Lost in Space

FUTURE MAKERS TEACHER RESOURCE

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

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Contents

Workshop Overview

Within this 'out of this world' workshop, students explore how far we have come in travel and exploration, investigate the conditions on Earth, and look to the future to determine the perfect planet and shelter design for Australia's extra-terrestrial base. To conclude the workshop, students will study rocket design and then stomp their way into deep space with their paper stomp rockets.

This workshop has been structured using the 5E's instructional model.

The following topics and concepts are explored in each aspect of the workshop:

ENGAGE	Consider how human transportation has changed over time.
EXPLORE	Examine how technological developments impact our lives and the world.
EXPLORE **EXPLAIN**	Investigate the conditions that enable life on Earth.
ENGAGE **EXPLORE** **EXPLAIN**	Recognise the contribution of Aboriginal Australian's to astronomy.
EXPLORE **EXPLAIN** **ELABORATE** **EVALUATE**	Investigate and model how the positions of Earth and the Sun create our seasons.
EXPLAIN	Participate in a community of inquiry to discuss, 'Is space research important?'
EXPLAIN **ELABORATE**	Calculate and create a scale model of the solar system.
ELABORATE	Use research to justify where the first human colony should be built.
EXPLAIN **ELABORATE** **EVALUATE**	Investigate, design and construct a shelter to survive in the hostile conditions of another planet.
EXPLORE **EXPLAIN** **ELABORATE** **EVALUATE**	Use physics to create a rocket capable of travelling through the solar system.

ENGAGE

Transportation Through the Ages: Science as a Human Endeavour

Teacher Resource

Humans are constantly working to develop and improve our technology and understanding. In this introductory activity, students will begin to think about why innovative design and improvement is important to their lives and how we learn from the past to improve technology and understanding for the future.

In this activity, students first have one minute to record on sticky notes as many types of transport, or ways for getting from one place to another, they can think of. This will then develop into a community of inquiry as students discuss why new types of transport are developed.

Detailed step-by-step instructions can be seen below. It is recommended that you use these instructions to guide your students through the activity as a class. Use prompts in your discussions such as, 'Why do you think that?' and ask students to give reasons for their answers.

Transportation Through the Ages
Step-by-step Instructions

1. In groups of three, students have one minute to record onto sticky notes as many types of transport/ways of getting from one place to another as they can think of.
2. Groups take it in turns to read aloud one type of transport on their list. Students should listen carefully during this time and make a note of any responses on their list that are stated by another group (students should move these into a 'read' pile). Students should only read aloud responses that have not yet been stated by another group. You should continue to rotate between groups until the class has been through all responses.
3. Discuss with the class: Which transportation came first? Which was developed most recently?
4. Place a continuum line on the wall or floor with the oldest types of transport on one end and most recent types of transport on the other end.
5. In their groups, students place their transport sticky notes along the continuum, in order of oldest to most recent.
6. Facilitate a class discussion about this activity. Ask students: What do you notice? Were there any types of transport that you are not sure about? Are there any that you think should be rearranged?
7. Ask students to rearrange the order of the transport sticky notes from slowest to fastest. It is likely that very few will need to be moved.
8. Implement a Think-Pair-Share activity using the following questions: Why didn't many of the sticky notes move? What have you learned? Why do humans create new things? How do you think this has changed the world? We are always working to travel to places faster and to improve our technology. Why is this important?

Following this activity, you may wish to discuss why we are encouraged to walk and ride bikes now, rather than use cars and other modes of modern transport. Alternatively, you could extend this activity by asking students to invent a new type of transport based on those previously discussed. Students select a type of transport and then identify the features they would keep, improve or remove. Following this, students redesign the transport, while also considering the intended user and their needs. Students could even create a prototype, as a sketch, digital representation or physical object.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

YEAR 6

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

YEAR 7

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE121)

YEAR 8

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE136)

YEAR 9

Science as a Human Endeavour

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE158)

Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)

YEAR 10

Science as a Human Endeavour

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE192)

Values and needs of contemporary society can influence the focus of scientific research (ACSHE230)

Design and Technologies

YEAR 7 AND 8

Design and Technologies: Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures (ACTDEK029)

YEAR 9 AND 10

Design and Technologies: Knowledge and Understanding

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

General Capabilities

Critical and Creative Thinking

Inquiring: Identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Analysing, synthesising and evaluating reasoning and procedures

Ethical Understanding

Exploring values, rights and responsibilities

Cross-Curriculum Priorities

Sustainability

Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts (OI.8)

EXPLORE

Travel Times

Teacher Resource

Life would be very different today if we did not have modern transport. In this activity, students will use calculations to tell a story about how technological advances in transport have changed the world.

One story of change over time is the relationship between two Australian heroes – Dr Andy Thomas and Sir Charles Kingsford Smith. When Sir Charles Kingsford Smith piloted the first trans-Pacific flight from America to Australia it took 83 hours and 38 minutes, and it had to be completed in three stages. Today, many trans-Pacific flights depart Brisbane airport every day. These flights can take as little as 12 hours to reach their destination.

Sir Charles Kingsford Smith's flight was a worldwide sensation, dominating news at the time and opening up a new way to travel across the Pacific. Being the first to safely complete this journey was a significant achievement, and Sir Charles Kingsford Smith has had many landmarks named after him, including Kingsford Smith Airport in Sydney and Kingsford Smith Drive in Brisbane. Andy Thomas was also a pioneer, becoming Australia's first member of NASA's elite astronaut corps. He honoured the great Sir Charles Kingsford Smith by carrying the aviator's watch during his mission on the space shuttle Discovery.

A single watch is not the only thing that connects these explorers – without invention, the advancement of technology, and brave people willing to try new things, humans would never have taken to the sky, let alone flown across the Pacific or into space.

In this activity students are required to calculate the time it would take for humans to travel long distances through different modes of transport. They will then analyse the impact of these technological developments. Students may use their knowledge, and additional research as required to answer the question: 'How has this development changed the world?' You may wish to prompt student answers and facilitate discussions, for example, what is the advantage of walking upright (bipedalism)? How does flying between countries affect the way we live, and society as a whole?

Life would be very different without the development of new technologies and advancement over time. We would not be able to reach many of the places we are currently able to or do many of the things that are now part of our daily lives.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

YEAR 6

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

YEAR 7

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE121)

YEAR 8

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE136)

YEAR 9

Science as a Human Endeavour

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE158)

Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)

YEAR 10

Science as a Human Endeavour

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE192)

Values and needs of contemporary society can influence the focus of scientific research (ACSHE230)

Design and Technologies

YEAR 7 and 8

Design and Technologies: Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures (ACTDEK029)

YEAR 9 and 10

Design and Technologies: Knowledge and Understanding

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Numeracy

Estimating and calculating with whole numbers

Using spatial reasoning

Travel Times

Student Activity

On December 17, 1903, Wilbur and Orville Wright invented the first successful airplane, making four brief flights near Kitty Hawk, North Carolina. Once the Wright brothers demonstrated that the basic technical problems of flight had been overcome at the beginning of the 20th century, military and civilian aviation developed quickly. Just 66 years later, Commander Neil Armstrong and pilot Buzz Aldrin landed the Apollo Lunar Module *Eagle* on the moon on July 20, 1969.

Humans are always working to travel places faster and improve our technology. We can now build rockets and fly into space, something that even 100 years ago humans only dreamed of! What new frontiers will be explored this century?

Going to Space

When rockets are launched into space the mass of the rocket is really important. If a rocket is too heavy it will not be able to blast off from the ground. This means every item the rocket is built from and every item that is taken into space, including an astronaut's possessions, must be chosen very carefully.

In March 2001, Australian-born astronaut Dr Andy Thomas undertook his third space mission STS-102, aboard the space shuttle Discovery, to the International Space Station (ISS). Andy Thomas took special Australian artefacts into space during the mission, including a watch worn by Queensland aviation hero Sir Charles Kingsford Smith during a number of historic flights. Why did Andy Thomas decide to take this object with him?

Sir Charles Kingsford Smith wearing his watch
Image credit: State Library of Queensland.

Andy Thomas.
Image credit: Andy Thomas/NASA

First Trans-Pacific Flight

During the First World War, Sir Charles Kingsford Smith was a lieutenant and flying instructor in the Royal Flying Corps. He served in Gallipoli, Egypt and France. In 1928 Kingsford Smith piloted a three-engined Fokker Plane, the *Southern Cross*, in the first trans-Pacific flight from the United States of America to Brisbane, travelling with Australian Charles Ulm and two American crewmen. This flight took 83 hours and 38 minutes. They also had to stop twice to re-fuel!

The Southern Cross flown by Sir Charles Kingsford Smith on the first trans-Pacific flight.
Image credit: State Library of Queensland

The watch, seen in the portrait of Kingsford Smith, was worn as he flew 11 585 kilometres from California to Brisbane, completing the first successful trans-Pacific flight. Just over 70 years later in March 2001, it travelled 8.5 million kilometres with Andy Thomas into space. This piece of Australian history can be seen in the Queensland Museum's collection.

Part of the Queensland Museum's collection since 1975, the watch was loaned to Andy Thomas for the ISS mission in 2001. The back of the watch is engraved to commemorate two of Kingsford Smiths historic flights.
Image credit: Queensland Museum, Peter Waddington

1. Considering this information, why do you think Sir Charles Kingsford Smith's watch was important to Andy Thomas?

2. How long would it take different types of transportation to:
   - Travel this distance today?
   - Travel the average distance of 384 400 km the Moon?

