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Space Innovators • Lesson 1 • How do scientists investigate?

**Lesson 1**

**Launch**

**F-Y10**

**Year 6**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-1-how-do-scientists-investigate](https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-1-how-do-scientists-investigate?utm_source=docx&utm_medium=lesson1&utm_campaign=SI) |

# Lesson overview

This lesson introduces the content and context of this sequence: observing the relative positions of the Sun, Earth, Moon, and planets, and the scientific and technological advancements that have made closer observation of these phenomena possible.

## Key learning goals

Students will:

* identify what they think they know about the relative position of the Sun, Earth and Moon and how this position impacts the phenomena of day and night, phases of the Moon, seasons etc.
* ask questions about these phenomena.
* determine some key scientific practices.

**­**

Students will represent their understanding as they:

* contribute to the creation of a TWLH chart.
* recount a fictionalised story of a scientific discovery and use it to make inferences about some key scientific practices.

## Assessment advice

In the launch phase, assessment is diagnostic

Take note of:

* what students *Think* and *Want to know* about space and the solar system.
* what students identify as scientific practices.
* what students claim about the position of the Sun, Earth and Moon.
* the vocabulary students use.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Demonstration copy of the **In perspective Resource sheet**
* Demonstration copy of the **But it looks flat! Resource sheet**
* Demonstration copy of the **Claims about the sky Resource sheet**
* Optional: sticky notes (dependent upon how the TWLH chart is constructed)
* Equipment to access the internet and show suggested video clips and images
* Video: [Amateur Astronomer - Behind The News](https://www.abc.net.au/btn/classroom/amateur-astronomer/10526998) (3:59)

**Each student**

* Individual science journal (digital or hard-copy)
* Optional: sticky notes (dependent upon how the TWLH chart is constructed)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Experience and empathise | 15 minutes | Whole class |
| Elicit | 15 minutes | Whole class, Individual |
| Anchor and Connect | 10 minutes | Whole class |
| Question | 15 minutes | Individual |

# Launch

## Experience and empathise • Is the Earth a sphere?

As a class, discuss the images on the demonstration copy of the **In perspective Resource sheet**. Order the images based on how close you are to the house/mountains.

**Potential discussion prompts**

* *Why do you think the house/mountains may appear small on the horizon in one image, and bigger in another?*
* *Why do you think this picture is from furthest away?*
* *Why do you think this picture is from closer in?*
* *What might be happening to cause that?*

Ask students how they think scientists may have first figured out that the Earth was round/a sphere.

Introduce the comic strip from the **But it looks flat! Resource sheet**, which explains how scientist Eratosthenes (pronounced *Era-tos-the-neez*) proposed that the Earth was round/spherical and how he went about convincing others. Prompt students to pay close attention to *how* Eratosthenes worked during the reading of the comic strip.

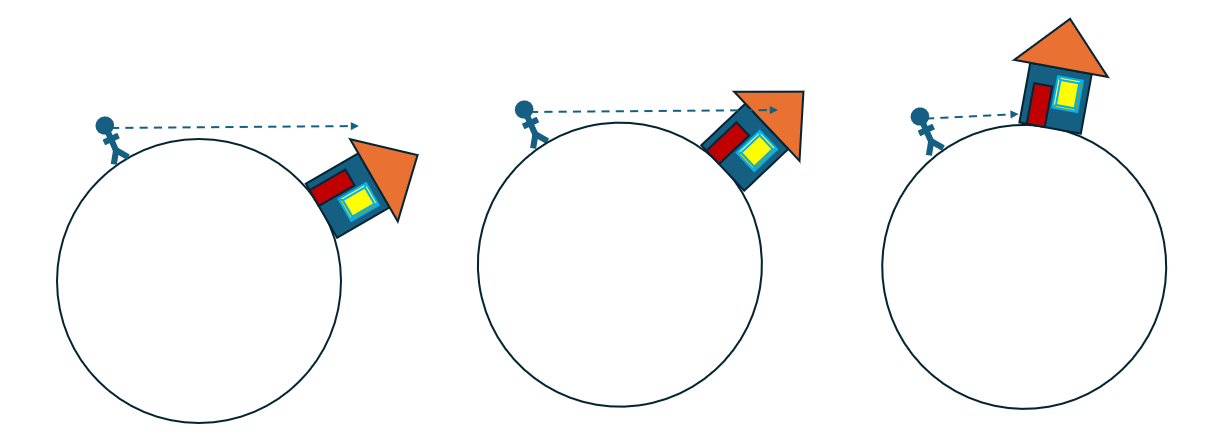
After reading, ask students what they noticed about the scientific process Eratosthenes followed and what he found out as a result. Record it in the class science journal.

**Potential discussion prompts**

* *What happens in the story?*
* *Scientifically speaking, what steps does Eratosthenes take?*
  + He proposes that the Earth is a very large sphere.
  + He draws on his past observations of how islands appear to rise out of the sea when on a sailing ship to support his claim.
  + He uses the analogy of the ant crawling across the orange to support what he’s saying and help his friend understand.
  + He devises an investigation to find out of his idea is correct.
  + He shares his planned investigation with his friend (a peer if you will), who seems to agree that the investigation would indeed prove if the idea was correct.
  + He carries out the investigation.
  + He measures the angle of the shadow created in the bottom of the well.
  + He shares his findings with his friend, who now agrees the Earth must be a sphere.
  + He proposes that next he might be able to calculate the exact size of the Earth.
* *Do you think this story is 100% historically accurate? Why? Why not?*
* *If the story is not historically accurate, then what is its purpose?*
* *What information do you think Eratosthenes got that led to his idea that he might now be able to determine the size of Earth?*

As a class, create a diagrammatic representation to consider the reason why mountains or a city cannot be seen from far away, as they are below the horizon on a curved earth. As you approach the objects they appear on the horizon and more and more of the object can been seen as you get closer.

You might like to prepare a diagram as in the example below and ask students to indicate the direction of the person's line of sight at each location and discuss.



You might also discuss how the diagram is not drawn to scale, considering the sizes of the city/mountain etc., and how the people are exaggerated in order to make it easier to model.

If using arrows to indicate the line of sight, you might discuss the difference between using arrows to show direction in general representations, and the typical scientific use of arrows to show the flow of energy (students will be familiar with this use from learning about heat in Year 3 and light in Year 5).

Students might also complete this diagram as individuals. They may need support and prompting about the best perspective to take, which is a side-on view. One way to do this is to model using a 3D globe before asking them to create their diagram

## Elicit • Claims about the sky

Explain to students that over the course of history, many different scientists and astronomers have tried to explain things about Earth (such as how day and night happen) by making claims about the position of the Sun, Earth and Moon in relation to each other and how they move around. Over history these claims have been accepted or disputed by both scientists and people in the community, based on their own experiences and evidence—just like what Eratosthenes experienced.

Using the **Claims about the sky Resource sheet**,present students with three claims that scientists have

made during the course of history about the position of the Sun, Earth and Moon in relation to one another:

* Claim 1: The Moon and the Sun both circle around the Earth.
* Claim 2: The Moon circles the Earth and the Sun circles them both.
* Claim 3: The Moon circles the Earth while the Earth circles the Sun.

Ask students to think about which claim they agree with and why. Record students’ thinking. See the embedded professional learning on *Collecting and using diagnostic data on students’ initial thinking* for further information about this.

If appropriate, give students the opportunity to role-play, make a model, or draw pictures before deciding which claim they think is correct.

Introduce a TWLH chart and discuss its purpose as a means of supporting students to track their learning over the course of the sequence.

Begin the TWLH chart by prompting students to write down what they THINK they know about the Earth, Sun and Moon, where they sit in the sky/space/solar system, what they know about day and night, or anything else they might think is relevant.

Repeat this process, this time prompting students to write what they think they know about how scientists go about investigating and answering questions about the Earth, and the problems they might encounter in doing so. Students will be given an opportunity to add questions to the *What we want to know* column of the TWLH chart at the end of the lesson.

Share and categorise students’ ideas. For example you might bundle together ideas about planets, ideas about astronauts and space exploration and ideas about space inventions. Acknowledge the volume of ideas/questions students have contributed, and that it might not be possible to investigate/learn about everything over the course of the sequence.

## Anchor and Connect • Investigation and innovation

Introduce to the students that during this sequence they will be working like scientists to investigate the claims made about the positions and movements of the Earth, Sun and Moon, and some other claims, to work out which ones are best supported by evidence.

Referring to the process Eratosthenes followed, and students’ other experiences and ideas, write a list or create a mindmap of ideas about what scientists do when planning and undertaking scientific investigations.

Watch [Amateur Astronomer - Behind The News](https://www.abc.net.au/btn/classroom/amateur-astronomer/10526998) (3:59) about Jonah, a home astronomer who lives in rural Queensland. Discuss what Jonah did to help him learn more about what was happening in the sky above him.

**Potential discussion prompts**

* *What does Jonah do (as in the job he does)?*
* *How long has Jonah been interested in Astronomy?*
* *Is Jonah a scientist? Why do you think that?*
* *How does Jonah work like a scientist to plan and carry out his investigations?*

Introduce that students will also be learning about the scientific and technological advancements that have enabled and encouraged the exploration of the universe. At the end of the sequence, they will become ‘Amateur Astronomers’ and undertake the design process to ideate a creation that could contribute further to the exploration of the universe.

Discuss what questions students have about electricity. Record their questions in the ‘What we WANT to know’ column.

