DECODING THE UNIVERSE

RESOURCE BOOK OF IDEAS

National Science Week 2025

9 - 17 AUGUST

Exploring the unknown with nature's hidden language

Australian Science Teachers Association

An Australian Government Initiative

Inspiring Australia

Welcome

The outstanding series of National Science Week resource books has been published annually by the Australian Science Teachers Association (ASTA) with Australian Government funding support since 1984. This year's theme is Decoding the Universe – Exploring the unknown with nature's hidden language. This resource book can be used in planning for National Science Week 2025 and is also a resource that can be used every year as it is mapped to the Australian Curriculum: Science. Gather inspiration from this resource and engage your students in authentic and relevant science topics.

I would like to thank all those involved in the production of this resource book, and in particular the teachers who have shared exemplary learning activities.

ASTA would like to acknowledge the eight state and territory Science Teachers Associations and their National Science Week representatives for their ongoing support of National Science Week in schools at the local level.

Margaret Shepherd

ASTA President

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:

The scientific advisory group for reviewing this book for accuracy – Leanne McMahon, Australian Mathematical Sciences Institute; Gregory Rowbotham, CSIRO and David Shaw, CSIRO.

The teacher review group for feedback on the draft of this book – Sheree Epe, Eden Marine High School, NSW; Jess Fulton, Lauderdale Primary School, TAS; Tundra Morscheck, Fraser Primary School, ACT and Daizee Wiles, Edith Cowan University, WA.

Cultural collaborator Aleryk Fricker, Deakin University, for reviewing the First Nations connections, and Australians Together for introducing us.

Alice Ryder, Questacon, for her assistance and feedback.

Foreword

I am delighted to share the 2025 edition of ASTA's annual teacher resource book for National Science Week, proudly supported by the Australian Government. Over the years these resources have explored an incredible diversity of topics, from the fundamental properties of glass to the frontiers of space exploration

This year's theme, Decoding the Universe – Exploring the unknown with nature's hidden language builds on the 2025 United Nations International Year of Quantum Science and Technology and the 2025 International Mathematical Olympiad being hosted in Australia.

The desire to 'decode' or explain the world around us seems almost universal. As a father, I know the delight prompted by the question 'why?' from my son. This question and the joy of discovery drives everyone in the world of science and education and it is great to see that being celebrated.

Decoding the world around us has been taking place in Australia for millennia. First Nations cultures maintain cultural practices that embed understanding, respect and connections between land, water and sky. The cultural knowledge of seasonal calendars and astronomy are just some examples of 'decoding' that have been passed down through generations. I'm pleased to see First Nations STEM interwoven throughout this resource and encourage you to integrate this knowledge into your classrooms.

I am also thrilled that this theme welcomes students and educators alike, to look forward to the exciting possibilities offered by quantum science. Australia is a world leader in quantum technologies. Australian-made innovations in quantum have already moved from ideas in university labs to commercial products used by industries as diverse as the mining and banking sectors. Commercialising quantum technologies could create an Australian quantum industry worth $6 billion and directly employing 19,400 people by 2045.

I hope the activities in this resource will support teachers' efforts to inspire and skill the next generation of future innovators and decoders.

The Hon Ed Husic MP.
Minister for Industry and Science

INTRODUCTION

This resource book is designed for educators from Foundation to Year 10 to engage with National Science Week through inquiry-based classroom activities. It is also appropriate for parents, preschools, science clubs, outreach officers and children.

The National Science Week Schools Theme for 2025 is 'Decoding the Universe – Exploring the unknown with nature's hidden language.' This theme invites students and teachers across Australia to delve into the mysteries of the universe by exploring the fundamental languages of nature, including mathematics and the groundbreaking field of quantum science.

Aligned with the 2025 United Nations International Year of Quantum Science and Technology and the 2025 International Mathematical Olympiad being hosted in Australia, this theme serves as a bridge between basic science education and the exploration of specialised topics.

Inside this book you'll find inquiry-based classroom activities for students to engage with intricate patterns and decode meaning from observations. There is also a special quantum section for high school students, and a project-based learning idea suitable for all year levels to investigate their local ecosystem and decode their world.

This resource book also contains many opportunities to incorporate cross-curriculum priorities, including Sustainability and First Nations connections.

First Nations connections

First Nations cultures use Traditional Knowledge systems gained by observing the land, recognising patterns and decoding meaning. This knowledge has been practised, refined and passed down for thousands of years, and forms exciting Indigenous-led STEM practice today. Many First Nations Australians work in science, technology, engineering and mathematics (STEM) today and combine Traditional Knowledges with western scientific practice in a two-way knowledge system. Ideas for including two-way learning in your class are included throughout the book. We thank Aleryk Fricker for reviewing these sections. Find them using the content map on page 7.

If you would like to gain more confidence and capability when including First Nations connections in your practice, 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.
- Ngarrngga has innovative curriculum resources in collaboration with Indigenous Knowledge Experts.
- Aboriginal and Torres Strait Islander Mathematics Alliance provides professional learning on culturally responsive mathematics education.

Sharing and socials

Share photos and students' work 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 decoding the universe in your classroom.

Printing this book?

You'll find all weblinks at scienceweek.net.au/schools/2025-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
- Design thinking: Activity promotes design thinking and a STEM approach to learning

	Foundation – Year 2	Year 3 – Year 6	Year 7 – Year 10
Decoding life and space	Nature art and observations	Fibonacci flowers	Decoding DNA
	Sensory stamps	Communicate with light	Decoding seed shapes
	Decoding animal prints	Big scale solar system	Laser interference and special quantum section
		Decoding shadows	
For all year levels			
Project-based learning and competitions		Decoding your world	
		Competition ideas	

Consider safety

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

* ACTIVITIES
for Foundation to Year 2

Activities align to the Australian Curriculum as follows:			Nature art and observations	Sensory stamps	Decoding animal prints
Foundation	Living things have basic needs, including food and water	ACSSU002			✓
	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		✓	
	Engage in discussions about observations and represent ideas	ACSIS233	✓	✓	✓
	Share observations and ideas	ACSIS012	✓	✓	✓
Year 1	Living things have a variety of external features	ACSSU017	✓		✓
	Living things live in different places where their needs are met	ACSSU211			✓
Years 1 and 2	People use science in their daily lives, including when caring for their environment and living things	ACSHE022			✓
	Use informal measurements to collect and record observations, using digital technologies as appropriate	ACSIS026	✓		
	Compare observations with those of others	ACSIS213	✓	✓	✓

NATURE ART AND OBSERVATIONS

Teacher instructions

Get up close with leaves gathered from around the school. In this activity, students will carefully observe the features of leaves and describe what they see. Observation is a key part of science, and this activity comes with a printout report they can complete. Students can also be guided to discuss what plants need to survive.

Learning objective

We are learning to observe leaves using our sense of sight.

Activity length

30 minutes

Success criteria

What I'm looking for is a drawing and description of a leaf that shows you have observed it carefully.

Explanation

Collecting samples is something scientists do to understand and investigate the world. A botanist is a scientist who studies plants. Botanists sometimes work with artists to draw detailed images of plants. You might have seen them in an art gallery or museum.

