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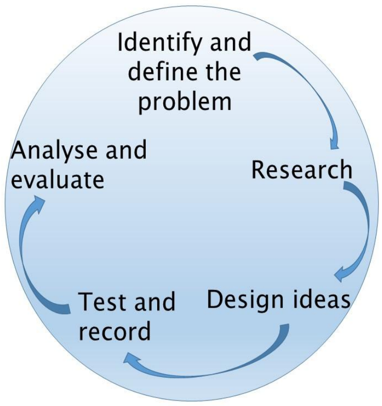
2. Download the file and **save** it as Project Name _Your Name e.g. Going for Gold_Joe Bloggs
   It is really important you do this otherwise none of your input will be saved.
3. Fill in your answers in the text boxes
4. Where there are image boxes take photos/scans of your work and upload the picture file. If you cannot do this upload the pictures as separate files and save them as Project Name_Your Name_Image number e.g. Going for Gold_Joe Bloggs_Image 1
5. Save your work as you go along
6. When you have finished email/upload as your teacher has instructed.

Making an Orrery – Student Booklet

The Challenge

The Science technician has been clearing out the storeroom and has come across an old orrery that shows the planets of the Solar System and Earth's moon. The planets spin around the Sun at different rates, and are different sizes, however, this model is not very accurate. You have been asked to investigate how to make this more accurate so you can build your own orrery.



Background Information

There are eight planets in the Solar System; Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. The planets all rotate around the Sun in a (semi) circular motion known as an orbit. The time taken for each planet to orbit the Sun is different, this is called the planet's orbital period. The planets also have days of different lengths (how long the planet takes to rotate on its axis). Each planet is a different size. Scientist try to model the relationship between the planets using models known as orreries.

Figure 1. An orrery

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Making an Orrery – Student Booklet

Background Research

1. How long does it take the Earth to rotate on its axis?

Suggested site: https://www.solarsystemscope.com/spacepedia/earth/orbital-and-rotational-characteristics-of-earth

2. How long does it take the Earth to revolve around the Sun?

Suggested site: https://geography.name/the-earths-revolution-around-the-sun/

3. How long does it take the moon to revolve around the Earth?

Suggested site: https://www.space.com/24871-does-the-moon-rotate.html

4. Complete the table below:

Planet	Orbital period (length of one year in Earth days)	Distance from the Sun (10^6 km)
Mercury		
Venus		
Earth		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		

Suggested site: https://nssdc.gsfc.nasa.gov/planetary/factsheet/

5. Which planets are known as gas giants?

Suggested site: https://www.space.com/30372-gas-giants.html

6. Which force keeps the planets orbiting the Sun?

Suggested site: http://curious.astro.cornell.edu/about-us/57-our-solar-system/planets-and-dwarf-planets/orbits/243-why-do-the-planets-orbit-the-sun-beginner

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7. Does the Sun rotate? If so, how long does it take to rotate?

Suggested site: https://www.livescience.com/32894-does-the-sun-rotate.html

8. What might be a problem with modelling the rotation of the Sun and the gas giants?

Suggested site: https://www.livescience.com/32894-does-the-sun-rotate.html

9. Draw and label a diagram to show the position of the Earth, Sun and Moon during a lunar eclipse. Attach this as a separate file or insert below.
   Suggested site: https://solarsystem.nasa.gov/moons/earths-moon/lunar-phases-and-eclipses/

10. Draw and label a diagram to show the position of the Earth, Sun and Moon during a solar eclipse. Attach this as a separate file or insert below.
    Suggested site: https://www.timeanddate.com/eclipse/solar-eclipse.html

Making an Orrery – Student Booklet

Mathematical Modelling

Objective

To compare the orbital period and diameter of different planets and discuss the difficulties you might face in creating an orrery to scale.

The distance between the Earth and the Sun is known as one Astronomical Unit (AU). This distance is about 1.5×10^8 km. Complete the table below to compare planets in our Solar System.

Planet	Distance from Sun to planet (km)	Distance from Sun to planet (AU)
Earth	150,000,000	1
Mercury		0.39
Venus		0.72
Mars		1.52
Jupiter		5.2
Saturn		9.54
Uranus		19.2
Neptune		30.06
Earth to Moon		0.00257

2. Below is a table showing the distances for a scale model of the Solar System, if a scientist used the distance from the Earth to the Sun as 10cm.

