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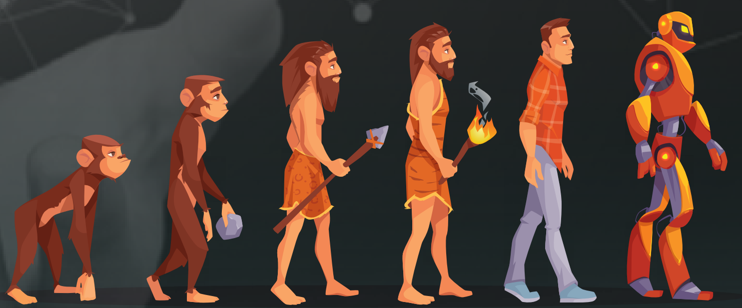

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Rosemary Anderson

ASTA President

As we approach National Science Week, I am delighted to introduce the 2023 National Science Week Resource Book, Innovation: Powering Future Industries.

As the President of the Australian Science Teachers Association, I am proud to present this educational resource to you.

This year's theme could not be more relevant to our society, where innovation is essential for economic growth, sustainability, and progress. Science and innovation are the driving forces behind significant progress in various fields, including health, technology, and the environment. As teachers, it is our duty to inspire and empower the next generation of innovators who will shape the world and drive future industries.

Our National Science Week Resource Book aims to equip you with the tools and resources necessary to inspire your students to think critically, creatively, and develop problem-solving skills. It is designed to encourage students to take an active role in identifying and developing innovative solutions to real-world challenges.

Experiential learning is at the heart of this resource, enabling students to work collaboratively, gain hands-on experience, and develop new ideas and approaches. This approach to learning empowers students to think outside the box, be innovative and creative, and prepare them for the challenges and opportunities of the future.

We hope that this resource book will create an atmosphere of innovation that fuels curiosity and inspires students to explore the realms of scientific discovery. Our aim is to instil in them a deep appreciation for scientific endeavours and equip future innovators with the tools they need to succeed.

I invite you all to join us in celebrating National Science Week and utilising these resources to inspire and equip future generations of STEM innovators.

Acknowledgements

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

The materials in this educational resource have been developed and written by Sarah Kellett, edited by Dr Kath Kovac and designed by Elise Adams.

We wish to acknowledge:

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FOREWORD

The Hon Ed Husic MP.

The Hon Ed Husic MP. Credit: Supplied

In 2023, National Science Week celebrates innovation as the cornerstone of progress. STEM innovation is happening at an extraordinary pace across every major sector – in agriculture, defence, resources, energy and medicine – and our local scientists are frequently on the cutting edge of that progress. Australians are world-class innovators whose advancements improve the quality of life for people around the globe.

To ensure that our science community can continue this calibre of research and development over coming decades, we must bolster human capacity. The Australian government is committed to supporting STEM in schools, because it is in classrooms and school laboratories that our next great scientists are cultivated. Schools are where early scientific understanding is fostered and where awe is inspired.

That's why I am excited to introduce the 2023 National Science Week Resource Book for teachers, celebrating STEM innovation, with a particular focus on Australia's contribution to science and technology. The resource book offers teachers the opportunity to draw on dozens of ideas and hands-on activities to nurture their students' curiosity – curiosity being the germination of all innovation.

The 'Innovation: Powering future industries' resource book offers a glimpse into humanity's progress toward a stronger, more sustainable future, from developing new materials and technology to the rapid rise of AI. Students might investigate how innovation is improving farming practices and addressing the health of our planet and its people, or innovation might be examined in a historical context through the perspective of thousands of years of First Nations innovation.

'Innovation: Powering future industries' aims to support teachers' efforts to inspire Australia's next generation of STEM innovators and to equip them for the challenges of the future.

INTRODUCTION

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

'Innovation: Powering Future Industries' is the school theme for National Science Week in 2023. It incorporates advances in technology in all industries.

This Resource Book of Ideas for National Science Week offers teachers and students an opportunity to explore creativity, science, technology, engineering and ethics. It includes ideas for teaching artificial intelligence, coding, and the way innovation is applied to agriculture, transport, water and medicine.

The following themes of this resource book contain inquiry-based classroom activities, worksheets and spotlight stories to inspire students.

Responsible innovation: Engage with ethics, impacts and benefit-sharing through the lens of responsible innovation.

Innovations in agriculture: Explore the science and technology that is enabling smarter agriculture in Australia.

Innovations in space: Find out about amazing innovations in space, including rockets, rovers and spaceplanes.

Innovations around us: Discover innovations that have enabled transport, water management and medical technologies throughout history and into the future.

This resource also contains many opportunities to incorporate cross-curriculum priorities, including sustainability. First Nations connections are included throughout; we thank Aleryk Fricker for reviewing these sections.

Drone spraying fertiliser on green plants Credit: freepik / user6702303

We would love to see what you do this National Science Week. Share photos and students' work samples via National Science Week's online community using #scienceweek on social media, or by emailing ASTA (nscwk@asta.edu.au).

Please ensure that you have parental permission before posting any images of students. We hope you enjoy exploring innovation in your classroom.

Milky Way above the SKA-Low antennas. Credit: Michael Goh /ICRAR/Curtin

WHAT IS INNOVATION?

Innovation is about applying ideas to improve a product or service to create more value. People in all organisations innovate when they find better ways of doing things. Innovation can also mean creatively solving a complex problem.

Future industries

Australian industries that are undergoing innovation include agriculture, space, biotechnology and advanced manufacturing. Many changes to these industries are coming thanks to advances in computing, such as artificial intelligence (AI).

Agriculture

Farms are becoming smarter. Sensors in the ground that measure soil moisture are linked to automatic irrigation, saving water. Remote-sensing technology can spot disease and stressed plants. And new technology can track and manage livestock and feral animals in remote areas.

Space

Australian innovators are using new technologies, such as CubeSats (small satellites) and optical (laser) communications, to increase the role of space in our daily lives. Satellites enable internet access in remote parts of the country, send data between sensors, and observe the land and ocean. Australia is also supporting NASA on the new Moon to Mars initiative.

Biotechnology

This has been around for decades and has been used to create medicines, vaccines, foods and herbicides. New technologies in computing and the ability to precisely edit DNA has opened up huge possibilities to create new biotechnology products. This could help feed the world, improve health, and make our agriculture industries resilient to climate change.

Advanced manufacturing

Any type of manufacturing that uses high-tech robotics, sensors or AI is considered advanced manufacturing. This can allow organisations to shift from mass production to bespoke, one-of-a-kind products, or to be more sustainable in their operations. An example is additive manufacturing, also known as 3D printing.

Responsible innovation

Innovation goes hand in hand with change. Sometimes change is good, and sometimes not so much – it's not always clear how things will turn out in the end. By using the concept of responsible innovation, teachers can support students to practise making decisions in the face of uncertainty, balancing risks and benefits, and considering multiple viewpoints.

As a group, brainstorm examples of helpful and harmful innovations. Notice that some innovations are good in some ways and harmful in others. Choose one of the innovations and drill deeper with these questions:

- How can people benefit from the innovation?
- How are people harmed by it?
- Does the same group of people experience both benefit and harm, or are the benefits unevenly distributed, such that one group is harmed more than they benefit?
- How could the innovation be misused?
- How could the innovation be improved to make it even better?

Innovation or invention?

Invention is the discovery of something new. Innovation may improve inventions or change the way they are used. Some innovations do not require an invention, while others combine multiple inventions into a new product.

For example, the first car was an invention, while Uber was an innovation. The iPhone was an innovation based on existing mobile phones using a new combination of existing technologies, and it has changed the way we communicate.

First Nations connections

First Nations people are Australia's first innovators and continue to innovate today. Ideas for including First Nations learning in your class are included throughout the book; find them using the content map on page 9.

If you would like to gain more confidence and capability when including First Nations connections in your teaching, the following organisations have professional development courses and resources:

- Narragunnawali supports schools to introduce meaningful reconciliation initiatives.
- Australians Together has a Building Confidence Workshop and an online course on exploring culture.
- The National Museum of Australia has an online professional learning course on First Nations histories and cultures in schools.
- The First Scientists: Deadly Inventions and Innovations from Australia's First Peoples, a new book by Corey Tutt aimed at upper-primary students.

Australian $50 bank note featuring David Unaipon
Credit: Reserve Bank Australia

David Unaipon appears on the $50 note.
He was a Ngarrindjeri man from the Coorong region of South Australia, and worked as an inventor and engineer.
He is famous for designing hand-held, mechanical sheep shears.

David was unable to attain full patents for his inventions, and received no money and little recognition for the sheep shears that revolutionised the wool industry in the early 1900s.

Printing? Find links for these resources at scienceweek.net.au/schools/2023-resource-book-links/

CONTENT MAP

Discover the activities in this resource book. The following icons are used throughout:

- First Nations: Activity includes material about Aboriginal and Torres Strait Islander histories and cultures
- Sustainability: Activity includes material about sustainability
- Remote learning: Students can do this activity at home with support from an adult
- Design thinking: Activity promotes design thinking and a STEM approach to learning

Activities in this book	
For all year levels	Code a binary bracelet (First Nations) Responsible innovation (Sustainability, Remote learning, Design thinking)

	Foundation – Year 2	Year 3 – Year 6	Year 7 – Year 10
Innovations in ag tech Explore the science and technology that is enabling smarter agriculture in Australia	Design a smart farm (First Nations, Sustainability, Remote learning, Design thinking)	Make an insect trap (First Nations, Remote learning, Design thinking)	Make a water pump (Sustainability, Remote learning)
Innovations for space Investigate innovations that enable space travel	Make a balance scale The wheels go round and round (Remote learning)	Make a better paper plane (Remote learning, Design thinking)	Filter water (First Nations, Sustainability, Design thinking) Ballon-powered rockets
Innovation around us Engage students with innovations linked to transport, health and energy industries.	Innovation card search (Sustainability, Remote learning)	Teabag hot air balloon (Sustainability) Make a mega spinner (First Nations, Sustainability)	Innovation for a healthy future (First Nations, Remote learning)

Logos for cross-curriculum priorities: credit: ACARA

Consider Safety

Involve students in a discussion about safety and managing risks at the start of activities.

Downloadable digital cards

SPECTRA is an activity card based science award program developed by ASTA for students between Years 1 and 10.

SPECTRA provides students with a range of engaging practical and observational activities, research tasks, experiments and projects using everyday items. Students complete activities to earn certificates relating to different science topics.

SPECTRA can be used:

- as a class activity;
- to extend capable students;
- to encourage and inspire students that find science a challenge;
- in science clubs, homeschooling and community groups.

Science Program Exciting Children Through Research Activities

SPECTRA
AWARDS

Visit **www.asta.edu.au** and look under Resources for more information or to order your *SPECTRA* cards

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02

ACTIVITIES

FOR ALL YEAR LEVELS

Curriculum alignments

Code a binary bracelet aligns with Australian Curriculum for Digital Technologies, especially Digital Technologies Knowledge and Understanding for Years 5–8.

Responsible innovation aligns to the Australian Curriculum for Science as follows:

Science Understanding

Foundation	ACSSU003	Objects are made of materials that have observable properties
Year 2	ACSSU031	Different materials can be combined for a particular purpose
Year 4	ACSSU074	Natural and processed materials have a range of physical properties that can influence their use
Year 6	ACSSU095	Changes to materials can be reversible or irreversible
Year 7	ACSSU116	Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable

Science Inquiry Skills

Foundation	ACSIS233	Engage in discussions about observations and represent ideas
Foundation	ACSIS012	Share observations and ideas
Year 1 & 2	ACSIS025	Participate in guided investigations to explore and answer questions
Year 1 & 2	ACSIS029	Represent and communicate observations and ideas in a variety of ways
Year 3 & 4	ACSIS060	Represent and communicate observations, ideas and findings using formal and informal representations
Year 5 & 6	ACSIS093	Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts
Year 7	ACSIS133	Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate

Science as a Human Endeavour

Year 1 & 2	ACSHE022	People use science in their daily lives, including when caring for their environment and living things
Year 3 & 4	ACSHE051	Science knowledge helps people to understand the effect of their actions
Year 5 & 6	ACSHE083	Scientific knowledge is used to solve problems and inform personal and community decisions
Year 7 & 8	ACSHE119	Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available
Year 7 & 8	ACSHE223	Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures
Year 7 & 8	ACSHE120	Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations
Year 7 & 8	ACSHE121	People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity
Year 9 & 10	ACSHE158	Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries
Year 9 & 10	ACSHE228	Values and needs of contemporary society can influence the focus of scientific research

Code a binary bracelet

Students design and create a bracelet using coloured beads that spell out the first letter of their name using binary code. This activity suits students of all ages.