**Potential discussion prompts**

* *How does electricity get to our power points?*
* *How does the electricity move from our power points to the objects?*
* *How does a switch turn an object on/off?*
* *What could we do if we had no electricity on the power points?*

## Question • What do we want to know?

Use the [Question Formulation Technique](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/question-formulation-technique?utm_source=docx&utm_medium=lesson2&utm_campaign=SI) to brainstorm questions to add to the *What we want to know* column of the TWLH chart. Prompt students to ask a broad range of questions about, for example, the Earth, Sun, Moon and planets, the scientific process, or the innovations that have allowed humans to study and learn about space.

## Reflect on the lesson

You might:

* begin a class word wall or glossary with relevant terms.
* review the class TWLH chart.
* consider how Jonah was working like a scientist when designing his telescope and/or weather balloon.
  + What questions did he ask?
    - For example: How can I get a good photograph of the darkness of space? How can I get above the atmosphere?
  + What did he do to solve his technological challenge that allowed him to explore space?

**Year 6**

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Space innovators • Lesson 2 • What’s where?

**lesson 2**

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# Lesson overview

Students use models to investigate claims about the relative position of the Sun, Earth and Moon, and consider how currently accepted scientific understanding came about. They explore how lenses work and how they are utilised in a telescope.

## Key learning goals

Students will:

* use models to represent the movement of the Sun, Earth and Moon.
* investigate how lenses work.
* consider the role of lenses in the construction of a telescope.

Students will represent their understanding as they:

* contribute to class discussions to build shared understanding.
* construct a timeline of notable events in the history of what is now widely accepted about the positions and movements of the Sun, Earth and Moon.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ understanding of how scientists build on each other’s work.
  + Are they able to recognise the connections between the work of various astronomers over time?
  + Are they able to notice the changing design of the telescope, and suggest reasons for it?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Equipment to access the internet and watch suggested video clips and view images
* Demonstration copy of the **View finder Resource sheet**
* Demonstration copy of the **Investigating claims Resource sheet**
* Demonstration copy of the **A scientific history of the heavens Resource sheet**
* Demonstration copy of the **Telescopes Resource sheet**
* Demonstration copy of the **Magnifying magic Resource sheet**
* Demonstration copy of the **How does a lens work? Resource sheet**
* Materials to create a word wall
* Video: [Sun, Moon and Earth Model](https://www.youtube.com/watch?v=U3iRnIsti3s) (1:00)

**Each group**

* Investigating claims Resource sheet
* A collection of spherical objects of different sizes, such as basketballs, soccer/netballs, tennis balls, ping pong balls, marbles etc. Each group of students will select three objects to represent the Sun, Earth and Moon.
* Optional: A scientific history of the heavens Resource sheet
* 1 x magnifying glass
* 1 x piece of hard, clear plastic—the lid of a take-away container works well

**Each student**

* Individual science journal (digital or hard-copy)
* 2 x paper plates
* 3 x split pins
* Scissors
* Coloured textas or pencils
* Magnifying magic Resource sheet (or make their own)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 20 minutes | Collaborative teams |
| Integrate | Variable | Collaborative teams, Whole class |
| Question | 10 minutes | Whole class |
| Investigate | 15 minutes | Individual |
| Integrate | 20 minutes | Whole class |

# Inquire

## Re-orient

Revisit the three claims about the position of the Sun, Earth and Moon that students considered in Lesson 1. Ask students to recall which claim they thought was true and why.

Explain that in this lesson they will be using models to explore each claim, considering the claims in light of their own experiences, and investigating how humans’ understanding of the positions of the Sun, Earth and Moon has changed over time.

Using the **View finder Resource sheet**, view an image of the sky, both during the day and at night, as taken from the Earth, and an image of the Earth taken from space. Discuss the different perspectives that the images are taken from (an ‘Earth’ view and an ‘Astronaut’ view) and determine which is which.

Ask students to take particular note of this, as they will be asked to model various phenomena interchangeably from these two perspectives throughout the sequence.

## Question • Who claimed what?

Remind students that the three claims they have considered were made by different scientists/astronomers over the course of history as they tried to explain phenomena such as day and night, seasons, etc.

These claims have been accepted or disputed by both scientists and people in the community, based on their own experiences and evidence, just like Eratosthenes experienced.

**Pose the question:** *What might a model of each claim look like, and how do they compare to our own experiences?*

## Investigate • Modelling claims

In collaborative teams, students use the **Investigating claims Resource sheet** and three spherical objects (representing the Sun, Earth and Moon) to model each of the claims made. Allow students to select from a selection of spherical objects of different sizes—do not provide any instruction about which object to assign as the Sun, Earth or Moon.

Teams discuss each model as they test it, considering each one in light of their own experiences of day and night etc. Prompt them to look at each model and determine if it explains these experiences.

Note: It is unlikely that students will be able to determine which claim is correct based only on the models and their experiences. The discussion is, however, worthwhile as a means of getting them to think more deeply about phenomena they experience every day. ‘Proving’ which claim is correct would be extremely difficult to do in a primary classroom setting without specialised equipment. The evidence that has been collected by scientists over history will be examined in the *Integrate* step of this sequence.

## Integrate • Which claim is accepted?

Teams share their thoughts, ideas, and other discussions they had for each model. Also ask each team which objects they selected to represent the Sun, Earth and Moon and why they selected each object. Take a note of these across all of the groups.

Discuss any trends or interesting anomalies that occurred in the students’ choices, and what we can infer from these. For example:

*Most groups assigned their smallest sphere to represent the Moon. This suggests that most people in this class think the Moon is smaller than the Earth and the Sun.*

*Some groups have assigned their largest sphere as the Earth, and some have assigned it as their Sun. This tells us that collectively we don’t have a consensus about the sizes of the Sun, Earth and Moon compared to each other.*

Ask students if they have been using 2D and/or 3D models from an ‘Earth’ view or an ‘Astronaut’ view and why they think that. Through discussion, establish a consensus that students have been using models from an ‘Astronaut’ view.

Read the text **A scientific history of the heavens Resource sheet**.

Students use the information in the text and the table provided to build a timeline, showing accepted scientific understandings about the planets over time, how they changed, and the technological innovations that contributed to this change in thinking. See the embedded professional learning *Adapting to your context* for details on how you might modify this task to suits your students and context.

After reading the text, determine which of the three claims is considered most accurate according to current scientific evidence.

Discuss the technological innovation of the telescope, and how it led to Galileo’s findings about the planets.   
  
Discuss how and why Galileo’s findings about Venus and Jupiter’s moons did not fit easily with the commonly held conception that the Earth was in the centre and that everything moved around it. This eventually led to the widespread acceptance of the heliocentric model of the solar system, with the Sun at the centre.

Using a paper plate and split pins, students make a model of the Sun, Earth and Moon showing their positions and movement relative to each other. Watch the video [Sun, Moon and Earth Model](https://www.youtube.com/watch?v=U3iRnIsti3s) (1:00) for a demonstration of how to construct this model.

Discuss how this model shows the Earth moving around the Sun, and the Moon moving around Earth. Introduce the terms *orbit*and *revolve/revolving* as the terms for this movement.

**Optional:** Discuss the meaning and origins of the terms *heliocentric*and *geocentric*.

## Question • Remembering Jonah’s telescope

Recall, or rewatch if needed, [Amateur Astronomer - Behind The News](https://www.abc.net.au/btn/classroom/amateur-astronomer/10526998) (3:59) from the previous lesson. Ask students to remember what two things Jonah did to support him to investigate the sky more closely.

Focus on the telescope Jonah built, and how he mentioned that he used mirrors. Discuss how this is different to what students read about the telescope Galileo built, which only mentioned lenses.

Using a demonstration copy of the **Telescopes Resource sheet**, look at the labelled diagrams of a Galilean telescope (a refracting telescope) and a more modern telescope (a reflecting telescope). Discuss the differences and similarities, noting that both use lenses.

**Pose the question:** *How does a lens work?*

## Investigate • Using lenses

Brainstorm with students other items that use lenses, e.g. magnifying glasses, eyeglasses, cameras, binoculars, telescopes, microscopes.

In collaborative teams, students explore how lenses work by reading text through a piece of clear plastic, a drop of water, and a magnifying glass, and comparing the effects.

1. Look at the text through a piece of clear, hard plastic and observe if the writing is the same or easier to read (larger).
2. Place a drop of water on the surface of the plastic and observe the writing again, considering if it appear different.
3. View and read the text through a magnifying glass.
4. Compare the effect of the water drop to that of a magnifying glass.

Students record their observations on the **Magnifying magic Resource sheet**, including observations about the shape of the water droplet when viewed from the side and the shape of the magnifying glass.

## Integrate • How does a lens work?

Students share their observations: comparing the similarities and differences of what could be viewed through just the piece of plastic, the water droplet, and the magnifying glass.

Discuss the shape of the items. What similarities and differences do students notice? How easy was it to read the secret message through them? Draw attention to the convex shape of the drop of water and the lens of the magnifying glass. Explain that it is this shape that makes the writing appear larger. The magnifying glass is double, or biconvex, meaning it is curved outwards on both sides. The drop of water is plano-convex as it sits flat where it touches the against the plastic.

Examine the photographs of light travelling through differently shaped lenses using a demonstration copy of the **How does a lens work? Resource sheet.**

Ask students to describe the shape of the lenses and how the beams of light are travelling through them. Jointly construct a description for the class science journal. For example:

* A convex lens is thicker in the middle and thinner at the edges. The light rays bend inwards towards each other (they converge).
* A concave lens is thinner in the middle and thicker at the edges. The light rays bend outwards away from each other (they diverge).

