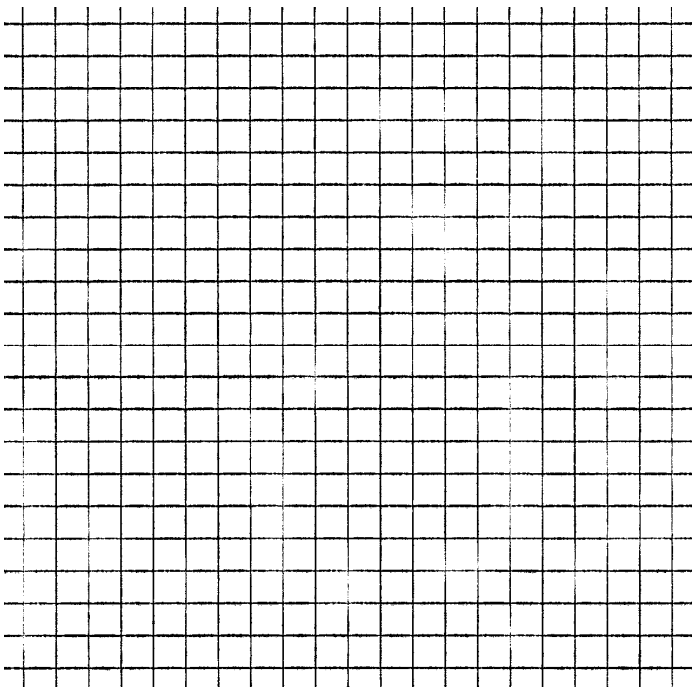
Gather Data: Tape the string to a table with the desired length measured from where the string becomes free to the center of the hex nut. For each different length of string, measure the time it takes for the pendulum to swing back and forth (the time for one full "back and forth" swing is called the period, T). Do three (3) trials of ten swings for each length and average the results.

Helpful advice: When counting swings, **start counting "zero"** when you press start on the stopwatch and stop the stopwatch when you reach "ten." Use only **small angles**, less than 20 degrees from the vertical.

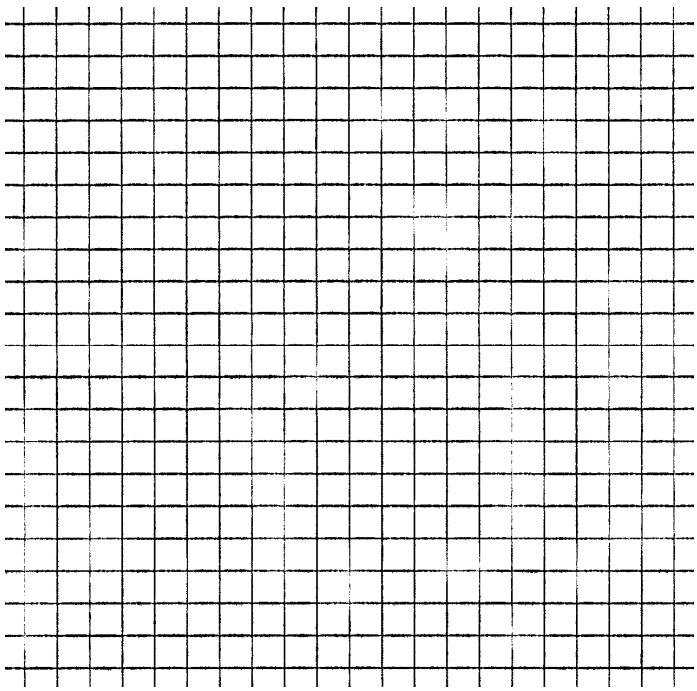
Length, L (cm)	**Time for 10 swings, 10T (seconds)**			**Average 10T**	**Period, T** (s) [10T÷10]	**Squared T** (s^2) [T^2]
	Trial 1	Trial 2	Trial 3			
10						
20						
30						
40						
50						
60						
70						

Plot Data: Plot the period, T, (y-axis) versus length, L, (x-axis) using the grid on the left.

T versus L



T^2 versus L



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Pendulum Investigation, continued

Questions and data analysis:

1. What do you think the value of T would be if L were very small (almost zero)?
2. Do you think that T versus L is a curve or a straight line? Why or why not?

Calculate the last column of data, T^2. Plot T^2 versus L.

3. Do you think that T^2 versus L is a curve or a straight line? Why or why not?
Do you need to change your answer to question 2? Which data are closer to being a straight line?

Find a ruler and draw a line through the point (0, 0) and the best fit through the data points of T^2 versus L.

4. What is the slope of the line (rise over run)?

5. In physics we learn that the slope is predicted to be $4\pi^2/g = 4\pi^2/981$, where g is the acceleration due to gravity. What is the ratio of your measured slope to the predicted value?

6. How close is your measurement to the prediction? (A ratio of 1.10 would mean your measurement is 10% higher than the prediction.)

7. If $T^2 = 4\pi^2 L/g$, what is the relationship between T and L? What is T as a function of L (or, if $y^2 = c^2 x$, what is y as a function of x)?

Linear Regression – using the calculator to find the best fit:

8. Enter the T^2 versus L data in the TI-83 calculator.
Use [STAT] 1: Edit…. Put Length into List 1 (L1). Put T^2 into List 2 (L2).

9. Plot the data on the calculator.
Use [2nd] [STAT PLOT] 1: Plot 1 Turn ON and use the First Type of plot (scatter). XList: L_1 YList L_2
Before you plot, do [ZOOM] 9: Zoomstat
[GRAPH] Show the teacher.

10. Find the slope of the line using linear regression (a statistical method).
Use [STAT] CALC (right arrow) 4: LinReg (y=ax+b)
What is your measured slope? a=
What is your measured y-intercept? b =
How does the slope compare to $4\pi^2/981 = 0.0402$?

11. Put the function ax+b into the calculator. Use the [Y=] button. Push [GRAPH]. Show the teacher.

12. If there is time, go back and enter the data for T in L3 and do a power regression, $y=ax^b$
Use [STAT] CALC A: PwrReg. The expected values are a=0.201 and b=0.5. Why would b be 0.5?