Learning objective

Students understand that computers use an on/off code to store information. The pattern of the code is important.

Success criteria

Students create a bracelet using binary code.

Activity length

20 minutes

Credit: Elise Adams

Context

Binary is the system of zeroes and ones that computers use to code text, images and videos. Each one or zero is called a bit, and a series of eight bits is called a byte. One byte is used to code each letter of the alphabet.

Materials to prepare in advance

- Two colours of beads – about six of each colour per student
- Coloured pencils that match the coloured beads (e.g. if using red and yellow beads, provide a red and yellow pencil for each student)
- String for the bracelet – about 20 cm per student (elastic string works well, and pipe cleaners are easier for young students)

Instructions

1. Before class, make a bracelet yourself so you can show students what it will look like.
2. Introduce the activity and pass out the worksheet.
3. After the activity, explain that binary code is used by computers.

First Nations connections

- Watch how Maitland Lutheran School used a humanoid robot to raise the profile of the Narrunga language.
- Students can create binary bracelets that code the first letter for words in their local First Nations language.

Printing? Find links for these resources at scienceweek.net.au/schools/2023-resource-book-links

Tips for teachers

- The activity can be adapted to create a pattern to hang on a key chain, or to make a necklace, a sign for a bedroom door or a painting.
- For younger students, pre-knot one end of the string and offer to help tie up the bracelet once they have put the beads on. This is a good activity for younger students to do in pairs with older students.
- Depending on the age of the students, you can introduce binary as counting in twos. The student handout explains how many bytes are in a megabyte (MB), and you can explain why it's not exactly a million, because a megabyte is 2^{20} (base 2) = 1,048,576 and this is close to 10^6 (base 10) = 1,000,000.
- Watch a video by GCFLearnFree that explains how binary works.

Worksheet: Create a coded bracelet using binary

Instructions

1. Find the first letter of your name in the diagram below.
2. Decide which colour bead will be zero and which will be one. Use coloured pencils to shade the zeroes and ones of your letter in the right colours.
3. At one end of the string, tie a knot big enough so the beads will stay on.
4. Put the coloured beads onto the string in same order that you coloured in for your letter.
5. Tie the two ends of the string together to make a bracelet.

LETTER	BINARY	LETTER	BINARY
A	0 1 0 0 0 0 0 1	N	0 1 0 0 1 1 1 0
B	0 1 0 0 0 0 1 0	O	0 1 0 0 1 1 1 1
C	0 1 0 0 0 0 1 1	P	0 1 0 1 0 0 0 0
D	0 1 0 0 0 1 0 0	Q	0 1 0 1 0 0 0 1
E	0 1 0 0 0 1 0 1	R	0 1 0 1 0 0 1 0
F	0 1 0 0 0 1 1 0	S	0 1 0 1 0 0 1 1
G	0 1 0 0 0 1 1 1	T	0 1 0 1 0 1 0 0
H	0 1 0 0 1 0 0 0	U	0 1 0 1 0 1 0 1
I	0 1 0 0 1 0 0 1	V	0 1 0 1 0 1 1 0
J	0 1 0 0 1 0 1 0	W	0 1 0 1 0 1 1 1
K	0 1 0 0 1 0 1 1	X	0 1 0 1 1 0 0 0
L	0 1 0 0 1 1 0 0	Y	0 1 0 1 1 0 0 1
M	0 1 0 0 1 1 0 1	Z	0 1 0 1 1 0 1 0

Did you know?

In binary, each spot that has an option for 'on' or 'off' is called a bit. Your bracelet is made using eight bits. A group of eight bits is called a byte. A megabyte is 1,048,576 bytes, which is about a million bytes.

SPOTLIGHT: AUSTRALIA'S NEWEST SUPERCOMPUTER

Setonix is covered in art by Elder Margaret Whitehurst, who was inspired by the stars that shine over Wajarri county in Western Australia. Credit: Pawsey Supercomputing Research Centre

The most powerful research computer in the Southern Hemisphere is called Setonix. It is in Perth, at the Pawsey Supercomputing Research Centre.

Setonix is ranked the fourth-greenest supercomputer in the world thanks to innovations that make it more efficient to run, such as liquid cooling. Computers generate a lot of heat as they work hard to do calculations. Liquid is pumped to transfer heat from the computer to water stored in an aquifer underneath the Centre. The pumps are powered by solar energy.

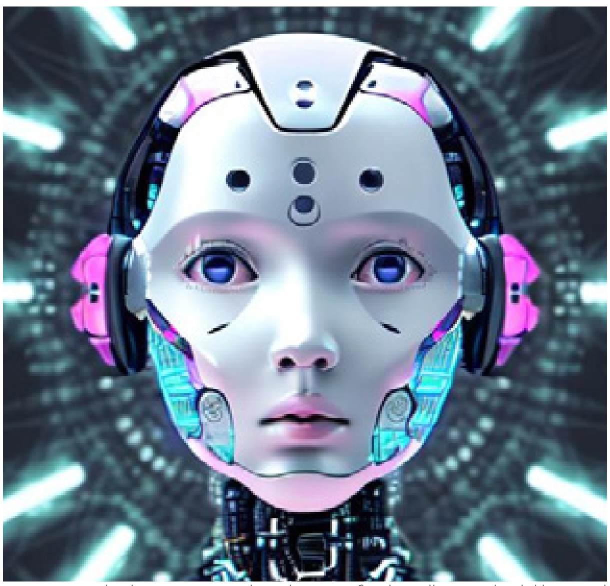
The cabinets of Setonix are covered in art designed by Margaret Whitehurst, a Wajarri Yamatji Elder.

Researchers process huge quantities of data using the supercomputer. Setonix is used to gain insights into our future climate, create images from data gathered by the Australian Square Kilometre Array Pathfinder telescope, and predict medical complications in time for patients to be treated.

What is AI?

Artificial intelligence is used in computers to allow them to recognise speech, translate language and for computer vision. If you use 'Hey Siri' or 'Okay Google', you're using AI. If you're searching on Google, it's using AI. If Netflix is recommending a movie based on what you watched last week, it's using AI. And self-driving cars use AI to help them recognise pedestrians and road signs.

Another term you might hear is machine learning. This is a type of AI in which machines use data to learn and get better at tasks. All these things already exist. What does not yet exist is artificial consciousness – a machine that is aware of its own existence. So far, that's only found in science fiction.



We asked openart.ai 'What does Artificial intelligence look like?' and it generated this image. Credit: openart.ai

Questacon

The National Science and Technology Centre

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> *"I have taken several Engineering is Elementary professional learning sessions and would absolutely recommend them to other teachers."*
>
> – Sarah Fletcher (2020 Recipient of the Prime Minister's Prize for Excellence in Science Teaching in Primary Schools & STEM Specialist teacher, ACT)

Engineering is Elementary was developed by the Museum of Science, Boston, and has been adapted for Australian educators by Questacon. This program is supported by Diamond Partner, Department of Defence.

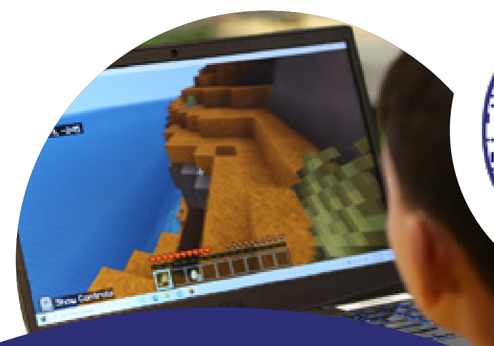
Questacon Cyber Castle Challenge

Available to play for free, the *Questacon Cyber Castle Challenge* is an exciting learning experience created by Questacon in Minecraft: Education Edition.

Protect your chickens! Defend against foxes! Build your castle defences!
Students will learn about the cyber security life cycle while defending their castle.

There's no better time than now for students to start learning how cyber security impacts our lives. The *Questacon Cyber Castle Challenge* comes supported with teacher resources, student playbooks, and videos from cyber professionals. Take advantage of this fantastic classroom resource today!

More information is available by scanning the QR code, or by visiting **our website.**



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Questacon – The National Science and Technology Centre
King Edward Terrace, Parkes ACT 2600

www.questacon.edu.au

Responsible innovation

This project-based learning activity introduces the idea of responsible innovation and invites students to explore sustainability and waste in their school. The activity can be done in small groups, as a class or as a whole school.

Getting started

Project-based learning is a student-led approach based on real-world contexts, and often features:

- a driving question
- an entry event
- connections with the community
- possible products
- a culminating event.

The responsible innovation activity is structured with ideas under these subheadings to help you build your own activity based on the interests of your students and the opportunities in your community.

Driving question

How can we innovate to reduce the impact of plastic in our environment?

In 1869, John Wesley Hyatt created the first synthetic plastic from combining camphor with cellulose from cotton fibres. The plastic was used to replace ivory from elephant tusks. In 1907, Leo Baekeland created a new type of hard plastic called Bakelite that was used in early versions of the telephone. After World War II, the plastic industry expanded, with new plastics used for furniture, cars and packaging. Plastic waste became a problem after the 1960s, and the problem continues to grow today. It gets into forests, oceans and rivers, and kills animals who mistake it for food.

Here are some facts on plastic from the Australian Government Department of Climate Change, Energy, the Environment and Water:

- Australia used 3.4 million tonnes of plastics from July 2018 to June 2019, and our use of plastic is increasing.
- Only about 13 per cent of plastic used in Australia is recycled.
- Every year, about 130,000 tonnes of plastic leaks into the marine environment from Australia.

Entry event

Go for a walk around your school and collect data on how much plastic students can find. Wearing gloves for safety, students can collect rubbish and put in the bin/recycling, or keep it as a collection, inspiration or for making into art.

Depending on the age of students, data can be grouped into categories or arranged in a table. Categories could include: hard plastic, soft plastic (large), soft plastic (small), paper, glass, metal, mixed materials, or other. Discuss how much plastic was found and ways to reduce its impact on the environment.

Possible science activities could include:

- Find out whether plastic floats or sinks.
- Put a plastic bag in a tank of water to observe how it looks. Turtles might eat them because they look like jellyfish.
- Learn about the chemical composition of polymers.

Big ideas

Should we have invented plastic?

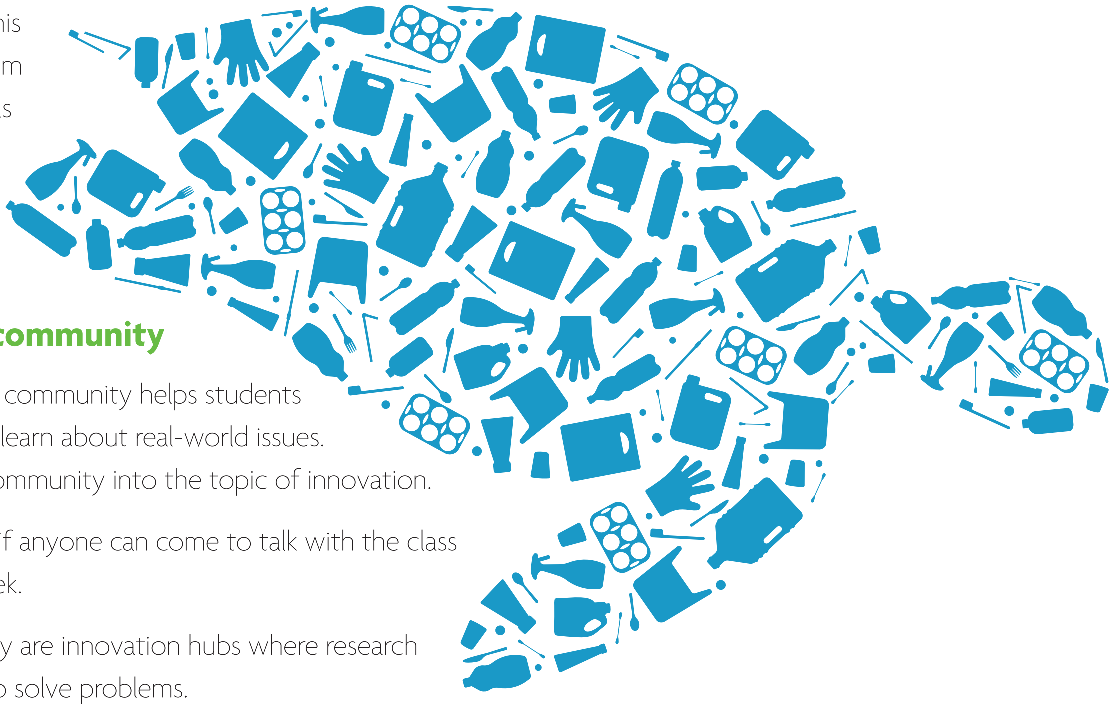
On one hand, plastic is versatile and useful (think medical gloves and sticky tape). On the other hand, it creates a huge waste problem. What would the world be like if we had never invented plastic? Students could explore this idea with a class debate on the topic of 'Should we have invented plastic?'

