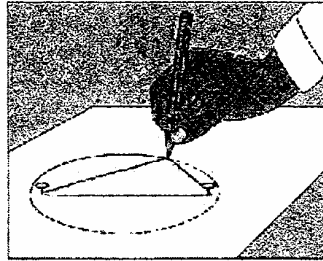
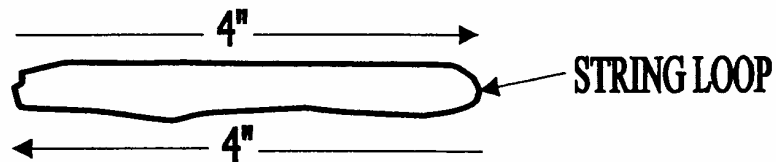


## Drawing Scale Models of Asteroid Orbits

The elliptical orbit of an asteroid can be drawn on a piece of paper with a pencil, a piece of thick cardboard, a loop of string and two thumb tacks as shown below.



Make a loop of string four inches long (a total of eight inches of string) as shown here:



Place a piece of paper on top of a piece of cardboard. Separated by a distance of two inches, stick the tacks through the paper and into the cardboard. The tacks represent the two foci of the ellipse that you are going to draw. Stretch the four-inch loop of string around the tacks and practice drawing an ellipse by placing your pencil against the string as shown in the diagram above.

Change the distance between the two tacks, and draw another ellipse. Observe the effect on the eccentricity of the ellipse as the tacks (foci) are moved closer, and then further away from each other. Describe your observations.

Using this method for drawing ellipses, draw the elliptical orbits of the asteroids introduced in the Table on a previous page. Make your drawing on the scale diagram of the inner Solar System provided. The lengths of the string loops needed to accurately draw the orbit of each asteroid have been calculated and are also provided.

### **Procedures for drawing the elliptical orbit of an asteroid.**

1. Since the tacks represent the FOCI of the asteroid's orbit we need to calculate the distance between the FOCI, and thus the distance between the tacks. The FOCI of an orbit is:

$$\text{Distance between FOCI} = \frac{\text{MAJOR AXIS}}{2}$$

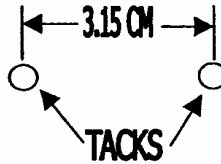
For the asteroid named Castalia, the distance between FOCI (or tacks) would be 1.05 AU's

- Since we couldn't possibly measure a distance of 1.05 AU's across a piece of paper, we must reduce the distance in size to fit the paper. We will draw a scale diagram where the scale will be:

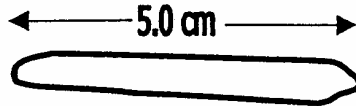
$$1 \text{ AU} = 3 \text{ cm}$$

Therefore the distance between FOCI for Castalia on our paper will be 3.15 cm.

- Stick two tacks through a piece of paper at this calculated distance between FOCI.



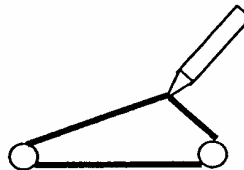
- On this scale we have calculated the length of the string loop to be 5.0 cm. Make a string loop 5.0 cm in length



- Place the string loop around the tacks.



- With your pencil point, stretch the string tight around the tacks and start drawing the elliptical orbit.

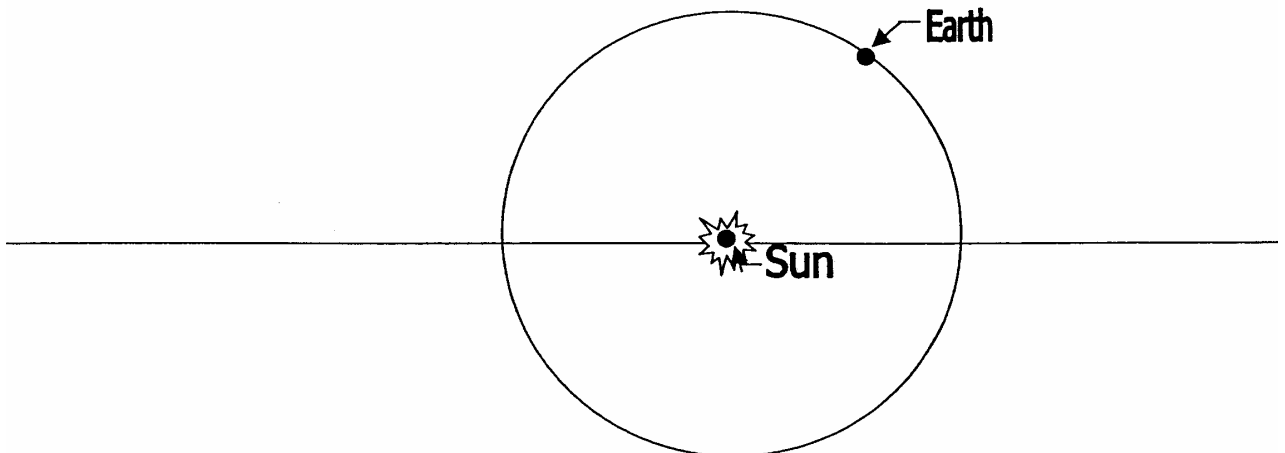


- The calculated loop lengths and tack separation distances (distance between FOCI) are provided in the table below. Use these measurements, and the procedure above, to draw a scale model of the solar system on the diagram below.

**ASTEROID   LOOP LENGTH   TACK SEPARATION**

Mathilde	9.6 cm	7.9 cm
Icarus	7.1 cm	3.2 cm
Castalia	5.0 cm	3.2 cm
Rodari	7.9 cm	6.6 cm
Eros	5.1 cm	4.4 cm

Since the sun is one of the foci for an asteroid's elliptical orbit, place, and keep, one thumb tack at the Sun. The second thumbtack should be placed to the left of the Sun and the string loop draped around each tack. Paste this picture onto a larger piece of paper if you don't have enough room to draw your scale diagram..



**Related Resources on the Internet**

Online computer generated elliptical orbits.

<http://www-groups.dcs.st-and.ac.uk/~history/Java/Ellipse.html>

Johns Hopkins Applied Physics Laboratory's NEAR Mission

<http://NEAR.jhuapl.edu/>

Discovery Channel's Asteroid watch

<http://www.discovery.com/stories/science/meteors/meteors.html>