Welcome to Operation: Goldilocks!

This document outlines a three-lesson teaching sequence designed to explore the planets in our solar system and beyond.

Learning outcomes are framed around how we use measurement, scale, coordinates and other scientific data to describe and explore the planets within our universe.

How to use this resource

The lesson sequence takes place over the following activities:

1. Planetary Puzzle
2. Goldilocks and the Bear-able Planets [**virtual excursion**]
3. Exoplanet Explorers

Adapt and use the resources provided to deliver a short planetary science unit in your classroom!

Teacher Brief 1: Planetary Puzzle (45 min)

IN CLASS, TEACHER LED.
Pre-Mission Lesson

This activity is designed to give students an introductory glimpse into the solar system, and get them thinking about ideas around scale and size.

Students will play the role of planetary data scientists and use mathematics to represent the size of the planets in different ways. 'Mission Cards' with different Mathematical challenges are highly differentiable for different student groups.

Introduction

"The Earth is a very small stage in a vast cosmic arena." – Carl Sagan (1994)

Though this quote dates back to over 30 years ago, it rings true today. Our solar system is just one of billions within the Milky Way, and our galaxy is one of potentially trillions in the observable universe.

What lies beyond Earth's atmosphere is much larger than any tools we previously developed to measure things here on our planet. In this lesson we will explore the planetary neighbours that make up our solar system, and discover how we can measure and describe them Mathematically.

Learning Objectives

- Explore units of measurement appropriate for the scale of space science.
- Think mathematically about the dimensions of planets (e.g. ascending order of size, perform calculations using diameter and circumference of planets)
- Explore the sizes of planets relative to Earth.

Supplies

- Planetary Puzzle Supplementary Materials (bar graph templates, additional scaffolding)
- Planetary Scale Reference*

*Credit: NASA/JPL

Activity

Intro	5 min	Teacher Priming/Framing: What sorts of units to we use to measure big things? How do we illustrate really big things so that we can understand them properly? (e.g. maps)
Introductory Video Future program iterations may contain a bespoke video introduction to the activity.	10 min	[Solar System Introductory Video] Credit: National Geographic OR [This 5.9 km Solar System Model is Built to Scale] Credit: Julian O'Shea Note: The first video is more technical, whilst the second is more socially contextualised (planetary public art installation) and features an Australian creator. Choose accordingly!
Missions	30 min	Complete the **Mission Cards** located at the bottom of this document. You will need: • **Planetary Puzzle Supplementary Materials** (PDF) • **Planetary Scale Reference** (PDF)* Levels 1-3 range from low to high ability levels. Choose the most appropriate set of activities for your class! **Planetary Scale Data provided by NASA JPL.* Ideas for implementation: • Place each activity card in a different table or location around the room and have students move around as they complete them. • Allocate teams to complete the activities in, assigning points or rewards to each. **Additional Ideas for Extension:** Conduct this as an Excel/ICT task with cell formulae and digital graphing tools. Extend students further by introducing Scientific Notation to the activity.

Links to Numeracy General Capability

Number Sense and Algebra	
	Proportional Thinking (P 2-3) Representing ratios using diagrams, physical or virtual materials.
✓	**Interpreting Fractions (P 3-4)** Problem-solving with fractions, decimals, factors/multiples, and scale.
✓	**Number Patterns and Algebraic Thinking (P 7-8)** Interpreting a table of values to plot points on a graph. Using mathematical formulae to calculate values and solving worded problems involving variables.
✓	**Multiplicative strategies (P 7-8)** Solving multi-step problems involving multiplicative situations using appropriate mental strategies, tools and algorithms.
Measurement and Geometry	
✓	**Understanding Units of Measurement (P 5-9)** Recognising units are used to measure attributes of shapes, objects and events. Establishing the relationship between circumference and diameter of a circle.
	Positioning and Locating (P5) Use of Cartesian and Polar coordinate systems to locate the position of planets.
Statistics and Probability	
✓	**Interpreting and Representing Data (P 4-6)** Constructing numerical data displays and representations including graphs and tables. Analysing and interpreting patterns in graphical representations of data from real-life situations.

