Name _________________________________ Date _____________

Partners ____

Simple Harmonic Motion of a Spiral Spring: Lab #14

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Objective: to understand the simple harmonic oscillation of a spring.

Equipment: spacer pad, C-clamp, pole, arm with screws, brass spiral spring, mass hanger, masses, 2-m stick, stop watch, Excel or graph paper, transparent ruler, balance

Sketch:

Background: A spiral spring hung from a support illustrates simple harmonic motion very well. Its motion is smooth, repetitive and also easy to measure. We will investigate which variables influence the period (length of time for one oscillation), and how that influence is expressed mathematically.

What are some of the variables which might affect the period?

Definitions, in words and equations:

Kinetic Energy:

Potential Energy of a spring:

Hooke's Law:

Equation of a straight line:

Procedure:

1. Getting started

Weigh your spring (mass = __________), then set up the apparatus. The small end of the spring goes upwards, behind the little metal plate on the arm.

2. Statics:

Determine the spring constant k for your spring by gently adding masses and recording the position of the stretched spring. A handy reference mark is the bottom of the mass hanger itself.

Data Table:

Mass (kg)	Position (m)	Force (N)
.1		
.2		
.4		
.6		
.8		

Enter these data into your team's Excel spreadsheet.
Plot a graph of force vs. position and measure its slope. (dF/dx = k = ____________________)

3. Dynamics: Exploratory research.

Now we will investigate the effect that mass has on the period of the spring as it oscillates up and down. Put 50 grams onto the hanger (this makes 100 grams total = .100 kg), pull it down gently, and measure the time for 10 full cycles. _________________

Time another 10 cycles. ______________. Average for 10 cycles ___________________

The period for one cycle is = (your average time)/10 = _________________

Put another 100 grams onto the hanger (.200 kg total) and measure the time for 10 cycles.
_________________. Repeat ________________. Average ________________.

Period _________________

4. A working hypothesis: More mass makes the period ________________________

Predict the period for a mass of 300 grams. ______________
Explain how you made this prediction:

Try it and see how close you came to an accurate prediction for the period of a mass of 300 grams.
Actual period _______________

Percent difference = 100 * (actual - predicted)/actual = ____________

5. More data will extend our understanding of this phenomemon. Make measurements to fill in only the first two columns of this data table. You have already done the first three.

Mass (kg)	Period (sec)	(See below: $Mass^n$)
.1		
.2		
.3		
.4		
.5		
.6		
.7		
.8		

Graphical Experimental Analysis:
Enter these data into your Excel spreadsheet.
Plot a graph of period vs. mass (horizontal axis). Print one copy of this graph.
Is it monotonic? __________
Is it a straight line? __________
Use a transparent ruler to draw a straight line fitting <u>the first three</u> data points (lowest masses), then extend it across the whole graph. If the data points for higher masses bend upwards from this straight line then we should calculate values of $mass^2$ (n = 2) for the final column in the data table. However, if the later data points bend downwards from this straight line then we should calculate values of $mass^{.5}$ (n = .5, or square root) for the final column in the data table.
Your data indicate that n = _______.
Label the final column correctly and calculate the values.

Plot a graph of period (vertical axis) vs. $mass^n$ (horizontal axis). (You may need to copy and paste the period data in your spreadsheet to a new column to the right of the $mass^n$ column.)
Is it a straight line? _________

Write the equation of this line using the standard y-intercept version:

What is the value of the slope of this line? ________________________ (include units)

What is the value of the y-intercept (mass = x = 0)? ________________ (include units)

What is the value of the x-intercept (period = y = 0)? ________________ (include units)

Let's think about what these numbers may mean.

What does the y-intercept (mass = 0) mean?

Make a prediction for this period, then try it by removing all mass.

Prediction ____________, Actual ___________, Percent difference _____________

What does the x-intercept mean (period = 0)?

How does this relate to the mass of the spring itself?

Theoretical analysis:
From the textbook, for a spring in simple harmonic motion the period = T = 2 pi ( )

Does this agree *in form* with what you found from your measurements and graphs?

Using this equation calculate the value of k: _____________

What was the value of k which you measured earlier? _________________

Percent difference of the calculated k from the measured spring constant k = _______________

Conclusions:
Describe the oscillation in terms of kinetic and potential energy:

How does this relate to your life?

Extensions and future work in this field:
If you were to put a mass of 100 kg on this spring, then you would predict the period of oscillation to be _______________________.
Why would this be impractical to do?