Responsible innovation is a process that happens before or during innovation to try to minimise negative impacts and increase benefits to society. When people are innovating, it's important that they think about what difference the innovation will make for the world.

To do this, innovators:

- talk to potential users of their innovation and the wider community
- research potential impacts of their innovation; e.g. consider the process of manufacturing and how to manage waste
- imagine what the innovation might do – good and bad
- modify their innovation to reduce negative impacts (also known as 'grimpacts') and increase benefits.

As students are innovating in this learning activity, encourage them to use responsible innovation as part of their process.



Connections with the community

Connecting with experts in the community helps students collaborate, problem solve and learn about real-world issues. Here are some ideas to bring community into the topic of innovation.

- Reach out to parents to ask if anyone can come to talk with the class during National Science Week.
- Approach universities, as they are innovation hubs where research and inventions are applied to solve problems.
- Local businesses are likely to be innovators too, especially those in a technology or engineering field.

Suggested text to email to potential guest speakers is in the box below. If a virtual session would be acceptable, it may be easier for your guest to fit into their day.

Join us for National Science Week

National Science Week is 12 – 20 August 2023 and the theme is Innovation: Powering Future Industries. We're inviting you to participate by visiting the class for an informal discussion about how you find new ideas and solve problems in your work. The discussion will be led by students and there is nothing to prepare in advance. If you can come in for 20 minutes during National Science Week, we'd love to have you! Email us to organise a time.

Possible products

Create a campaign to reduce plastic in the community

We can all make choices to use less plastic in our lives. Working in groups, students can come up with ideas on how to educate or encourage the school or community to use less plastic.

Students could advocate to government to ban single-use plastics, or find out what is already happening in your state or territory. Many have recently started bans. There might be an upcoming ban on single-use plastics that students could help promote, or another product that students think should be banned.

Design different packaging

Students could choose a challenge item – for example, a bag of chips or a packaged toy – and design a new way to package it without plastic. They can research different materials and create prototypes. Their designs could even be sent to the item's manufacturer.

Prevent plastic from entering the environment

Students could design and build a system that prevents plastic from damaging the environment. The system might function on the land, at the point of wastewater collection, or might prevent plastic from entering rivers or the ocean.

To spark thinking, explore these Australian start-up companies tackling plastic waste:

- Samsara Eco is using chemistry to infinitely recycle plastics.
- Advanced Circular Polymers is innovating plastic recycling technology.
- ULUU is making plastic alternatives to protect marine environments.

Culminating events

A culminating event is a celebration that authentically shares learning from the school with the community. The audience can include other students, parents, the school board, local government and businesses.

Students' products could be shown at an exhibition, fair, public debate or presentation. A digital showcase could include a video, blog post or online news story. You could combine this with a film night and show WALL-E, about the last robot on Earth tasked to clean up waste.

More resources

- Read about the history of plastics from Science History.
- Learn about responsible innovation from UK Research and Innovation.
- Explore the data and charts on plastic pollution from Our World in Data.
- Use the plastic waste infographic from the US National Oceanic and Atmospheric Administration.
- Explore citizen science and educational tools from CSIRO.

Printing? Find links for these resources at sciencweek.net.au/schools/2023-resource-book-links/

03

ACTIVITIES

FOR FOUNDATION TO YEAR 2

Credit: iStockphoto / Jiraroj Praditcharoenkul

Activities align to the Australian Curriculum as follows:

			Design a smart farm	Make balance scales	The wheels go round and round	Innovation card search
Foundation	Living things have basic needs, including food and water	ACSSU002	✓			
	Objects are made of materials that have observable properties	ACSSU003		✓	✓	
	Daily and seasonal changes in our environment affect everyday life	ACSSU004	✓			
	The way objects move depends on a variety of factors, including their size and shape	ACSSU005			✓	✓
	Science involves observing, asking questions about, and describing changes in, objects and events	ACSHE013		✓	✓	✓
	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	Living things live in different places where their needs are met	ACSSU211	✓			
	Observable changes occur in the sky and landscape	ACSSU019	✓			
Year 2	Different materials can be combined for a particular purpose	ACSSU031		✓	✓	✓
	Earth's resources are used in a variety of ways	ACSSU032	✓			
	A push or a pull affects how an object moves or changes shape	ACSSU033			✓	
Years 1 and 2	People use science in their daily lives, including when caring for their environment and living things	ACSHE022	✓	✓	✓	✓
	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 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	✓	✓	✓	✓

Design a smart farm

Tap into the creativity of your students by inviting them to design a smart farm.

Learning objective

We are learning how innovation can make farming better.

Success criteria

What I'm looking for is a drawing and an explanation of the kind of technology you would use if you were a farmer.

Activity length

30 minutes

Context

Plants and animals need water, nutrients, light and air to grow and be healthy. Smart farms use innovation to look after their plants and animals through technology such as automatic irrigation, weather forecasting, and sensors that use satellites to connect the field to the farmhouse.

Materials to prepare in advance

- Paper and pencils
- Optional: Craft material, clay, DUPLO or LEGO bricks.

Instructions

1. Spark thinking before students draw by watching videos from the links below and/or reading the spotlight story on the next page.
2. Ask students to draw a farm that uses technology to work better, such as robots, automatic watering systems, a shade system – whatever it might be.
3. If students are stuck for ideas, ask what their farm would produce, and suggest they could draw a robot to help their farmer with that – what might the robot do?

More resources

- Read about robots harvesting raspberries.
- Watch robotic farming from the University of Sydney.
- Watch a TED-Ed video on creating the 'perfect' farm.
- Watch Sprinkler Nerd Andy explain how sensors measure soil moisture.

Robot apple picker Credit: Monash University

- Read and watch a video about the robotic dairy farm at the WA College of Agriculture – Denmark.
- Watch a video about how farmers use space-based technologies.
- Watch a video about SpaceCows by CSIRO.

Printing? Find links for these resources at scienceweek.net.au/schools/2023-resource-book-links/

Tips for teachers

- This activity can be done individually or in small groups, and the drawing could be made as a poster presentation.
- You can swap the drawing for another medium, such as clay, LEGO bricks or Minecraft.
- Prompt thinking with questions, such as:
  - How will the robot gather data about its environment?
  - How might it share the data with the farmer?
  - Have you thought about safety, battery life and maintenance?
  - Will the robot 'talk' with other robots on the farm? What information would they share?

SPOTLIGHT: SMART FARMS

Drones and robot fruit pickers. Credit: Monash University

Should you turn on the sprinklers if it's been raining outside? Do the cows need more water to drink? Farmers must make all sorts of decisions to keep their farm running smoothly. Innovations can be a big help.

How wet is the soil?

By putting a sensor in the soil, farmers can measure how much moisture is in the ground. If it's already moist, it doesn't need extra water from the sprinkler. Even better, the sensor can send information to the sprinkler and turn it on or off automatically. That way the farmer can spend their time on other jobs.

Are my cows okay?

On a big farm, cows might be in a far paddock where it's not easy to check on them. Farmers have to check on cows each day to make sure they are healthy and have enough water. Putting a water sensor into the cows' water trough means the farmer can know whether it's running low. Sensors can even be put on a cow to track where it goes during the day, how much time it spends eating, resting and walking, and to alert the farmer if it escapes or seems unwell.

What else can we do?

Farms grow food for everyone, and innovations are helping them to feed Australia. Satellites, drones and small planes can take photos of a farm to see how well plants are growing. Sensors in the field can send information to the farmhouse via satellites. Tractors can drive up and down rows by themselves. And robots can carefully pick fruit and berries.

SPOTLIGHT: SPACE COWS

In some parts of Australia, feral cattle and buffaloes damage the land and rivers by eating and trampling plants.

A new project by CSIRO and Microsoft is using satellites to track herds of cattle, and predict where they will go next. This helps Indigenous rangers know how to manage the cattle best.

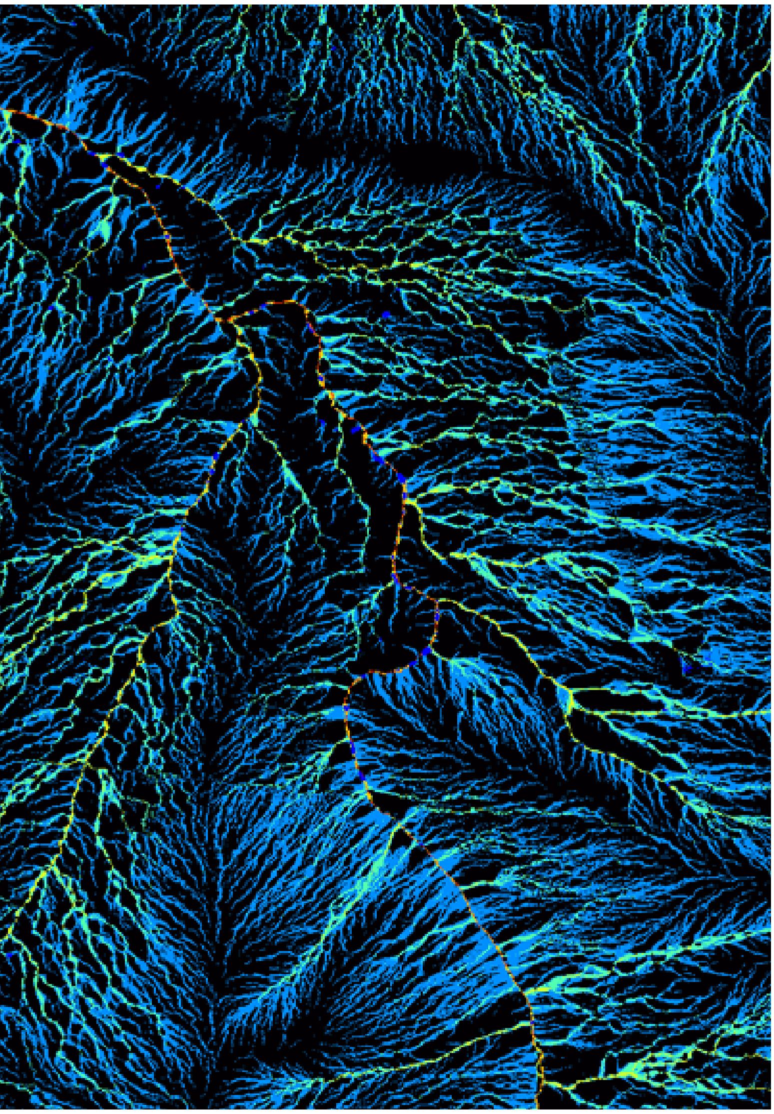
Protecting country

“The project gives us the latest technology to help with land management and tracking cattle,” says Vince Harrigan, Balnggarrawarra ranger and Traditional Owner at Normanby Station in Cape York.

“It also provides training with drones and tablets, which is a big thing for our Mob, especially the younger ones.”

The SpaceCows project is supported by the Australian Government Smart Farming Partnership initiative. It combines technology, science and Indigenous knowledge to protect important environmental and cultural sites.

How else can technology and First Nations knowledge of Country benefit the Land and agriculture?



Data gathered by a constellation of satellites Credit: Seth Seden/CSIRO

Unmanaged feral cattle and buffalo. Credit: Seth Seden/CSIRO

Make balance scales

This simple set of scales can tell you if one item is heavier than another. Use them as a group activity, as part of a rotation station, or for free play.

Learning objective

We are learning to measure weight.

Success criteria

What I am looking for is a test to find out which items are heavier and which are lighter.

Activity length

30 minutes

Context

Scales are devices used to measure weight. Many innovations over the years have made scales more accurate. This homemade set of scales is an easy way to introduce a way of measuring relative weight. By adding household scales, you can extend learning into measuring weight in grams.

Materials to prepare in advance:

- Coathanger (ideally one with notched shoulders for hanging singlets)
- String (two pieces, each 40 cm long)
- Scissors
- Two paper cups
- Hook (ideally on a wall or a door handle) to hang the coathanger from
- Items for weighing (e.g. toys, fruit, classroom objects)
- Blocks or other items to compare weights

Tips for teachers

If you have hooks or door handles, you can make several scales and hang them around the room.