Speed of different types of transport

Transport	**Average Speed (km/h)**	**Travel Time from Brisbane to California** 11 585 km	**Travel time to the Moon** 384 400 km	**How has this changed the world?**
Walking	5			
Ship	25			
The Southern Cross – Sir Charles Kingsford Smith's plane	138			
787 Dreamliner Aircraft	903			
International Space Station	27 500			

3. How would your life be different if technology had not improved human transportation?

4. Conduct research to predict how space travel will change between today, and when humans reach Mars.

5. Astronauts are assigned 0.682 kg (1.5 lbs) to carry personal items on Space Shuttle missions. This Personal Preference Kit (PPK) does not include day-to-day clothing and must fit in a container approximately 12.82 centimetres x 20.51 centimetres x 5.13 centimetres (5” x 8” x 2”). What items would you take to space?

EXPLORE – EXPLAIN

It's Alive: Conditions on Earth

Teacher Resource

Life has adapted to survive in the specific conditions found on Earth; but what are the conditions that enable life to survive on Earth?

The distance between the Earth and the Sun and the mass and temperature of the Sun are critical in sustaining life. The Earth is located in the 'Goldilocks Zone' – the habitable zone around a star where the temperature is not too hot and not too cold. This temperature allows water to exist as a liquid and provides the perfect conditions for the existence and survival of life on Earth. However these conditions are not all constant; some differ across the globe and are always changing.

In this activity, students will investigate and measure the conditions of their planet. They will explore temperature and gravity, specifically the temperature of the environment, the weight of 2L of water and how high they can jump. Students will also discuss how some conditions on Earth are constant, while other conditions regularly change, and how living things have adaptations to survive these changes.

This activity can be organised around the room as stations. Students move between the four stations in groups, and then complete the KWL (Why does life exist on Earth when we have not found life on other planets?) to synthesise their learning.

Station 1:
Temperature

Station 2:
Weight of Water (gravity)

Station 3:
Jump Height (gravity)

Station 4:
Needs of Living Things Brainstorm

Concluding activity:
KWL (Why does life exist on Earth when we have not found life on other planets?)

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science Inquiry Skills

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 6

Science Understanding

The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

Science Inquiry Skills

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS104)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

YEAR 7

Science Understanding

Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)

Science Inquiry Skills

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

General Capabilities

Numeracy

Using measurement

Using spatial reasoning

Critical and Creative Thinking

Analysing, synthesising and evaluating reasoning and procedures

Cross-Curriculum Priorities

Sustainability

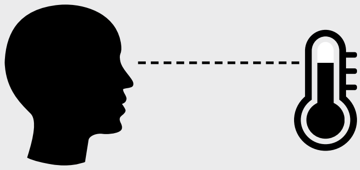
The biosphere is a dynamic system providing conditions that sustain life on Earth (OI.1)

It's Alive: Conditions on Earth

Student Activity

Record the conditions of your planet.

TIP: When reading a thermometer, ensure your eyes are level with the measurement – looking from an angle can cause **parallax error** where the measurement appears different to the true value due to the angle of view.



Temperature

1. Place a thermometer outside in the shade.
2. Leave the thermometer for two minutes.
3. Record the temperature below.

4. Is the temperature on Earth always the same? Why/why not?

5. Is the temperature on other planets the same as Earth? Why/why not?

Weight of 2L of Water

1. Place a 2L bottle on a scale and tare the scale.
   (If you do not tare the scale, to find the weight of the water you will need to subtract the weight of the 2L bottle from the total weight.)
2. Using a large measuring cylinder, pour 2L of water into the bottle. Remember to keep your eyes level with the measurement to avoid parallax error.
3. Place the full bottle on the scale and measure the weight. Record the weight below.

Weight vs. Mass

Mass is the amount of matter in an object.

Weight is the amount of force acting on the mass due to gravity.

If you were on the Moon, there is less gravity than on Earth so you would weigh less, but your mass would be the same.

Floating in space your mass would be the same as on Earth and the Moon, however there is zero gravity. Can you calculate your weight in space?

4. Is the weight of 2L of water on Earth always the same? Why/why not?

5. Would 2L of water weigh the same on other planets? Why/why not?

Jump Height

1. Stand with your side to a wall.
2. With your feet flat on the ground, reach the arm closest to the wall as high as possible.
3. Mark the highest spot you can reach using chalk on your fingers or tape.
4. Place chalk or tape on your fingers again. From the same standing position, jump and touch the wall at the highest point of your jump.
5. Try three jumps and record the average.
6. Subtract your standing reach from your jumping reach to get your vertical jump.

Average Jump Height

Name:	Jump 1	Jump 2	Jump 3	Average
Jump Height (cm)				

7. Was your jump height approximately the same each time? Why/why not?

8. Would your jump height be different if you were standing in another location on Earth?

9. Would your jump height be the same on other planets?

Living Things

1. What do living things need to survive?

Survival in Different Environments (KWL)

1. Why does life exist on Earth when we have not found life on other planets?

What I **know**:	What I **wonder**:	What I **learned**:

ENGAGE – EXPLORE – EXPLAIN

Australians and the Sky

Teacher Resource

Most people have heard of Stonehenge, however have you heard of Wurdi Youang? Wurdi Youang is an Aboriginal stone arrangement in Victoria that aligns to the setting Sun at the equinox and solstice, while the major axis is aligned almost exactly east-west.

The egg-shaped arrangement of stones, built by the Wathaurong people before European settlement, consists of about 100 basalt stones from 0.2 m to 0.75 m in height. The whole arrangement has been estimated to weigh about 23 tonnes! Statistical tests have shown that this arrangement of stones lining up to significant astronomical events is unlikely to have occurred by chance. Instead they were intentionally aligned with the setting Sun on these significant dates, requiring careful observation and measurement. Wurdi Youang is possibly 5000 years older than Stonehenge; this could make Australian Aboriginal people the world's first astronomers.

Alignment of Wurdi Youang to summer solstice, equinox and winter solstice.
Image credit: Ray Norris and John Morieson, cc

You may wish to use Wurdi Youang and/or the ***Australian Space Agency Brand Animation*** as stimulus for a research task into Aboriginal astronomy.

Additionally, you can find out more about learning from observation and passing down knowledge by listening to the ABC Podcast, ***The science of the Dreamtime*** by Patrick Nunn on *Conversations with Richard Fidler*.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

YEAR 7

Science Understanding

Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)

Science as a Human Endeavour

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE223)

General Capabilities

Intercultural Understanding

Recognising culture and developing respect

Cross-Curriculum Priorities

Aboriginal and Torres Strait Islander Histories and Cultures

Aboriginal and Torres Strait Islander Peoples have holistic belief systems and are spiritually and intellectually connected to the land, sea, sky and waterways (OI.3)

The significant contributions of Aboriginal Peoples and Torres Strait Islander Peoples in the present and past are acknowledged locally, nationally and globally (OI.9)

EXPLORE – EXPLAIN – ELABORATE

Modelling the Seasons

Teacher Resource

In this inquiry-based activity, students will investigate how the tilt of the Earth's axis causes the seasons. This activity can be further modified by including measurements of the North Pole and South Pole. Black cardboard should be used for every point of measurement to increase the fairness of the experiment; this is because different colours absorb and reflect different wavelengths of light which would influence results.

If the experiment is not producing a measureable result, your light may not be producing enough heat. To increase heat on the world globe you could move the light closer to the world globe, or change the bulb. Heat lamps and incandescent bulbs produce the best result, followed by halogen lamps; higher wattage is preferable.

Light bulbs can get very hot. Do not leave the light on while unattended and remind students not to touch the light globes.

Thermochromic Globe

Another fantastic visual model includes using a colour changing globe. You can paint a globe with thermochromic paint which will change colour as it warms.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 7

Science Understanding

Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)

Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124)

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126)

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS129)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

General Capabilities

Critical and Creative Thinking

Inquiring: Identifying, exploring and organising information and ideas

Analysing, synthesising and evaluating reasoning and procedures

Modelling the Seasons

Student Activity

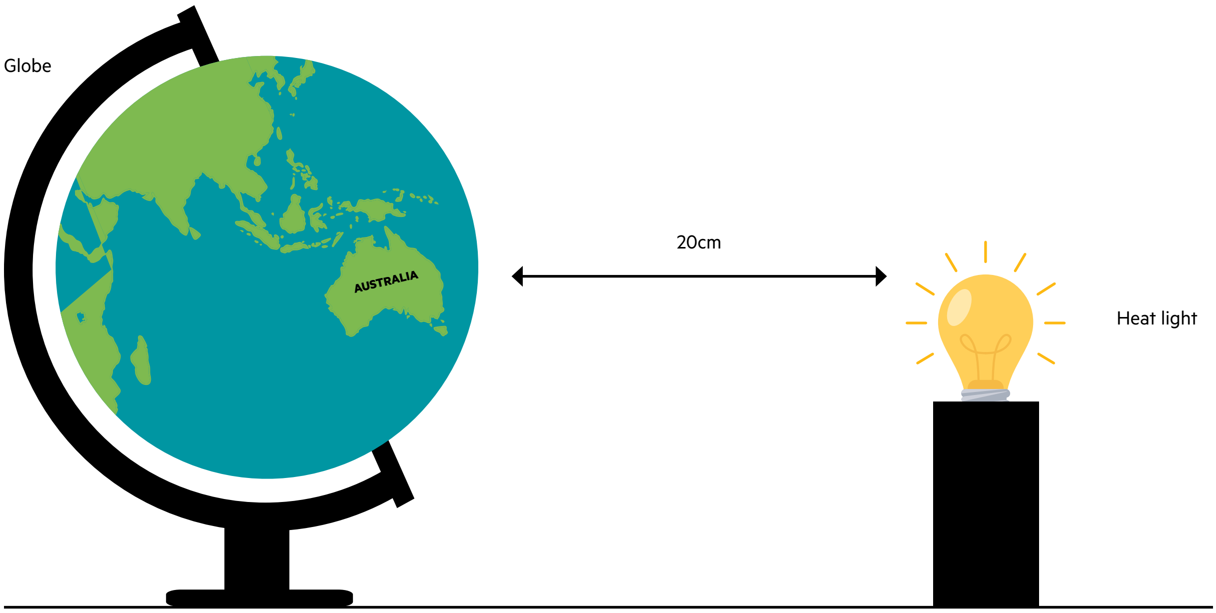
Australia is located in the Southern Hemisphere, to the south of the equator. How does this position affect our seasons?