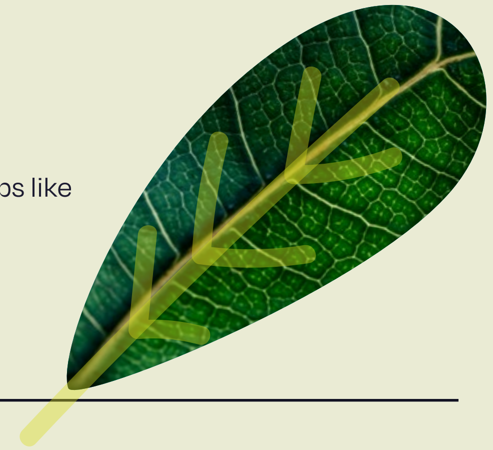
These drawings allow other scientists to identify the plant, by decoding particular features from the image and matching it to a plant. Botanical art has been used for hundreds of years and is still used today because some plant features are not obvious in a photo. Why do we want to identify a plant from a drawing? By identifying plants we can know which ones are good to eat, which ones are dangerous, and which ones make useful medicine.

More ideas

- Do a skip counting activity, counting by fives for the number of students in the class to figure out how many leaves have been collected.
- Eating bush tucker in Kakadu
- Learn about how First Nations people use native plants
- Extend this activity by making leaf-inspired artwork such as a collage, painted leaves, or leaf rubbings on paper with crayons.
- Extend this activity to make First Nations connections by learning about leaves used in bush tucker, smoking ceremonies, soap and medicine in your local area.
- Ask students to combine their leaves and, as a class, group and sort them. For example, they can put leaves that look the same into groups, and then they can sort by size within each group.

Materials to prepare in advance

- Print outs of the worksheet on page 12 for each student
- Coloured pencils and/or a pencil/fineliner for each student
- Access to leaves outside (or collect a variety of leaves in advance). Herbs like mint and coriander will add smells for students to observe.
- Magnifying glasses (optional)



Instructions

1. Ask students to go outside and collect five different leaves each.
2. Encourage them to talk about their leaves as they find them – describing the colour, shape and size.
3. Return to the classroom and explore botanical drawings from the Flickr galleries on the Botanic Gardens of Sydney website. Notice how the images are mostly in one colour and capture intricate detail.
4. Pass out the worksheet on page 12 to each student.
5. Ask students to choose one leaf to look at closely (option to use a magnifying glass), noticing all the details, and then to draw a picture of the leaf on the worksheet and answer the questions. Encourage them to capture details with just one colour first, like the botanical drawings you looked at.
6. When they have finished, lead a group discussion about the activity. You can link this to the biology curriculum for your year level by talking about leaves as a source of food for animals (Foundation), plants as having a variety of external features (Year 1) and that plants grow, change and reproduce (Year 2).

Safety

As always, do a risk assessment before this activity. Collecting leaves can include risks such as cuts from thorns or sharp edges, allergies, or insect bites and stings.

Rose hips and leaves. Image from Wellcome Collection CC-BY 4.0

Name: ....

NATURE ART AND OBSERVATIONS

Student worksheet

Draw a picture of a leaf

What interesting features does the leaf have?

....

....

....

The leaf is coloured:

Green	Yellow	Purple
Brown	White	Black
Red	Grey	White
Orange	Blue	Pink

Compared to my finger, the leaf is:

Shorter	About the same	Longer

The surface of the leaf is:

Bumpy	Smooth	Spiky
Soft	Hairy	

SENSORY STAMPS

Teacher instructions

In this activity, students use cut fruit, vegetables, flowers and other natural materials to stamp painted shapes. All students can use this activity to make observations about features of living things. Older children can look for planes of symmetry. This is also a great sensory activity.

Learning objective

We are learning to make shapes with paint and fruit, vegetables and flowers.

Success criteria

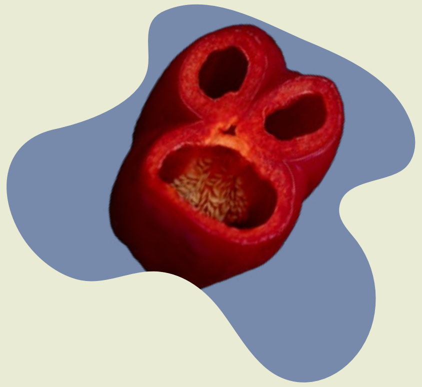
What I'm looking for is a picture of different shapes, and for you to explain how you made it.

Activity length

20 minutes

Explanation

Many natural products have a plane of symmetry (one side the mirror image of the other) or rotational symmetry (looks the same if you rotate it, like a flower).



More ideas

- You can use this activity to make cards for family members.
- Have a variety of whole fruit and vegetables and ask students to predict the shape they will make when cut in half and stamped. For example, a cucumber will make a circle. A starfruit will make a star.
- Use leaves or flowers as stamps and stick them on the paper as artwork.
- Encourage observation. What else can the children observe about the cut fruit, vegetables and flowers? Can they see seeds and other features?
- If you find seeds in the fruit, check for prior knowledge about seeds. Have a classroom discussion about seeds, and try counting the seeds you find.

Materials to prepare in advance

- Cut fruit and vegetables (for example, celery sticks, apple halves, capsicum halves, starfruit halves)
- Flowers
- Twigs or leaves
- Paints on small plates
- A table covered in butchers paper

Instructions

1. Invite students to use the fruit, vegetables, flowers, twigs and leaves as stamps. They can dip them in the paint, then stamp onto the paper.
2. Discuss what they observe. Can they see shapes, patterns or symmetry?
3. Once the paintings have dried, you can look at the pictures as a group. Can students figure out what was used to make each stamp?

DECODING ANIMAL PRINTS

Teacher instructions

In this activity, students will practice decoding patterns left behind by animals in their natural habitats. By following the prints of kangaroos or other Australian animals, they can learn about what animals need to survive. You can do this activity with or without a demonstration at the start. It lends itself to making First Nations connections in tracking animals.

Learning objective

We are learning to track animals from their prints.

Success criteria

What I'm looking for is an explanation of where animals have been and how we can tell.

Activity length

20 minutes

Materials to prepare in advance

- Printouts of the worksheet on pages 17 and 18 for each student
- Coloured pencils for each student
- If conducting the demonstration on page 16, you will need a baking tray, 1 cup of cocoa, 1 cup of cornflour, small plastic animal, and a spoon

Ways to do this activity

This activity is flexible and can be adapted to your classroom in these ways:

- Conduct a teacher demonstration by following the instructions on the next page, or play one of the videos linked in the 'More ideas' section.
- Get everyone involved by giving each student a tray, cocoa/cornflour, spoon and plastic animals, and letting them play by making prints. It might get messy!
- Instead of cocoa and cornflour, you can try making animal prints in mud, loose dirt, clay wet sand or play dough.

Whichever way you do it, you can also include the worksheet on page 17 to extend the learning and end with a discussion about what animals need to live in their habitat. The videos in 'More ideas' allow for First Nations connections.

More ideas

- Watch a video by NSW Fisheries about how local First Nations people track animals
- Watch a video by Perth Region NRM about making animal tracks with your hands
- Discuss why it is useful to track animals. For example, animal tracks can be followed to find water or food that animals (and people!) need.

Safety

We recommend using cornflour to avoid exposing gluten-free students or those with celiac disease to gluten.

Some cornflour is actually made from wheat, so check the ingredients before purchasing.

DECODING ANIMAL PRINTS

Teacher demonstration

Explanation

When animals walk across the land, they leave behind prints – and sometimes poo, too! These traces can tell us where they have been and which way they are going, if we know how to decode them.