Explain that convex lenses make things look bigger, and concave lenses make things look smaller, but closer. Add these details to the relevant image in the class science journal.

Show students a glass full of water and place something behind the glass (e.g. a pencil, or a piece of card or paper with writing on it). Students describe and discuss what they observe and what they know about it.

Discuss refraction as light changing its direction when it moves from one material to another (air-to-lens or lens-to-air).   
See the embedded professional learning *How a lens works*for details on what prior knowledge students might have about refraction.

Drawing on students’ existing knowledge of light and how it reflects off mirrors, and referring again to the **Telescopes Resource sheet**, discuss how the design of modern telescopes has changed (they use mirrors to direct light rays) and why this might have happened (to make more powerful telescopes, capable of seeing further into space). See NASA’s page [How do telescopes work](https://spaceplace.nasa.gov/telescopes/en/) for further information.

**Optional:**Build a crude refracting lens with a soft drink bottle and water. See [How to make lens at home || DIY Magnifying Glass || science project](https://www.youtube.com/watch?v=1FSzVsCt1_U) (2:58).

**Optional:**Build a simple Galilean telescope using a set of magnifying glasses and a cardboard tube. See [How to Build a Telescope](https://leftbraincraftbrain.com/how-to-build-a-telescope/).

## Reflect on the lesson

You might:

* consider the two questions posed before each investigation: *Which of the three claims seems correct?* and *How does a lens work?* Jointly construct a sentence or two to answer these questions and record them in the class science journal.
* add relevant terms to the class word wall or glossary.
* add to the L and H columns of the TWLH chart.

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**Year 6**

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Space innovators • Lesson 3 • What causes day and night?

**lesson 3**

**INQUIRE**

# Lesson overview

Students use a 3D physical model, in the form of a role-play, to explore how the position and movement of the Sun and Earth cause day and night.

## Key learning goals

Students will:

* explore and investigate what causes day and night.
* determine that the anti-clockwise revolution of the earth causes day and night.
* consider the impact this has on different parts of Australia and the world.

Students will represent their understanding as they:

* contribute to discussions about the causes of the varying length of day and night.
* represent how the revolving of the earth causes different locations to experience sunrise/sunset at different times.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* how students model the orbit and rotation of the Sun and Earth.
* the conclusions that students draw from this modelling/simulation.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* For the Sun/shadow stick observation (note that this is best completed on a sunny day):
  + Large sheet of white paper
  + A stick/skewer to cast a shadow
  + A compass (a compass on a phone/tablet is fine)
  + Markers
* Equipment to access suggested websites and view images
* Optional: a strong lamp to model the Sun’s light
* A ball to represent the Earth
* A cut out of a map of Australia, available on the **Map of Australia Resource sheet**. Resize the map appropriately for the ball you have selected to represent Earth before printing and cutting it out.
* Demonstration copy of the Sunrise sunset Resource sheet
* Optional: Demonstration copy of the **Earth from space Resource sheet**

**Each group**

* Optional: a strong lamp or torch to model the Sun’s light
* A ball to represent Earth
* Cut out of a map of Australia

**Each student**

* Individual science journal (digital or hard-copy)
* **Sunrise sunset Resource sheet**

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | Variable | Whole class |
| Investigate | 250minutes | Collaborative teams, Whole class |
| Integrate | 20 minutes | Whole class, Individual |

# Inquire

## Re-orient

Using the TWLH chart, refer to any questions or comments about day and night and their causes.

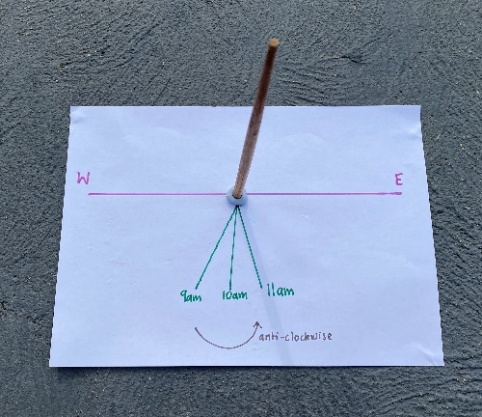
## Question • Observations about day and night

**An observation to take place over the course of a school day**

Explain to students that you will undertake an observation of the location of the sun over the course of a school day, using a shadow stick. Note that this is best done on a sunny day.

On a large sheet of white paper, draw a horizontal line and mark its ends with "E" and "W". Take the paper outside and lay it on the ground in a location that will be in full sun for most of the school day. Using a compass, position the paper so that the "E" and "W" points are pointing east and west. Use blu-tac to attach a stick, skewer or chopstick in the centre of the line at a 90° angle.

Mark the position of the shadow created by the stick at regular intervals throughout the day. You might also take photographs of the shadows to show their movement over the course of the day. The data collected will be examined and discussed as part of the *Integrate* routine of this lesson.

****

Shadow stick set up

The movement of the shadow

Ask students to define and describe day and night by identifying different times throughout the day (for example 9am, 1:30pm, 7pm, 12am) and detailing:

* what they, and others, might be doing at that time of the day.
* if light from the Sun can be seen at that time.
* where the Sun is.

For example:

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| **Time** | **What is happening** |
| 9am | It is light.  You can see the sun.  You don’t need the lights on.  School begins.  People are at work. |
| 2pm | It is light.  You can see the sun.  You don't need the lights on.  It might be hotter than it was in the morning.  Lunchtime is finishing. |
| 6:30pm | In summer it is still light and you can still see the sun.  In winter it is already dark and you can see the moon.  You might need to turn lights on to be able to see.  People are cooking or eating dinner.  People are getting home from work. |
| 11pm | It is dark.  The moon can be seen.  You need to turn lights on to be able to see.  Lots of people are in bed.  Some people are working. |

**Pose the question:** *What causes day and night?*

## Investigate • Modelling day and night

Darken the room and place a single light source in the centre of the room to represent the Sun. Role-play day and night with students by asking them to face towards the light (day) and away from the light (night). Remind students not to look directly into the light source.

This role-play might also be replicated in collaborative teams using a torch. One student holds a torch to represent the Sun. Holding the torch horizontally they should point it towards another student representing the Earth (taking care not to shine it directly into students' eyes).

Discuss the role-play and how students moved to face towards and away from the light. Also discuss the role-play as a form of scientific model, created in 3D.

**Potential discussion prompts**

* *What was the main difference you saw/experienced when facing towards and away from the light?*
* *How did you move your body when you changed positions?*
* *What was representing the Sun?*
* *What was representing the Earth?*
* *What did the model allow us to experience?*
  + When we were ‘facing’ the Sun we experienced day, and when we were turned away from the Sun we experienced night.
* *What were the limitations of the model?*
  + For example, the light source may not have been able to send out 360° light waves, there was no or little heat to accompany the light (making it unlike the Sun), students’ bodies are not the same shape as the Earth, the model doesn’t provide a full explanation of what causes day and night.
* *Why do you think scientists might call this a 3D model?*
* *What does 3D mean?*
  + 3 dimensions—height, width and length. Real objects are 3 dimensional.
* *What does 2D mean?*
  + 2 dimensions—length and width. Flat images are 2 dimensional.
* *What would be different if we tried to model the same thing in 2D?*
* *Is this model using an ‘Earth’ view or an ‘Astronaut’ view?*
  + When the student is taking the role of Earth in the model they are looking at the light as if it is the sun, and viewing how they would from Earth. The student holding the torch to represent the Sun (and any observers) are actually experiencing the ‘Astronaut’' view, as they can see what is happening from space.

**Optional:** Use the **Earth from space Resource sheet**to view a gallery of images that show Earth as it would be viewed from space. Compare it to a flat 2D map of the Earth (noting that the images are also 2D), and discuss how and why these maps are different. Point out the different continents that might be visible in the images, including Australia. You might also look at a globe to compare the flat 2D images to a 3D model.

Display a 2D map of Australia and ask students to identify the approximate location of their school. Ask them to identify the location of Sydney and Perth and discuss how Sydney is on the east coast of Australia and Perth is on the west coast. You might use Google Maps or a similar tool to view the relevant locations in an interactive way. Alternatively, students might locate these themselves in groups, before a class discussion.

Create an example 3D model for students with a small, cut-out map of Australia, with Sydney and Perth marked on it, stuck to a basketball or similar. Discuss how the basketball is a 3D model (sphere) of the Earth. Note that the map of Australia is 2D, as it is flat, but it will suffice for the purposes of the model.

In teams, students create their own 3D models by attaching a cut-out map of Australia to a ball.

Darken the room, and in collaborative teams, students model the following scenarios using their model of the Earth and a strong lamp or torch to represent the Sun's light:

* daytime in both Perth and Sydney.
* daytime in Sydney and nighttime in Perth.
* nighttime in Sydney and daytime in Perth.

Note: Sydney and Perth have been selected for this model as they are the two major Australian cities with the closest latitude. However, any locations on the east coast versus the west coast of Australia will suffice. Locations may be changed to better suit your context.

## Integrate • How does Earth move?

Teams share what they found when working with their 3D models.

