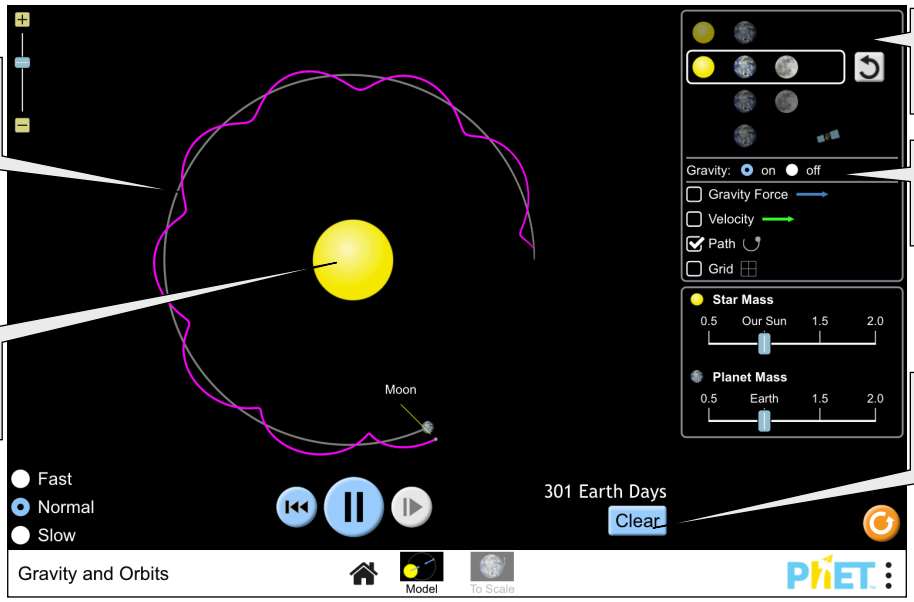
PhET Tips for Teachers

Gravity and Orbits

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 objects to relocate

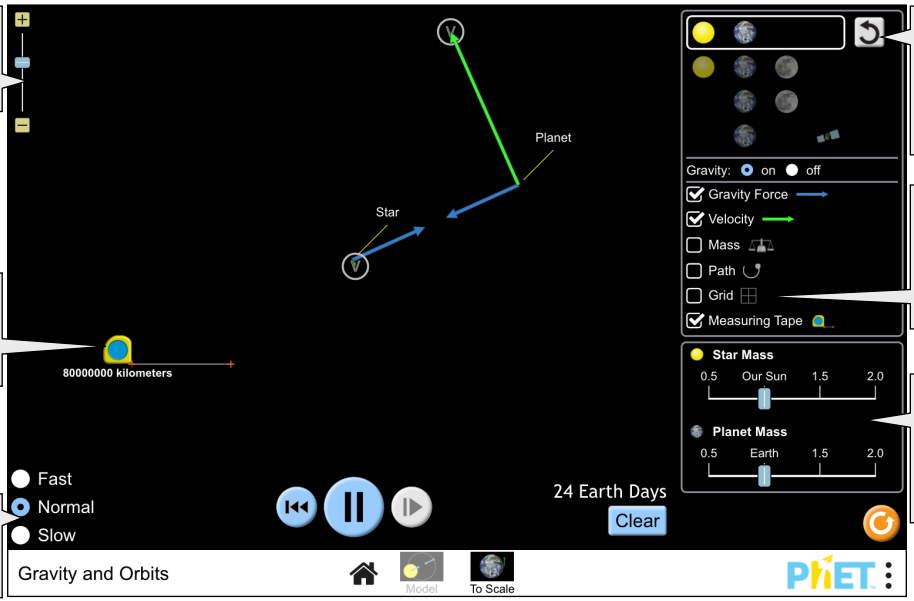
CHOOSE a system

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 masses relative to benchmark

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '`?`' to the sim URL, and separating each query parameter with a '`&`'. The general URL pattern is:
`…html?queryParameter1&queryParameter2&queryParameter3`

For example, in Gravity and Orbits, if you only want to include the 1st screen (`screens=1`), with pan and zoom disabled (`supportsPanAndZoom=false`) use:
https://phet.colorado.edu/sims/html/gravity-and-orbits/latest/gravity-and-orbits_all.html?screens=1&supportsPanAndZoom=false

To run this in Spanish (`locale=es`), the URL would become:
https://phet.colorado.edu/sims/html/gravity-and-orbits/latest/gravity-and-orbits_all.html?locale=es&screens=1&supportsPanAndZoom=false

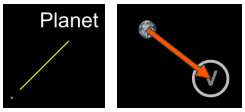
⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Example Links

`screens` - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the Help Center.	`screens=1`
	
	`screens=2,1`

`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=1` `initialScreen=2`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
⚙ `colorProfile` - changes simulation colors for easier projection.	`colorProfile=projector`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`

Complex Controls



- The objects can be repositioned by dragging them or their label. 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.

