

SIMPLE HARMONIC MOTION (SHM) – Lab Worksheet

Name _____ Period _____

Lab Partner(s) _____

I. Spring-Mass Systems

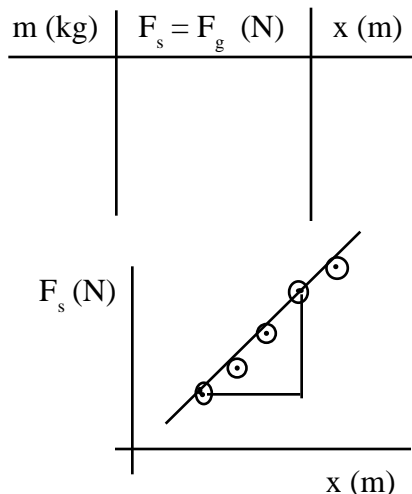
A. Verification of Hooke's Law

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

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:

$$k_A = \text{_____ N/m}$$



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. $m = \text{_____ kg}$. Vary the amplitude (A) and record the period (T) for four different amplitudes.

2. Dynamic Determination of the Spring Constant, k . Calculate the average time period, \bar{T} . Use this in the following

formula, $T_o = 2\pi\sqrt{\frac{m}{k}}$, to calculate the spring constant, $k_B = \text{_____ N/m}$

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).

A (m)	T (s)

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

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

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

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

II. Simple Pendulums

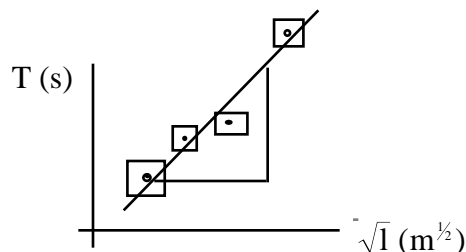
A. Determination of “g”.

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

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



Record your derived value for $g = \underline{\hspace{2cm}}$ m/s². (Is it close to 9.8 m/s² ?)

B. Finding the “natural period”, T_o , of the simple pendulum.

1. Select one length, $l = \underline{\hspace{2cm}}$ m. Vary the angular amplitude, θ , of the swing by taking three angles 15° or less and three angles 30° 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 period for the three angles fifteen degrees or less, $\bar{T} = \underline{\hspace{2cm}}$ s.
3. Calculate the theoretical value for time period,

$$T_o = 2\pi\sqrt{\frac{l}{g}} = \underline{\hspace{2cm}} \text{ s. By what percent does } \bar{T} \text{ vary with } T_o \text{? Show your work here.}$$

θ (deg)	T (s)

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

1. Select one length, $l = \underline{\hspace{2cm}}$ 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)