Making an Orrery - Teacher Resource

Intended Use of Resources

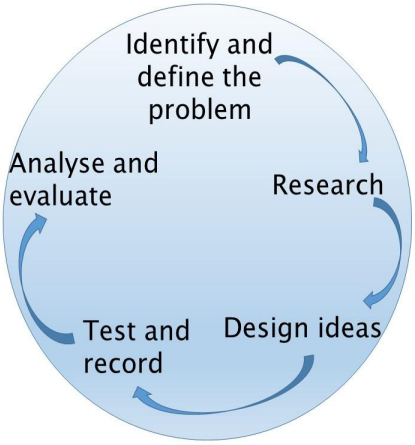
This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

There are three **student workbooks - Open, Guided and Scaffolded,** that go along side this resource; all have the same suggestions for activities, however they have been written and edited to provide differentiated learning options to support good teaching practice**.** Teachers may pick and choose which versions they give which students and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open-ended investigation then you could just give the students the challenge and background information section of the Student Workbook.

The Woodside Australia STEM Project aims to be accessible and supportive for teachers and students, please contact us if you have questions, require assistance or would like to arrange an incursion or a professional development workshop – www.wasp.edu.au

The Student 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.



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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.

The main problem with orreries is that the size difference between planets and distance of orbits is so vast that it is very difficult to model to scale.

Useful websites

- These YouTube Videos are an excellent demonstration of the scale of the Solar System: https://www.youtube.com/watch?v=zR3Igc3Rhfg and https://www.youtube.com/watch?v=TKSDp8xdgoQ
- This animation is also an excellent resource to show the scale of the universe (note: you will need to download this program to view it): http://www.htwins.net/scale2/
- This poster could be useful to print out to put on the wall of the classroom https://nineplanets.org/the_sun.jpg

Activities

This booklet contains extra information on each activity, including syllabus links the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links*.

The syllabus links have been colour coded. These links to the Australian Curriculum are also relevant to the Western Australian Syllabus. – Please see the colour key below:

Covered in Scaffolded, Guided and Open Student Booklet
Covered in Guided and Open Student Booklet
Covered in Open Student Booklet
Italics – WA syllabus for DT and D and T

List of Activities

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Background Research

Objective

Students will learn some key terms and become more familiar with the scale of the Solar System. They will find out more about the Earth – moon relationship, and what causes lunar and solar eclipses. Students will research the orbital periods of different planets and should observe that the further they are from the Sun the longer the orbital period. They will learn that gravity keeps the planets orbiting the Sun, and that the Sun rotates.

	Australian Syllabus Links
Science	ACSSU115 Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon.
Technologies	ACTSIP025 Explore how to acquire data from a range of digital sources.
Mathematics	ACMNA149 Investigate index notation and represent whole numbers as products of powers of prime numbers ACMNA156 Round numbers to a specified number of decimal places

Useful websites

- This NASA website gives a table of information about planets: https://nssdc.gsfc.nasa.gov/planetary/factsheet/
- Information and tables about the planets of the Solar System: https://www.enchantedlearning.com/subjects/astronomy/planets/
- Crash course on astronomy and an explanation of eclipses: https://www.youtube.com/watch?v=PRgua7xceDA
- Short video from ESA explaining the difference between a solar and lunar eclipse: https://www.youtube.com/watch?v=SczY9FtfhNw

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Mathematic Modelling

Objective

Students compare the orbital period and diameters of different planets and discuss the difficulties in creating an orrery to scale.

Students will learn that the planets of the solar system vary greatly in size and orbital period. They will realise that making a model solar system to scale will involve using a wide variety of objects of different sizes. They may discuss why most model solar systems are not made to scale or have only the orbital distance to scale or only the diameters to scale rather than both factors.

	Australian Syllabus Links
Mathematics	ACMNA149 Investigate index notation and represent whole numbers as products of powers of prime numbers ACMNA156 Round numbers to a specified number of decimal places ACMNA173 Recognise and solve problems involving simple ratios.

Useful Websites

- Information and tables about the planets of the solar system: https://www.enchantedlearning.com/subjects/astronomy/planets/
- Video showing a group of people making a model of the Solar System to scale: https://www.youtube.com/watch?v=zR3Igc3Rhfg

Timing Turns

Objective

Students will compare the orbital periods of planets and their periods of rotation and discuss how this could be modelled.

Students will find that the planets all have different day lengths and should notice that there is no relationship between the length of day and distance from the Sun or size of the planet. They will notice that there is a relationship between the length of a year and the distance from the Sun (the greater the distance the longer the orbital period). The length of the orbital periods for the gas giants is so great it would be very difficult to create a model which showed the planets moving at a scaled speed in relation to another – even if the inner planets moved very fast; Neptune for example will take around 170 x longer to spin around the Sun. This means if a model was made where the Earth took 10 seconds to rotate around the Sun, Neptune would take nearly half an hour to complete one orbital period. This would also mean that if the time was kept to scale an Earth day would take around 0.03 seconds. This would be very difficult to create as a model.

	Australian Syllabus Links
Science	ACSIS133 Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate. ACSIS129 Construct and use a range of representations including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies.
Mathematics	ACMNA149 Investigate index notation and represent whole numbers as products of powers of prime numbers ACMNA156 Round numbers to a specified number of decimal places ACMNA155 Express one quantity as a fraction of another, with and without the use of digital technology ACMNA173 Recognise and solve problems involving simple ratios.

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Useful websites:

- This website has plotted the years of planets on a graph to give a good visual representation of how long each planet's year is:
  https://space-facts.com/orbital-periods-planets/
- This website is very useful if you want to work on graphing and ask students to plot the length of day on different planets:
  https://spaceplace.nasa.gov/days/sp/

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Designing an Orrery

Objective

Students will complete a design process, and independently design and build an orrery. This activity could either be completed by students making a physical model, or they could use a programme on the computer which shows the Earth-Moon-Sun system (a digital system could be made to scale more easily).

In this activity students will first compare and critically evaluate models which have already been created before designing their own Sun-Moon-Earth orrery. Students will consider what object they can use to keep the model to scale, and also what diameter the obits of the Earth and Moon need to be to keep them to scale. Most students will probably decide that it is not viable to make the model to scale, however, it is quite simple to make the moon rotate around the Earth 13 x in the time it takes the Earth to rotate around the Sun by simply using a circle which has a circumference 13 x smaller.

Students create their own plan, ensuring they have stated safety precautions and compiled a list of equipment they will need.

When they have made their model, they complete the design cycle by evaluating their model, this may involve comparing theirs with those made by other students.

	Australian Syllabus Links
Science	ACSIS133 Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate. ACSIS129 Construct and use a range of representations including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies. ACSSU115 Predict phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and moon.
Technologies	ACTDEK031 The use of motion, force and energy to manipulate and control electromechanical systems WATPPS41 Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology. WATPPS43 Safely make solutions using a range of components, equipment and techniques.

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	Australian Syllabus Links
Mathematics	ACMNA173 Recognise and solve problems involving simple ratios.

Useful websites

- This video shows how to make a basic Sun- Earth – Moon system orrery: https://www.youtube.com/watch?v=ndE8gGbEB18
- This video is another simple design for a Sun – Earth- Moon system orrery https://www.youtube.com/watch?v=iCHFNlEoFII

Bibliography

(Figure numbers from scaffolded booklet)

Figure 1: Drawing with Numbers, Orrery Remix, accessed at http://drawingwithnumbers.artisart.org/tag/orrery/, on 15/05/19