Other Curriculum Associations

	Science
✓	**Processing, Modelling and Analysing** Construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships. AC9S5I04 AC9S6I04 AC9S7I04 AC9S8I04
	Questioning and Predicting Develop investigable questions, reasoned predictions and hypotheses to explore scientific models and identify patterns. AC9S5I01 AC9S6I01 AC9S7I01 AC9S8I01
	Earth and Space Sciences (Year 6) Describe the movement of Earth and other planets relative to the sun. AC9S6U02
	Biological Sciences (Year 6) Investigate the physical conditions of a habitat and analyse how the growth and survival of living things is affected by changing physical conditions. AC9S6U01
	Chemical Sciences (Year 6) Explain observable properties of solids, liquids and gases (in the context of Terrestrial and Jovian planets). AC9S6U04

Mission Cards: LEVEL 1

Colour and cut out the Planets, then use the **Planetary Scale Data** to fill in their correct sizes. Arrange the planets in order from smallest to largest Diameter.

Use the **Planetary Scale Data** to fill in the Planetary Diameter Column Graph.

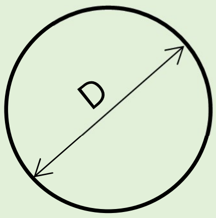
Colour in each bar the colour of the planet it represents!

Choose any planet that is not Earth. How many times would Earth fit across the diameter of that planet? e.g. "Jupiter is ___ Earths across."

For an extra challenge, pick another 'weird' object you could use to measure with (e.g. a Footy Oval, the Moon, or Australia!). How many of that object would fit across the diameter of your chosen planet?

Use the **Planetary Scale** data provided (NASA JPL) to calculate the circumference of each planet.

Diameter



Circumference = π x D

Mission Cards: LEVEL 2

Using the **Planetary Scale Data**, fill in the table of data for the planets <u>in order</u> from smallest to largest diameter.

Construct a <u>Column Graph</u> to display the **Planetary Scale** data provided (NASA JPL). The x axis should show the name of each planet, and the y axis should display the Diameter in Kilometres.

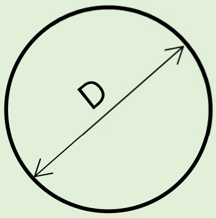
Colour in each bar the colour of the planet it represents!

Choose a planet that is not Earth. How many times would Earth fit across the diameter of that planet? e.g. "Jupiter is ___ Earths across."

For an extra challenge, pick another 'weird' object you could use to measure with (e.g. a Footy Oval, the Moon, or Australia!). How many of that object would fit across the diameter of your chosen planet?

Use the **Planetary Scale** data provided (NASA JPL) to calculate the <u>circumference</u> of each planet.

Diameter



Circumference = π x D

Mission Cards: LEVEL 3

Using the **Planetary Scale Data**, create a table of data for the planets <u>in order</u> from smallest to largest diameter.

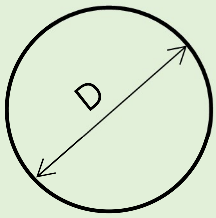
Construct a <u>Column Graph</u> to display the **Planetary Scale** data provided (NASA JPL). The x axis should show the name of each planet, and the y axis should display the Diameter in Kilometres.

Colour in each bar the colour of the planet it represents!

Choose a planet that is not Earth. Use your understanding of <u>Volume</u> and <u>Planetary Sizes</u> to estimate how many Earths could fit inside that planet.

Use the **Planetary Scale** data provided (NASA JPL) to calculate the <u>Surface Area</u> of each planet.

Diameter



Surface Area = $4 \times \pi \times \left(\frac{D}{2}\right)^2$

Teacher Brief 2: Goldilocks and the Bear-able Planets (45 min)

VIRTUAL SESSION - DELIVERED BY AUSTRALIAN SPACE DISCOVERY CENTRE
Please ensure virtual sessions are booked through Trybooking.
Email book@discover.space.gov.au for more info.

