FACTORS AFFECTING THE FREQUENCY OF A

SIMPLE HARMONIC OSCILLATOR

|  |  |
| --- | --- |
| **OBJECTIVE:** | To investigate the dependence of the frequency of oscillation on the following physical quantities: amplitude, spring constant and mass. |
| **MATERIALS** | masses-and-springs-en.html, spreadsheet |
| **ONLINE RESOURCES** | Masses and Springs PhET simulation: <https://phet.colorado.edu/sims/html/masses-and-springs/latest/masses-and-springs_en.html> |
| **PROCEDURE** |  |
| Frequency and Amplitude of Oscillation | 1. Open the Masses and Springs PhET simulation. Select LAB.
2. Set the following parameters:

|  |  |
| --- | --- |
| Simulation | PAUSED |
| Mass | 50 g |
| Spring Constant | “Large” |
| Mass Equilibrium | Enabled |
| Movable Line | Enabled |
| Gravity | Earth |
| Damping | None |
| Simulation Speed | Slow |

 1. Hook the 50-g mass and adjust the position of the movable line tracer 20 cm below the equilibrium line. This will be the starting position of the 50-g mass.

1. Start the simulation by clicking on the Pause/Play button. Using the built-in stopwatch, determine the time it takes the 50-g mass to make 10 complete oscillations. Make two trials.
2. Adjust the starting position to 40 cm and repeat procedure no. 4. Record your measurements and calculations in Data Table I.

Data Table 1

|  |  |  |
| --- | --- | --- |
| Starting Position | Time for 10 complete oscillations (s) | Frequency (Hz) |
| Trial 1 | Trial 2 | Ave. |  |
| 20 cm |  |  |  |  |
| 40 cm |  |  |  |  |

QUESTIONS:* What does the starting/initial position of the 50-g mass represent?
* What happens to the length of the path travelled by the 50-g mass when the starting position is increased from 20 cm to 40 cm? What happens to its speed?
* Does the starting position of the object affect the frequency of the object-spring system? Explain.
 |
| Frequency and Spring Constant | 1. Set the following parameters:

|  |  |
| --- | --- |
| Simulation | PAUSED |
| Mass | 50 g |
| Spring Constant 1 | 1 unit from “Small” |
| Mass Equilibrium | Enabled |
| Movable Line | Enabled |
| Gravity | Earth |
| Damping | None |
| Simulation Speed | Slow |
| Starting position from equilibrium line | 30 cm |

1. Run the simulation by clicking on the Start/Stop button. Determine the frequency of oscillation of the 50-g mass.
2. Using the same parameters in (1), make several trials, each time, increasing the spring constant by 2 units from “Small” until the spring constant = 9 units. In each trial, make sure that the starting position is always kept at 30 cm below the equilibrium line. Summarize your measurements in Data Table 2.

Data Table 2

|  |  |
| --- | --- |
| Spring constant k | Frequency of Oscillation |
| 1 |  |
| 3 |  |
| 5 |  |
| 7 |  |
| 9  |  |

 1. Using a spreadsheet, plot the values of the frequency against the values of the spring constant. Describe the graph formed.
2. Plot the values of f2 against the values of k. Describe the graph formed.

QUESTIONS:* What happens to the frequency of oscillation of the mass-spring system as the spring constant increases?
* What does the graph of f2 against k suggest about the relationship between the frequency and the spring constant? Explain
 |
| Frequency and Mass | 1. Set the following parameters:

|  |  |
| --- | --- |
| Simulation | PAUSED |
| Mass | 50 g |
| Spring Constant 1 | LARGE |
| Mass Equilibrium | Enabled |
| Movable Line | Enabled |
| Gravity | Earth |
| Damping | None |
| Simulation Speed | Slow |
| Starting position from equilibrium line | 30 cm |

1. Run the simulation. Determine the frequency of oscillation of the 50-g mass.
2. Using the parameters in (1), make several trials, in each time increasing the mass of the object by 50 g until the mass equals 300 g. For each trial, make sure to set the starting position from the equilibrium line to 30 cm. Enter your measurements in Data Table 3

Data Table 3

|  |  |
| --- | --- |
| Mass (g) | Frequency of Oscillation (Hz) |
| 50 |  |
| 100 |  |
| 150 |  |
| 200 |  |
| 250  |  |
| 300 |  |

1. Plot the values of the frequency against the values of the mass. Describe the graph formed.
2. Plot the values of f2 against the values of 1/m. What is the shape of the graph?

**QUESTIONS:*** What happens to the frequency of oscillation as the mass of the oscillator increases?
* What does the graph of f2 against 1/m suggest about the relationship between f and m? Explain.
 |
| **CONCLUSION(S)** |  |
| **GOING FURTHER** | In the simulation, the mass of the blue and the red weights are not known. Develop a procedure on how you will determine the masses of these objects. |