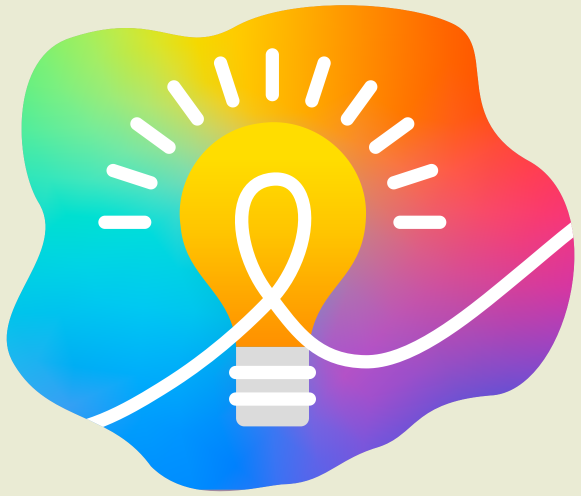
Decoding animal traces is useful for hunting and looking after Country. This skill has been used for thousands of years by First Nations Peoples and is still used today. Scientists also use traces to track animals and understand their habits.

Materials

- Baking tray (approx. 25 cm by 15 cm)
- 1 cup of cocoa
- 1 cup of cornflour
- Spoon
- Small plastic animal (with 'feet' that will leave prints)
- Optional: twigs, grass or plastic plants, blue paper, additional plastic animals

Instructions

1. Pour the cocoa and cornflour onto the baking tray.
2. Mix with the spoon.
3. Pat the surface flat with the back of the spoon.
4. Optional: Decorate the surface with twigs or plastic trees, blue paper and additional animals to represent a habitat.
5. Show the students as you 'walk' the plastic animal across the surface, leaving prints behind. Explain how the prints show where the animal has been.



Did you know?

Traces have been found of dinosaur footprints and dinosaur poo, which are so old they have turned into stone. The poo tells scientists what the dinosaurs ate, and the footprints give clues about how dinosaurs once lived millions of years ago.

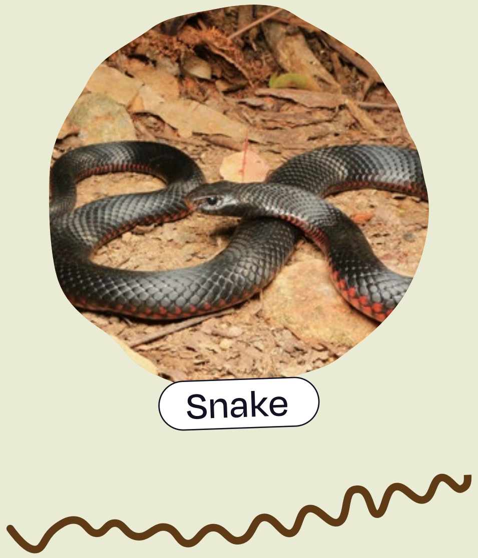
Name: ....

DECODING ANIMAL PRINTS

Student worksheet

Here are the prints left by different animals.

Kangaroo



Snake

Emu

Use the habitat picture to answer these questions.

1. Where did the kangaroo go first?

....

....

....

2. Where did the kangaroo go next?

....

....

....

3. Which animals visited the river?

....

....

....

Engage your students with hands-on science!

Spectra awards

Looking for a fun and engaging way to spark a love of science in students? Spectra is a hands-on, nationally recognised program designed to inspire curiosity and encourage scientific exploration in students from Years 1 to 10. Whether used in the classroom, with extension students, in science clubs or by homeschooling groups, Spectra provides a structured yet flexible approach to learning through experiments, research, and hands-on investigations.

With vibrant, full-color activity cards – featuring Spike the Echidna in Junior Spectra (Yrs 1–4) – students can explore a wide range of science topics at their own pace. Plus, they'll be awarded a certificate upon completion!

Available as digital downloads, Spectra cards are continuously updated to align with the Australian Curriculum: Science, ensuring fresh and relevant content.

Explore the full range of topics and order today at asta.edu.au/spectra
For more information call 02 9346 9600 or email asta@asta.edu.au

Spectra Card Topics

- Active Earth ^
- Aeronautics ^
- Animals *^
- Astronomy ^
- Biodiversity ^
- By the sea *
- Carbon ^
- Chemistry * ^
- Clean and green *
- Electricity ^
- Energy ^
- Entomology ^
- Finding out about ourselves *
- Heat *
- Horticulture and agriculture ^
- Indigenous science *^
- Inventing and designing *
- Looking into liquids *
- Moving with air *
- Nuclear power ^
- Oceans ^
- Outdoor science *
- Pets and gardens *
- Plants *^
- Polar science ^
- Predators and prey *
- Rocks *^
- Science and the environment ^
- Science on the move *
- Seasons *
- Sight, light and colour ^
- Sound science *^
- Space science ^
- Technology, designing and engineering ^
- The human body ^
- Tools, toys and machines ^
- Water *^
- What is it made of? *