Materials

- World Globe (25 cm diameter or larger)
- Infrared thermometer
- 2 x 2x2cm squares of black cardboard
- Heat light (some regular lamps may produce enough heat to conduct the experiment)

Method

1. Record the latitude and longitude of your location next to the (1) in the table below.
2. Place a 2x2 cm square of black cardboard over your location.
3. Place another 2x2 cm square of black cardboard over the corresponding location in the Northern Hemisphere. Record latitude and longitude next to the (2).
   (Note: You can search the exact location with the same longitude and corresponding positive latitude in the Northern Hemisphere by copying your coordinates into Google Maps and removing the negative sign before the latitude).
4. Using an infrared thermometer, measure the 'before' temperature of both locations and record them in the table.
5. Set up your world globe and light as shown below.



Modelling the seasons material set-up

6. Switch on the light and leave for 15 minutes. Ensure your location is directly facing the heat lamp.

7. Make a prediction. What do you think you will observe after this time period?

8. Record the temperature at both locations.

Results

Title

Location	Latitude	Longitude	Temperature	
			Before	After
(1)				
(2)				

1. Record observations.

Discussion

1. Discuss and explain the results. Was it as predicted? Why/why not?

2. What season/s does this represent? What else can you learn from this model?

3. Draw a labelled diagram explaining the location of Australia and the Sun during this season.

Opposite Seasons

Modify your model to represent the opposite season and repeat your experiment.

Title

Location	Latitude	Longitude	Temperature	
			Before	After
(1)				
(2)				

1. Record observations.

2. Discuss and explain the results.

3. What season/s does this represent? What else can you learn from this model?

4. Draw a diagram explaining the location of Australia and the Sun during this season.

5. How could your model be improved?

6. Based on this experiment, why does the South Pole experience polar night during the winter?

Create a poster to explain what you have learnt from this model. You may also wish to include:

- Why are the poles cold all year long?
- Why is the equator hot all year long?
- Why is it colder at night than during the day?

EXPLORE

Space Exploration: Community of Inquiry

Teacher Resource

In the following activity, students will participate in a community of inquiry to consider the implications of human space travel. This process gives students the opportunity to come to a full, shared understanding of the concepts and issues around human space travel.

The community of inquiry is a process of discussion where participants pose open-ended questions, listen to the viewpoints of others, and share their own ideas. Disputed or contestable issues and concepts are considered collaboratively within a supportive and respectful classroom environment. It is important that all participants reflect on their own thinking.

The following ways of working are used during the community of inquiry process. These should be put up on a wall for all students to refer to throughout the process.

- Listen attentively to others
- Build upon and connect ideas
- Have respect for others, yourself and place
- Disagree with respect and reason
- Many responses and opinions may be considered to be correct

Detailed instructions for this activity are below.

1. Commence with the following stimulus and prompt a class discussion of current developments in space travel:

   In 2018, Australia established a space agency. In 2019 China landed a spacecraft on the far side of the Moon, and a Japanese rover has collected samples from under the surface of the asteroid Ryugu, which will be brought back to Earth in 2020. The International Space Station (ISS) partners are committed to establishing a permanent human presence on the Moon in the next few years, and putting humans on Mars by the 2030s.

2. Students should discuss in small groups the overall question: Is space-related research important?

   Students can consider the following prompts and should give reasons for their answers:

   - The advantages/disadvantages of space travel
   - Our own impact on our planet
   - Any risks to individuals, society, our own or other planets
   - Other ethical and economic considerations

3. Now invite students to share their responses, while you note their answers on the whiteboard or butchers paper (a PMI chart is useful for this activity).

   If it isn't clear where a response fits, ask the students if they see it as an advantage or a disadvantage. If it is uncertain, record in the Interesting column.

4. Ask the students if there are questions they are still wondering about, and record in the Interesting Column.

   You can also ask if they think the advantages of space travel outweigh the disadvantages.

   Keep the PMI as a resource for use during the rest of the unit. You may want to ask these questions again at the end of the unit, as students may change their minds based on new information or understandings.

   A number of other questions you could use as prompts are:

   - Why do you think people have always been fascinated by space?
   - Why do you think people want to understand and explore space?
   - Do you think we should be spending a lot of money on space research?
   - Do you think space research is important?
   - Should humans be focused on travelling to Mars?
   - Why do you think returning to the moon and travelling to Mars is a goal of international space agencies?
   - How might artificial intelligence assist us to travel to Mars?
   - Would it be useful to discover life on planets other than Earth? Why do you think that?
   - If space travel can risk human safety, why do you think many people have expressed interest in becoming part of a colony/settlement on Mars?
   - How might the colonisation of Mars benefit our own planet?
   - Are there risks in putting a human colony on Mars? Could these be avoided?
   - Could sending humans into space impact on our connections to nature here on Earth?
   - What are the key ethical considerations around sending humans into space?
   - Would you be interested in travelling into space or colonising Mars? Why/why not?

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

YEAR 7

Science Understanding

Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)

Science as a Human Endeavour

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119)

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE121)

General Capabilities

Critical and Creative Thinking

Inquiring: Identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Personal and Social Capability

Social awareness

Ethical Understanding

Understanding ethical concepts and issues

Reasoning in decision making and actions

Intercultural Understanding

Interacting and empathising with others

Cross-Curriculum Priorities

Sustainability

Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts (OI.8)

Space Exploration – PMI Chart

Student Activity

What are the advantages (Plus) and disadvantages (Minus) of space research? In the Interesting column you may record anything that you find interesting or wonder about space research.

Plus	Minus	Interesting

EXPLAIN - ELABORATE

Modelling the Solar System

Teacher Resource

In this activity, students use fractions to create scaled model planets. Before beginning the activity, students should predict how big each planet will look in comparison to Earth. Students can draw their predictions in their books.

Depending on student ability and mathematics focus at the time, this activity can be modified by changing fractions into decimals or percentages. To simplify the activity, you could change fractions into equivalent fractions or tenths as a class before students build the planets.

Different methods can be used to measure the diameter of the model planets. Students can either hold a ruler against their models to estimate the diameter, cut the model in half and measure the diameter, or record the circumference of the model using string then divide the circumference by pi ($C=\pi d$).

Pluto is not a planet!

Science is constantly evolving with improved observation and understanding. An example of this change in understanding is Pluto. Pluto is no longer classified as a planet; instead it has been reclassified as a *dwarf planet*. Why? As telescopes and our space visualisation systems improved, scientists started to identify many (thousands) of objects in orbit past Neptune. While most of these *transneptunian objects* were smaller than Pluto, there were objects in orbit that were significantly larger than Pluto. These discoveries prompted scientists to ask, 'How do we define a planet?'

After much deliberation and consultation, in 2006 the International Astronomical Union (IAU) defined a planet as:

A celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit.

This resolution means that our solar system officially has eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. A new class of objects was also decided on – *dwarf planets* – which Pluto belongs to (along with others including Ceres and Eris).

Students may wish to research this decision further. For now, let's appreciate this definition because we only have to memorise 8 planets of our solar system, rather than thousands!

Teacher Answers

Teacher answers for this activity are provided below. There will be some variation in student answers due to inaccuracies while dividing the clay and measuring the size. This is to be expected and can be discussed with the class – students should know that they can be correct without getting the exact same answer.

Students may want to check their answers using the ***Exploratorium's Build a Solar System*** website. This allows students to input the size of the diameter of the Sun, and the corresponding planet sizes and distances are automatically calculated. This can also be used to help students decide on a more appropriate scale to show distances between the planets.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Mathematics

YEAR 5

Number and Algebra

Compare and order common unit fractions and locate and represent them on a number line (ACMNA102)

Investigate strategies to solve problems involving addition and subtraction of fractions with the same denominator (ACMNA103)

Describe, continue and create patterns with fractions, decimals and whole numbers resulting from addition and subtraction (ACMNA107)

YEAR 6

Number and Algebra

Compare fractions with related denominators and locate and represent them on a number line (ACMNA125)

Solve problems involving addition and subtraction of fractions with the same or related denominators (ACMNA126)

Find a simple fraction of a quantity where the result is a whole number, with and without digital technologies (ACMNA127)

Make connections between equivalent fractions, decimals and percentages (ACMNA131)

General Capabilities

Numeracy

Using fractions, decimals, percentages, ratios and rates

Estimating and calculating with whole numbers

Modelling the Solar System

Teacher Answers

1. Measure the diameter of each planet and place in the table below.

Diameter of Planets in the Solar System

Planet	Real-life Diameter (km)	Model Diameter (mm)
Mercury	4879	2
Venus	12 104	5
Earth	12 756	6
Mars	6792	3
Jupiter	142 984	65
Saturn	120 536	53
Uranus	51 118	21
Neptune	49 528	21
*Pluto	2302	1

2. Calculate the scale of your solar system.

a. My planet: Jupiter

b. Divide the real life diameter by the model diameter to find the scale.

$$\frac{\text{real-life diameter}}{\text{model diameter}}$$

$$= \frac{142\,984 \text{ km}}{65 \text{ mm}}$$

$$= \frac{2200 \text{ km}}{1 \text{ mm}}$$

$$= 1 \text{ mm} = 2200 \text{ km}$$

In the solar system, 1 mm represents 2200 km.

