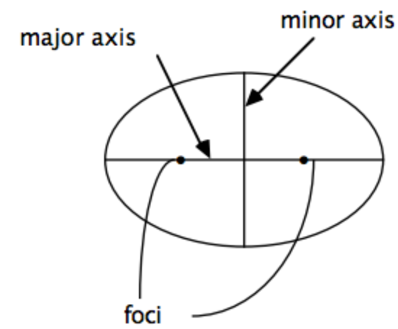
Elliptical Orbit Lab

Purpose: To study the properties of ellipses and to compare the shapes of the planet's orbits.



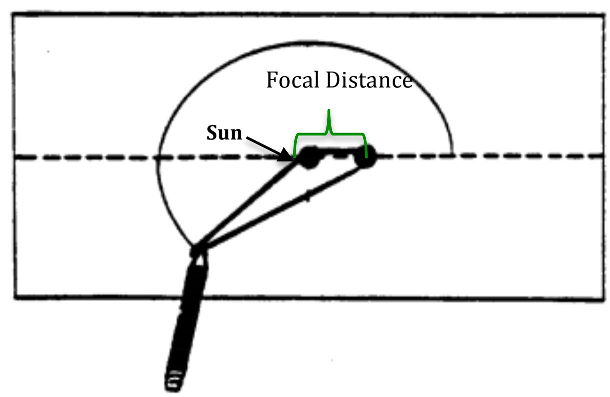
Background: The shapes of the planet's orbits are ellipses and that the sun is at a special place in the ellipse called the focus. An **ellipse** is a slightly flattened circle. Its largest diameter is called the major axis. The shortest distance across the ellipse is called the minor axis. Two points located on the **major axis** are called the foci (plural of focus).

The flatness or "out-of-roundness" of an ellipse is described by its **eccentricity**. The eccentricity (e) can be obtained by measuring the length of the major axis (m) and the distance between the 2 foci (c). The eccentricity is a ratio, therefore it has no units and is given by the equation: **eccentricity = focal distance ÷ major axis**

All the planets' orbits are elliptical. However, the extent of their eccentricity varies. The following describes a mechanical method of creating an ellipse. The odds of creating an ellipse equal to that of one of the planets is astronomical. Therefore, you will compare the eccentricities of the 4 ellipses you draw to the eccentricities of the planets to discover how eccentric the planets' orbits are.

Materials: 2 thumbtacks, metric ruler, 4 pencils, 4 sheets of blank paper, board, 30 centimeter long string, calculator

Procedure:



1. **Read** the entire lab before doing anything.
2. To draw an ellipse
   a. Place a clean sheet of paper lengthwise on the board.
   b. Put one thumbtack at the very center and **label it "Sun**." This will **stay in the same place for every ellipse you draw**.
   c. Place the 2nd thumbtacks 5 cm away from "sun" along the centerline. (See illustration)
   d. Tie the ends of the string together, making a 20 cm loop.
   e. Put the loop of string around the tacks and pull the string tight with a pencil. Keeping the pencil straight up and the string tight, slide the pencil along the string to draw the ellipse.
3. Remove string and 2nd thumbtack
   a) **Mark** the 2nd thumbtack *foci*
   b) **Draw** the major axis, **label** these as Ellipse 1 (respective) on your paper.
   c) **Measure** the length of the **major axis** and the **focal distance**. Make all measurements in metric.
   d) **Record** measurement on the data table for Ellipse 1 (respective)
   e) **Calculate** the eccentricity of your ellipse, record this in data table 1.
4. Place the 2nd thumbtack slightly further apart than you did for Ellipse #1. Using a different colored pen/pencil and the same string as above, draw another ellipse, then repeat step 3, labeling as "Ellipse 2".
5. Using a different colored pen/pencil and the same string as above, move the 2nd thumbtack as far apart from the Sun as possible. Draw an ellipse. This would be the most eccentric an ellipse could be. Then repeat step 3, labeling as "Ellipse 3".
6. Using a different colored pen/pencil and the same string as above, draw an ellipse that has the smallest eccentricity you can possibly make. Then repeat step 3, labeling as "Ellipse 4".
7. **Answer Analysis Questions and Rank Planet Eccentricity on Table B**

Data Table A

Ellipse #	Focal Distance (cm)	Major Axis (cm)	Eccentricity *focal dist ÷ major axis*
EX	9 cm	11 cm	9 ÷ 11 = 0.818
1	Record on paper	Record on paper	____÷____=_____
2	Record on paper	Record on paper	____÷____=_____
3	Record on paper	Record on paper	____÷____=_____
4	Record on paper	Record on paper	____÷____=_____

Data Table B

Planet	Eccentricity	Rank
Mercury	0.206	Record on Paper
Venus	0.007	
Earth	0.017	
Mars	0.093	
Jupiter	0.048	
Saturn	0.056	
Uranus	0.047	
Neptune	0.008	
Pluto	0.247	