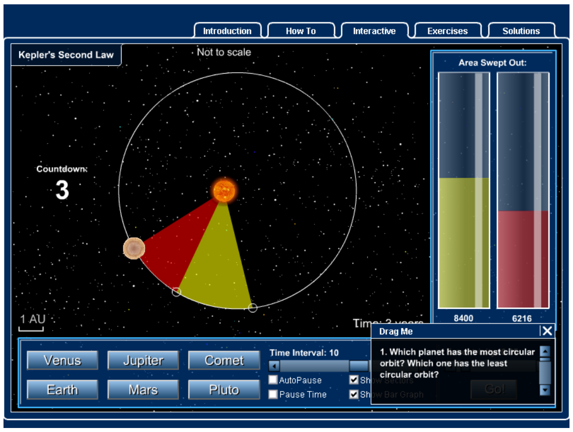
Kepler's Laws Interactive **Name**________________________________

Cobb Virtual Academy

Astronomy

http://highered.mheducation.com/sites/0072482621/information_center_view0/interactives.html



Background: As a planet moves about its orbit, it sweeps out a certain amount of area of its orbit in a certain amount of time. Kepler was the first to state that these orbits were not circular, but instead, the orbits were slightly elliptical. Kepler also mathematically found that a planet will sweep out the same amount of area of its orbit in equal increments of time. The only way this is possible is if the orbiting object is moving faster when it is closer to the Sun, and slower when it is farther away.

Directions: Visit the following website and click on the Kepler's Second Law Interactive. Make the changes using the menu at the bottom of the interactive to observe all of the different planets. Observe and record the areas swept out in the time interval (which is defaulted at 10 units of time). In addition, record the eccentricities of the orbits in the data table.

Data:

Orbiting object	Area swept out in 10 units of time	eccentricity
Venus		
Earth		
Mars		
Jupiter		
Pluto		
Comet		

Analysis questions:

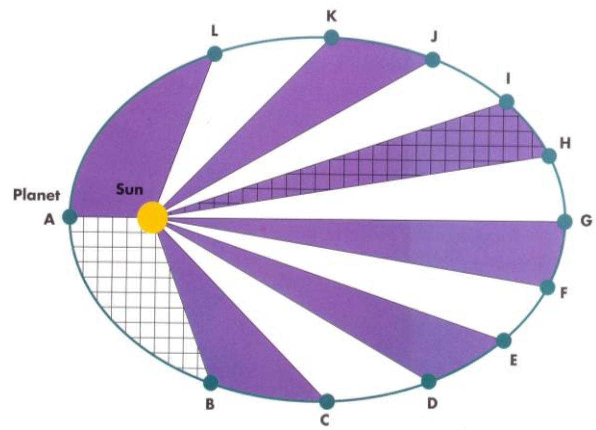
1. Which object's orbit is the most circular, and which object's orbit is the most elliptical?

2. In your own words, describe what ***eccentricity*** means.

3. Rank and list these objects in the simulation in order of the eccentricity of their orbits. Start with the most circular and end with the most elliptical.

4. Generally speaking, how does the eccentricity of comets compare to that of regular planets?

5. Which object experiences the most drastic change in velocity as it orbits the sun? Explain why this is the case.

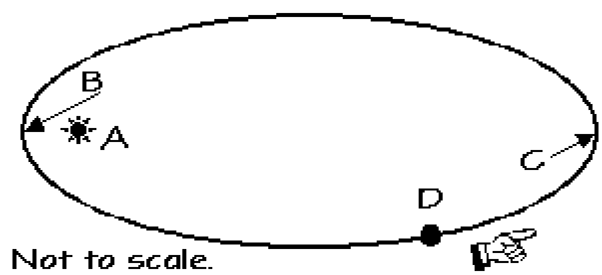


6. In the diagram, how does the area from A to B compare to the area from F to G?

7. Fill in the blanks using the diagram. The time it takes for the planet to go from L to A is ________ ___________ the time it takes the planet to go from G to H.

8. Examine the next figure of the "Planet D" orbiting the Sun "A" in a counter-clockwise direction and fill in the blanks with the correct letter:

   A. Focus ______
   B. Aphelion (the point when a planet is farthest from the Sun) ______
   C. Perihelion (the point when a planet is nearest to the Sun) ______
   D. Increasing speed: ____ to ____
   E. Decreasing speed: ____ to ____
   F. Planet has greatest speed ____
   G. Planet has lowest speed ______



9. Kepler did not have a mechanism that explained *why* a planet would move faster when closer to the Sun. However, Newton later showed that his law of universal gravitation matched perfectly with Kepler's mathematics. How does Newton's law of gravitation explain why a planet would sweep out equal amounts of area in equal amounts of time?

10. Kepler's Third Law relates the period **(*P*)** it takes a planet to go around the Sun in an orbit of a given semi-major axis **(*a*)**. Assume that the mass of the Sun is much, much greater than any of the planets (which it is), and measure *P* in years and *a* in astronomical units. The simplified relationship (formula) is $P^2 = a^3$

The following two orbits have about the same value for **a**. How do their values of **P** compare? Explain how this can be when the orbits look so different, and explain how this still makes sense.