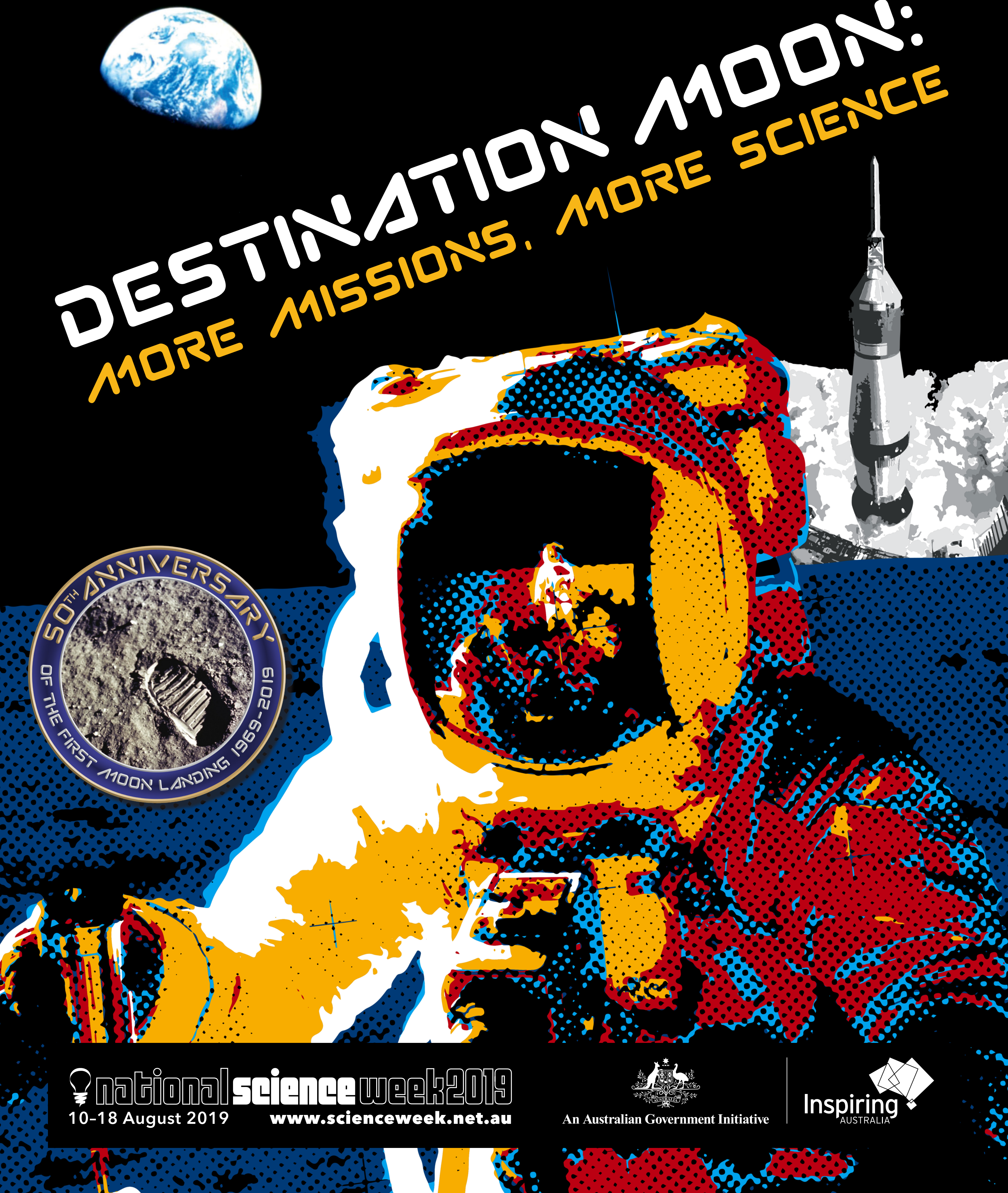
resource book of ideas

for National Science Week 2019

DESTINATION MOON:

MORE MISSIONS, MORE SCIENCE



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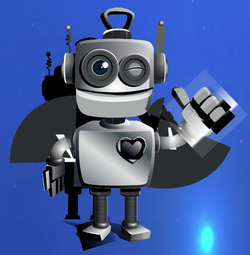

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DESTINATION MOON:
MORE MISSIONS, MORE SCIENCE

Acknowledgements

This online curriculum-linked resource was produced by the Australian Science Teachers Association (ASTA).

This curriculum-linked resource is designed to introduce young people to the importance of science and technology in solving problems, designing new solutions, and predicting humanity's future expansion into space.

The materials in this educational resource have been developed by Angela Colliver from Angela Colliver Consulting Services Pty Ltd and designed by Carl Davies, CMDphotographics.

We would like to acknowledge Dr Brad Tucker, Geoff Crane, Kerrie Dougherty, Phillip Berrie and Delese Brewster for their assistance and feedback.

All links to websites were valid between October 2018 and January 2019. As content on the websites used in this resource book might be updated or moved, hyperlinks may cease to function.

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Minister's Foreword

In 2019, the world celebrates the 50th anniversary of the Apollo 11 lunar landing and first moonwalk. Australia's space tracking stations played a vital supporting role, relaying to the world the first televised images of Neil Armstrong stepping onto the Moon's surface. In fact, Australia has been an integral part of NASA's deep space missions since 1957… and now we have our own space agency.

In July 2018, the Australian Government announced the establishment of the Australian Space Agency to capitalise on the burgeoning growth in the international space industry. The agency will use 'big picture thinking' to solve problems and use science, technology, engineering and mathematics (STEM) to design new solutions to forge our future paths in the areas of space operations, space science, Earth observations, positioning systems and communications.

The Australian Government is also proud to be the major supporter of National Science Week. National Science Week 2019 offers a real-world opportunity to enhance the level of societal understanding and engagement with space science, global space activities and the work planned by the Australian Space Agency.

'Destination Moon: more missions, more science' is the school theme for National Science Week in 2019. This is an important theme for teachers and their students to discover and investigate not only past space programs and missions to the Moon, but also the new and innovative space programs, operations and missions of today, and those planned for the future.

This year's Resource Book of Ideas for National Science Week offers teachers and students the opportunity to celebrate the 50th anniversary of Apollo 11 as well as the UN-declared International Year of the Periodic Table of Chemical Elements. It offers many opportunities to explore 'big picture thinking' when exploring, understanding and utilising science to investigate people in the space industry, in space agencies, in universities, and in science organisations that are all delivering solutions in space science.

I encourage all teachers to explore this amazing resource and to share the wonders of space science with their students.

The Honourable Karen Andrews MP

Minister for Industry, Science and Technology

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Introduction

National Science Week is Australia's annual celebration of science and technology.

It aims to provide an opportunity to acknowledge the contributions of scientists and STEM professionals to the world. It also aims to encourage an interest in science and STEM among the general public, and to encourage younger people to become fascinated by the world in which we live, a world where the prospect of interplanetary travel and extraterrestrial colonisation becomes more real every day.

The school theme of 2019 National Science Week is 'Destination Moon: more missions, more science'. It focuses on:

- how the combination of scientists, engineers, chemists, designers, mathematicians, flight directors, software experts, aerospace technicians and the technologies they used made the NASA Apollo 11 mission a success 50 years ago;
- the space technologies and designs that have made more missions into space possible;
- the space industry capabilities being envisioned and prototyped today, that inevitably will fulfil ambitions of returning to the Moon and other destinations in our solar system.

Any chronicle of our fascination with space must begin at a time when Indigenous Australians, and other indigenous peoples around the world looked out into the night sky, at the Moon and stars, and shared stories about the constellations they saw there.

Thousands of years later, history tells us that the Chinese invented and fired the first rockets around 1200 AD. In 1926, American rocketry pioneer, Dr Robert H Goddard designed and fired the first liquid-fuelled rocket (and this date marks the birth of modern rocketry). Other nations were quick to follow, with the Germans achieving their first success with a liquid-fuelled rocket in 1931 and the Russians in 1933. The US Army then followed in the 1950s with the Redstone rocket, a derivation of the German V2.

The next significant stepping stone into space was the invention, design and launching of space satellites that orbit the Earth. Some carry cameras and take photographs of the planet that help meteorologists predict weather and track extreme weather events. Some take photographs of other planets, the Sun, black holes, dark matter or faraway galaxies. These photographs enable scientists to better understand the solar system and universe. Other satellites are used for communications, such as television, satellite phones and emergency systems. A group of satellites working together also make up the Global Positioning System, or GPS.

In October 1957, the first space probe, Sputnik 1, was launched by the Soviets. It was placed in orbit around the Earth, and was followed by Sputnik 2 in November of that same year. Since that time, thousands of space probes have explored the surface of Mars, created maps of Venus and Mercury, taken close-up photographs of all the planets and many of their moons, and have even left our solar system altogether.

The first human in space was the Soviet cosmonaut Yuri Gagarin—who made the first ever crewed spaceflight on April 12, 1961—while Valentina Tereshkova was the first woman in space in 1963. Then, in March 1965, Alexei Leonov made the first spacewalk in history. Many space probes have been launched since that time to study Earth and measure the properties of space. A significant space probe was Voyager 1 which was launched in 1977 and has flown past Jupiter and Saturn. Some spaces probes have also left our solar system altogether.

The American Apollo missions began in 1967 and ended in 1972. The flight of Apollo 8 to the Moon marked the first occasion in which humans entered the gravity field of another celestial body. The Apollo 10 mission in May 1969 was a full-dress rehearsal for the Apollo 11 mission, in which all operations were performed except for the lunar landing. It was the Apollo 11 mission in July 1969, which conducted the first crewed landing on the Moon, and it deployed instruments, took photographs, collected samples, and safely returned the crew and samples back to Earth. Between late 1969 and 1972, Apollo missions 10–17 excluding the unsuccessful Apollo 13 continued to land, walk, and drive on the Moon, and studied the geological particles and magnetic field of the Moon and mapped its lunar gravity field. The Apollo 17 mission was the first to include a scientist, who investigated the Moon firsthand.

After these Moon missions, the Americans launched the first space shuttle, which was developed to provide a reusable vehicle for launching satellites and for other work in space.

In the late 1990s, five space agencies collaborated to build and send the International Space Station (ISS) into low Earth orbit. International crews have lived and worked on the ISS since November 2000 serving missions of 5–6 months apiece. This has demonstrated that people can live in orbiting space stations for extended periods of time.

Since then, more sophisticated space satellites, probes, orbiters, landers and rovers have been designed, programmed and launched into space to track, detect and make observations, collect data and expand our knowledge and understanding of space.

These epic phases of space science, space technology and innovation have in the twenty-first century, enabled a dynamic era of space science, space technology, and innovation to evolve, one in which a new generation of space instruments and satellite capabilities have been informed by quantum technologies, big data, optical research and data science.

Space programs are likely to evolve in the period from 2020 onwards, when new propulsion systems will make interplanetary travel more commonplace, and when we contemplate the colonisation of other planets. NASA plans to start building a Moon-orbiting space station called the Lunar Orbital Platform-Gateway in 2020 for launch in 2022. This outpost will be a waypoint for future missions and more distant destinations.

Space research is providing a source of inspiration for entrepreneurs, inventors, investors and stakeholders in space science across Australia and globally.

And, space science headlines are now heralding a new **Australian Space Agency**, Australia's central coordination point for national space activities and partnerships.

In the wake of these opportunities in space science, entire industries are being transformed and entirely new industries being created.

Today, those people involved in space industries are actively asking new questions, making new predictions, experimenting with new ideas and 'big picture thinking', and reaching conclusions that are shaping and creating new discoveries, ideas, and opportunities in the many areas of space science.

The stories and narratives of scientific space discovery, and the inquiries and activities in this resource book are drawn from historical and current day STEM contexts.

In compiling this resource book and its ideas, we have tried to sample the full breadth of topics and issues that might interest students in early childhood, primary and secondary school settings. We have also attempted to highlight space science, space research and innovations at work in Australia and overseas, in addition to ongoing space programs, space exploration, space activities and new space industries.

This resource book aims to encourage questions, inspire conversations, stimulate ideas, encourage experimentation and speculation, and offers a glimpse into the space sector, its discoveries, technological capabilities, and visions for our future in space.

National Science Week 2019

National Science Week for schools aims to inspire students about space science just as the Apollo program to the Moon did in the 1960s and 1970s.

This year (2019), is the 50th anniversary of the Apollo 11 Moon landing on July 20, 1969.

With this in mind, some of the inquiries, activities and themes used in this resource book examine space programs, space exploration, space projects, space activities, space technology, space efforts and our growing space industries.

Additionally, 2019 is the UN-declared International Year of the Periodic Table of Chemical Elements. It coincides with the 150th anniversary of the table's creation by Dimitri Mendeleev. This resource book also celebrates this anniversary by including scientific discoveries and information about the periodic table, its elements, and the elements found in space, and on the Moon. Additionally, the elements in space probes, tools and the technologies used by the Apollo astronauts are investigated. The following icons can assist teachers locate activities and case studies that support inquiries in these areas.


The 50th anniversary of the Apollo 11 Moon landing.


The International Year of the Periodic Table.

This resource book features past and emerging space-related research, technologies and ideas from the worlds of science, design, technology, engineering, mathematics, computer science and data science in connective and sometimes surprising ways.

Today there are many scientists, technologists, researchers, entrepreneurs, engineers, aerospace technicians and mathematicians laying the foundations for space activities in the 22nd century. Many of these individuals are working in areas that could result in new big picture, space-related ideas and discoveries, and we hope they will inspire students during National Science Week in 2019.

How to use this resource book

This resource book provides learning experiences to support your school's involvement in National Science Week 2019.

Aims

The National Science Week Resource Book, *Destination Moon: more missions, more science* provides schools with opportunities to:

- explore the creative processes at the heart of STEM, and their far-reaching influence in space exploration, space programs, the space industry and its activities;
- develop an understanding about the roles STEM, design and innovation play in understanding and addressing complex real-world space-related scenarios;
- discover how STEM has, and is, enabling scientists, researchers, inventors, entrepreneurs, engineers, and creative thinkers in growing space industries to influence space research and developments;
- discover and envision a range of creative solutions to real-world space scenarios;
- design research projects with the ultimate goal of sharing exhibitions, events, performances and educational activities, as part of National Science Week;
- design the steps required to create exhibitions, events, performances and educational activities, as part of National Science Week;
- dream and consider the many possible solutions to deal with the challenges posed by mankind's advances into space;
- deliver and debrief solutions for real-world space scenarios; and
- practise and reinforce the science, technology, engineering and mathematics messages delivered in the Australian Curriculum Learning Areas, General Capabilities and Cross Curriculum Priorities.

For schools, there is also the scope for teachers to integrate this resource book into their existing classroom programs.

The learning experiences

Teachers can use the learning experiences to plan, publicise, provoke, stimulate, support and inspire their National Science Week festivities. It is recommended that the activities are read and considered well before National Science Week, as many involve preparation and timing considerations.

The 'Solution Fluency', project-based learning activities require many weeks work. The standalone activities, and fun ideas for science stations referenced on **page 7** can be undertaken during National Science Week.

The resource book includes ideas to support students' involvement in investigating, exploring, experimenting, designing, creating and communicating their understandings about past and present space programs, space missions and their explorations, space activities, space projects, space science and our growing space industries.

The resource book is complemented by a National Science Week **Student Journal** that can be downloaded and printed. It is intended for older students to record their ideas: from defining the problems posed in the suggested activities to debriefing the solutions they devise.

The standalone activities and ideas for classroom work and science fairs found in the 'Have a go at this' sections of this resource book involve the purposeful application of knowledge, experience and resources to invent, design, create and make space-related objects, products, services and environments.

A **timeline** of Australia's history in space also complements this resource book. It tells the story of Australia's involvement with space activities from the earliest exploits to the latest Australian endeavours in space and the establishment of Australia's Space Agency.

Our goal in providing this range of activity types is to provide students with exciting and creative educational experiences so that they can contemplate career paths in space.

The '**At a glance**' section (**p 7**) gives an overview of activities and a list of the videos linked to in this resource book.

The '**Looking for PBL Tasks for National Science Week**' section (**p 8**) provides an overview of what is involved in each PBL task that uses the Solution Fluency methodology in the resource book.

Curriculum focus

This learning resource has a variety of student activities that link to the Australian Curriculum for science, technologies, mathematics, history, and the arts. It also has many opportunities to integrate the Australian Curriculum's General Capabilities and Cross Curriculum Priorities into school's learning programs.

STEM, STEAM, Project Based Learning (PBL) and the use of makerspaces are supported in the ideas in this book.

Teaching and learning featured in this resource book can therefore be integrated into a range of learning areas and learning contexts in the lead up to and during National Science Week.

A suggested learning process

The PBL learning sequences used in some of the learning activities in this book are underpinned by the work of Lee Watanabe-Crockett.

It uses the Solution Fluency methodology through six phases: Define, Discover, Dream, Design, Deliver and Debrief. The phases of the model are based on the **21st Century Fluencies** created by *Crockett et al.* (2011).

The Essential Fluencies are outlined extensively in the book *Mindful Assessment* (Crockett, L. & Churches, A. (2016) Mindful Assessment (Solution Tree). See also '**Solution Fluency**' on the Global Digital Citizen Foundation website, and the Solution Fluency video **Solution Fluency** on YouTube (3:13 min).

For reference the fluencies are:

- Define: The 'Define' phase begins with lessons that intellectually engage students with a challenge, problem, question and task. This phase captures their interest, provides an opportunity for them to express what they know about the topic, share understandings being developed, and helps them to make connections between what they know and the new ideas.
- Discover: The 'Discover' phase includes activities in which students can explore, investigate, research, read, discuss, gather, organise and compare knowledge and data. They grapple with the challenge, problem, question or phenomenon and describe it in their own words. This phase provides a context and enables students to acquire a common set of experiences that they can use to help each other make sense of the new knowledge or understandings.
- Dream: The 'Dream' phase enables students to imagine and develop possible solutions and explanations for the challenge, problem, question and task they have experienced. The significant aspect of this phase is that the students' explanations follow substantive conversations and higher-order thinking experiences.
- Design: The 'Design' phase provides opportunities for students to apply what they have learned to new situations, to map production processes and so develop a deeper understanding of the challenge, problem, question or phenomenon. It is important for students to extend explanations and understandings, using and integrating different modes such as diagrammatic images, written language and media.
- Deliver: The 'Deliver' phase has two stages—production and publication or presentation. In the production phase, the task comes to life—this is the doing aspect. At the end of this phase, the student task should be completed. Next, they present or publish their work sample to an audience.
- Debrief: The 'Debrief' phase provides an opportunity for students to revisit, review and reflect on their own learning and new understanding and skills. This is also when students provide evidence for changes to their understanding, beliefs and skills.

*Source: '**Solution Fluency'**, Global Digital Citizen Foundation website.*

At a glance…

The following overview chart provides page references and links to stand alone activities, videos and ideas for science fairs. Number in brackets after each activity also denotes page number.

