

eMATH**Acceleration and Velocity of a Horizontal Mass-spring System****Purpose:**

To explore the interaction of the spring constant, mass, and displacement on a horizontal mass-spring system's acceleration and velocity.

Background:

As a mass-spring system oscillates on a horizontal frictionless surface its velocity and acceleration are changing as it moves back and forth. The book explains and illustrates how the acceleration of the mass is always opposite of its motion, and its velocity is not a linear graph.

In this eMATH you will be able to change the values of the mass and spring constant of the system. You will observe how changing these quantities affects the shape and slope of the velocity and acceleration graphs.

Download and open the accompanying Excel spreadsheet. You will see the initial data for the horizontal mass-spring system. The displacement values are already entered. They represent the motion of the mass starting at its maximum positive displacement through to its maximum negative displacement, or one-half of an oscillation.

Instructions:

1. Using Excel or an appropriate graphing calculator, plot the graph of velocity and acceleration as a function of displacement using a mass of 2.0 kg and spring constant of 20 N/m. Make sure the scale of the x -axis is the same as the y -axis. Print the graph and record the mass and spring constant values on the graph.
2. Increase the value of the mass in cell C6 to 10 kg, then press enter so the spreadsheet can calculate the new values of velocity and acceleration. Using Excel or an appropriate graphing calculator, plot the graph of velocity and acceleration as a function of displacement using the new value of the mass. Make sure the scale of the x -axis is the same as the y -axis. Print the graph and record the mass and spring constant values on the graph.
3. Finally, increase the mass to the same quantity as the spring constant. Using Excel or an appropriate graphing calculator, plot the graph of velocity and acceleration as a function of displacement using the new value of the mass. Make sure the scale of the x -axis is the same as the y -axis. Print the graph and record the mass and spring constant values on the graph.
4. Experiment with changing the mass of the system. Observe the effect this has on the velocity and acceleration of the system.
5. Reset the value of the mass to 2.0 kg. Now experiment with changing the spring constant of the system. Observe the effect this has on the velocity and acceleration of the system.

Analysis:

1. What happens to the general shape of the velocity-displacement graph as the mass increases?
2. What happens to the maximum acceleration of the mass-spring system when the mass of the system is increased?
3. What effect does changing the mass have on the period of oscillation, maximum speed, and acceleration?
4. What effect does changing the spring constant have on the period of oscillation, velocity, and acceleration?

Extension:

5. What is the shape of the last velocity-displacement graph when the mass had an equivalent value to the spring constant? Why does it have this shape?