Virtual Learning

Physics

Gravity and Orbits

May 13, 2020

Physics

Gravity and Orbits: May 13,2020

Objective/Learning Target:

Students will use a computer simulation to explore Gravity and orbits.

Quick Review #1

If the moon were twice as massive, would the attractive force of Earth on the moon be twice as large? Of the moon on Earth?

Quick Review #1 Answer

Yes The forces would be twice as much. 2m means 2F. The forces are equal and opposite.

$$F = G \frac{mM}{r^2}$$

Quick Review #2

If planet A and B are both circling around star A and A completes an orbit in 2 days while B needs 10 days, then what is the radius of B's orbit if that of A is 3.0×10^8m (in meters) ?

Quick Review #2 Answer

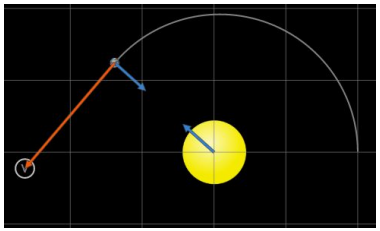
Use the formula $T_1^2 / (r_1^3) = (T_2^2) / (r_2^3)$

and substitute the values given:

$2^2 / (3.0 \times 10^8)^3 = 10^2 / x^3$

$X = 8.77 \times 10^8$ m

Gravity and Orbits



Introduction

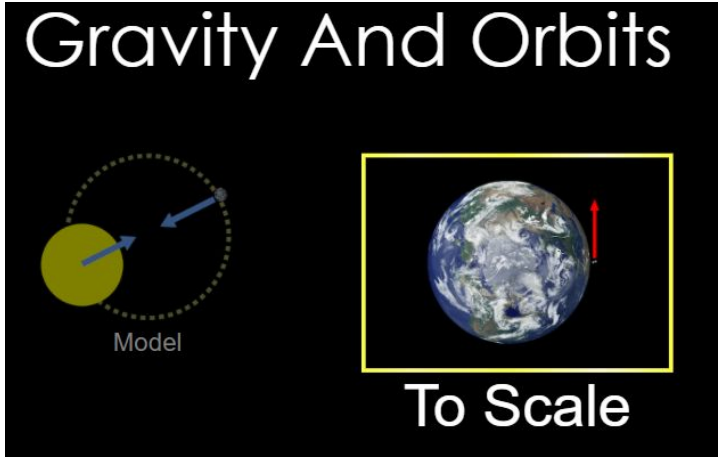
You will use a computer simulation today to investigate Gravity and Orbits. Since this is "inquiry based", you're not supposed to know everything going in, but learn as we walk through the lesson. **You must read the following slides carefully.** Let's get started!

Gravity and Orbits

Website:Gravity and Orbits

Make sure to use the HTML5 version.

Select To Scale to get started.



Is the orbit of a planet circular?

Choose the star and planet the top one), see image.
Check the path/grid option to turn it on.
Allow the planet to move through 360° and hit pause.

Turn on the measuring tape from the toolbar, and measure the horizontal distance from the path line on the left of the star. Write the measurement in the table below. Now do the same from the star to the path line on the right hand side.

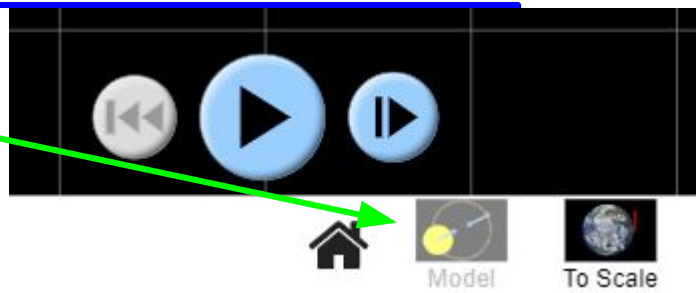
	Distance (miles)
Left side path to star	
Right side path to star	

