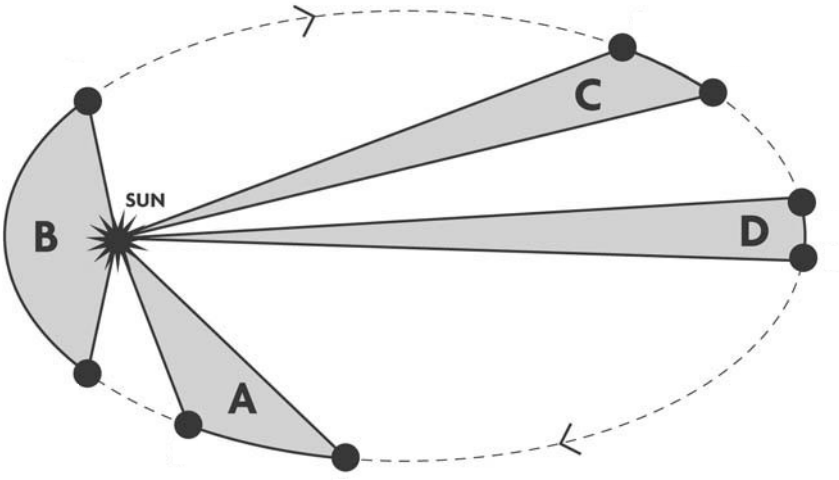
Kepler's Laws

Before Kepler, it was thought that the orbits of the planets were all circular.

Part A: Rankings

***Exercise 1:**

Description: The figure below shows several positions of a comet traveling in an elliptical orbit around the Sun. Four different segments of its orbit (A – D), and the corresponding triangular shaped area swept out by the comet, have been shaded in gray. Assume that each of the shaded triangular segments have the same area.



1. Rank the time it took (from greatest to least) for the comet to move along each of the segments (A – D) of the orbit.

Ranking Order: Greatest 1_____2_____3_____4_____Least

Or, the time to travel each segment would be the same._____(Indicate with an "X").

Carefully explain your reasoning for ranking this way:

_____
_____
_____
_____

2. Rank the distance (from greatest to least) the comet traveled during each of the segments (A – D) of the orbit.

Ranking Order: Greatest 1_____2_____3_____4_____Least

Or, the distance traveled during each segment would be the same._____(Indicate with an "X").

Carefully explain your reasoning for ranking this way:

_____
_____
_____
_____

3. Rank the speed (from slowest to fastest) of the comet during each segment (A – D) of the orbit.

Ranking Order: Slowest 1_____2_____3_____4_____Fastest

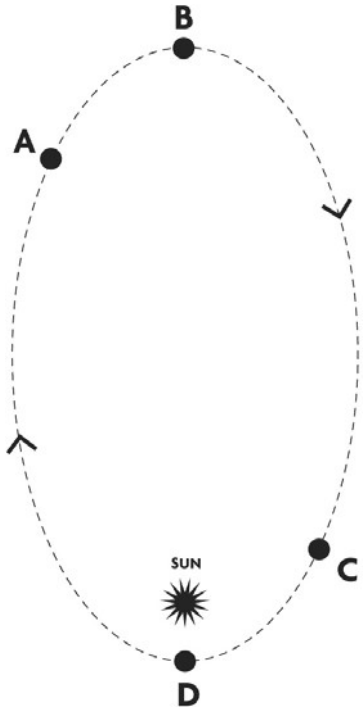
Or, the speed of the comet during each of the segments would be the same._____(Indicate with an "X").

Carefully explain your reasoning for ranking this way:

_____
_____
_____
_____

***Exercise 2:**

Description: The figure below shows four locations (A – D) of an asteroid during its elliptical orbit around the Sun.



Ranking Instructions: Rank the speed (from fastest to slowest) that the asteroid would have at each of the four locations.

Ranking Order: Slowest 1 _____2_____3 _____4 _____ Fastest

Or, the orbital speed at each location would be the same._____(Indicate with an "X").

