Lab : Eccentricity

Objective: The purpose of this lab is to demonstrate Kepler’s first law of planetary motion by calculating the eccentricity of ellipses.

Kepler’s 1st Law of Planetary Motion- the orbit of every planet is an ellipse with the Sun at one of the foci.

Materials: Ruler, cotton string, 2 push pins, pencil, calculator, box-top (or styrofoam board)

Procedure:
1. On plain paper draw a straight line lengthwise across the middle of the paper. (Fold it hot dog and draw on the crease).
2. Near the center of this line, draw two dots 2 cm apart. These two dots will represent the foci of your ellipse.
3. Placing the paper on a piece of cardboard put a thumbtack in each dot.
4. Loop the string around the thumbtacks and draw the ellipse by placing your pencil inside the loop as shown below.
5. Label this Ellipse #1.
6. Label each tack hole #1 and measure the distance between the holes (foci). This is “d”. Record this on your Report Sheet.
7. Measure the length of the major axis (L) and record this on your Report Sheet (total distance of length of line INSIDE the circle).
8. Move each tack out 1 cm and draw a new ellipse (they will be a total of 4 cm apart). Label it #2 and measure and record the d and L.
9. Move each tack out 1 cm and draw a new ellipse. Label it #3 and measure and record the d and L.
10. For Ellipse #4 place a single tack in between the first two holes that represent the foci of Ellipse #1. Draw the ellipse, measure and record the d and L.
11. Calculate the eccentricity of these orbits. Show all work, and record your answers to the nearest thousandth.
Object A represents the orbit of a comet. How does the orbit of object A compare to the orbits of Earth and Jupiter? Use the word eccentric or eccentricity in your answer.

Report Sheet

Ellipse #1
\[ d = \_\_\_\_\_\_ \quad l = \_\_\_\_\_\_ \quad e = \_\_\_\_\_\_ \]

Ellipse #2
\[ d = \_\_\_\_\_\_ \quad l = \_\_\_\_\_\_ \quad e = \_\_\_\_\_\_ \]

Ellipse #3
\[ d = \_\_\_\_\_\_ \quad l = \_\_\_\_\_\_ \quad e = \_\_\_\_\_\_ \]

Ellipse #4 (one focus pt.)
\[ d = \_\_\_\_\_\_ \quad l = \_\_\_\_\_\_ \quad e = \_\_\_\_\_\_ \]
**Discussion Questions:**

1. Describe the relationship that exists between the distance between foci and the eccentricity of an ellipse.

2. Which planet in the solar system has an eccentricity closest to Ellipse #1? Refer to the Earth Science Reference Tables (p. 15).

3. What shape is produced when only one pushpin is used? What is the eccentricity of this shape?

4. Which planet has an eccentricity closest to Ellipse #4? What does this indicate about the orbit of that planet?

5. Use the following data to calculate the eccentricity of Earth’s orbit around the Sun. Report your answer to the nearest thousandth.

<table>
<thead>
<tr>
<th>Length of the Major Axis</th>
<th>299,000,000 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance Between Foci</td>
<td>5,083,000 km</td>
</tr>
</tbody>
</table>

Show work here:
6. How does the shape of Earth's around the Sun compare to the four ellipses you drew in this lab? Use the term *eccentric* or *eccentricity* in your answer.

7. 
   a. Find the other focal point for the ellipse shown below left and place an X at that location.
   b. Label one possible location of the Sun if this orbit represents one of the planets in the solar system.

8. Much like the orbits of planets, comets usually move around the Sun in elliptical orbits. The orbit of Halley's comet has an orbital eccentricity of .967 and is shown in the diagram above on the right. Explain why this comet is only visible from Earth for a short period of time every 76 years.

*What can the Pringles man teach us about the eccentricity of planets?

Equation for determining eccentricity:

(Eyebrows = ?)

(Mustache = ?)