Interactive Lesson (Online)

This activity is designed to expand students' understanding of the Solar System, bringing in the dimension of **distances** between planets and introducing the concept of the 'Goldilocks Zone'. Students will get the chance to speak virtually with a Space Communicator, learn about planetary exploration, and create their own scale model of the solar system.

Introduction

This keystone session is delivered **virtually** by the Australian Space Discovery Centre via Microsoft Teams. A friendly Space Communicator from our education team will connect with your class through Microsoft Teams to deliver the lesson online.

- When joining the Teams meeting, please state your name and school so our team can check we are connecting to the correct group.

We've now explored the different sizes of the planets in our solar system; this lesson adds another level of depth to our measurement of the solar system, expanding students' understanding of **where** everything is. At this scale, distances become so large that we adopt new units – Astronomical Units (AU) will be used to describe the distance of planets from the sun and assist in creating a 'Pocket Solar System' out of paper.

Learning Objectives

- Understand that Astronomical Units (AU) are used to describe planetary distances.
- Recall that our solar system consists of Terrestrial (rocky), Gas and Ice planets
- Describe the 'Goldilocks Zone', and recall characteristics that make Earth suitable for supporting life.
- Create a scale diagram of planetary distances within our solar system.

Supplies and preparation

Please prepare your class prior to joining the session such that student workstations are set-up with all crafting materials and resources needed for the hands-on Pocket Solar System activity (details below).

- Computer (1 needed for class) with Microsoft Teams enabled
- Long strips of A3 paper (approx. 4-5 cm wide) – 1x per student
- Coloured Pencils/Pens
- Pocket Solar System Instructions (PDF)*

*Credit: National Informal STEM Education Network

Activity

Intro	10 min	Space Communicator (SC) introduction, overview of workshop and priming.
Tour on NASA Eyes	15 min	SC will give virtual tour of the solar system using NASA Eyes on the Solar System. Topics covered: • Overview – where are we? • Rocky, Gas, Ice planets • Size comparisons • Goldilocks Zone and habitability
Pocket Solar System Activity	15 min	SC will guide the class through creating a Pocket Solar System (*adapted from the US National Informal STEM Education Network).* Instructions located here or in download pack (see **Supplies**). Can be printed and placed on tables for students' reference. By the end, each student will have their own self-made model of the solar system!
Space Communicator Q&A	5 min	Any last burning space questions? SC will allocate time for Q&A before log-off.

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Measurement and Geometry	
✓	Understanding Units of Measurement (P 5-9) Recognising units are used to measure attributes of shapes, objects and events. Establishing the relationship between circumference and diameter of a circle.
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Statistics and Probability	
✓	Interpreting and Representing Data (P 4-6) Constructing numerical data displays and representations including graphs and tables. Analysing and interpreting patterns in graphical representations of data from real-life situations.