Spectra cards Yrs 5–10 ^

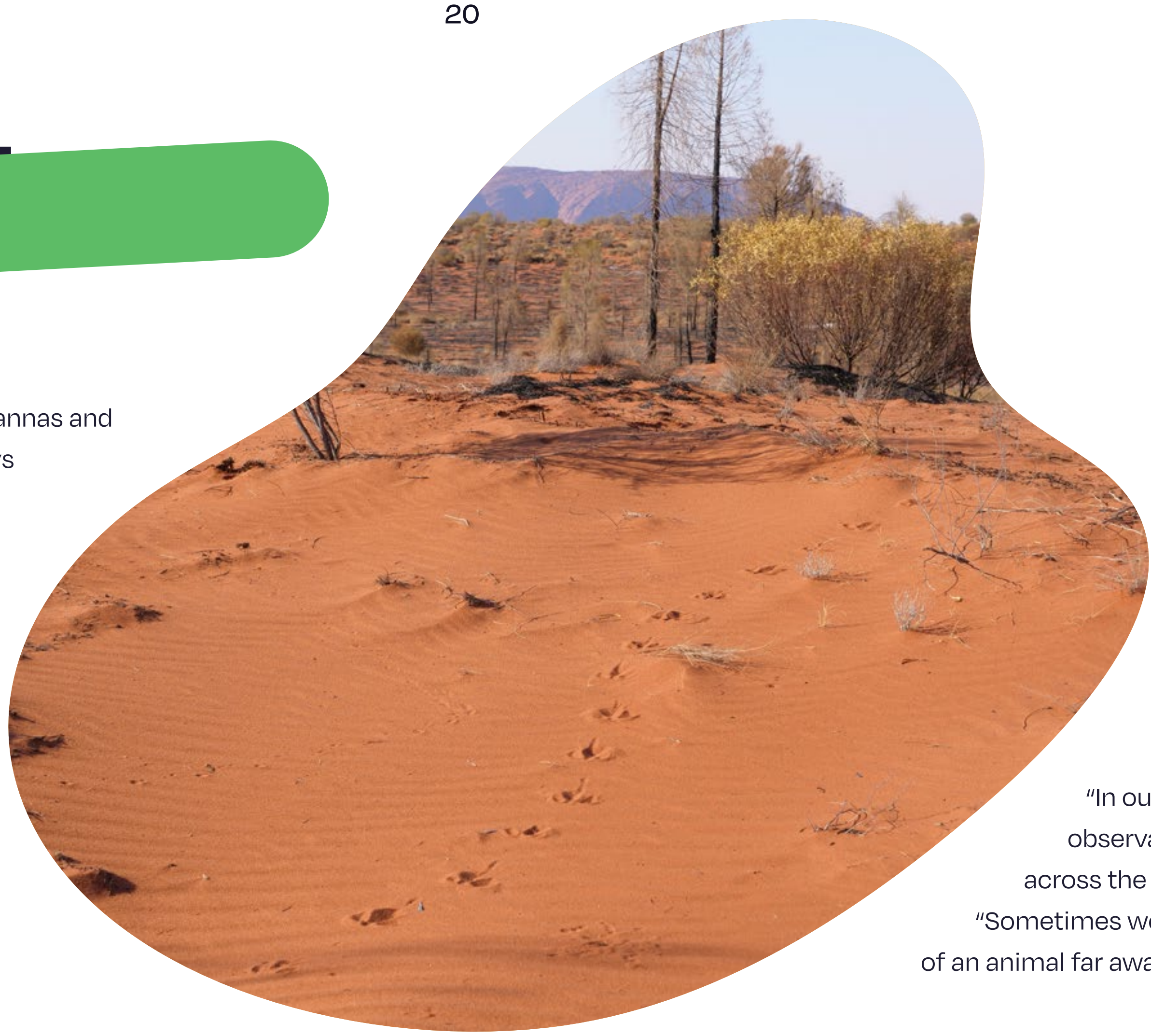
Spectra Junior cards Yrs 1–4 *

Australian Science Teachers Association

asta.edu.au/spectra

DECODING ANIMAL PRINTS

The desert is a habitat to many Australian animals. Bilbies, emus, goannas and bush turkeys call the desert home. But it's not easy to find them, says researcher Sarah Legge at the Australian National University and University of Queensland.



"Many desert animals are rare and shy," says Sarah. "They sleep during the day and come out at night. That makes finding them really tricky!"

Sarah explains that many types of animals in the desert are getting rarer, and even becoming extinct. Extinct means that there isn't a single living animal left.

"We need to monitor desert animals so we can make sure they are doing okay. Monitoring means checking up on something regularly. Like going to the dentist, or the doctor. If we keep checking up on bilbies, and great desert skinks, we will notice when they are starting to get into trouble, and that gives us a chance to do something about it."

Using local knowledge, First Nations people in desert Country can identify animals by observing animal tracks and scat (poo) left in the sand. Scientists and First Nations rangers have been working together to record animal track sightings on an iPad or paper.

In the Arid Zone Monitoring Project, animal tracks have been collected the same way over many years in many different places. Recently, this data was decoded to reveal new information about animals in the desert.

Images by Jaana Dielenberg

"In our project, we collected observations of animals from right across the Australian desert," Sarah explains. "Sometimes we were surprised to find observations of an animal far away from where we thought it lived."

"For example, a chunky orange-coloured skink lives in little families in burrows. Scientists call it the great desert skink. Aboriginal people have different names for this animal – like Mulyamiji, Tjalapa or Tjakura. We found this animal was living in a part of the desert that we hadn't known about before. Of course, the local people know about it, but it's good to share knowledge with others."

Image by Nicolas Rakopare

* ACTIVITIES
For Year 3 to Year 6

Activities align to the Australian Curriculum as follows:

Year	Curriculum content	Code	Fibonacci flowers	Communicate with light	Big scale solar system	Decoding shadows
Year 3	Living things can be grouped on the basis of observable features and can be distinguished from non-living things	ACSSU044	✔			
Year 3	Earth's rotation on its axis causes regular changes, including night and day	ACSSU048			✔	✔
Year 4	Living things have life cycles	ACSSU072	✔			
Year 3 and 4	Science involves making predictions and describing patterns and relationships	ACSHE050	✔		✔	✔
Year 3 and 4	Represent and communicate observations, ideas and findings using formal and informal representations	ACSIS057	✔			
Year 5	The Earth is part of a system of planets orbiting around a star (the sun)	ACSSU078			✔	
Year 5	Light from a source forms shadows and can be absorbed, reflected and refracted	ACSSU080		✔		✔
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	ACSIS090	✔			

FIBONACCI FLOWERS

Teacher instructions

In this fun activity, students will learn about Fibonacci numbers and how they apply to flower petals. The activity builds numeracy and pattern awareness.

Learning objective

Students can describe the Fibonacci numbers and how to find them through addition.

Success criteria

Students can identify which flowers had the same number of petals as a Fibonacci number.

Activity length

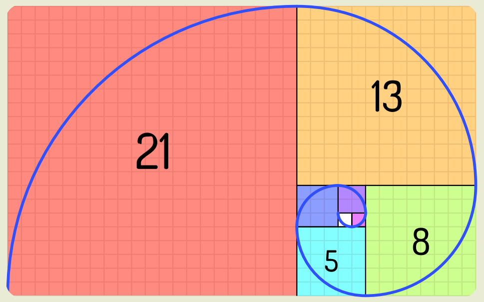
One hour

Materials to prepare in advance

- Printouts of the worksheet on page 26
- Variety of flowers, at least one for each student (e.g. a mix of daisies, roses, wildflowers)
- If using small flowers, provide tweezers to make the petals easier to handle
- Optional: Calculators to work out the golden ratio

What to do

1. Surprise the class with a basket of flowers.
2. Ask each student to pick a flower and draw a picture of it.
3. When they have finished drawing, ask them to count how many petals the flower has. They may need to pull the petals off to help them count. Ask them to write the number of petals on their picture.
4. Ask students individually to call out how many petals their flower had. Write this data on the whiteboard. The data can be represented in a table or graph. They might notice a pattern where most flowers have either 5, 8, 13 or 21 petals. Interesting!



5. Explain that 5, 8, 13 and 21 are part of a pattern of numbers called the Fibonacci sequence. The Fibonacci sequence is a series where each number is the sum of the two numbers that come before it. Consider asking students to look for the pattern before you tell them explicitly. You can give them clues such as 'addition is important in this sequence' and 'how might you predict the next number?' Then hand out the worksheet on page 26 for students to complete.

Safety

A small number of flowers are dangerous to children (for example, oleander).
A list is available here: https://raisingchildren.net.au/toddlers/safety/poisons/dangerous-plants.
Some flowers trigger hay fever. Check flowers for thorns, insects or spiders.

Why do flowers form this pattern?

Petals, leaves and branches grow in rotations or spirals to reduce gaps. This can help leaves to capture the most sunlight, because the leaves above are not entirely shading those below.

Why don't all flowers fit into the pattern?

Some species have a slightly different number of petals per flower, with the average being a Fibonacci number. Some flowers might have lost a petal or two, or still be growing them. You might notice six petals sometimes – this is usually three petals plus three sepals (the part of a plant that protects the flower bud).

Teacher notes for the worksheet

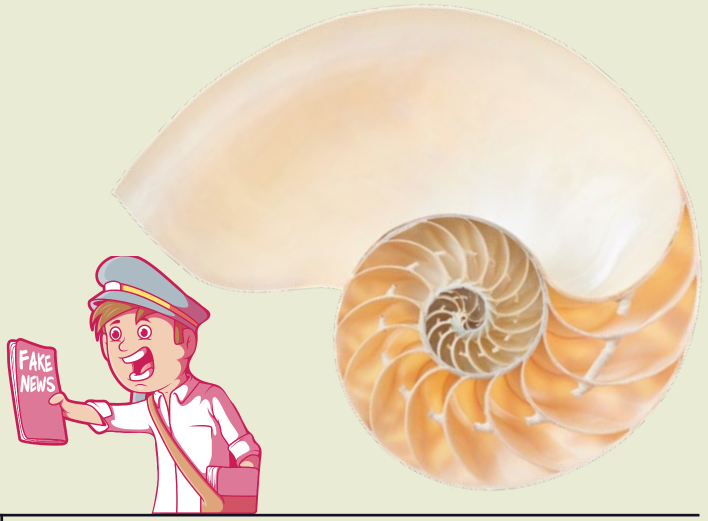
The Fibonacci sequence answer is 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144. Each number in the sequence is made by adding the previous two numbers together.

