Gravity and Graphing

Science Knowledge:

- To know that the gravity of the sun keeps the planets in our solar system orbiting the sun;
- To know that Uranus is a large planet but it is a long way from the Earth and the Sun so it is not visible to the naked eye.

Maths Knowledge

- To be able to identify an ellipse;
- To know that a bar chart is best for comparing discrete data.

Maths Skills

- Drawing a bar chart

Resources:

- Caroline Herschel Gravity and Graphing PowerPoint
- Squared paper
- Rulers and pencils

WARM UP

Tell the children:
William Herschel was really interested in everything in the sky. He wanted to note everything that was there – not just the planets that were known at the time. He and Caroline developed a particular way to systematically 'sweep the heavens' with a telescope to make sure they looked at the whole sky. William tried to make notes but when he went inside (to have enough light to write down his observations), he found he then had to wait ages for his eyes to adjust to the dark again when he went back to the telescope. So, he enlisted the help of his sister, Caroline. William would operate the telescope and call out what he could see to Caroline, who sat with a notebook at the window of the house. Caroline had to have an equal understanding of astronomy to her brother in order to understand and correctly note down his observations.

Over the course of a few months, William tracked what he thought might be an undiscovered comet. His day by day account of his observations are held in the Royal Astronomical Society Library. You can see them in the following video. Let's find out what that comet turned out to be.

Watch:
https://www.youtube.com/watch?v=OI9FUri3FOM
(This is a fairly dry video, but the artefacts shown are genuine and, if you have done the first Caroline Herschel lesson, then it will refer back to the mirrors mentioned there.)

Tell the children:
Let's see what a sweep of the heavens might look like if you stayed out all night. Remember that there was no light pollution in their day so the stars would have been easier to see than they are nowadays. This film is speeded up so you can see how the stars appear to move across the sky. This happens because the Earth is turning.

Watch:
https://youtu.be/xTvvQ65jWVs

INTRODUCTION

Tell the children:
William and Caroline Herschel recorded the first observation of the planet Uranus. At that point in time, telescopes were relatively new. Mercury, Venus, Mars, Jupiter and Saturn can all be observed with the naked eye and were identified by ancient civilisations. So, when the Herschels were looking at the sky with the telescope there were only six known planets including Earth. Finding another planet in our Solar System was a really exciting and important discovery.

Uranus was huge but it was also further from the sun than any planet discovered. This chart (also shown on *Slide 1* of the PowerPoint) shows the relative diameters.

Planet	Diameter to the nearest 100km
Mercury	4,900
Venus.	12,100
Earth	12,800
Mars	6,800
Jupiter	143,000
Saturn	121,000
Uranus	51,100

However, this data is not as clear as it could be. Let's plot it on a graph to see how that might look.

Show Slide 1 and 2 of the Caroline Herschel Gravity and Graphing PowerPoint

Ask:

- What information are we going to show on this graph? (planet vs diameter)
- Shall we use columns or mark points on the graph? (columns)

Ask the children to draw a bar chart to show the different diameters of the planets.
Use *Slide 3* to check your bar chart.

Tell the children:
Bar charts are great for comparing the sizes of different items or groups. They use discrete data (where there is no halfway point between groups e.g. there is no halfway point between people who like gerbils and people who like dogs).

Line graphs show patterns in continuous data. Halfway points can be identified in continuous data (e.g. time – the halfway point between 10am and 11am is 10.30am).

MAIN ACTIVITY

Tell the children:
Uranus was the furthest planet from the Sun that had been discovered at the time of Caroline Herschel. But exactly how far away was it?

This question is not easy to answer! The planets orbit the Sun because they are pulled towards the Sun by the Sun's gravity and yet they are moving forwards all the time. This forward and sideways motion combines to create a path that runs in a loop around the Sun – an orbit. But the orbit of each planet is not necessarily circular. They are in fact elliptical. A perfect circle is a very special kind of ellipse and a circular orbit is rare.

Show Slide 4

Watch:
https://www.youtube.com/watch?v=Jxri2rBqs-U

Look closely at the shape of each orbit. At some points on that orbit, the planets are closer to the Sun than at others. So, we will take the average of the closest point and the furthest point from the Sun.

Table showing the distance of each planet from the Sun.

Planet	Closest (million km)	Furthest (million km)	Average (million km)
Mercury	46	70	57
Venus	107	109	108
Earth	147	152	150
Mars	205	249	228
Jupiter	741	817	779
Saturn	1,350	1,510	1,430
Uranus	2,750	3,000	2,880

Show *Slide 5 of the PowerPoint.*

Ask:

- How would you plot this data to compare the distances of each planet from the Sun?

The data is discrete, so it requires a bar chart. Ask the children to draw a bar chart to show this data.
Use *Slide 6* to check your bar chart.

EXTENSION

Use all three columns of data – closest, furthest and average, to plot a bar chart.
You could also extend this task by only supplying the closest and furthest data so that the children have to calculate their own average.

Tell the children:
Uranus was much further away from the sun than the other planets which is what made it impossible to see with the naked eye.

REVIEW

ALL: Children will be able to draw a bar chart and know that Uranus is a large planet which is far away.
MOST: Children be able to identify that this is discrete data so it is best shown on a bar chart.
SOME: Children will be able to show three different sets of data on one chart and know that a circle is a special kind of ellipse.