Activity Type–Standalone activities for Science Fairs

Foundation–Year 2	Year 3–Year 4	Year 5–Year 6	Year 7–Year 10
Can you create a moonscape and program a Sphero to navigate it safely? (**p 19**)	Which astronaut, scientist, engineer or technician, who made landings on the Moon possible, might make the best Pokémon? (**p 36**)	Get your crew ready (**p 55**)	Breathe life into history (**p 72**)
Design and create a Moon-inspired artwork using TurtleArt (**p 20**)	Create a night sky journal (**p 37**)	Travelling to the Moon (**p 56**)	More advanced than us? (**p 73**)
Create a 3D spacecraft using Quiver (**p 21**)	Might space travel be easy and fun? (**p 38**)	Space probes and the Moon (**p 57**)	The Australian Space Agency (**p 74**)
Let's create and make (**p 22**)	Design a lunar rover (**p 39**)	Make the impossible possible (**p 58**)	The Periodic Table (**p 75**)
Write it up (**p 23**)	Comic relief (**p 40**)	What can you do to help make people aware of the Australian Space Agency? (**p 59**)	
The Australian Space Agency- dream, draw and write your ideas about it (**p 24**)	It's confidential (**p 41**)	The Periodic Table (**p 60**)	
The Periodic Table (**p 25**)	It's elementary (**p 42**)		

Looking for PBL Tasks for National Science Week?

The following information provides an overview of what is involved in each PBL task that uses the Solution Fluency approach in the resource book.

Foundation–Year 2

Activity 1: "I Spy" lots about the Earth's moon (p 13)

In this learning sequence, students are challenged to explore the Earth's moon. They design and produce a text modelled on the game "I Spy" to share their observations and understandings of the Earth's moon.

Students will:

- investigate the Moon using videos, stories, images and other information;
- locate information about features found on the Moon;
- learn about the Moon's craters and how they were formed;
- experiment with different substances to simulate and make craters on a moon;
- observe the Moon and learn about the phases of the Moon;
- use their findings and the words needed to write an "I Spy" text;
- share the observations and facts learned about the Earth's moon; and
- make a glossary of words and phrases about the Moon.

Activity 2: Rocketry (p 16)

In this learning sequence, students are challenged to investigate the rockets that put humans into space and on the Moon, and they design, engineer and build a model rocket. Students also try a number of science activities, ask some scientific questions, make a *Fascinating Facts about Rockets* book describing what they have learned and share it as part of National Science Week.

Students will:

- investigate how scientists are curious, investigate questions, and make fascinating discoveries;
- use makerspaces and explore how rockets can be built and launched as well as discover fantastic facts about rockets; and
- design and make a *Fascinating Facts about Rockets* book.

Year 3–Year 4

Activity 1: How might astronauts live and work in space? (p 29)

In this learning sequence, students explore forces. Their task is to use science to show exactly how microgravity affects how astronauts live and work in space.

Students will:

- explore forces and gravity;
- experiment with water bottles, paper, magnets, string, straws, balloons and paperclips;
- investigate how weightlessness affects astronauts on space missions; and
- design a demonstration about what weightlessness is and how it affects the way astronauts live and work in space.

Activity 2: Australia's part in a great adventure (p 33)

In this learning sequence, students investigate the role Australia played in the Apollo 11 landing on the Moon.

Students will:

- investigate the Honeysuckle Creek Tracking Station, Tidbinbilla Deep Space Tracking Station and the telescopes at the Parkes Observatory in NSW;
- view videos and images about the Apollo 11 mission to the Moon;
- locate information and images of the massive radio antennas or 'dishes' that are used to relay commands to, or receive data from, spacecraft;
- draft the story their exhibition piece might tell others about Australia's contributions to televising the first landing on the Moon in July 1969; and
- design and present their exhibition piece for a pop-up Science Week museum display.

Year 5–Year 6

Activity 1: Let's manage some space traffic (p 45)

In this learning sequence, students explore space traffic issues and then design and make a solution for managing satellites out in space.

Students will:

- investigate methods used to manage traffic and then apply them in space;
- investigate space satellites and space traffic;
- design ways of managing space satellites to stop them colliding with one another; and
- host a 'Space Traffic Management Day' and invite students, teachers and parents to discover what the class thinks might be possible.

Activity 2: Design and build a shock absorbing system to assist the Lunar Module land safely on a surface like the Moon (p 47)

In this learning sequence, students learn from the best engineers and design a shock absorbing system to assist spacecraft land safely.

Students will:

- investigate the purposes of shock absorbing systems and how they are a mechanical or hydraulic device designed to absorb and dampen shock impulses;
- design and build a shock absorbing system that can allow a vehicle similar to the Lunar Module and its equipment and crew to descend and land safely;
- investigate springs and their ability to absorb impacts;
- learn about the Lunar Module and its landing equipment;
- use ideas as a springboard to help them consider ways they can design and produce their own shock absorbing system;
- design and build their own shock absorbing system for a vehicle similar to the Lunar Module; and
- Host an 'Apollo 11 Descent Day' as part of National Science Week.

Activity 3: Cosmic war on waste (p 50)

In this learning sequence, students design and create a technology to remove space junk from our skies and then increase awareness about debris issues affecting space.

Students will:

- discover information about the amount of space debris circling the Earth;
- research technologies in the planning and currently being executed to clean up space;
- find examples of what people are doing to address sustainable practices and promote ways people can reduce the amount of space debris; and
- design a solution that can remove debris from space.

Activity 4: Looking into space (p 52)

In this learning sequence, students research astronomers and technologies used in space exploration. They also use science, technology and art to create a piece for a Science Week Exhibition titled 'Looking into Space'.

Students will:

- investigate the role of telescopes, space probes, satellites, spacecraft, rockets, space shuttles, space telescopes and space stations in enabling us to 'look into space';
- view art installations for ideas;
- research the Australia Telescope National Facility; and
- design and present their artwork for a Science Week exhibition titled 'Looking into Space'.

Year 7–Year 10

Activity 1: Pitch your space idea (p 63)

In this learning sequence, students investigate emerging ideas in Australia's space industry and then design a sustainable space solution and sell a pitch as part of a 'Space Pitch' competition.

Students will:

- discover how people in the space industry are working with new ideas, technologies and entrepreneurs to re-imagine how space can be explored;
- discover pioneering companies and their engineers that are pursuing careers in space industries;
- analyse theories and business ideas;
- consider sustainable products and systems integrated into space technology and space activities;
- explore space start-ups and discover their innovative ideas;
- investigate the application of Artificial Intelligence (AI) in rocket launching and landing as well as data transmission;
- learn how to design and deliver an effective pitch;
- re-imagine and design a service, product or system that could be used in space exploration; and
- sell their pitch as part of a 'Space Pitch' competition.

Activity 2: Asteroid mining (p 67)

In this learning sequence, students consider what is ethically and socially responsible in a future with asteroid mining.

Students will:

- investigate how many asteroids may exist in a near-Earth orbit that could potentially be mined and what minerals they might contain;
- learn about Australian research teams involved in investigating the various options for mining asteroids;
- find out which minerals are thought to be found within asteroids and the reasons for mining them;
- use a SWOT analysis, Edward de Bono's Six Thinking Hats, and Positive, Minus, Interesting (PMI) techniques to analyse ethical considerations involved in the idea of mining asteroids; and
- create a scientific report or presentation and host an 'Investigating Mining Asteroids Day' as part of National Science Week.

Activity 3: Colonisation in space (p 70)

In this learning sequence, students investigate attempts to design and construct colonies in space.

Students will:

- investigate what NASA and other authors have written about space colonisation; and
- design and deliver presentations to audiences about the issues and opportunities of creating colonies in space and share information about how scientists and researchers are looking at creating colonies in space.

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Early Years of Schooling
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Activity 1: "I Spy" lots about the Earth's moon

Iron
Fe
Atomic No. 26

Who Knew?

Iron is found in the core of the Earth and the Moon.

Overview: *Explain to the class that they will be exploring the Earth's moon. They will design and produce a text modelled on the game "I Spy" to share their observations and understandings of the Earth's moon.*

Background science for teachers and students: Earth's moon

Earth's moon is the only place beyond Earth where humans have set foot. It is the brightest and largest object in our night sky. It is the fifth largest moon in our solar system. The Moon has no air; however, there is a very, very thin layer of gases on the lunar surface called an 'exosphere'.

Our moon has many surface features that we do not have on Earth. There are 'seas' without water. In photographs, the Moon's seas are smooth, large, dark areas. They were formed when large asteroids impacted with the Moon's surface.

There are lots of dark and light spots on the Moon's surface. The moonscape includes cracks, dead volcanoes, rocks, boulders and craters. The majority of the Moon's craters are circular and are impact craters that formed when meteoroids, asteroids, or comets collided with the Moon's surface. There are many craters on the Moon, some large and some small.

From the space missions that have explored the Moon, we know that it is a cold, harsh ball of rock with extreme temperatures, bleak rocky terrain, and no obvious liquid water. However, more recently, some evidence of water has been found on the Moon.

We know that anyone without a spacesuit would suffocate, overheat when in full sunlight and freeze if exploring in shadow on the Moon.

The essential question:

How can we investigate and understand more about the Earth's moon?

Scenario:

Be inquisitive and understand more about the Earth's moon. Observing and recording information is an important part of science.

National Science Week is looking for classes to observe things about the Earth's moon and then create I Spy posters to share observations and facts about the Moon.

What science investigations might help you?

Your challenge is to use science and observe, discuss and record your observations and the facts you learn about the Earth's moon.

A suggested learning process:

Define:

Share the essential question with the class and talk about the Earth's moon.

Record students' ideas on a classroom's 'Word Wall'.

Present the scenario, assign groups if appropriate, and ask students to define the task they have been set.

Discover:

Capture student interest by going outside on a clear day when the Moon is visible. Ask the students what they observe. Share observations and record where the Moon was found, what shape it was, what it might be close to, how it might be reached, and—if reached—what might be found there.

View the video **Landing on the Moon: 20 July 1969** on YouTube (9:55 min) of the Apollo 11 mission and witness our first glimpse of what the surface of the Moon looks like. As a class, talk about and describe what the Moon looks like.

Visit the NASA website and view the **gallery of images of the Moon**. Make lists of students' comments and questions. These could be presented as a table under the headings "What we know", "What we are not sure about", and "What we want to know".

Immerse students in virtual moon environments using the app **Moon Atlas 3D**. Using pinch and finger gestures, ask students to manipulate the 3D globe of the Moon and locate and find named features and spacecraft that have reached the Moon's surface. Invite students to double tap on labels to get more information about features found on the Moon. Ask students to record information found about features of interest on the Moon for possible use in their I Spy posters.

Talk about the Moon's craters. Ask students the question: 'How might the Moon have got its craters?' In groups, ask students to work like planetary scientists to model the formation of craters by experimenting with different surface substances (sand, water, play dough, wet plaster and mud) and bombard the substances with pebbles or marbles to create craters. Compare findings using the different substances. Groups might also simulate a moon by covering a polystyrene foam ball with modelling clay and create craters by 'crashing' rocks onto the surface.

Invite students to do further research to help answer the question: 'How might the Moon have got its craters?' and share their answers.

Introduce 'STEM Story time' and share nonfiction stories about the Moon. The following are examples that can be used.

- **The Moon** by Carmen Bredson. This book features real photographs and photo illustrations accompanied by about three sentences per page. The book describes how the Moon was formed, what the surface of the Moon is like, why the Moon seems to change shape during the month, and how astronauts landed on the Moon in 1969.
- **The Moon Seems to Change** by Franklyn M. Branley. This book helps students understand why the Moon seems to change shape over the course of each 28 days. It provides labels for certain phases of the Moon (full, quarter, and crescent). It also discusses how the Moon appears to wax (get bigger) and wane (get smaller). Little diagrams, plus a suggested activity, help children understand how it is the Moon orbits around the Earth and makes it appear to change shape from night to night.
- **So That's How the Moon Changes Shape!** by Allan Fowler. This book explains why the Moon seems to change shape over the course of each month. The book describes several phases of the Moon. It also deals with two common misconceptions: that the Moon is actually changing shape, and that the Moon generates its own light. The book uses mostly real photographs plus simple text to help children understand how the Moon changes shape.

After sharing and reading stories, talk about what students now know about the Moon.

As a class, brainstorm what facts students know and discuss the questions they might still like to find answers to.

Ask students if they can recall seeing the Moon in different shapes. Talk with students about the different shapes of the Moon that can be seen over a month.

Talk about the different Moon shapes that students can recall. In groups, look at **images of different moon shapes**. Learn more about why the Moon keeps changing its shape by viewing the video **Phases of the Moon** on YouTube (5:41 min). Talk with students about why the Moon keeps changing it shape and how this is called the 'phases of the Moon'. Discuss the causes and factors of the changing positions of the Moon and the various phases of it. Introduce the names of the different phases.

Download NASA's **Simulation of the Moon's Phases** and guide students through the phases of the Moon.

Using Oreo biscuits, ask students to replicate the phases of the Moon. Click **here** for a printable sheet to use in class.

Model the words needed to write an I Spy text. For example: 'I spy with my little eye something about the Moon. What can it be? It starts with...'. Give the students practice reading the words.

Design and create a **Rebus handout** to support younger students with their reading. For example: Use a picture of a magnifying glass and add the text 'with my little' and then add an eye... In small groups, ask students to choose three things they have learned about the Earth's moon, and formulate a draft of their text and I Spy phrasing. For example: Crater. The Moon has lots of craters. 'I spy with my little eye something about the Moon. What can it be? It starts with C'.

Invite students to read aloud and share the observations and facts learned about the Earth's moon.

Ask students to identify words they may not be familiar with. Display these where all students can see them. Use a dictionary and look up the words and model this process to the students.

As a class, make a glossary of words and phrases about the Moon.

Dream:

Ask students to decide on the fact or observation about the Moon that they are going to use on their I Spy poster.

Ask students to imagine the steps involved in creating their I Spy posters to represent, share and reflect on observations or facts learned about the Moon.

Challenge students to think about the materials, tools, and equipment they will need to make or draw their I Spy posters.

Design:

Provide students with a folded sheet of cardboard with two eye holes on the first page. Invite students to design their I Spy posters.

Talk about the importance of an I Spy title above the two eye holes on the title page and ask students to decide on the text to be placed beneath the eye holes. Invite students to illustrate something about the Moon on the following page.

Ask students to gather the materials, tools, and equipment needed and then make their I Spy poster. Photograph students at work.

Deliver:

Play the game I Spy and share student understandings about the Earth's moon.

Create a display of students' posters and enjoy a day of learning about the Earth's moon.

Set up a display area in the class and invite other students, teachers and parents to "Discover our observations and facts learned about the Earth's moon".

Debrief:

Ask students to:

- reflect on their learning about the Earth's moon and draw and write about something new they discovered;
- describe their favourite memory of creating their work sample.
- describe how they might improve on what they have done, and
- name one thing they still want to learn about the Earth's moon.

Curriculum connections

Australian Curriculum: Science (ACARA)

Foundation

Science Inquiry Skills

Pose and respond to questions about familiar objects and events ACSIS014

Participate in guided investigations and make observations using the senses ACSIS011

Engage in discussions about observations and represent ideas ACSIS233

Share observations and ideas ACSIS012

Year 1

Pose and respond to questions, and make predictions about familiar objects and events ACSIS024

Participate in guided investigations to explore and answer questions ACSIS025

Use a range of methods to sort information, including: drawings and provided tables, and through discussion, compare observations with predictions ACSIS027

Compare observations with those of others ACSIS023

Year 2

Pose and respond to questions, and make predictions about familiar objects and events ACSIS037

Participate in guided investigations to explore and answer questions ACSIS038

Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions ACSIS040

Compare observations with those of others ACSIS041

Foundation, Year 1 and Year 2

Science as a Human Endeavour—Nature and development of science

Science involves observing, asking questions about, and describing changes in, objects and events ACSHE013, ACSHE021, ACSHE034

Year 1

Earth and space sciences

Observable changes occur in the sky and landscape ACSSU019

Technologies

Foundation, Year 1 and Year 2

Design and Technologies Processes and Production Skills

Explore needs or opportunities for designing, and the technologies needed to realise designed solutions ACTDEP005

Generate, develop and record design ideas through describing, drawing and modelling ACTDEP006

Use materials, components, tools, equipment and techniques to safely make designed solutions ACTDEP007

Use personal preferences to evaluate the success of design ideas, processes and solutions including their care for environment ACTDEP008

Sequence steps for making designed solutions and working collaboratively ACTDEP009

General Capabilities:

Literacy; ICT capabilities, Critical and creative thinking, Personal and social capability

Case Studies

The Apollo 11 landing on the Moon

In July of 1969, humans set foot on the first—and to date, only—celestial body away from their home planet. Watch **the story of Apollo 11** on YouTube (14:55 min) and find out about the story of Apollo 11, the mission that took Neil Armstrong, Buzz Aldrin, and Michael Collins to the Moon to take that historic “one small step for man, one giant leap for mankind”, watch the launch of the massive Saturn V rockets, listen to exchanges between the astronauts and mission control, see footage from the historic space mission that landed on the Moon, and find out more about how the astronauts got to the Moon (and back safely) and what they did there.

Space School

A number of Australian states and territories have Space Education Centres or hold Space Schools and Space Camps each year. Click on the links to find out what **Adelaide**, **Melbourne**, **Brisbane** and **Canberra** offer.

Activity 2: Rocketry

Overview: *Explain to the class that they will be investigating the rockets that put humans into space and onto the Moon, and that they will design, engineer and build a model rocket.*

Beryllium
Be
Atomic No. 4

Who Knew?

The mirrors of NASA's Spitzer Space Telescope are made almost entirely from beryllium.

Background science for teachers and students: Rockets

"A rocket is a missile, spacecraft, aircraft or other vehicle that obtains thrust from a rocket engine. Rocket engine exhaust is formed entirely from propellant carried within the rocket before use. Rocket engines work by action and reaction and push rockets forward simply by expelling their exhaust in the opposite direction at high speed, and can therefore work in the vacuum of space." Source: **Wikipedia**

NASA says a rocket is: "A vehicle, typically cylindrical, containing liquid or solid propellants which produce hot gases or ions that are ejected rearward through a nozzle and, in doing so, create an action force accompanied by an opposite and equal reaction force driving the vehicle forward. Because rockets are self-contained, they are able to operate in outer space."
Source: **NASA's 'Rockets Educator Guide'**

The essential question:

What happens when we understand how scientists, engineers and technicians design and engineer solutions that put humans and lots of experimental equipment into space and on the Moon?

The scenario:

Brilliant ideas have driven science and mathematics throughout time.

Thanks to space scientists, astrophysicists, aeronautical engineers, aerospace technicians, mathematicians, software experts, flight directors, designers, navigators and astronauts we have had many missions to the Moon and beyond.

Your challenge is to think like a space scientist, an aeronautical engineer or a technician and try a number of science activities and then design, engineer, and build a model rocket to test and fly at school.

You are also required to describe what you have learned about rockets and contribute it to a *Fascinating Facts about Rockets* book. Are you up for the challenge?

SAFETY NOTE:
Risk assessments will limit the materials students can use to propel their rockets.

A suggested learning process:

Define:

Capture students' interest by showing them some videos of rocket launches on the **NASA Jet Propulsion Laboratory** website.

Start collecting ideas by watching **Sylvia's Super Awesome Mini Maker Show: Rockets** on YouTube (3:04 min) showing how a young rocket scientist designs and makes a rocket. Instructions are available **here**.

