**Planetary Orbits Lab**

**Background Information:** During the early years, one of the goals of astronomy was to understand the motions of the planets, including how they orbited around the sun. When Ptolemy created his Earth-centered model of the solar system, he believed the planets orbited in circles, with some orbiting in circles within a circle (specifically Mercury and Venus). When Copernicus developed the sun-centered model of the solar system he, again, believed the planets orbited around the sun in circles. Kepler also tried to describe the motions of the planets with circles. However, he had to stray from this idea when he discovered the positions of the planets could not be correctly identified using this a circle. Instead he found planets orbit in almost circular ellipses with the sun being one of the foci of the ellipse.

 In this lab you will draw different ellipses and see what can make the ellipses change shape.

**Problem:** How does changing the foci of the ellipse change its shape?

**Materials:**

* Paper
* Colored Pencils
* Two thumbtacks
* Cardboard Box

**Procedure (Part A): Drawing Ellipses and Calculating Eccentricity**

1. Place a piece of paper on the cardboard. Put the thumbtacks in the paper so that the thumbtacks are 10 cm apart.
2. Label one of the thumbtacks as the sun.
3. Take the string and put it around the two thumbtacks.
4. Using one of the colored pencils, gently pull the string tight and gently drag the pencil around the pins to draw an ellipse.
5. Use the ruler to measure the length of the major axis and focal length. Put these values in the data table.
6. Repeat steps 1🡪5, but this time the thumbtacks should only be 8 cm apart.
7. Repeat steps 1🡪5, but this time the thumbtacks should only be 6 cm apart.
8. Repeat steps 1🡪5, but this time the thumbtacks should only be 4 cm apart.
9. Repeat steps 1🡪5, but this time the thumbtacks should only be 2 cm apart.
10. To find the **eccentricity** of the ellipse use the following equation.

Focal Length

Eccentricity = Major Axis

**Data Table 1:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Ellipse (Color)** | **Focal Length (cm)** | **Major Axis (cm)** | **Eccentricity (See #10)** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Procedure (Part B): Observing Properties of an Ellipse**

1. Choose one of your ellipses from part “A” and label one of your foci A and one of your foci B.
2. Choose a point anywhere on that same ellipse and label it C.
3. Using your ruler, measure the distance between A and C. Record in Data Table 2.
4. Using your ruler, measure the distance between B and C. Record in Data Table 2.
5. Repeat steps 1🡪 4 for each of your other ellipses.

**Data Table 2:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Ellipse Color** | **Length of AC (cm)** | **Length of BC (cm)** | **Length of AC + BC (cm)** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Conclusion Questions: Answer the following in complete sentences.**

1. Look at Data Table 1. As your focal length decreases, what happens to the length of the major axis?
2. Look at Data Table 1. As your focal length decreases, what happens to the eccentricity of the ellipse?

Look at the following data.

|  |  |
| --- | --- |
| **Planet** | **Eccentricity** |
| Mercury | .206 |
| Venus | .007 |
| Earth | .017 |
| Mars | .093 |
| Jupiter | .048 |
| Saturn | .056 |
| Uranus | .047 |
| Neptune | .009 |

1. Based on this data, which planet has the most eccentric orbit?
2. Which of the planets has the most circular orbit? How do you know?
3. If you created an ellipse with a focal length of zero, what would the eccentricity be?
4. What shape would the orbit be?
5. What object in the solar system do you believe is one of the focal points for the Luna’s orbit?