The Ellipse Lab- Predicting Planet Orbits

The ellipse is the geometric shape of most orbits. In this lab, you'll construct 2 ellipses, and examine and measure them to determine some of the fundamental properties of ellipses.

Follow the directions below, making sure you draw and measure carefully along the way. When you have completed the construction and measurement of your ellipses, carefully and thoughtfully answer the questions posted at the end of this lab.

1. Gather up the materials you need to complete this lab (See Fig. 1):
   - A piece of cardboard
   - 2 sheets of clean white paper
   - 2 push pins
   - A 30 cm (or so) length of string
   - A metric ruler/straight edge
   - A pen or sharp pencil

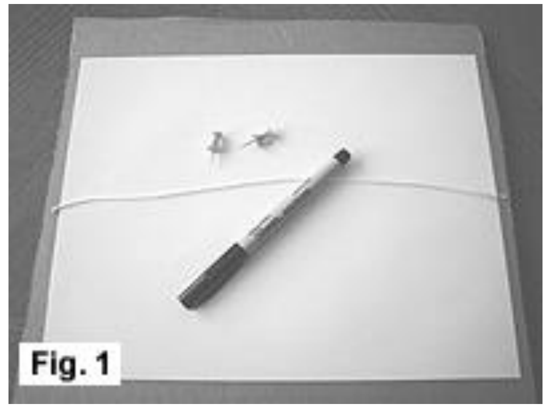


Fig. 1

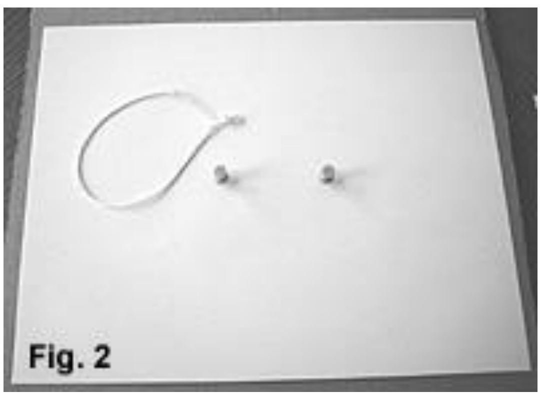


Fig. 2

2. Tie your string into a loop. The loop, when stretched tight, should be 12 cm or so long (anything between 10 and 13 cm will work fine) (See Fig. 2)

2A. Place one sheet of paper on the cardboard, and place the 2 push pins horizontally about 6 cm apart near the center of your paper as shown in Fig. 2.

3. Place your loop of string around the 2 push pins, and, keeping the string tight, use the string as a guide to carefully draw an ellipse around the push pins. (See Fig 3.) Be patient - you may have to try it a few times before you get the hang of it

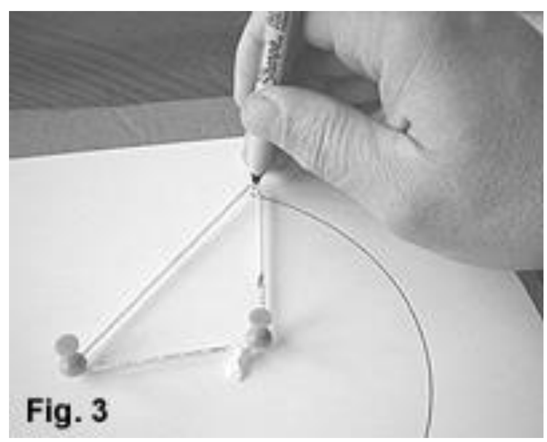


Fig. 3

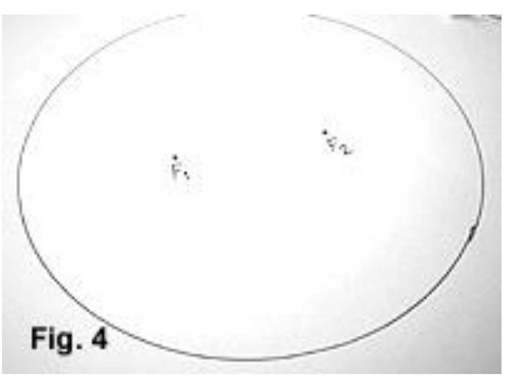


Fig. 4

4. After you've drawn your ellipse, remove the push pins (it's probably a good idea to stick them in the margin of cardboard so they don't roll away). The 2 pinholes are called the *foci* of the ellipse (each one is called a *focus*). Label the 2 foci F_1 and F_2 as indicated in Fig.4.