Play NASA's game, **Build your own Space Mission**, where students can be a scientist or engineer, design their lab, choose a spacecraft, add equipment to it for the mission and then place the spacecraft into the nose of a rocket and launch it.

Ask students to articulate their understanding of the task/ challenge through oral conversation, and if appropriate, a written (scribed) statement.

Discover:

Watch videos and discover what the Apollo spacecraft looked like. It was made up of three modules: the Command Module, the Service Module and the Lunar Excursion Module.

Invite students to explore makerspaces with lots of materials, equipment and tools where they can explore and design, engineer and build a model rocket.

Suggestions for makerspaces:

Makerspace 1 can be set up with **pictures of different spacecraft and rockets**, for example: NASA's Apollo spacecraft or Saturn V rocket, Gagarin's Vostok capsule, the Falcon 9 rocket, or the SpaceX rocket.

Ask the students, working in pairs or small groups, to view the pictures and talk about the design features of the different rockets. Ask students to locate the nose cone, fins, body of the rocket and engine.

Ask students to share and compare their findings.

Invite students to justify their findings and discuss ways in which the different rocket features might be useful when designing their own rockets. For example: the fins stabilise and help direct the rocket; the nose cone is a pointed aerodynamic feature that assists in speeding the rocket through the atmosphere; etc.

Makerspace 2 can be set up with **a template to make a straw rocket** along with paper straws, sticky tape, textas, glue and thick card.

Ask students to design and make their rocket. Then, using the straw and a deep breath, test the rockets and measure the distance they can travel.

Makerspace 3 can be set up with digital devices and the game Minecraft.

Ask students to use their knowledge about rockets to create a new world and then design and build a rocket in Minecraft.

Challenge students to describe the design features included in their rocket.

Makerspace 4 can be set up with **instructions** and materials to make a paper rocket. For example: paper, sticky tape, scissors, thick pencils and straws. Note: This activity may need teacher support.

Invite students to read the instructions and safely use the materials and tools to design and make a paper rocket. Ask students to make one with fins and one without fins and to then test which flies better.

Challenge students to fly their rockets outside and discuss which ones flew the furthest, highest and why.

Makerspace 5 can be set up an iPad with the following **video**, and with the **instructions**, materials, tools and equipment needed to make a bubble-powered rocket. Materials needed include: A4 paper, refillable water bottles with a stopper, sticky tape, scissors, antacid tablets, paper towel, water and safety glasses. Note: This activity may need teacher support.

Challenge students to read the instructions and safely use the materials, equipment and tools to design their bubble-powered rocket. Ask students to wear their safety glasses and to test their rockets outside.

Invite students to talk about what forces might be powering their rockets. Ask students to draw a labelled diagram that describes what is happening to project the rocket into the air.

Makerspace 6 can be set up with LEGO bricks and a digital device with the LEGO WeDo program.

Challenge students to design and then build with LEGO bricks a rocket with a nose cone, fins, body of the rocket and engine. Then, task them with writing a program in LEGO WeDo to make their rocket launch and fly.

Makerspace 7 can be set up with a digital device, Squishy Circuit dough, LEDs, a piezoelectric buzzer, and a battery. Challenge the students to watch the video, **Squishy Circuits | Rocket Launch Project** on YouTube (2:39 min), follow the **instructions** and make a rocket.

Dream:

Ask students to imagine the steps involved in designing their model rocket and a 'Fascinating Fact' page that will be part of the class book.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples.

Design:

Ask students to design their model rocket and the layout for the accompanying Fascinating Fact page and decide on its title and text.

Ask students to draft their Fascinating Fact page text and plan what illustrations will complement the text.

Invite a peer class group to the class and ask the students to explain their model rocket's concepts and features to this audience and seek feedback on their ideas.

Deliver:

Ask students to make their rocket, fly and test it, and then create their Fascinating Fact page and what they have learned about rockets.

Prepare a class book of students' work samples.

Visit a local pre-school, kindergarten or day care centre to test and fly rockets and share the class book, then discuss the facts your students have learned about rockets with younger children.

Debrief:

Ask students to recall what fascinating facts about rockets they discovered.

Talk about what they might still like to discover and whether there is anything they would like to research or delve into more deeply.

Ask students to imagine ways to improve the design of their model rockets and reflect on possible additional improvements.

Ask students to describe their favourite part of designing, engineering and building a model rocket and sharing it with others as part of National Science Week.

Curriculum connections

Australian Curriculum: Science (ACARA, 2015a)

Foundation, Year 1 and Year 2

Science as a Human Endeavour—Nature and development of science

Science involves observing, asking questions about, and describing changes in, objects and events ACSHE013, ACSHE021, ACSHE034

Foundation

Science Inquiry Skills

Respond to questions about familiar objects and events ACSIS014

Participate in guided investigations and make observations using the senses ACSIS011

Engage in discussions about observations and represent ideas ACSIS233

Share observations and ideas ACSIS012

Physical Sciences

The way objects move depends on a variety of factors, including their size and shape ACSSU005

Year 1

Science Inquiry Skills

Respond to and pose questions, and make predictions about familiar objects and events ACSIS024

Participate in guided investigations to explore and answer questions ACSIS025

Use informal measurements to collect and record observations, using digital technologies as appropriate ACSIS026

Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions ACSIS027

Compare observations with those of others ACSIS213

Represent and communicate observations and ideas in a variety of ways ACSIS029

Year 2

Science Inquiry Skills

Pose and respond to questions, and make predictions about familiar objects and events ACSIS037

Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources ACSIS038

Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate ACSIS039

Use a range of methods to sort information, including drawings and provided tables ACSIS040

Compare observations with those of others ACSIS041

Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play ACSIS042

Physical Sciences

A push or a pull affects how an object moves or changes shape ACSSU033

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability, Ethical understanding.

Case Study

Learn about NASA's:

- **Juno mission** that travelled 588 million kilometres and has arrived at Jupiter after four years of space travel; and
- **ORIS-REx mission** that is recovering space rocks from the surface of a near-Earth asteroid called Bennu.

Activity 3:

Can you create a moonscape and program a Sphero robot to navigate it safely?

Be creative and design and make a moonscape using all of your knowledge about the Moon.

Will your moon have craters, ridges and boulders as seen in the images taken by the Apollo 11 crew?

What might you add to make the moonscape dusty just like our Earth's moon?

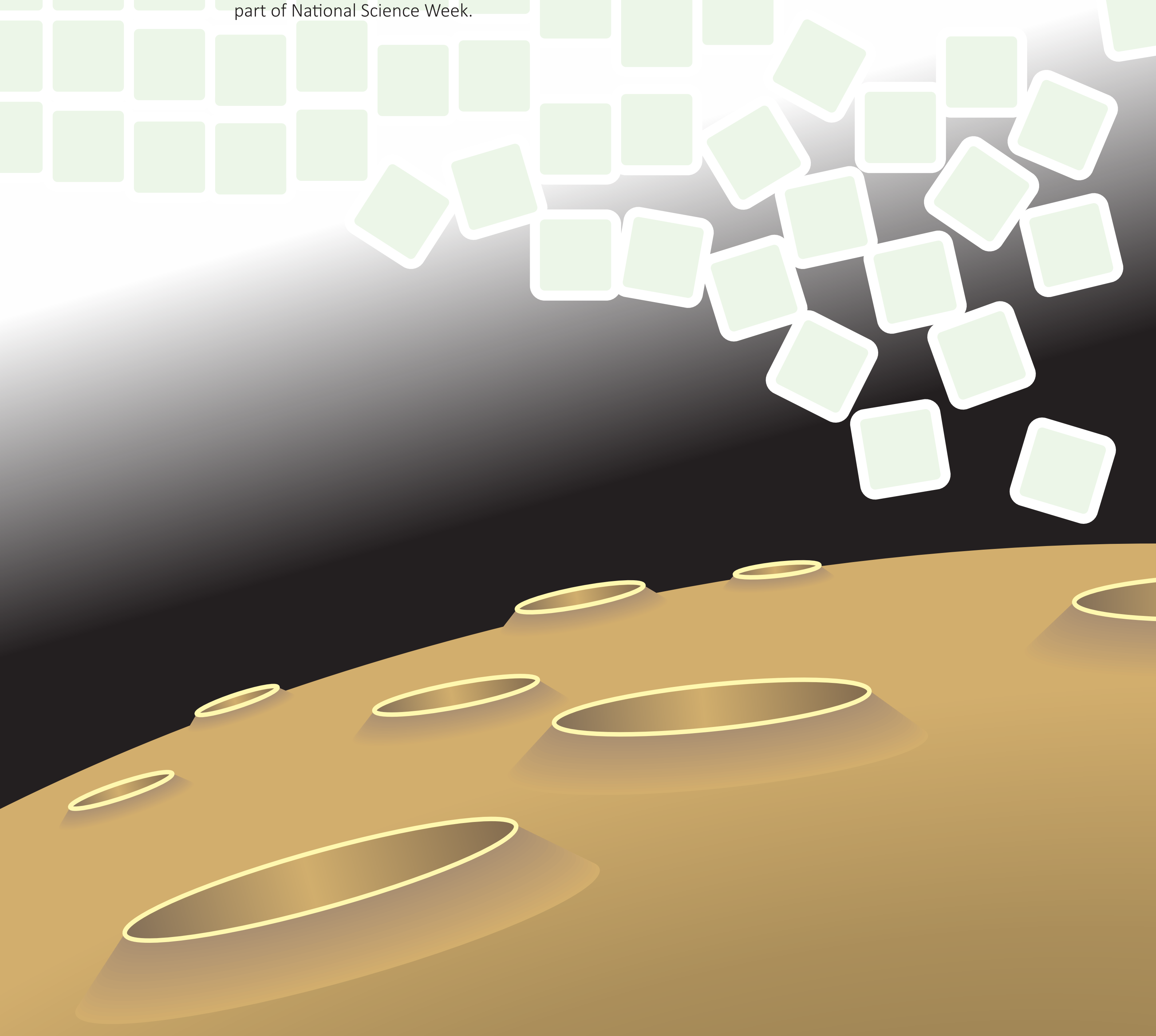
Once you have created your moonscape, drive a Sphero robot from the 'drive App' or program your Sphero and tell it how to navigate safely around your moonscape.

Document your project from start to finish using a video camera and share your video as part of National Science Week.

Oxygen
O
Atomic No. 8

Who Knew?

The Moon's crust is made up of oxygen, silicon, magnesium, iron, calcium and aluminium, with small amounts of titanium, uranium, thorium, potassium and hydrogen.



Activity 4:
Design and create a Moon-inspired artwork using TurtleArt

*Design and create a gallery of Moon-inspired images using your computer and the **TurtleArt** programming language.*

Hydrogen
H
Atomic No. 1

Helium
He
Atomic No. 2

Who Knew?

Stars are made of ionised hot gas (i.e. gas atoms stripped of some or all of their electrons). This gas is mostly made of hydrogen and helium, which are the two lightest elements.

Explore geometry and programming to design and create Moon-inspired artworks.

Brainstorm the geometric shapes that exist in space... Where might they be found?

Remember geometric shapes can include circles, squares, triangles, rectangles and trapezoids.

Program the Turtle cursor to draw a square by putting together enough forward, left and right blocks or use the repeat block; a square has four sides and programming the Turtle to repeat a forward and left (or right) movement four times will achieve a square.

Try circles and triangles too.

Experiment and create a star design by programming the Turtle to go forward and back the same amount of times while rotating through 360 degrees.

Use the TurtleArt program to program a night sky with stars varying in brightness, colour and length of lines in each point of the star. (Note that the “store in box” block allows students to use variables to change the size of their star’s rays while allowing the forward and backward number to remain the same. Using this feature enables the Turtle to draw a star with rays of varying length.)

Access a copy of the TurtleArt software **here**.

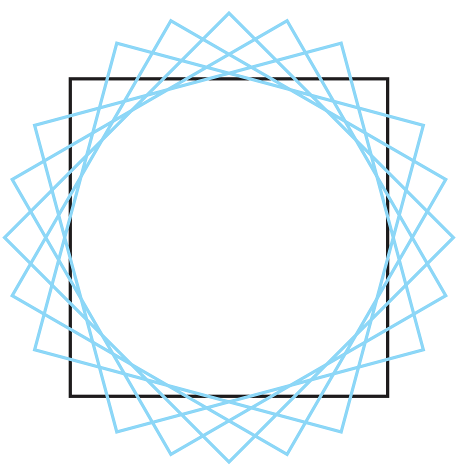
Case Studies

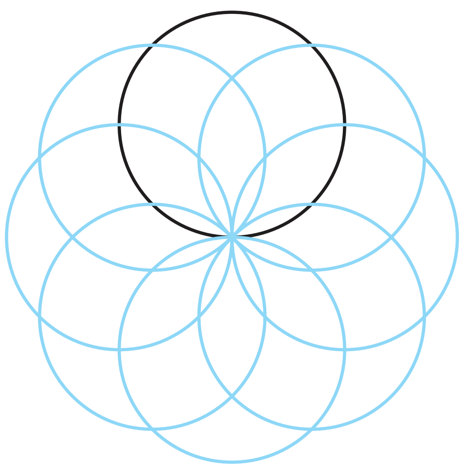
NASA TV

Did you know that NASA has its own television station? You can watch it via the internet. **NASA TV** features regular shows about NASA’s missions and discoveries and has live broadcasts of launches, landings and astronauts in space.

ESA Television

The European Space Agency (ESA) also has live and recorded broadcasts. **ESA Television** features the missions and discoveries from its European-wide partners.





Activity 5:
Create a 3D spacecraft using Quiver

National Science Week is celebrating the 50th Anniversary of the Apollo 11 Moon landing.

Aluminium
Al
Atomic No. 13

Who Knew?

The aluminium foil we might have in our science rooms is made of the pure soft metal that is aluminium, but when alloyed with other metals it lends its lightness to the other's strength. These alloys reduce the weight of materials so that rockets and spacecraft can go faster and further on less fuel.

Have you ever used an augmented reality, colouring-in program to make things come alive with 3-dimensional features, movement and colour?

Download the **Quiver Education app**, use cutting-edge colour technology and experience an augmented reality colouring experience.

Locate the spaceships and rockets, pages about the Moon, colour them in, print them and use the Quiver Education app to bring them to life.

Create a National Science Week Quiver Festival for others to attend, see and enjoy.

(Note there is a one-time purchase price for the Quiver Education app.)

Activity 6:
Let's create and make

Use the **National Science Week Science Activity Characters** (you will need to scroll to the bottom of this web page) and create a range of art and craft samples to celebrate the missions and science discoveries you have investigated as part of National Science Week.

How might you use this character?

Activity 7:
Write it up

Drag and drop the National Science Week Science Activity Characters into a storyboard. Choose a character and write a story about how they are using science. Draw a picture of yourself using science during National Science Week and write a story to accompany the picture.

You can also download and print outlines of the **National Science Week characters** to colour in.

Be inspired by Redmond Henry, a student from Derby in far-north Western Australia who, in 2017, attended Space Camp in the United States. View his video, **Redmond Henry – Adventure to Space Camp!** on YouTube (19:54 min) and witness the array of science activities he participated in.

Astro's story

"When I look out my bedroom window at night I see the Moon and I want to fly there in a rocket just like the astronauts did. Sometimes the Moon is round and bright, and other times I can only see a little bit of it. Why does it change? I wonder how far away the stars must be to be so small. I ask grown-ups questions about space and rockets all the time and they tell me how the Moon goes around the Earth and Earth goes around the Sun and the Sun is a star like all the tiny ones in the sky. I want to learn lots more and I read science books in the library to try and find out."

Activity 8:

The Australian Space Agency–dream, draw and write your ideas

The Australian Space Agency opened its doors in 2018.

If you could make one wish for the Australian Space Agency, what would it be?

1.

Think of five things that are absolutely possible for the Australian Space Agency to do.

1.	4.
2.	5.
3.	

What might the current activities within the Australian Space Agency look like? Draw your ideas below.

(If you don't have enough space ask for another piece of paper :)

Dream big and draw what you think is being planned by the Australian Space Agency.

(If you don't have enough space ask for another piece of paper :)

Activity 9:
The Periodic Table

Introduce the Periodic Table through **The Periodic Table Song** on YouTube (2:53 min).

Explain that 2019 is the International Year of The Periodic Table and that to celebrate this and the Apollo 11 landing on the Moon, the class is going to investigate the elements in the Periodic Table.

Play the song and view the video and ask students to look for space-related images like rockets and planets. Play a game spotting the elements that relate to space.

Extension idea: Introduce students to the song titled **The Elements** by Tom Lehrer on YouTube (3:02 min).

Case Study

Science Smarts

View an **episode of the Ellen DeGeneres Show** on YouTube (5:09 min) that invites a 3-year-old girl to recite the Periodic Table.

View a **graphic** of the Periodic Table where each element is clickable. Ask students to click on elements and discover more information about each element.

Questacon

The National Science and Technology Centre

SPARK YOUR STUDENTS' CURIOSITY!

SELF-GUIDED GALLERY EXPERIENCE

Questacon's Science and Technology Centre in Parkes offers over 200 hands-on experiences in eight themed galleries.

Perfect for self-guided exploration, the galleries encourage interaction and invite questions as students explore the science behind our world. Students can free fall down a six-metre slide, star in a Spectacular Science Show or gaze at the giant glowing 7m moon and take in the incredible NASA imagery of the lunar surface.

Q By Night experiences are also available for groups who cannot attend during opening hours.

WORKSHOPS

Questacon also offers **free** two-hour hands-on workshops for students in Years 6–12 to immerse and engage in ideas, tools and creativity. Delivered from The Ian Potter Foundation Technology Learning Centre in Deakin, students will find inventive solutions to a range of curriculum-linked engineering, design and computing challenges. After-hours workshops are also available.

QUESTACON SHOP

From the educational to the sensational, the Questacon Shop aims to extend the interactive science experience through a carefully selected range of innovative products. The products are inspired by the wide range of scientific fields in our permanent and temporary exhibitions. This includes; biology, chemistry, geology, physics, mathematics, astronomy and engineering. We also stock a range of science and technology books and curriculum based learning tools for the classroom. Also available online. www.questacon.edu.au/qshop

CAN'T COME TO QUESTACON? WE'LL BRING A VIRTUAL EXCURSION TO YOU!

Questacon delivers engaging workshops via videoconference to schools across Australia, from one-hour workshops to ongoing cross-curricular projects. Whether they're getting hands-on with the innovation process or connecting with scientists across Australia, students and teachers can explore STEM through interactive, real time experiences.

Bookings are essential for all Questacon programmes – head to our website for more information. www.questacon.edu.au

For the
Primary Years of Schooling
Years 3–4

DESTINATION MOON: MORE MISSIONS, MORE SCIENCE


SOLUTION
Top Charts
Genius
Purchased

Activity 1: How might astronauts live and work in space?

Overview: *Explain to the class that they will be exploring gravity—a force—and what microgravity is. Their task is to use science to show exactly how microgravity affects how astronauts live and work in space.*

Background science for teachers and students: Gravity

Gravity and microgravity are something NASA has a lot of experience with, so let's see what they have to say about the nature of this mysterious force.

