

Virtual Lab – Mass on a Spring, Hooke’s Law, Simple Harmonic Motion

Spring Constant 1
Small Large

Spring Constant 2
Small Large

Displacement →
 Natural Length - - -
 Mass Equilibrium - - -
 Movable Line - - -

Gravity
None Lots
 Earth ▼

Damping = 0

Velocity →
 Acceleration →
 Forces
 Gravity →
 Spring →
 Net Force →

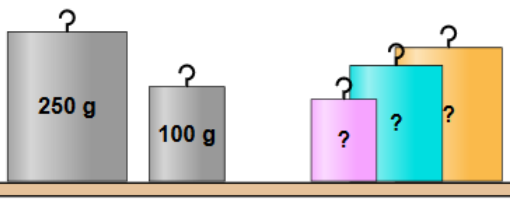
Goals: verify Hooke’s Law, determine spring constant, and verify by simple harmonic motion.

Experiment with different spring constants

Try attaching different masses and observe.

To start, play around with the simulation as suggested here...

Go to PhET Masses and Springs and use the Vectors option.



▶ ▶

Normal
 Slow

Stop puts mass at rest at equilibrium.



Spring Constant 2

Small Large

blue line: normal length
green arrow: change in length
red line: adjust to help measure

Click and drag the mass up and down – notice the effect on the forces. Then click the stop button.

Use the ruler tool to measure the spring's elongation – 9.0 cm in this example.

Use these options, measure the elongation for three different masses. Calculate the value of the spring constant ($k = F/x = mg/x$) and find the mean. The result should be in the range: $2 \text{ N/m} < k < 12 \text{ N/m}$

- Displacement →
- Natural Length - - -
- Mass Equilibrium - - -
- Movable Line - - -

Gravity

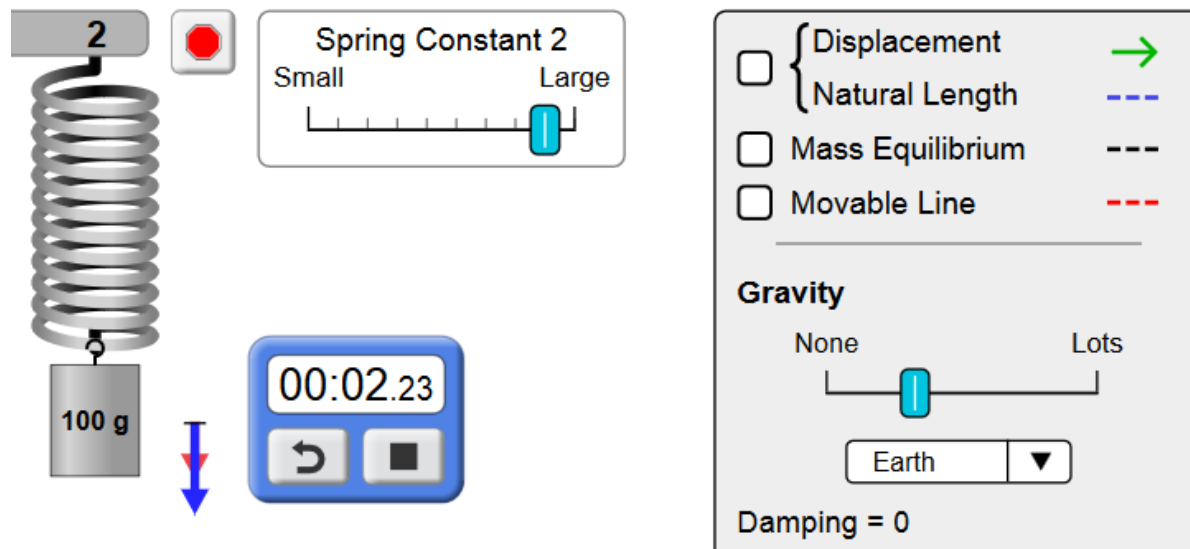
None Lots

Earth ▼

Damping = 0

- Velocity →
- Acceleration →
- Forces
- Gravity →
- Spring →
- Net Force →

Select the 4 options shown.



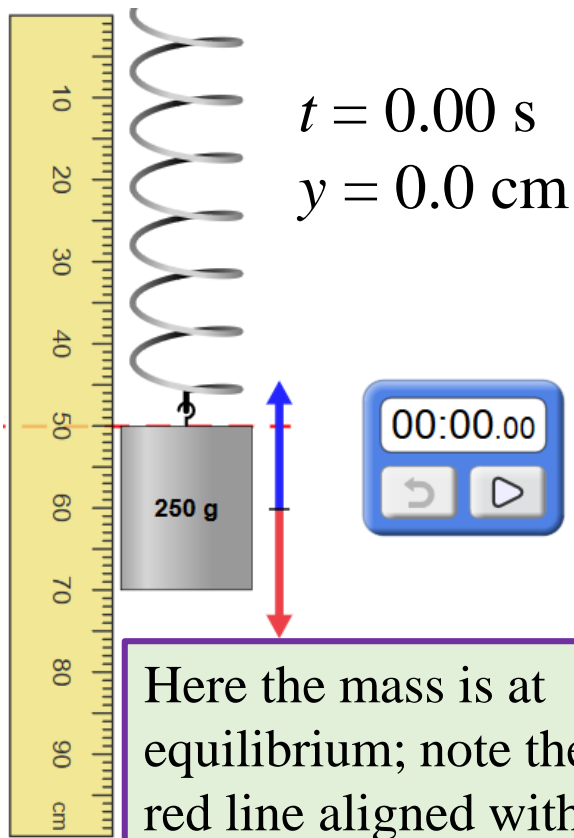
Now using the *same spring*, experiment with a mass oscillating up and down. Measure the period using the stopwatch tool – measure the time for 10 oscillations and divide the total time by 10. (Or you can pause and step through the animation.)

