http://phet.colorado.edu/en/simulation/gravity-and-orbits

Gravity and Orbits

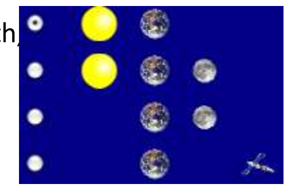
Name: ____ **Date:**_________________ **Period:**____________

Learning Objectives- Students will be able to:

- Draw the motion of the planets, moon, and Sun.
- Draw diagrams to show the force of gravity.
- Identify the variables that affect the strength of the gravity.
- Predict how motion would change if gravity was stronger or weaker.

Part 1: Understanding motion

1) Open the ***Gravity and Orbits*** simulation. Take a few minutes to **explore** how the Earth, Moon, and the Space Station move. Talk about what you find with your partner.



2) Compare the path of the **Earth moving around the Sun** with the **Moon moving around the Earth**. If you and your partner each have a computer: Try choosing a different view on each computer for this question.

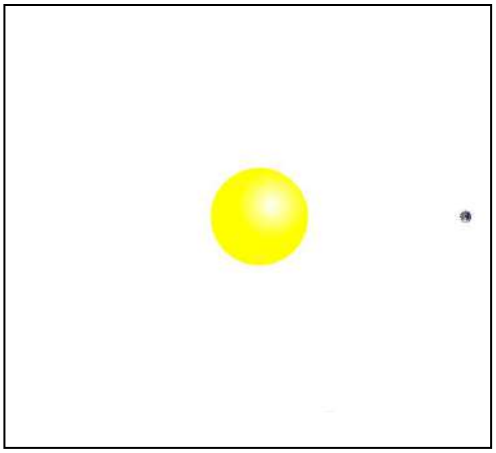
Earth moves around the Sun	**Moon moves around the Earth**
Your Picture	Your Picture
Your Description	Your Description
What are some things you find that are the **same** about these motions?	
What are some things you find that are **different** about these motions?	

Part 2: Understanding Gravity

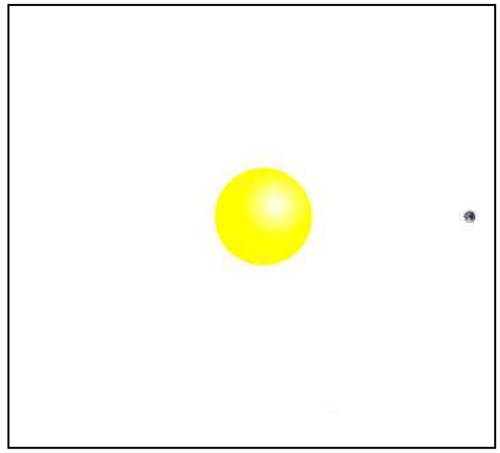
3) For the Sun and Earth system:

a. **Draw** the path of the Earth with **Gravity ON** and **Gravity OFF**

GRAVITY ON

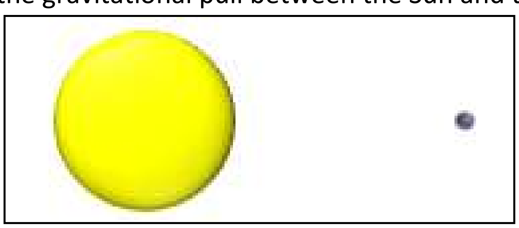


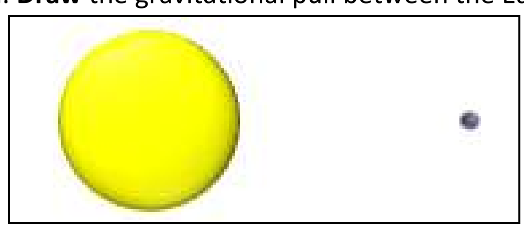
GRAVITY OFF



b. **Why** do you think gravity is important?

4) **Draw** the gravitational pull between the Sun and the Earth. **Draw** the gravitational pull between the Earth and Moon.