NASA scientists have said that "Gravity is a force of attraction that exists between any two masses, any two bodies, and any two particles. Gravity is not just the attraction between objects and the Earth. It is an attraction that exists between all objects, everywhere in the universe. Sir Isaac Newton (1642–1727) discovered that a force is required to change the speed or direction of movement of an object. He also realized that the force called 'gravity' must make an apple fall from a tree, or humans and animals live on the surface of our spinning planet without being flung off. Furthermore, he deduced that gravity forces exist between all objects." Source: **NASA**

"Microgravity is the condition in which people or objects appear to be weightless. The effects of microgravity can be seen when astronauts and objects float in space. Microgravity can be experienced in other ways, as well. "Micro-" means "very small", so microgravity refers to the condition where gravity seems to be very small. In microgravity, astronauts can float in their spacecraft - or outside, on a spacewalk. Heavy objects move around easily. For example, astronauts can move equipment weighing hundreds of pounds with their fingertips. Microgravity is sometimes called 'zero gravity', but this is misleading." Source: **NASA**

The essential question:

What happens when we understand how gravity affects the interactions between objects?

The scenario:

National Science Week is looking for students to discover how microgravity affects how astronauts live and work in space.

What science investigations can assist you in your mission?

Your challenge, in pairs or small groups, is to help others understand what weightlessness is and how it affects the way astronauts live and work in space. You will also be demonstrating this to other classes during National Science Week. Are you up for the challenge? What kind of demonstration comes to mind?

A suggested learning process:

Define:

Capture students' interest by showing the video, **Astronauts floating weightless**, on YouTube (2:33 min).

Talk about how there is gravity in space, especially where the International Space Station is located, which is only about 400 km from the Earth's surface. Watch a **Veratasium video, Why are Astronauts Weightless?** on YouTube (3:40 min) that explains how the astronauts on the International Space Station are seemingly weightless while still experiencing a gravitational pull similar to what we experience on the ground. This weightless effect is brought about because both the astronauts and the space station are accelerating equally towards the Earth. The reason why they don't fall to the planet's surface, is because their orbital velocity is so great (27,600 km/h) they are continuously falling over the horizon, with only the Earth's gravitational pull preventing them from flying off into space.

Talk about how once a spacecraft reaches orbit, everything inside it appears to be weightless and anything (or anyone) that is not tied down can appear to float.

Explain that astronauts first feel the effect of weightlessness when the rocket engines are turned off. Straight away, they begin to drift in space, held down only by seatbelts.

Share the essential question and scenario with the class and talk about 'forces, gravity and microgravity'.

Ask students the following question: Which of these is not a force?

a. A push

b. A pull

c. A rock

d. Gravity

Talk about how forces change the way things move.

Ask students the following question: If you push a toy car from behind what will happen?

a. It will move forward.

b. It will move backwards.

c. It will stay still.

d. It will start and drive to Sydney

Ask the following True or False question: *Does an object have to move if it is pushed and pulled hard enough?*

Ask the following question about gravity.

Gravity pulls on things to make them fall down or to keep them down?

a. True

b. False

Talk about how nature and the universe are also constantly exerting forces. Air can push, water can push, and gravity is always pulling things towards the centre of the Earth. We observe the effects when moisture falls from the sky as rain acting under the force of gravity.

Introduce 'STEM Story time' and view or read the book *Gravity* by Jason Chin. View the book **Gravity** as a video on YouTube (2:09 min). Talk about the key messages about gravity on each page and discuss how the author illustrates and communicates gravity on each page.

Take a short course in gravity by watching a video, **Gravity Compilation: Crash Course Kids**, on YouTube (14:32 min) that explains why we don't fly off into space, what mass has to do with it, how air resistance works, and why the force of gravity is different on the Moon.

Hear from a NASA scientist. Watch and listen to her explanation of gravity in the video **What is gravity?** on YouTube (0:32 min).

Introduce 'microgravity' as being the condition in which people or objects appear to be weightless in space.

Listen to a NASA scientist explain microgravity in the video **What is Microgravity?** on YouTube (0:17 min) and learn more about the **importance of microgravity** to NASA (YouTube, 0:24 min).

Present the scenario again, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Explore forces and gravity by placing a water bottle on a table. Talk about gravity being the force that is being applied to the bottle.

Ask students to hypothesise what will happen if they put the same water bottle onto a piece of tissue paper.

In groups, ask four students to hold the corners of some tissue paper 10 cm above a table and have a fifth student place the water bottle onto the tissue paper.

Explain that the force on the bottle is gravity and that the force applied to the tissue paper is a lateral force, as it is being pulled from all four corners. Again, highlight how the density of the tissue paper cannot withstand the weight of the bottle and the force of gravity, so the bottle falls through the tissue paper.

Ask students to draw a labelled diagram of the forces seen in this activity in their learning logs.

Ask student to hypothesise what will happen if we put the same water bottle on a sheet of A4 photocopy paper.

In groups, ask four students to hold the corners of a sheet of photocopy paper 10 cm above table and ask a fifth student to place water bottle on the sheet of photocopy paper.

Explain that the force on the bottle is gravity and that photocopy paper may or may not exert sufficient upward force to balance gravity, so bottle may fall through or stay on the sheet of photocopy paper. Talk about the strength of the fibres in the sheet of paper and how this affects what happens.

Encourage students to draw a labelled diagram of the forces in this activity in their learning logs.

Challenge students to use an inquiry process to explore gravity and get a straw to move along a piece of string (without directly pushing it with their hands) using just a balloon, string and tape.

For example students might experiment with the following sequences:

- threading one end of the string through the straw;
- tying each end of the string between two solid supports such as a chair, table leg or door knob, making sure it is strung tightly;
- blowing up the balloon but not tying it;
- holding the opening of the balloon closed with their fingers, taping one side of the balloon to the straw so that it hangs horizontally below the string;
- getting ready for launch and letting the end of the balloon go; and
- watching as the air escapes and sending the balloon rocketing across the string track.

Delve deeper into gravity.

Explain how the Earth pulls everything down towards its centre and how this pull is called the force of gravity.

Explain how, if you lift things up, you have to pull against gravity (weight).

Talk about how, if you drop a pencil, gravity pulls it to Earth.

Challenge students to experiment with magnets to discover more about gravity. (Safety note: Small magnets are choking hazards, and magnet ingestion poses a serious threat to the health of students. Students should be supervised when exploring with magnets).

Set up an Explorer Space with:

- magnets
- small dowels or sticks
- string
- paperclips

Encourage students to explore gravity. Invite students to tie the paperclips onto pieces of string and then tie each piece of string onto the small piece of dowel or stick.

Then, ask students to lift up the stick so the paperclips hang from the string.

Ask the following questions:

- Which direction do the paperclips point?
- What happens if you tilt the stick?

Talk about how the paperclips are being pulled toward the Earth by gravity, and how they can't fall because the string is holding them in the air. Show that, no matter which way the stick is tilted, the paperclips are always being pulled straight toward the Earth by gravity.

Challenge students to think of ways they might investigate how weightlessness and microgravity affect astronauts on space missions. Suggest that they might need to think about how astronauts:

- eat in space;
- wash their hair in space;
- sleep in space;
- brush their teeth in space;
- go to the toilet in space;
- exercise in space;
- stay healthy in space;
- collect information and data in space; and
- store their scientific equipment in space.

View the video **Getting ready for Micro-g** on YouTube (1:27 min) about how NASA astronauts prepare to live and work in microgravity.

Ask students to locate and view NASA videos to find out more information and see firsthand how weightlessness and microgravity affect astronauts on space missions.

Have students share information with other peers about the information they have discovered about how weightlessness and microgravity affect astronauts on space missions.

Dream:

In pairs or small groups, students should envision or dream about the many possible solutions to designing and making a demonstration to show how weightlessness affects astronauts on space missions.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to demonstrate to others how weightlessness affects astronauts on space missions.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their demonstration.

Ask students to gather the materials, tools and equipment needed and then design and create the solution.

Invite a peer class group to the class to hear from students to find out more about how weightlessness affects astronauts on space missions.

Deliver:

In pairs or small groups, showcase the creations and associated messages.

Classes host a 'National Science Week Day' and invite students, teachers and parents to discover what the class knows about how weightlessness affects astronauts on space missions.

Debrief:

Ask students to reflect on their learning and to describe three things they learned that they didn't know before and to share two things that surprised them.

Ask students to describe how they might improve on what they've done.

Ask students to describe what worked well, and not so well, in their efforts to demonstrate how weightlessness affects astronauts on space missions.

Curriculum connections

Australian Curriculum: Science (ACARA, 2015a)

Year 3 and Year 4

Science Understanding—Physical sciences

Forces can be exerted by one object on another through direct contact or from a distance ACSSU076

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050, ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051, ACSHE062

Science Inquiry Skills

With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS053, ACSIS064

Represent and communicate observations, ideas and findings using formal and informal representations ACSIS060, ACSIS071

Technologies (ACARA, 2015b)

Year 3 and Year 4

Design and Technologies Knowledge and Understanding

Investigate how forces and the properties of materials affect the behaviour of a product or system ACTDEK011

Investigate the suitability of materials, systems, components, tools and equipment for a range of purposes ACTDEK013

Design and Technologies Processes and Production Skills

Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques ACTDEP015

Select and use materials, components, tools and equipment using safe work practices to make designed solutions ACTDEP016

Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment ACTDEP017

Plan a sequence of production steps when making designed solutions individually and collaboratively ACTDEP018

General Capabilities:

Literacy; Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability.

Case Study

Space Shuttle Discovery

Learn about what NASA built the **Space Shuttle Discovery's main engines** from. Did you know that it was made from 65 percent nickel-based alloys because of the ability of nickel to resist corrosion at high temperature?

Activity 2: Australia's part in a great adventure

Yttrium
Y
Atomic No. 29

Who Knew?

The Apollo missions showed that yttrium seems to be more abundant on the Moon than on Earth.

Overview: *Explain to the class that their task will be to investigate the little known history of the role Australia played in the Apollo 11 landing on the Moon.*

Background science for teachers and students: Space tracking stations

In February 1960, a formal agreement was signed between Australia and the United States for cooperation in US space programs. Australia undertook to provide and run a number of tracking stations which would form part of NASA's worldwide network.

Tracking stations use radio antennas or 'dishes' to relay commands to, or receive data from, spacecraft that may be millions or even billions of kilometres from Earth.

The first tracking station built under the agreement (in 1960) was at Island Lagoon near Woomera in South Australia. It provided scientists with radio and optical tracking data for satellites.

In June 1964, a second tracking station was built at Carnarvon in Western Australia. It was designed specifically for tracking NASA's Gemini, Apollo and Skylab programs.

Also in 1964, the Tidbinbilla Tracking Station (now known as the Canberra Deep Space Communication Complex) was built. It was designed for the tracking of crewed space flights and deep space monitoring. It tracked the Apollo Lunar Module.

In 1966, a tracking station near Toowoomba in Queensland was built, and a year later the Honeysuckle Creek Tracking Station in the ACT was established with the task of tracking and communicating with the Apollo Moon missions.

For all of these activities, the big dishes and telescopes of the tracking stations played vital roles as they sent commands to, and received information and televised images from, spacecraft thousands of kilometres from Earth.

The essential question:

What happens when we understand Australia's contribution and major role in one of humanity's greatest adventures?

The scenario:

Nestled in the quiet valleys of the Australian Capital Territory, the Honeysuckle Creek Tracking Station and the Tidbinbilla Deep Space Tracking Station were massive radio antennas that became the most important of their kind in the world in July 1969. These tracking stations, and the telescopes developed by the CSIRO at the Parkes Observatory in NSW, played a key role in tracking the Apollo 11 mission to the Moon and in receiving the signals that enabled people around the world to see the initial TV pictures from the Moon and Neil Armstrong's first steps on the lunar surface. The reason why these facilities became the most important is that they were the only tracking stations on the surface of the Earth that could actually see the Moon at the time of the landing due of the time of day and their location in the southern hemisphere.

Your challenge is to curate an exhibition piece for a pop-up museum display that explores Australia's role and contributions to televising the first landing on the Moon in July 1969.

How might you make a display to show the contributions? How might you decide what to include? What could you put in your own exhibition piece so that other people could understand Australia's role?

The National Science Week team in Canberra requests that you create an exhibition piece and include a labelled map, pictures, objects and text that describe Australia's contributions to televising the first landing on the Moon.

Note: A Pop-Up Museum, in the context of this learning sequence, is defined as a short-term exhibition that facilitates a sharing of ideas and conversations.

A suggested learning process:

Define:

Capture students' interest by recalling exhibits that they all really liked.

Talk about what made the exhibits interesting and so memorable.

Use **Pinterest** to find exhibits and displays made by students and discuss their features.

Make a list of the features of exhibits that the students like.

Invite students to recall the focus of the exhibit that the National Science Week team has invited them to create.

Talk with students about the word 'contributions'. What does the word mean?

Ask students to share what they know about any of Australia's contributions to televising the first landing on the Moon in July 1969.

Ask students what they might need to know more about in order to undertake the challenge set by the National Science Week team. Might they need to know something about how Australia contributed to televising the Moon landing in 1969? Might they need to create a map? Might they need to think about a picture and object for their exhibition piece? Could they actually create their exhibition piece using their digital devices? Could they create their exhibition piece using other materials and tools?

Discover:

View the video, **Landing on the Moon: 20 July 1969** on YouTube (9:55 min) of the Apollo 11 mission to the Moon and witness our first glimpse of what the Moon looks like.

View images associated with the Apollo 11 Moon landing and listen to the lyrics of a song titled **Space Race** (2:16 min). Note that the images seen at 0:58 minutes into the video were captured by Australian the radio antennas at Parkes NSW and Honeysuckle Creek near Canberra in 1969.

Research and read information about Australia's contributions from **CSIRO - Apollo 11 Moon landing**. Students should prepare a draft information report to inform their exhibition piece about Australia's contributions.

Invite students to learn more about the **Canberra Deep Space Communication Complex** (CDSCC) and identify information from its website to assist in the challenge.

Explore how the CDSCC provides two-way radio contact with many robotic spacecraft and space telescopes and how it acts like a telephone exchange, sending and receiving information between scientists, spacecraft and telescopes.

Locate information and images for the massive radio antennas or 'dishes' that are used to relay commands to, or receive data from, spacecraft.

Think about the role of people in design and technology occupations who work at the CDSCC. Imagine what the engineers might do at the CDSCC and what equipment they might maintain now, and what they might have worked with during the Apollo 11 mission.

Discuss the impact that the massive radio antennas that are used to relay commands to, or receive data from, spacecraft.

Search for information to read about the **Parkes Radio Telescope** and record information for the National Science Week exhibition piece.

Consider the role of people in design and technology occupations who work there. Brainstorm the technologies that the operations teams may have worked with during the Apollo 11 mission.

Consider the role and impact of the huge radio antennas at Parkes during the Apollo mission.

Find out more about the **Honeysuckle Creek Tracking Station** and its role in televising the first landing on the Moon.

Think about the role and impact of the radio antennas that the antenna technicians at the Honeysuckle Creek Tracking Station might have worked with before, during and after the Apollo 11 mission.

Remind students to create a bibliography and to reference source materials acknowledging where information has been taken from.

Explore maps and locate where the tracking stations involved in supporting the Apollo 11 mission to the Moon and the tracking stations involved in receiving signals that enabled the televising of the Moon landing to be shared with Australians and others all around the world.

Research and investigate where to locate pictures and objects for the exhibition piece that describes Australia's contributions to televising the first landing on the Moon.

Ask students to create an image bank of images and objects for their exhibition piece, reminding them to reference the source where the images and objects have been taken from.

Find out what students now think about what Australia's contributions to televising the first landing on the Moon in July 1969 might have involved.

Ask students to draft some text about Australia's contributions.

Invite students to sketch a plan of what their exhibition piece might contain and look like. Ask students to consider the placement of their labelled map, pictures, objects and text.

Share the students' understandings with others. For example, ask students to share what they have been learning about with family members at home.

Dream:

Revisit sketches and ask students to think about the story their exhibition piece might tell others about Australia's contributions to televising the first landing on the Moon in July 1969.

Look at ways museums display exhibition pieces. Using digital devices, search for museum exhibits. Talk about how some exhibits use frames to provide a window to the exhibit.

Imagine ways frames can be created using different recycled materials. For example, recycling cereal boxes or packaging boxes.

Talk about colour and how students can use it to bring their exhibition pieces to life.

Talk about how digital tools and devices can also be used to design and create exhibition pieces.

Ask students to visualise their exhibition piece. What features might they include? How will the labelled map be planned? Will the map contain descriptions of how the tracking stations were involved in the Apollo 11 mission? Will the map have a title?

As a class, brainstorm and describe all the different ways they might create a map. For example, students might use a digital device, paper, pens and colours.

Develop possible solutions by collecting images from the **Parkes Radio Telescope**, **Honeysuckle Creek Deep Space Station** and the **Canberra Deep Space Communication Complex** websites and cutting out features that help explain Australia's contributions to televising the first landing on the Moon.

Challenge students to think about the materials, tools, and equipment they will need to create their exhibition piece that will contain their labelled map, pictures, objects and texts.

Invite students to think about how they might present their exhibition piece.

Design:

Ask students to describe the features and purpose of their exhibition piece for a pop-up museum that uses a labelled map, pictures, objects and text to explain Australia's contributions to televising the first landing on the Moon.

Review rules on personal safety, group safety, and classroom and furniture safety with the students.

Ask students to establish a workstation and to gather the materials and tools they require.

Talk about safely storing their exhibition piece and keeping a record of the processes they undertake.

Ask students to consider who might be interested in visiting their pop-up museum display to view their exhibition pieces? Might this affect their design of the exhibition piece in any way?

Ask students to apply what they have learned about Australia's contributions to televising the first landing on the Moon and to create their exhibition piece.

Invite families and friends to the class and share the process used to create the exhibition pieces that explain Australia's contributions to televising the first landing on the Moon.

Deliver:

Ask students to share ideas about how they are going to deliver their exhibition pieces that use a labelled map, pictures, objects and text to explain Australia's contributions to televising the first landing on the Moon.

Ask students to share and explain their exhibition piece as part of a 'Pop Up Museum' display, in which they explain the key features of their exhibition piece.

Debrief:

Ask students to talk about the processes they used to create an exhibition piece.

Invite students to evaluate their exhibition piece and write three sentences about the tasks that were involved. Ask them to include details on the quality of their research and planning, their finished exhibition piece and whether they enjoyed the task.

Invite others to critique the exhibition pieces. Did they communicate and explain Australia's contributions to televising the first landing on the Moon?

Curriculum connections

Technologies (ACARA, 2015b)

Year 3 and Year 4

Design and Technologies Knowledge and Understanding

Recognise the role of people in design and technologies occupations and explore factors, including sustainability that impact on the design of products, services and environments to meet community needs ACTDEK010

Design and Technologies Processes and Production Skills

Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques ACTDEP015

Select and use materials, components, tools and equipment using safe work practices to make designed solutions ACTDEP016

Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment ACTDEP017

Plan a sequence of production steps when making designed solutions individually and collaboratively ACTDEP018

Science (ACARA, 2015a)

Year 3 and Year 4

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050, ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051

General Capabilities:

Literacy; Numeracy, ICT capabilities, Critical and creative thinking and Personal and social capability.