3. How big would the Sun be at this scale?

To find the size of the Sun in mm, divide the real-life diameter by the scale of 2200.

Diameter of the Sun: 1 392 000 km

$$= \frac{1\,392\,000}{2200}$$

$$= \frac{632.72}{1}$$

$$= 633 \text{ mm}$$

At this scale, the sun would be 633mm (or 63 cm) in diameter.

4. To create an accurate model the distances should be scaled in the same way as the model planets. Use the table below to determine the distance of each planet from the Sun at this scale.

Planet	Real distance from the sun (km)	Space for working out	Model Distance from Sun		
			mm	cm	m
Mercury	58 000 000	= 58 000 000 / 2200 = 26 364	26 364	2636.4	26.36
Venus	108 000 000	= 108 000 000 / 2200 = 49 091	49 091	4909.1	49.09
Earth	149 600 000	= 149 600 000 / 2200 = 68 000	68 000	6800	68
Mars	227 900 000	= 227 900 000 / 2200 = 103 591	103 591	10 359.1	103.59
Jupiter	778 600 000	= 778 600 000 / 2200 = 353 909	353 909	35 390.9	353.91
Saturn	1 433 500 000	= 1 433 500 000 / 2200 = 651 591	651 591	65 159.1	651.59
Uranus	2 872 500 000	= 2 872 500 000 / 2200 = 1 305 682	1 305 682	130 568.2	1305.68
Neptune	4 495 100 000	= 4 495 100 000 / 2200 = 2 043 227	2 043 227	204 322.7	2043.23
*Pluto	5 900 000 000	= 5 900 000 000 / 2200 = 2 681 818	2 681 818	268 181.8	2681.81

5. Is this an effective scale to show the distance between planets? Why/why not?

Teacher discretion – it would be difficult to see a model over 2 km!

6. Why do you think Pluto is no longer classified as a planet?

Teacher discretion.

Modelling the Solar System

Student Activity

In this activity you will use fractions to make scale models of the planets of the solar system. Before you begin, predict which planet is the largest and which is the smallest.

*(*Note: Pluto is classified as a dwarf planet, rather than a planet. It has been included in this activity as a comparison to the eight planets in the solar system.)*

Materials

- 500 g modelling clay
- Plastic knife
- Electronic scale
- Paper plate
- Labels for the planets of solar system
- Ruler

Method

1. Divide the clay into tenths.
   a. Use $\frac{3}{5}$ to make Jupiter, and place on label (continue to place planets on labels while working through the activity)
   b. Use $\frac{3}{10}$ to make Saturn
   c. Use the remaining clay $\frac{1}{10}$ in step 2.
2. Divide the remaining clay into tenths.
   a. Add $\frac{1}{2}$ to Saturn
   b. Use $\frac{1}{5}$ to make Neptune
   c. Use $\frac{1}{5}$ to make Uranus
   d. Use the remaining clay $\frac{1}{10}$ in step 3
3. Divide the remaining clay into fourths
   a. Add $\frac{3}{4}$ to Saturn
   b. Use the remaining clay $\frac{1}{4}$ in step 4
4. Divide the remaining clay into tenths
   a. Use $\frac{1}{5}$ to make Earth
   b. Use $\frac{1}{5}$ to make Venus
   c. Add $\frac{2}{5}$ to Uranus
   d. Combine the remaining clay $\frac{1}{5}$ to use in step 5

5. Divide the remaining clay into tenths
    a. Use $\frac{1}{10}$ to make Mars
    b. Add $\frac{2}{5}$ to Neptune
    c. Add $\frac{2}{5}$ to Uranus
    d. Use the remaining clay $\frac{1}{10}$ in step 6
6. Divide the remaining clay into tenths
    a. Use $\frac{7}{10}$ to make Mercury
    b. Add $\frac{1}{5}$ to Uranus
    c. Use remaining clay $\frac{1}{10}$ in step 7
7. Divide the remaining clay into tenths
    a. Add $\frac{9}{10}$ to Mercury
    b. Use the remaining clay $\frac{1}{10}$ to make Pluto

Questions

1. Measure the diameter of each planet and place in the table below.

Diameter of Planets in the Solar System

Planet	Real-life Diameter (km)	Model Diameter (mm)
Mercury	4879	
Venus	12 104	
Earth	12 756	
Mars	6792	
Jupiter	142 984	
Saturn	120 536	
Uranus	51 118	
Neptune	49 528	
*Pluto	2302	

2. Calculate the scale of your solar system.

   a. My planet: ______

   b. Divide the real life diameter by the model diameter to find the scale.

$$\frac{\text{real-life diameter}}{\text{model diameter}}$$

$$= \frac{\square}{\square}$$

$$= \frac{\square}{\square}$$

= ______

In the solar system model, ______ represents ______

3. How big would the Sun be at this scale?

To find the size of the Sun in mm, divide the real-life diameter by the scale of ______

Diameter of the Sun: 1 392 000 km

$$= \frac{\square}{\square}$$

$$= \frac{\square}{\square}$$

= ______

At this scale, the Sun would be ______ in diameter.

4. To create an accurate model the distances should be scaled in the same way as the planets. Use the table below to determine the distance of each planet from the Sun at this scale.

Planet	Real distance from the sun (km)	Space for working out	Model Distance from Sun		
			mm	cm	m
Mercury	58 000 000				
Venus	108 000 000				
Earth	149 600 000				
Mars	227 900 000				
Jupiter	778 600 000				
Saturn	1 433 500 000				
Uranus	2 872 500 000				
Neptune	4 495 100 000				
*Pluto	5 900 000 000				

5. Is this an effective scale to show the distance between planets? Why/why not?

6. Why do you think Pluto is no longer classified as a planet?

ELABORATE

Beyond Earth: Colonising Space

Teacher Resource

Humans have dreamt of colonising space for decades. While building a permanent human settlement in space poses huge biological, technological and economic challenges, there has never been a time in history where human knowledge, understanding and desire to colonise space has been greater. Today, human settlement in space is closer to becoming a reality than ever before, and your students could be some of the first humans to inhabit a planet other than Earth.

In this persuasive writing task, students determine where humans should create the first space colony, using prior learning and research to justify their decisions. This task could be presented as a video, podcast, multimodal presentation or written report. Students could work in pairs to complete this task.

Students should compare options and choose the planetary body they believe would best suit the needs of humans. This could include:

a) Atmosphere

b) Gravity

c) Availability of resources

d) Distance from Earth

Students may use the Future Makers planet posters to gather information about the planets in our solar system. If desired, students may also investigate the moons of our solar system when deciding where the first human settlement should be.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

English

YEAR 5

Literacy

Clarify understanding of content as it unfolds in formal and informal situations, connecting ideas to students' own experiences and present and justify a point of view (ACELY1699)

Identify and explain characteristic text structures and language features used in imaginative, informative and persuasive texts to meet the purpose of the text (ACELY1701)

Use comprehension strategies to analyse information, integrating and linking ideas from a variety of print and digital sources (ACELY1703)

Plan, draft and publish imaginative, informative and persuasive print and multimodal texts, choosing text structures, language features, images and sound appropriate to purpose and audience (ACELY1704)

General Capabilities

Literacy

Composing texts through speaking, writing and listening

Critical and Creative Thinking

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Beyond Earth: Colonising Space

Student Activity

Today, human settlement on another planet is closer to becoming a reality than ever before. You could be some of the first humans to inhabit a planet other than Earth. Where would you go?

In this persuasive task you should answer the question:

Where should humans create the first space colony?

You should choose the planet/moon you believe would best meet the needs of humans and justify your decision. In your answer you should also compare your chosen planet/moon to others in the solar system.

Your answer should consider:

a) Atmosphere

b) Gravity

c) Availability of resources

d) Distance from Earth

EVALUATE

Beyond Earth: Shelter from the Elements

Teacher Resource

In this activity, students develop a shelter to protect humans from the hostile conditions on other planets. Students should draw on their existing scientific understanding (for example, conductors and insulators), along with their understanding of the conditions of their chosen planet, to complete this activity. You may provide a selection of materials for students to choose from (e.g. foam, plastic, foil, metal, wood, glass), or students could select and source their own materials.

When constructing their shelters, students may wish to consider:

- Temperature and insulation
- Protection from radiation
- Protection from weather and the elements
- Living in low or high gravity
- Length of a day on the planet, and how to deal with prolonged light or darkness

Students may choose different methods to test their designs. For example, if the planet has high gravity students could investigate if their shelter will withstand pressure. A hairdryer and thermometer could be used to heat the shelter and investigate insulation. Students could spray their shelters with water to see if they leak or place materials in a dilute acid to see if it would withstand acid rain.

You may extend this activity by asking students to develop a settlement and describing not only how humans will survive, but how they could be self-sufficient (for example, accessing oxygen, water and food, or how they could access resources and travel to the planet with enough equipment to survive and solve future problems). For background research, students may wish to investigate how spacesuits are designed.

Teachers could also ask students to research and develop travel brochures to encourage people to travel to the chosen planet.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

Design and Technology

YEAR 5 AND 6

Design and Technologies: Knowledge and Understanding

Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use (ACTDEK023)

Design and Technologies: Processes and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (ACTDEP024)

Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025)

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions (ACTDEP026)

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

General Capabilities

Critical and Creative Thinking

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Beyond Earth: Shelter from the Elements

Student Activity

- **Investigate** the conditions of the planet you have chosen to colonise and compare these with the conditions on Earth.
- **Design** a shelter that will allow people to survive on this planet. Consider the properties of various materials in your design.
- **Create** a model of your shelter.
- **Test** the effectiveness of your shelter by simulating conditions with materials on Earth. What could you use to test the effectiveness of your shelter?
- **Refine** your shelter to improve on the original design.
- Present your shelter and results to the class.