Instructions

1. Build the scale. This can be done before class by following these steps.

   i. Make two holes on opposite sides near the lip of each paper cup.

   ii. Tie each end of the string to each hole of the cups, as shown in the pictures.

   iii. Loop one string over the notches on each side of the coathanger, so the cups hang down equally on either side.

Credit: Elise Adams

   iv. Test the scales by putting one of two identical items in each cup. It should balance. If it doesn't, you may need to adjust the strings.

2. Set the scene for the activity using the bushwalk or space ideas below.

   Bushwalk: Imagine we are going on a bushwalk to look for animals. We are going to camp there, too. You can choose some items to take with you. They have to be small and light to fit into your backpack, because you don't want it to be too heavy.

   Space: Astronauts on the International Space Station are allowed to take a small kit of personal items, such as family photos, books or a musical instrument. What would you pack into your personal kit? Your items must be small and light to get into space.

3. Put one or two blocks in one cup. Ask students to choose an item to weigh, and take turns to put it in the other cup. If the cup with the blocks sinks lower than the cup with their item, then their item is too heavy.

Credit: Elise Adams

More ideas

- Use the balance scales to explore the relative weight of different fruits.
- Bring in a set of kitchen scales or digital scales, and use them after the activity to weigh the same items and collect data about how much they weigh in grams.
- Bring in bathroom scales so students can weigh themselves.

Credit: Freepik / edgarbj

Weighing in

Innovations have made it possible to measure weight more precisely. This is useful when mixing chemicals to make medicine, because the amounts have to be just right for it to work without making you sick. People also weigh large objects. Farmers may weigh animals, such as cows, to make sure they are healthy and eating well.

Some scales are connected to computers so that weight can be measured and recorded automatically. This is really useful in manufacturing and food processing, as it makes sure the right items are made, packaged and sent on their way. Many supermarkets have self-serve checkouts with scales that weigh items as you add them to your shopping bag.

The wheels go round and round

This activity explores wheels and is a great option to engage students with a non-English language background, or to incorporate into sensory activities.

Learning objective

We are learning how wheels move, and how they make all sorts of other things move too.

Success criteria

What I'm looking for is to observe and test the movement of different machines with wheels.

Activity length

20 minutes

Credit: Elise Adams

Context

The wheel was an invention, while its application to carts and wheelbarrows was an innovation. Wheels are circular, rotate around an axle and allow things to roll. Skateboards, bicycles, cars, planes and Mars rovers all use wheels to move.

Materials to prepare in advance

- Toys with wheels (e.g. DUPLO trains, Matchbox cars, toy trucks)
- For one of the toys, glue the wheels so they no longer rotate
- An area to race (tables or the floor, not a rug)
- Optional: Include ramps, which can be made with cardboard or books
- Optional: Include sand or bubbles for a sensory activity
- Optional: Encourage tinkering by providing parts with wheels that can be built into machines, like a mechanical set

Instructions

1. Demonstrate how the wheels of a toy (unglued) rotate and help the toy move.
2. Demonstrate the toy with the glued wheels, pointing out that the wheels do not rotate and the toy does not move.
3. Invite students to choose toys and see how far they can make them go. Allow some free play time.
4. Bring the class back together to talk about what they observed. Which toys went furthest?
5. Discuss different machines in our lives that have wheels (e.g. bicycles, cars, trains, scooters). How would we get around without them? For students with a non-English language background or who are non-verbal, you can replace the discussion with a craft activity (e.g. colour in a bicycle, or stick paper wheels on a car print-out).

More ideas

- Discuss innovations in transport – for example, self-driving cars or electric vehicles.
- Extend this activity with the song 'The Wheels on the Bus Go Round and Round' and books about transport.

SPOTLIGHT: WHEELS IN SPACE

This is one of NASA's Mars Exploration Rovers. Planet Mars is so far away that it looks like a star in the sky, but scientists have sent rovers in rockets all the way there. The two Mars Exploration Rovers explored Mars between 2004 and 2018.

Rovers take photos and do experiments to see what materials Mars is made of, and they use wheels to get around.

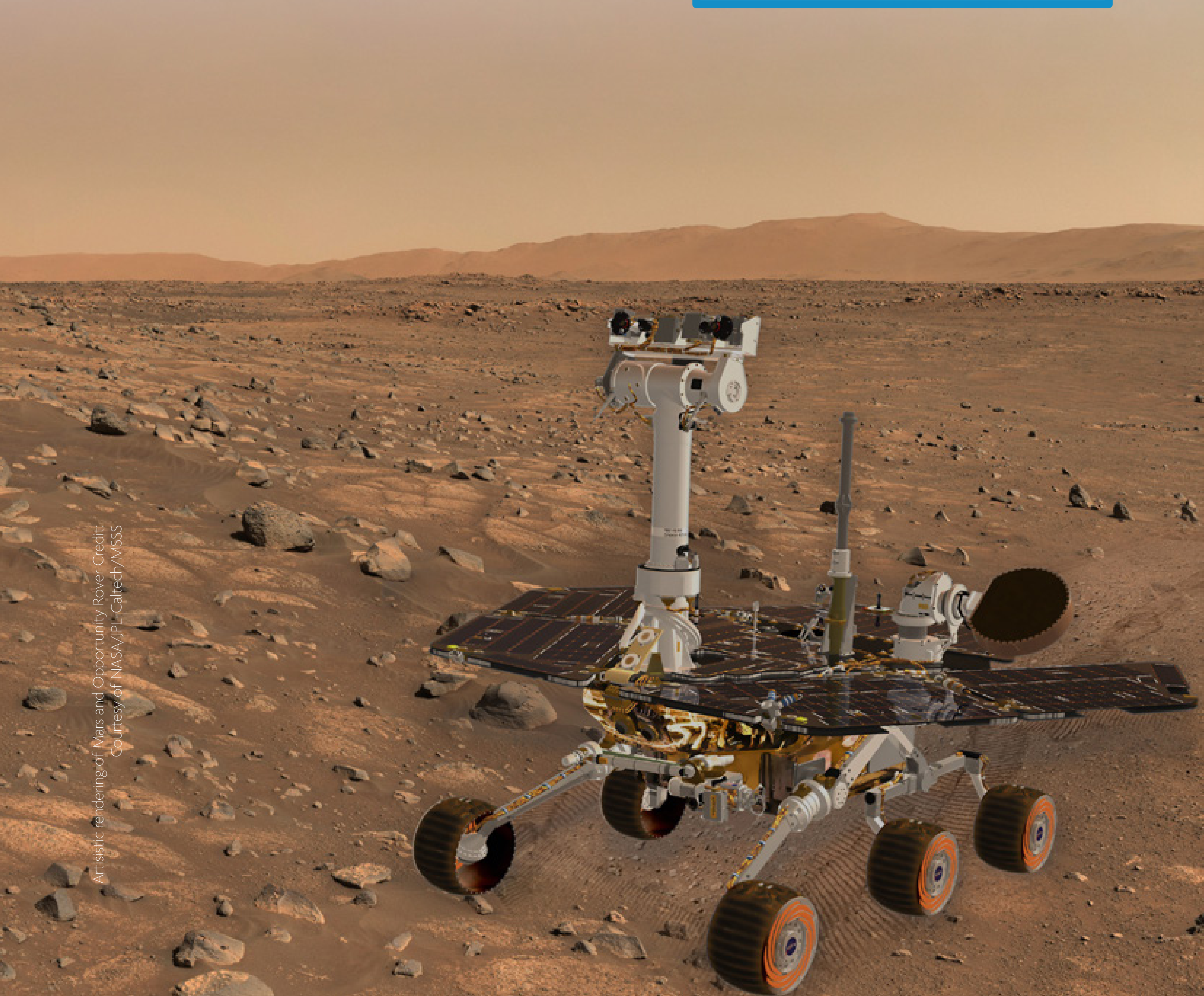
Can you see the wheels on the rover in the picture? The Mars Exploration Rovers' wheels were made of metal. This helped them travel over rough, rocky ground. The rover had six wheels, so it could keep going even if one broke.

The rover never had to go to a petrol station (which is good, because there are none on Mars!). Instead, it was powered by electricity, which came from two solar panels on its back that look a bit like wings.

Can you find the solar panels on the picture of the rover?

Think about this

Have you ever been in an electric car? Is it noisy or quiet?



Artistic rendering of Mars and Opportunity Rover Credit: Courtesy of NASA/JPL-Caltech/MSSS

Innovation card search

In this fun and easy activity, students find innovation-themed cards around the classroom and put them on a whiteboard. This is a great one for younger year levels.

Learning objective

We are learning about innovations and how they shape our world.

Success criteria

What I'm looking for is to share ideas about the cards and listen to others' ideas.

Activity length

20 minutes

Credit: Elise Adams

Context

Innovations are all around us. They have enabled new modes of transport, ways to power our homes, and delicious food and drinks. Using real-world examples makes it easier for students to understand what innovation is and why it is important.

Materials to prepare in advance

- Print the innovation cards on the next page and cut out enough for one per student, plus some spares. If your students are learning colours, you can print them on different coloured paper and include this in the discussion.
- A whiteboard or wall with Blu-Tack to hold each card

Tips for teachers

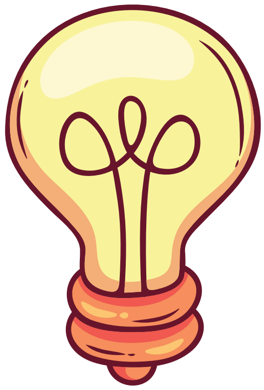
Hide some extra cards so that the last student doesn't spend too much time searching for the last card.

Instructions

1. Hide the innovation cards around the classroom.
2. Ask students to look for a card, and when they find one to pick it up and sit on the floor or mat.
3. When all the students have found a card, start a group discussion. Invite students to describe what is on their card and stick it on the whiteboard.
4. Guide some categorisation of the cards – for example, group together things that fly, or things we use to communicate.
5. Use the cards to start a discussion about the innovations around us.

More ideas

- If you print out multiple copies of the cards, you can use them to play card games. Print out two copies for Snap! or four copies for Go Fish.
- Extend the ideas into story time by choosing books about flight, robots or inventions.

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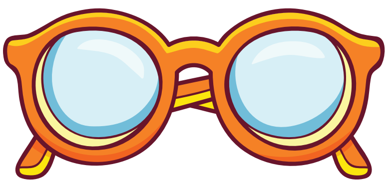




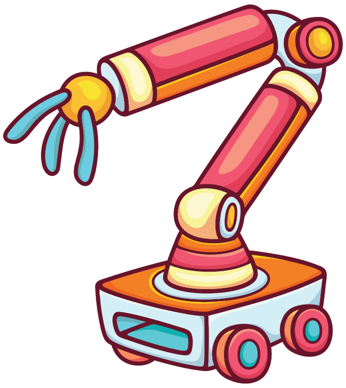



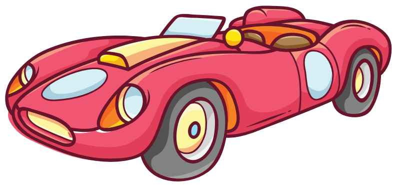
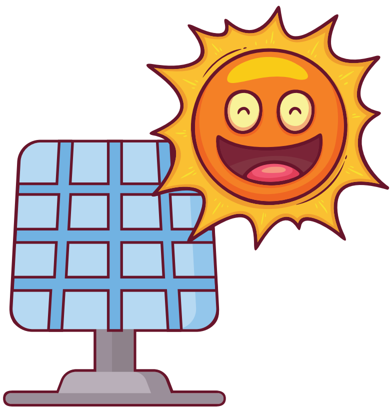

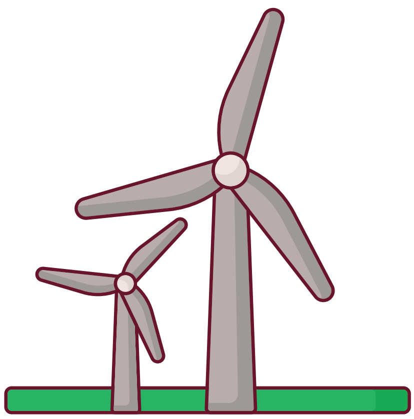




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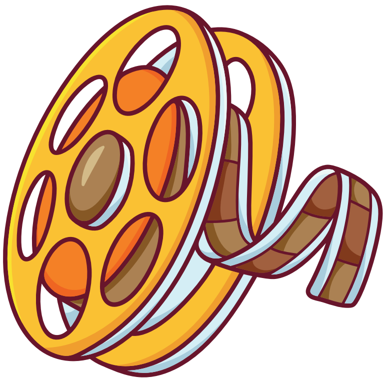
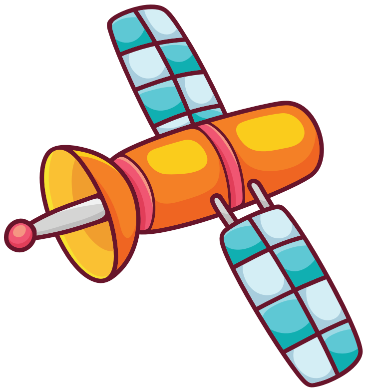






