Phet Simulation: Gravity and Orbits

Names: _____ Period: _____ Date: _____.

Learning Goals:

- 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
- Predict how motion would change if gravity was stronger or weaker

Follow the directions carefully before answering the following questions while using the Phet Simulation "**Gravity and Orbits**". http://phet.colorado.edu/en/simulation/gravity-and-orbits

1) Run the Simulation, Keep all the default settings, but select the *Earth and Satellite option*. Turn *on all of the options* in the "*Show"* menu, then run and play with the simulation for a while. Which is experiencing a greater gravitational force: The satellite or the earth?

2) Pause the Simulation. Hit "Reset". (not "Reset All"). Alter the mass of the Satellite. Does the mass of the satellite have any impact on its Orbit? Explain.

3) Pause the Simulation. Hit "Reset." Click and drag the "v" at the end of the red velocity in order to *decrease* the satellite's velocity.
   a. What happens when you hit play? Why?

   b. Why doesn't this happen to satellites normally?

4) Pause the Simulation. Hit "Reset." Click and drag to *increase* the satellite's velocity.
   a. What happens when you hit play? Why?

5) Pause the Simulation. Hit "Reset." Click and drag the satellite itself to move it further away from earth.
   a. What happens when you hit play? Why?

6) Try to create another stable orbit that is further or closer to earth. Show your instructor or post a screenshot here. What other very important variable is altered with this new orbit?

7) Just for fun. Click and drag earth to create a very small velocity for earth. Can the satellite still orbit a moving planet effectively?

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8) Pause the Simulation. Hit "Reset." On the top left tabs, change your view so that you are *to scale*. In the *Show* menu, you can now also turn on the "Tape Measure". Run the simulation, with the path shown.
   a. How far out is the satellite?
   b. How long does it take for the satellite to orbit earth?

9) Switch modes, so that you are now looking at just the earth and the moon.
   a. How far is the moon?
   b. How long does it take for the moon to orbit the earth?

10) Again Switch modes, so that you are now looking at just the earth and the sun.
   a. How far is the earth from the sun?
   b. How long does it take for the earth to orbit the sun?

11) According to Kepler's third law, The time it takes for one complete orbit is proportional to the mean distance between the centers of two bodies. $T^2 \approx r^3$. When a constant is included, the equation is (upper right).
Use the adjustable mass controls on the simulation of just the earth and sun to determine what mass the "m" in Kepler's equation must refer to. Is it the mass of the orbiting object or the mass of the central object?

12) Hit Reset All. View all three objects in Cartoon mode. Sketch a small diagram showing their paths for one full year.

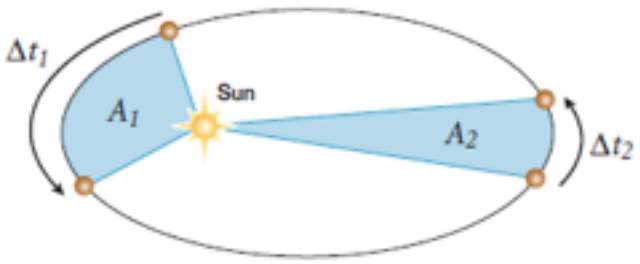
13) Kepler actually proposed three laws.

KEPLER'S LAWS OF PLANETARY MOTION

First Law: Each planet travels in an elliptical orbit around the sun, and the sun is at one of the focal points.

Second Law: An imaginary line drawn from the sun to any planet sweeps out equal areas in equal time intervals.

Third Law: The square of a planet's orbital period (T^2) is proportional to the cube of the average distance (r^3) between the planet and the sun, or $T^2 \propto r^3$.



An Illustration of Keplers 1st and 2nd Laws is Shown here: $A_1=A_2$. In this case you can see that when a planet is closer to the sun then it must cover more distance in the same time. It must move faster.

Reset all. Select the Earth and Sun. Choose to show only the path and velocities. Manipulate the Simulation until you achieve an elliptical orbit. The speed of the earth increases slightly as it orbits closer to the sun but decreases slightly when it is further from the sun. (hint: move the sun itself.) Show your instructor for an initial or stamp on your work here.