

Physics 20 eLab

Spring Harmonic Motion

Background:

A mass hung from a vertical from a vertical spring will oscillate as energy is continually converted from potential energy to kinetic energy, and back again.

Accurately measuring the oscillation of the spring for the purpose of studying simple harmonic motion can be difficult. By using a motion sensor, the motion of the spring can be accurately recorded with a time scale for the purposes of calculating frequency.

In this activity, you will use a motion sensor to track the simple harmonic oscillation of a spring. In addition, you will investigate the relationship that mass has to the spring oscillation.

The Question:

How can the motion of a mass on an oscillating spring be described? What is relationship between the mass on a spring and the spring's oscillation?

Variables:

This experiment involves these variables: period of vibration, mass.

Materials:

- motion sensor
- USB link
- base and tall support rod
- lab clamp and rod
- spring
- hooked masses (25 g, 50 g, 100 g)
- 4 cm square piece of cardboard

Procedure:

Step 1:

Plug the sensor into the USB link (that is connected to the computer).

Orient the motion sensor upward, and set it for a narrow focus (on Pasco motion sensors, this means moving the switch on top the picture of a cart).

Step 2:

Use a lab clamp to attach the spring to a support rod so that the spring hangs downward. Attach a mass to the bottom of the spring. It is advisable to attach a square of cardboard to the bottom of the mass so that the motion sensor is better able to "see" the mass as it oscillates. Your mass should be able to oscillate freely without striking the motion sensor. If your lab stand is not tall enough to accommodate this, then hang the mass over the edge of a counter.

Step 3:

Configure the DataStudio software to display a position-time graph. Click the "Setup" button and increase the sampling rate of the motion sensor to 50 Hz.

Pull the mass downward slightly and let it go so that it begins to oscillate. Click "Start" in the DataStudio software and record data for a few seconds before stopping.

Step 4:

Repeat if necessary to obtain a smooth oscillating curve on your position-time graph. Use the graph to determine the time from one peak on the graph to another. This is facilitated in DataStudio by using the smart tool in the DataStudio graph to measure the time from one peak to the next peak. This value represents the period of the spring's simple harmonic motion, record it in your notes.

Step 5:

Repeat steps 3 and 4 with the other two masses.

Analyzing and Interpreting:

1. Describe the motion of the mass on the spring - refer to your graph in your explanation.
2. What effect does changing the mass have on the motion of the spring?
3. Calculate the frequency of vibration for each of the masses. (Recall that frequency is the inverse of the period.)
4. Based on your data, make a prediction of what the frequency of vibration would be for the spring if the mass was changed to 500 g. Provide a mathematical explanation for your prediction.

Forming Conclusions:

5. How can the motion of a mass on an oscillating spring be described? What is the relationship between the mass on a spring and the spring's oscillation?

Extending:

6. What would be the effect of using stronger or weaker springs (springs with different spring constants) for this experiment? Design an experiment that would include different springs, make a prediction of what their frequency of vibration would be, and carry out the experiment.