SIMPLE HARMONIC MOTION (SHM) – Lab Worksheet – H

Name ________________ Period ______
Lab Partner(s) ________________________

I. **Spring-Mass Systems**

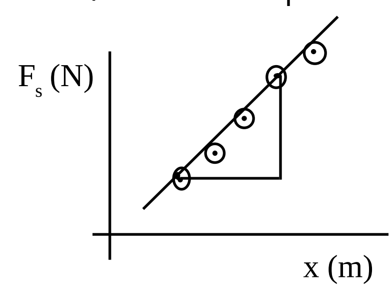
A. Verification of Hooke's Law

1. Use 5 different masses and measure the resulting displacements. (Let the stand be the first mass, 0.050kg.)

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. Static Determination of the Spring Constant, k. Show your calculation here for the slope of your line:



k_A = _______ N/m

B. Finding the "natural frequency", ω_o , of a spring-mass system.

1. Show that the period, T, is "amplitude-independent." Select some mass, including the mass of the stand. m = ______ kg. Vary the amplitude ,A, and record the period, T, for at least four amplitudes.

A (m)	T (s)	ω (Rad/s)

Use $\omega = \frac{2\pi}{T}$ to calculate the natural or angular frequency.

2. Dynamic Determination of the Spring Constant, k. Calculate the average angular frequency, $\overline{\omega}$. Use this in the following formula, $\omega = \sqrt{\frac{k}{m}}$, 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.
2. Now attach the two springs together and determine the effective or equivalent spring constant, k_{eff} = ______ N/m.
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”.

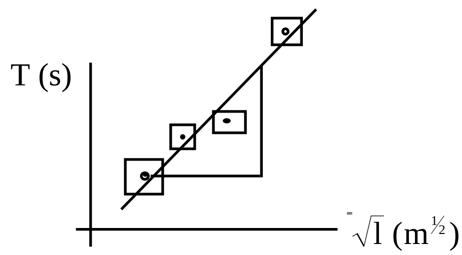
1. Vary the length (l) of the pendulum and determine the period, T, of oscillation. Use one angular amplitude of less than 15^0 . Use at least four different lengths.

2. Graph “Period vs Square Root of the Pendulum Length”

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

Use $\omega = \sqrt{\frac{g}{l}}$ and $\omega = \frac{2\pi}{T}$ to obtain $T = \left(\frac{2\pi}{\sqrt{g}}\right)\sqrt{l}$.

Assuming your data is linear, the slope of the “best-fitting” line can be used to calculate “g” by equating the slope to the parenthetic expression above. Show your slope calculations here.



Record your derived value for g = ______ m/s^2.

B. Finding the “natural frequency”, ω_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.

2. Does the period,T, seem to be “amplitude-independent”? Record the average natural or angular frequency for the angles fifteen degrees or less, $\overline{\omega} =$ _____ Rad/s.

θ (deg)	T (s)	$\omega = 2\pi/T$

3. Calculate the theoretical value for angular frequency,

$\omega_o = \sqrt{\frac{g}{l}} =$ _______ Rad/s. By what percent does $\overline{\omega}$ vary with ω_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)