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INTD290: Number Systems in Pre-Columbian Context

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1 How to Submit this Assignment

Once you answer the questions, take a picture of your work and convert it to a PDF. Submit the PDF to the assignment link on Moodle.

2 Introduction

For this asynchronous assignment, we will be using something called a Physics Educational Technology simulation, or PhET simulation. For an introduction to this tool, please follow this link to a tutorial video by one of my colleagues:

https://youtu.be/m6e2y4fef1I ✔

3 The Simulation

To find this simulation, which teaches us how gravity and planetary orbits work, follow this link:

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

4 The Basics: Circular and Elliptical Orbits

Instructions:

1. Starting with the link above, press the "to scale" option at the bottom of the screen. Choose the option with the star and planet. ✔
2. Activate the path and grid options at right. ✔
3. Click the play button and allow the planet to rotate through 360 degrees, all the way around the star. You can speed up or slow down the motion, which is just governed by gravity, with the controls. ✔
4. Use the yellow measuring tape tool at right to measure two distances: (a) the distance from the star to the path of the planet on the right, and (b) the distance from the star to the path of the planet on the left. Are they the same number?

The two distances are not the same, though they are very close. The left side has a longer distance travelled than the right side.

5. What would be true of the numbers if the orbit was perfectly circular?

If the orbit was perfectly circular, the orbiting planet must have a constant velocity all around which is extremely unlikely.

5 Gravity

Instructions:

1. Using the controls at right, display the direction of the force of gravity. ✔
2. What happens to the path of the planet if you deactivate gravity?

When gravity is deactivated, the orbiting planet stops orbiting and instead follows the straight line of velocity due to inertia.

3. What happens to the force of gravity if you leave it activated, but click and drag the planet farther from the star?

Dragging the planet farther away from the star causes the orbit to become an elliptical orbit. If the planet is too far away, it breaks free from the star's gravitational pull and flies off in a straight line due to inertia.

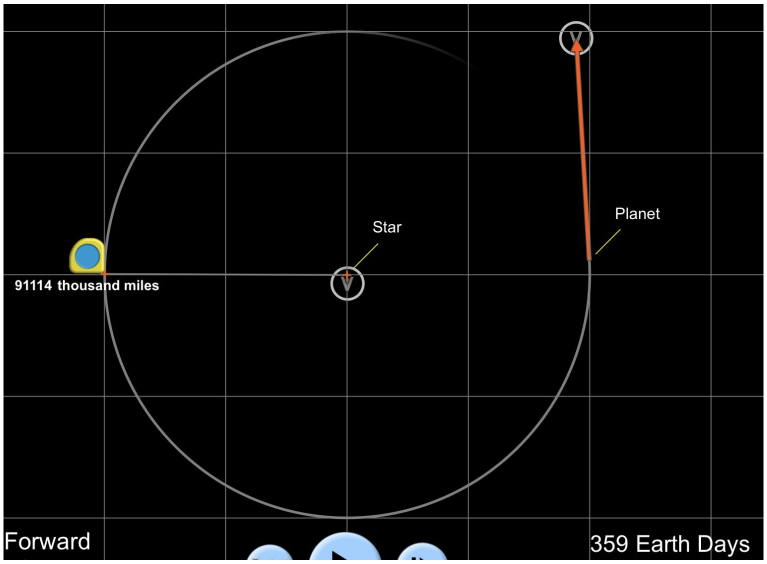
4. Display the velocity with the control at right. Reveal what happens if you let the planet follow one orbit, and then pause, and then change the length of the velocity arrow. This corresponds to changing the speed of the planet. (Changing the direction of the arrow changes the direction of the velocity).

