SIMPLE HARMONIC MOTION

Mechanics

Unit 7

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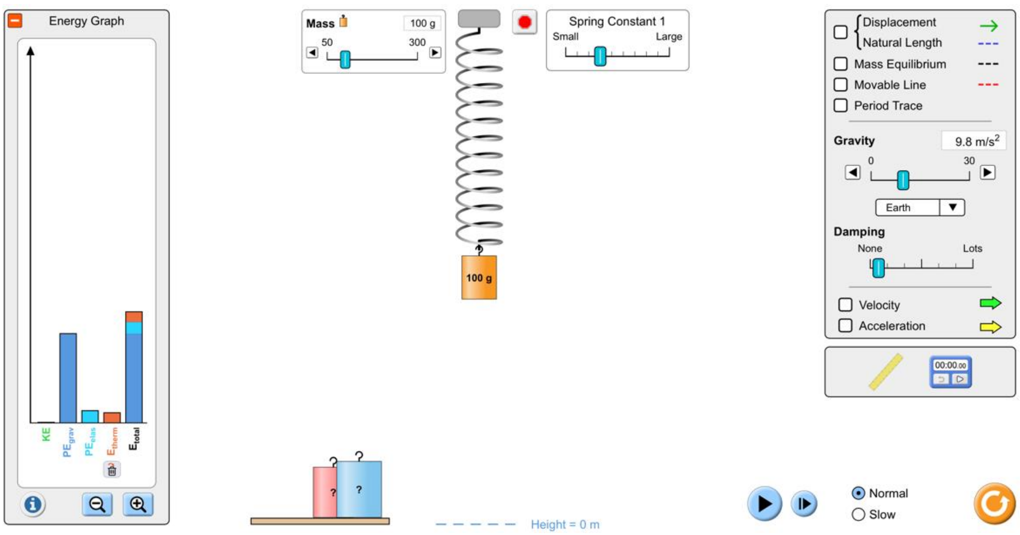
Simulation Activity #8: Masses and Springs
Simulation created by the Physics Education Technology Project (PhET)
c/o The University of Colorado at Boulder http://phet.colorado.edu/



Investigating Springs: Harmonic Motion and Energy Exchanges

Objective:
This activity is intended to enhance your physics education. We offer it as a virtual lab online. We think it will help you make connections between predictions and conclusions, concepts and actions, equations and practical activities. We also think that if you give this activity a chance, it will be fun! This is an opportunity to learn a great deal. Answer all questions as you follow the procedure in running the simulation.

You need to familiarize yourself with this spring mass system simulation. The spring's stiffness can be adjusted using "spring constant" slide and the mass can be adjusted using "mass" slide. There are also sets of unknown masses that can easily be hanging on springs. The oscillation of a mass can be real time or slowed down. The damping effect can be controlled by "damping" slide bar. You can also transport the virtual lab to a different planet. You have also an option to observe how the potential and kinetic energies exchange during oscillation and thermal energy due to friction in the system. Timer is also available if check the "stopwatch" box in the control panel. Use the "ruler" to make vertical position measurements.

Introduction:

When a load is applied to the free end of a spring suspended from a fixed support, the spring stretches until the tension in the spring balances the weight of the load. If the stretch is within the elastic limit of the spring, the load on the spring is directly proportional to the stretch of the spring and the spring obeys *Hooke's law.*
Hooke's law: F = -kΔx, where k is the spring constant and Δx is stretched (or compressed)
Under this conditions, the loaded spring, if set into vibration, will undergo harmonic motion with a period given by the equation,

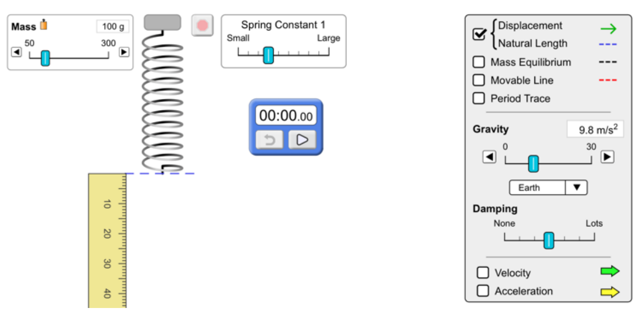
$$T = 2\pi\sqrt{\frac{m}{k}}$$

Where T = period of motion, m=the effective mass of the vibrating system, and k=the spring constant