Case Study

The Carnarvon Space and Technology Museum

Discover the role the Carnarvon tracking station played in the space race. View a video, **Buzz in Carnarvon**, on YouTube (2:50 min) and find out about Buzz Aldrin's visit to the Carnarvon Space and Technology Museum. The Apollo 11 Lunar Module pilot, Buzz Aldrin, visited Carnarvon, north of Perth, Australia from June 22nd to 23rd, 2012 for a two-day program called 'To the Moon and Back Festival' where he officially opened the Carnarvon Space and Technology Museum.

Activity 3:

Which astronaut, scientist, engineer or technician who made landings on the Moon possible, might make the best Pokémon?

NASA has estimated that it took more than 400,000 scientists, engineers and technicians to accomplish the Moon landings. They all helped put Neil Armstrong, Buzz Aldrin and Michael Collins into space and made it possible for Neil Armstrong and Buzz Aldrin to land on the Moon.

Can you design and create a series of Pokémons to celebrate the 50th anniversary of the Apollo Moon landing?

Can you design astronauts with 21st century abilities? Mind map the types of abilities that astronauts might need to live and work on the Moon. Might they have the ability to change gravity or the ability to breathe in space?

Can you design and create a series of Pokémons who are women?

Brainstorm names of women who made outstanding contributions to space science.

Have you heard of Katherine Johnson, a mathematician whose calculations assisted the Apollo 11 astronauts return safely to Earth, or Sally Ride, an astronaut and physicist?

Have you heard or read about Mae Jemison, an engineer physician and NASA astronaut? She became the first African American woman to travel in space when she went into orbit aboard the Space Shuttle Endeavour on September 12, 1992.

Have you heard about Margaret Hamilton, who is a computer scientist? She and her team developed the guidance and navigation system for the Apollo 11 Moon landing program.

Explore Pokémons and all of their powers, then design and make your very own Pokémons to celebrate the 50th anniversary of the Apollo Moon landing.

Build your own display featuring the Pokémons of accomplished astronauts, scientists, engineers and technicians and showcase their contribution to missions to the Moon.

Hold a science exhibition during National Science Week.

Case Studies

Women involved in the Apollo 11 mission to the Moon

Many women played very important roles in the Apollo 11 mission. Learn about these women and the work they undertook to make the mission a success by listening to '**The Women Who Brought Us Apollo 11**' article on the Science Friday website.

Abigail Allwood, an Australian astrobiologist and the 2020 Rover mission

Since the Moon landing, lots of bigger ideas have taken people on missions into space. Learn about the astrobiologist **Abigail Allwood** who is the principal investigator on NASA's 2020 rover mission, the first woman to oversee a scientific instrument on a Mars expedition.

Iron
Fe
Atomic No. 26

Nickel
Ni
Atomic No. 28

Sulfur
S
Atomic No. 16

Who Knew?

The core of Mars is most likely made up of iron, nickel and sulfur.

Activity 4:
Create a night sky journal

The next time you look at the sky at night, why not make a journal.

Hydrogen
H
Atomic No. 1

Who Knew?

Hydrogen is the most abundant element, making up over 75 percent of the visible matter in the universe.

Take a look at Australia's night-time attractions.

Whether you focus on the Moon or the stars, capturing what you see in the night sky will help you remember what you observed and enjoy it at a later date too.

Have you ever seen Orion, the Southern Cross or the Milky Way?

Your challenge is to observe the sky and recall what you see, then create a space journal to publish and share as part of National Science Week.

Case Studies

Indigenous Astronomers

Did you know that the study of the sky knowledge of ancient and traditional cultures is called "cultural astronomy"?

Aboriginal and Torres Strait Islander people have been living in Australia for a very long time and they are considered to have the oldest continuous culture on Earth.

As knowledge of the night sky was an important part of their cultures, they are considered to be the world's first astronomers.

Discover more about the **Star Stories of the Dreaming** guide and read some of the rich cultural astronomy stories of the Kamilaroi and Euahlayi peoples.

Astronomers

Learn about astronomers like Copernicus, Galileo Galilei, Sir Isaac Newton, Tycho Brahe, Johannes Kepler, Henrietta Swan Leavitt, Edwin Hubble and Carl Sagan. Read about their interest in space and actual discoveries on the **Kids Astronomy** website.

Activity 5:
Might space travel be easy and fun?

Use storytelling to stimulate ideas and creativity.

Helium
He
Atomic No. 2

Who Knew?

Helium is the original ET (extraterrestrial) as it was the first element to be discovered outside of our atmosphere.

Read the story *How to Bicycle to the Moon and Plant Sunflowers* by Mordicai Gerstein, ISBN 978-1596435124, published by Roaring Brook Press.

In this story, a boy in an astronaut suit, shares a plan to go to the Moon that involves 2,000 used inner tubes, a flagpole, a ship's anchor, enough garden hose to stretch 238,900 miles, a peanut butter and jelly sandwich washed down with a splash of chocolate milk (plus some "nourishing, flavoured GLOP" courtesy of NASA) and, some sunflower seeds, a trowel and a little bit of compost.

The challenge is to design a step-by-step plan of how you imagine you might get to the Moon too.

Could you re-purpose existing designs for spacecraft, orbiters or satellites for your own means? How might you land? What might you do there? What might you see and encounter? How might you react and what ultimately might you do on the Moon?

Experiment with your ideas, troubleshoot the design challenge, flow chart your ideas, document your process and design a solution.

Share it as part of National Science Week.

Case Study

Space Exploration

View the *ABC Education* video **Space exploration from rockets to the Red Planet** (8:15 min) and learn about space exploration and missions to different planets.

Discover more about space exploration to places other than the Moon. Explore the history of spaceflight using the **Kids Astronomy** website.

Activity 6:
Design a lunar rover

A lunar rover or Moon rover is a space exploration vehicle designed to move across the surface of the Moon.

Lithium
Li
Atomic No. 3

Who Knew?

Lithium was one of the three elements created during the Big Bang, along with hydrogen and helium.

A rover (or sometimes called a planetary rover) is a space exploration vehicle designed to move across the surface of a planet or other celestial body. Some rovers have been designed to transport members of a human spaceflight crew; others have been partially or fully autonomous robots. Source: **Wikipedia**

Apply what you know about rovers and design and build a lunar rover that can survey the Moon in greater detail than ever before.

NASA suggests that the entire Moon is covered by powdery dust and lots of rocky debris. Consider how your rover design might scout out over the rough terrain of the Moon and how it might take soil samples, detect traces of water and survey the composition of rocks.

Will your rover be robotic, or will you be the driver?

Design, make, test and share your design as part of National Science Week.

Case Studies

The International Space Station

In the 1990s, many countries came together to design, prototype, test and build the International Space Station (ISS). It is the largest satellite currently orbiting the Earth. For over 18 years, astronauts from many different countries have lived on the ISS. Discover how the ISS was built, one module at a time, and find out about all of its features including its size, speed, weight, and what it can do.

Sources to explore include the: **NASA** website, **European Space Agency** website, and the **Kids Astronomy** website.

WRESAT

Find out about the Woomera Research Establishment Satellite commonly known as **WRESAT**.

WRESAT was Australia's first satellite. It was launched at Woomera in South Australia on the 29th of November 1967.

Discover how many orbits it completed and learn more about the scientific information and data it collected and brought back to Earth.

Activity 7: Comic relief

Show your support for National Science Week and entertain at the same time by creating a cartoon for science awareness.

Using the National Science Week Science Activity Characters and a range of **cartoon templates**, bring your ideas alive with a unique story and cartoon about how science can be celebrated during National Science Week.

Activity 8:
It's confidential

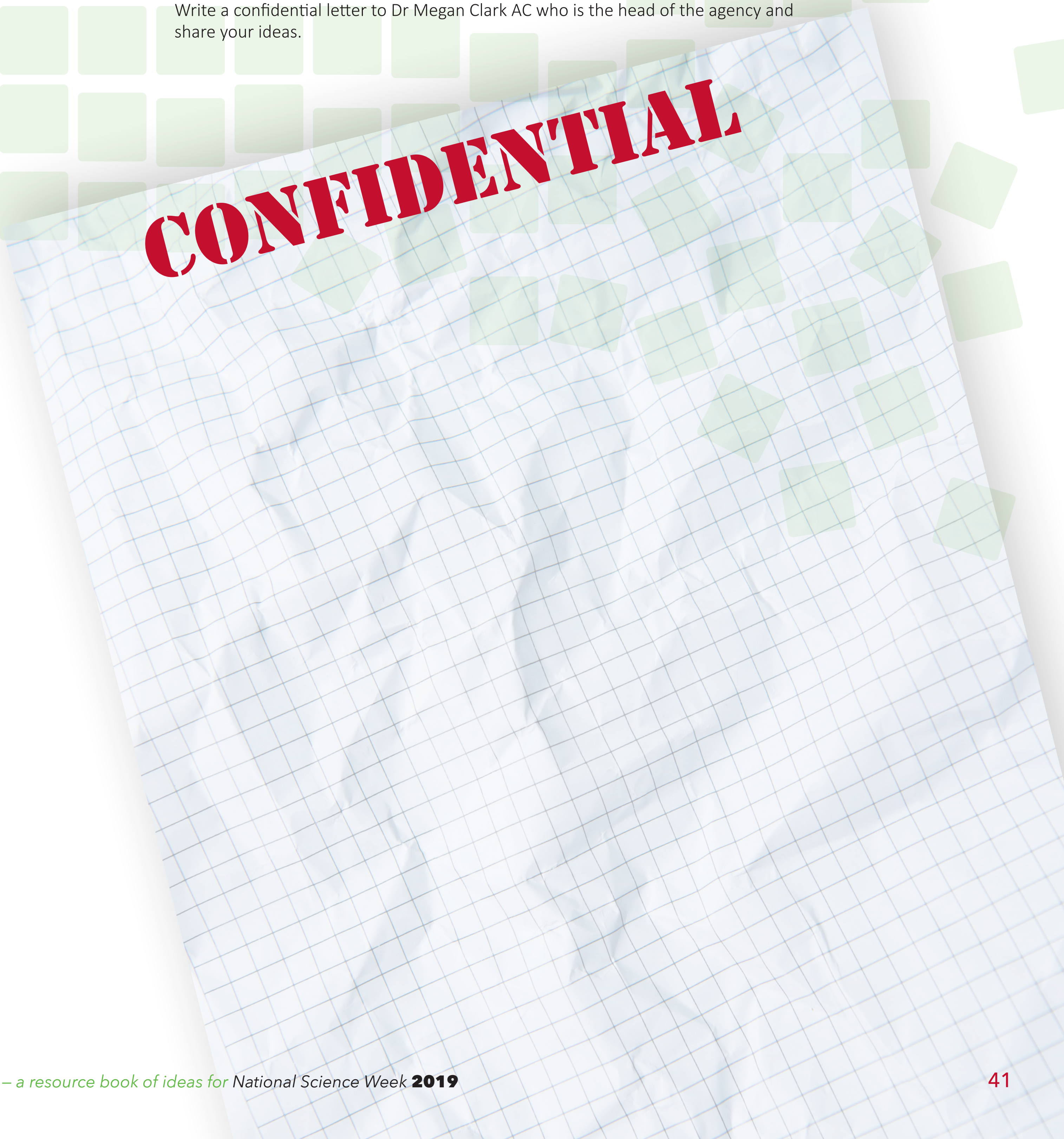
In 1969 humans landed on the Moon.

Fifty years later, Australia has launched its own space agency.

The Australian Space Agency wants to know what you see happening in the agency.

What might the Australian Space Agency design, make, create or do?

Write a confidential letter to Dr Megan Clark AC who is the head of the agency and share your ideas.



Activity 9:
It's elementary

Talk with the students about 2019 being the 'International Year of the Periodic Table'.

Explain that students usually learn about the Periodic Table in chemistry classes in science in high school.

Talk with the students about the fact that there are 118 different elements found on the Periodic Table.

Research books in the library or use a digital device and find out the names of some elements.

Play a game of **Elemental Hangman** using the information found.

For the
Primary Years of Schooling
Years 5–6

COMING SOON... AUSTRALIAN SPACE OUTLOOK

TO BE RELEASED IN JULY 2019 IN PARTNERSHIP WITH THE AUSTRALIAN SCIENCE TEACHERS ASSOCIATION, NATIONAL SCIENCE WEEK AND SPACE INDUSTRY ASSOCIATION OF AUSTRALIA

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Activity 1: Let's manage some space traffic

Europium
Eu
Atomic No. 63

Who Knew?

Different oxidation states of europium were used to produce the red and blue light in the colour television sets that televised the Apollo 11 landing on the Moon in 1969.

Overview: *Explain to the class that their task will be to explore space traffic issues and then design and make a designed solution for managing satellites and space junk out in space.*

Background science for teachers and students: Space traffic

The term 'space traffic' refers to all spacecraft (both active and inactive) and space debris that are currently orbiting the Earth. The variety of objects in space is large. Orbital debris comprises expired spacecraft, spent rocket boosters, individual pieces of space assets, and even objects such as gloves. Source: *The Space Review*

The essential question:

What happens when we understand methods used to manage traffic in modern societies? Can they be applied in space?

The scenario:

Right now, there are lots of working satellites in space. In fact, there are over 4,000 active satellites and over 2,600 older ones that no longer work. They vary in size, with some being as big as a bus and others being as small as a mobile phone.

Your challenge is to investigate methods used to manage traffic and then apply them in space.

Your task is to design a system that might prevent space satellites from colliding with one another. Then, you should illustrate the steps involved in your chosen traffic management system in a labelled drawing supported with a procedure of how to avoid collisions in space. You should then contribute your ideas, and the steps involved, as part of National Science Week.

A suggested learning process:

Define:

Share the essential question with the class and talk about 'traffic management methods' and the why and how they have been used to manage traffic on the Earth and in our skies.

Brainstorm known ways that humans have managed traffic on the Earth and in our skies over time. For example, use of directions, lanes, altitudes, or restricted areas.

Present the scenario—assign pairs or small groups if appropriate—and ask students to define the task they have been set.

Ask students to draw something they think of when they hear the phrase 'space traffic'.

Ask questions to establish students' prior understandings about the rules, technologies and equipment that are used to manage traffic. The following are example questions that can be used.

- What rules, technologies and equipment might be used to manage traffic in and around our school?
- What rules, technologies and equipment might be used to manage traffic in busy cities?
- What rules, technologies and equipment might be used to manage aeroplanes, helicopters, and drones in our skies?

Go further and talk about how pilots need to develop a flight plan and submit it to a traffic controller so that traffic in particular areas and routes can be managed.

Talk about the use of transponders in aircraft that emit a signal that identifies the aircraft to radar operators. Might these tracking systems already have been applied to satellites and spacecraft?

Discuss whether registering satellites and spacecraft through a central authority might help manage what is launched into space. Could sharing the following information assist us in managing space traffic?

- Where the satellite or spacecraft is going;
- Whether it's coming back;
- Distance from Earth (altitude);
- Whether it will be geosynchronous, geostationary or polar orbit;
- How long it will be in space;
- Who owns it;
- Who is responsible for it; and
- Whether it has been given approval to go into space.

Invite students to discuss how some of these systems could be applied in space.

Discover:

Capture students' interest and share a variety of images of **NASA's Earth Science Satellite Fleet** showing what might be crowding and causing traffic issues in space.

Talk about the different satellites and find out what students might know about how them.

Explain how the oldest satellite, named Sputnik, is still in space, and how a collision of two satellites occurred in 2009, and how the collision resulted in thousands of pieces of debris being released into near-Earth orbit.

Invite scientists, astronomers, parents, grandparents and carers to visit the class to talk about what they know about these topics.

View a video on the **Iridium 33 and Cosmos 251 Collision** on YouTube (1:06 min) to find out more about how these two satellites collided in space.

Ask students to research and investigate the methods and technologies they might like to use in designing a system that could prevent satellites from colliding with one another.

Ask students to communicate their ideas by drawing and writing a description of what they might suggest for their traffic management system.

Talk about procedural writing and practice writing a procedure for managing traffic in and around the school to prevent people colliding with one another.

Dream:

In pairs or small groups, envision making a labelled drawing and writing a procedure about how to manage space satellites from colliding with one another. Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to include a labelled drawing and a procedure about how to manage satellites and prevent them from colliding with one another.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their solutions.

Ask students to gather the materials, tools and equipment needed and then design and create their solution.

Ask students to illustrate the steps involved in their management system that prevents satellites from colliding with one another. Remind them that they need to communicate their design ideas and instructions in labelled drawings.

The students then need to write a procedure of how to use the designed solution. They then evaluate their design, and suggest improvements where necessary, giving reasons.

Students will then use their labelled drawing and procedure in a National Science Week presentation to spread the word about what might be possible.

Invite a peer class group to the class to hear from the students and find out more about management systems to prevent satellites in space from colliding with one another.

Deliver:

In pairs or small groups, showcase the creations and associated messages.

Classes host a 'Space Traffic Management Day' and invite students, teachers and parents to discover what the class thinks might be possible.

Debrief:

Ask students to reflect on their learning and draw something they learnt that was new.

Ask students to describe what worked well and not so well in their efforts to design a management system that might prevent satellites from colliding with one another.

Curriculum connections

Science (ACARA, 2015a)

Year 5 and 6

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE081, ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083, ACSHE100

Technologies (ACARA, 2015b)

Year 5 and Year 6

Design and Technologies—Processes and Production Skills

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

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

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

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

General Capabilities:

Literacy; ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability.

Case Studies

Live from space

Ever wanted to see Earth from space, just like the astronauts on the International Space Station? Well you can. There are cameras on the station that beam live images back to Earth. There are apps available for smart phones and tablets that provide you with instant access to information, live video and activities that you can use to discover more about life in space. Go to an App store and search using acronyms and words like NASA, JPL, and space exploration or space science.

SERC Space Environment Centre

Discover more about the **SERC Space Environment Centre**, an Australian Cooperative Research Centre (CRC), and the scientists researching ways to increase the power of Australia's laser trackers so that lasers on Earth can eliminate space debris.

Activity 2: Design and build a shock absorbing system to assist the Lunar Module land safely on a surface like the Moon

Titanium
Ti
Atomic No. 22

Who Knew?

The SR-71 Blackbird, the fastest jet ever built, was made predominantly from titanium, that is both light and strong and has a high melting point.

Overview: *Explain to the class that their task is to learn from engineers and design a shock absorbing system to assist spacecraft landing safely.*

Background science for teachers and students: Engineers

Engineers do an amazing job designing and building spacecraft.

Did you know that there are many types of engineers?

1. Aerospace engineers design and build spacecraft.
2. Chemical engineers discover and manufacture plastics, paints, fuels, fibres, medicines, fertilisers and paper.
3. Structural engineers oversee the construction of spacecraft, buildings and structures.
4. Civil engineers design roads, bridges and unique structures.
5. Electrical engineers develop the electrical parts of most things we use.
6. Mechanical engineers design and make all sorts of equipment.
7. Biomedical engineers make artificial legs, joints and heart valves for people.
8. Industrial engineers design efficient systems that integrate workers, machines, materials, information, and energy to make a product or provide a service.