1. Record the conditions that your shelter will need to withstand based on the conditions of your chosen planet.

2. Brainstorm the advantages of different construction materials in the given conditions

3. Draw a labelled diagram of your shelter, including reasons for design and selection of materials.

4. Test the shelter and record the results in the PMI Chart below.

Plus	**Minus**	**Interesting**

5. Recommend future changes that could improve the effectiveness of the shelter.

EXPLORE – EXPLAIN – ELABORATE – EVALUATE

Stomp Rocket Design Challenge

Teacher Resource

Students are tasked with designing and building a stomp rocket that can travel to a chosen planet. Students will follow the design-thinking framework to investigate relevant aspects of the design challenge.

Based on your school's STEM agenda, the *Stomp Rocket Design Challenge* can be incorporated into a lesson or two, or modified to become a cross-disciplinary project-based unit. A cross-disciplinary task will integrate the Australian Curriculum subjects of Science, Technologies and Mathematics to address the design challenge.

Building a Stomp Rocket Launcher

Materials

Plastic Soft Drink Bottle and Bike Tube

- 1 x empty 1 or 1.5 litre plastic soft drink bottle
- 1 x 1 metre bike tube
- 1 x 50cm PVC pipe, 2.5cm in diameter
- Utility knife
- Gaffer tape

Foot pump

- 1 x foot pump
- 1 x 50cm PVC pipe, 2.5cm in diameter
- Utility knife
- Gaffer tape

500mL Plastic Bottle and Plastic Straw

- 1 x empty 500mL plastic bottle with lid
- 1 x plastic straw
- PVA glue

Please note: Total number of materials required to implement the design challenge will depend on the number of student groups completing the task. Each group may have access to their own rocket launcher. Alternatively, rocket launchers may be shared between groups of students.

Method

If using a plastic soft drink bottle and bike tube:

1. Use a utility knife to cut a 1 metre section of bike tube.
2. Attach one end of the bike tube to the opening of the soft drink bottle and tape in place securely.

3. Attach the other end of the bike tube to the PVC pipe and tape in place securely.
4. To use the stomp rocket launcher, students:
    a. Design and create their rocket using paper and tape. Students may like to use spare pieces of PVC pipe to help construct their rocket.
    b. Place the bottle on the ground in an open area pointing away from other people. Gently rest one foot or hand on the bottle to keep it in place.
    c. Slide the rocket over the open end of the PVC pipe, ensuring the pipe is pointing horizontally, towards the intended target.
    d. Step or press firmly down on the bottle to shoot the rocket into the air.
    e. Press the bottle back into its original shape.

If using a foot pump:

1. Ensure the foot pump hose is securely attached to the 'inflate' hole. Attach one end of the PVC pipe to the end of the hose. Gaffer tape may need to be wrapped around the join to ensure the connection is air-tight.
2. To use the stomp rocket launcher, students:
    a. Design and create their rocket using paper and tape. Students may like to use spare pieces of PVC pipe to help construct their rocket.
    b. Place the foot pump on the ground in an open area pointing away from other people. Gently rest one foot or hand on the foot pump to keep it in place.
    c. Slide the rocket over the open end of the PVC pipe, ensuring the pipe is pointing horizontally, towards the intended target.
    d. Step or press firmly down on the foot pump to launch the rocket into the air.

If using a 500mL plastic bottle and plastic straw:

1. Carefully cut a hole approximately the same diameter as the plastic straw into the lid. The lid should be resting on a flat surface during completion this task.
2. Tightly screw the lid onto the bottle. Insert the straw into the lid. Approximately two-thirds of the straw should remain outside the bottle.
3. Use PVA glue to secure the straw to the lid.
4. To use the stomp rocket launcher, students:
    a. Design and create their rocket using paper and tape. Students may like to use spare straws to help construct their rocket.
    b. Hold the bottle in their hands and slide the rocket over the plastic straw.
    c. Ensure the bottle is used in an open area facing away from other people. Point the bottle towards the intended target. Firmly squeeze the bottle to launch the rocket into the air.

Representing the Solar System

In order to represent how far students' rockets are able to travel, you could:

- Measure the space available for rocket launch and develop a scale based on this space. This option will be most suitable if working indoors with limited space. The 500mL plastic bottle and plastic straw will make the best stomp rocket launcher in a limited enclosed space.
- Go outside and create a larger scale to model how far students' rockets are able to travel. Planets could be represented using sports markers, traffic cones or bollards. To add an extra challenge, students may be required to fly their rockets through a series of upright hoops, with the hoops representing planets of the solar system (however the scaled distance will need to be different to the scaled planet diameter for hoops large enough to fly through). PVC pipes may be used to construct bases and stands to hold the hoops upright. The soft drink bottle or foot pump will make the best stomp rocket launcher in this instance.

Student launching a stomp rocket using a foot pump.

Implementing the Design Challenge

1. Investigate students' prior knowledge of rockets by asking:
   - What do you already know about rockets?
   - Where do they go? Why do we build them?
   - How are they shaped?
   - What parts do rockets need to operate properly?

   Record students' responses to these questions, and any other questions they may raise during this discussion.

2. Introduce students to the design challenge:

   Design, build and launch a paper rocket that can travel to a planet in our model solar system.

   This chosen planet may be:

   - The planet previously explored by student groups in *Beyond Earth: Colonising Space*; or,
   - A planet freely selected by student groups.

   Provide students with an opportunity to examine the stomp rocket they will use within the design challenge. Explore how the stomp rocket works with students. The following prompts may be used to guide this investigation:

   - Year 5

     Revise forces. Ask students to:

     Identify any pushes or pulls acting on the stomp rocket.

     Consider how a large and small push might affect the way in which the rocket moves through the air.
   - Year 7

     Revise forces. Ask students to identify the balanced and unbalanced forces acting on the stomp rocket.
   - Year 10

     Revise forces. Use the laws of physics to describe the motion of the rocket.

     Ask students to identify any factors that could influence how far the rocket travels. Responses may include the capacity of the bottle, the diameter and length of the straw or hose used, the size of the force used to launch the rocket, the mass of the rocket, the features of rocket including shape and fins, angle of launch, wind speed etc.

   During this time students should also see the distance their rockets will need to travel, whether this is using a paper-based scale, a larger outdoor scale or an alternative representation of distance.

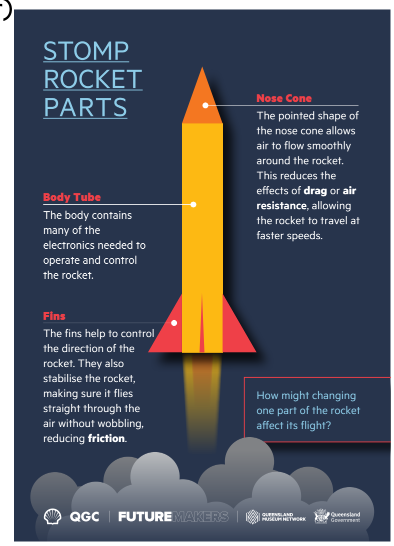
3. Share or negotiate any specific challenge requirements, restrictions or criteria for success with students. These may include:

   - Size of student groups (three students per group)
   - Student roles
   - Materials to complete the challenge
   - Time limit to complete the challenge

4. Divide students into small groups, ensuring each group knows which planet their rocket must reach and their individual roles, if assigned. These may be the groups they worked with to design and develop a shelter in *Beyond Earth: Colonising Space* or new groups.

   Provide students with time to conduct research to gather additional ideas and information that will inform the design of their rocket. Students use this information to write a design proposal and gain approval from the lead scientist (the classroom teacher) before constructing. The proposal should include:

   - Background information on rockets and how they are designed to travel to space (students may like to use the *Stomp Rocket Parts* poster to assist in the completion of this task)
   - Selected planet and the distance their rocket must travel from Earth, based on the chosen scale
   - A labelled sketch or digital representation of the rocket
   - Justification for design
   - Materials required to build the rocket
   - Control, independent and dependent variables to be tested



The Stomp Rocket Parts poster may be printed from Queensland Museum Learning Resources and displayed in the classroom.

5. Following approval from the lead scientist, students create their rockets.
6. Provide students with at least three test flights to evaluate the design of their rocket. Students identify dependent and control variables, record their observations and relevant measurements for each test flight, including distance travelled.

   During this time, students may also:

   - Identify the forces acting on the rocket as it moves through the air.
   - Construct force-arrow diagrams that represent the type, size and direction of forces acting on the rocket.
   - Explore how the application of different forces and/or the angle of launch affects the flight of the rocket.
   - Identify and record any energy transfers or transformations present immediately before, during and after the rocket launch.
   - Calculate the speed at which the rocket travels.
7. Students refine the design and construction of their rockets to increase distance travelled before re-testing. During this time, students should share their observations, challenges experiences and discuss what they should change to address or resolve these problems. Following subsequent testing, students should describe how any changes made to the rocket influenced its performance.

   Extension opportunities exist for students who successfully complete the design challenge within the allocated time. These may include:

   - Changing the independent variable and investigating how this affects the rocket's flight.
   - Modifying the rocket so that it can travel as far as possible.
   - Increasing the rocket's stability during flight.
   - Increasing the speed at which the rocket travels through the air.
   - Designing a self-inflating parachute that can be attached to the rocket and activated after launching the rocket upward.
8. Students reflect on and evaluate their final design and experiences:
   - What new knowledge/understandings helped you make decisions about your rocket design?
   - Are there any further changes you could make to improve your design?
   - What were the main challenges you experienced during the design process? How did you overcome these?
   - What have you learnt about science and design from this activity?
   - How could you apply this knowledge and understanding to your learning in other contexts?
   - What more would we like to know about space, space travel and/or rockets?