Other Curriculum Associations

	Science
✓	**Processing, Modelling and Analysing** Construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships. AC9S5I04 AC9S6I04 AC9S7I04 AC9S8I04
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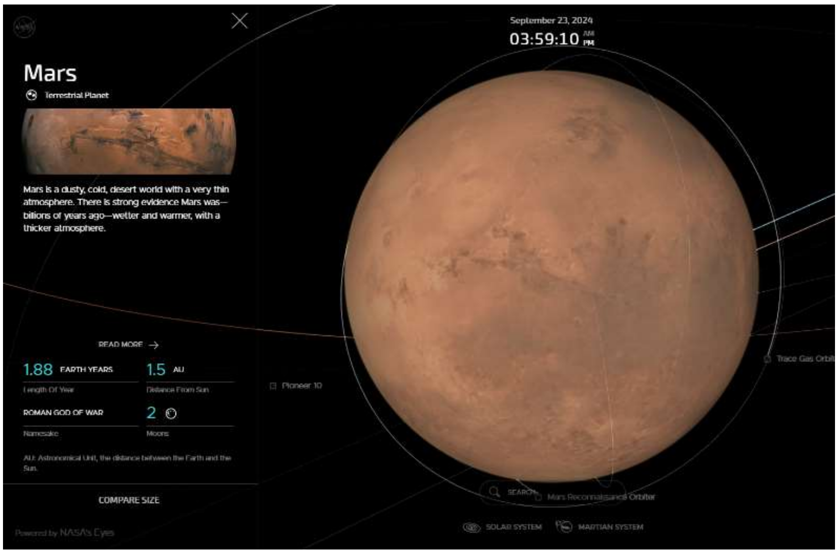
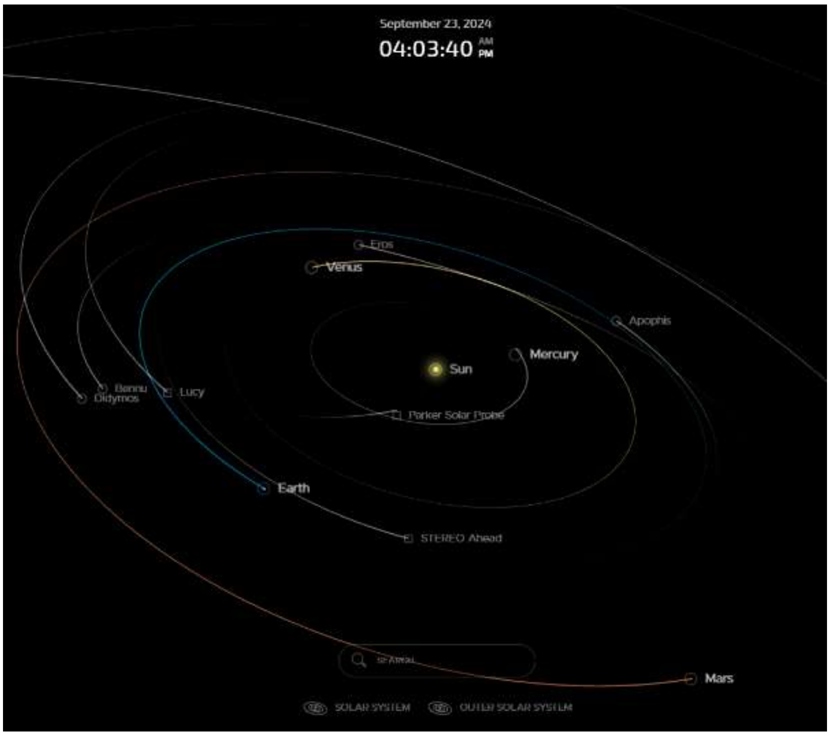
✓	**Earth and Space Sciences** (Year 6) Describe the movement of Earth and other planets relative to the sun. AC9S6U02
✓	**Biological Sciences** (Year 6) Investigate the physical conditions of a habitat and analyse how the growth and survival of living things is affected by changing physical conditions. AC9S6U01
✓	**Chemical Sciences** (Year 6) Explain observable properties of solids, liquids and gases (in the context of Terrestrial and Jovian planets). AC9S6U04

GALLERY


MERCURY
VENUS
SUN
EARTH
MARS
ASTEROID BELT
JUPITER
SATURN
URANUS
NEPTUNE
KUIPER BELT


September 23, 2024
03:59:10 PM
Mars
Terrestrial Planet
Mars is a dusty, cold, desert world with a very thin atmosphere. There is strong evidence Mars was—billions of years ago—wetter and warmer, with a thicker atmosphere.
READ MORE
1.88 EARTH YEARS
Length Of Year
1.5 AU
Distance From Sun
ROMAN GOD OF WAR
Namesake
2
Moons
COMPARE SIZE
SOLAR SYSTEM
MARTIAN SYSTEM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Eros
Venus
Apophis
Mercury
Sun
Bennu
Didymos
Lucy
Parker Solar Probe
Earth
STEREO Ahead
Mars
SOLAR SYSTEM
OUTER SOLAR SYSTEM

Teacher Brief 3: Exoplanet Explorers (45 min+)

IN CLASS, TEACHER LED.
Post-Mission Lesson

This activity is designed to extend thinking around planets beyond our solar system, imagining students as future planetary explorers deciding where to search for life. Students will also use coordinates to play 'Exoplanet Explorers', a game where they must find the locations of a classmate's exoplanets without seeing their map.

