Orbits of the Planets

How can you draw an ellipse? And how can you draw an ellipse representing the orbits of the planets? This activity will help you find out.

Materials Needed (for every student)

- pushpins
- thread or thin string
- paper
- ruler
- pencil or pen
- Styrofoam board or thick cardboard

Background

What is an ellipse? *An ellipse is a curve for which the sum of the distances from any point along the curve to each foci inside the ellipse are always equal*. **Figure 1** below shows the geometry of an ellipse. Note that ellipses have two *foci*, a *semi-major axis* (a), and a *major axis* (2a). The *eccentricity* (e) of an ellipse is the ratio of the distance between the two foci and the length of the major axis.

e = (Distance between the foci)/(Length of the major axis)

We will use this information to investigate the eccentricity (e) of different kinds of ellipses.

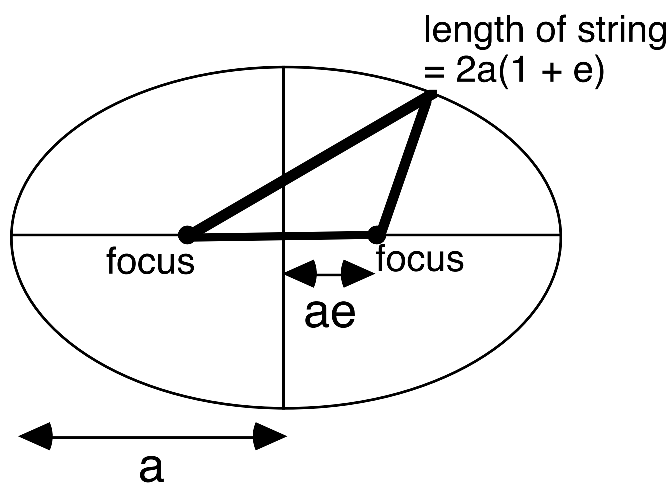

Figure 1

What To Do

- Place a large sheet of paper on a Styrofoam board or piece of cardboard. Place the thumbtacks some distance apart in the center of the paper. *Cut a length of string that is more than twice as long as the distance between the thumb tacks*. Fold the length of string in half and tie the ends together so you have a loop of string.

- Put the loop around the pins. Using a pencil as shown in **Figure 2**, sketch out the shape of the orbit.

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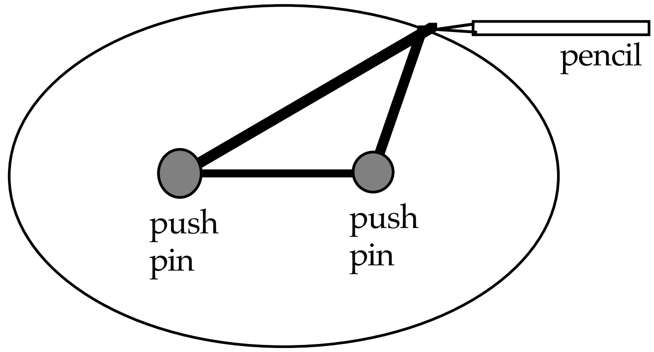

Figure 2

- Measure the major axis (widest part) of the ellipse. Measure the distance between the pushpins. Calculate the eccentricity of the ellipse that you drew by using the following formula:

e = distance between push pins ÷ length of the widest part of the ellipse

- Have students write the eccentricity (e) on their sheets of paper and post the ellipses they drew around the room. Have the students examine the drawings. What can be inferred say about the eccentricity of ellipses. *When the eccentricity (e) gets close to zero, the shape of the ellipse becomes circular. As e gets close to 1, the ellipse becomes flat.*

Planet	e (eccentricity)
Mercury	**0.200**
Venus	**0.001**
Earth	**0.017**
Mars	**0.093**
Jupiter	**0.048**
Saturn	**0.056**
Uranus	**0.047**
Neptune	**0.008**
Pluto	**0.250**

- Look at the table on the previous page. This table shows the eccentricity for the orbits of each of the nine planets. Which drawings posted of the walls are closest to representing the orbit of one of the nine planets. If none of them are close, can the students use their knowledge of ellipses to draw a figure that approximates the correct shape of the orbits?

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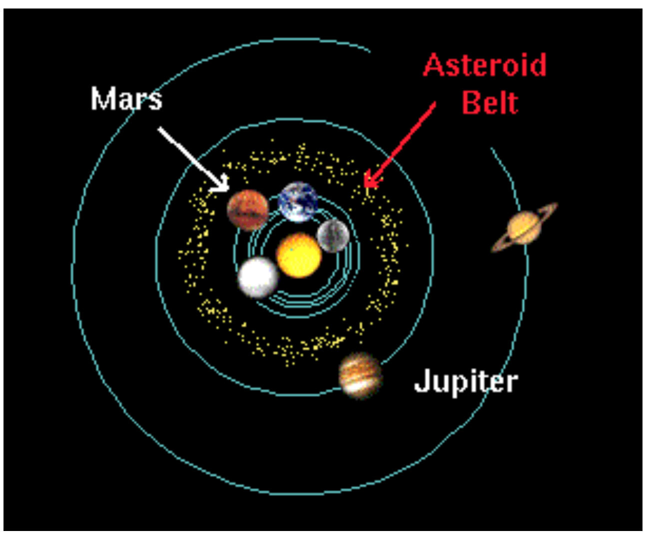
Which planet has the most circular orbit (*e nearest to zero*)? Which has the orbit that is most flattened (*e nearest to one*)?

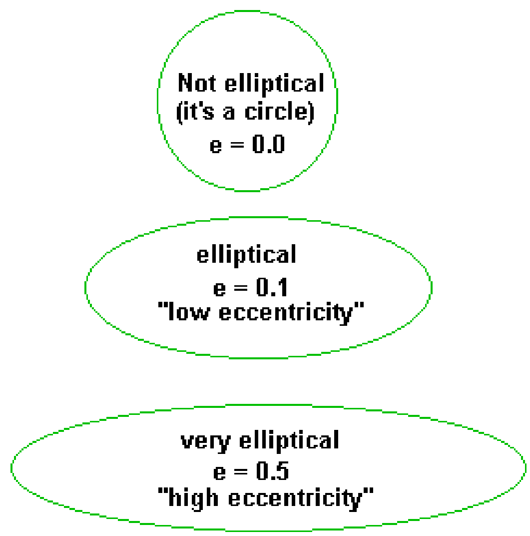
What's Going On?

Because of misleading diagrams often seen in books other astronomy reference materials, most people believe that the orbits of the planets are highly elliptical – almost cigar shaped. In fact, the orbits of the planets are very nearly circular.

The problem with this misconception about planetary orbits is that it leads many students to erroneously believe that the cause of the earth's seasons has something to do with changing distance to the sun. After all, if the earth's orbit were as elliptical as these students believe, we would in fact be much closer to the sun during certain times of the year and much further away at other times.

The fact is that the earth's orbit is very close to being circular. At our closest approach to the sun, we are 147,000,000 kilometers away. At farthest approach to the sun, we are 152,000,000 kilometers away. Our distance from the sun varies by only 3% – not enough to account for changes in how the earth is heated by the sun during the year.





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