The sequence goes even, odd, odd, even, odd, odd, even, odd, odd. Why? Because adding an odd and even makes an odd, and adding two odds makes an even.

Students might need a calculator to work out the calculations using the golden ratio. You could also do this as a class on a smart board.

Watch out for that shell!

Many websites say the nautilus shell is an example of a Fibonacci spiral, but it's actually a logarithmic spiral. A logarithmic spiral grows while it turns, while a Fibonacci spiral grows at each quarter turn.



More ideas

- You can find Fibonacci numbers in pinecones by counting the number of left spirals and the number of right spirals.
- Watch 'What is the Fibonacci sequence and golden ratio' by Science ABC
- Talk about the purpose of flowers and the role they play in the lifecycle of plants.
- Talk about the interaction between bees and flowers and how they depend on each other to survive.

FIBONACCI FLOWERS

Student worksheet

The Fibonacci sequence is a series of numbers where each number is the sum of the two numbers before it.

It usually starts with 0 and 1. Here are the first six numbers in the Fibonacci sequence:

0, 1, 1, 2, 3, 5

For example, 0 + 1 = 1, 1 + 1 = 2, 1 + 2 = 3, 2 + 3 = 5.

What is the next number in the sequence?

Your answer: ....

Complete the sequence below by filling in the blanks.

0, 1, 1, 2, 3, 5, .../....../....../....../....../......

Meet the golden ratio

There's another way to calculate the Fibonacci sequence.
It uses a special number called the golden ratio, which is about 1.6. Try it!

2 x 1.6 = ...

3 x 1.6 = ...

5 x 1.6 = ...

Add the next numbers of the Fibonacci sequence below and keep calculating!

...... x 1.6 = ...

...... x 1.6 = ...

...... x 1.6 = ...

Did you know?

The golden ratio is an irrational number, which means the decimal places keep going forever!

For example: 1.618033988.....

Why does this happen?

Petals, leaves and branches grow in rotations or spirals. Using the golden ratio:

- Petals can fit together tightly in the bud before they bloom.
- Plants can fit the most seeds into a seed head.
- Leaves can grow along a branch without completely shading each other.

Fibonacci numbers and the golden ratio have a tendency to appear in nature, but it's not a rule or law. And sometimes people think they find patterns that aren't really there! This is why it's important to collect data.

Plants often grow their leaves, petals or seeds in spirals. Next time you find a plant, look for a spiral pattern. If you count the number of spirals going left, you'll probably find out it's a Fibonacci number.

COMMUNICATE WITH LIGHT

Teacher instructions

Need to communicate but can't use your voice? Try sending messages with lights! This activity invites students to create a code for communicating using a torch. Scientists are finding new ways to use light to send messages from satellites back to Earth. This will improve communication in upcoming missions to the Moon and Mars.

Learning objective

We are learning how to use light to communicate.

Activity length

30 minutes

Success criteria

What I'm looking for is a code that can be used to send messages using a torch.

Materials to prepare in advance

- Print outs of the worksheet on page 29 for each student
- Pens or pencils for each student
- Two torches for each group of students (groups of 2 to 4)

What to do

1. As a class, talk about where students have seen light signals being used. For example: traffic lights, lighthouses, aircraft on the ground.
2. Explain that today they will be creating their own light code to communicate using torches. They will work in small groups to make a secret code and write it on the worksheet. Then the group will split up and one half will communicate with the other half using the torch.
3. Give each student a printed copy of the worksheet on page 29.
4. Assign students to groups of two to four and give two torches to each group.
5. Give students some time to create their codes. Then get each group to split up and practise sending messages with the torches.
6. Tell students to rejoin their groups. This time they need to communicate to a different group.

Tips

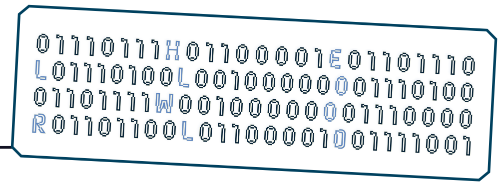
- This activity can be done inside or outside, but there will be more space to spread around outside.

More ideas

- Students can create a relay and try to communicate the message on to a third group. Can the message be successfully transmitted?
- Students can research morse code.

COMMUNICATE WITH LIGHT

Student worksheet



Instructions

Make a code to communicate with light. You can flash your light or move it around. Make a shared code in your group for yes, no and want to play, and then create your own messages and codes.

Got your code? Then split your group into two and stand far away from each other. Use the torches to send messages back and forth. No talking allowed!

Words	Light code
Yes	
No	
Want to play?	

Did you know?

People use signal lamps in air traffic control and to communicate between ships on the ocean. It's a great backup in case radios fail. One commonly used code is morse code, which is made up of short and long flashes (called dots and dashes) that is decoded to make letters of the alphabet.

Light waves can be coded in a different way to send data to and from satellites. Scientists are working on ways to make light communication better and more secure. Quantum technologies might improve how we send data across very large distances, like to the Moon or Mars.

LARGE-SCALE SOLAR SYSTEM

Teacher instructions

Get your class outside and turn them into the Sun, planets and asteroids to create a scale-distance model of the solar system. This activity will give students a memorable, fun and possibly chaotic learning experience about decoding distances and movement.

Learning objective

Students learn about the scale of the solar system and its features.

Success criteria

Students calculate the distance from planets to the Sun. They can describe features of the solar system in class discussions.

Activity length

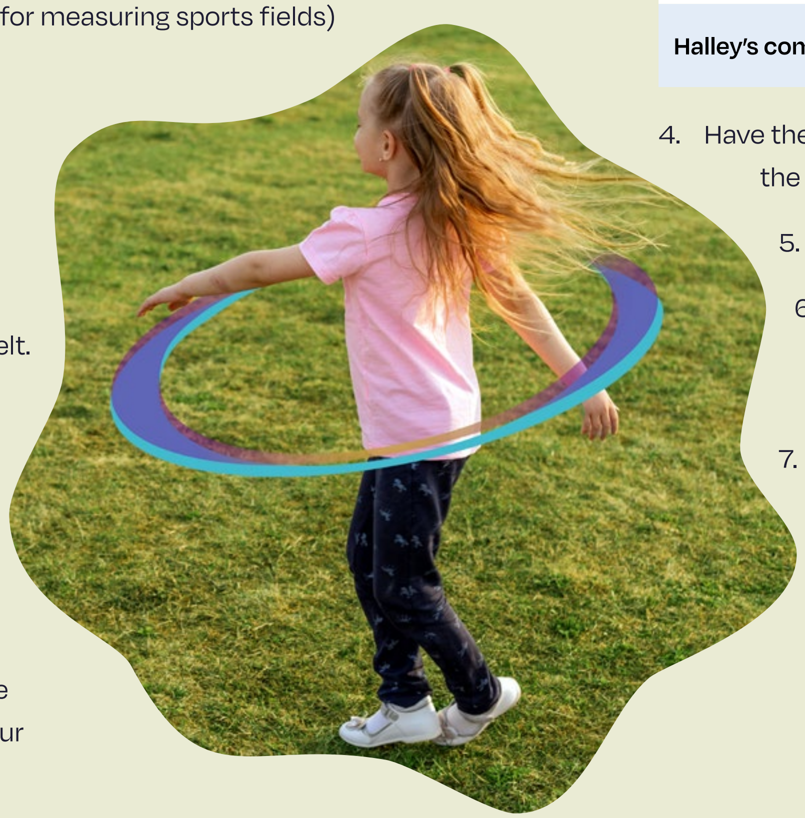
One hour

Materials to prepare in advance

- Print outs of the worksheet on page 32 and 33 for each student
- Measuring tape or measuring wheels at least 30 m long (e.g. one used for measuring sports fields)
- An oval or other large outdoor area (at least 120 m in diameter)
- A whistle