Engineers use a design process. It helps them stay on track when developing a spacecraft or a solution to a problem.

The essential question:

What happens when we understand how engineers design and produce shock absorbing systems to protect spacecraft, their equipment and crew on landing?

The scenario:

When speaking of the flight of Apollo 11, Commander Neil Armstrong said, "We had a great deal of confidence. We had confidence in our hardware, the Saturn rocket and the Command and Lunar Modules. All flight segments had been flown on the earlier Apollo flights with the exception of the descent and ascent from the moon's surface, and of course, the exploration works on the surface". Source: Lindsay, H. **Apollo 11 Essay**

Your design team's challenge is to design and build a shock absorbing system that can allow a vehicle similar to the Lunar Module and its equipment and crew to descend and safely land on a surface similar to the Moon.

Imagine you are a team of expert aeronautical engineers and design and build your own shock absorbing system for a vehicle similar to the Lunar Module.

What investigations can assist you develop your engineering skills? How might you design a shock absorbing system? How might you test it and demonstrate that it can safely land on a surface similar to the Moon without damaging the spacecraft and its equipment or injuring the crew.

A suggested learning process:

Define:

Share the essential question and scenario with the class and talk about 'shock absorbing systems'.

Talk about the purposes of shock absorbing systems and how they are a mechanical or hydraulic device designed to absorb and dampen shock impulses.

View an **animation of a shock absorber** in this video on YouTube (1:23 min) and talk about its function.

Discuss how it looks like a spring and how it might cushion the landing of a spacecraft on the Moon's surface.

Talk about how the work of an engineer always begins with a 'brief'. Explain how the brief they will be given as engineers is a set of requirements written by the people they will be building the shock absorbing system for.

Present the scenario again, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Locate where shock absorbers can be found. Talk about what they are used for and the types of people who design and build them.

Ask students to bring springs to class and investigate their shapes and properties. Talk about their ability to absorb impacts.

As a class, talk about the Lunar Module. Use Google Images to source photos of the Lunar Module. Discuss how the Lunar Module was the' landing portion' of the Apollo 11 spacecraft.

Ask students to look at its shape and design features and describe what they see.

View images of the Lunar Module, noting it has four landing legs that had to carry the weight of the vehicle, its equipment and its crew.

Talk about how the Lunar Module was designed by a company called Grumman and an Aerospace Engineer named Thomas J Kelly.

Explain that the initial design had three landing legs. As any particular leg would have to carry the weight of the vehicle if it landed at any significant angle, three legs was the lightest configuration possible. However, it would also be the least stable if one of the legs was damaged during the landing. Explain how the next landing gear design iteration had five legs, which was the most stable configuration for landing in an unknown terrain.

That configuration, however, was too heavy and the designers compromised on four landing legs. Source: **LM Landing Gear**

Ask students to view the **actual plans of the Lunar Module landing gear** and, in design teams, brainstorm ways to cushion the Lunar Module's landing on the Moon's surface and determine the materials they might use.

Invite design teams to use these ideas as a springboard to help them consider ways they can design and produce their own shock absorbing system.

Remind students that there is no air on the Moon. Talk about how the Lunar Module descended and ascended with the use of rockets. Discuss how the models being designed may need to use a design mechanism that simulates the use of rocketry (i.e. parachutes).

Ask students to consider manipulating materials, developing prototypes, testing ideas, and accessing information sources to use in the following phases of their designs.

Talk about using either high-tech solutions like Minecraft to scope their design; low-tech solutions like LEGO® or no-tech solutions like newspaper, cardboard, springs, marshmallows, eggs, balloons, popsicle sticks, pens, pipe-cleaners, string, paperclips, straws, masking tape, glue and tape.

Dream:

In pairs or small groups, envision or dream about the many possible design solutions to design and build your own shock absorbing system for a vehicle similar to the Lunar Module.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to descend and safely land on a surface similar to the Moon without damaging the spacecraft and its equipment or injuring the crew.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in designing and building their shock absorbing system for a vehicle similar to the Lunar Module. Will their system be attached to a replica of the Lunar Module? Might their model use a similar shape of the Lunar Module?

Ask students to gather the materials, tools and equipment needed and then design and build the solution.

Invite students to prototype and test their model, evaluate its ability to descend and safely land on a test surface, and where necessary redesign it.

Where necessary, encourage students to think about why their model might tip over when it descends and how a re-positioning of parts to better balance the weight might be needed.

If there is an issue with the model bouncing instead of landing softly, encourage students to think about changing the size, position or the number of shock absorbing parts on their model.

If there is an issue with crashing instead of landing safely, encourage students to consider adding a means to slow down the speed of the descent.

Encourage students in their design teams to demonstrate their Lunar Module models and associated shock absorbers and their ability to descend and safely land on a test surface.

Ask groups to talk about how they solved any problems that emerged as they designed, built, tested and adjusted their models.

Test models and allow them to descend from different heights. See which ones descend and safely land on a surface similar to the Moon.

Talk about the forces that may have affected the Lunar Module models as they fell. Talk about the pull of gravity and the air resistance that slowed the models down.

Invite a peer class group to the class to hear the aeronautical engineers in the class describe the type of shock absorbing systems they designed and built and see them demonstrate how their models can descend and safely land on a surface similar to the Moon without damaging the spacecraft and its equipment or injuring the crew.

Deliver:

In pairs or small groups, showcase the shock absorbing systems and associated messages explaining the type of shock absorber they designed and built as well as demonstrate how the prototypes of their lunar landers can descend and safely land on a surface similar to the Moon without damaging the spacecraft and its equipment or injuring the crew.

Host an 'Apollo 11 Descent Day' as part of National Science Week and invite students, teachers and parents to discover what students can do as aeronautical engineers.

Debrief:

Ask students to reflect on their learning and answer the following questions.

- What worked and what didn't?
- How could you improve on what you have done?
- What are three things you learned that you didn't know before?
- What are three things that surprised you?
- What was your most inspiring moment in the challenge?
- How can you apply what you have learned to other challenges, now and in the future?

Curriculum connections

Science (ACARA, 2015a)

Year 5 and Year 6

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE081, ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083, ACSHE100

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS231, ACSIS232

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks ACSIS086, ACSIS103

Compare data with predictions and use as evidence in developing explanations ACSIS218, ACSIS221

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts ACSIS093, ACSIS110

Technologies (ACARA, 2015b)

Year 5 and Year 6

Design and Technologies—Knowledge and Understandings

Examine how people in design and technologies occupations address competing considerations, including sustainability in the design of products, services, and environments for current and future use ACTDEK019

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

Design and Technologies—Processes and Production Skills

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

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

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

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

General Capabilities:

Literacy; ICT capability, Critical and creative thinking, Ethical Understanding and Personal and social capability.

Case Studies

Landing the Mars Rover

View the video **Rover Landing in Mars** on YouTube (2:41 min) and find out about the innovative air bags that assisted the landing of the Mars Rover.

Gilmour Space Technologies

Discover how an Australian start-up company called **Gilmour Space Technologies** from South East Queensland launched a prototype hybrid rocket in 2016 and is currently on track to launch its hybrid rocket propulsion system in 2020.

Chinese land on the lunar far side of the Moon

Learn about the two spacecraft that landed on the lunar far side of the Moon in early 2019. Read about how '**China's Yutu 2 Rover is Driving on the Far Side of the Moon**' and learn about the science investigations being undertaken in the mission.

Activity 3: Cosmic war on waste

Chromium
Cr
Atomic No. 24

Overview: *Explain to the class that their task is to show their support for less waste in space by designing and creating a technology to remove space junk from our skies as well as increase awareness of others about the debris issues affecting space.*

Who Knew?

Chromium metal shines through a thin transparent layer of chromium oxide that prevents the metal underneath from corroding.

Background science for teachers and students: Space debris

"Space debris includes all human-made, non-functioning objects in orbit around Earth, some of which regularly re-enter the atmosphere. As of the end of 2017, it was determined that 19,894 observable bits of space junk were circling our planet, with a combined mass of at least 8,135 tonnes—that's more mass than the entire metal structure of the Eiffel Tower." Source: **ESA**

The rising volume of space debris increases the potential danger to all space vehicles, but especially to the International Space Station and other spacecraft with humans aboard.

"There are more than 20,000 pieces of debris larger than a softball orbiting the Earth. They travel at speeds up to 30,000 km/h, fast enough for a relatively small piece of orbital debris to damage a satellite or a spacecraft. There are 500,000 pieces of debris the size of a marble or larger. There are many millions of pieces of debris that are so small they can't be tracked.

Even tiny paint flecks can damage a spacecraft when travelling at these velocities. In fact a number of space shuttle windows have been replaced because of damage caused by material that was analysed and shown to be paint flecks." Source: **NASA**

The essential question:

Can we clean up space before it's too late? What is the best way to get people thinking about finding solutions to the debris issues in space?

The scenario:

For more than 60 years humans have been hurling hardware into orbit. We now have landfill in space and we won't be able to use space if we don't clean it up.

Space debris is also a hazard to our satellites and spacecraft as well as a contributor to near-Earth space pollution.

Your design team's challenge is to design a technology to remove debris from space.

You are also challenged to inspire other people about debris issues in space.

A suggested learning process:

Define:

Share the essential question with the class and talk about the problem that needs to be addressed.

Present the scenario, assign teams if appropriate, and ask students to define the task they have been set.

Discover:

Use the video **Space debris – a journey to Earth** on YouTube (12:34 min) by the European Space Agency (ESA) to find out about debris in space.

For information about the amount of space debris circling the Earth, read a summary of ESA's **Annual Space Report**.

Listen to a **recording of The Science Show** recorded on the 15th July 2018 and titled 'Space junk—cleaning up after ourselves' and note any technologies in the planning that are possibilities for each design team's consideration.

Brainstorm the many ways people can reduce the amount of space debris in our skies.

As a class, build understanding by sharing ideas and recording issues that the class would like to know more about.

Encourage students to find examples of what people are doing are to address sustainable practices and promote ways people can reduce the amount of space debris. The students are to bring their findings back to class.

Read for information, view images and discover more about a **space net** that has been designed in Britain to clean up debris in space.

View the video, **This satellite net is cleaning up space junk** (3:01 min), of the space net in action cleaning up space debris.

Discuss the design features of the technology and discuss how they capture the debris.

Ask students to communicate their ideas by drawing and writing a description of what technologies they might suggest as ways to clean up space.

Ask students what they might need to know more about in order to undertake the challenge set. Might they need to start thinking about how to inspire other people about debris issues in space?

Dream:

Ask students to imagine the steps involved in designing their technology to remove debris from space.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples. Will they use digital or non-digital equipment and tools?

Ask students how they might inspire other people about debris issues in space? Might they design a poster, film a video or write a blog?

Design:

Talk about the importance of a clear layout and design that makes it easy for an audience to understand and interpret the information that is being given.

Discuss the importance of sourcing graphics, photos and information correctly.

Discuss the importance of responsible digital citizenship.

Talk with students about responsible digital citizenship in online environments. Work with students to have them understand appropriate use. Emphasise the following principles.

- Respect themselves
- Protect themselves
- Respect others
- Protect others
- Respect intellectual property
- Protect intellectual property

Source: Crockett, L., Jukes, I., & Churches, A. (2011) *Literacy is not enough*. 21st Century Fluency Project Inc, p 81.

Review rules on personal safety, group safety, and classroom and furniture safety with the students.

Ask students to establish a workstation and to gather the materials and tools they require.

Talk about safely storing their design and keeping a record of the processes they use to create it.

Ask students to draft the steps involved in making their chosen digital or non-digital designs.

Ask students to gather the materials, tools, and equipment needed and then plan each step involved in creating the digital or non-digital designs.

Invite students to start creating the design of a medium that might inspire others about orbital debris issues.

Talk with students about how they might share and present their designs to an audience.

Ask students to explain how they plan to finalise and create their designs with a peer in their class and seek feedback on their ideas.

Remind students that they also need to inspire other people about debris issues in space using something like a blog, poster or brochure.

Invite students to design their work samples.

Photograph students at work.

Deliver:

Share work samples, including the designed solution that can remove debris from space and the inspirational blog, poster or brochure that will engage others about debris issues in space.

Ask students to share their designs with others.

Film student presentations of their designed solution, blog, poster or brochure, and enjoy a day of learning about how we might remove debris from space and why we need to.

Set up tables or booths in the class and invite students, teachers and parents to 'Discover National Science Week in 2019!'

Debrief:

Ask students to evaluate their designs and write a paragraph about whether each design:

- matched the definition of the task;
- used a clear layout and design;
- was feasible; and
- included the sources of the ideas and information each design piece used.

The students should also write about the quality of their planning, their finished designs and whether they enjoyed the task.

Finally, they should describe their favourite memory of creating their work samples for National Science Week.

Curriculum connections

Science (ACARA, 2015a)

Year 5 and Year 6

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Science as a Human Endeavour—Use and influence of science

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Technologies (ACARA, 2015b)

Year 5 and Year 6

Design and Technologies Knowledge and Understandings

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

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

General Capabilities:

Literacy; ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability.

Case Study

Where spaceships go to die?

Discover more about the **spacecraft cemetery** in the Southern Pacific Ocean and read about the **Chinese space station that crashed on Easter Monday** in 2018.

Activity 4: Looking into space

Overview: *Explain to the class that their task is to use science, technology and art to create a piece for a Science Week Exhibition titled 'Looking into Space', which visitors of all ages will be invited to enter and explore.*

Cobalt
Co
Atomic No. 27

Who Knew?

Cobalt is the lightest of the elements that cannot be produced in the core of a star. However it is produced in a supernova explosion, which is the way stars 8 to 15 times the mass of the Sun die.

Background science for teachers and students: Astronomy and space science

Astronomy is the study of everything in space. It is the science of things beyond the Earth, including the Sun, Moon, planets and stars.

"Space science encompasses all of the scientific disciplines that involve space exploration and study natural phenomena and physical bodies occurring in outer space, such as space medicine and astrobiology." (Source: **Wikipedia**, 2017)

The essential question:

What happens when we understand that space has been studied by scientists and artists for millennia and is an infinite source for human creativity?

The scenario:

Your challenge is to research early and later astronomers and the people and technologies used in space exploration. Then use science, technology and art to create a piece for a Science Week Exhibition titled 'Looking into Space', which visitors of all ages will be invited to enter and explore.

Are you up for the challenge?

A suggested learning process:

Define:

Capture students' interest and brainstorm words, phrases and ideas that come to mind when they think about the phrase: 'looking into space'.

Talk about the role of telescopes, space probes, satellites, spacecraft, rockets, space telescopes and space stations in enabling us to look into space.

Discuss the first humans in space and the first humans on the Moon.

Be inspired by an art installation in the **Singapore ARTSCIENCE Museum** and explore how art can meet science.

View the video of an art installation that showcases an exhibition titled '**NASA - A Human Adventure**' on YouTube (14:16 mins). It featured in Singapore in 2016.

Present the scenario, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Capture students' interest and share the following information about early and later astronomers who studied what is in space.

Early astronomers were interested in how the universe worked.

- Indigenous Australians are considered the first astronomers.
- The early ancient Greeks also started asking questions about the universe and how it worked.
- In the 2nd century BC, Hipparchus of Nicaea catalogued more than 800 stars. At a similar time, Ptolemy of Alexandria devised a model of the solar system with the Earth at its centre and the Sun, Moon, planets and stars circling it.
- In the 16th century, Copernicus tried to persuade people that the Sun, not the Earth, was at the centre of the solar system.
- In the 17th century, Tycho Brahe discovered a supernova and suggested that it was outside the solar system and it was his accuracy of observations that allowed astronomers who followed him to make the discoveries they did. His observations were instrumental in changing astronomer's views of the planets from a Earth-centric to a Sun-centric one.
- In the 17th century, Johannes Kepler devised the laws of planetary motion, that link a planet's speed through the heavens with its elliptical orbit around the Sun. The most important thing about Kepler's laws were that they showed that the observations of planetary movements through the sky could be explained because they move in an elliptical orbit around the Sun, not a circular one as had been previously assumed.
- It was also in the 17th century when Galileo Galilei began using a telescope and John Flamsteed made the first extensive star charts.
- In the 18th century, Caroline Hershel discovered eight comets and assisted her brother William in discovering the planet Uranus.
- In the 18th century, Edmund Halley predicted the return of a comet that was later named after him.
- In the 20th century, Annie Jump Cannon was instrumental in developing a stellar classification system and she is credited with the creation of the Harvard Classification Scheme.
- In the 20th century, Henrietta Swan Leavitt discovered the relationship between the luminosity and the period of Cepheid variable stars.
- In the 20th century, Edwin Hubble determined that there were other galaxies outside the Milky Way.

- In the 21st century, the work of Vera Rubin on the angular motion of galaxies brought about the theory of dark matter.
- During the 20th and 21st centuries, Linda Spilker managed the Cassini mission that probed the planet Saturn, its rings and moons.
- In the 21st century, Jill Tarter oversaw the construction of an array of 350 radio telescopes that listen for signs of extraterrestrial intelligence as part of the Search for Extraterrestrial Intelligence (SETI) program.
- In the 21st century, Stephen Hawking worked on a theory that could unite the four basic forces in the universe, namely: gravity, electromagnetism, and the strong and weak nuclear forces.

Invite students to learn more about and be inspired by the following space probes that have been launched from Earth to explore the solar system and the planets.

- Luna 9, which landed on the Moon
- Venera 7, which landed on Venus
- The probe Ulysses was used to study the Sun
- Voyager 1 and Voyager 2 were used to study the outer planets
- The Cassini probe that photographed Saturn
- The Huygens probe that was launched from Cassini to land on Titan, a moon of Saturn
- The New Horizons probe performed a flyby of Pluto
- The Kepler mission that has discovered planets orbiting other stars

Invite students to research at least three space probes that may inform their artwork.

Investigate the first humans in space and on the Moon.

Find out about the observatories on Earth that use reflecting telescopes and refracting telescopes.

Research the **Australia Telescope National Facility** and investigate the amazing and diverse observatories and technologies that are used to study different aspects of the universe.

Talk about how scientists are still researching so much about the universe that defies explanation.

Dream:

In pairs or small groups, envision or dream about the many possible aspects of astronomy and space science that could feature in an art piece, art installation and art exhibition.

Revisit the Singapore ARTSCIENCE Museum's '**NASA – A Human Adventure**' on YouTube (0:30 sec) exhibit for ideas.

Explore ideas and practices used by artists, including Aboriginal and Torres Strait Islander artists, to represent different scientific ideas.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to also explain and help others understand the extraordinary advances in technology used by space agencies, as well as the scientific endeavours that have involved scientists throughout the ages, that have brought us to a golden age of discovery in astronomy and space exploration.

Design:

Invite students, in pairs or small groups, to begin drafting designs for their solutions.

Ask students to draft the steps involved in making their artwork for the Science Week exhibition titled 'Looking into Space'.

Ask students to gather the materials, tools and equipment needed and then create their solution.

Ask students to plan the display of artworks to enhance meaning for their audience.

Invite a peer class group to the class to hear from the students and find out more about the extraordinary advances in technology used by space agencies, as well as the scientific endeavours that have involved scientists throughout the ages, that have brought us to a golden age of discovery in astronomy and space exploration.

