

## Model Screen

Move the Sun, Earth, Moon and Space Station to see how it affects their gravitational forces and orbital paths.

**VIEW** the orbits of the objects

**DRAG** the objects to relocate

**CHOOSE** a system

**TURN OFF** gravity

**RESET** the Earth Days counter

## To Scale Screen

Explore how gravity controls the motion of our solar system at the real-world scale.

**ADJUST** the zoom level

**MEASURE** the real-life distances

**CONTROL** the playback speed

**RESET** the system to its default state

**USE** the grid to compare the vector lengths

**ADJUST** the masses relative to a benchmark object

## Complex Controls

- The objects can be repositioned by dragging them. Their velocities can also be changed by dragging the encircled v at the tip of the vector.



- Students can save a custom configuration by pausing the sim, dragging the objects and/or velocity vectors to the desired location, and then playing the sim. To repeat the experiment, use the rewind button (to the left of the play/pause button).
- The sliders controlling the masses of the star, planet, moon, and satellite are scaled relative to the benchmark object (Sun, Earth, Earth's moon, and the International Space Station, respectively). The sliders range 50% (0.5) to 200% (2.0) of the benchmark object's mass.
- The background color of the simulation can be changed for easier projection by clicking on the PhET menu bar, selecting Options, and checking Projector Mode. Projector Mode can also be accessed by adding ?projectorMode to the end of the sim's URL.

## Model Simplifications

- The Model screen is not drawn to scale. The objects appear larger and closer together than they are in real life. This close-up view allows students to more comfortably play with the variables important to understanding gravity and orbits. The distances and masses are accurately represented in the To Scale screen.
- The perspective of the images used for the Earth and Moon are different. The Earth is shown from the North Pole looking down, so that the path of the Moon's orbit appears more accurate. However, the Moon's image is an equatorial view so that it is more easily recognizable.
- In the Sun-Earth-Moon system, the gravitational force vectors are the **net** gravitational force vectors, which most noticeable on the moon.
- On the To Scale screen, the paths of very closely orbiting/passing bodies can be greatly affected by the playback speed, resulting in different outcomes in Fast Forward, Normal, and Slow Motion. This happens because the time step used in the simulation is scaled by the playback speed. However, the paths of the objects in their default configurations will **not** be affected by the playback speed.

## Suggestions for Use

### Sample Challenge Prompts

- Predict what happens to the Earth's orbit if the Sun's mass is doubled.
- Find three ways to change the number of days it takes the Earth to complete one revolution around the sun.
- Determine how to make the Moon go around the sun in a larger orbit.
- Draw a picture of what would happen if there was no gravity at all.
- Design an experiment to determine the factors that influence the size of the gravity vector.
- Compare the gravity forces on the Earth and Sun. Does the Sun move?
- The mass of Venus is similar to the Earth, but it is much closer to the Sun. How does the gravitational force between the Sun and Venus compare to the gravitational force between the Sun and the Earth? Is a year on Venus longer or shorter than an Earth year?

See all published activities for Gravity and Orbits [here](#).

For more tips on using PhET sims with your students, see [Tips for Using PhET](#).