Carefully explain your reasoning for ranking this way:

_____
_____
_____
_____

Part B: Eccentricity of the Planet's Orbits

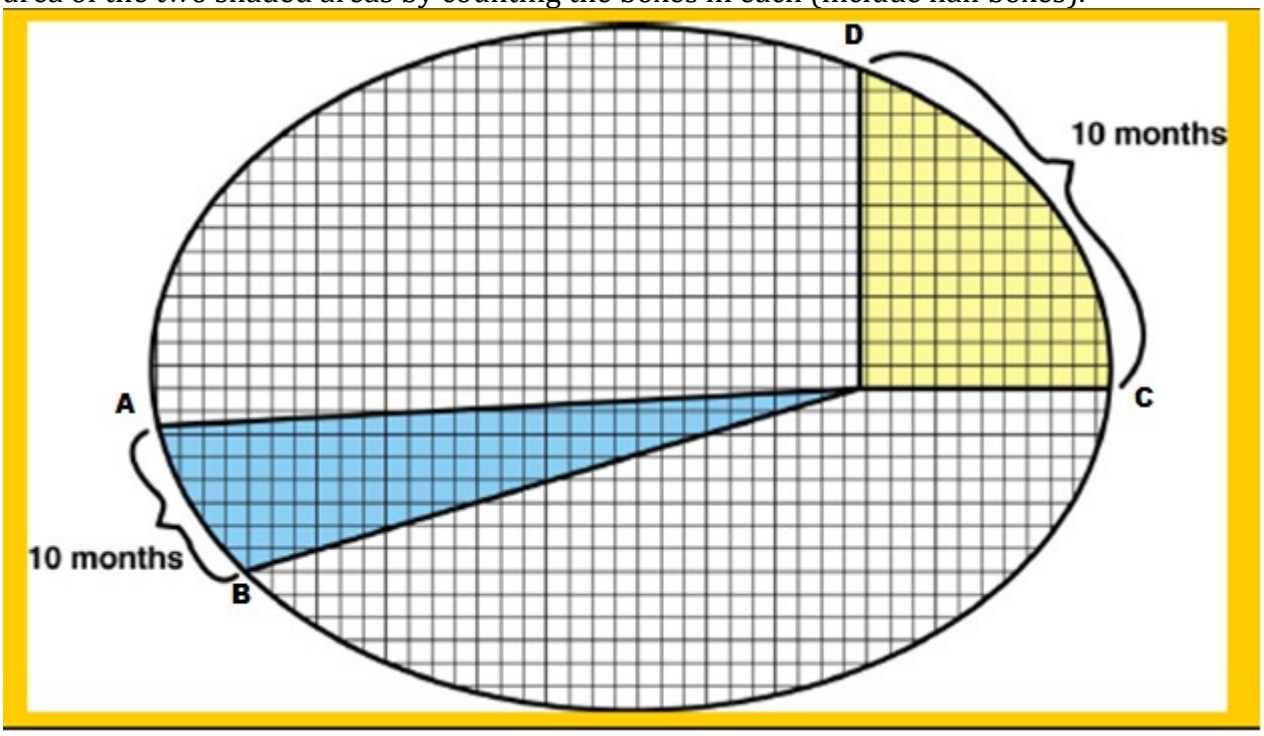
Using the formula **e = c/a**, find the eccentricity of each of the objects by filling in the chart below:

Planet	Distance from center of ellipse to focus in Astronomical Units (c)	Semi-major Axis in Astronomical Units (a)	Eccentricity (e)
Mercury	0.080	0.387	
Venus	0.005	0.723	
Earth	0.017	1.000	
Mars	0.142	1.524	
Jupiter	0.250	5.203	
Saturn	0.534	9.540	
Uranus	0.901	19.180	
Neptune	0.271	30.060	
Pluto	9.821	39.440	

1. Which planetary orbit is the most eccentric? What does this mean?
2. Which planetary orbit is the closest to being a circle?
3. Which two orbits have the closest eccentricity?
4. What other planet has an orbital eccentricity most similar to the Earth's?

Part C: Sweeps

1. Observe the following diagram. This shows an elliptical orbit of a planet around the sun. Determine the area of the two shaded areas by counting the boxes in each (include half boxes).



2. If it takes a planet the same amount of time to move from point A to point B as it does from point C to point D, what can you say about the speed of the planet as it moves around the sun in this elliptical orbit?

3. Describe the speed of the planet at perihelion (closest point to the sun) versus aphelion (furthest point from the sun).

Part D: ratios

Planet	Period (yr)	Average Distance (au)
Mercury	0.241	0.39
Venus	.615	0.72
Earth	1.00	1.00
Mars	1.88	1.52
Jupiter	11.8	5.20
Saturn	29.5	9.54
Uranus	84.0	19.18
Neptune	165	30.06
Pluto	248	39.44

Time^2	**Distance^3**	**Ratio → Time^2/Distance^3**