SIMPLE HARMONIC MOTION (SHM) – Lab Worksheet

Name ________________ Period ______
Lab Partner(s) ______________________

I. **Spring-Mass Systems**

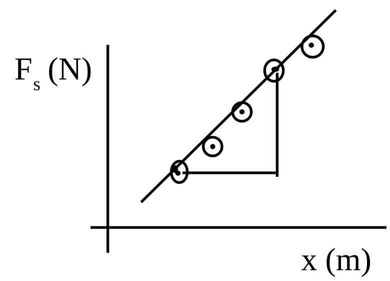
A. Verification of Hooke's Law

1. Use 5 different masses and measure the resulting displacements. (Use the mass of the stand as the first mass.)

m (kg)	$F_s = F_g$ (N)	x (m)

2. Graph "Spring Force vs Displacement" on graph paper and draw a "best-fitting" line.

3. <u>Static Determination of the Spring Constant</u>, k. Show your calculation here for the slope of your line:



k_A = _______ N/m

B. Finding the "natural period", T_o, of a spring-mass system.

1. Show that the period, T, is "amplitude-independent." Select a mass, but in this case (unlike part A) include the mass of the stand. m = ______ kg. Vary the amplitude (A) and record the period (T) for four different amplitudes.

A (m)	T (s)

2. <u>Dynamic Determination of the Spring Constant</u>, k. Calculate the average time period, $\bar{T}$. Use this in the following formula, $\bar{T}_o = 2\pi\sqrt{\frac{m}{k}}$, to calculate the spring constant, k_B = _______ N/m

3. Compare the two determined spring constants by showing the percent error of the dynamically determined constant (k_B) with the statically determined constant (k_A).

$\frac{|k_B - k_A|}{k_A} \cdot 100$ = _____ % error (The static method is most accurate.)

C. (Optional) Find the spring constant for two springs (k_1 and k_2) which are strung in a series.

1. Use $k_A = k_1$ = _____ N/m from part A above. Obtain a second spring from your instructor and determine its constant, k_2 = ______ N/m. (If you believe Hooke's Law is correct, do <u>not</u> repeat the graphing procedure of Part A. Just hang some weight, measure the stretch and...)
2. Now attach the two springs together and determine the effective or equivalent spring constant, k_{eff} = ______ N/m. (Again, use Hooke's Law and only one weight and...)
3. Theory shows that this effective spring constant should be:

$$k_{theoretical} = \frac{1}{\frac{1}{k_1} + \frac{1}{k_2}} = \frac{k_1 \cdot k_2}{k_1 + k_2} = \_\_\_\_\_\_\_\_ \ N/m$$

II. Simple Pendulums

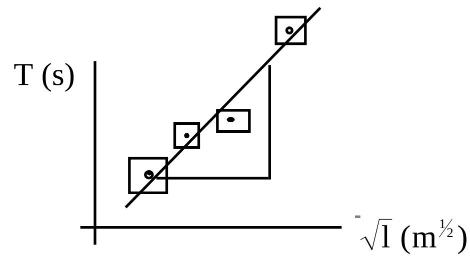
A. Determination of "g".

1. Vary the length (l) of the pendulum and determine the period, T, of oscillation. Use one angular amplitude of less than 15^0 . Select at least four different lengths.

l (m)	$\sqrt{l}$	T (s)

2. Graph "Period vs Square Root of the Pendulum Length"
3. Use:

$$T_o = 2\pi\sqrt{\frac{l}{g}} \text{ and rewrite as } T_o = \left(\frac{2\pi}{\sqrt{g}}\right)\sqrt{l}.$$



Notice that the parenthetic expression above is the slope of the "best-fitting" line and can be used to calculate "g". Show your slope calculations here.

Record your derived value for g = ______ m/s^2. (Is it close to 9.8 m/s^2 ?)

B. Finding the "natural period", T_o, of the simple pendulum.

1. Select one length, l = ______ m. Vary the angular amplitude, θ, of the swing by taking three angles 15^0 or less and three angles 30^0 or more. Record the period of oscillation,T, for each swing angle.

θ (deg)	T (s)

2. Does the period,T, seem to be "amplitude-independent"? Record the average period for the three angles fifteen degrees or less, $\overline{T}$ = _____ s.
3. Calculate the theoretical value for time period,

$T_o = 2\pi\sqrt{\frac{l}{g}}$ = _____ s. By what percent does $\overline{T}$ vary with T_o ? Show your work here.

C. (Optional) The period of oscillation is independent of the mass of the simple pendulum.

1. Select one length, l = _______ m, and vary the mass of the pendulum bob. Record the period of oscillation for each different mass. For each different mass use the same small angular amplitude.

m (kg)	T (s)