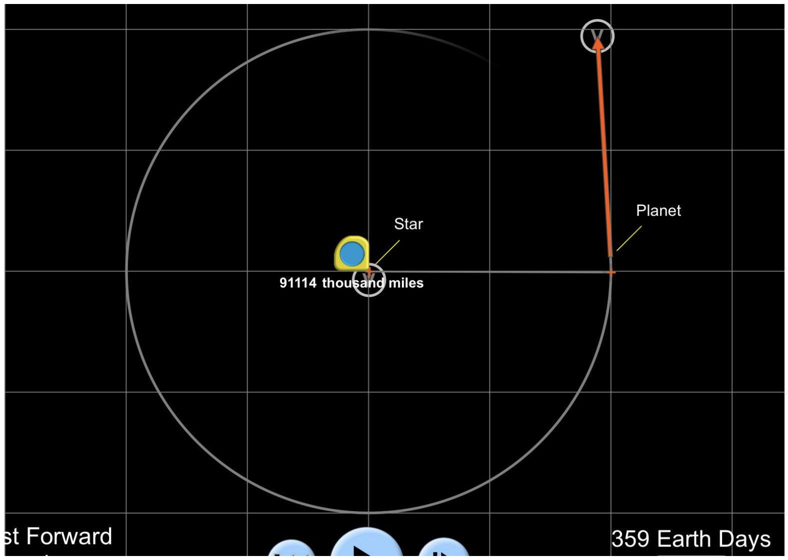
Slowing down the planet's velocity causes the near-perfect circular orbit to become an elliptical orbit. Thus, the earth days are shortened for one orbit around the star. Speeding up the planet's velocity causes the planet to break free from the star's gravitational pull and the planet flies off in a straight line due to inertia.

6 Kepler's Laws

Instructions:

1. Now that you can see how to control the system using velocity, force, and distance from the star, try to make an orbit that is nearly circular. Show that the radius of the orbit is almost the same when measured at different places (it should be the same number all the way around for a circle, but this might be challenging). ✔

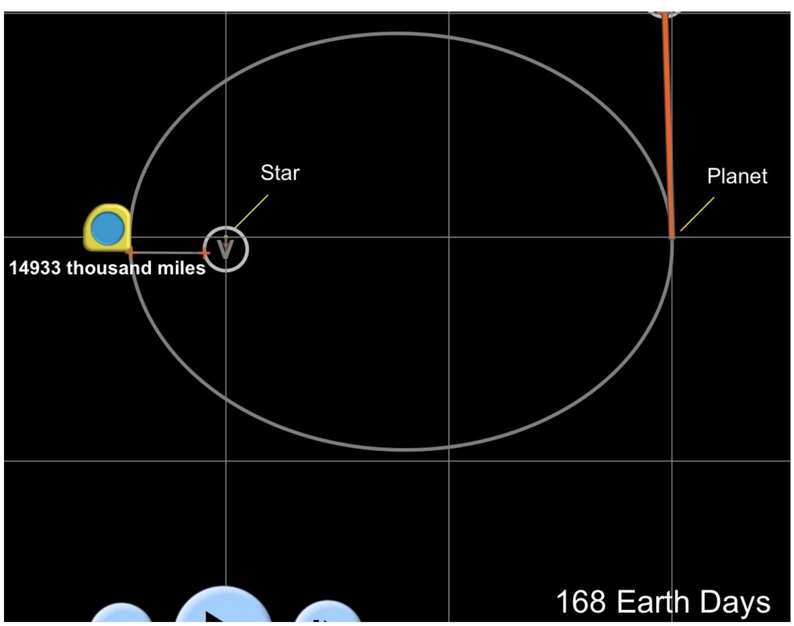




2. For your circular orbit, determine what happens if you change the mass of the planet (controls at right). Answer this question: does the rate at which something accelerates downward due to gravity here on Earth depend on its mass? Is it different for planets?

Changing the mass of the planet does not affect the orbit because gravitational pull is constant. An example of how gravity is constant is dropping two quarters at the same height: one landing straight down, one flicked off a table producing a trajectory. The rate of something accelerating downward due to gravity on Earth does not depend on its mass, therefore, is not different for planets.

3. Finally, tweak your orbit so that it is elliptical. Using the ruler and grid, find the area of a triangle swept out by the orbit when it is going faster (nearer to the star). The planet needs some number of days to sweep out this area. Find a different triangle on the other side of the orbit that requires the same number of days. Can you show that these triangles have the same area? This is Kepler's 2nd Law.



https://www.youtube.com/watch?v=7ZQym42wJFU