SOAP

04

ACTIVITIES

FOR YEAR 3 TO YEAR 6

Credit: Envato / Mint_Images

Activities align to the Australian Curriculum as follows:

Year	Content	Code	Make an insect trap	Make a better paper plane	Teabag hot air balloon	Make a mega spinner
Year 3	Living things can be grouped on the basis of observable features and can be distinguished from non-living things	ACSSU044	✓			
	Heat can be produced in many ways and can move from one object to another	ACSSU049			✓	
Year 4	Natural and processed materials have a range of physical properties that can influence their use	ACSSU074	✓	✓		
	Forces can be exerted by one object on another through direct contact or from a distance	ACSSU043		✓		✓
Year 5	Living things have structural features and adaptations that help them to survive in their environment	ACSSU043	✓			
	Solids, liquids and gases have different observable properties and behave in different ways	ACSSU077			✓	✓
Year 6	Changes to materials can be reversible or irreversible	ACSSU095			✓	
	Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources	ACSSU097				✓
Year 3 and 4	Science involves making predictions and describing patterns and relationships	ACSHE050	✓		✓	
	Science knowledge helps people to understand the effect of their actions	ACSHE051	✓			✓
	Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately	ACSIS055		✓		
	Represent and communicate observations, ideas and findings using formal and informal representations	ACSIS060	✓	✓	✓	✓
Years 5 and 6	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions	ACSHE081	✓		✓	✓
	Scientific knowledge is used to solve problems and inform personal and community decisions	ACSHE083	✓		✓	✓
	With guidance, pose clarifying questions and make predictions about scientific investigations	ACSIS231	✓			
	Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts	ACSIS093	✓	✓		✓

Credit: Envato / Mint_Images

Make an insect trap

In this fun and creative design activity, students will create a device to trap an imaginary insect that is damaging a local farm.

Learning objective

Students design an insect trap by applying their knowledge of insect biology.

Success criteria

Students can describe why their trap will successfully attract insects.

Activity length

One hour

Context

Insect traps are used to detect pests and measure biodiversity, which is the variety of plant and animal life living in an area. The traps generally catch and store insects so they can be identified later by an entomologist (a scientist who studies insects).

Materials to prepare in advance

- Paper cups (variety of colours)
- Paper plates (variety of colours)
- Coloured paper
- String
- Scissors
- Textas
- Masking tape
- Craft sticks
- Glue
- Aluminium foil
- Straws
- Cotton balls
- Items to act as a lure (e.g. sugar, lemon, vanilla essence, apple)
- Printed copies of the worksheet on pages 40 and 41

What to do

1. Introduce the activity. An unknown insect has been spotted near the school and it's eating plants in nearby gardens. Your class has been asked to construct traps to catch as many of the insects as possible so that scientists can study it.

2. Explain that as engineers, the students need to understand the requirements of the trap. It has to attract and catch the insect so it can be studied later. The trap also has to be strong enough to be outside for a few days without being damaged by the weather.

3. Students can ask questions about the insect using the table in the worksheet, so they know how to design their trap. You can do this at the start or during the activity.

4. Split the class into small groups. Their task now is to generate and develop design ideas for the insect trap. You may like to bring groups together to share their designs. Encourage diverse thinking and scientific collaboration by asking them to incorporate an improvement suggested by another group.

5. Groups select materials and construct a prototype insect trap.

6. Towards the end of the activity, put the insect traps outside on a tree or the ground. As a group, discuss and evaluate the potential effectiveness of the traps.

Caution

If you live in an area that has recently experienced a biosecurity issue, this activity may be upsetting for some students. Biosecurity measures can have significant impacts on people's livelihoods and may be stressful. It's possible students could be bullied if their farm is seen as the cause of a local problem. In this event, please use discretion.

Links for the handouts on pages 43 and 44

- View data from Sentinel units deployed for iMapPESTS. Click on Onion Thrips to see how many they detected in Ayr, Queensland in 2022. Go to Previous Deployments and see if they have come near you. You can also watch a video about iMapPESTS.
- Sentinel units are being operated in the Royal Botanic Garden Sydney, Adelaide Botanic Garden and Mount Lofty Botanic Garden in autumn and winter 2023.
- Watch a video and learn about fruit fly with content from the Australian Government Department of Agriculture, Forestry and Fisheries.
- Watch a video about the Brewarrina fish traps.
- Watch a video about fish and eel traps created by Gunditjmara people at Budj Bim.

Tips for teachers

Before the lesson, decide on the following features of your imaginary insect:

- Does it fly?
- What colour is it attracted to? Make sure you have cups, paper and plates available in the colour you decide the insect is attracted to. If you can't find different coloured cups and plates, you can use white ones and the students can cover them with coloured paper.
- What smell is it attracted to? Make sure you have some of that smell (e.g. vanilla)
- Is it attracted to shiny things (like aluminium foil), black stripes, or is this unknown?

The Mediterranean fruit fly and other species of fruit fly are serious pests that damage crops. Surveillance and monitoring programs are trying to limit the spread of fruit fly. Credit: Freepik / Alessandro Grandini

Worksheet: Insect trap

A new type of insect has been spotted near the school. It's eating plants in the gardens, and people are worried it will spread to nearby farms and damage food crops. To stop the insects, scientists need to study them, and for that they need specimens.

Your mission is to design a trap to catch this new insect.

Ask questions and write down these details about the insect you are going to trap.

Does it fly?	....
What colours is it attracted to?	....
What smells is it attracted to?	....
Is it attracted to shiny things?	....

What features does your insect trap need? Note them below.

………

………

………

………

………

Draw a picture of the insect trap.

Build an insect trap using the materials provided. As you build, check back against the features you noted above. How can you modify your trap to be more successful?

SPOTLIGHT: HIGH-TECH INSECT TRAPS

Fruit fly, aphids and other insect pests cause millions of dollars of damage to crops every year. To protect plants, it's important to spot pests as quickly as possible before they spread and multiply.

Sentinel units are high-tech devices that can trap insects so scientists can quickly identify them.

"The Sentinel units can be used to manage biosecurity, biodiversity, pests and disease," says Andrew Baker, Research Lead for the Centre for Advanced Biosecurity Surveillance.

The units feature a six-metre insect suction trap to monitor for insects that fly long distance, and a two-metre trap to monitor for local flying insects. They also have a weather station to record temperature and rainfall, and a spore trap that can spot disease-causing fungi.

"Automation has been around for a while in manufacturing, but it is now pushing into the agriculture sector," Andrew explains. "So you need to be able to deploy technology that can keep working and working in remote areas."

To do this, the Sentinel units have their own solar panels to generate electricity.

This innovation can help Australian agriculture thrive. By monitoring and quickly identifying pests, farmers can act before the pests become a problem.

The Sentinel 7 unit traps insects. Credit: Andrew Baker

SPOTLIGHT: FANTASTIC FISH TRAPS

The first Australians have caught fish in traps for thousands of years. Baiame's Ngunnhu, also known as the Brewarrina fish traps, are innovative structures that are still here today.

The rocks you can see in the river are Baiame's Ngunnhu, the fish traps.
Credit: John Spencer/DPE

The design has a series of U-shapes made from rocks that allowed fish to be caught during their migration, when they moved along the river at a particular time each year. The structure was designed to let some fish through so they could breed, making it a sustainable method of fishing.

The Ngemba people are custodians of the fishery, and collaborated with other tribes in the area that spoke different languages. The fish traps were a place to meet, trade and have ceremonies.

The people used their deep knowledge of the river system and fish behaviour, combined with engineering approaches, to design Baiame's Ngunnhu.

Make a better paper plane

Paper planes are always fun, and this activity puts a twist on it by starting with a straw as the fuselage (or body) of the plane.

Learning objective

Students gain confidence in designing, building, testing and improving designs.

Success criteria

Students build a prototype paper plane, test how well it flies and improve their design.

Activity length

40 minutes. Can be extended to 1 hour.

Credit: Elise Adams

Context

Innovations in air transport are made by including new materials and creating new designs. In this activity, a straw must be used as the fuselage, encouraging students to be innovative with their designs. The activity can easily be adapted into a challenge or competition. Encourage students to innovate and try something different with their designs.

Materials to prepare in advance

- Straws (paper or plastic)
- Paper
- Cardboard
- Scissors
- Sticky tape
- Paper clips
- Worksheet of different paper planes (see next page)

Instructions

1. Set a challenge with the class. You are going to make the best paper planes. But what does 'the best' mean? It could be the plane that goes the furthest, spends the most time in the air, or does a trick such as a loop-the-loop.
2. Show the class the worksheet on page 46 with examples of paper planes and leave them somewhere accessible.
3. Ask students to use the materials provided to make paper planes. They can test their planes, and then make improvements or try another design to make it the best it can be.
4. After a set amount of time, tell students it is time for their final flights and then to sit down. As a group, talk about which designs worked best. What did they discover about their designs? Were they able to improve their plane by trying new things?