Determine k based on values of m and T using the equation: $T = 2\pi\sqrt{\frac{m}{k}}$
 If all goes well it should match the previously determined value!
 Does it? You must allow for error in measurement.

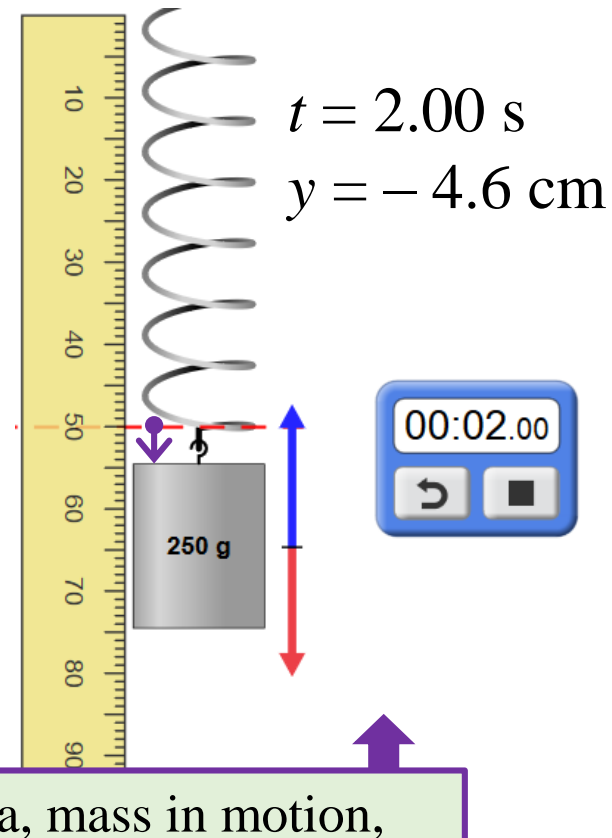
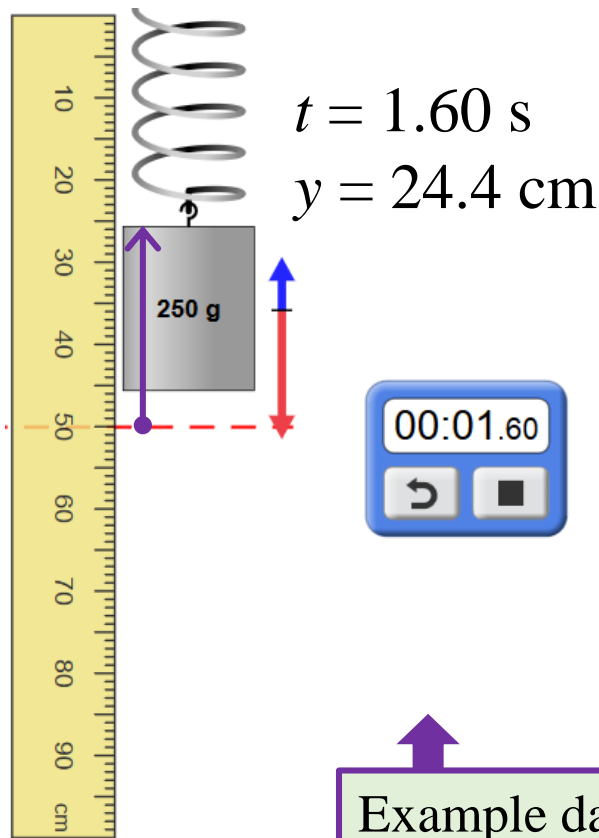
Other things to try:

Repeat all or part of the experiment using gravity of a different world. If you choose the “Custom” setting you can also try zero gravity.

Determine one of the unknown masses by timing the period and solving for m and/or by measuring the elongation it causes and using $F = kx$. Check yourself by doing both!



Here the mass is at equilibrium; note the red line aligned with the top of the mass.



Example data, mass in motion, timer running, simulation paused.

Optional challenge: Use a setup similar to this to collect data needed to create a position vs time graph. You can pause and “step through” the simulation, recording the time and position at increments of 0.10 s. Then do a sinusoidal curve fit of this data using an equation of the form $y = A \sin(Bt + C)$. Determine the spring constant k using the coefficient B and the mass of the object, compare to previous results.