Lab 10: Planetary Orbits

Goals

1. Investigate properties of ellipses

2. Determine the shape of any object in solar orbit

3. Understand Kepler's First Law

4. Construct three ellipses with varying eccentricities

Materials and Equipment

Ruler
(2) Thumb tacks
30 cm of string

Materials Not Included

Pencil
Cardboard (or box)
Transparent tape
Plain paper

Introduction

The shape of the Earth's orbit is not quite circular. Circles have constant radii and orbits do not. Their specific shape is called an ellipse. The amount of curvature of the ellipse is called the eccentricity of the ellipse. The eccentricity of the ellipse is a mathematical quantity and is calculated by equation (1).

(1) $e = \frac{f}{l}$

Where e is the eccentricity; f is the focal distance, and l is the length of the major axis.

The eccentricities range only from 0 (a circle) to 1 (a straight line). In this experiment you will investigate the properties of ellipses. What you learn here applies to all objects in orbit about another object (the sun, Earth, moon, planets, comets, asteroids, and so on).

Devotional

"By the word of the Lord were the heavens made, their starry host by the breath of his mouth. He gathers the waters of the sea into jars; he puts the deep into storehouses. Let all the earth fear the Lord; let all the people of the world revere him. For he spoke, and it came to be; he commanded and it stood firm." Psalm 33:6-9

Evidence of God are the laws he made when He created the universe. These laws govern the actions of everything. In this activity you will learn about a law God established that controls the orbits of an object around another. This law happens because of another law, the law of gravity.

God also gave laws to people that he expects us to follow. In the Gospel of Matthew, Jesus summarized and simplified all God's laws for us into a simple command—Love. We are to love God and love people. Why would God want us to love? Love is one of the foundational attributes of God. Love brings peace, harmony, and enjoyment to the human race. The Bible also warns us that in the last days there will be terrible times when many people will only love themselves, money, and pleasure.

As you do this activity, remember that an expression of God's love is the reliability of the laws He made to govern the universe (including the planetary orbits).

Procedure

1. Draw a faint line lengthwise along the center of the paper. Locate the center of the line with a dot.

2. Mark two x's on the line, and on both sides of the dot, 2 cm from the dot. Label these A and B.

3. Mark two more x's on the line, and on both sides of the center dot, but 5 cm from the center. Label these C and D.

4. Mark two more x's on the line, and on both sides of the center dot, but 6 cm from the center. Label these E and F. You should now have six x's on the line.

5. Tape the paper to the cardboard (or box). Push thumb tacks into positions A and B. Tie 30 cm of string to form a loop.

6. Place the string loosely around the two thumb tacks. With the point of the pencil pull the string taunt, and draw a line on the paper as you move the pencil completely around the paper. This is ellipse one.

7. Move the thumb tacks to positions C and D, and repeat procedure #6. This is ellipse two.

8. Move the thumb tacks to positions E and F, and repeat procedure #6. This is ellipse three.

9. For each orbit, measure the distance between the pins (a), and the longest distance across the orbit (b).

10. Calculate the eccentricity of each ellipse by dividing (a) by (b). Record the answer in Table 1.

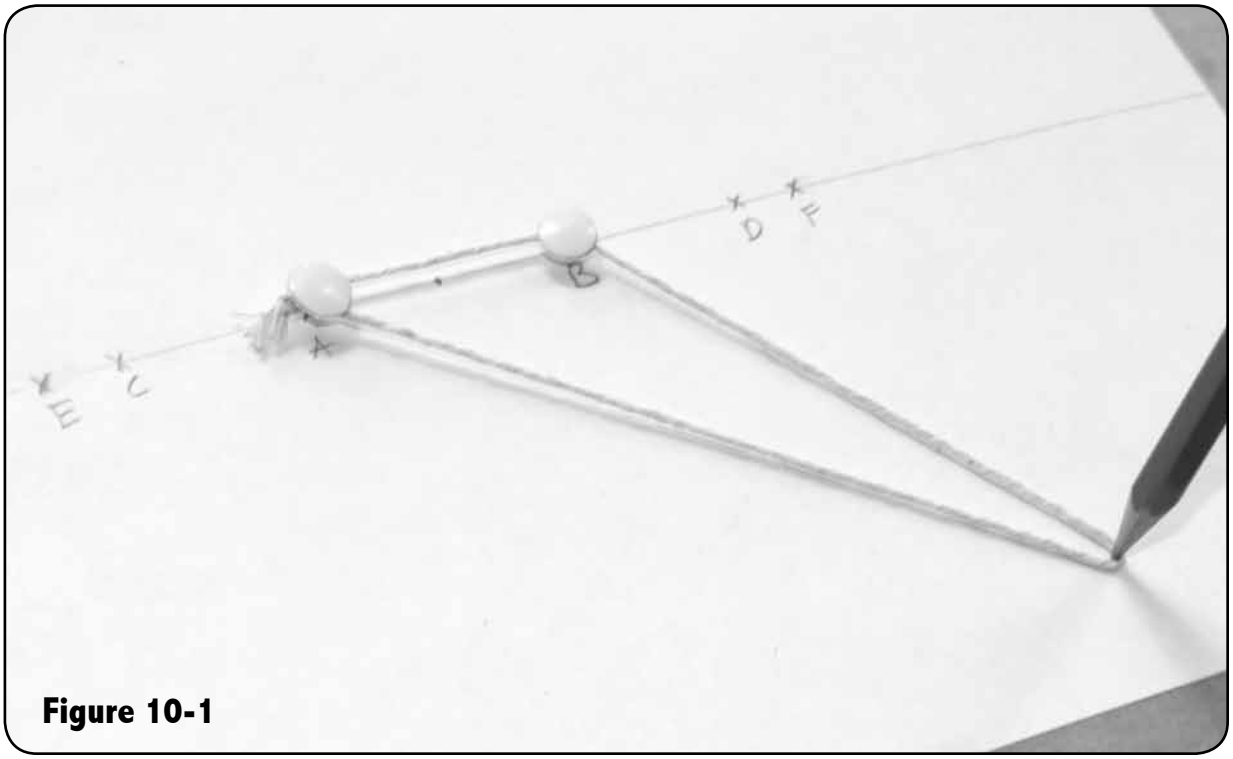

Figure 10-1

Lab 10

Questions for Planetary Orbits

Table 1

	Focal Distance, cm	Length of Major Axis, cm	Eccentricity
Ellipse 1			
Ellipse 2			
Ellipse 3			

1. What happens to the shape of an ellipse as you move the two foci further apart?

2. Does the eccentricity of an ellipse increase or decrease as the shape becomes more round?

3. Calculate the eccentricity of the Earth from the following data.

   Length of major axis = 298, 000, 000 km

   Focal distance = 4, 800,000 km

4. Are there units of eccentricity? Why or why not?

Table 2 - Eccentricity of Planets

Planet	Eccentricity
Mercury	0.206
Venus	0.007
Mars	0.093
Jupiter	0.048
Saturn	0.054
Uranus	0.047
Neptune	0.009

5. What does Mercury's eccentricity indicate about the shape of its orbit compared to the orbits of the other planets?

6. Which planets have orbits that are more nearly circular than Earth's?

7. The eccentricity of Halley's Comet is 0.967. What does this tell you about the shape of the orbits of comets?