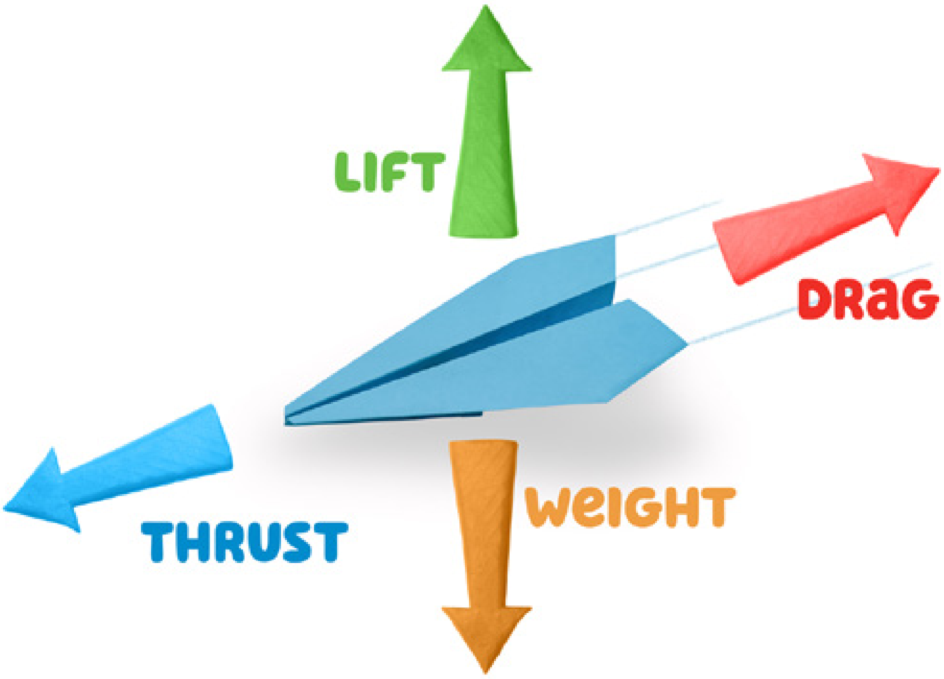
Tips for teachers

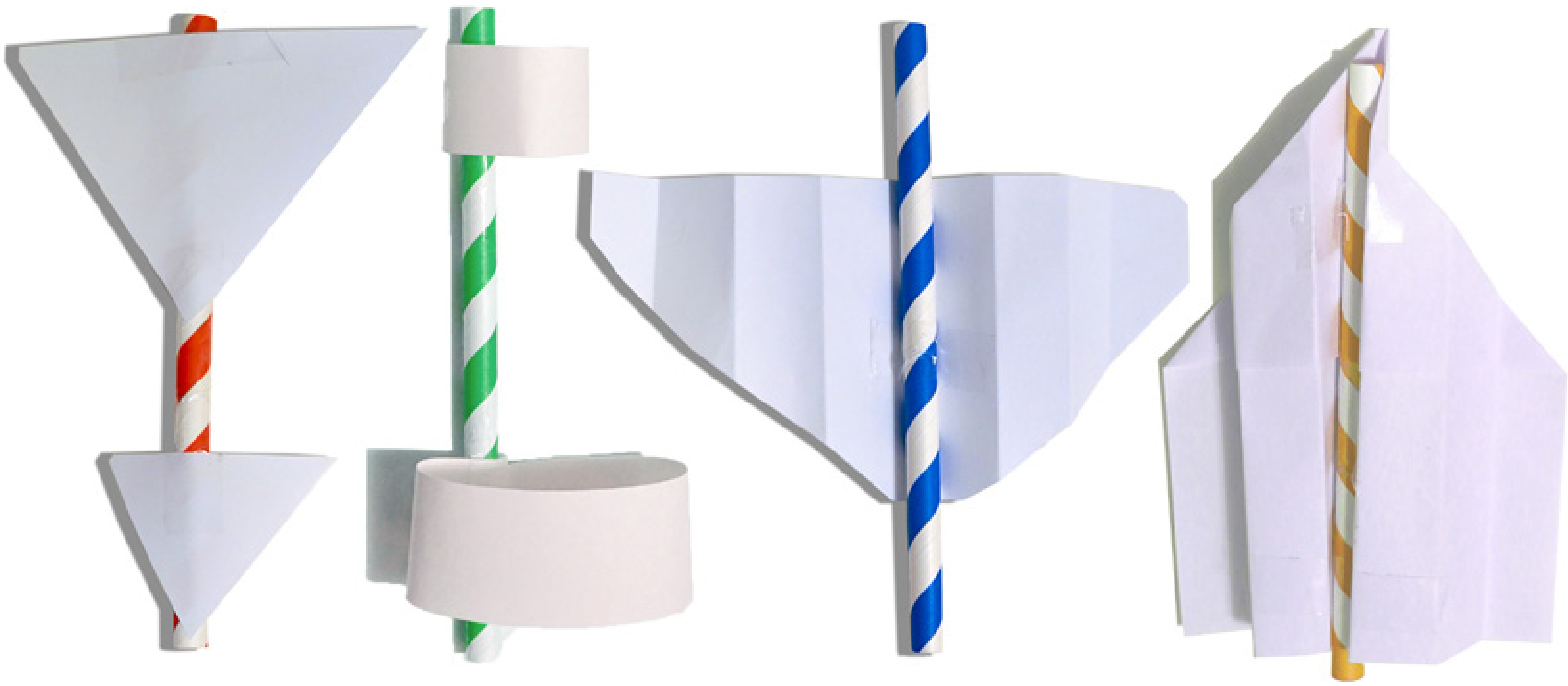
- If running a competition you can have heats, a semi-final and a final.
- You might want to set up a dedicated area of the classroom for testing planes.

Worksheet: Paper planes

Make the best paper plane you can by using a straw as the fuselage (or body) of the plane. Add paper, cardboard or other materials.

How does a paper plane glide?





SPOTLIGHT: GLIDING TO THE FUTURE

Spaceplanes are launched into space on a rocket. Apart from a system that helps the spaceplane manoeuvre in space, it has no engine to help it land like an ordinary plane. Instead, it becomes a glider when it re-enters the atmosphere, gliding back to land just like your paper plane. Because spaceplanes can land like an aircraft, they are reusable.

NASA's Space Shuttle Orbiter was a spaceplane. Future spaceplanes, such as the Sierra Nevada Dream Chaser, will also glide back to Earth after a mission. An automated version of the Dream Chaser will carry cargo to the International Space Station, and a crewed version might take visitors to and from a commercial space station. The Dream Chaser is being designed to launch on American and European rockets and land on many types of runways, so it could be used for many different types of space mission.

Artist impression of spaceplane system. Credit: freepik/paopano

Teabag hot air balloon

This captivating demonstration only takes a few moments. When you set fire to a teabag, the heat makes it float up into the air. This is a great non-verbal demonstration.

Safety

This activity involves fire. The teabag quickly burns to ash before rising. We recommend performing the demonstration in an area protected from wind or breeze from air-conditioners, and not directly below a smoke alarm.

Learning objective

Students observe the movement of the teabag hot air balloon as an indication that air is moving due to the change in temperature.

Success criteria

Students can explain that heat moves from the tea bag into the air.

Activity length

15 minutes

Credit: Elise Adams

Context

Hot air rises because it is less dense than cold air. This influences our daily weather. It's also the reason why lofty hot air balloons rise, and people can launch lanterns for the Lantern Festival celebrated in China and other Asian countries. This activity is an opportunity to make an observation a moment of awe and wonder. Explain how hot air rises afterwards.

Materials to prepare in advance

- Paper teabag (a kind that is stapled closed – Twinings brand works well)
- Scissors
- 2 plates (non-flammable material)
- Matches
- Table to do the demonstration

Tips for teachers

- Have a few teabags handy as a backup.
- Test the activity before the demonstration. Some brands of teabag may not rise after they burn.

You can add an explanation and discussion about changes to material, noting that burning (or combustion) is an example of an irreversible change to a material.

Instructions

1. Ask students to sit or stand at least a metre away from the demonstration table.
2. Cut the top off a teabag (e.g. where it is stapled).
3. Pour the tea leaves onto one plate and set aside.
4. Open the empty teabag so it forms a cylinder and place it upright on the other plate.
5. Use a match to light the top of the teabag.
6. Watch as the fire travels down the teabag until the ash rises into the air.

More ideas

- Before the activity, share a video about hot air balloons, such as this one about the Canberra Balloon Festival. Have a group discussion on how and why the balloons go up. This is useful to discover what students already know and what misconceptions they hold.
- This activity works because of convection currents. Dr Adele Morrison was awarded the 2022 Malcolm Macintosh Prize for Physical Scientist of the Year for her innovative modelling of currents in the Southern Ocean. Share her story in the handout and watch a video about her work.

Handout: Teabag hot air balloon

What's happening with the teabag?

The teabag ashes rise after it burns because hot air rises. Why does hot air rise? When air is heated, the molecules of gas in the air, such as nitrogen and oxygen, get lots of energy and move around quickly. This makes them spread out from each other. Because of this, hot air is less dense than cold air, in which the molecules are close together.

Because hot air is less dense than cold air, hot air rises. More cold air comes underneath the hot air, and the hot air moves up and up. This is called a convection current.

Convection currents are responsible for the weather we see every day. The movement of cold air and hot air, or low and high-pressure systems, creates wind and rainfall. Ocean currents are also convection currents. Deep inside Earth, hot magma (molten rock) moves in convection currents too, and this leads to earthquakes and volcanic eruptions.

Innovations that use convection currents include weather forecasting and hot air balloons.

Did you know?

Convection is movement in a liquid or a gas that is caused by a difference in temperature.

Credit: Australian National University Media

MEET ADELE MORRISON

Hi, I'm Adele Morrison, a researcher at The Australian National University. I study the ocean circulation around Antarctica. This is important, because Antarctica is melting due to warm ocean water coming into contact with the edges of the ice sheet. Cold, dense water also forms next to Antarctica and sinks to the bottom of the ocean. This is a convection current, just like in the teabag experiment.

My research tries to predict how quickly the ice of Antarctica will melt in the future. To find out, we run models using a supercomputer at the National Computing Infrastructure in Canberra. We put in data about winds, air temperature and other factors into the model, and see how the ocean currents and water temperature responds. Then we play with it, and see what happens if we increase the wind speed or meltwater entering the ocean from Antarctica.

The ocean around Antarctica has a lot of tiny features, such as swirls and eddies, which mean that a computer has to do a lot of calculations to run the model. Innovations in computing have made it possible to make complex models that mimic the real world. We use programming languages called Fortran and Python to write the code.

Science is a lot of fun! I spend my days solving problems and working with a great team.

Make a mega spinner

In this cool but complex activity, students can make a large spinner powered by a battery. The activity is a bit fiddly and would suit Year 6 students, or students in a science club.

Learning objective

Students learn that electricity can power their spinner, and that a wind turbine can generate electricity.

Success criteria

Students can explain how their spinner works.

Activity length

One hour

Safety

Be careful with the hot glue gun to avoid burns.

Context

In this activity, electricity from batteries goes to the motor to spin the blades of the spinner. You can compare and contrast this to a wind turbine, where wind spins blades attached to a generator to make electricity.

Materials to prepare in advance

- Poly irrigation barbed 4 mm joiner, available in hardware or garden supply stores. They are inexpensive and used to connect the motor to the blades.
- 6 volt DC motor (any motor between 3 and 12 volts is fine; the lower the voltage, the faster the blades will spin). Available in hobby stores or online for less than $5 each.
- The rest of the items listed on the student worksheet, which are easily obtained.

More ideas

- Research wind turbines or organise a visit to a wind farm.
- Discuss wind as a renewable source of energy

More resources

- Read why [Aboriginal people have little say over energy projects on their land] on The Conversation.
- Find out about the [First Nations Clean Energy Network].

Printing? Find links for these resources at scienceweek.net.au/schools/2023-resource-book-links/

Tips for teachers

- This activity can be done individually or in pairs.
- The spinner is about 30 cm high and quite eye-catching

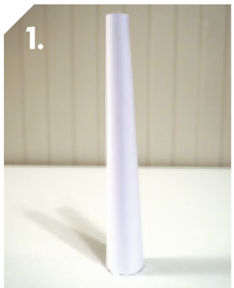
Worksheet: Make a spinner

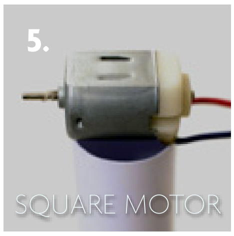
Materials

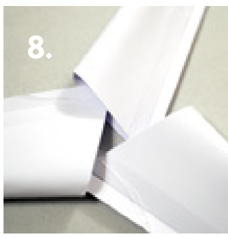
- 1 piece of 250 gsm paper (thick paper that is like cardboard)
- Sticky tape
- Scissors
- Paper bowl
- Electric motor
- Hot glue gun with glue
- 1 printed template for the blades on page 53
- Barbed 4 mm joiner
- 2 alligator clips
- AA battery

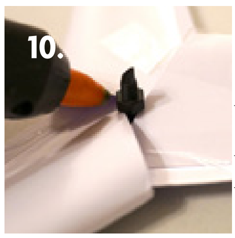
Instructions

1. Roll the piece of paper longways to form a tube, with one end more tightly rolled than the other.
2. Put sticky tape all the way along the edge of the tube to keep it rolled up.
3. Cut the wide end of the tube to make a flat base. The tube should be able to stand up with the narrow end pointing upwards. This will be the tower of the spinner.
4. Put the paper bowl upside down on the table, and glue the bottom of the tower on it. This helps the tower stay up.
5. If you are using a square motor, attach the motor to the top of the tower with a few dots of hot glue. If you are using a round motor, cut a V into the top of the tower first before you glue the motor on.
6. Now you will make the three blades. Take the printed template and cut along the dotted lines.
7. Fold each blade together as shown on the template and fasten the long edges with sticky tape, leaving the bottom of the blade open.
8. Insert the open blades into each other as shown in the photo. It should look like a star with a small hole right in the middle. Note that each blade has a narrow side and a wide side, and when arranged together each narrow side should be next to a wide side.
9. Stick the three blades together with sticky tape, without covering the hole. Flip them over and tape them on the other side.
10. Put the barbed 4 mm joiner in the hole in the middle of the blades. Use hot glue to stick it on.



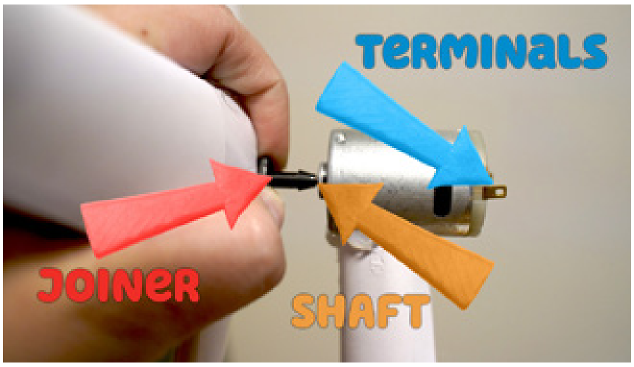






Credit: Elise Adams

11. Look at the motor on the tower. One side has two terminals poking out, and the other has a metal shaft poking out. That metal shaft is going to go into the other end of the joiner, so that the motor can turn the blades. When you attach it in step 12, it's important not to get glue on the body of the motor, as it will stop the shaft turning.



12. Carefully put a blob of hot glue in the other side of the joiner and lift the blades up to the tower. Insert the motor shaft into the joiner while the glue is still warm, leaving a gap between the joiner and the body of the motor.

