PhET Tips for Teachers

Masses and Springs

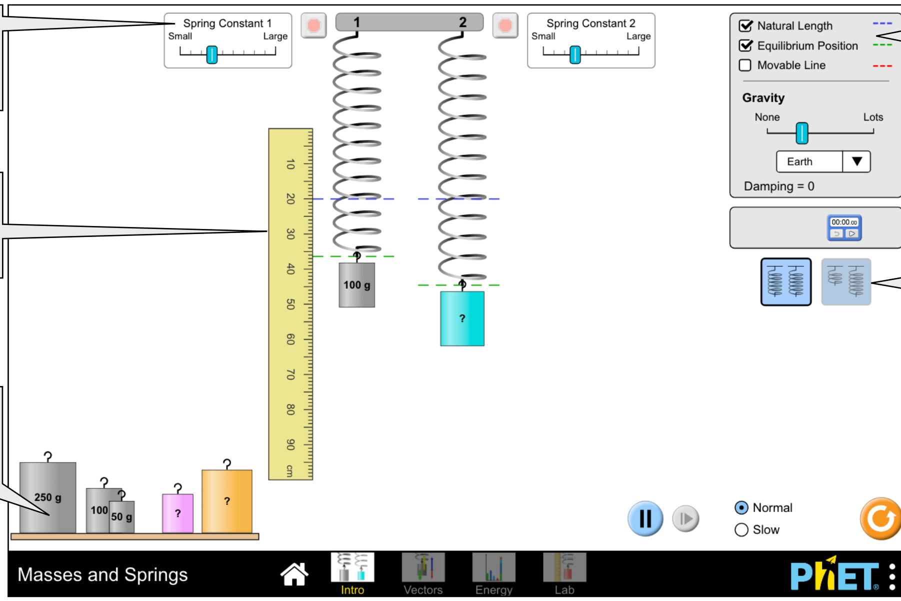
Intro Screen

Play with one or two mass-spring systems and discover which variables (such as mass, gravity, spring constant, spring length) affect the period.

ADJUST the spring constant

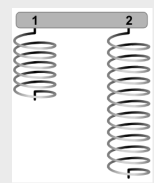
MEASURE the displacement

HANG masses from springs



VIEW natural length and equilibrium position

COMPARE springs with different natural lengths



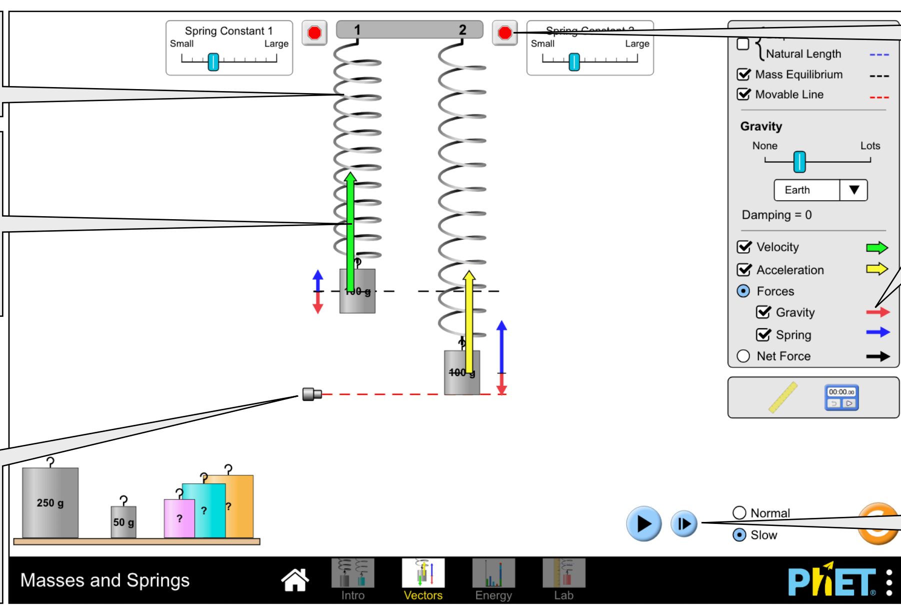
Vectors Screen

View the net force or component forces in the system, and explore how the velocity and acceleration change throughout the oscillation.