Planet	Distance from Sun (cm)
Earth	10
Mercury	3.9
Venus	7.2
Mars	15.2
Jupiter	52
Saturn	94.5
Uranus	192
Neptune	300

Earth to its Moon = 0.02 cm

3. What would be difficult about building an orrery of our Solar System to scale?

4. The planets range greatly in size. Below is a table giving the diameter of each planet.

Planet	Diameter (km)
Earth	12,926
Mercury	4,875
Venus	12,104
Mars	6,787
Jupiter	142,796
Saturn	120,660
Uranus	51,118
Neptune	48,600
The Sun	1,390,000

Earth's Moon = 3,474

5. Calculate how many times bigger the Sun is compared to each planet to complete the table below. Some examples have been completed for you.

Planet	How many times bigger the Sun is in diameter
Earth	1,390,000/12,926 = 107.5 (diameter of Sun/diameter of Earth)
Mercury	1,390,000, / 4,875 = 285.1
Venus	
Mars	
Jupiter	
Saturn	
Uranus	
Neptune	
Earth's Moon =	

6. A student decided to use an exercise ball to represent the Sun in their model. The ball had a diameter of 1.5m (or 150cm). If they were to make the planets to scale calculate how big each planet would be and suggest an item they could use to represent each planet.

Planet	Model size (cm)	Suggested item
Earth	150/107.5 = 1.4	A marble
Mercury	150/285 = 0.5	A dried pea
Venus		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		
Earth's Moon =		

Timing the Turns

Objective

To compare the length of days and years of planets and consider how this could be represented in a model.

The Earth takes 24 hours to complete one rotation on its axis, this is known as an Earth day.

1. Complete the table below to compare the length of a "day" on other planets.

Planet	Period of rotation (hours)	Period of rotation (Earth days)
Earth	24	1
Mercury	1,408	1,408/24 = 58.7
Venus	5,832	
Mars	25	
Jupiter	10	
Saturn	11	
Uranus	17	
Neptune	16	

The Earth takes 365 days to complete one revolution around the Sun, this is known as a year.

2. Complete the table below to compare the length of one year on other planets. Some examples have been done for you.

Planet	Orbital period (Earth days)	Orbital period (Earth years)
Earth	365	1
Mercury	88	88/365 = 0.2
Venus	225	
Mars	687	
Jupiter	4331	
Saturn	10,747	
Uranus	30,589	
Neptune	59,800	

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3. Do you notice any relationship between the length of year (orbital period) and the distance of the planet from the Sun?

4. If you made an orrery and it took the Earth 1 minute to revolve around the Sun, how long would it take each of the other planets?

Planet	Time taken to revolve around Sun (min)
Earth	1
Mercury	
Venus	
Mars	
Jupiter	
Saturn	
Uranus	
Neptune	

Designing an Orrery

Objective

To design an orrery that shows the Earth and its moon orbiting the Sun.

Step 1. Research some designs for orreries and discuss their strengths and weaknesses. Consider factors such as ease to build, materials used, time taken to revolve and scale.

Website	Strengths	Weaknesses

Step 2. Draw a plan view for your own orrery. Ensure you add a scale and detail the materials you would use. Attach this as a separate file.

Step 3. Provide a list of materials required to build your orrery.

Step 4. Write a method for how you will build your orrery, ensuring that you have taken safety into account and explained how you will minimise any hazards.

	Method steps	Hazards	Precautions
1			
2			
3			
4			
5			
6			
7			

Step 5. Show your method, equipment list and design to your teacher to get feedback and make any necessary changes.

Step 6. Once you have gained your teacher's permission you can build your orrery.

Step 7. Compare your finished orrery to your design and method to evaluate.

a) How different is your design to your actual model?

b) Did you follow your method, or did you have to add in extra steps? If so, rewrite your method so that somebody else could produce your design.

	Method steps	Hazards	Precautions
1			
2			
3			
4			
5			
6			
7			

c) What are the strengths and weaknesses of your final model?

Strengths	Weaknesses

d) If you could make any changes to your model what would they be and why do you think that they would improve the model?

Changes	Why would they improve the model?

Insert a photo of your orrery below or attach as a separate document

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