13. Check the blades of the spinner can spin, and the tower can still stay up. Make adjustments if needed.

14. Now your spinner is looking good, it's ready for power! Clip an alligator clip to each terminal of the motor.

15. Touch the other ends of the alligator clips to either side of the AA battery. The blades should start spinning!

Explanation

Electricity from the battery goes through the alligator clips to the motor, and makes the shaft spin. The shaft spins the blades of the spinner. Your spinner looks like a wind turbine, but a wind turbine works differently to your spinner.

In a wind turbine, wind pushes the blades and makes them spin. This spins a generator, which produces electricity. The electricity goes into the electrical grid or a battery, and is used to provide electricity to homes and businesses.

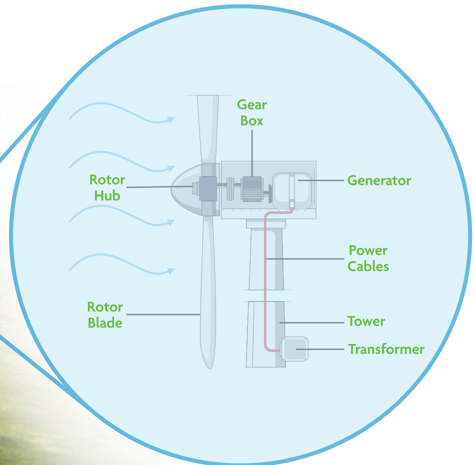
Motor or generator?

An electric motor is the opposite to an electric generator.
An electric motor converts electricity to rotational kinetic energy.
An electric generator converts rotational kinetic energy into electricity.
Your spinner uses a motor, while a wind turbine uses a generator.

Who should decide where a wind farm is built?

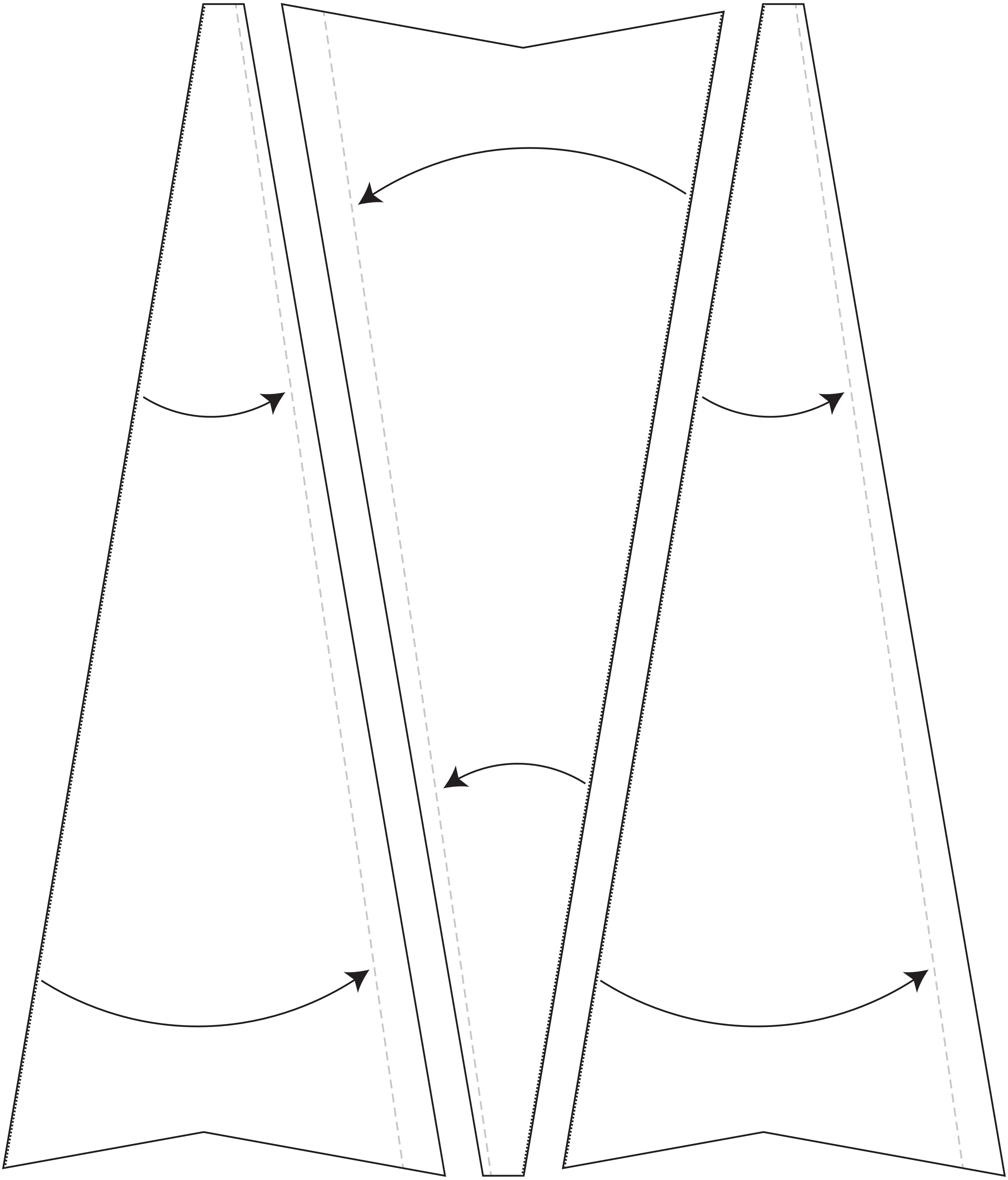
Is it the people who need the electricity, the people who sell the electricity, the people who own the property, the local community or Traditional Owners of the unceded land? These people all have a stake in the decision, but what happens if they don't all agree?

Capital Wind Farm to the east of Lake George powers 69,700 homes.
Credit: Tim Fitt / underthedrone.com.au



Spinner Blades

Cut along black outlines, fold to the dotted lines.



05

ACTIVITIES

FOR YEAR 7 TO YEAR 10

An artist rendering of community vertical farms of the future Credit: James Haig Streeter

Activities align to the Australian Curriculum as follows:			Make a water pump	Filter water	Balloon-powered rockets	Innovations in health
Year 7	Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques	ACSSU113		✓		
	Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable	ACSSU116	✓	✓		
	Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object	ACSSU117	✓		✓	
Year 8	Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce	ACSSU150				✓
	Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems	ACSSU155	✓		✓	
Year 9	Energy transfer through different mediums can be explained using wave and particle models	ACSSU182	✓		✓	
Year 10	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere	ACSSU189	✓			
	Energy conservation in a system can be explained by describing energy transfers and transformations	ACSSU190	✓		✓	
	The motion of objects can be described and predicted using the laws of physics	ACSSU229			✓	
Year 7 and 8	Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures	ACSHE223		✓		✓
	Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations	ACSHE120		✓		✓
	People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity	ACSHE121	✓	✓		✓
	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed	ACSIS125	✓	✓	✓	
	Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate	ACSIS133	✓		✓	✓
Years 9 and 10	Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries	ACSHE158	✓	✓	✓	✓
	Values and needs of contemporary society can influence the focus of scientific research	ACSHE228	✓	✓		✓
	Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods	ACSIS165	✓	✓	✓	

Make a water pump

This mini water pump, or fountain, uses air pressure to force water up through a straw. The air pressure is supplied by releasing the air from a balloon into a plastic bottle.

Learning objective

Students understand that the water pump works because gases move from high-pressure areas to low-pressure areas, energy is transferred within the system, and forces are unbalanced.

Success criteria

Students can explain how air pressure changes in the activity and transfers energy.

Activity length

40 minutes

Safety

Be careful to avoid injury when making a hole in the side of the plastic bottle. Depending on your students' age and abilities, you may wish to do this step in advance using a boxcutter.

Context

This mini water pump is made using a bottle of water and is powered by a balloon. The air in the balloon is at a higher pressure than the air in the bottle. When the neck of the balloon is released, the forces in the balloon and bottle are unbalanced. The air pressure equalises by pushing air from the balloon into the bottle.

As air moves into the bottle, the air pressure in the bottle becomes higher than the air on the outside of the bottle. As a result, the air in the bottle pushes water up the straw and out of the bottle. The forces in the system, which started in an unbalanced state, come to equilibrium.

Materials to prepare in advance

Students will do this activity in pairs or small groups. Each group will need:

- 1 plastic bottle (600 mL, no lid)
- Scissors (or you can complete Step 1 in advance, see worksheet)
- 1 straw
- 20 cent sized piece of Blu-Tack
- Tray to catch water
- 300 mL water in a jug or measuring cylinder (optional: add a few drops of food dye to make it easier to see)
- 1 balloon
- Hand towels or paper towel to wipe up spills
- Optional: Funnels to make it easier for students to pour water

Credit: Elise Adams

More resources

- Watch a video of this activity by IISER Pune Science Activity Centre.
- Watch a video of smart irrigation for the dairy industry from the Tasmanian Institute of Agriculture.

Printing? Find links for these resources at
scienceweek.net.au/schools/2023-resource-book-links/

Worksheet: Make a water pump

Make a simple water pump or fountain.

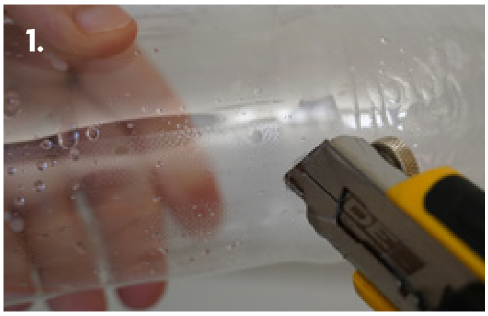
Materials

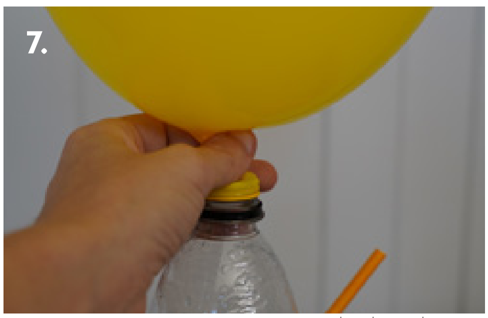
- Plastic bottle (600 mL, no lid)
- Scissors or utility knife
- Straw
- Blu-Tack
- Tray
- 300 mL water
- Balloon

Credit: Elise Adams

Instructions

1. Use the scissors or utility knife to carefully make a hole in the side of the bottle near the top.
2. Push the straw through the hole, so the end of straw is near the bottom of the bottle.
3. Wrap Blu-Tack around the straw and the hole, and push it down firmly so that it seals the gap. Ensure that air will not be able to escape around the straw.
4. Stand the bottle in the tray to catch spills.
5. Pour water into the bottle.
6. Blow up a balloon about halfway, and pinch the neck of the balloon closed. Don't tie it off.
7. This bit is tricky. While pinching the neck of the balloon with one hand, use the other hand to stretch the opening of the balloon around the neck of the bottle. You might want to ask someone to hold the bottle while you do this, as it might tip over.
8. Let go of the balloon and watch what happens!





Credit: Elise Adams

Explanation

When you release the balloon, water should come out of the straw like a fountain. This happens because the air in the balloon is initially at a higher pressure than the air in the bottle. When the neck of the balloon is released, the forces in the balloon and bottle become unbalanced, and the air pressure equalises by pushing air from the balloon into the bottle. The air pressure in the bottle then becomes higher than the air on the outside of the bottle, so the air in the bottle pushes the water up the straw and out of the bottle. The forces in the system, which started in an unbalanced state, come to equilibrium.

If the balloon does not completely deflate in the activity, you might want to check if the straw is blocked. If the straw is blocked, it creates a closed system, and the air and water cannot move. Try moving or replacing the straw.

If the balloon deflates but water does not come out of the straw, it's likely the air is escaping from somewhere. Check the Blu-Tack is completely sealing the hole, that the end of the straw is immersed in water, and that there are no gaps between the opening of the balloon and the opening of the bottle. If there's a gap, fix it and try again.

SPOTLIGHT: IRRIGATION IN AUSTRALIA

Plants need nutrients, sunlight, air and water to grow. Where does the water come from? When the weather is right, it can come from rain. But that's not always the case.

Irrigation is any method that people use to apply water to land so plants can grow. Most farms in Australia use some form of irrigation. Examples include drip systems that release water to the ground, and sprinkler systems that spray water over crops.

To move water from one place to another, you need energy. The energy can be transferred using electricity, but another way is to use pressurised air, as we did in this activity.

Innovations are improving how we use irrigation. Sensors and smart systems are used to look for leaks in the pipes, and to only water plants when needed. By checking weather forecasts and measuring the moisture in the soil, farmers can make the most of water – a valuable resource.