COMPARE two systems

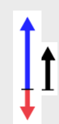
OBSERVE the velocity and acceleration in real-time

SET reference point with Movable Line



STOP oscillation

DISPLAY components or net force



PAUSE the sim to set up an experiment; **JUMP** forward by 0.01 seconds

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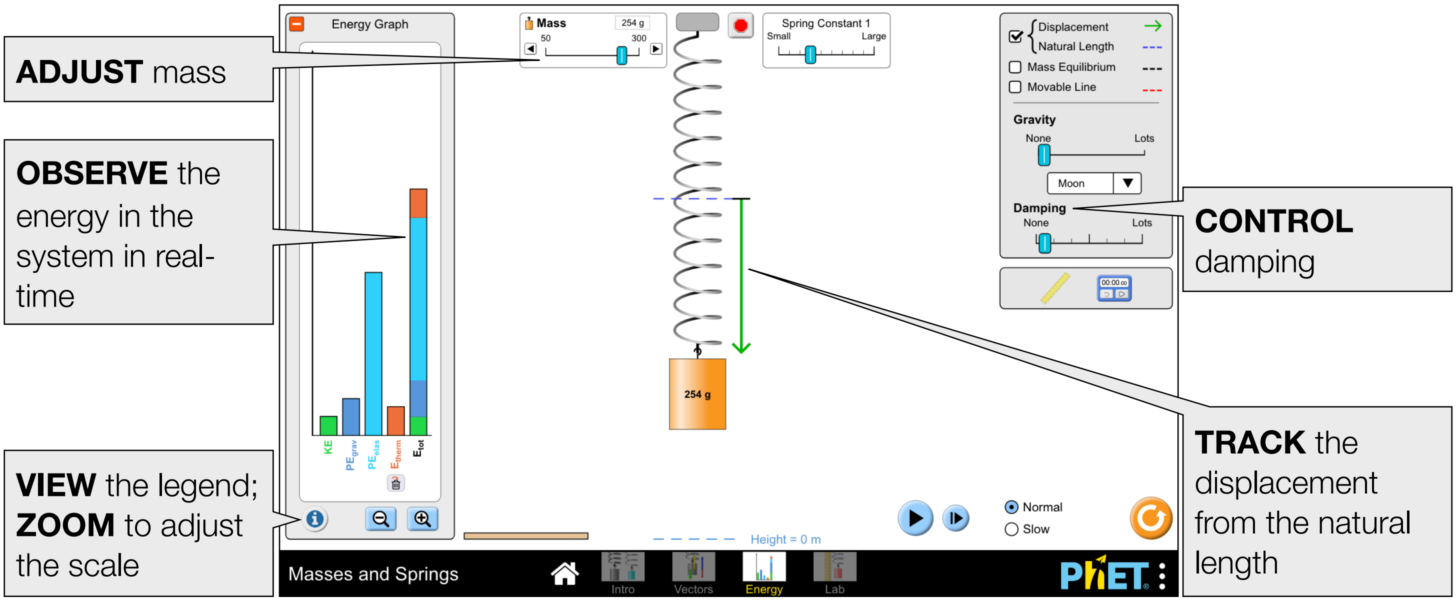
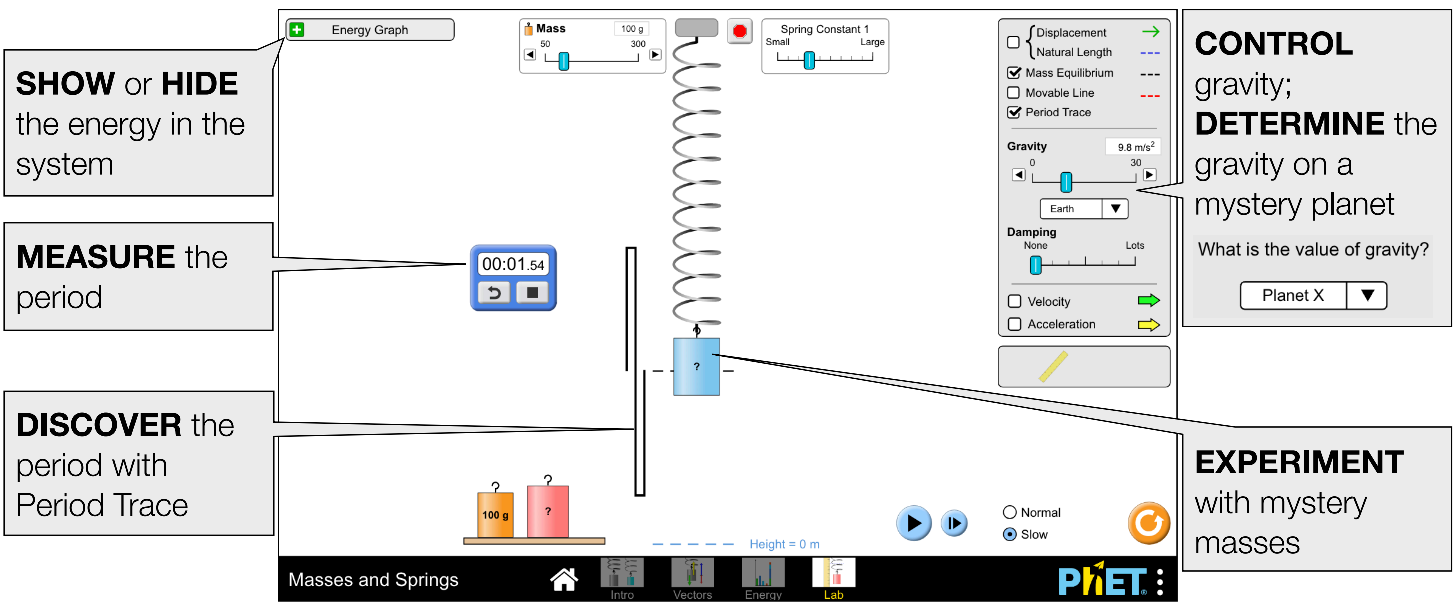
Energy Screen