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Reflect on and suggest improvements to scientific investigations (ACSIS091)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 7

Science Understanding

Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117)

Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124)

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126)

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS129)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS131)

Use scientific knowledge and findings from investigations to evaluate claims based on evidence (ACSIS132)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

YEAR 8

Science Understanding

Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems (ACSSU155)

Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS139)

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS140)

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS141)

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS144)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS145)

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS146)

Use scientific knowledge and findings from investigations to evaluate claims based on evidence (ACSIS234)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

Design and Technology

YEAR 5 AND 6

Design and Technologies: Knowledge and Understanding

Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use (ACTDEK023)

Design and Technologies: Processes and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (ACTDEP024)

Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025)

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions (ACTDEP026)

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

YEAR 7 AND 8

Design and Technologies: Knowledge and Understanding

Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment (ACTDEK034)

Design and Technologies: Processes and Production Skills

Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas (ACTDEP035)

Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques (ACTDEP036)

Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions (ACTDEP037)

Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability (ACTDEP038)

Use project management processes when working individually and collaboratively to coordinate production of designed solutions (ACTDEP039)

Mathematics

YEAR 5

Measurement and Geometry

Choose appropriate units of measurement for length, area, volume, capacity and mass (ACMMG108)

Statistics and Probability

Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies (ACMSP119)

YEAR 7

Statistics and Probability

Calculate mean, median, mode and range for sets of data. Interpret these statistics in the context of data (ACMSP171)

Describe and interpret data displays using median, mean and range (ACMSP172)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Recognise and using patterns and relationships

Using measurement

ICT Capability

Investigating with ICT

Creating with ICT

Critical and Creative Thinking

Identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social management

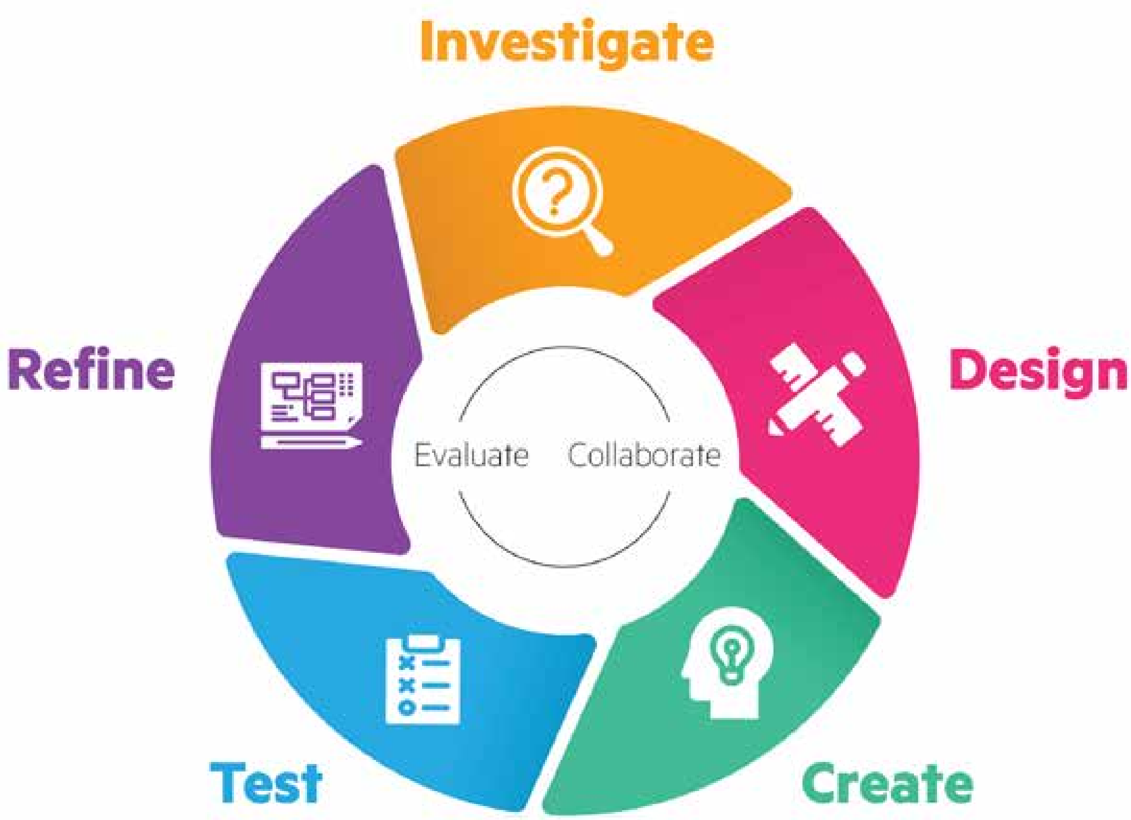
Stomp Rocket Design Challenge

Student Activity

Design, build and launch a rocket that can travel to one of the planets in our solar system.

You must:

- **Investigate** how rockets are designed to reach space.
- **Design** a rocket that can travel to one of the planets in the model solar system and be launched from the stomp rocket launcher provided by your teacher.
- **Create** a prototype of your rocket from recyclable materials supplied by your teacher.
- **Test** the prototype's ability to reach your chosen planet using the stomp rocket launcher.
- **Refine** the rocket design and construction so that it can reach your chosen planet.
- **Collaborate** in teams of three. Your teacher may allocate a role to each team member.
- **Evaluate** continuously to design a rocket that is able to travel to your chosen planet.



Investigate and Design

You must write a proposal to explain the design of the rocket and gain approval from your lead scientist (in this case, your teacher) before creating your rocket.

Your proposal should include:

- [ ] Background information on rockets and how they are designed to travel to space
- [ ] The planet your rocket will travel to, and the distance your rocket must travel from Earth based on the scale chosen by your teacher
- [ ] Control, independent and dependent variables to be tested
- [ ] Labelled sketch or digital representation of the rocket
- [ ] Justification for design
- [ ] Materials required to build the rocket

Once your proposed design has been approved, you can create your rocket prototype.

Investigate how rockets have been designed to travel to space. Record your findings below.

Our rocket will travel to:

Distance of this planet from the Earth:

Explain how a scale will be used to model the distance of this planet from the Earth:

Distance from Earth to your planet according to the scale above:

Consider the variables you will explore in this challenge. What will you:

Change? (independent variable)	**Measure?** (dependent variable)	**Keep the same?** (control variables)

Draw a labelled diagram of your rocket. Make sure you identify the materials you will use to make the rocket, and explain and justify the selection of its parts.

Create

Create your rocket using the materials provided. Record any modifications required as you build the rocket.

Modification	Reason

Test

The lead scientist will guide you to the rocket test zone and demonstrate how to use the stomp rocket launcher. You will have three test flights to determine how far the rocket can travel and evaluate the rocket's design. Record your findings on the next page.

Refine

Based on your observations, modify the rocket's design to make it travel further, and the re-test in the rocket test zone. Continue to refine and test until your rocket is able to reach your chosen planet.

Recording Results

1. Record the results gathered from each test flight in the tables below.

Test Flight 1

Trial	**Distance**
Trial 1	
Trial 2	
Trial 3	
Average Flight Distance	
Observations	

Test Flight 2

Trial	Distance
Trial 1	
Trial 2	
Trial 3	
Average Flight Distance	
Observations	

Test Flight 3

Trial	Distance
Trial 1	
Trial 2	
Trial 3	
Average Flight Distance	
Observations	

2. Graph the results gathered from each test flight below.

3. Construct a force-arrow diagram to record the type, size and direction of forces that acted on the rocket as it moved through the air.

4. Identify and represent the energy transfers and transformations that occur as the rocket is launched and moves through the air.

Discussing Results

1. Did the rocket reach your chosen planet during the first test flight? Why?

2. What did you do to increase distance travelled for the next test flight?

3. Were these changes effective? Why?

4. What further tests would you conduct in the future?

5. How would you change this rocket if it were to really travel into space:
   a) Manned
   b) Unmanned

Evaluate

Reflect on your actions with your team or class after you have completed the design challenge. You might like to think about the following questions to assist with your reflection:

