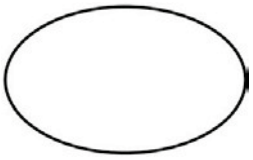
Ellipse – Student Activity

Definition - A planetary orbit is: _____

_____

Some ancient scientists thought that all the heavens orbited (circled) the Earth. Slowly observations showed that in our solar system most planets orbit the Sun.

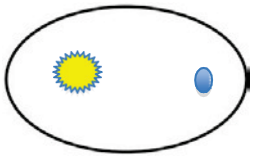
Johannes Kepler (1571-1780) was a German astronomer and mathematician. He used scientific observations and mathematics to disprove earlier ideas of planets being in simple circular orbits round the Sun. He proposed three laws that described planetary motion as observed.



Kepler's first law stated that:

PLANETARY ORBITS ARE ELLIPSES

The English scientist and mathematician **Isaac Newton** (1643-1727) corrected some mathematical mistakes Kepler made and using his own and other's observations suggested that it was the **FORCE OF GRAVITY** originating from the huge mass of the Sun that deflected the straight paths of celestial objects into ellipses around the Sun.



The ellipse does not have one centre like a circle but two foci because it is the product of two competing factors (the motion of the planet and the pull of gravity).

Investigate the eccentricity of ellipses and discuss why it took astronomers so long to realise the planets were travelling in elliptical orbits

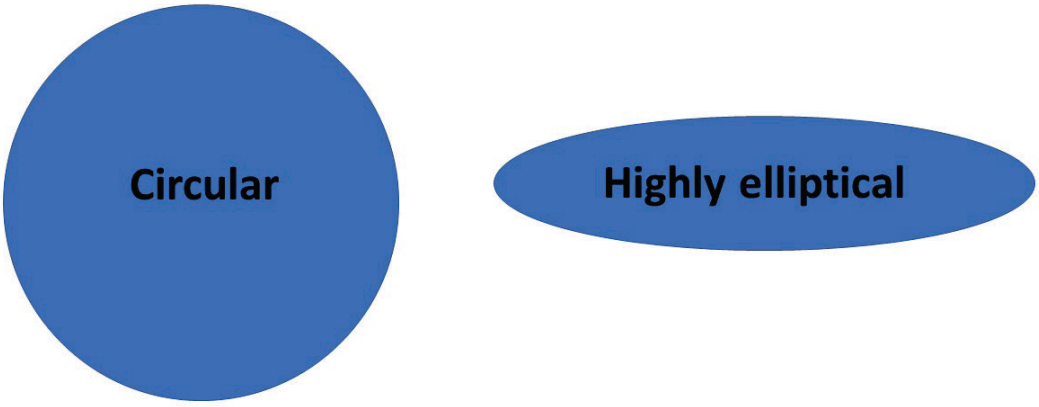


Figure 1. The more elliptical an object the higher its eccentricity

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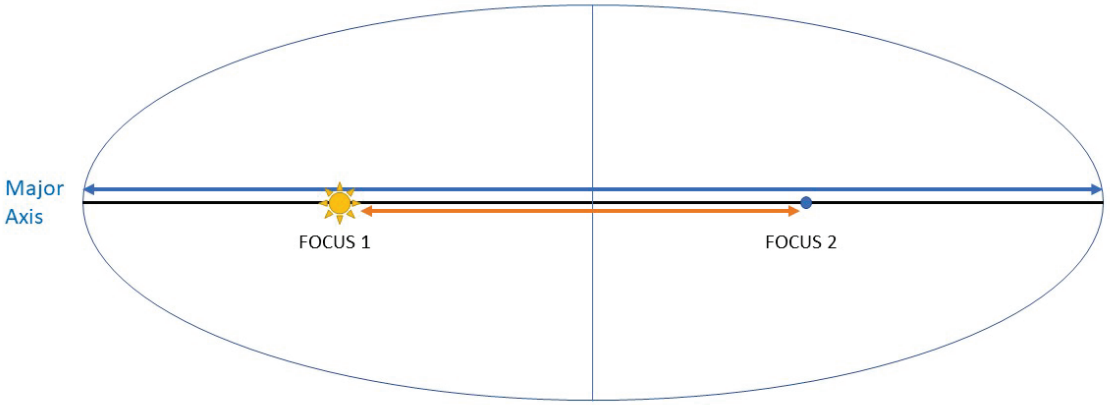
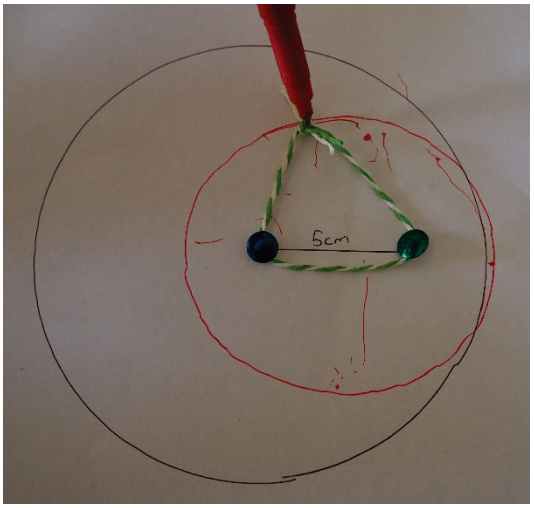
Materials per student or group

- Two thumb tacks or nails. If neither is possible, one student can hold a pencil point down at each of the foci whilst the other draws the path of the ellipse.
- A large sheet of scrap paper newspaper or cardboard. Placing polystyrene or thick card beneath the paper permits the nails or tacks to be easily pressed in and prevents damaging the table beneath.
- A piece of string about 20 cm long
- Three different coloured pencils
- A ruler

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





Method

1. Loosely tie the piece of string into a loop.
2. Fold your piece of paper in four to find the central point.
3. Push the first tack into the centre.
4. Place the loop over the tack and then stretch it using a pencil and draw the first ellipse. This should be perfectly circular.
5. Place the second tack 1 cm away from the other tack.
6. Put the loop over the two tacks as shown in the picture above and use a different colour pencil to mark out the ellipse.
7. Measure the length of the major axis and enter this in the table.
8. Repeat step 6 and 7 with the tacks 4 cm and 7 cm apart.
9. Calculate the eccentricity of the ellipses using the formula given above.

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Orbit of object	Distance between foci (cm)	Length of major axis (cm)	Eccentricity
Orbit 1 (circle)	0		
Orbit 2	1		
Orbit 3	4		
Orbit 4	7		

Observations

What happens to the shape as the distance between the foci increases? _____

What happens to the eccentricity as the distance between the foci increases? _____

Applying your knowledge

Below is a table of the eccentricity of different planets in the Solar System.

Planet	**Major axis (AU)**	**Eccentricity**
Mercury	0.774	0.2056
Venus	1.446	0.0068
Earth	2	0.0167
Mars	3.048	0.0934
Jupiter	10.406	0.0484
Saturn	19.074	0.0542
Neptune	60.14	0.0086

1. Is there any relationship between eccentricity and distance from the Sun? _____

_____

2. Which planet has the highest eccentricity?_____

3. Why do you think it took astronomers so long to realise that the planets were orbiting in ellipses?

_____

To learn more about the planets orbit and view them in 3D go to this website:
https://theskylive.com/3dsolarsystem

Planets fall round the Sun rather than into the Sun