Deliver:

Pairs or small groups showcase their artwork for the Science Week exhibition titled 'Looking into Space'.

Classes host a Science Week exhibition titled 'Looking into Space' as part of National Science Week and invite students, teachers and parents to discover what they can learn about space science too.

Debrief:

Ask students to reflect on their learning and draw something new they learnt about.

Ask students to describe what worked well and not so well in their efforts to explore the extraordinary advances in technology used by space agencies.

Talk about what students might still like to find out about.

Invite students to consider ways they might improve on, or even redesign, aspects of their work samples.

Curriculum connections

Science (ACARA, 2015a)

Year 5 and Year 6

Science Understanding—Earth and space sciences

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

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE081, ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083, ACSHE100

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS231, ACSIS232

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks ACSIS086, ACSIS103

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts ACSIS093, ACSIS110

The Arts (ACARA, 2015b)

Year 5 and Year 6

Visual Arts

Explore ideas and practices used by artists, including practices of Aboriginal and Torres Strait Islander artists, to represent different views, beliefs and opinions ACAVAM114

Develop and apply techniques and processes when making their artworks ACAVAM115

Plan the display of artworks to enhance their meaning for an audience ACAVAM116

General Capabilities:

Literacy; ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Aboriginal and Torres Strait Islander Histories and Cultures.

Activity 5:
Get your crew ready

Plutonium
Pu
Atomic No. 94

Who Knew?

The Curiosity rover currently surveying Mars and the New Horizons probe that flew past Pluto, each rely on plutonium for their energy.

"A series of unexpected events meant that the Honeysuckle Creek Tracking Station captured the first images of the Apollo 11 landing on the Moon. Despite widespread interest in the moonwalk footage, the primary focus of the station was to actually receive information about the astronauts' health.

Mike Dinn, the Deputy Director at the Honeysuckle Creek Tracking Station in 1969, said each of the astronauts had sensors that monitored medical parameters such as heart rate and breathing and relayed the data down to Earth.

"That's literally what determined the life support of the people on the Moon", he said. "That data getting back to the relevant people in Houston was far more important than the television footage. The heart rate and the breathing and the oxygen were all directly relevant to the support of astronauts walking around in a vacuum, which had never really been done before. The television footage was really nice to have at the time."
Source: '*Accidental Triumph*' by N. Skilton, The Canberra Times, Monday July 20, 2009, page 5.

Your challenge is to investigate spacesuit designs. Then sketch, ideate and design a spacesuit with perfectly placed sensors that can capture the data that Houston eagerly awaited from the Honeysuckle Tracking Station. How might you capture medical parameters such as heart rate, breathing rates and oxygen levels?

Could there be other medical and health indicators worthy of capturing too?

Design your spacesuit with its technologies that can capture health data and present is as part of National Science Week.

Case study

Designing metal woven fabrics for use in space

Learn about the innovative **metal fabrics** that are being woven to shield a spacecraft from meteorites, for astronaut spacesuits, or for capturing objects on the surface of another planet.

Activity 6:
Travelling to the Moon

Looking for an escape from Earth? Might travelling to the Moon be an idea that entices you?

Gold
Au
Atomic No. 79

Who Knew?

The mirrors of the James Webb Space Telescope are gold coated.

Breathe life into space history and design a scientific presentation that highlights our journey to and fascination with the Moon. Create an engaging scientific account of our explorations where rockets and humans have orbited and landed on the Moon.

APOLLO PROGRAM

The first crewed rocket humans sent to the Moon was Apollo 8. The rocket and crew didn't land or leave footprints; however it was the first time humans ever left Earth orbit for another celestial destination.

In early 1969, Apollo 9 was launched and it tested the Lunar Module for the first time. The Lunar Module was designed to take astronauts to the surface of the Moon and NASA wanted to ensure that the spacecraft worked well in Earth's orbit before testing it on the Moon.

In May 1969, Apollo 10 went through the steps of separating the Command Module spacecraft from the Lunar Module and taking the Lunar Module through the first part of its descent to the surface of the Moon. Although Apollo 10 stopped short of landing on the Moon by about 15,000 metres, it was a key test ahead of the successful Apollo 11 landing of July 21 (in Australia) 1969.

In July 1969, Apollo 11 landed on the Moon and two crew members walked on the Moon, set up instruments and experiments, took photographs, collected samples of Moon rocks and soil, and returned those samples safely back to Earth.

Later in 1969, Apollo 12 landed on the Moon and more scientific activities were undertaken.

In 1970, Apollo 13 was scheduled to land on the Moon, but it had a malfunction on the way there. The crew flew around the Moon and returned safely to Earth.

In early 1971, Apollo 14 was the next mission in which humans landed on the Moon.

It was in July 1971, that Apollo 15 became the fourth mission to land on the Moon. On this occasion, the astronauts drove a vehicle. Prior to the return to Earth, Apollo 15 launched a sub-satellite to study the magnetic field of the Moon and map its gravitational field.

In April 1972, Apollo 16 was the fifth mission to land on the Moon, and like Apollo 15, the astronauts landed, walked and drove on the lunar surface, undertook scientific observations, collected samples and data, and launched a sub-satellite to study the magnetic field of the Moon and further map its gravitational field.

Later in 1972, Apollo 17 was the sixth and final mission to the Moon for the Apollo program. It also explored the lunar surface, however, it was the first mission in which a scientist, (a geologist) was able to investigate the Moon firsthand.

Your challenge is to visualise and design a scientific presentation that highlights the various aspects of our interest and fascination with the Moon. Then, create an engaging account of our explorations in orbit and on the Moon.

What might your scientific presentation share with your audience?

Define your challenge, then discover and record information about missions to the Moon.

Imagine your scientific presentation and what it might communicate. Will it be high-tech, low-tech or no-tech? Will you film and make a video, will you write a song, might you design and create a poster or digital presentation?

Draft your scientific presentation, then finalise and deliver your scientific presentation as part of National Science Week in 2019.

Case Study

Discover more about the Apollo missions and read an **online book** about the history of Apollo, written by the people who led the project.

Activity 7:
Space probes and the Moon

Lanthanum
La
Atomic No. 57

Who Knew?

Lanthanum glass is used in camera and telescope lenses.

View the ABC Education video, **Satellites** (1:32 min), and learn about satellites: how many there are, how they are seen, what they look like, and also find out about the largest one called the International Space Station (ISS).

Did you know that space probes do not have astronauts? They are spacecraft that travel through space to collect scientific information. They can have instruments that take pictures, measure atmospheric conditions, track cyclones, and then report the data back to Earth. These probes send back data for scientists to study.

SATELLITES

The first satellite to be launched into orbit around Earth was ***Sputnik,*** which was launched by the Soviet Union in 1957. It was just a little silver ball, less than a foot across, with antennas that sent out a "beep-beep-beep" to let the rest of the world know that they had been the first into space.

There have been a number of space probes launched from Earth to explore the Moon.

In September 1959, a space probe/artificial satellite named Luna 2 was the first to reach the Moon's surface, and in October that year Luna 3 made the first circumnavigation of the Moon and returned the first photographs of its far side.

Luna 9 was the first space probe/artificial satellite that landed on the Moon. It sent back the first close-up images of the Moon's surface to Earth. In 1966, Luna 10 orbited the Moon.

In September 1970, Luna 16 was the first probe to carry lunar soil samples back to Earth and in November of that same year Luna 17 soft-landed a robot vehicle named Lunokhod I on the Moon. It contained television equipment that transmitted live pictures of several kilometres of the Moon's surface back to Earth.

In 1974, Luna 22 orbited the Moon 2,842 times while conducting space research in its vicinity. And in 1976, Luna 24 returned with lunar soil samples taken from a depth of seven feet (about two metres) below the surface.

Since then, thousands of artificial satellites have been launched into space to collect weather information like rainfall and snow, cloud cover, temperatures, ocean information, temperatures, waves, location of icebergs, and other information about the ozone layer and the influence of the Sun on the Earth's magnetic field.

Your challenge is to design a space probe that can be launched into space to create maps, and take close-up photographs of the Moon—all while the probe is orbiting it—and communicate what it finds back to Earth.

What might your space probe need so that it can be propelled towards the Moon?

What might it carry and contain so that it can communicate with Earth?

What might it need so that it can stay in space?

What equipment will it have so that it can send its data, including the maps and photographs, back to Earth?

What design features will it need to be able to collect and retrieve soil samples?

Define your challenge, then discover and record information about space probes.

Imagine your space probe, which can be launched into space, collect soil samples, create maps, and take close-up photographs of the Moon while the probe is orbiting it and still communicate all this data back to Earth.

Draw your designed solution. Include labels of the equipment and instruments that it has. Finally, make and test your space probe and deliver it as part of National Science Week in 2019.

Activity 8:
Make the impossible possible

Strap yourselves in and join the journey as we're going to the Moon.

Uranium
U
Atomic No. 92

Who Knew?

Uranium takes its name from the planet Uranus, which was discovered just a few years before the element uranium was.

From the spacecraft that have been launched to explore the Moon we know that it is a harsh place with extreme temperatures and a bleak rocky terrain, and lacking in water. We know that it has a thin atmosphere that is not breathable, and anyone caught on the Moon without a spacesuit would instantly start to suffocate.

NASA is currently preparing to establish a base on the Moon. Like NASA, design and deliver your theory about what it might take to establish a colony on the Moon.

View the ABC Education video **Living on the Moon!** (2:43 min). Research ideas and then design and create a model of a moon base with all the support systems to enable that base to survive. Educate and excite an audience with your ideas as part of National Science Week.

Case Study

Elon Musk's Innovative Designs

Discover what the tech giant has designed and manufactured for space exploration and colonisation. Read about the **Falcon 9**, **Falcon Heavy** and **Dragon** spacecraft and learn about their innovative design features.

Activity 9:
What can you do to help make people aware of the Australian Space Agency?

Begin finding out about the Australian Space Agency, what it is and why it's so important.

Record information about what you discover and then think about how you might share your ideas with others.

Might you design a question and answer game using standard art materials or might you incorporate the use of digital technologies using apps like Poll Everywhere or Mentimeter?

Might you design a talking avatar using Voki?

Might you design an info graphic?

Set up an activity day where teachers, students and parents can learn all about the agency for space.

Activity 10:
The Periodic Table

Mendelevium
Md
Atomic No. 101

Who Knew?

Dmitri Mendeleev was the founding father of the modern periodic table. The name mendelevium honours him.

Explain that 2019 is the International Year of The Periodic Table and that to celebrate this and the Apollo 11 landing on the Moon, the class is going to investigate the elements in the Periodic Table.

Download the Periodic Table app from the iTunes store or view a copy of the **Periodic Table** online.

Play a **game** of Battleships using the Periodic Table.

Try a **game** matching the elements to their symbols.

View a **graphic** of the Periodic Table where each element is clickable. Ask students to click on the elements to discover more information about each element.

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Activity 1: Pitch your space idea

Copernicium
Cn
Atomic No. 112

Overview: *Explain to the students that their task is to investigate emerging ideas in Australia's space industry and then design a sustainable space solution which they will pitch as part of a space 'Pitch' competition.*

Who Knew?

Copernicium is named after the Polish astronomer, Nicolaus Copernicus, who first suggested that the Earth orbited the Sun. It is an extremely radioactive element, and can only be created in a laboratory.

Background notes for teachers and students: Start-ups inspiring innovation

The Australian space industry has come a long way in the past ten years. Australia has many space-related start-ups, which are inspiring innovation and making an impact in the world of space exploration.

There is an ever-expanding space industry emerging in Australia seeking to expand its slice of the $420 billion global space industry.

The essential question:

What benefits accrue in space exploration when we have an understanding of how traditional and contemporary approaches are used in conjunction with advanced and innovative technologies when designing sustainable products, systems and solutions for a secure and sustainable space future?

Scenario:

Discover how people in the space industry are working with new ideas, technologies and entrepreneurs to re-imagine: how space can be explored, how minerals may be extracted from asteroids, how planets might be colonised, how space debris might be removed, and how rockets and satellites might be recycled, re-used, up-cycled and be more sustainable.

Investigate how nanotechnology, quantum mechanics, the use of remote sensors, satellites, artificial intelligence (AI), robotics and the Internet of Things (IoT) are now part of the innovation occurring in the world of space exploration and space activities.

Then, as part of a design team, students will re-imagine a service, product or systems used in space exploration and imagine how it might be more sustainable, socially, economically and environmentally. Produce a folio of ideas to explain your entrepreneurial thinking.

Each design team is also tasked with then selling their pitch as part of a pitch competition.

A suggested learning process:

Define:

Share the essential question with the class and talk about the tasks that need to be addressed.

Present the scenario, assign teams if appropriate, and ask students to define the task they have been set.

Discuss how investors and successful businessmen are currently investing in space. Discuss entrepreneurs like Elon Musk, Richard Branson and Jeff Bezos, who are all putting in their own money to start a new space race economy. Analyse their theories and business ideas, and explain how they might work.

View the video **Space Invaders: the entrepreneurs taking humans into space** on YouTube (13:36 min) and discover pioneering companies and their engineers in the Mojave Desert who are pursuing careers in the space industry and designing cutting-edge technologies and innovations, as well as prototyping designs, testing them and venturing to the frontiers of space.

In design teams, investigate Elon Musk's company **SpaceX,** which develops and manufactures advanced rockets and spacecraft for missions around and beyond Earth's orbit.

Find out about **Falcon 9**, the first orbital-class rocket that is re-usable. Discuss Falcon 9 and the merits of it being re-usable. Use a **Consequence Chart** template to map the first-, second- and third-order consequences of this reusable rocket design.

Discover the **Falcon Heavy**, which is currently the world's most powerful rocket. Undertake a Plus-Minus-Interesting (PMI) analysis of its features.

Talk with the students about how exciting space technology and space activities are as areas of study. Describe how they provide opportunities to solve all sorts of problems in a practical way by designing and making things, and also changing and adapting things that are already in existence.

Discover:

Talk about the word 'sustainability'. As a class, consider the differences between 'environmental sustainability', 'economic sustainability' and 'social sustainability'. For example: When an aerospace manufacturer thinks of being economically sustainable, they might ask themselves a question like 'Are we sustainably profitable?' or 'What do we need to do to make sure that the spacecraft design provides a living for our family into the future?'.

When NASA, or an aerospace manufacturer, thinks about being socially sustainable, they might ask themselves a question like 'Are we behaving in a way such that the community will support us into the future?' or 'How should we be involved in our community, to support the community and benefit us into the future?'

When NASA, or an aerospace manufacturer, thinks about being environmentally sustainable, they might ask themselves a question like 'Are we maintaining our manufacturing plants and their assets for future generations?' or 'How can we utilise the plant's natural surroundings so that future aerospace manufacturers can operate successfully in that environment?'

Delve deeper and think about how waste management, water re-use, wastewater treatment, resource recovery, and innovative power generation feature when designing a service, product or system used in space exploration. Ask students to visualise how these ideas might be integrated into new designs for anything used in space exploration.

Ask students to develop criteria describing the standards they feel best describe 'sustainable aerospace manufacturing'. Share these as a class and display ideas for future reference.

As a class, build understanding by sharing ideas and recording issues that the class would like to know more about on how an aerospace manufacturer might address sustainable processes and systems in their business.

Discuss ecological footprints on Earth and imagine these in space.

Focus on something like 'what we eat'. Talk about how, when talking about our ecological footprint and eating on Earth, our ecological footprint is influenced by: what we eat; how the food is produced; how far it has travelled; how it is processed and packaged, prepared and cooked, and the portion size we consume; and how we dispose of what is left. Talk about how all the food consumed in space is packaged in some way and brainstorm ways that food packaging might be reduced.

Imagine a space-related context like 'the fuel it takes to launch and fly spacecraft' and think about how this ecological footprint of this aspect of spaceflight might be reduced. Talk about hydrogen fuel cells and discuss how they might reduce the ecological footprint of space flight, especially as the only by-product from its use is water.

Consider space junk and mind map ways we can clean up space and recycle the pieces of junk that are found. What service, product or system used in space exploration could be designed to clean up space?

Talk about how most rockets and spacecraft are not reusable. Discuss how they return to Earth by landing in an ocean, never to be seen again. Discuss whether such practices are economically or ecologically sustainable and how they might be reinvented.

Capture students' interest and introduce **Cuberider**, an Australian company that provides high schools with kits that enable students to design experiments that are sent off to the International Space Station (ISS). Check out the types of innovative and scientific thinking that the high schools use and the experiments that have been created.

Introduce students to **Fleet Space Technologies**, a company in South Australia that is designing nanosatellites and sending them into space with Elon Musk's SpaceX rocket.

Introduce students to **Myriota,** a company in South Australia that is developing technology for the space industry and the IoT.

Read about **Neumann Space**, a company that has built an ion engine (a new type of rocket engine) that can send a space probe to Mars and back using a single fuel rod. Learn about how it uses solid fuel and electricity to produce thrust.

Learn about **Gilmour Space Technologies**, a company that has designed a suite of launchers that use hybrid rocket propulsion techniques. Then discover more about the water-extracting Mars rover that it has plans to design and build.

Go further and explore space start-ups and discover their innovative ideas via **Delta V**, a business accelerator that works with Australia's new space start-ups.

In design teams, students undertake a SWOT analysis and analyse whether the technologies and systems being designed by these start-ups add value to space exploration and sustainable space activities.

Talk about Artificial Intelligence (AI) and Machine Learning. Explain to the students that, hypothetically, it is possible for machines to learn to solve any problem relating to the physical interaction of things within a defined or contained environment through the use of artificial intelligence and machine learning.

Explain that the principle of artificial intelligence is one where a machine can become aware of its environment, and through a certain capacity of flexible rationality, take action to address a specified goal related to that environment. Machine learning is when a machine receives sets of data that can be categorised using specified protocols. When this is done, the machine's ability to rationalise in areas relevant to the supplied data increases, allowing it to better 'predict' a range of outcomes for similar data.

In design teams, students investigate the **application of Machine Learning** in space activities like rocket launching, landing and data transmission.

Ask each design team to share what their research has told them and what they still have to accomplish within the task.

Engage students in **how to develop a pitch**. Review the pitches made in Shark Tank or **Australia Post's Regional Australia Pitchfest** for ideas.

Dream:

Ask design teams to create a vision for a service, product or system used in space exploration that they are re-imagining.

Ask the teams to use all the knowledge they have gathered to visualise a creative and appropriate solution for a service, product or system used in space exploration that they know about and are excited to innovate on.

Ask students to visualise what the solution will appear like in the future.

Ask students to consider the many possible ways that they can design their idea. Talk about the use of research, working sketches, models, drawings, 3D modelling, experimentation, or photographic samples.

Ask students to develop possible solutions by brainstorming ideas.

Ask students to imagine the steps involved in designing the service, product or system used in space exploration that they are re-imagining.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples. Will they use digital or non-digital equipment and tools?

Also, ask students to envision the pitch that will be used to sell their ideas as part of a space and sustainability pitch competition.

Design:

Ask students to explain how they are going to re-imagine and document design ideas for a service, product or system used in space exploration and produce a folio of ideas to explain their entrepreneurial thinking.