1. What do you notice about the distances?

2. What does this data say about the orbit of the planet, discuss?

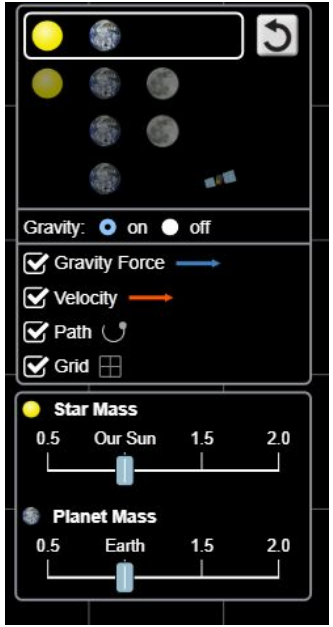
Gravity and Orbits

Go to model



Click sun and planet

click on path/gravity force/velocity/grid

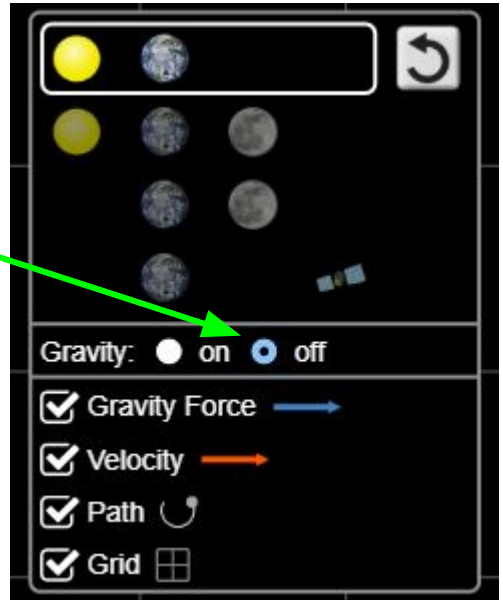


Press PLAY and leave for one cycle then PAUSE.

Gravity and Orbits

3. Draw a complete diagram of the situation.
4. What holds the planet in the orbit?
5. What shape is the orbit, explain this using the diagram?
6. What direction do the gravitational forces face make sure they are labeled in the diagram?

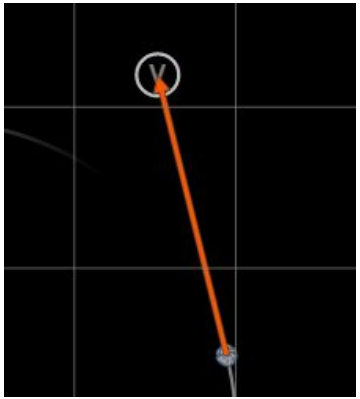
Turn the gravity OFF and push play.



7. Draw a diagram of what happens and explain why.

Gravity and Orbits

Now **<u>increase slightly</u>** the velocity of the plant by extending the red ‘v’ arrow of the planet.



8. What happens to the planet in the orbit?

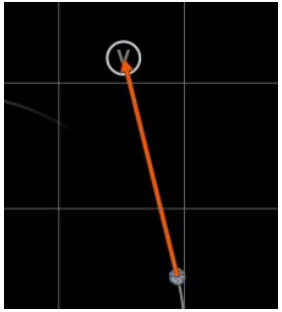
9. What is the shape of the orbit when increased?

Now increase the velocity of the plant to a **<u>large extent</u>** by extending the red ‘v’ arrow.

10. What happens to the planet in the orbit?

Gravity and Orbits

Now **<u>decrease slightly</u>** the velocity of the plant by diminishing the red ‘v’ arrow.



11. What happens to the planet in the orbit?

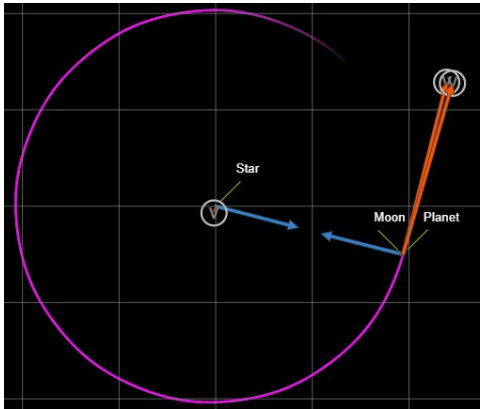
12. What is the shape of the orbit when decreased?

Now decrease the velocity of the plant to a **<u>large extent</u>** by moving the ‘v’ arrow in.

13. What happens to the planet in the orbit?
14. Now try to explain this in terms of v and gravity?
15. Is the velocity constant throughout the journey?
16. Which one of Kepler’s law does this relate to?

Gravity and Orbits

To get more familiar with the Sim and its controls the next slide asks you to change some variables to alter Earth's orbit around the sun. Experiment with different Sun sizes, Earth sizes, adjust the vectors for speed, slide the Sun and Earth further apart or closer together. Everything can be adjusted in one way or another. Select all the boxes to get as much information as possible.



