**General Physics eJournal 11**

**Simple Harmonic Motion**

**Instructions:**

Follow the Writeup and fill out the eJournal as you complete the lab activities. Submit your eJournal report by uploading the completed WORD or PDF document to our class Learninghub site. If the Learninghub site is down, email the completed report file directly to a lab TA.

**Preliminaries:**

* Title:
* Name(s):
* Date:
* Time In & Out:

**Plan:**

**Hypothesis**

Sketch a predicted graph of acceleration vs. time for a simple harmonic oscillator. Write the equation that describes this sinusoidal motion. What equations are used to predict the period of oscillation of a spring (Option 1) or pendulum (Option 2)?

*Insert image of your graph*

**Experiment Outline**

Briefly describe your plan for testing your hypothesis.

**Equipment List**

* List
* Equipment
* Here

**Action:**

Describe the techniques used to collect data by responding to the bullet point questions:

* How did you anchor your spring/pendulum?
* What did you use for your oscillating mass (on the spring or the pendulum)?
* If you chose Option 1, how did you determine the spring constant, k?
* If you chose Option 2, how did you vary the length of the pendulum?
* How did you determine the period from the acceleration data in Phyphox?

*Insert labeled image of your apparatus*

**Note: Fill out the results, analysis, and conclusion sections for the experiment option you chose (Option 1 or Option 2).**

**Results (Option 1): Spring**

Record the individual masses of the carrier, smartphone, and various objects. Record the total hanging mass (carrier + phone + objects). Record the mass of the spring.

**Table I: Individual masses of carrier, smartphone,
misc. objects, and the total combined mass**

|  |  |
| --- | --- |
| **Object** | **Mass (kg)** |
| Carrier |  |
| Smartphone |  |
| 100 Pennies |  |
| Hot Wheels Car 1 |  |
| Hot Wheels Car 2 |  |
| Hex Nut |  |
| Wood Block |  |
| Measuring Tape |  |
| Total Hanging Mass (Carrier + Phone + Objects) |  |
| Spring |  |

**Table II: Spring Constant Measurement
(hanging mass, force, distance to floor, and spring elongation)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Hanging Objects** | **Combined Mass, mi (kg)** | **Force, ΔFi (N)** | **Distance to Floor, xi (m)** | **Elongation, Δxi (m)** |
| Nothing | m0 = 0 | ------ | x0 =  | ------ |
| ex. Shoe + Pennies | m1 =  |  | x1 =  |  |
| ex. Shoe + Pennies + Hex Nut | m2 =  |  | x2 =  |  |
|  | m3 =  |  | x3 =  |  |
|  | m4 =  |  | x4 =  |  |
|  | m5 =  |  | x5 =  |  |

From your Phyphox graph of Acceleration Y vs. Time, find the time difference across N full periods. Divide the time difference by the number of periods to determine the average period.

*Insert Phyphox graph of Acceleration Y vs Time*

**Table III: Determining period from the acceleration graph**

|  |  |  |
| --- | --- | --- |
| **Time Difference, Δt (s)** | **# of Periods, N** | **Period, Tmeas = Δt/N (s)** |
|  |  |  |

**Analysis (Option 1): Spring**

Calculate the forces, ΔFi (Eq. 12) and elongations, Δxi (Eq. 13) and record them in Table II.

Generate a plot of ΔF vs. Δx and apply a linear trendline. Record the slope as the spring constant k.

*Insert graph of ΔF vs Δx*

Slope (spring constant) k = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ N/m

Calculate the theoretical period, Ttheory using Eq. (2) and Eq. (4). Use a percent difference to compare the measured period to the theoretical period.

**Table IV: Compare the theoretical and measured period**

|  |  |  |
| --- | --- | --- |
| **Tmeas (s)** | **Ttheory (s)** | **%Diff** |
|  |  |  |

**Conclusion (Option 1): Spring**

Interpret your results in light of your hypothetical predictions. How similar were the results? What changes might you expect if you combined two springs in (a) parallel or (b) series?



**Results (Option 2): Pendulum**

For each run, measure and record the pendulum length (from the top of the twine to the middle of the phone). On each Phyphox graph of Acceleration Z vs. Time, record the time difference across N full periods and the resulting average period, T, from Δt/N.

**Table I: Measured periods for 5 pendulum lengths**

|  |  |  |  |
| --- | --- | --- | --- |
| **Pendulum Length, L (m)** | **Time Difference, Δt (s)** | **# of Periods, N** | **Period, T = Δt/N (s)** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Insert a representative graph from Phyphox showing the sinusoidal data of one of your pendulum runs.

*Insert Phyphox graph of Acceleration Z vs Time*

**Analysis (Option 2): Pendulum**

Calculate and record $\sqrt{L}$ for each pendulum length, L, you used. Copy the measured periods from Table I into the Table II.

**Table II: Square root length and period**

|  |  |
| --- | --- |
| $\sqrt{L}$ **(**$\sqrt{m}$**)** | **T (s)** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Generate a plot of T vs. $\sqrt{L}$ , apply a linear trendline, and record the slope and correlation coefficient, R.

*Insert graph of T vs*  $\sqrt{L}$

Slope = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ $1/\sqrt{m/s^{2}}$

R = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Use the slope = 2π/$\sqrt{g}$ to determine the measured acceleration of gravity, gmeas. Compare gmeas to the accepted value, gtheory = 9.80 m/s2 using a percent error.

**Table III: Compare the theoretical and measured acceleration of gravity**

|  |  |  |
| --- | --- | --- |
| **gmeas (m/s2)** | **gtheory (m/s2)** | **%Error** |
|  | 9.80 |  |

**Conclusion (Option 2): Pendulum**

Interpret your results in light of your hypothetical predictions. How similar were the results? Based on the correlation coefficient, R, how accurate (linear) were your results? The formula used to predict the period of the pendulum assumes a simple pendulum (i.e. a point mass on the end of a massless string). Solid objects oscillating like a pendulum are called physical pendulums. Could the finite size of your phone at the end of the string be significant enough to affect your results? How might you improve this experiment or explore it further?