What to do

1. Assign students to the following roles: Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Halley's comet, Pluto, Orcus, Haumea, Quaoar, Makemake and Ceres. The rest can be asteroids in the asteroid belt.
2. Ask students to complete the worksheet on pages 32 and 33. They need to read about their features and how they move. Explain the difference between rotating on the spot and orbiting in a big circle.
3. Go outside to the oval. Tell students that you'll help arrange the solar system. When you blow your whistle once, they should all rotate counterclockwise (spin on the spot slowly) and when you blow your whistle twice they should begin orbiting – which means walking in a circle counterclockwise around the Sun (while still rotating). When you blow your whistle three times, everyone should stop moving.

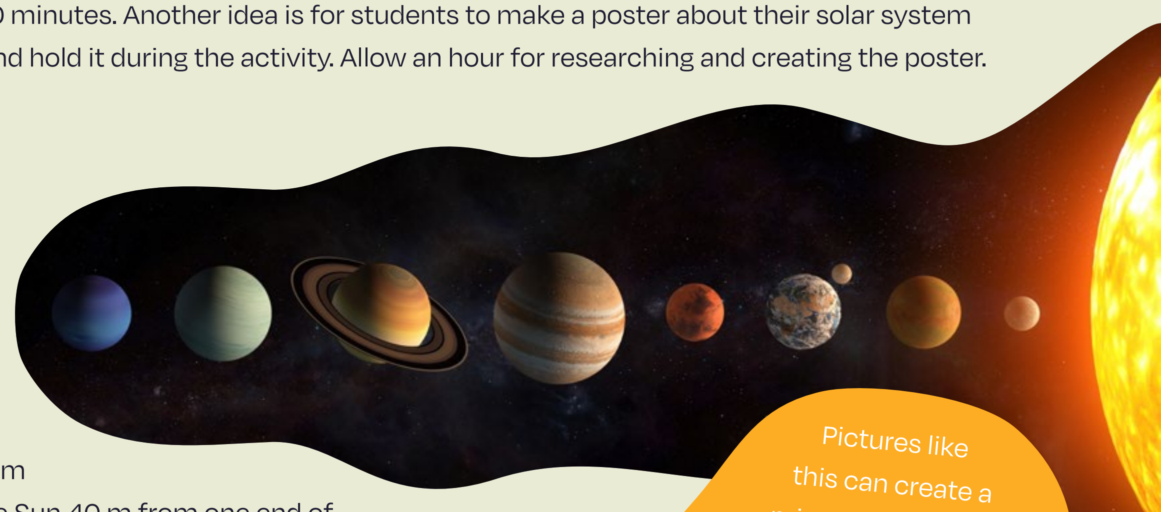


More ideas

- Ask students to research the rotation and orbital speed of the different planets. Do all planets rotate and orbit in the same direction? Do they move at the same speed?
- Watch a video that explains how orbits are odd by Crash Course Kids.
- Make a paper solar system with this activity from the Australian Space Agency.
- Find out the size of planets and their distance from each other in this video by NASA.
- Educational resources on Indigenous knowledge and astronomy by Ngarrngga.

Mercury	0.78 m
Venus	1.44 m
Earth	2 m
Mars	3.04 m
Ceres and asteroids	5 to 8 m
Jupiter	10.4 m
Saturn	19.08 m
Uranus	38.36 m
Neptune	60 m
Pluto, Orcus, Haumea, Quaoar, Makemake	Greater than 60 m
Halley's comet	Start near Saturn

4. Have the Sun stand in the middle of the oval. Using the measuring tape, place the students the distances from the Sun as shown in the table above.
5. Blow your whistle to get the children rotating. Blow it a second time to get them orbiting.
6. When you've had enough, bring the class back together. Talk about what was surprising in that activity. Were they surprised at how close the near planets are to the Sun? Were they surprised at how many objects are in the asteroid belt?
7. Optional: Students can wear a hat that represents their assigned feature. If doing this option, allow an extra 30 minutes. Another idea is for students to make a poster about their solar system feature and hold it during the activity. Allow an hour for researching and creating the poster.



Pictures like this can create a misperception that all the planets are equal distances apart. This activity will challenge that misperception.

Tips

If your oval is less than 120 m across, you can position the Sun 40 m from one end of the oval and tell Neptune and the outer dwarf planets to only complete part of an orbit.

Use coloured cones to organise the revolution circuits.

Name: ....

MAKE A MODEL SOLAR SYSTEM

Student worksheet

Decode the universe by making a model solar system using people as the planets.

This model will be at a scale that accurately represents the distance between the Sun and the planets. Begin by calculating a scaled distance from the Sun in metres for each planet. Fill in your answers in the third column of the table below.

For example: Mercury is 0.39 astronomical units from the Sun, and 0.39 x 2 = 0.78. So write 0.78 in the third column. The person who is Mercury will need to be 0.78 metres (78 centimetres) from the person who is the Sun.

What is an astronomical unit? One astronomical unity (AU) is equal to the average distance from the centre of Earth to the centre of the Sun.

Complete the table

Planet	Actual distance from Sun (astronomical units)	Scaled distance from Sun in metres (multiply the actual distance by 2)
Mercury	0.39	
Venus	0.72	
Earth	1.00	
Mars	1.52	
Jupiter	5.20	
Saturn	9.54	
Uranus	19.18	
Neptune	30.00	

Did you know?

Scientists use astronomical units to describe distances in the solar system. One astronomical unit is equal to the average distance from the Sun to Earth. The closest star to Earth is Proxima Centauri, and it's about 268,770 astronomical units away.

Other features in the solar system to decode in your model

The asteroid belt is a region of space between the orbits of Mars and Jupiter. It contains lots of asteroids and Ceres, a dwarf planet. Asteroids are small, rocky objects that orbit the Sun.

The Kuiper belt is a region beyond the orbit of Neptune that contains the dwarf planets Pluto, Orcus, Haumea, Quaoar and Makemake.

Halley's comet moves around the solar system in an eccentric orbit. An eccentric orbit means a non-circular orbit. It nears the Sun and inner planets about every 75 years, then moves out past Pluto's orbit. Its orbit is influenced by the gravity of Saturn and Jupiter – the two planets of greatest mass.

Fast Facts:

Halley's comet is named after English astronomer and mathematician Edmond Halley, who decoded a pattern of comet observations that had been recorded across 150 years.

In what ways does the solar system move?

Planets rotate by spinning on their axis. You can do this by spinning around in a circle. The Sun also rotates on its axis.

Planets also move around the Sun. You can do this by walking in a circle around the person who is the Sun. The asteroid belt and Kuiper belt also orbit the Sun, and Halley's comet moves around the solar system at times closer to Jupiter and other times closer to Earth.

Planets orbit the Sun at different speeds. This means sometimes Mars is relatively close to Earth, and sometimes it's on the other side of the Sun to us. Why is this important when planning a mission to Mars? What other information might you want to gather, decode and calculate to send a spaceship to Mars?