**Potential discussion prompts**

* *How was the ball positioned in relation to the sun when both cities were in daylight?*
* *How was the ball positioned in relation to the sun when both cities were receiving no light?*
* *Do you think we can show half of Australia receiving light and the other half of the Australia still being slightly dark? Can you model that?*
* *Did the direction (left or right) you turned the model affect which city received light first?*
  + When the model was turned towards the right (or clockwise) Perth would have received light first. When the model was turned towards the left (or anti-clockwise) Sydney would have received light first.
* *What time of the day is it when we’re first receiving light?*
  + Sunrise.
* *What's the opposite time of day to this?*
  + Sunset.
* *Is it possible for both cities to receive the first light of the day/experience sunrise at the same time?*
* *How might we confirm which way the Earth is turning, and therefore which city receives light/experiences sunrise first?*
* *Is the Sun moving, or are we/Australia moving?*
* *In the morning, is the Sun coming up, or are we turning towards the Sun? Why do you think that? Can you show me on your model?*

Remind students about the observations/recordings/images they took to track the movement of shadows over the course of day. Explain that by working out the change in direction of these shadows, they can figure out which way the Earth is turning.

Discuss the data collected and draw conclusions from it.

**Potential discussion prompts**

* *When shadows are formed, does the shadow fall towards the light source, or does in fall in the opposite direction to the light source?*
  + Shadows fall in the opposite direction to the light source.
* *Over the course of the day, did the shadows we marked move from east to west or west to east?*
  + The shadows moved from closer to west, to towards east as the day moved on.
* *What do you think that might tell us?*
  + Because shadows are cast in the opposite direction of the light source, in the morning when the shadows are pointing towards the west it must mean the sun is shining from the east. In the afternoon when the shadows are pointing east, the sunlight must be coming from the west.
  + That means the sun rises in the east and sets in the west.
* *Were the shadows moving clockwise, or anti-clockwise?*
  + The shadows were moving anti-clockwise.
* *What must this confirm for us about the direction the Earth spins?*
  + It tells us that the earth spins in an anti-clockwise direction.

Use one of the 3D models (ball with the map of Australia attached) to show that in this model, the east coast of Australia receives light first, before it gradually moves across all of Australia. Also, discuss how this means that the east coast also moves into night first, as the shadow reaches it first.

Introduce the term ‘rotates’ as the term typically used to describe the spinning movement of the Earth.

Students use the **Sunrise sunset Resource sheet** to represent what they observed using 3D models on a 2D model. Support students to do this by comparing this view to what an astronaut might be able to see from space (Astronaut view) if they were observing sunrise over Australia.

Discuss other places in the world and how the people on the other side of the Earth experience ‘opposite’ times as compared to people in Australia—when we are facing the Sun and experiencing ‘day’, they are facing away from the Sun and experiencing ‘night’, and vice versa. Demonstrate this by placing stickers or small figures on a part of the ball that corresponds approximately to the location of another country in relation to Australia. Select locations to explore that students may have, for example, travelled to or where they may have relatives.

Ask students to identify if they know how long it takes for the Earth to rotate once, going through a cycle of day and night. Students may already have identified that a day takes 24 hours.

Either as a class or independently, construct a sentence to explicitly identify that it takes (approximately) 24 hours for the Earth to rotate, which is why days are 24 hours long.

Review the original question posed, *What causes day and night?*, and write a sentence to answer the question.

**Optional:** Use the ‘world clock’ feature available on mobile devices or [a world clock website](https://www.timeanddate.com/worldclock/) to explore the current time/date at various locations around the world.

**Optional:**Discuss 24-hour time.

**Reflect on the lesson**

You might:

* add relevant terms to the class word wall or glossary.
* add to the L and H columns of the TWLH chart.
* consider and discuss the importance of using models in science to help study and understand phenomena we cannot ‘touch’ or see easily, and why it is valuable to learn about the Earth, Sun, Moon, and space.

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**Year 6**

Space innovators • Lesson 4 • How long is the day?

**lesson 4**

**inquire**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit:  [https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-4-how-long-day](https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-4-how-long-day?utm_source=docx&utm_medium=lesson4&utm_campaign=SI) |

# Lesson overview

Students use physical models to explore how the tilt of the Earth affects the length of the day and night.

## Key learning goals

Students will:

* explore and investigate variable day and night length.
* consider the impact variable day and night length has on their life and the lives of others.

Students will represent their understanding as they:

* contribute to discussions about variable day and night length.
* draw a labelled diagram to represent their learning.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* how students model the orbit and rotation of the Sun and Earth, as well as the tilt of the Earth.
* the conclusions that students draw from this modelling/simulation.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* [Midnight sun Antarctica](https://www.youtube.com/watch?v=9jF349mX2lw) (1:49)
* Optional: a strong lamp to model the Sun’s light
* Optional: a wooden skewer or similar
* Optional: a styrofoam ball

To demonstrate the group investigation you will need the following:

* A strong lamp/torch to model the Sun’s light
* A ball to represent Earth
* A sticker or label to place on the ball to represent the location of Australia

**Each group**

* A strong lamp/torch to model the Sun’s light
* A ball to represent Earth
* A sticker or label to place on the ball to represent the location of Australia

**Each student**

* Individual science journal (digital or hard-copy)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | 15 minutes | Collaborative teams, Whole class |
| Integrate | 30 minutes | Whole class, Individual |

# Inquire

## Re-orient

Refer back to the experiences of Lessons 2 and 3, reviewing:

* the terms ‘orbit’ and ‘revolve’.
* the sentences composed in Lesson 3 to explain what causes day and night.
* why a day is 24 hours long.

## Question • What’s happening in Antarctica?

Watch the video [Midnight Sun Antarctica](https://www.youtube.com/watch?v=9jF349mX2lw) (1:49).

Watch the first 1-2 seconds of the video before pausing. Draw students’ attention to the timestamp at the bottom of the recording (this is different from the YouTube timestamp). The time visible will be around 02:30-03:30. Discuss what this time of the day is like, what students are typically doing at that time of the day, what they expect Antarctica to be like at this time, and what the people there (scientists mostly) would be doing.

NOTE: The recording device is measuring in 24-hour time. However, as sunlight is clearly visible, students are likely to assume that the footage was captured in the afternoon.

As you watch, note that at 21 seconds (according to the YouTube timestamp) the video time on the recording device clicks over to 13:00. Discuss 24-hour time and acknowledge that the video started at a time students would consider “the middle of the night”.

As you continue to watch the video, draw students’ attention to the time and the level of daylight visible. Re-watch the video as required.

Determine the perspective the video is taken from (an ‘Earth’ view).

**Pose the question:** *How can Antarctica experience ‘daytime’ all day, and not have night?*

## Investigate • 24 hours of day!

Discuss with students whether any of the models they worked with in Lesson 2 could be used to explain how Antarctica can have periods where it faces the Sun for the whole 24 hours of the day. Note that Antarctica also has periods where it faces away from the Sun for whole days at a time and constantly experiences night.

Inform students that they are now ‘switching’ to Astronaut view to try and work out how Antarctica might experience 24-hour periods of sunlight and darkness.

Show students a ball, representing a 3D model of the Earth. Place a sticker/label at the location of Antarctica. Using a light source to represent the Sun, model that a 24-hour day or night cannot be fully explained by the Earth simply rotating.

In collaborative teams, students use a light source and a model of the Earth (with Antarctica marked) to investigate how they might position the Earth so that Antarctica is facing the Sun for a full rotation of the Earth.

Allow teams time to explore what they might do to achieve this. Ask them to make a claim, if possible, about the position the Earth would have to be in to make this possible.

Monitor groups as they explore, prompting students to tilt the ball at various angles as required.

## Integrate • Tilted Earth

Teams present their findings to the class and (if they can) make a claim about how the Earth might be positioned so that Antarctica is facing the sun for a full rotation.

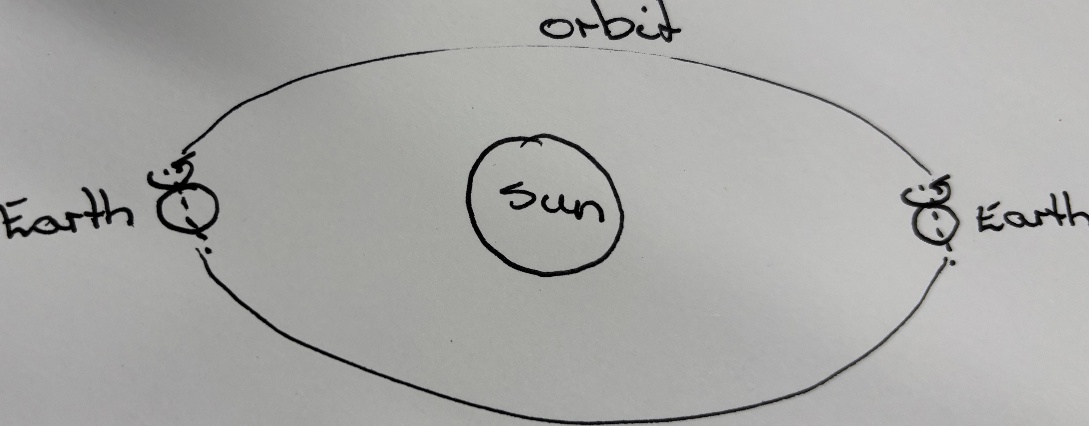
Discuss what students noticed during their modelling, with a focus on the location of Antarctica relative to the Sun throughout the year. Determine through questioning and discussion that, if Antarctica receives light from the Sun constantly for some of the year and no light at all some of the year, then it must be angled towards the Sun for part of the year and angled away from the Sun for part of the year. Continue on to explore if the same applies to the Arctic.