Introduction

Now that we have explored our own solar system, it's time to start thinking about other systems in our stellar neighbourhood. A planet that orbits around another star is known as an **exoplanet**. 'Exo' means *outside of*, which is why exoplanets are only found outside of our solar system.

At 4.2 Light Years away (that's around 26,000 AU), Proxima Centauri b is the closest exoplanet to us. It orbits Proxima Centauri, our closest neighbouring star.

There are likely **billions** more exoplanets in our galaxy; missions such as NASA's Kepler Space Telescope or TESS (Transiting Exoplanet Survey Satellite) have discovered thousands so far. Exoplanet scientists work to classify and determine whether these distant planets may contain the building blocks for life.

Learning Objectives

- Recall that exoplanets orbit stars beyond our solar system.
- Analyse and Evaluate scientific evidence about exoplanets' suitability to support life.
- Use coordinate systems to describe the location of exoplanets in a planetary system.

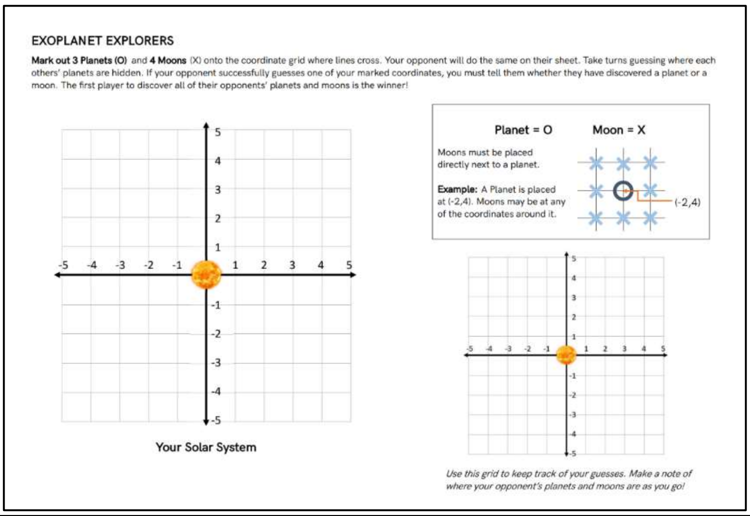
Supplies

- Icebreaker Activity Cards
- Exoplanet Explorers Gamesheet
- Counters/Tokens
  Optional – allows for gamesheets to be reused.

Australian Space Agency

Goldilocks ONLINE
Australian Space Discovery Centre

Activity

<table>
<tr><td>Intro</td><td>10 min</td><td>Recap previous lesson(s) and raise some questions:
- What is an exoplanet?
- Why might we want to discover and explore planets beyond our solar system?
- What should we look for in an exoplanet if we are searching for life or possible places to send humans?</td></tr>
<tr><td>Icebreaker</td><td>10 min</td><td>Introduce some well-known exoplanets through a group icebreaker. Students must decide in pairs or small groups about which exoplanet they think is best suited to support life.
Use Icebreaker Activity Cards slideshow.
Note: There is no correct answer to this activity! Students must exercise scientific evaluation skills to decide.</td></tr>
<tr><td>Game instructions</td><td>5 min</td><td>Select a template from Exoplanet Explorers Gamesheet to suit your class ability level.
Deliver game instructions (included on template).

</td></tr>
<tr><td>Exoplanet Explorers</td><td>20 min +</td><td>Students pair up and play Exoplanet Explorers game. Can be done in threes for rotating partner if odd numbers.
Note: Students will need to prop up books or laptops to shield their gamesheets from partners (exactly how one would play 'Battleships'!).</td></tr>
</table>

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