Lab #9
Physics 111

Hooke's Law and the Simple Pendulum

Name: ________________

I. Hooke's Law:

Most springs obey a simple relationship between the amount by which they are stretched and the force required to stretch the spring. This relationship is called Hooke's Law and is given by

$$F_{spring} = k\,\Delta x = k(x - x_i) = k(x - x_{unstretched}).$$

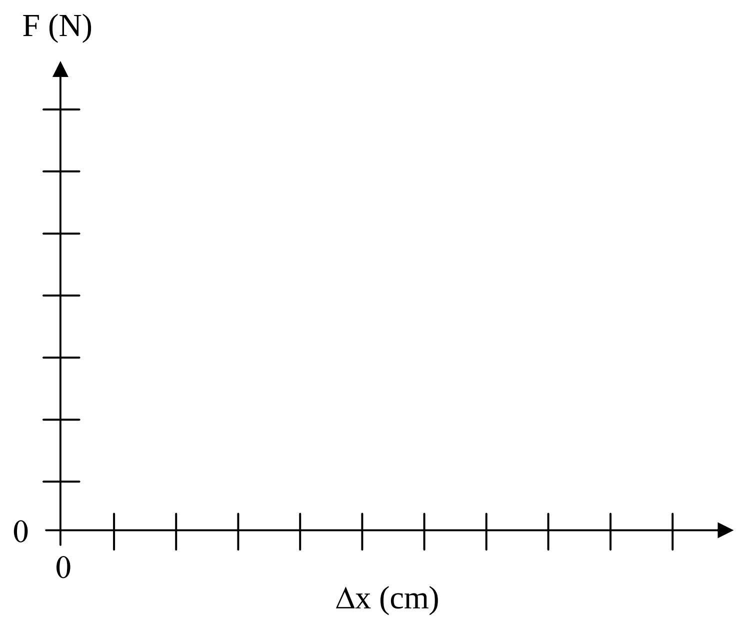
You will investigate this relationship in this lab by doing the following:

- Start with the spring on the table with no tension on it.
- "Zero" the force probe with nothing touching it.
- On the table, use chalk to mark the initial position listed in the table below.
- Use the force probe to pull the spring out to various lengths x.
- Hold these in place for ~2.0 seconds so the computers can record the spring force.
- Use your data to fill out the data table.
- Plot your values for F and Δx on the graph provided.

[15 pts] Data Table

Stretch Δx(cm)	Force (N)
0.0	0.0 N
1.0	
3.0	
3.0	
4.0	
6.0	
8.0	
10	
12	
16	
20	
24	
28	
32	

<u>[6 pts] Graph of F(N) vs. Δx (cm)</u>



[6 pts] Calculate the spring constant *k* using Hooke's Law $F_{spring} = k\,\Delta x = k(x - x_i)$. Do this with at least ***4*** pairs of points in the linear (flat) part of the line and then take the average. Note that ***3*** significant figures is enough here. ***Show your work.***

Hooke's Law and the Simple Pendulum

Name: ________________

The simple pendulum—simple harmonic motion example

- Set the photogate timers on "pend" and the timing accuracy (on their undersides) to "1ms."
- Lengthen your string so the mass is in front of the curved angle scale at the bottom of the setup.
- Measure your string lengths from the pivot point to the center of the masses.
- For each of the items below, pay attention to ***large differences*** only.

A. [8 pts] Use the initial amplitudes listed below and determine the period of oscillation for each. Put a 100g mass on your string. ***Make your string 1.0m long.***

Amplitude A	Period T (sec)	Punchline
very small (~5cm)		*Does the **amplitude** affect the period of oscillation of a pendulum?* yes no (circle one)
small (~10cm)		
medium (~15cm)		
large (~20cm)		
very large (~25cm)		

B. [8 pts] Use the masses listed below and determine the period of oscillation for each.

Mass m	Period T (sec)	Punchline
50g		*Does the **mass on the pendulum** affect the period of oscillation of a pendulum?* yes no
100g		
200g		
500g		

C. [8 pts] Use the string lengths listed below and determine the period of oscillation for each.

Length L	Period T (sec)	Punchline
60 cm		*Does the **length** affect the period of oscillation of a pendulum?* yes no
80 cm		
100 cm		
120 cm		

Hooke's Law and the Simple Pendulum

Name: ________________

As you have seen, not all of the variables of mass *m*, string length *L* and amplitude *A* come into play with the period of a pendulum. Oddly enough, the variables that you might suspect "surely would" determine the period of the pendulum have no effect. Thus, any equation that describes a simple pendulum should reflect that some variables matter while others don't.

The period T and length L of a simple pendulum are related by the equation

$$T^2 = \frac{4\pi^2 L}{g}.$$

Here, *g* is the gravitational acceleration at the location of the pendulum. This assumes the oscillations have settled down into a consistent rhythm, and the amplitude of the oscillations is not too large. (The phrase "amplitude…not too large" means not more than about 15^0 away from the vertical.)

[8 pts] Use your data with the various lengths above to calculate *g* for all ***5*** cases. Show your work for all ***5*** cases below. Your answers should have ***3*** significant figures.

L= T=	L= T=	L= T=	L= T=

If any of your calculations indicate problems with the data, it is legitimate to throw out that point.

[3 pts] Take the average of your values above for *g*: g = _______________ .

[3 pts] How does your average value compare to the value of g=9.8 m/s^2 we so often use in class?