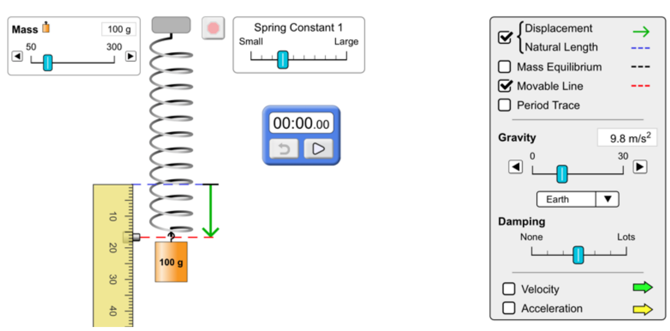
Procedure: Finding Spring Constant: *Open Masses and Springs*

http://phet.colorado.edu/simulations/sims.php?sim=Masses_and_Springs

When you start the lab, make sure you click on the Lab button.



1. Apply the settings as shown above.
   a. Determine the starting position by placing the ruler next to a spring. x_{0sp1} = <u>0.00m</u>



   b. Hang a 100g mass from the spring and read the position of the spring. x_{1sp1} = <u>0.16m</u>

   c. Find the displacement and calculate the constant of the spring. Δx = <u>0.16m</u>, Force = <u>0.98N</u>
   K_{sp1} = <u>6.125N/m</u>

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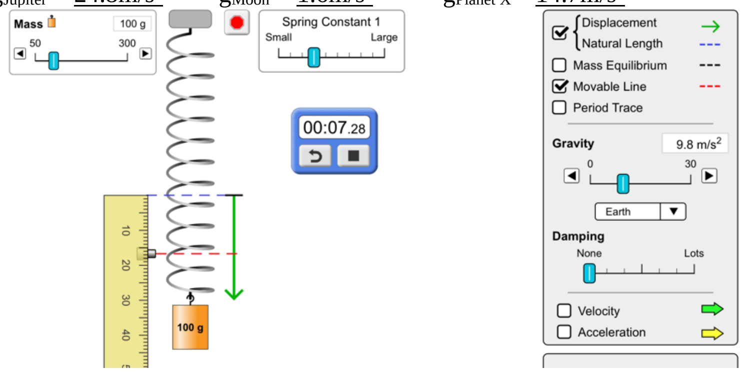
2. Using spring's constant you just found for the spring, determine the unknown masses of red and blue masses.
   M_{red} = 0.375kg, M_{blue} = 0.234kg,

3. Using spring's constant you found for the first spring and a known mass, determine the acceleration due to gravity of Jupiter, Moon, and Planet X.
   $g_{Jupiter}$ = 24.8m/s^2 g_{Moon} = 1.6m/s^2 $g_{Planet\ X}$ = 14.7m/s^2



4. Apply the above settings and answer the questions
   a. Remove damping (or slide to none)
   b. Check the stopwatch box to activate the timer
   c. Attach the 100g mass slowly and record the initial position of this spring-mass system.
   d. Now stretch additional 10cm and let it be moving up and down so that it constitute SHM

5. Record the time it takes for 20 complete oscillations and calculate the period (the time for one complete cycle).
   Time (t) = 16.60s, Period (T) = 0.83s

6. Using the spring constant found in step 1 and the 100g mass, calculate the period of this SHM. Hint use equation described in the Introduction. 0.803s

7. Compare the periods you found in steps 4 and 5. I am assuming you mean steps 5 and 6. The periods are very similar except they are slightly off. My measurement for the time was probably off by a bit.

8. Repeat steps 4 to 7 for Jupiter

   Step 4: Time (t) = 16.23s, Period (T) = 0.81s

   Step 5: Period (T) = 0.803s

   Step 7: Similar to before the measurement is slightly different. This was probably due to a timing mistake.

9. Using the spring constant you found in step 1 and the red and blue masses found in step 2, calculate the period of these masses.
   T_{red} = 1.55s, T_{blue} = 1.22s,

Follow-up Questions:

1. How far would a spring with a constant of 20 be extended with a force of 160 N? 8m
2. How much force would be required to stretch a spring (k = 12) 3.6 meters? 43.2N
3. As mass on a spring increases, the period of motion (one full up and down) **increases** /decreases / remains the same.
4. As gravity (Jupiter) on a spring increases, the period of motion increases / decreases /**remains the same**.
5. As the spring constant increases, the period of motion increases / **decreases** / remains the same.

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6. Amplitude is the displacement (meters) from the equilibrium position (zero upon period? **Yes** / No
7. What is the period of 1.2 kg mass bouncing on a spring with a spring constant of 15? 1.78s
8. What is the period of a 450 gram mass bouncing on a spring with a spring constant of 9.0? 1.40s