Name ______________________________ Date ______________

Chapter 26 Lab Activity

Ellipses and Eccentricity

Copernicus and his model of the heliocentric solar system were vital in reshaping people's perceptions of the universe. However, Copernicus's model was not any better at predicting the position of the planets than Ptolemy's geocentric model. Kepler solved this problem by proposing that each planet has an elliptical orbit rather than a circular orbit.

Lab Skills and Objectives

- ***Graph*** several ellipses.
- ***Interpret*** graphs to discover relationships between ellipse variables.
- ***Compare*** the ellipse models with orbits of planets.

Materials

- graph paper
- pencil

Procedure

1. On a sheet of graph paper, draw six sets of axes. Each axis should resemble an enlarged plus sign, and be labeled from −5 to +5 on both axes. Label the sets of axes "Ellipse 1" through "Ellipse 6."
2. Look at the Ellipse Data Table. The top row gives the coordinates (x, y) of the two foci of each ellipse. For Ellipse 1, note that the x-coordinates are ±4.5. Therefore, the first x-coordinate is +4.5 and the second is −4.5. The y-coordinate for both points is 0. Use + signs to plot the foci for Ellipse 1 on on the appropriate set of axes.
3. Use the data table to plot several points for Ellipse 1. Plot enough points so that you can draw an accurate smooth curve. Complete Ellipse 1 by connecting the plotted points with a smooth curve.
4. Repeat Steps 2–3 for the other ellipses.
5. The major axis is the line that passes through the two foci and connects the two farthest ends of the ellipse. For each ellipse, find and record the length (L) of the major axis. Find the distance (D) between the foci. Then use the formula in the data table to calculate the eccentricity.

Ellipse Data Table

	Ellipse 1		**Ellipse 2**		**Ellipse 3**		**Ellipse 4**		**Ellipse 5**		**Ellipse 6**	
	x	**y**	**x**	**y**	**x**	**y**	**x**	**y**	**x**	**y**	**x**	**y**
Foci	±4.5	0	±3.0	0	±1.5	0	±3.0	0	±1.5	0	±0.9	0
Data Points	0	±2.2	0	±4.0	0	±4.8	0	±1.5	0	±2.0	0	±2.9
	±1.0	±2.1	±1.0	±3.9	±1.0	±4.7	±1.0	±1.4	±1.0	±1.8	±1.0	±2.7
	±2.0	±2.0	±2.0	±3.7	±2.0	±4.4	±2.0	±1.2	±2.0	±1.2	±2.0	±2.1
	±3.0	±1.7	±3.0	±3.2	±3.0	±3.8	±2.5	±1.0	±2.5	0	±2.5	±1.6
	±4.0	±1.3	±4.0	±2.4	±4.0	±2.9	±3.0	±0.6			±3.0	0
	±4.5	±1.0	±4.5	±1.7	±4.5	±2.1	±3.3	0				
	±5.0	0	±5.0	0	±5.0	0						
Distance between foci (D)												
Length of major axis (L)												
Eccentricity (e = D/L)												

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Analysis and Conclusions

1. Study Ellipses 1–3. Which ellipse looks most like a circle? Which ellipse looks least like a circle? Describe the relationship between how circular an ellipse appears and its eccentricity.

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2. Which ellipse has the same eccentricity as Ellipse 1? How do the shapes of these two ellipses compare? Which ellipse has the same eccentricity as Ellipse 3? How do these two ellipses compare?

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3. If two ellipses have the same shape, which of the following must be equal: distance between foci, length of the major axis, and eccentricity? Give evidence for your answer.

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4. What geometric shape would result if both foci were located at point (0, 0) of the graph? What would be the eccentricity of such an ellipse?

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5. The table to the right shows the orbital eccentricity of the planets. Compare the shapes of your ellipses with the shapes of the planets' orbits. Which ellipses are the best models for the shapes of the planets' orbits? Explain your answer.

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Eccentricities of the Planets

Planet	Orbital Eccentricity
Mercury	0.206
Venus	0.007
Earth	0.017
Mars	0.093
Jupiter	0.048
Saturn	0.056
Uranus	0.047
Neptune	0.009
Pluto	0.250

6. Which planet has the most circular orbit? Which planet has the least circular orbit? Explain your answer.

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7. Many comets have eccentricities of close to 1. Describe the shape of such an orbit. Which of your ellipses is most similar to a comet's orbit?

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8. The orbit of Mars has an eccentricity of 0.093. The distance between the two foci is 0.283 AU. The closest Mars gets to the sun during its orbit is 1.38 AU. What is the farthest Mars gets from the sun? Hint: Remember that the sun is located at one of the foci.

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