Next, explore what this means for the varying number of daylight hours we receive in Australia across the course of the year. Make a generalisation, applicable to your location in Australia, about daylight and darkness hours and how they change over course of the year. For example: In September/October the days are beginning to become longer. We know this because it is still light later at night. In January/December the days are longer and we see more sunshine. We can stay outside until much later without the need for a torch or other artificial light source. As it moves into March and June the days begin to get shorter. By July and August, the darkness hours are the longest.

You might support this by looking at data on sunrise and sunset times for today’s date at your location, making a note of them in the class science journal ([Sunrise and Sunset in Australia](https://www.timeanddate.com/astronomy/australia) is a good resource for this). Select another day approximately three months ago, also noting sunrise and sunset times. Repeat twice more so that you have represented (approximately) quarterly Sunrise and Sunset times for your location.

Give collaborative teams time to again explore the concepts using their 3D model, this time focusing on the location of Australia, and how it is angled towards the Sun during different times of the year. Focus on the difference between rotation, which provides day and night, and orbit (with angle), which provides variable day and night length.

Introduce the term ‘axis’ and discuss. This might be modeled using a skewer or similar pushed through a styrofoam ball.

Discuss how the 3D model students were working with can be drawn as a 2D model using an Astronaut view. Suggest that students may need to draw two or more diagrams to show the Earth orbiting around the Sun at different times of the year.

A 2D drawing, from the 'Astronaut' view, showing the Earth's orbit around the Sun in a single diagram. Note that students may also draw two separate diagrams to show this.

Allow students time to complete a 2D diagram/s from the Astronaut view showing how the rotation, orbit and tilt of the Earth cause days and nights that are different lengths throughout the year.

Ask students how long they think it takes for the Earth to orbit around the sun, and why they think that. Refer back to the generalisations made about daylight hours over the course of the year and determine that these are cyclical and repeated every year, therefore the orbit around the sun must take a year, or 365 days.

Optional: Discuss how Earth's orbit actually takes approximately 365 and ¼ days, so every 4 years we have an extra day in a leap year to make up for these extra ¼s.

## Reflect on this lesson

You might:

* consider the original question posed before the investigation: *How can Antarctica experience ‘daytime’ all day and not have night?* Jointly construct a sentence or two to answer this question and record it in the class science journal.
* add relevant terms to the class word wall or glossary.
* add to the L and H columns of the TWLH chart.

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**Year 6**

Space innovators • Lesson 5 • Phases of the moon

**lesson 5**

**inquire**

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# Lesson overview

Students use secondary data to explore the phases of the Moon and track the phases over the time period of a lunar month. They explore a timeline of events that led to the Moon landing.

## Key learning goals

Students will:

* explore the phases of the Moon.
* determine if the Moon revolves and/or orbits.

Students will represent their understanding as they:

* record the changing shapes of the Moon over time.
* contribute to discussions about the appearance of the Moon.
* make notes about the Apollo 11 mission.
* contribute to discussions about the design of spacecraft.

## Assessment advice

In this lesson assessment is formative.

Feedback might focus on:

* students’ recognition of patterns in terms of the phases of the Moon.
* students’ understanding of the different points of view of the Moon.
* students’ understanding of how the relative positions of the Sun, Earth and Moon causes the phases of the Moon.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Equipment to access the internet and watch suggested video clips and view images
* Demonstration copy of the **Moon gazing Resource sheet**
* Demonstration copy of the **Moon monitoring Resource sheet**
* Demonstration copy of the **What’s in a rocket? Resource sheet**
* [Footage from the 1969 Apollo 11 moon landing](https://www.youtube.com/watch?v=hzApsIPHRwo) (1:27)
* [Humans in Space - Behind The News](https://www.abc.net.au/btn/classroom/humans-in-space/10526760) (3:59)

**Each group**

* [Stellarium Web’s sky viewer](https://stellarium-web.org/) or [NASA’s Daily Moon guide](https://moon.nasa.gov/moon-observation/daily-moon-guide/?intent=011)
* One of the following videos:
  + [How the Apollo Spacecraft works: Part 1](https://www.youtube.com/watch?v=8dpkmUjJ8xU) (3:38)
  + [How the Apollo Spacecraft works: Part 2](https://www.youtube.com/watch?v=tl1KPjxKVqk) (4:57)
  + [How the Apollo Spacecraft works: Part 3](https://www.youtube.com/watch?v=qt_xoCXLXnI) (3:45)

**Each student**

* Individual Science journal
* **Moon monitoring Resource Sheet** (or make their own)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | Variable | Collaborative teams, Individual |
| Integrate | 15 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | 15 minutes | Collaborative teams |
| Integrate | 15 minutes | Whole class |

# Inquire

## Re-orient

## Using the TWLH chart, refer back to anything students identified or any questions students asked about the Moon.

## Question • Looking at the moon

**Pose the question:** *Does the Moon look the same every night from Earth? How does its shape change over time?*   
  
Discuss with students what they have observed about the shape of the Moon, as from the 'Earth' view.

View the image gallery in the Moon gazing Resource sheet and ask student to describe the 2D ‘shapes’ of the Moon they can see.

Explain that scientists/astronomers refer to the changes in the Moon’s shape as *phases*, and that today we will be investigating these phases to find out what they are and what causes them.

**Pose the question:** *What are the phases of the Moon?*

## Investigate • Making observations of the moon

**Investigation Part 1**

Using [Stellarium Web’s sky viewer](https://stellarium-web.org/)(or [NASA’s Daily Moon guide](https://moon.nasa.gov/moon-observation/daily-moon-guide/?intent=011)), and the Moon monitoring Resource sheet, students chart and record what the Moon looks like over a four-week period, noting the date and recording an image of what the Moon looked like on that date.

Note: The shadows on the Moon are different in the southern hemisphere than the northern hemisphere. If using the Stellarium Web's sky viewer, it can detect your location and will show you the Moon accordingly. You can also select a location manually. If using NASA's Daily Moon guide, make sure to use the toggle to switch the view to 'Southern hemisphere'.

You might like to assign each group a different four-week period throughout the year, to establish a pattern. It’s also preferable if students begin their data collection on the date of a new Moon, as that represents the beginning of the lunar cycle, and matches the simulator they will view later.

Encourage students to view the Moon themselves over the course of the coming week, recording the shape of the moon at the same time and in the same location each evening, to see if their personal observations match the shapes shown by the Moon viewer.

**Investigation Part 2**

Discuss how in the previous lesson students turned a 3D model into a 2D drawing. Explain that this time, students have made 2D drawings of the Moon, and are now going to model the phases of the moon in 3D.

Place a lamp in the centre of the room to represent the Sun (alternatively, each group can use a torch to represent the Sun). Provide each collaborative team with a ball to represent the Moon. Explain that one student’s head will represent the Earth. That student will have an ‘Earth' view of the Moon. The other member/s of the team will have a an 'Astronaut' view of the moon.

Have teams spread out across the classroom, ensuring that the ‘Earth’ is not looking directly into the lamp.

Note to students that, whilst in reality the Earth would also be moving around the sun (as determined in previous lessons), it is not necessary to include that movement in this model to gain an understanding of how the phases of the Moon occur. Students may experiment with including this extra movement if they wish.

Teams move the Moon ball around the ‘Earth’ and observe how much of the surface of the ball is lit up as they do so.

Students should take turns changing roles so they can experience the 'Earth' view and the 'Astronaut' view.

Note: This investigation might also be carried out with each group using a torch to represent the sun. The torch should be held horizontally and pointed directly at the Earth.

## Integrate • What’s happening to the Moon?

Teams share and compare their observations of how the lit part of the Moon changed over time in both the 2D model and the 3D model they have looked at.

**Potential discussion prompts**

* *How were you viewing the moon when you were tracking its shape—using an 'Earth' view or the 'Astronaut' view?*
* *How did the 2D appearance of the Moon change during the time frame you tracked?*
* *Was there any order, or pattern, to the way its appearance changed? If so, what was this pattern?*
* *Did you observe a full lunar cycle? How do you know?*
  + *The first shape of the cycle appears again.*
* *What do you think causes the phases of the Moon?*

Discuss the comparison between the 2D model and the 3D models of the Moon at different stages.

**Potential discussion prompts**

* *How much of the Moon was lit up as you moved it around the ‘Earth’?*
* *Did the Moon become more or less bright?*
* *What view are you taking in each role? An Earth view or an Astronaut view?*
* *What were the similarities/differences in what you could see in each position?*
* *Is the far side of the Moon always dark? How do you know? Which view are you using to see this?*

Discuss students’ thoughts about the Moon as a source of light, and if they think it makes its own light. Present the claim that the Moon does not create its own light (as some parts of the Moon can be dark) and is only reflecting the light of the Sun.

Introduce the terms ‘waxing’ (to increase) and ‘waning’ (to decrease). Note for students that this particular definition of ‘waxing’ comes from Old English, and is rarely used in that sense today in modern language. Acknowledge the more common usages of the words wax and waxing as in candles, ear wax and hair removal.

Show students the terms for all the phases of the Moon and attempt to match them to the images using deductive reasoning connected to the definitions of the terms used.

Relate the language to what part of the Moon can be seen.

**New Moon:** No Moon can be seen at all, or only the edge can be seen. It’s the start of the cycle.

**Waxing crescent:** The part of the Moon that can be seen is a crescent. The crescent is growing.

**First quarter:** A quarter of the Moon can be seen. Discuss why it is called a ‘quarter’ when it actually looks like half (because it’s only half of a half—remember there is a full half of the Moon we can’t even see!).