INDIGENOUS ASTRONOMY AND THE SOLAR SYSTEM

Aboriginal and Torres Strait Islander Peoples are keen observers of the night sky, having detailed knowledge systems built around the Sun, Moon and planets visible to the eye (Mercury, Venus, Mars, Jupiter and Saturn). For countless generations, they studied the motions of Solar System bodies through detailed observation, which was recorded and passed across successive generations through oral tradition. Aboriginal and Torres Strait Islander peoples distinguished planets from the background stars, noted the changing positions of planets in the sky over days and months, and observed their changing positions relative to each other and the characteristics of their journey across the sky.

In many Aboriginal traditions, the planets are seen as children of the Sun and Moon. They represent ancestor spirits walking across the sky, connecting ceremony and Law to various groups of stars. In Wardaman Aboriginal traditions, Uncle Bill Yidumduma Harney describes the planets moving across the sky as ancestral beings walking along a road. Just as you or I walk down the street, sometimes we stop and turn back before moving forward again. Sometimes we slow down and chat with other people during our journey.

Uncle Yidumduma says the ancestral beings are coming back for another 'yarn' with other planets as they travel across the sky. Sometimes they come close together, in what is called a conjunction.

The Aboriginal people of the Great Victoria Desert observe how Jupiter and Venus always followed one another along the 'Dreaming Road' that the planet-ancestors had made. These planets are seen as ancestral beings with heads, but no bodies. The Dreaming Road described by some Aboriginal communities is equivalent to what western astronomers call the zodiac. This is the region of the sky nine degrees on either side of the ecliptic (the path of the Sun). Since the Earth and all the planets orbit the Sun in one direction in a relatively flat plane, they will all appear to move along the zodiac.

In western astronomy, the constellations found within the zodiac comprise the 12 star signs used by astrologers (although there are actually more than 12). These are constellations through which the Sun, Moon and planets pass. In Aboriginal and Torres Strait Islander traditions, these stars and constellations often have special relationships and connections to the Sun, Moon and planet ancestor spirits. In Tiwi Lore of Bathurst and Melville Islands in the Northern Territory, the Sun-Woman carries her torch across the sky each day from east to west, reflecting the Sun's diurnal motion from dawn to dusk. The Moon-Man follows the same path, illuminating his way with a smaller torch. He is often attended by his four wives: the planets Mercury, Venus, Mars and Jupiter.

RETROGRADE MOTION

The Sun, Moon, stars and planets all move diurnally (from east to west) over the course of a night. But if we observe their motions over the course of days, weeks and months, we notice they have strange motions. Observers, including Indigenous people, know the positions of the planets with respect to the background stars, which gradually move from west to east night after night. Each planet is a different distance from the Sun, and this means they orbit at different periods. Mercury, the planet closest to the Sun, orbits the Sun in just 88 days. Saturn, the farthest planet we can see with the unaided eye, takes 29 years to go around the Sun once. This means the planets closer to the Sun than us are always relatively close to the Sun. Mercury is seen either just before sunrise or just after sunset, but not for very long. Venus is similar, but is further from the Sun, meaning it can be a bit higher in the sky. The other planets can be visible anywhere along the zodiac as they orbit the Sun farther than Earth.

There are times when two or more planets come close together (conjunction) and the faster orbiting planet will overtake the slower, outer planet. From our perspective, it can appear as if a planet slows down in its gradual west to east motion, stops, then moves backwards. This is called retrograde motion. After a period of time the planet will slow down, stop and resume its normal motion against the stars.

The Wardaman traditions about planet spirits moving back and forth during their journey along the Dreaming Road is a description of retrograde motion, showing us how Aboriginal people long ago observed the complex motions of the planets and incorporated that knowledge into oral traditions, which were passed to younger generations.

This article has been republished with permission by Ngarrngga. Ngarrngga (pronounced 'Naan-gah') is a Taungurung word meaning to know, to hear, to understand and is a program of works structured around three project nodes:

- Indigenous Knowledge in curriculum
- Indigenous Knowledge in schools
- Indigenous Knowledge in Initial Teacher Education.

Informed by a design-based research methodology, Ngarrngga strives to support educators to be confident in showcasing Indigenous Knowledge within their teaching and learning to provide opportunity for all Australian students to learn about the contributions and achievements of Aboriginal and Torres Strait Islander Peoples to Australian society through a practical and sustained approach.

To learn more visit ngarrngga.org

DECODING SHADOWS

Teacher instructions

Shadows change throughout the day as the position of the Sun changes in the sky. In this activity, students will create a decoder to match the time of day to the shape of a shadow. There are two ways to do this activity. One is for the student to be the sundial; the other is to make a sundial from a paper plate. Choose which option works best in your school.

Learning objective

Students create a sundial.

Success criteria

Students understand that the position of the Sun in the sky causes shadows to change position throughout the day in a predictable pattern.

Activity length

Allow 20 minutes to start the activity, and 10 minutes every hour for data collection.

What to do

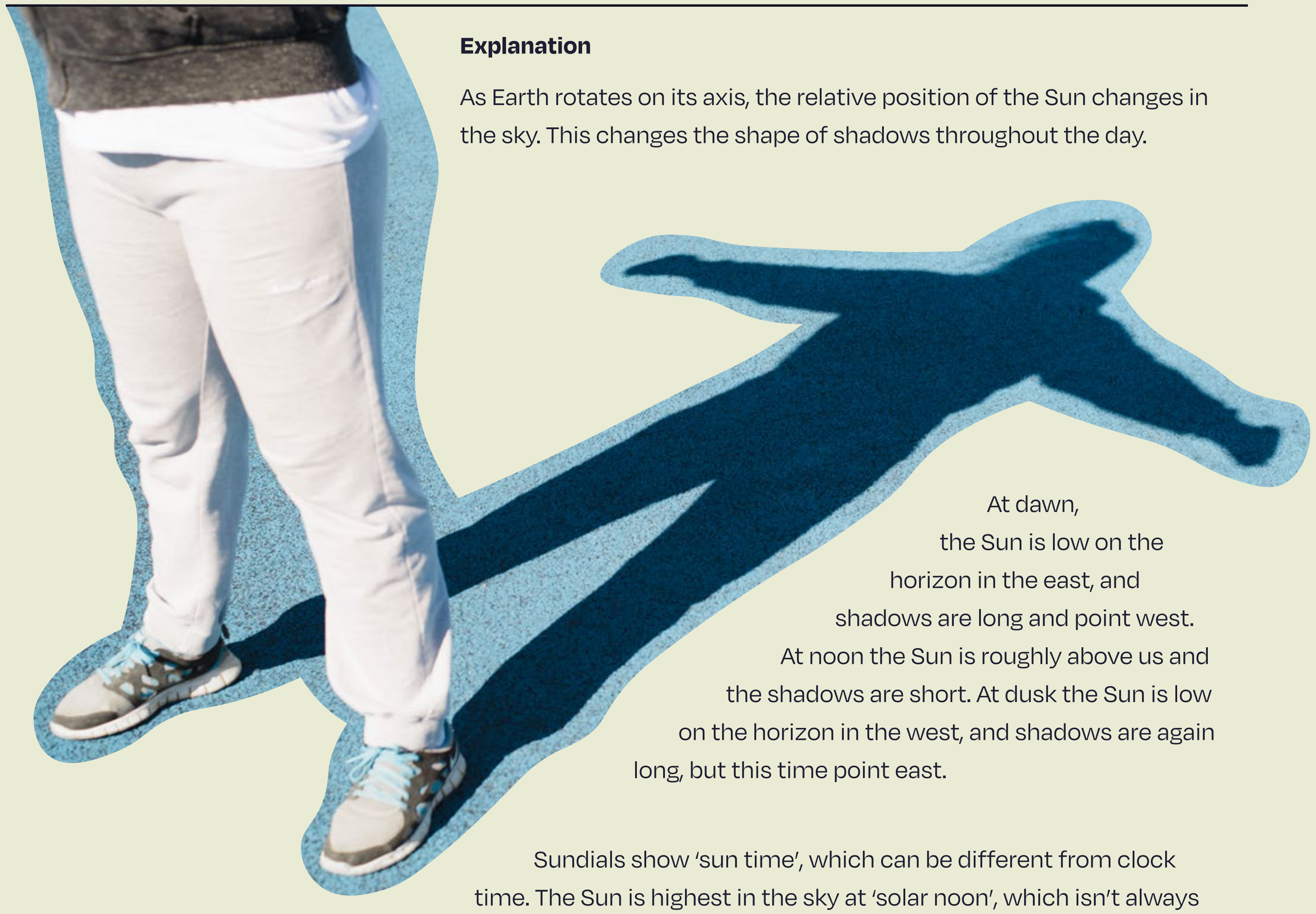
1. Choose which activity you'd like to do (Be a sundial or Make a sundial) and prepare the materials listed on the worksheet. Print the instructions on either page 38 or 39 and the science report worksheet on page 40 (optional).
2. Both activities require a sunny day, and for students to go outside for data collection about once an hour.
3. Begin the activity by leading a discussion about sundials. You can show one of the videos from the More ideas section, or an image gallery.
4. Hand out the instructions and do the activity.
5. At the end of the activity, you can hand out the science report worksheet on page 40 for students to complete (optional). Encourage the students to describe what they observed.