Explore the energy in the system in real-time and discover the conservation of mechanical energy.



Lab Screen

Collect data and determine the value of the mystery mass or g on Planet X.



Complex Controls

- The remove heat button in the Energy Graph will instantaneously remove the thermal energy from the system. If damping is on, the thermal energy will still continue to accumulate.
- The zero-point of the gravitational potential energy is indicated by the — — — — — Height = 0 m dashed line at the bottom of the screen. GPE will be zero when the bottom of the mass is at this line.
- When the energy is off-scale, an arrow will appear above the bar in the Energy Graph. To re-scale the graph, zoom out until the arrows are no longer visible.

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Insights into Student Use

- When setting up an experiment, it may be helpful to first pause the sim.
- Students may notice that the displacement vector is asymmetric about the natural length. You can ask students to find a way to make this displacement equal (g = 0) or ask them to instead compare the displacement about the Mass Equilibrium (always symmetric).

Model Simplifications

- The thickness of the spring is used to indicate the spring constant. A spring with n coils can be treated as n identical springs (each with spring constant k) connected in series, with an effective spring constant of $k_{eq} = k/n$. For springs with an unequal number of coils (unequal natural lengths) to have the same effective spring constant, the shorter spring must have a thinner gauge. Similarly, if these two springs have the same thickness, the shorter spring will have the greater effective spring constant.
- The mystery masses on the Intro and Vectors screens have the same density as the other masses, so their size can be used to (roughly) determine their mass. On the Lab screen, the mystery masses have different densities, so students will need a more sophisticated strategy to determine their value.
- Two equilibrium reference positions can be displayed in this sim: Equilibrium Position (end of spring) and Mass Equilibrium (center of mass). The Equilibrium Position appears on the Intro screen to allow students to discover the displacement. Vectors are drawn with respect to the center of mass, so the Mass Equilibrium is a more useful visual reference on the later screens.
- The damping force is proportional to the velocity ($F = -c \cdot v$), and the damping slider controls c. For more information about the damping or the equation of motion, see Masses and Springs Model.
- If a parameter (e.g. gravity, mass) is changed mid-oscillation, the instantaneous displacement, mass, spring constant, gravity, and velocity will be used as the new initial conditions for the equation of motion. Frequent mid-oscillation changes can lead to hard-to-interpret (though technically still accurate) behavior, so we recommend stopping the mass between experiments.

Suggestions for Use

Sample Challenge Prompts

- Describe the Natural Length and Equilibrium Position in your own words.
- Identify all the ways to increase the displacement at equilibrium.
- Determine the relationship between the applied force and displacement.
- Explain what the period represents, and determine a method to measure it.
- Design a controlled experiment to (qualitatively or qualitatively) determine how a variable — such as mass, gravity, spring constant, or displacement — affects the period.
- Determine a way to give a heavier mass a shorter period than a lighter mass.
- Sketch the gravitational and spring forces at several points throughout the oscillation.
- Predict the direction and magnitude of the velocity and acceleration vectors throughout the oscillation.
- Identify where in the oscillation the kinetic energy, gravitational potential energy, and elastic potential energy are increasing/decreasing, and identify the locations where the energies are maximum or zero.
- Estimate the speed of the mass (e.g. max, medium, zero) or its position from the Energy Graph.
- Determine the mass of the mystery masses or the value of g on Planet X (qualitatively or quantitatively), and explain your method(s).

See all published activities for Masses and Springs here.
For more tips on using PhET sims with your students, see Tips for Using PhET.

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