Lab #1 Simple Harmonic Oscillation 9/7/00

Objectives:

In this lab we will determine between both the mass of the oscillator and the amplitude of oscillation. We will also verify the statement $k_{eff} = k_1 + k_2$. We will begin by calculating the values of $k_1$ and $k_2$, next, we will examine the relation between the amplitude and the period and finally we will examine the relation between the mass and the period.

Part 1:

Introduction:

This part of the experiment involves two separate calculations. First we will use the force sensor to directly measure the spring constant of each individual spring. This data will be used to calculate a theoretical period. Next we will use both springs simultaneously. In this section of the experiment, the measure of the force sensor gives a sine wave directly related to that of the acceleration. We use this wave to measure the actual period.

Data:

Spring 1

| Extension(m) | Force(N) |
|---|---|
| 0 | 0.007 |
| 0.05 | -0.089 |
| 0.1 | -0.182 |
| 0.15 | -0.271 |
| 0.2 | -0.367 |
| 0.25 | -0.459 |
| 0.3 | -0.555 |

Spring 2

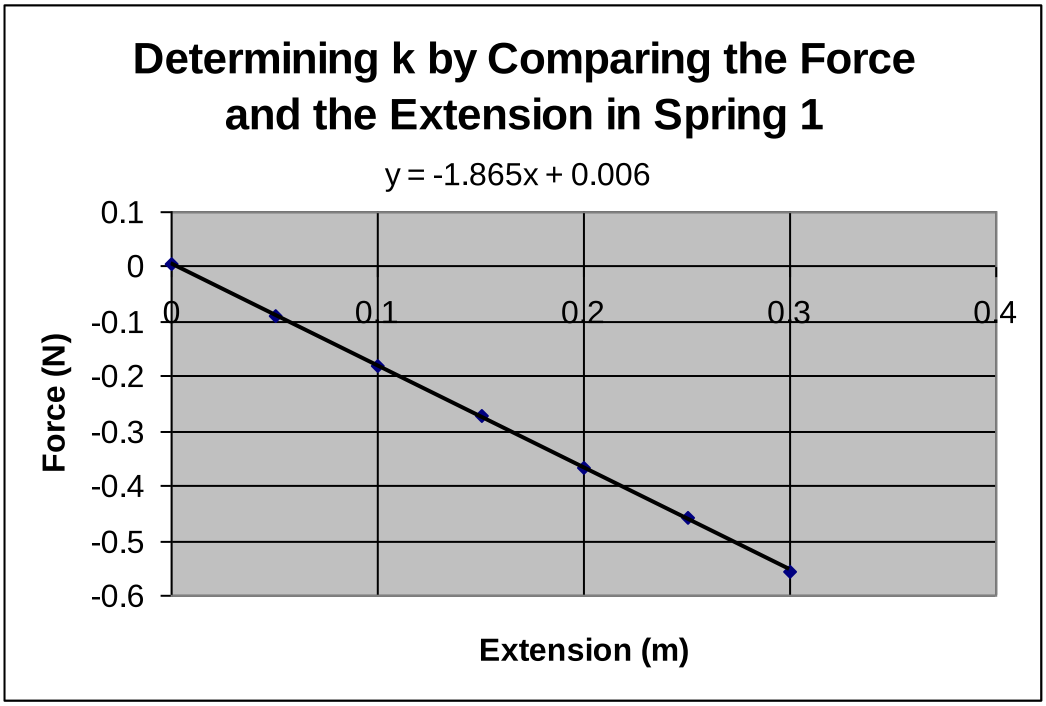
| Extension (m) | Force (N) |
|---|---|
| 0 | -0.003 |
| 0.05 | -0.052 |
| 0.1 | -0.111 |
| 0.15 | -0.17 |
| 0.2 | -0.224 |
| 0.25 | -0.282 |
| 0.3 | -0.334 |