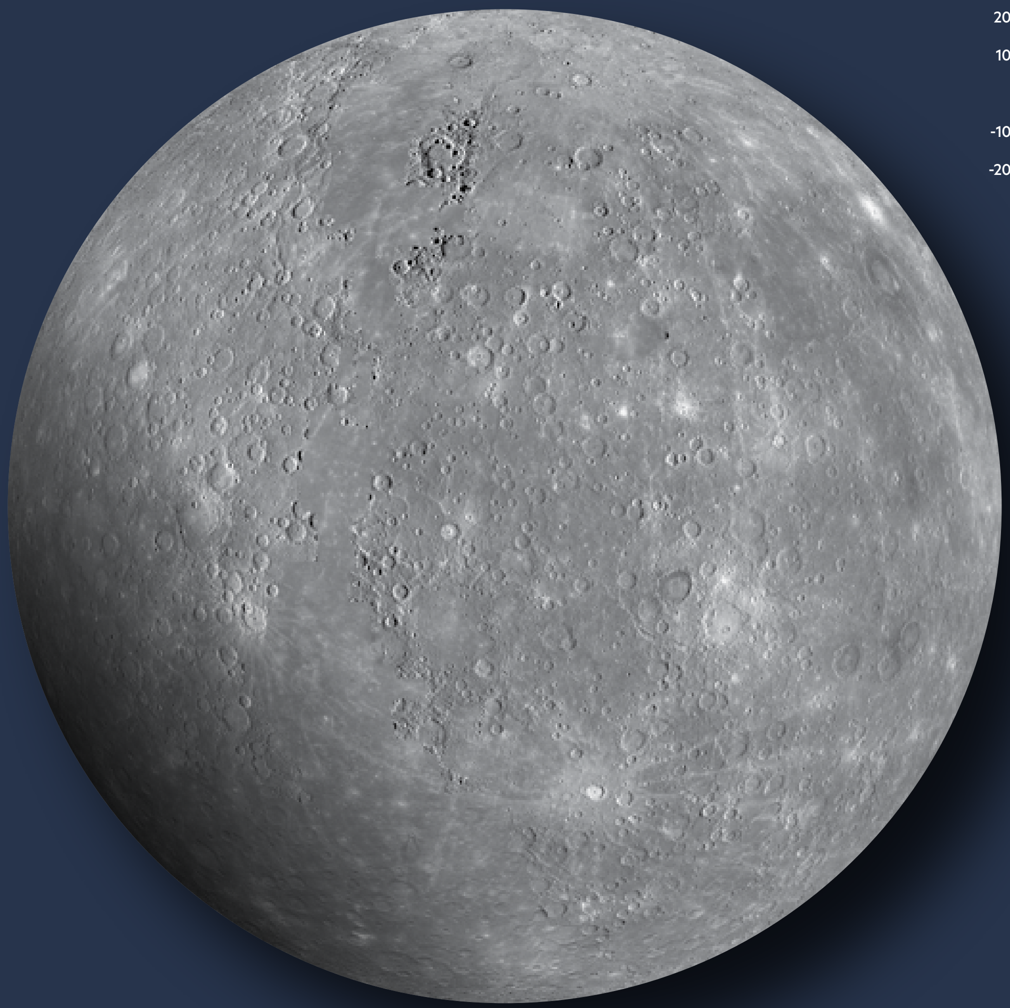
- What new knowledge/understandings helped you make decisions about your rocket design?
- Are there any further changes you could make to improve your design?
- What were the main challenges you experienced during the design process? How did you overcome these?
- What have you learnt about science and design from this activity?
- How could you apply this knowledge and understanding to your learning in other contexts?
- What more would we like to know about space, space travel and/or rockets?

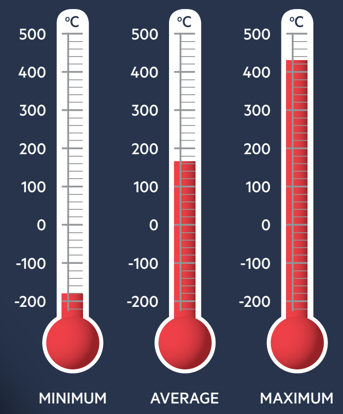
Planet Posters

Teacher Resource

Future Makers planet posters can be downloaded from Queensland Museum Learning Resources, and printed in A3 to display around the classroom. Students may use the Future Makers planet posters to gather information about the planets in our solar system including temperature, distance from the Sun, diameter and atmosphere composition.

Mercury





Distance from Sun	58,000,000 km 0.4 AU
Diameter	4879 km
Gravity	3.7 m/s²
Atmosphere Composition	42% oxygen 22% hydrogen 22% sodium 6% helium 8% other
Day Length	1,408 hours
Year Length	88 Earth days

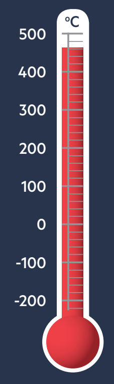
INTERESTING FACTS

Mercury is the smallest planet in the solar system – only slightly bigger than Earth's Moon. It also has craters and a thin atmosphere like our Moon.

From the surface of Mercury, the Sun would appear more than three times larger than when viewed from Earth, and the sunlight would be as much as 11 times brighter.

While Mercury is the closest planet to the Sun, it is not the hottest (Venus is hotter due to its dense atmosphere).

Venus



Distance from Sun	108,000,000 km 0.7 AU
Diameter	12,104 km
Gravity	8.9 m/s²
Atmosphere Composition	96.5% carbon dioxide 3.5% nitrogen <1% other
Day Length	5,832 hours
Year Length	225 Earth days

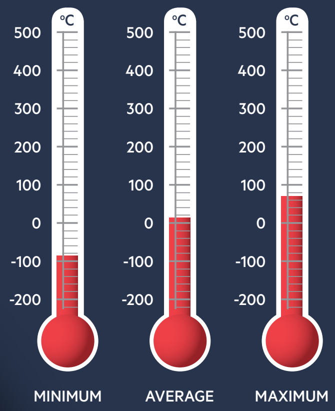
INTERESTING FACTS

With an atmosphere of 96% carbon dioxide, Venus is the hottest planet in our Solar System and an example of the Greenhouse effect gone amuck!

Venus is fascinatingly hostile. Future missions will have to contend with not only the heat, but also frequent sulfuric acid rainstorms and very high air pressure. Standing on the surface of Venus would feel like standing under 1 km of water!

Venus is a similar size to Earth and our closest neighbour, but a very different world!

Earth



Distance from Sun	149,600,000 km 1 AU
Diameter	12,756 km
Gravity	9.807 m/s²
Atmosphere Composition	78% nitrogen 21% oxygen 1% argon <1% other
Day Length	24 hours
Year Length	365.2 Earth days

INTERESTING FACTS

Liquid water is very important for life. The Earth is located in the 'Goldilocks Zone'. This is the habitable zone around a star where the temperature is not too hot and not too cold – instead it is just the right temperature for water to exist as a liquid.

While 70% of the Earth is covered in water only 2.5% is fresh water, and most of this is inaccessible in glaciers and icecaps.

Earth's atmosphere is 160 km thick and composed of 78% nitrogen and 21% oxygen.

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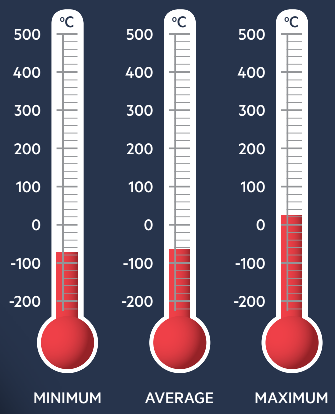
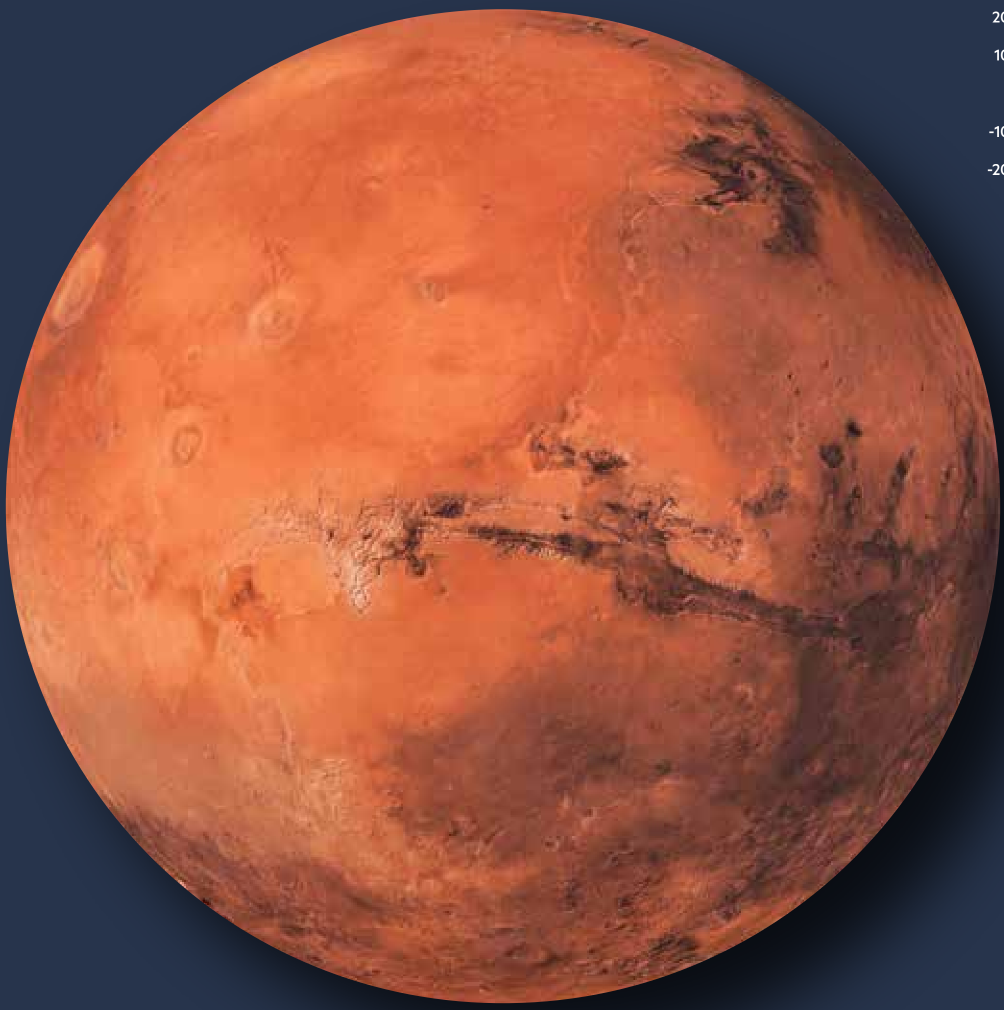
Mars





Distance from Sun	227,900,000 km 1.5 AU
Diameter	6792 km
Gravity	1.6 m/s²
Atmosphere Composition	95% carbon dioxide 2.7% nitrogen 1.6% argon 0.7% other
Day Length	25 hours
Year Length	687 Earth days

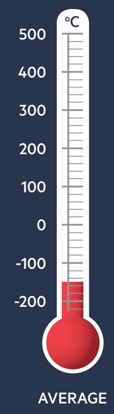
INTERESTING FACTS

Olympus Mons, an extinct volcano on Mars, is the highest mountain in the Solar System – 2.5 times bigger than Mt Everest! Mars also has the biggest valley (Mariner Valley).