Rouinfar, November 2021

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.
- Orbiting bodies start at periapsis.
- In the Star-Planet-Moon system, the gravitational force vectors are the **net** gravitational force vectors, which is 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 (Fast, Normal, Slow), resulting in different outcomes. 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

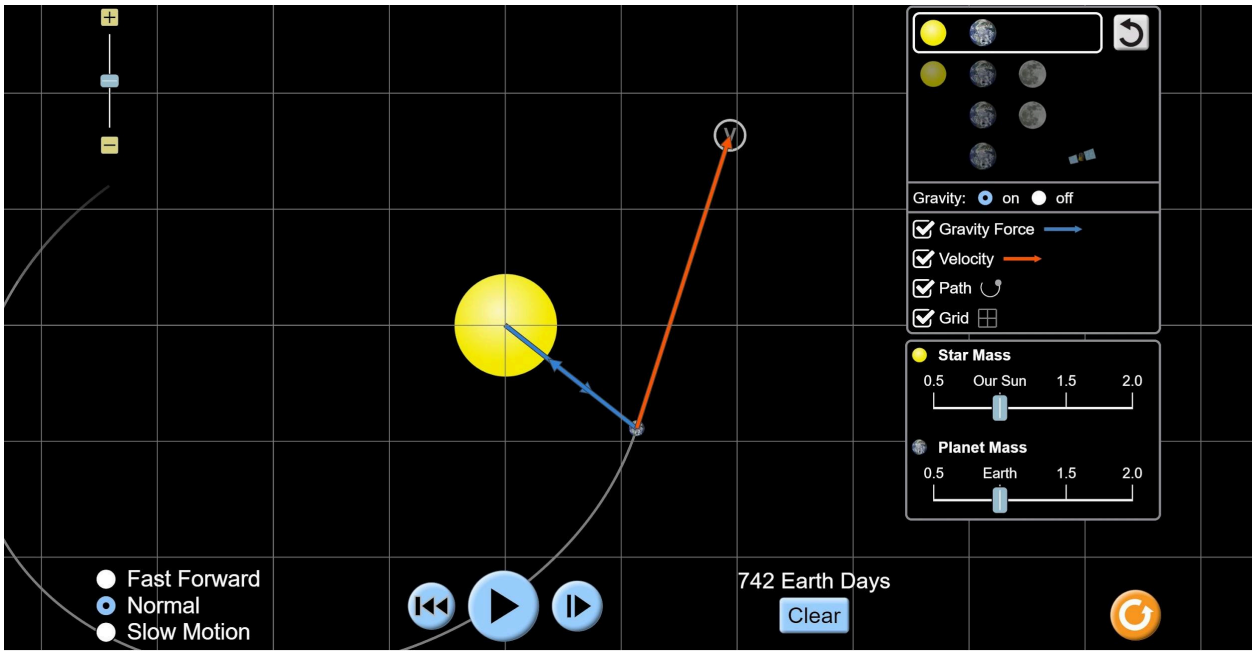
Sample Challenge Prompts

- 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.

Rouinfar, November 2021

Gravitational Force and Orbits Lab



Use the **PhET Simulation**. Make sure to click **Gravity Force**, **Velocity** and **Path** and make sure **Gravity** is checked **On**. Run several simulations, changing parameters as you go.

1. What direction is the gravitational force of the orbiting objects?

2. What direction is the velocity of the orbiting object?

3. If you turn gravity **off**, what happens? Why does this happen?

4. If you increase the mass of the Sun, provide an explanation of what happens to the Earth .

5. If you decrease the mass of the Sun, provide an explanation of what happens to the Earth .

6. If you increase the mass of the Earth, and drop the mass of the Sun, what happens?

7. Move the satellite closer to the object it is orbiting and further from the object it is orbiting. Describe what happens and explain why this happens.

8. Do you think changing the mass of the satellite ONLY will change the orbit?
(Choose one) **Yes** **No**

9. Change the mass of the satellite only. Explain what happens.

10. Invent a previously untried set of changes to make something interesting happen. Describe what you did, and what the effects were.