$m = .26345\ kg$

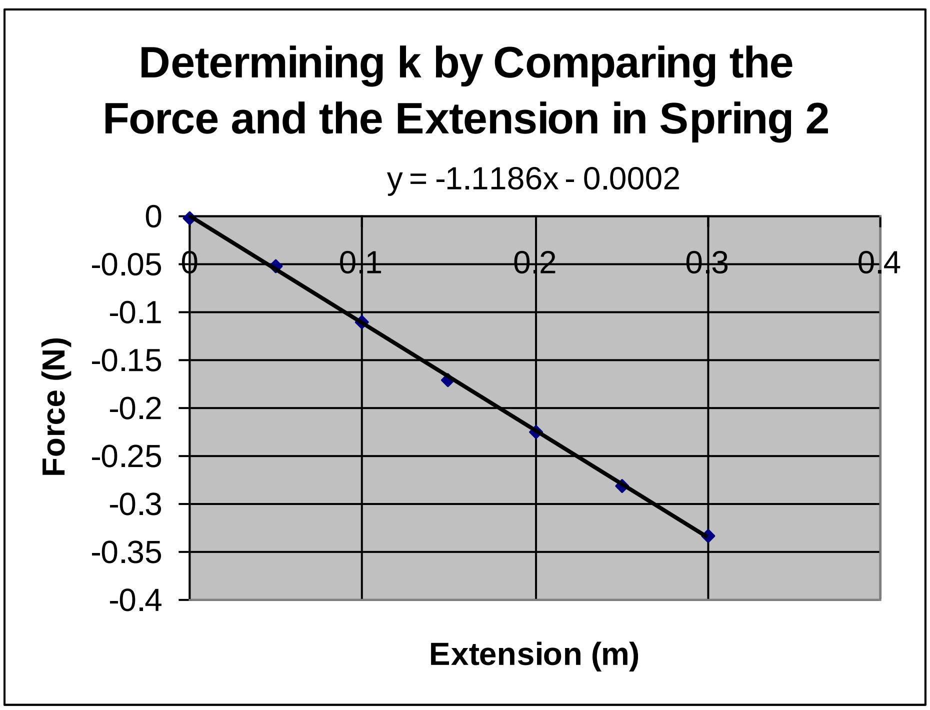
$T_{measured} = 1.88$

Data Analysis:

Spring 1




Spring 2:



Results:

$$k_1 = 1.865 \qquad k_2 = 1.186$$
$$\therefore \textit{the predicted } k_{eff} = 3.051$$

$$T_{calculated} = 2\pi\sqrt{\frac{m}{k_{eff}}} = 1.85$$

$$\%\ difference = \left|\frac{calculated - measured}{calculated}\right| \cdot 100 = 1.62\ \%$$

Uncertainty:

There are two places where uncertainty can become a factor in this section of the experiment. The first is in the measurement of the extension and is approximately ± .001 m. The second involves the precision of the force censor, which is unknown to us at this point in time. Assuming an uncertainty of ±3 % in the force censor, we may estimate a possible uncertainty of slightly over 4 %.

Part 2:

Introduction:

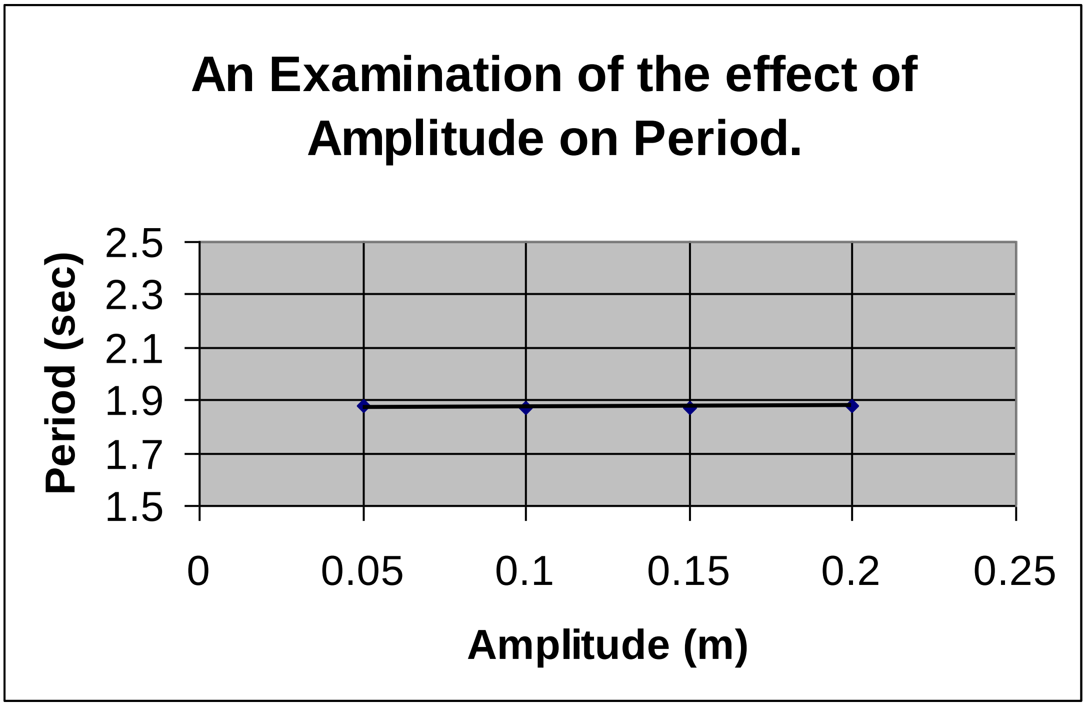
In this section of the lab, we will repeat the second half of part 1 with varying amplitudes. An examination of the periods calculated will be compared with the varying amplitudes to determine the effect of the amplitude on the period.

Data:

| Amplitude (m) | Period (sec) |
|---|---|
| 0.05±.001 | 1.88 |
| 0.1±.001 | 1.87 |
| 0.15±.001 | 1.87 |
| 0.2±.001 | 1.88 |

m= .26345 kg

Data Analysis:




Results:

From the graph, we observe that the amplitude has no effect on the period that cannot be explained by experimental uncertainty. The value of the period is 1.875 ± .3%

Uncertainty:

There are two sources of uncertainty in this experiment. The first comes from our inability to measure to a precision finer than 1 mm. The second source of error comes from the force sensor used to calculate the period. We do not know the precision of the calibration or the manufacturers accuracy of the sensor.