5. Carefully draw a straight line across the ellipse so that it passes **exactly** through the foci. That line, which is the longest one you can draw in the ellipse, is called the *major axis* of the ellipse. Label it on your diagram. (See Fig. 5)

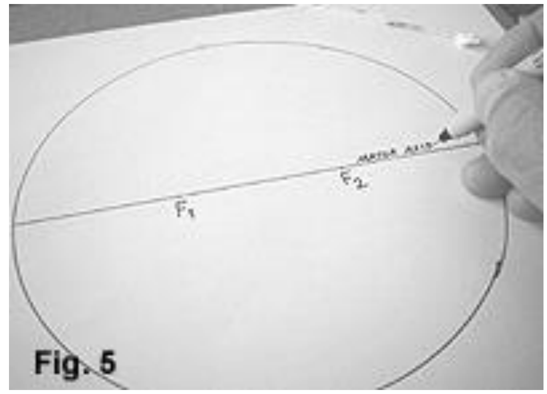


Fig. 5

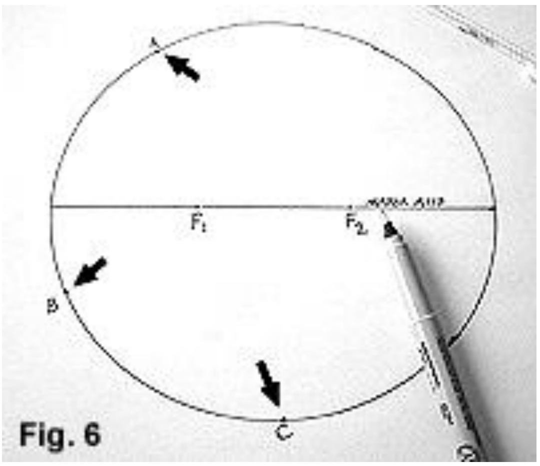


Fig. 6

6. Select and make a mark at 3 randomly located points on the ellipse. Label the points A, B, and C as indicated in Fig. 6. The black arrows point to 3 possible locations for points - but yours can be anywhere on the ellipse.

7. Draw a line from each point (A,B, and C) to each of the foci as indicated in Fig. 7. When you've done that, you're done with your first ellipse!

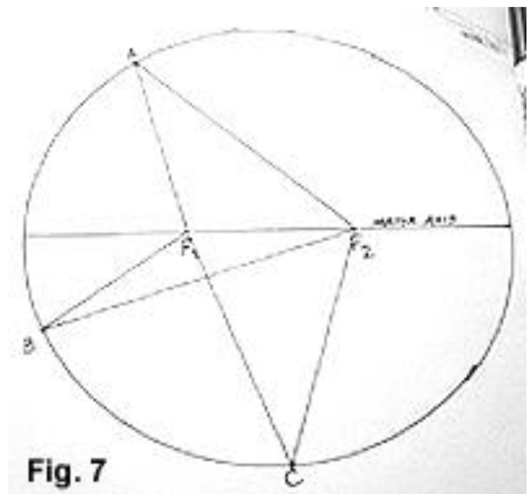
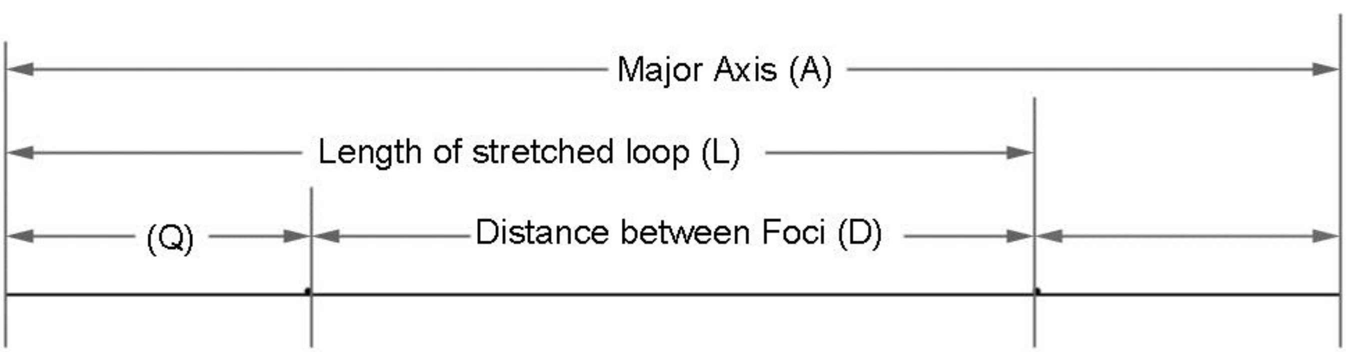


Fig. 7



The Ellipse Lab

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8. Make all the measurements listed below to the nearest 1/10 of a cm. Record them on this sheet **and** label them on your diagram. Don't forget to include the units of your measurement as well.

