Name_____ Period_____

Kepler's Laws Activities

Kepler's First Law PhET Simulation: https://phet.colorado.edu/sims/html/gravity-and-orbits/latest/gravity-and-orbits_en.html

- Press the TO SCALE option at the bottom of the screen with the star and planet chosen
- Turn on the path and grid options (see image)
- Press play and allow the planet to move through 360°
- Turn on the measuring tape from the tool bar (see image)
- Measure the horizontal distance from the path line on the left of the star
- Write the measurements in the table below
- Now do the same from the star to the path line on the right side

1. Distance Table

	Distance (kilometers)
Left side from path to star	
Right side from path to star	

2. What do you notice about the distances?

3. What does this data say about the orbit of a planet?

4. How does this demonstrate Kepler's first law of planetary motion?

5. Reset the diagram with the orange button in the bottom right corner. Turn the path and grid back on. Change the planet mass to 1.5 Earth's mass. Press play. Based on the simulator, does the planet mass impact the eccentricity of the planet's orbit?

6. Reset the diagram with the orange button in the bottom right corner. Turn the path and grid back on. Change the star mass to 1.5 our star's mass. Press play. Based on the simulator, does the star mass impact the eccentricity of the planet's orbit?

Kepler's Second Law Simulation – https://www.walter-fendt.de/html5/phen/keplerlaw2_en.htm
Note: 1 AU is the average distance of Earth from the Sun.

Fill in the chart for each planet by using the dropdown menu.

Planet	Eccentricity	Semimajor Axis (AU)	Minimum Velocity (km/s)	Maximum Velocity (km/s)	Difference Between Min/Max Velocity
7. Mercury					
8. Venus					
9. Earth					
10. Mars					
11. Jupiter					
12. Saturn					
13. Uranus					
14. Neptune					

15. Select Mercury from the dropdown menu. Press play. In which color (yellow, purple, or green) is the point when it reaches the minimum velocity? _____ The maximum velocity? _____

16. Still looking at Mercury, in which color (yellow, purple, or green) is the point at its furthest distance from the sun? _____ Closest distance from the Sun? _____

17. Is there a relationship between eccentricity and semimajor axis length? If yes, describe the relationship.

18. Describe the relationship/pattern between the difference in minimum/maximum velocity and eccentricity.

19. Look at the simulator for each of the 8 planets. For which planet do the purple and green areas look similar in size? _____ For which planet do they look least similar in size? _____

20. Use the data from your chart to provide an explanation for your answer to number 19.

21. Drag the bar labeled "Sectors" to the highest setting. Describe what you see and **why** it looks the way it does.

22. Change the dropdown box to select Haley's Comet. Use the velocity, eccentricity, colors of the diagram, etc. to describe why/how the diagram is significantly different from the planets.

Kepler's 3rd Law (modified from https://www.rmg.co.uk/schools-communities/teacher-resources/keplers-3rd-law)

23. Fill in the table below by calculating the Orbital Period squared and the Average Distance to the Sun cubed for each planet.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Average distance to Sun (AU)	0.39	0.72	1	1.52	5.2	9.54	19.18	30.06
Orbital Period (Earth years)	0.24	0.62	1	1.88	11.86	29.46	84.01	164.8
Period squared								
Average distance cubed								

24. What do you notice about the Period squared and the Average Distance to the Sun cubed?

25. Below, construct a graph of the data above with the x-axis as the average distance to the sun cubed and the y-axis as the orbital period squared.