Part 3:

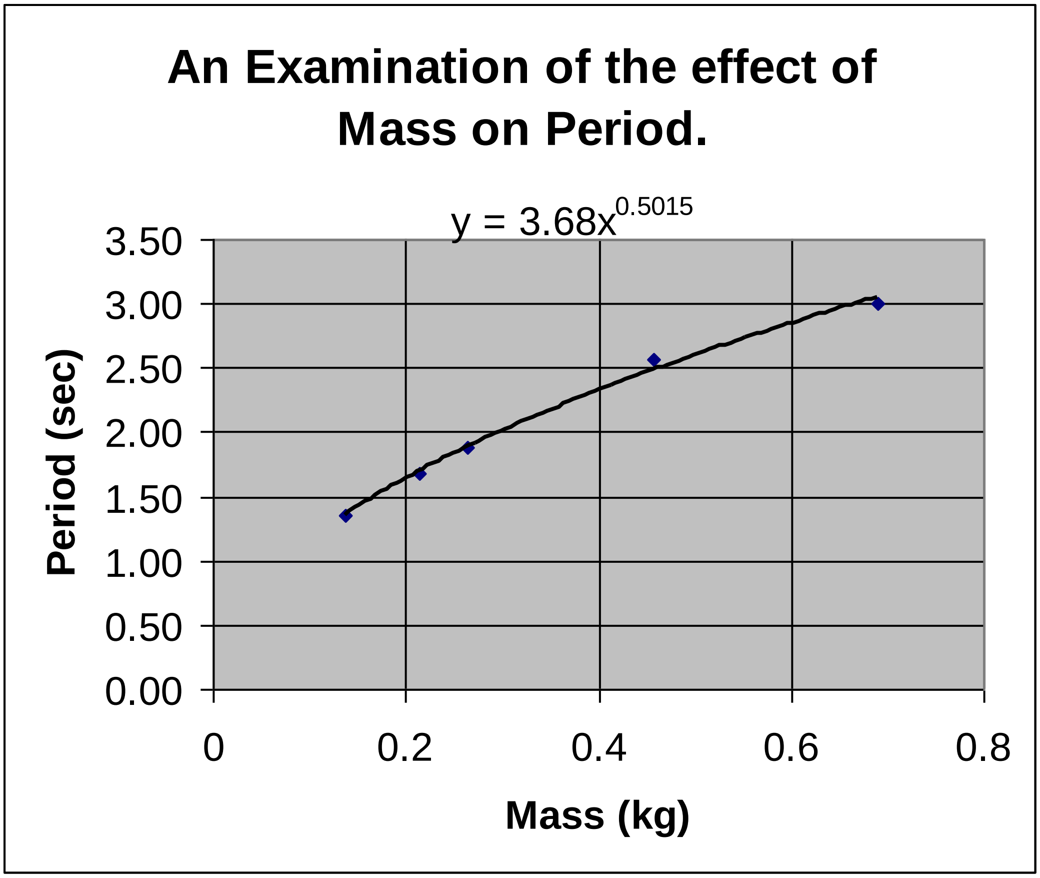
Introduction:

In this part, we will repeat part 2 with a slight modification. This time, instead of varying the amplitude, we will change the mass of the glider. We will now be able to determine the relationship between the mass of the glider and the period of oscillation. We predict that the period will increase with the mass. We predict that the period and the mass will be related by the formula $T = \frac{2\pi}{\omega}$, which leads to the formula $T = \frac{2\pi}{\sqrt{k_{eff}}}\sqrt{m}$ because $\omega = \sqrt{\frac{k}{m}}$

Data:

| Mass (kg) | Period (sec) |
|---|---|
| 0.26345 | 1.88 |
| 0.68908 | 3.00 |
| 0.13645 | 1.36 |
| 0.4569 | 2.56 |
| 0.21485 | 1.68 |

Data Analysis:




Results:

An examination of the graph of the mass vs. the period shows that the period increases with the mass and follows a curve of the type $y = C\sqrt{x}$. This corresponds with our theoretical formula since $C$ is a constant and can equal $\frac{2\pi}{\sqrt{k_{eff}}}$. Our calculated value for $C$ is 3.6 while the measured value is 3.68. This gives a percent difference of 2%.

Conclusion:

From Part 1 we determined that the effective spring constant was 3.051. This value is well within the value allowed for by the experimental uncertainty. We can therefore state that the effective spring constant is equal to the sum of all the individual spring constants or $k_{eff} = k_1 + k_2$.

From Part 2, we have confirmed that the amplitude of the oscillation does not vary the period.

In Part 3, we verified that the relation between the mass and the period is of the type $T = C\sqrt{m}$ .

In all three sections, our predictions proved correct within the limits of the experimental uncertainty.