Talk about how the students might use a model, prototype, blog, display folder, digital presentation or a combination of these to show evidence of their design and production process.

Ask students to draft the steps involved in making their chosen design.

Talk about the importance of a clear layout of information and a clear design that makes it easy for an audience to understand and interpret the information given.

Discuss the importance of including information in the design about how the service, product or system used in space exploration might:

- manage water, energy and waste productively and sustainably,
- treat the universe ethically,
- reduce space junk,
- maintain equipment sustainably,
- collect and/or transmit data, and
- make money or save money.

Talk about the importance of sourcing graphics, photos and information correctly.

Review rules on personal safety, group safety, and classroom and furniture safety with the students. Ask students to establish a workstation and to gather the materials and tools they require. Talk about storing their design safely and keeping a record of the processes they use to create it.

Remind students to record the steps involved in making their chosen digital or non-digital design.

Talk with students about how they might share and present their designs to an audience.

Ask students to explain how they plan to finalise and create their designs with a peer in their class to seek feedback on their ideas.

Remind each design team that they are also tasked with selling their pitch as part of a 'space pitch' competition.

Deliver:

The delivery phase has two stages—production and publication. In the production stage, the project comes to life. This is the 'doing' phase. At the end of this phase, the publication/presentation of the design for the service, product or system used in space exploration, that the design teams are re-imagining should be completed. Similarly, the design of the script for a pitch as part of a 'space pitch' competition should also be completed.

Ask students to design and create their individual design samples required for this unit.

In the publication phase, students showcase all of their thinking and planning. This is the time when students present their designs to each other or an audience, and is a good time for peer or self-assessment.

Ask students to share their designs with others.

Video student presentations, and if possible, enjoy a whole day of learning about how sustainability ideas might pioneer a better space future.

Debrief:

Ask students to retell their findings about the ways Australian companies are working with new ideas, technologies and entrepreneurs to re-imagine how a service, product or system used in space exploration might be more sustainable. Ask students to evaluate their designs and write about whether their design:

- matched the definition of the task,
- used a clear layout and design,
- was feasible, and
- included the sources of the ideas and information each design piece used.

Ask students to write about the quality of their planning, their finished design and whether they enjoyed the task.

Invite students to reflect on the learning by completing a self-assessment activity. Some example questions to stimulate reflection follow.

- How has my/our attitude and behaviour changed as a result of my learning?
- How well did I/we contribute to any team learning activities?
- How can I/we apply what I/we have learned to another topic?

Curriculum connections

Technologies (ACARA, 2015b)

Year 7, Year 8

Design and Technologies Knowledge and Understanding

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

Year 9 and 10

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

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

Science (ACARA, 2015a)

Year 7, 8, 9 and 10

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations ACSHE120, ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121, ACSHE136

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities ACSHE160, ACSHE194

Values and needs of contemporary society can influence the focus of scientific research ACSHE228, ACSHE230

Science as a Human Endeavour—Nature and use of science

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

General Capabilities:

Literacy; ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability.

Case Study

Australia's involvement in space research and development

Read about **Opaque Space**, a Melbourne-based company that is working with NASA to redesign its virtual reality astronaut training simulator.

Learn about RMIT and how it is developing **hydrogen-based fuels** for space travel.

Activity 2: Asteroid mining

Overview: *Explain to the class that their task is to consider what is ethically and socially responsible in a future of asteroid mining.*

Platinum
Pt
Atomic No. 78

Who Knew?

South Africa has the largest platinum deposits on Earth, and the largest production capacity.

Background science for teachers and students: Asteroid mining

Asteroids contain many resources and as such could be mined.

The idea of exploiting asteroids for their natural resources is older than the US space program.

In 1903, renowned Russian rocket scientist Konstantin Tsiolkovskii listed the "exploitation of asteroids" as one of fourteen reasons for the conquest of space.

Currently, two US companies, Planetary Resources and Deep Space Industries, are spearheading the private sector push to mine asteroids.

In Australia, there is an Australian-led project made up of 60 academics from the Australian National University, the University of South Australia, the University of Adelaide and the University of Western Sydney involved in projects that are scoping and developing models for mining operations on asteroids.

Source: Daly, J. '**Gold, water and platinum: Australians lead the way towards an asteroid mining boom**' from the WAtoday website.

Essential question:

What happens when we understand that scientists are designing and developing models for future mining operations on asteroids, and are seeking solutions using science and technology, that may impact on society, and may involve ethical and welfare considerations?

Scenario:

The revolution in space research and development gives us many divergent visions of the future. One vision, suggested by the space industry, is that of mining asteroids for their metals, minerals, water and other resources.

Some companies are intending to sell the materials mined and thereby generate healthy profits for themselves.

Others involved in scientific research and development programs suggest their mining activities will advance humanity's exploration of space, with their mining activities being a way to fund their further explorations into space.

Is it ethical to mine asteroids, and if so, under what guidelines?

Your ethics team has been approached by a local National Science Week Coordinating Committee. They want you investigate the various ethical questions that are posed when considering the mining of asteroids and the possibilities of bringing the asteroid's ores back to Earth.

Your challenge is to consider the effects of mining asteroids, the associated risks involved and help others understand what you think is socially and ethically responsible.

Are you up for the challenge?

If so, then celebrate your science investigations, create a scientific report or presentation and host an 'Investigating Mining Asteroids Day' as part of National Science Week.

A suggested learning process:

Define:

Capture students' interest and share an article about **asteroid mining ventures** that was unveiled in 2012.

Talk about asteroid mining as a contemporary issue and discuss whether students think schools should help young people studying science explore such mining opportunities.

Present the scenario, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Ask students to investigate how many asteroids may exist in near-Earth orbit that could potentially be mined; what minerals they might contain; and whether there are any organic materials that might need to be understood, if and when, mining activities are undertaken.

Research information about how and why scientists and mining entrepreneurs are developing models for future mining operations on asteroids. Read the article '**Interplanetary players: a who's who of space mining**'.

Read about **Australian research teams** involved in investigating the various options with respect to mining asteroids either in situ or on Earth. Locate and record information about the ways the team believes Australia could be on the cusp of asteroid mining. Delve deeper and find out which minerals are thought to be found within asteroids and the reasons for mining them.

Ask students questions like the following.

- Do you think people might think it ethical to manipulate and mine asteroids?
- Who owns asteroids in space?
- What are some of the positive things about possible mining operations in space?
- What are some of the more negative things about such activities?
- What might be the advantages and disadvantages of bringing an asteroid with unknown organic materials to Earth be?
- Who might benefit and who might lose in these possible scenarios, where we are taking advantage of asteroids that can potentially benefit the country that mines it?
- Can you describe what is socially and ethically responsible in this area of science?

Talk about the word 'ethical'. How might students describe an ethical way to mine asteroids? What might need to be considered? (For example: international laws, contamination, biohazards etc.)

Collate ideas about the ethical way to mine asteroids using, a mind mapping app or map ideas using a concept mapping technique.

Introduce a SWOT analysis. Talk about 'SWOT' being an acronym for **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats.

Model the use of a SWOT analysis using asteroid mining as an example and identify the:

- strengths of the concept;
- weaknesses of the concept;
- real opportunities that the concept offers the entrepreneurs, scientists and overall society living on Earth;
- real threats that might adversely impact on humanity and Earth's environment.

Ask students to clarify ideas and explanations and summarise these in written form.

Explore the issues uncovered and use **Edward de Bono's Six Thinking Hats** to think through the issues according to each coloured hat.

Use a Positive, Minus, Interesting (PMI) chart to revisit and analyse the associated advantages and disadvantages and interesting ethical considerations involved in the idea of mining asteroids. When using a PMI consider:

- Pluses—focussing on the perceived positive outcomes,
- Minuses—focussing on the perceived negative outcomes, and
- Interesting to see—being the issues and questions that arise from that idea.

Ask students how they might communicate the ways their ideas, scientific report or presentation might communicate their findings about the effects of mining asteroids and help others understand what is thought to be socially and ethically responsible.

Dream:

In pairs or small groups, students envision or dream about the many possible solutions to a preferred future in which ethical and welfare considerations are used to inform any proposed mining of asteroids.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to also explain and help others understand what they think is socially and ethically responsible when mining asteroids in space.

Design:

Invite students, in their pairs or small groups, to begin drafting their designs for their solutions as part of a scientific report or presentation to share with others as part of National Science Week.

Ask students to draft the steps involved in making their 'Investigating Mining Asteroids Day' item.

Ask students to gather the materials, tools and equipment needed and then design and create the report or presentation.

Invite a peer class group to the class to hear about what students think is socially and ethically responsible when mining asteroids.

Deliver:

Pairs or small groups showcase their ideas about what is socially and ethically responsible when mining asteroids.

Classes host a 'Investigating Mining Asteroids Day' as part of National Science Week and invite students, teachers and parents to discover more about the issue.

Debrief:

Ask students to reflect on their learning and something new they learnt about.

Ask students to describe what worked well, and not so well, in their efforts to engage others in thinking about what is socially and ethically responsible about mining asteroids.

Curriculum connections

Science (ACARA, 2015a)

Year 7, Year 8, Year 9 and Year 10

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations ACSHE120, ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121, ACSHE136

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities ACSHE160, ACSHE194

Values and needs of contemporary society can influence the focus of scientific research ACSHE228, ACSHE230

Science as a Human Endeavour—Nature and use of science

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

Technologies (ACARA, 2015b)

Year 9 and 10

Design and Technologies Knowledge and Understanding

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

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

Investigate and make judgments, within a range of technologies specialisations, on how technologies can be combined to create designed solutions ACTDEK047

Design and Technologies Processes and Production Skills

Apply design thinking, creativity, innovation and enterprise skills to develop, modify and communicate design ideas of increasing sophistication ACTDEP049

General Capabilities:

Literacy; ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability.

Case Study

ORIRIS-REx

Learn more about the NASA initiated **OSIRIS-REx** mission and its numerous mission operations that include investigating and drilling into asteroids.

Activity 3: Colonisation in space

Overview: *Explain to the class that their task will be to educate the broader community to better understand how we are witnessing a number of discoveries and milestones in space as scientists expand the current knowledge base we have and attempt to design and construct colonies in space.*

Xenon
Xe
Atomic No. 54

Who Knew?

Xenon gas is finding use in ion drives that power spacecraft. The spacecraft's propulsion system ionise the gas before accelerating it.

Background science for teachers and students: Going back to the Moon and going further

The scientific community is looking at creating colonies in space. Space colonisation is permanent human habitation off the planet Earth.

"No space colonies have been built so far. Currently, the building of a space colony would present a set of huge technological and economic challenges. Space settlements would have to provide for nearly all (or all) the material needs of hundreds or thousands of humans, in an environment that is very hostile to human life. They would involve technologies, such as controlled ecological life support systems, that have yet to be developed. They would also have to deal with the as-yet unknown issue of how humans would behave and thrive in such places long term." Source: **Wikipedia**.

The essential question:

What happens when we understand how scientists are contemplating the colonisation of other planets?

The scenario:

The scientific community is looking at creating colonies in space. They are hypothesising about the cost of constructing space colonies, such as setting up a colony on the Moon.

There has never been a time in history where knowledge of what might be possible in terms of colonies in space has been greater than it is today.

Your task is to educate the broader community to better understand how scientists and researchers are looking at creating colonies in space. You could create a presentation, a series of podcasts, a video, a documentary or write a scientific report that you can present during National Science Week.

A suggested learning process:

Define:

Capture students' interest by watching **How Would You Envision a Space Colony** on YouTube (8:37 min) about how humans might live and work in space.

Talk about the messages conveyed in the video.

Ask students what they might need to know more about in order to undertake the task set for National Science Week. Might they need to know something about the key opportunities, possibilities and challenges involved in creating colonies in space? Might they need to know something about the radically different types of rockets required to carry out long-haul interplanetary missions? Might they need to know about what's involved in supplying a manned base on another planet?

Brainstorm what students know about creating colonies in space. List key words and create a flow chart to show links between the students' ideas.

Discover:

Discover more about creating colonies in space. Much of the latest science is freely available online.

Explore NASA's ideas about what may be possible. View NASA's **Giant Space Colony Concepts Explained (Infographic)** and read about what NASA and other authors have written about '**Space Colonization**'.

In groups, explore the issues presented and list ideas concerning understandings about space colonisation.

Ask students to develop a concept map describing what they know about colonies in space, what they are, what they comprise, what they affect, their potential impacts on humans and the varying suggested planets that might be colonised.

Use the **web map** from the Global Education website to develop a concept map.

Create a mind map and collate ideas or create a '**Wordle**' or word cloud.

Undertake further research and read and take notes about the sources and their suggestions about colonies in space.

Dream:

Ask students to visualise work samples that can educate the broader community about how scientists and researchers are looking at creating colonies in space.

Ask students to imagine what their work samples might look like and how they will bring awareness to the National Science Week school theme 'Destination Moon; more missions, more science' and to the issues and opportunities of creating colonies in space.

Design:

Ask students to design their work sample.

Ask students to gather the materials, tools, and equipment needed and then design their work sample.

Deliver:

Create the work samples.

Deliver work samples to real audiences during National Science Week and discuss the issues and opportunities of creating colonies in space and share information about how scientists and researchers are looking at creating colonies in space.

Debrief:

Ask students to recall what they learned.

Talk about what students might still like to find out about how scientists and researchers are looking at creating colonies in space.

Ask students to identify and describe what the most surprising thing they learned about was.

Invite students to evaluate their work sample and write about whether their work matched the definition of the task

Ask students the question "What would you do differently next time?"

Ask students to write about the quality of their planning, their finished work sample and whether they enjoyed the task.

Curriculum connections

Science (ACARA, 2015a)

Year 7, Year 8, Year 9 and Year 10

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations ACSHE120, ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121, ACSHE136

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities ACSHE160, ACSHE194

Values and needs of contemporary society can influence the focus of scientific research ACSHE228, ACSHE230

Science as a Human Endeavour—Nature and use of science

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE223, ACSHE226

Technologies (ACARA, 2015b)

Year 7, Year 8, Year 9 and Year 10

Design and Technologies Knowledge and Understanding

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

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

General Capabilities:

Literacy; ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability.

Case Study

The Gateway

Discover more information about NASA's proposed Moon Space Station called **The Gateway** that may provide a gateway to Mars.

Activity 4:
Breathe life into history

Narrate the journey of humanity's first landing on the Moon.

Selenium
Se
Atomic No. 34

Who Knew?

Jacob Berzelius suggested the name selenium after the Moon (the Greek word 'selene') because tellurium was named after the Earth (the Greek word 'tellus').

Use digital media to recreate the era, recall the tumult of a changing nation, as well as the tension felt by those involved both on Earth and in space.

Recreate the suspense and drama, then communicate the risks involved in the mission that had no room for error.

Present the challenges, risks and success of the Apollo 11 mission with respect to its crew members.

Create an engaging account of human ingenuity and exploration in space and share it with others during National Science Week.

Case Studies

Neil Armstrong and the Apollo 11 Mission

Learn more about the mission and watch the trailer for the movie **The First Man**. Students 15 years and over (M rating) could watch the whole movie.

The Apollo 13 Mission

Watch the 1995 biopic *Apollo 13* (PG) to learn about how mission control staff used all of their ingenuity to solve a problem that enabled the crew of Apollo 13 to return to Earth safely after a catastrophic event.

NASA Johnson Style

View and listen to a '**Gangnam Style parody**' on YouTube (3:47 min) by graduate interns at NASA's Johnson Space Centre in Houston. Check out the astronauts who joined in too.

Activity 5:
More advanced than us

Some astrophysicists scan the heavens searching for signs of civilisations that might be more advanced than ours, and many scientists believe that the universe has other intelligent life forms.

Curium
Cm
Atomic No. 96

Who Knew?

Element 96 is extremely radioactive and its only real use in space has been to supply alpha particles as probes to analyse soil on Mars. The Mars exploration rovers have taken a little curium with them in devices known as alpha technology spectrometers.

Like them, design and deliver your theory about the characteristics and signatures of civilisations that may live within our Milky Way galaxy, which contains 100 to 400 billion stars.

Making a series of reasonable assumptions, for example, about the numbers of stars that are like our own, the number of stars that have planets, the number of planets that are Earth-like, the number of Earth-like planets that may have life, and consider the number of planets that might exist in our galaxy that could harbour human life.

Consider '**Carl Sagan – Cosmos – Drake Equation**' on YouTube (8:29 min) as part of your thinking.

Exobiologists believe there are only a few basic criteria for intelligent life. Explore what is commonly understood by exobiologists and then share your theory and speculate what other beings might look like.

Activity 6:
The Australian Space Agency

Across Australia space science headlines are now heralding a new Australian Space Agency, Australia's central coordination point for national space activities and partnerships.

Research the Australian Space Agency, interpret the information, extract the essential knowledge, authenticate it and consider its meaning and significance.

Start by compiling a list of questions about the Australian Space Agency. Take smart notes and collect informational materials from the most appropriate digital sources.

Authenticate, organise and arrange your information.

Use Edward de Bono's Six Thinking hats to explore the Australian Space Agency further. Use each coloured hat and the questions asked below to assist your thinking.

Red Hat

Feelings

What are the emotions and feelings associated with the Australian Space Agency's role, priorities and operations?

White Hat

Information

List the facts you know about the Australian Space Agency's role, priorities and operations?

Blue Hat

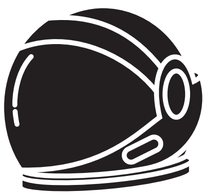
What thinking is needed?

What has happened so far? What should happen next? What questions should be considered about the Australian Space Agency's role, priorities and operations?

Green Hat

New ideas

How could any problems and opportunities related to the Australian Space Agency's role, priorities and operations be solved?



Black Hat

Weaknesses

What might be some of the negative aspects and outcomes of the Australian Space Agency's role, priorities and operations?

Yellow Hat

Strengths

What might be some of the positive aspects and outcomes of the Australian Space Agency's role, priorities and operations?

Finalise your information and share your investigations about the Australian Space Agency with other classes or create a display of findings within a school or community venue.

Activity 7:
The Periodic Table

Scientists use the Periodic Table to organise and categorise elements, and as such they can then predict how each element might react with other elements.

Your task is to consider the characteristics of elements in the Periodic Table, explore what properties they have and investigate how some react to one another.

Investigate the Periodic Table using a range of available apps in **iTunes** or **Google Play** and find the element you think is the most dangerous. Then, justify your choice using scientific evidence as part of your reasoning to the class.

View a **graphic** of the Periodic Table where each element is clickable. Ask students to click on elements and discover more information about each element.

Start researching, collating information and create your argument about the most dangerous element found in the Periodic Table.

Iridium
Ir
Atomic No. 77

Who Knew?

Element 77 was discovered in 1803 by Smithson Tennant in insoluble impurities in platinum. Iridium is the rarest element in the Earth's crust, because, along with other heavy metals, most of it sank to the Earth's core when the Earth was still molten and young.

An Australian Government Initiative

Inspiring Australia

How will you science this National Science Week?

national science week

10–18 AUGUST 2019

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ABC

Australian Science Teachers Association

CSIRO

THE SCIENCE OF EVERYTHING
COSMOS

POPULAR SCIENCE