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Teacher Facilitation

How can I use this in my class?

You can use the Gravity and Orbits sim:

- **In class** by having your students work individually or in pairs at computers. Check out the sample activities for this simulation available in the Teacher Resources section (below where you download the sim).
- **As a demo** by projecting the simulation onto a screen for your class to see. You can interact with the simulation yourself while focusing on specific components, ask students how you should interact with the sim to answer a certain question or just to explore, or select students to come and interact with Gravity and Orbits for the class.
- **As homework** by asking students to explore the relationship between gravity and mass and/or gravity and distance in preparation for class, or as practice after an introduction to gravity or orbits.
- **With clicker questions** by asking students to predict how the orbit will change after a specific scenario you set up, or how the gravity force will change.

What can students learn from playing with this sim?

A lot! Students can learn:

- Describe the relationship between the Sun, Earth, Moon and space station, including orbits and positions
- Describe the size and distance between the Sun, Earth, Moon and space station
- Explain how gravity controls the motion of our solar system
- Identify the variables that affect the strength of gravity (distance, mass)
- Predict how motion would change if gravity was stronger or weak

Tabs

What is the purpose of each tab?

The first tab (Cartoon) is not in real scale...meaning the objects are closer together in this tab than they are in real life. This is so that students can play with the objects in close up, which isn't possible if the distance between the objects is represented accurately.

In the second tab (To Scale) is in the real scale, with distances between objects represented accurately. You can even check using the measuring tape available in the second tab!

Having the two tabs allows easy play with the variables important to understand gravity and orbits (gravity force, velocity, mass, distance...etc) while allowing for comparisons to the real scale. This also helps to emphasize how big the real solar system is!

Toolbar

How do I change to a different system?

Use the buttons on the top of the blue toolbar. You can switch between the following systems:

- Sun/Earth
- Sun/Earth/Moon (students really like this one!)
- Earth/Moon
- Earth/Satellite

Can I turn gravity off?

Yes! Select the "Off" button next to "Gravity" in the blue toolbar. After turning gravity off, your planet/satellite will float off the screen. To bring it back, select "Reset" under the blue toolbar, or select the "Return Object" button that appears in the upper left side of the screen when your planet or satellite has floated completely off screen.

If you want to emphasize the effect of turning off the gravity, select "Path" and you see how the planet's path changes from circular to straight once the gravity is turned off.

To do this without explicit instructions: Try encouraging your students to play around with the sim to find options that help them 'see' the orbit. From classroom observations of 5th grade classes, students find and begin using the "Path" option quickly. If it seems a few students do not find it

quickly, ask a couple of students that are using the "Path" option to share what they have found to the whole class, or to demo something on a Smartboard or sim projected on a wall.

How do I show the force of gravity?

In the middle of the blue toolbar there is an option to show "Gravity Force". When this button is selected, blue vector arrows will show the gravity force between the objects you have on the screen.

Note: When gravity is "Off", you won't be able to see any blue arrows.

Using the Gravity Force arrows is a great way to help students 'see' the forces that keep the Earth in orbit around the Sun. The Gravity Force arrows can also be useful in introducing vectors to students. Try using Gravity and Orbits along with Forces and Motion to help students understand vectors and forces.

Is there a way to see the velocity of the sun/planets/satellites?

There sure is! In the middle of the blue toolbar select "Velocity". The velocity of the objects will be shown as red arrows.

Hint: You can grab the end of the arrow (where there is the letter 'V') to change the velocity of the object.

While this tab is intended to be qualitative, you can make it more quantitative if you select "Grid". Then you can use the grid spacing to measure and compare vector lengths.

Can I change the mass of my star or planet?

You bet! At the bottom of the blue toolbar there are two sliders so that you can increase and decrease the mass of your objects.

Note: Once you change the mass of the Earth/Moon, it will change color in the sim to remind you that you no longer are looking at the Earth or moon, but a different planet or satellite with a different mass. You may find it helpful to discuss this change in color with your students.

The color of the Earth (or Moon) changed...what happened?

You changed the mass of the Earth (or Moon) so that it is a different planet (or satellite). Don't worry! You can keep playing with your new bigger or smaller planet, you can set the slider at the bottom of the blue toolbar back to the value for Earth (the color will change back to the Earth picture) or you can select "Reset".