Mars is known as the Red Planet. Iron in the soil and atmosphere oxidises (rusts) giving Mars this distinctive colour.

Similar to Earth, Mars experiences seasons. It also experiences thousands of tornados or 'dust devils' every year which can get up to 2 km wide and 10 km high.

Jupiter



Distance from Sun	778,600,000 km 5.2 AU
Diameter	142,984 km
Gravity	23.1 m/s²
Atmosphere Composition	89.8% hydrogen 10.2% helium
Day Length	10 hours
Year Length	12 Earth years

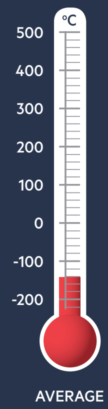
INTERESTING FACTS

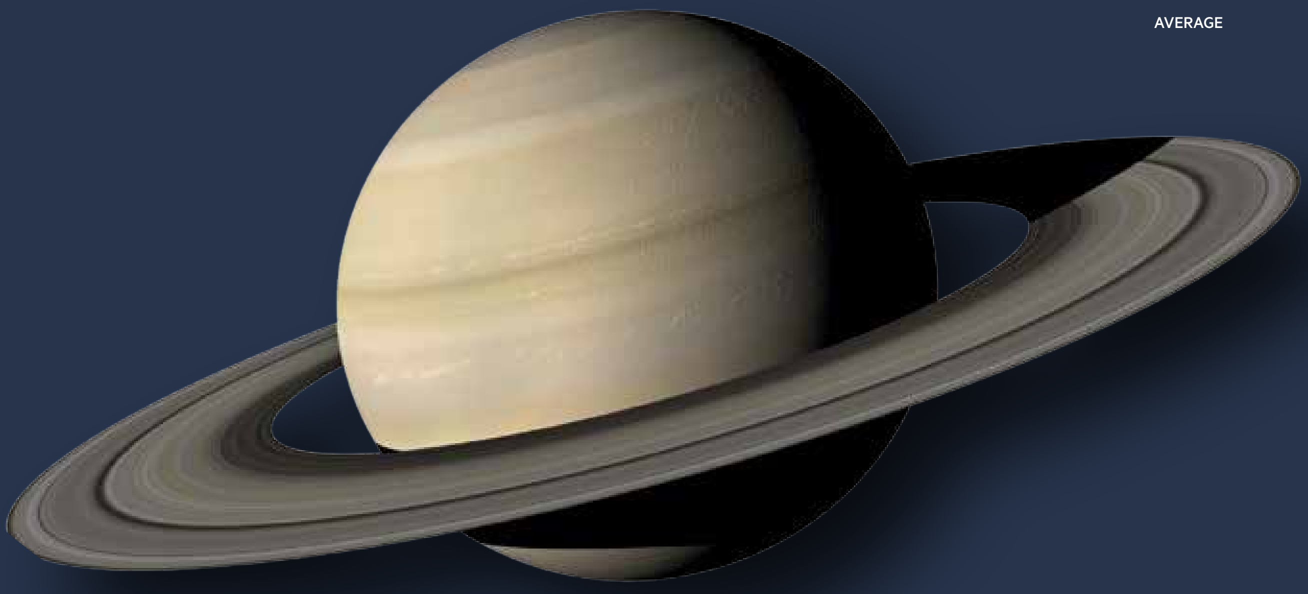
Jupiter is the largest planet in our Solar System – 11 Earths could fit across Jupiter's equator.

Like Saturn, Jupiter is a gas giant. Gas giants do not have a solid surface like Earth and other terrestrial planets.

The Great Red Spot is a giant cyclone-like storm on Jupiter. The storm has been continuously observed since 1830, and is twice the size of Earth. The colour bands on Jupiter are caused by powerful winds that circle the planet at 547 km/h.

Saturn





Distance from Sun	1,433,500,000 km 9.6 AU
Diameter	120,536 km
Gravity	9.0 m/s²
Atmosphere Composition	96.3% hydrogen 3.2% helium 0.5% other
Day Length	11 hours
Year Length	29 Earth years

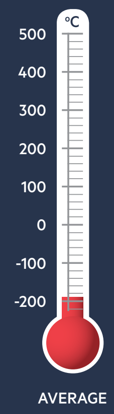
INTERESTING FACTS

Saturn's iconic rings are made of chunks of rock and ice. However, Saturn is slowly losing these rings as gravity pulls the rock and ice toward the planet.

53 known moons orbit Saturn, and there are more awaiting confirmation. Saturn's largest moon, Titan, is the only known world other than Earth where liquid collects on its surface. Liquid methane and ethane lakes cover the surface.

A monstrous thunderstorm appears on Saturn every 28 to 30 years, called the 'Great White Spot'.

Uranus



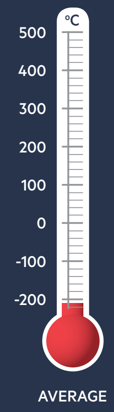
Distance from Sun	2,872,500,000 km 19.2 AU
Diameter	51,118 km
Gravity	8.7 m/s²
Atmosphere Composition	82.5% hydrogen 15.2% helium 2.3% methane
Day Length	17 hours
Year Length	84 Earth years

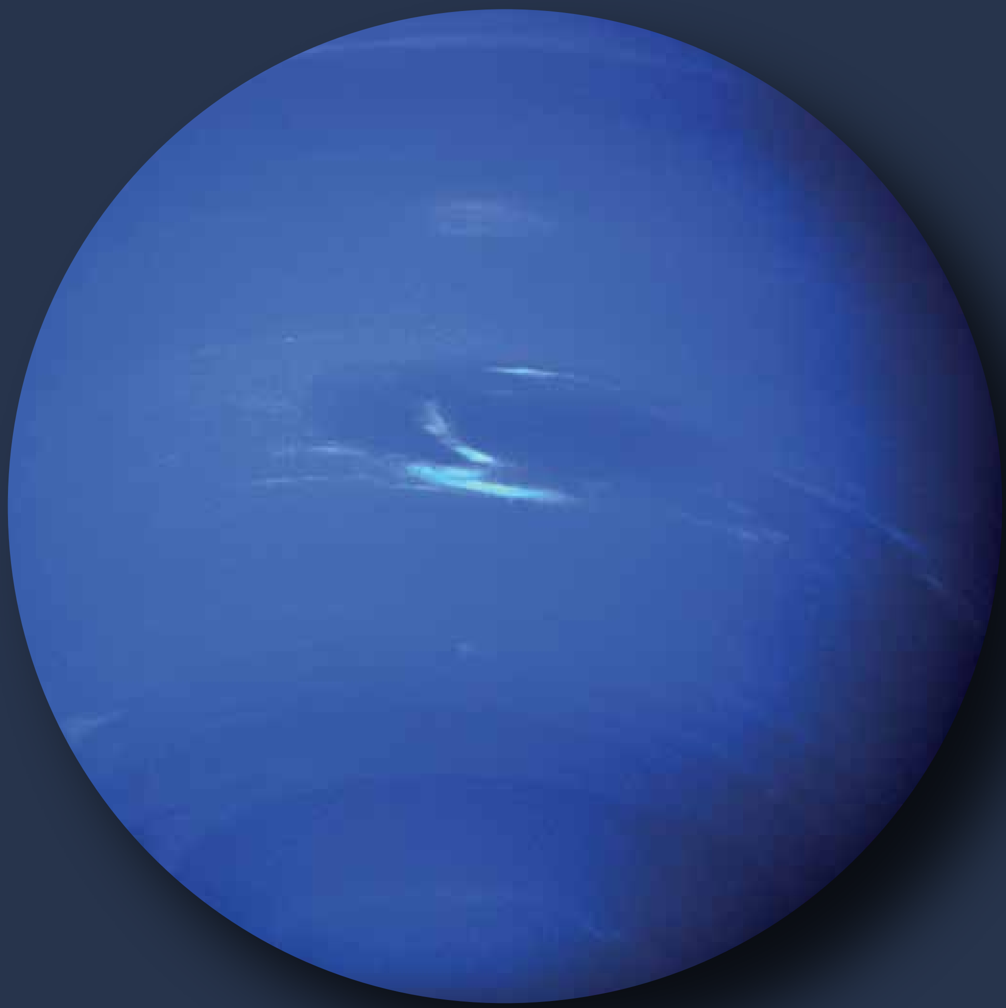
INTERESTING FACTS

Uranus is the only planet in our Solar System that rotates on its side –it almost appears to 'roll' around the Sun. This sideways rotation – possibly caused by a collision with a large object – causes extreme seasons. Summer for the planet's north consists of 21 Earth years of constant daylight, while winter is 21 years of complete darkness.

The blue-green colour of Uranus is due to the methane in the atmosphere.

Neptune





Distance from Sun	4,495,100,000 km 30.1 AU
Diameter	49,528 km
Gravity	11.0 m/s²
Atmosphere Composition	80% hydrogen 19% helium 1% methane
Day Length	16 hours
Year Length	165 Earth years

INTERESTING FACTS

Neptune and Uranus are ice giants – they do not have a solid surface. Instead the gasses of the atmosphere surround liquid methane, ammonia and water. The centre of the planet is a heavier solid core.

There is less friction on Neptune than on Earth and winds speed around the planet at 2000 km/h. These winds are the fastest in the Solar System, and faster than the speed of sound. Earth's most powerful winds only reach 400 km/h.

Notes

Notes