

In **Gravity Force Lab: Basics** students observe the gravitational force that two objects exert on each other, and adjust the properties of the masses to see the effect on gravitational attraction.

The screenshot shows the Gravity Force Lab: Basics simulation interface. Two masses, Mass 1 (blue, 2 billion kg) and Mass 2 (red, 4 billion kg), are separated by 4 km. Gravitational force vectors are shown: Force on mass 1 by mass 2 = 33.4 N (pointing right) and Force on mass 2 by mass 1 = 33.4 N (pointing left). Below the masses are control panels for Mass 1 and Mass 2, each with a numeric input field and a slider. A settings menu includes checkboxes for Force Values, Distance, and Constant Size. A callout box on the right shows a smaller version of the masses and a 'Constant Size' checkbox. At the bottom right, there are icons for sound, keyboard shortcuts, and a refresh button.

**VIEW** the forces in the system

**DRAG** the masses apart or together

**ADJUST** masses

**DISPLAY** the distance between the objects

**HOLD** the radius constant when changing mass

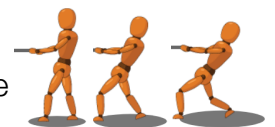
**ACCESS** sim controls (sound on/off, keyboard shortcuts) or add features (extra sounds, voicing)

## Insights into Student Use

- Students may identify the “size” as a variable which affects the force, which could lead to discussions about how mass and size are related.
- We encourage students to construct their own ideas through exploration, and have found that referring directly to the “Universal Law of Gravity” may encourage some students to simply look up the relevant equation.

## Model Simplifications

- The masses and distances are very large so that the gravitational force between has a more interpretable magnitude ( $10^{-1}$ - $10^3$  N). To explore the gravitational forces between everyday objects, see [Gravity Force Lab](#).
- By default, the masses will maintain a constant density. If the mass is increased, the radius will increase proportionally to maintain the density. If the simulation is in Constant Size mode, the radii of the masses will instead remain constant. The color saturation of the mass maps to its density (i.e. larger masses will have a more saturated color).
- The figures attached to the masses are displayed to help students understand why the objects stay apart, despite their attraction. The figure will lean further back to indicate that the force exerted on the mass it is holding has increased. However, the figure is massless and does not contribute to the forces in the system.



## Inclusive Features

### Sound and Sonification

- A tone plays that changes with the magnitude of the force as mass OR distance change to emphasize the change on the gravitational force by either variable.
- A change in mass also plays a percussive tone that changes pitch with the magnitude of the mass and emphasizes the mass as distinct from the force sound.
- See the Sound Features Video for more useful tips on how concepts and sound are integrated in this sim. See the published [Sound Design Documentation](#) for more details on all sounds in this simulation.

### Interactive Description

- This simulation features interactive description to support non-visual access, delivered only while using screen reader software. See the [Introduction to Interactive Description video](#) for more info on how to use this feature.
- Teachers can [access the A11y View here](#) to decide if this sim's interactive description meets their instructional needs. *Reminder: A11y View is not intended for student use and will not provide a good experience for learners using screen reader software.*

See the simulation page for all supported inclusive features.

## Suggestions for Use

### Sample Challenge Prompts

- Identify two ways you can change the amount of gravitational force that the objects experience. How could you increase gravitational force using each factor? How could you decrease gravitational force using each factor?
- If gravity is a force of attraction between objects, why aren't objects like your pencil being pulled towards you? Explain your reasoning.
- Select two different values for mass 1 and mass 2. How does the force that the smaller mass exerts on the larger mass compare to the force that the larger mass exerts on the smaller mass?
- Predict what happens to the gravitational force as the distance between the masses is doubled.
- Pick an independent variable to manipulate and design an experiment to determine what happens to the gravitational force as this variable is changed. What do you observe?

See all published activities for Gravity Force Lab: Basics [here](#).

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