**Waxing gibbous:**When the moon looks between half and full. ‘Gibbous’ comes from the Latin word for hump, and is often used to describe something that is rounded or convex in shape.

**Full Moon**: The full face of the Moon can be seen.

**Waning gibbous:** The Moon looks the same as the previous ‘gibbous’ phase, only on the opposite. It is said to be waning because it is decreasing towards a new Moon again.

**Third quarter:** We see only the other half of the half of the Moon we see.

**Waning crescent:** Again, a crescent shape, but waning to a new Moon.

Discuss how the Moon travels around the Earth. Reintroduce the term ‘orbit’ as a way of describing how the Moon moves around the Earth.

Review the original questions posed: *Does the Moon look the same every night from Earth? How does its shape change over time? What are the phases of the Moon?*Construct a sentence or paragraph to answer the questions.

## Question • Looking at the moon

View [Footage from the 1969 Apollo 11 moon landing](https://www.youtube.com/watch?v=hzApsIPHRwo) (1:27) and discuss what students know about the moon landing. Refer to anything on the TWLH chart that students might have shared at the beginning of the sequence.

Discuss how space exploration has allowed humans to get much closer to the Moon and explore more about space than telescopes could.

**Pose the question:** *How did humans first get into space?*

## Investigate • Looking at the moon

In collaborative teams, students watch one of the following video clips: *How the Apollo Spacecraft works:*[*Part 1*](https://www.youtube.com/watch?v=8dpkmUjJ8xU)*,*[*Part 2*](https://www.youtube.com/watch?v=tl1KPjxKVqk)or[*Part 3*](https://www.youtube.com/watch?v=qt_xoCXLXnI)*.*

Using the relevant section of the **Mission to the Moon Resource sheet**, they take notes and/or draw diagrams in relation to the question prompts and anything else they found interesting.

## Integrate • Looking at the moon

Teams share notes, answers and any diagrams on the relevant part of *How the Apollo Spacecraft works*. Record a version in the class science journal.

Using a demonstration copy of the **What’s in a rocket? Resource sheet,** discuss and label the main parts of the Saturn V rocket and the Apollo 11 spacecraft, including a description of the purpose of each part.

Create a Venn diagram to compare and contrast the similarities and differences between the lunar module and the command module, with a focus on the design features that enables each module to achieve its purpose:

Both modules had a similar purpose—to land the astronauts safely at the desired location.

The purpose of the lunar module was to land on the surface of the Moon.

The purpose of the command module to land the astronauts safely back on Earth.

Each module was designed specifically to achieve this purpose in light of the conditions.

Discuss how the design on a rocket might differ depending on its purpose. For example, if the rocket was delivering a communications satellite into Earth’s orbit it would not need to return to Earth.

**Optional:** Look at a diagram of a rocket/spacecraft designed for an alternative purpose and discuss how they differ from the Apollo 11 rocket/spacecraft.

Watch [Humans in Space - Behind The News](https://www.abc.net.au/btn/classroom/humans-in-space/10526760) (3:59). Discuss how space exploration technology has come a long way since the Moon landing in July 1969, with many space missions achieved, remote-controlled ‘cars’ landing on and exploring Mars, and even the launch of the International Space Station that has had astronauts living on it continuously since November 1998. Also accept, acknowledge, and discuss other information students may have pertaining to space exploration.

## Reflect on this lesson

You might:

* consider the two questions posed before each investigation: *What are the phases of the Moon?*and *How did humans first get into space?*Jointly construct a sentence or two to answer these questions and record them in the class science journal.
* add relevant terms to the class word wall or glossary.
* add to the L and H columns of the TWLH chart.

**Year 6**

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Space innovators • Lesson 6 • Our Solar System

**lesson 6**

**inquire**

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# Lesson overview

Students use secondary data to investigate and model the distances between the different planets and dwarf planets in our Solar System.

## Key learning goals

Students will:

* use secondary sources of information to identify the size of different planets and their distance from the Sun.
* use the information to compare the relative size of planets.
* use the information to compare the relative distances of the planets from the Sun.

Students will represent their understanding as they:

* identify appropriate secondary sources of information.
* collate and tabulate their information of the size of different planets and their distance from the Sun.
* compare and order the planetary information according to planet size and distance from the Sun.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ processing, modelling and analysing.
  + Are they able to develop a physical model of the Sun and Earth using objects or role-play to describe their relative positions?
  + Are they able to organise information in tables to describe patterns and trends?

In this lesson, assessment might also be also summative.

* Have students demonstrated an understanding of the relative position of the Sun and other planets in the solar system, particularly Earth, and used models to explain observable phenomenon?
  + Refer to students’ labelled scale models or diagrams to determine their understanding.
  + Does their diagram show an understanding of the relative position, size and distance between the Sun, Earth and Moon (allowing for limitations to the model caused by its form)?
  + Does their diagram show an understanding of the movements of these objects?
  + Do their annotations explain the observable phenomena they have explored?

## Resources

**Whole class**

* Class science journal (digital or hard-copy)
* Demonstration copy of **Solar System information organiser Resource sheet**
* 2 x balls, one large and one small
* Access to information about the Earth via the internet or books etc. on the solar system
* Optional: Objects to represent relative sizes of planets, for example:
  + a poppy seed (Mercury)
  + 3 x peppercorns (Earth, Mars and Venus)
  + table tennis ball (Jupiter)
  + large marble (Saturn)
  + 2 x large peas (Uranus and Neptune)
* Optional: 100m rope or similar
* Optional: Measurement tools to measure distances of up to 100m

**Each group**

**Solar System information organiser Resource sheet**

Access to information about the planets via the internet or books etc. on the solar system. Useful pages include:

* [Solar System Sizes - NASA Science](https://science.nasa.gov/resource/solar-system-sizes/)
* [Planet Sizes and Locations in Our Solar System - NASA Science](https://science.nasa.gov/solar-system/planets/planet-sizes-and-locations-in-our-solar-system/)
* [About the Planets - NASA Science](https://science.nasa.gov/solar-system/planets/)
* [How Long is a Year on Other Planets? | NASA Space Place – NASA Science for Kids](https://spaceplace.nasa.gov/years-on-other-planets/en/)

Optional: If building a scaled model, objects to represent relative sizes of planets, for example:

* a poppy seed (Mercury)
* 3 x peppercorns (Earth, Mars and Venus)
* table tennis ball (Jupiter)
* large marble (Saturn)
* 2 x large peas (Uranus and Neptune)

**Per student**

* Individual science journal (digital or hard-copy)

|  |  |  |
| --- | --- | --- |
| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 15 minutes | Collaborative teams, Whole class |
| Investigate | 20 minutes | Collaborative teams, Whole class |
| Integrate | Variable | Collaborative teams, Individual |

# Inquire

## Re-orient

Review the notes taken during the modelling task in Lesson 2, where students selected different sized balls to represent the Sun, Earth and Moon.

Ask students: *Now that you have learned more about space, would you select the same balls to represent the Sun, Earth, and Moon?*

## Question • It’s all about perspective

Confirm for students that the Sun and Moon are indeed very different in size, but sometimes they can appear to be the same size in the sky. Ask students why they think that is.

Present two balls, one large and one small and ask students how they might make the two balls appear to be the same size. Allow students time to experiment with perspective, to see how far away they need to move the larger ball to make it appear the same size as the smaller ball.

Highlight that the larger the object, the further away it has to be to appear much smaller.

**Pose the questions:***What else is in our Solar System? How big and how far away are things?*

Ask students to name/list any planets (or other things in the Solar System) that they know of.

## Investigate • Researching the solar system

Students work in collaborative learning teams to gather information about objects in our Solar System, so that they can make an accurate model or labelled diagram of the Solar System later in the lesson.

Using the demonstration copy of the **Solar System information organiser Resource sheet**, model how to use the tables provided by gathering information about Earth.

Discuss each part of the table, including:

* the size of the object is measured using its diameter (how wide the planet is if you measure from one point to another, going through the centre).
* how far the object is from the Sun.
* the length of a ‘day’ is how long it takes the object to rotate once on its axis.
* the length of a ‘year’ is the number of days it takes to orbit the Sun once. We often use ‘Earth days’ to measure the length of years on different planets, to help us compare values.
* the information source identifies where the secondary information comes from.

Remind students of the importance of recording the unit of measurement used for each answer, because it tells the reader the size of a number; for example, kilometres are 1000 times bigger than metres. Using the same unit where possible (e.g. km for size in diameter or average distance from the Sun) means that the numbers can be compared.

Note: If students end up using information sources from American-based websites (such as NASA), it might be helpful to discuss the different units of measurement used there in comparison to most countries in the world. In most instances imperial measurements will be given first followed by metric measurements. It might also be helpful to note other comparative language used that students might not have any reference for, for example, comparing the size of planets by referencing nickels and dimes.

In collaborative teams, students research and collect information on 2-3 objects in our Solar System, such as Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, the Kuiper Belt, and dwarf planets such as Pluto, Ceres, Orcus, Makemake.