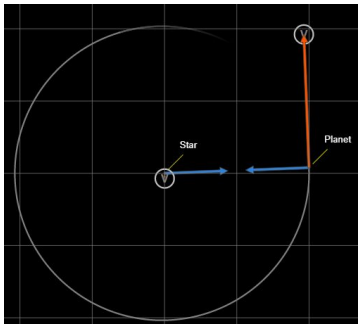
Gravity and Orbits

1. It takes 365 days for the Earth to complete one revolution around the Sun. Find three different ways to change the number of days it takes for the Earth to complete one revolution around the sun. Fill out the table with the results.

Method	How many days to make one revolution?	What was changed?	What happened to the Gravity force vectors?	observations
1				
2				
3				

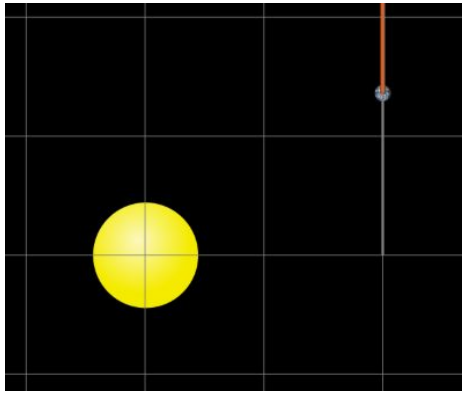
Gravity and Orbits Answers

	Distance (miles)
Left side path to star	94600
Right side path to star	91377

1. The distance are not equal, the left was larger than the right side.
2. This means that the orbit is not a circle but slightly elliptical.
3. 

4. The planet is held in orbit by gravity
5. The path is elliptical, using the gridlines you can see that the two sides of the orbit are not equal.
6. The forces pull towards each other shown by the blue vectors

Gravity and Orbits Answers



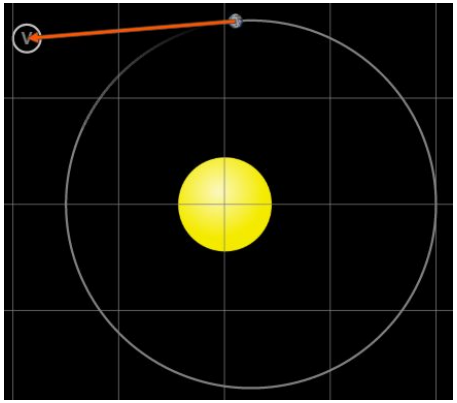
7. The planet travels in a straight line. Nio gravity to alter its path. So Newton's first law says it will travel in a straight path.

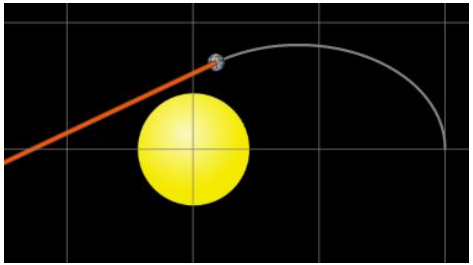
8. The planet travels faster and further away from the sun, The time to make it around increased to over 500 days.

9. The path becomes much more elliptical.

10. The planet flew off the screen in a super large elliptical path.

Gravity and Orbits Answers





11. The planet gets pulled in closer to the sun and speeds up when doing so.
12. The path becomes more elliptical, and smaller, closer to the sun.
13. The planet was pulled into the sun
14. The planet didn't have enough velocity to make it past the planet as it was pulled inward. Its curve was greater than the curvature of the sun.
15. The velocity increases greatly as it is pulled into the sun.
16. Kepler's first law states that the center of the sun would be one focus of the ellipse, but the diameter of the sun gets into the path of the planet (crash!).

Gravity and Orbits Answers

Method	How many days to make one revolution?	What was changed?	What happened to the Gravity force vectors?	observations
1	It took less time	Place the earth closer to the sun	Got longer	Time for a year went down
2	It took more time	Make velocity arrow longer	Started getting shorter	Took more time, path was different
3	It took less time	Increase the size of the sun	Got Longer	Took less time

For opposite actions the effect on revolution time is also opposite.

Additional Practice

Return to the sim and try to achieve a year that is 180 days, 600 days, or pick some time of your choosing.