Is there a way to track the orbit of the Earth/Moon/Satellite?

Yes! Try selecting "Path" in the blue toolbar. With "Path" selected, the orbit of the objects in the sim are tracked with a colored line. This makes it easy to keep track of how changes you make effect the object's orbit.

What can I do with the "Grid" option in the toolbar?

Lots! While this tab is intended to be qualitative in nature, using the grid helps to make semi-quantitative comparisons. With the "Grid" option selected, you can compare many options easily.

- You can compare how the starting position of your object effects the orbit: Start your sim at different places on the grid lines and compare what happens.
- You can compare multiple orbits based on number of gridlines passed. For example, with "Grid" and "Path" on, change the mass of your Sun, and make note of how wide the Earth's orbit is at the widest point using the grid lines. Compare your findings to the orbit that results from the original masses of the Sun and Earth.
- You can compare vector lengths. See what happens when you change the velocity arrows from one grid box in length to two grid box lengths. See how many ways you can double the gravity force vectors between the Sun and the Earth.

Are the masses shown in the "To Scale" tab correct?

You bet, and there's a number of ways your students can use the mass readout!

- Use the mass readouts as you change the size of objects, and see how the mass of an object affects the orbit.
- Change the mass and compare the length of the gravity force arrow to help your students understand the relationship between mass and gravity. Try this with the sim paused to really focus on the gravity and mass relationship.
- Change the mass of the object, and compare the length of the velocity arrows during orbit at different points in the orbit, and across different size objects.

How do I use the measuring tape? ("To Scale" tab only)

To use the measuring tape, select "Measuring Tape" from the blue toolbar. The measuring tape will appear at the bottom of the screen. You can move the entire measuring tape around by dragging on the yellow portion, and you can collapse and extend the tape by dragging the red crosshairs at either end of the grey tape.

Remember that the measuring tape is found only in the "To Scale" tab, so these are actual distances between objects!

Reset and Reset All

What's the difference between "Reset" and "Reset All"?

Great question!

"Reset": "Reset" will only reset the options you selected while keeping you in the same system.

If you are in the Earth/Moon system and select "Reset" all: the Earth/Moon will go back to their original locations, but you will stay in the Earth/Moon system with all of your current selected options maintained.

"Reset All": "Reset All" will reset all options back to the original settings for the entire tab, including resetting you to the Sun/Earth system if you are in the "Cartoon" tab, or back to Earth/Satellite system if you are in the "To Scale" tab. It will also reset all the options in the toolbar.

General Tips: If you just want to restart the same system again, use "Reset" but if you want to start back to where the tab first opened, use "Reset All".

It's a good idea to have students use "Reset All" after doing a classroom demo. This resets all of the settings back to the original ones, ready for the next classroom demo.

Play Area

My Earth/Moon/Satellite floated away! How do I get it back?

There are a couple of ways to do this:

- A button to "Return Object" will appear once your object gets off screen. Select this and the object will go back to its starting position.
- Use "Reset" this will bring your objects back to their original position, no matter where they are on (or off) the screen.
- Use "Reset All" if you want to reset all options back to the original for the tab you are in.

Can I zoom in or out?

Sure! In the upper left of the screen is slider that allows you to zoom in or out. Zoom all the way out to see really large orbits, or zoom in to focus on specific details.

Bottom Toolbar

I just opened the sim, but nothing is happening! How do I start my planet in motion?

At the bottom of the screen there is a Play/Pause button.



To start your objects in motion, select the "Play" button. You can also step forward incrementally or jump back to the start using the buttons to the right and left of the "Play" button.

Is there a way to see the orbits change faster?

Yes! At the bottom of the screen you can change the speed of the simulation. Keep in mind, sim speed changes only how fast you're seeing the motion, not the actual velocity of the objects. For example, with the original settings of the Earth/Sun system, it would still take a year for the Earth to complete an orbit around the Sun regardless of whether sim speed was set to fast or slow. You would just see the full orbit in less time if the sim speed was set to fast.

What does the "Clear" button at the bottom of the screen do?

This button clears only the time counter. The time counter will also clear when you select "Reset" and "Reset All".

If you want a measure of how long it takes to orbit, or how long it takes an object to reach some specific point, use the time counter. It may help to slow down the sim speed and use the grid if you need to be specific.