Note: You might provide students with specific websites to find reliable information, such as:

* [Solar System Sizes - NASA Science](https://science.nasa.gov/resource/solar-system-sizes/)
* [Planet Sizes and Locations in Our Solar System - NASA Science](https://science.nasa.gov/solar-system/planets/planet-sizes-and-locations-in-our-solar-system/)
* [About the Planets - NASA Science](https://science.nasa.gov/solar-system/planets/)
* [How Long is a Year on Other Planets? | NASA Space Place – NASA Science for Kids](https://spaceplace.nasa.gov/years-on-other-planets/en/)

## Integrate • Comparing data

Teams share and compare their findings with other groups. Create a complete picture of the objects in the Solar System by compiling all groups information. Discuss any unusual findings, for example, any differences between data found about the same object and why that occurred, or that a day on Venus is longer than a year (a full orbit of the Sun).

**Potential discussion prompts**

* *Is \_\_\_\_\_ larger or smaller than \_\_\_\_\_?*
* *Is \_\_\_\_\_ closer to the Earth or further away from the Earth?*
* *Why do you think different resources might report slightly different distances between the Sun and any given planet?*
  + For example: Orbits are elliptical, which means the distance from the Sun might vary depending on when the measurements were made.
* *How many years old might you be on that planet?*
* *Have you noticed that a day on Venus is longer than a year? How do you think that could happen? How could you model it?*

Reorganise the information by asking students to place their findings in order of size. Discuss how the planets start small closest to the Sun, become larger in the middle distance, and become smaller again as the objects are placed further away from the Sun.

Discuss with students what making something ‘to scale’ means, for example, ensuring that all parts of the model are the correct size relative to each other. Add an agreed-upon description to a word wall or glossary in the class science journal.

Next, students build a scale model using objects to represent the planets, or draw a scaled and labelled diagram.

**If building a scale model**

Show the objects students will have available to them to represent the planets (poppy seeds, peppercorns, peas, marbles, table tennis balls, basketballs). Discuss which objects could represent the planets in the Solar System and why, noting that Pluto and any moons will be too small to be represented. Also discuss with students how to represent the different distances between the planets.

Allow students time to create their scale model. Take a photograph of each student’s model, and ask them to label each object.

**If drawing a scaled diagram**

Discuss how students might compare the diameters of different planets to work out how large they might draw each object. For example, you might discuss how Earth and Venus are similar in size, with Mars about half the size, and Mercury about a third. Jupiter is 11 times bigger than Earth while Saturn is 9 times bigger than Earth. The sun is 10 times bigger than both of them! Also discuss with students how to represent the different distances between the planets.

Note: Students might find it difficult to make comparisons between such large numbers. If required, support your students by making these comparisons as a whole class, on all the objects you want them to include in their diagrams. Do the same for the distances between them.

Discuss how well students’ models represents the Solar System, where the objects in it are relative to one another, the distances between them, and how the objects move.

**Potential discussion prompts**

* *Was everything we know about the Solar System accurately represented in the scale model?*
* *What did you find challenging about arranging a model to scale?*
* *What have you found out?*
* *What are the strengths of this model?*
* *What are the weaknesses of this model?*
  + For example, some planets are harder to see as they are so small compared to the Sun.

**Optional:** To demonstrate the comparative distance between the planets, build a ‘human-sized’ model of the Solar System in a large open area. Position a student/s representing the Sun in the centre of the space and hand them a 100m rope. The student/s representing Neptune walk out along the rope for 97 metres to represent the distance between Neptune and the Sun. Repeat with the other planets using the information below. Use appropriate measuring devices as needed.

|  |  |
| --- | --- |
| **Planet** | **Scaled distance from the sun (m)** |
| Mercury | 1.25 |
| Venus | 2.33 |
| Earth | 3.23 |
| Mars | 4.91 |
| Jupiter | 16.77 |
| Saturn | 30.75 |
| Uranus | 61.85 |
| Neptune | 96.92 |

Discuss how long or short the orbits were and what this might mean in terms of ‘years’ and how fast the planet is moving.

**Note:**Depending on the available space, some space objects may not be able to ‘orbit’ the Sun.

Discuss how a planet further away from the Sun takes longer to complete an orbit. Model this by asking students to walk around a central ‘Sun’ at the same speed. Students who are further away will need to walk a greater circumference than students who are closer to the ‘Sun’.

**Optional**: View some of the standard images of the Solar System that students are likely to have seen in books or during their research. Discuss how neither the relative sizes nor the distances are to scale in these diagrams, why people choose to represent it this way, and the advantages and disadvantages of doing so.

## Reflect on the lesson

You might:

* consider, given the difference between the relative sizes and distances of planets, why scientists use scaled models to show what is happening in the Solar System.
* consider how we use the movements of the Earth and Moon to count time. While Europeans use Earth’s orbit around the Sun to identify a person’s age, the Ngarrindjeri Peoples of South Australia traditionally used the number of full moons to count the age of a baby under one year old.
* add relevant terms to the class word wall or glossary.
* add to the L and H columns of the TWLH chart.

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Description automatically generated with medium confidenceSpace innovators • Lesson 7 • Landing a command module

**Year 6**

**lesson 7**

**inquire**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit:  [https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-7-landing-command-module](https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-7-landing-command-module?utm_source=docx&utm_medium=lesson7&utm_campaign=SI) |

# Lesson overview

Students design a parachute system for a command module, then conduct a fair test to determine how the parachute’s design might affect its descent time.

## Key learning goals

Students will:

* design a parachute system for a command module, then conduct a fair test to determine how the parachute’s design might affect its descent time.

Students will represent their understanding as they:

* construct appropriate representations to record and interpret data collected during their tests.

## Assessment advice

In this lesson, assessment is summative.

Students working at the achievement standard for Science inquiry should have:

* planned safe, repeatable investigations to identify patterns, test relationships, and make reasoned predictions.
* identified variables to be changed, measured, and controlled.
* used equipment to generate and record data with appropriate precision.
* constructed representations to organise and process data and information and describe patterns, trends, and relationships.

## Resources

**Whole class**

* Class science journal (digital or hard-copy)
* Equipment to access the internet and watch suggested video clips and view images
* Demonstration copy of the **Command module landing investigation planner Resource sheet**
* Demonstration copy of the **Variables grid Resource sheet**
* Video**:** [How the Apollo Spacecraft works: Part 3](https://www.youtube.com/watch?v=qt_xoCXLXnI)(3:45).

**Each group**

* Various materials to design and construct a command capsule and parachute prototype for testing. For example: scissors, glue, sticky tape, blu-tac, string, cardboard, sheets of plastic, paper, foil, foam, felt etc.
* **Command module landing investigation planner Resource sheet**

**Per student**

* Individual science journal (digital or hard-copy)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Re-orient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | Variable | Collaborative teams |
| Integrate | 15 minutes | Whole class |
| Investigate | 15 minutes | Collaborative teams, Whole class |
| Integrate | 20 minutes | Collaborative teams, Whole class |

# Inquire

## Re-orient

As a class, rewatch [How the Apollo Spacecraft works: Part 3](https://www.youtube.com/watch?v=qt_xoCXLXnI)(3:45).

## Question • How was the command module designed?

Look closely at the command module, and list the design features that enabled it to re-enter Earth’s atmosphere and land safely:

* the heat shield designed to withstand the extreme temperatures of re-entry
* the parachutes to slow the descent of the capsule
* the material and shape of the capsule itself, designed to be buoyant (able to float) on the water after landing

Discuss whether students will be able to test all three of these features in the classroom, and why it would not be possible to replicate the extreme heat of re-entry in a safe manner in the classroom.

Explain that for this activity students will focus on the parachutes used to slow down the descent of the capsule as it comes in for landing.

**Pose the question:***What’s the best parachute design to allow for safe descent of the command module?*

## Investigate • Parachute design

Consider the question: *What things might affect the descent time of a command module as it lands?*

Discuss how taking a long time to land means that the landing will be more gentle for the astronauts. Therefore, a longer descent time (bigger number) is what is desired by Space Command.

Use a variables grid to record students’ ideas and the potential variables, for example; the size, shape, material, and number of parachutes, the way the parachute/s attached to the capsule, the weight of the capsule.

Determine which variable students are going to test (and therefore change) and write an investigable question.

For example: *What happens to the descent time of the command module if we change the number of parachutes attached?*or*What happens to the descent time of the command module if we change the shape of the parachutes?*, and so on.

Determine the variables students might be unable to control, such as the wind at the time of testing. Consider how they might lessen the impact of these (e.g. using weather predictions, or aborting testing for a more suitable time).

Determine ways that the parachutes and capsule can be tested safely. For example, selecting a set of stairs that people do not use very often and stationing people at the top and bottom of the stairs to prevent people from walking underneath the dropped capsules.

Using the **Command module landing investigation Resource sheet**, teams design and carry out a fair test to answer their testable question.

They record data on descent time as they carry out the test, and use the data collected to make a claim about how the variable tested affects descent time.

See the embedded professional learning *Adapting to your context—selecting or designing a command module* for more information on the command module students will use for this investigation.

## Integrate • Design decisions

Students share their investigation results with the class, including the claim they have made to answer their investigable question.

Use the [QCER tool](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/facilitating-evidence-based-discussions?utm_source=docx&utm_medium=lesson7&utm_campaign=SI%20)to help guide the discussion around claims and related evidence, and the [CROWN tool](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/crown?utm_source=docx&utm_medium=lesson7&utm_campaign=SI%20) to guide the discussion about the design on the capsule and parachute.

The class might refer to the [science question starters](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/facilitating-evidence-based-discussions?utm_source=docx&utm_medium=lesson7&utm_campaign=SI%20) as a means of interrogating students designs and results more deeply.

Discuss what the data collected by students might mean in terms of the design of the parachutes and the command module for spacecraft.