CLASS DISCUSSION:

a) Describe the gravitational force between the two bodies.

b) Why do you think the Earth revolves around the Sun rather than the Sun revolving around the Earth? Would this explain why the Moon revolves around the Earth as well?

5) **Explore** the simulation to find ways to change the gravitational force, whose magnitude is represented by the length of the blue gravity force arrows.

a) Fill in an **ACTION** below and place an X to indicate whether or not the gravitational force increases or decreases.

ACTION	Gravity Force Increases	Gravity Force Decreases
Put star and planet closer together		

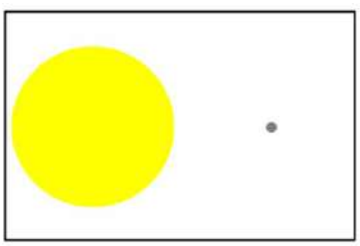
b) Based on the results in your table, what actions can increase the gravitional force?

c) Based on the results in your table, what actions can decrease the gravitional force?

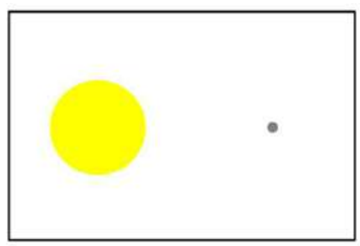
6) Comparisons:

a) **Compare** these two cases:

CASE 1



CASE 2

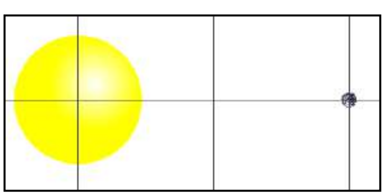


What was changed between Case 1 and Case 2?

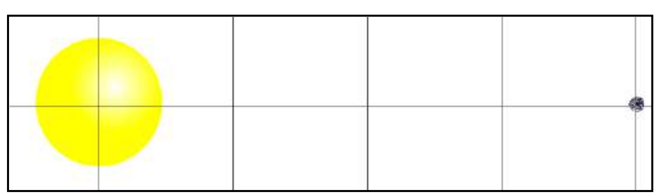
Draw the force of gravity on the Earth in each case.

b) **Compare** these two cases:

CASE 1



CASE 2



What was changed between Case 1 and Case 2?

Draw the force of gravity on the Earth in each case.

Part 3: Gravity and Motion

7) Fill in the table to help describe what you find out.

How can you….	Explain what you changed	Draw the motion paths	What other changes do you notice?
...make the Moon go around the Earth in a bigger circle?			
...make the Earth take more time to go around the Sun?			
...make the Earth take less time to go around the Sun?			

Part 4: Kepler's Third Law

Kepler's Third Law shows the relationship between the period of an object's orbit and the average distance that it is from the thing it orbits. This can be used (in its general form) for anything naturally orbiting around any other thing.

Formula: $\mathbf{P^2 = ka^3}$ where:

- P = period of the orbit, measured in units of time
- a = average distance of the object, measured in units of distance
- k = constant, which has various values depending upon what the situation is

This is the general form of the formula, so you need at least two of the quantities to find the third. "k" is the trickiest thing since it depends upon the objects that are involved and how you measure "P" and "a". Since "P" can be measured in any unit of time (seconds, days, years, etc), and "a" can be measured in any unit of distance (meters, km, AU), the value of "k" can be quite diverse from one system to another.

Problems

8. An object is orbiting around the star Gumby with a period of 80 years. If "k" = 2 (units of years and AU) in this system, what is the average distance of the object orbiting around Gumby in AUs?

9. If an object has an orbital period of 85 years and is at an average distance of 24 AU from the object it orbits, what is the value of "k"?

10. In our solar system, with objects orbiting our Sun, k = 1. What is the orbital period if an object is orbiting the Sun at an average distance of 71 AU?

Adapted from http://www.uni.edu/morgans/astro/course/Notes/section1/math3.html