Crop sprayers in action in Mornington Peninsula, Victoria, Australia
Credit: FiledIMAGE/freepik

Water filter

In this activity, students can create a simple water filter to clean out visible dirt – but don't drink the water!

Learning objective

Students understand that solutions can be separated using filtration.

Success criteria

Students construct a water filter and suggest improvements.

Activity length

40 minutes

Safety

Ensure students do not drink the water. Even though it may look clean, it could still contain toxins or bacteria.

Context

On the International Space Station, wastewater and urine are filtered so astronauts can drink them again. Water filters are also crucial in remote and regional areas where water is not safe to drink.

Materials to prepare in advance

Per group

- 1 empty 600 mL plastic bottle with no lid
- Scissors
- A 5 cm x 5 cm square of cheesecloth or other fabric
- Rubber band
- Printed copies of the worksheet on pages 61 and 62

Available for everybody

- A sample of dirty water, made by adding dirt to 2 litres of water
- Cotton wool
- Sand
- Gravel
- Lentils
- Rice
- Towels to wipe up spills

More resources

- Learn about water filtration on the International Space Station.
- Read an ABC News article about how a teenager tried to fix the problem of contaminated water in remote Australia.

Printing? Find links for these resources at scienceweek.net.au/schools/2023-resource-book-links/

Credit: Elise Adams

Tips for teachers

- This activity can be done in groups of three or four. Two litres of dirty water is enough for 7 groups to have 250 mL each, and one 250 mL sample left over for comparison.
- If time allows, students can improve their filter and try again.
- The sediment in the dirty water will settle to the bottom. Shake or stir the water just before testing.

Worksheet: Water filter

Disaster! A big flood has made all the town's drinking water dirty. You are an engineer and have received a sample of the dirty water. Your job is to design and test a water filter to make the sample cleaner, so it can go on to the next step of water purification.

Materials

- 1 plastic bottle
- Scissors
- Cheesecloth
- Rubber band
- Materials to put in the filter (e.g. gravel, sand, cotton wool)
- A sample of dirty water

Safety

Don't drink the water!
Never taste a science experiment.

Instructions

1. Cut the water bottle in half as shown in the picture. Set the bottom half of the bottle to one side.

2. Cover the small opening on the top half of the bottle with cheesecloth. Wrap a rubber band around it to keep it on. This is going to be your filter cartridge.

3. Fill the filter cartridge with the materials you think will best clean the water. Think about how you intend to mix or layer the materials to gain the best results.

4. Put the filter cartridge inside the bottom half of the bottle, so that the cheesecloth end is pointing down.

5. Test the filter by pouring some dirty water into the filter cartridge. Look at the water that comes out into the bottom of the bottle.

6. Compare the filtered water with the sample of dirty water. Is the filtered water cleaner?

7. Complete the worksheet on the next page to capture your design notes.

Credit: Elise Adams

Write down the materials you used in the filter. A diagram might help if you used layers.

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Write down your observations from filtering the water.

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Write down any ideas for how to improve the filter cartridge next time

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Did you know?

The International Space Station used to receive frequent deliveries of water. In 2008, an innovative water filtration system was installed. Now, the Station's wastewater – including astronaut sweat, condensation and urine – can be cleaned and reused. As we make our way to the Moon and Mars, filters will help make the trip a little easier.

Balloon-powered rockets

These balloon rockets zoom quickly along a string, powered by the air as it leaves the balloon.

Learning objective

Students understand that potential energy is stored in the balloon, and this is released to create kinetic energy.

Success criteria

Students can describe the movement of the balloon as an example of energy transfer and unbalanced forces.

Activity length

40 minutes

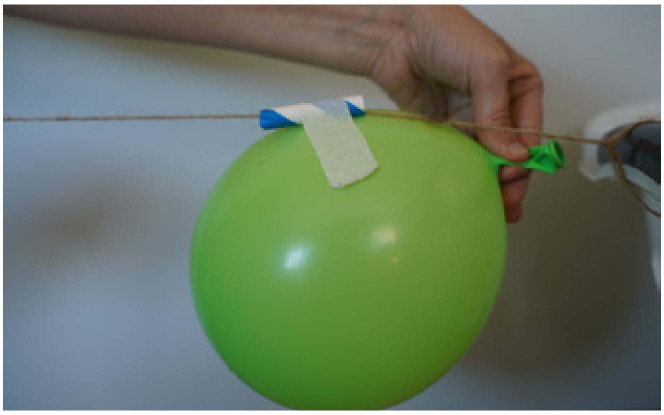
Context

The balloon rocket is a nice demonstration of Newton's third law of motion: every action has an equal and opposite reaction. The air rushing out of the balloon pushes the balloon rocket forward. This is the same as the thrust from a rocket, which comes from gas being squirted out of a nozzle after being produced by burning rocket fuel.

Materials to prepare in advance

Per group:

- 1 balloon (preferably a long balloon, but round ones are fine)
- A 2 m length of nylon string or fishing line
- A 4 cm length of straw
- Sticky tape
- Two chairs to tie the string to
- Optional: Balloon pump. If a balloon pump is not available, ask students to nominate one person in the group to blow up and hold the balloon so they aren't sharing germs.



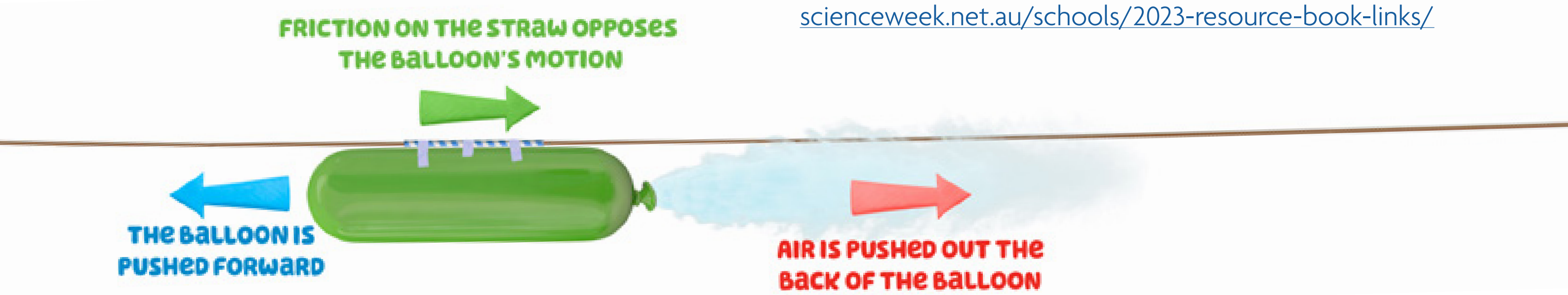
What to do

1. Split the class into groups of two or three.
2. Use the handout on the next page as instructions, and supply the materials above.
3. When the students release the balloon, it should zoom along the string away from the launch chair. If this doesn't happen, it could be because the string is too loose.

More resources

- Print posters about space technologies from the Australian Government (PDF, 5MB).

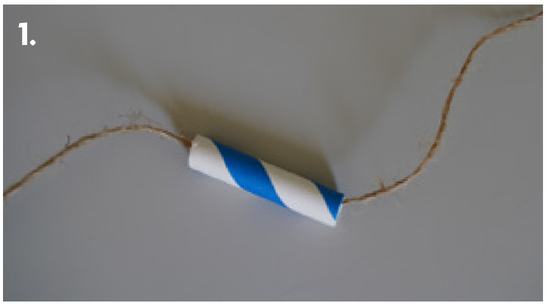
Printing? Find links for these resources at scienceweek.net.au/schools/2023-resource-book-links/



Worksheet: Balloon-powered rockets

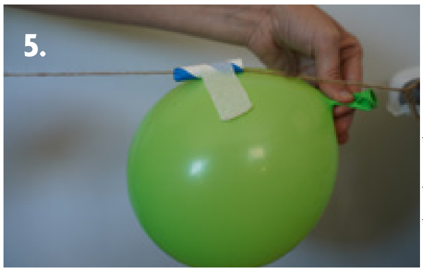
Watch a balloon-powered rocket zip along a line.

Materials



- 1 balloon. Round ones are fine but longer balloons are best
- A 2 m length of nylon string or fishing line
- A 4 cm length of straw
- Sticky tape
- Two chairs

Instructions



Credit: Elise Adams

1. Thread the string or fishing line through the straw.
2. Tie the string between the tops of two chairs.
3. Move the chairs apart so that the string is tight. Slide the straw so it is at one end of the string. We'll call the chair next to the straw the launch chair.
4. Blow up the balloon a bit (not all the way; about half full is good). Keep it untied, but hold the neck closed with your fingers.
5. Tape the side of the balloon to the straw, so that the neck of the balloon is closest to the launch chair. See the photo on this page.
6. Release the balloon. What happens?

Draw a diagram of your balloon-powered rocket. Use arrows and labels to show where energy and forces occur.

Explanation

As the air rushes out the back of the balloon, it pushes the balloon forward. This is called thrust, and is the same force that launches rockets into space. Real rockets burn rocket fuel to produce a gas that exits the nozzle at high speed, pushing the rocket forward.

If you've ever blown up a balloon and let it go whizzing around the room, you've seen thrust pushing a balloon in random directions. In this activity, you've limited its motion using the straw and the string, which keeps the balloon on a set path.

Did you know?

Modern rockets are an innovation based on an ancient Chinese invention. Using rockets we can launch satellites into orbit around Earth. Satellites are part of our daily lives, providing services from the weather report to internet banking and GPS. Rockets can also launch space missions. Australia is partnering with NASA to go to the Moon and Mars, and plans to place a rover on the Moon later this decade.

Innovations for a healthy future

As a science fair project or poster presentation, students investigate an Australian innovation linked to healthcare or medicine.

Learning objective

Students explore how Australian innovations are improving people's health.

Success criteria

Students communicate the innovation and its impact on people's health.

Activity length

One week

Context

Innovations are making enormous strides in healthcare and medicine. To increase the speed and success of innovation, organisations connect researchers, doctors, patients and businesses to come up with new ideas and rapidly test them.

First Nations connections

Explore how Purple House provides mobile kidney dialysis for First Nations people in remote communities.

Ultrasound equipment during a medical examination
Credit: RossHelen

More resources

- Watch a video about SpeeDx, a company that makes diagnostic tests for cancer and infectious diseases, founded by Alison Todd and Elisa Mokany, who won the 2022 Prime Minister's Prize for Innovation.
- Watch a video about Pip Karoly, who was awarded the 2022 Prime Minister's Prize for New Innovators for her work with Seer Medical, which improves the lives of people with epilepsy.

Printing? Find links for these resources at
scienceweek.net.au/schools/2023-resource-book-links/

Tips for teachers

- As a kick-off to this lesson, watch one of the videos above about a health innovation recognised at the 2022 Prime Minister's Prizes for Science.
- After the video, ask students what the innovation was (e.g. a test to diagnose disease, or a technology to forecast seizures). How has the innovation improved people's lives?
- Pass out the worksheet on the following page, and ask students to create a poster about an organisation's innovations.

Worksheet: Innovations for a healthy future

Australian innovations are improving the health of people around the world. Create an A3 poster about how an organisation is innovating to improve health.

- To make the poster, choose an organisation from the list below and use the web to find information about how they innovate.
- Your poster could explain the ways the organisation supports innovation, or the outcomes of innovation – such as a new test or treatment.
- Make the poster eye-catching using colour and images.

Organisations to choose from

- CSIRO
- Seer Medical
- Purple House
- World Health Organization
- Australian Red Cross Lifeblood
- Macquarie Park Innovation District
- Australian Centre for Health Services Innovation
- Choose your own organisation and discuss your idea with your teacher

Seer Sense is a wireless brain and heart monitoring wearable that assists doctors in diagnosing epilepsy.
Credit: Madeline Bishop

Dr Rena Hirani on left and PhD student Laura Rey Gomez on the right.

Credit: Dr Lauren Waters

MEET RENA AND LAURA

Hi, my name is Dr Rena Hirani, and I'm a senior researcher at Australian Red Cross Lifeblood.

To me, innovation means helping as many people do the best job they can using the fewest number of steps.

Blood needs to be tested before it can be given to a patient. I'm working with a PhD student, Laura, on some cool new ways to test blood.

We hope to make a device to help hospital staff do these tests quickly and cheaply without opening the bag of blood! The device will also be easy for people to use in places where fancy equipment is not available, or where disasters have happened.

Other parts of my research involve collecting data to understand how blood is used, which can help governments innovate to make decisions for public health.

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