**Potential discussion prompts**

* *Did the number of parachutes (or shape, material etc.) have a clear impact on the descent time of the parachute? What effect did it have? Why do you think this happened?*
* *Did the weight of the command module affect the descent time? Why do you think that?*
* *Why do you think they left so many parts of the original rocket behind and didn’t bring them all back from space?*
* *Do you think having the slowest descent time is always the best and safest option for landing astronauts back on Earth? Why do you think that?*
* *What other designs (besides the one used for the Apollo 11 mission and that we’ve tested) might help astronauts get back from space safely?*
* *What would you consider if you were redesigning the landing method from scratch?*

## Reflect on the lesson

You might:

* add relevant terms to the class word wall or glossary.
* add to the L and H columns of the TWLH chart.

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**Year 6**

Space innovators • Lesson 8 • Designing for space observation

**lesson 8**

**ACT**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit:  [https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-8-designing-space-observation](https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators/lesson-8-designing-space-observation?utm_source=docx&utm_medium=lesson8&utm_campaign=SI) |

# Lesson overview

Students apply their understanding of how scientists have built upon each other’s work over time by designing something that can be used to record data, information and observations about space, or space related phenomena.

## Key learning goals

Students will:

* design an innovation to enable better or further exploration into space.

Students will represent their understanding as they:

* contribute to discussions about the observable phenomena brought about by the Earth’s orbit and rotation, as well as the technological innovations that have enabled their exploration.
* share and explain their design, how it will enable further exploration of space, and how it builds upon the work of other scientists.

## Assessment advice

In this lesson, assessment is summative.

Students working at the achievement standard for Science as a human endeavour should have:

* recognised that science is a collaborative discipline, and that advancements and innovations are in some way based on what has come before.
  + Refer to students’ contributions to discussions.
  + Refer to their design for space exploration and how they have identified the previous innovation or work it is built on.
* described how individuals and communities use scientific knowledge.
  + Refer to students’ ideas on what they hope their innovation might contribute to the world.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://primaryconnections.org.au/teaching-sequences/year-6/space-innovators?tabIndex=2) for further information.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Equipment to access the internet and watch suggested video clips and view images
* [What's inside of the Lunar Module?](https://www.youtube.com/watch?v=oX8-IXdABuc) (7:30)
* [5 Space inventions we use everyday](https://www.youtube.com/watch?v=BXavpLJtHII) (3:40)
* [SpaceX completes world first landing after rocket booster caught by mechanical arms](https://www.youtube.com/watch?v=3GwQdrhp__k) (2:29)
* Demonstration copy of the **Invention convention Resource sheet**

**Per student**

* Individual science journal (digital or hard-copy)
* Optional: Various materials to build prototypes of their designs

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Anchor | 10 minutes | Whole class |
| Connect | Variable | Whole class |
| Design | Variable | Collaborative teams, Individual |
| Communicate | Variable | Collaborative teams, Whole class |

# Act

## Anchor • What have we learned so far?

Review the learning that has occurred over the course of the sequence using the class science journal, including concepts relating to:

* where the Sun, Earth and Moon are in relation to one another.
* what causes day and night.
* why day and night are different lengths at different times of the year.
* the phases of the Moon.
* the innovations that have enabled humans to observe and explore space more closely.

## Connect • Looking back to look forward

Review a timeline of how humans’ understanding of space has changed. Focus on how science knowledge about space has been built over time, and is often based on the work that has come before, as well as the design innovations that have enabled space exploration, and the impacts of these designs.

### A suggested timeline of events to review

**Ptolemy to Galileo**

Review the **A history of the heavens Resource sheet** and the subsequent notes taken in Lesson 2.

**Potential discussion prompts**

* *Even though scientists today no longer agree with them, the ideas of astronomers like Ptolemy who believed in an Earth-centric model of the solar system are still very important. Why do you think that might be?*
* *Besides Galileo, who else believed in a sun-centred model of the solar system? Did they have the ideas before or after Galileo?*
* *If Galileo was not the first scientist to think the sun was in the centre of the solar system, then why is his work remembered so widely today?*
* *Why was the invention and use of the telescope so important to establish what scientists now understand about space?*

**Apollo 11**

Watch [What’s inside of the Lunar Module?](https://www.youtube.com/watch?v=oX8-IXdABuc) (7:30). Through questioning and discussion consider the design choices that were made and why they were made. For example, discuss why the windows were made smaller on the Lunar Module, why its shape did not matter (it didn't have to be aerodynamic), how many designs were tested, why they were tested first without humans aboard, why the legs were retractable etc.)

**After Apollo 11**

Watch the video [5 Space inventions we use everyday](https://www.youtube.com/watch?v=BXavpLJtHII) (3:40).

Using the demonstration copy of **Invention convention Resource sheet,**discuss and take notes on the five inventions that were originally designed to solve a problem related to space travel that have been adapted for use on Earth.

|  |  |  |
| --- | --- | --- |
| **Invention** | **The space problem it solved** | **Adaption for use on Earth** |
| Scratch resistant lenses | To prevent the Moon dust from scratching the astronaut's visors | To prevent scratching on glasses and sunglasses |
| Infrared ear thermometers | To measure the temperature of the surface of the Sun and planets | To measure the temperature of sick people without touching them |
| Cordless tools/drill | Drill into Moon rock to collect samples | To build things when there is no electricity |
| Memory foam | Safer seats for astronauts during lift-off and return | Pillows and mattresses |
| Water filters | Clean/recycling water for astronauts | Clean/recycled water on Earth. |

**Optional:**Allow students time and opportunity to research other such inventions such as camera phones, athletic shoes (NIKE) shoes, foil blankets, dust buster vacuums, home insulation, the Jaws of Life, wireless headsets, freeze dried food, artificial limbs/robotics, portable laptop, nappies, and Light Emitting Diodes (LEDs).

**The now of space travel**

Watch [SpaceX completes world first landing after rocket booster caught by mechanical arms](https://www.youtube.com/watch?v=3GwQdrhp__k) (2:29).

Consider this innovation in light of previous space missions, and make a list of the parts of a rocket or spacecraft that are jettisoned during a mission and never reused.

Consider that as of 2024 there had been 391 human space flight missions—and this doesn’t count all the unmanned missions that take satellites and other communications equipment into space!

**The future of space travel**

Discuss what the future of space travel might look like and the problems that it might need to solve. This discussion leads into the first step of the upcoming design process.

## Design • Design for the future

Students will design, and potentially create a crude prototype of, an innovation that will enable new or further exploration of space. They might consider new frontiers in space exploration, or making space exploration more sustainable and environmentally friendly.

### Define

Outline the task in a simple manner such as:

*How can we design something that will enable humans to explore a space-related phenomenon more closely/easily?*

Outline who the students could be designing for. For example, will they design something to support astronauts travelling into space, for use on the International Space Station, or on the Moon or Mars? Examine the challenges that might be experienced.

Students might also be interested in building more complex working models to demonstrate the phenomena they have investigated throughout the sequence.

### Ideate

Brainstorm ideas for space related phenomena students would like to more about. For example, they might like to know how weather satellites work, what astronauts eat, how to colonise Mars, if we could travel to a black hole or the Sun.

At this stage, to support creative thinking, every idea offered by students should be recorded in the class science journal. No idea is discounted, as the practicality/possibility of each idea will be considered later.

As students offer ideas, ask probing questions (*What do you already know about weather satellites? What are scientists’ current claims/ideas about the Sun or black holes? Have humans ever made it to Mars, and in what capacity?*) to draw out where students may to start their thinking in order to design their innovations.

**Optional:** It may be appropriate here to allow students some time to research and take a deep dive into one particular area of interest.

Determine the criteria for how students’ designs might demonstrate the scientific concepts explored during the sequence. For example:

* The design should include some information about the phenomenon they seek to further explore.
* The design should reference the science and innovations that have come before/inspired the design.

### Prototype

Allow students time to design their innovations. They may work individually or in teams.

They may build a crude (i.e. non-operational) prototype to show their design, or produce a paper-based illustration of their design.

**Optional:**Students/teams are provided opportunities to share their ideas and receive peer feedback ([download AITSL's guide for more on peer feedback](https://www.aitsl.edu.au/docs/default-source/feedback/aitsl-peer-feedback-stratedy.pdf)).

## Communicate • Sharing our designs

### Communicate

Students share their designs with the class.

They might share:

* the phenomena their innovation seeks to further/better explore.
* illustrations or prototype models of their designs.
* the previous science and/or innovation on which their work is built.

Students could:

* present their models to the class using appropriate voice, volume and pace skills.
* take photos/videos of their presentations.
* use a ‘Shark Tank’ format with invited judges.
* present their designs during science week activities.

**Reflect on the sequence**

You might:

* refer to the list of student questions from the TWLH chart begun in Lesson 1. Determine which questions have been answered over the course of the learning sequence, what the ‘answers’ to the questions are, and the evidence that supports these claims. Address questions that have not been answered during the learning sequence, discuss why they might not have been addressed, and consider potential investigations that might support students to answer them.
* review students’ responses to the **Claims about the sky** activity completed in Lesson 1, comparing students’ initial ideas to what they think now and considering how their thinking has changed.
* consider what students have learnt about the Sun, Earth and Moon, other planets, and the innovations that have enabled space exploration.
* ask students to represent this learning in words, symbols and pictures.
* discuss why it’s important to have a good understanding of the position of the Sun, Earth, Moon and other planets.