Length of the major axis = __________

Distance between the foci = __________

Length of line A F_1 = __________

Length of line A F_2 = __________

Length of line B F_1 = __________

Length of line B F_2 = __________

Length of line C F_1 = __________

Length of line C F_2 = __________

9. Calculate and record your answers to the following sums:

Length of A F_1 + length of A F_2 = _______________

Length of B F_1 + length of B F_2 = _______________

Length of C F_1 + length of C F_2 = _______________

What do you notice about those sums? ____________________________

Think of how you drew the ellipse, and explain why the sums are equal to each other.

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____

____

10. The eccentricity of an ellipse tells us how "out of round" it is. Use this formula:

$$\textbf{Eccentricity} = \frac{\textbf{distance between the foci}}{\textbf{length of the major axis}}$$

to calculate the eccentricity of your ellipse. Round your answer to the nearest tenth, and record it on this sheet **and** record and label it on your ellipse drawing as well. (Notice what happens to the units when you do your division!)

Eccentricity = __________

11. Using a second sheet of white paper, repeat steps 2 through 6 of this lab, ***only this time place the push pins 9 or so cm apart.***

12. On your new ellipse, make the measurements listed below. Record them to the nearest tenth of a cm. on this sheet **and** label them on your diagram. Don't forget to record the units of measurement as well.

Length of the major axis = __________

Distance between the foci = __________

13. Recall the formula for calculating the eccentricity of an ellipse and calculate the eccentricity of your new ellipse. Round your answer to the nearest tenth, and record it on this sheet **and** record and label it on your ellipse drawing as well. (Remember to think about what happens to the units when you do your division!)

Eccentricity = __________

14. Carefully and thoughtfully do/answer the following:

a. Place your 2 ellipses on your desk in front of you so you can see both.

Which one looks more nearly circular?__________________

Which one has the greater eccentricity?__________________

b. Complete this statement in a way that indicates that you know what eccentricity measures:

"The greater the eccentricity of an ellipse, the

____

____

____

c. Imagine drawing ellipse after ellipse, each time moving the push pins closer and closer together, until they are both in a single hole at the center of your page.

What shape would that ellipse be?__________________

What would the eccentricity of that ellipse be? ________________.

Explain how you know that:____

____

Group Project: Solar System Orbit Poster

At your table in a group of four at most, create a poster of the nine planets (yes, I am including Pluto) drawing each planets distance and from the sun and orbit around the sun to scale using the data on the next page. Draw the planets sizes to scale and label each planets orbit with known given information. Build into the poster an understanding of Kepler's three laws and how they apply to our solar system.

	Component	4 / 3
Poster	**Required Elements**	The poster includes all required elements as well as additional information.
	Labels	All items of importance on the poster are clearly labeled with labels that can be read from at least 3 ft. away.
	Graphics - Relevance	All graphics are related to the topic and make it easier to understand. All borrowed graphics have a source citation.
	Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.
	Grammar	There are no grammatical/mechanical mistakes on the poster.
Physical Model	**Model**	Model follows guidelines, is completely finished, well thought out and is easily understood.
	Construction	The model is carefully constructed with materials that showcase student's creativity and are appropriate.
	Organization and Mechanics	Model is neat, accurate, easy to follow, and shows creativity.
	Legend/Key	Complete, easy to understand, and formatted correctly.

Note: Be sure to create a scale for your poster first

Name: ______________________________ Per: _____

Use the following table to determine the velocity and gravity of each of the planets

Solar System Data

Object	Mean Distance from Sun (millions km)	Period of revolution (Earth days)	Eccentricitiy of Orbit	Equitorial radius (km)	Mass (kg)	Velocity (m/s)	Gravity (m/s/s)
Sun	-	-	-	696000	$2.0\text{x}10^{30}$	-	
Mercury	57.9	88	0.206	2440	$3.3\text{ x}10^{23}$		
Venus	108.2	224.7	0.007	6052	$4.9\text{ x}10^{24}$		
Earth	149.6	365.26	0.017	6378	$6.0\text{ x}10^{24}$		
Mars	227.9	687	0.093	3394	$6.4\text{ x}10^{23}$		
Jupiter	778.3	4332	0.048	71400	$1.9\text{ x}10^{27}$		
Saturn	1427	10760	0.056	60000	$5.7\text{ x}10^{26}$		
Uranus	2869	30682	0.047	25900	$8.7\text{ x}10^{25}$		
Neptune	4496	60195	0.009	24750	$1.0\text{ x}10^{26}$		
Pluto	5900	90475	0.250	1150	$1.5\text{ x}10^{22}$		

Mean distance from Earth

Earth's Moon	385000 km	27.3	0.055	1738	$7.4\text{ x}10^{22}$		

Equations:

$$v = \sqrt{\frac{Gm_{sun}}{r_{sun\ to\ planet}}} \qquad T = 2\pi\sqrt{\frac{r^3}{Gm}} \qquad g = \frac{Gm_{planet}}{r_{planet}^2}$$

$G = 6.67\text{x}10^{-11}\ \text{Nm/kg}^2$