Lots of things vibrate or oscillate. A vibrating guitar string, a swaying bridge, the loudspeaker in a radio, and motion of a child’s playground swing are all examples of physical vibrations. A simple simulation of harmonic motion and simulation on springs can be found on the PhET website: <http://phet.colorado.edu>. These simulations model Simple Harmonic Motion (SHM) of a given object of unknown mass as well as explore springs and oscillations.

**To access simulations for Part 1 and Part 2 please go to my website!**

**Part 1**: Exploring velocity and acceleration of an oscillator

**Learning Objectives:**

1. Identify velocity and acceleration while observing the SHM of the particle.
2. Understand the key components of the sinusoidal equation for displacement, velocity and acceleration.
3. Determine the amplitude and period of an observed SHM.

**Procedure to set up the simulation:**

1. Open the “Motion in 2D” simulation”. (Note: this may not work if you have a Mac, please link up with another group\_
2. Select “show neither” for the “velocity or acceleration?” setting at the top of the window.
3. Select “Simple harmonic” at the bottom of the window.
4. Observe the particle’s movement and identify ***+xm, -xm***, and the ***equilibrium points***.
5. Select “show both” for the “velocity or acceleration?” setting at the top of the window.
6. Run the simulation and determine which vector represents velocity and acceleration.
7. Measure ***+xm, -xm*** using a metric ruler (***YES a REAL RULER***) and the ***period*** of oscillation using a stopwatch.. Using this data develop a model equation that defines displacement.
8. Assume the moving particle is an example of a linear simple harmonic oscillator with mass = 2 kg. that moves under the influence of a Hook’s law restoring force given by ***F = -kx.***
9. Find the value for the constant, k, in this linear simple harmonic oscillator.

**Part 2**: Exploring the simple harmonic motion of springs

**Learning Objectives:**

1. To explore the properties and relationships between masses and springs as oscillators

**Procedure to set up the simulation:**

1. Open the “Masses and Springs”.
2. Put a 100 g weight on the first and the third springs. They should hang at the same level. Increase the stiffness of spring 3.
3. What happens when the stiffness of spring 3 is increased?
4. What happens to all the energy columns as the stiffness in increased? How do they differ from spring 1?
5. In the same configuration as step 2, decrease the stiffness of spring 3What happens when the stiffness of spring is decreased?
6. What happens to the energy columns as the stiffness is decreased? How do they differ from spring 1?
7. Where does the spring have maximum elastic potential energy?
8. Where is the gravitational potential energy the least? (Note: in AP Physics we are currently locked on Earth’s surface…)
9. Where is the kinetic energy zero?
10. Where is the elastic potential energy zero?
11. Place the weights below on the end of spring #3 and fill in the data table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Mass (g)** | **Mass (kg)** | **Force - weight (N)**  **Hint: mass (kg) x gravity = weight** | **Distance spring stretched (cm)** |
| 50 | 0.050 | 0.050 x 10 = 0.5 |  |
| 100 |  |  |  |
| 250 |  |  |  |

1. Using Hooke’s Law (Force = elasticity x distance) calculate the elasticity of spring #3.
2. Set the stiffness of spring #3 to “hard”. Fill in the data table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Mass (g)** | **Mass (kg)** | **Force - weight (N)**  **Hint: mass (kg) x gravity = weight** | **Distance spring stretched (cm)** |
| 50 | 0.050 | 0.050 x 10 = 0.5 |  |
| 100 |  |  |  |
| 250 |  |  |  |

1. Using Hooke’s Law calculate the elasticity of spring #3 now.
2. Set the stiffness of spring #3 to “soft”. Fill in the data table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Mass (g)** | **Mass (kg)** | **Force - weight (N)**  **Hint: mass (kg) x gravity = weight** | **Distance spring stretched (cm)** |
| 50 | 0.050 | 0.050 x 10 = 0.5 |  |
| 100 |  |  |  |
| 250 |  |  |  |

1. Using Hooke’s Law calculate the elasticity of spring #3 now. What did you find interesting about this third setup?
2. Using your data about k and displacement, Write down and test a procedure for determining the mass of the red, gold, and green masses. Show all data, a sample table might look like the one below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Mass (g)** | **Mass (kg)** | **Force - weight (N)**  **Hint: mass (kg) x gravity = weight** | **Distance spring stretched (cm)** | **k** |
| Gold |  |  |  |  |  |
| Red |  |  |  |  |  |
| Green |  |  |  |  |  |

1. Compute the gravity for Jupiter, the moon, and planet X utilizing what you know or test about k, m, and x on these planets. Show all data. Compare the softness or hardness of the spring to the same spring on earth. Show your reasoning.