Safety

Advise students not to look directly at the Sun.

More ideas

- Take a crash course in following the Sun.
- Watch a video about the seasons
- Brainstorm different ways to track time. As an extension, students could make a poster or prototype of their ideas.
- Discuss why it's useful to know how shadows move during the day and in different seasons – for example, for choosing where to plant a garden for partial sun or full sun, or for shading a house during summer, or for installing solar panels.



Explanation

As Earth rotates on its axis, the relative position of the Sun changes in the sky. This changes the shape of shadows throughout the day.

At dawn, the Sun is low on the horizon in the east, and shadows are long and point west. At noon the Sun is roughly above us and the shadows are short. At dusk the Sun is low on the horizon in the west, and shadows are again long, but this time point east.

Sundials show 'sun time', which can be different from clock time. The Sun is highest in the sky at 'solar noon', which isn't always at 12:00 on our clocks. Shadow patterns also change depending on latitude. In northern Australia, the Sun is closer to being directly overhead, while in southern Australia it appears lower in the sky to the north of the viewer. This is why sundials must be designed for their specific location.

Some students might think the change in shadows over the day occurs because the Earth is moving around the Sun. You can point out that it takes one day for the Earth to rotate on its axis, but a whole year for the Earth to move around the Sun! Therefore the change in shadows observed in this activity is due to the Earth rotating on its axis.

DECODING SHADOWS – BE A SUNDIAL

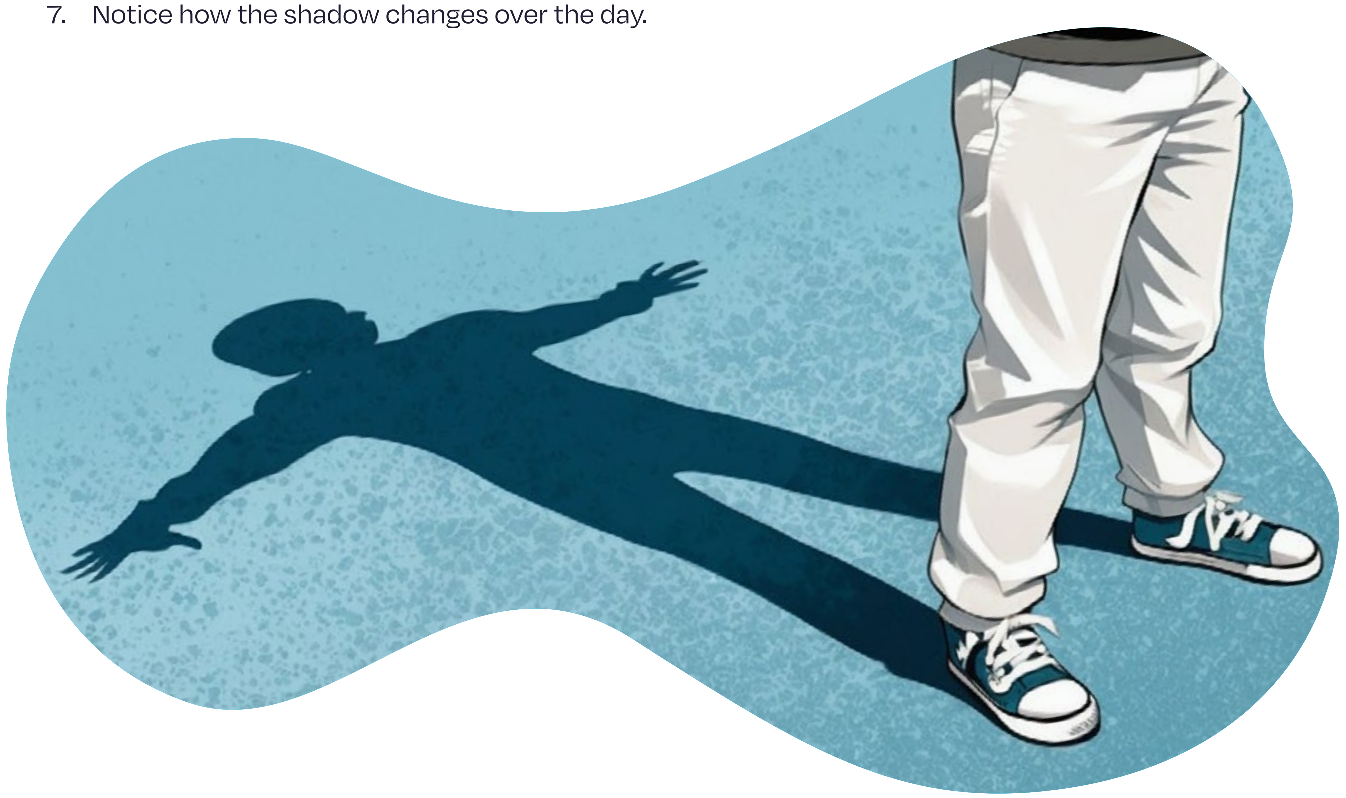
Student worksheet

Materials

- Chalk
- A partner
- Hard surface to draw on with chalk, in the sunshine

Instructions

1. Working in pairs, choose who will be the sundial, and who will be the data collector.
2. The sundial needs to stand in the sunshine. See where their shadow is?
3. The data collector first needs to use the chalk to draw around the sundial's feet and label it with their name, so they can return to the same place during the day.
4. The data collector draws an outline of the sundial's shadow and labels it with the time.
5. Without looking directly at the Sun (it is bad for your eyes), check roughly where it is. It might help to describe it as being near a certain building or tree, to your left or right or behind you. Note this down.
6. Come back every hour. The sundial needs to stand in the same place, while the data collector draws a new outline of the shadow and labels it with the time. Each time, check roughly where the Sun is and note it down.
7. Notice how the shadow changes over the day.



DECODING SHADOWS – MAKE A SUNDIAL

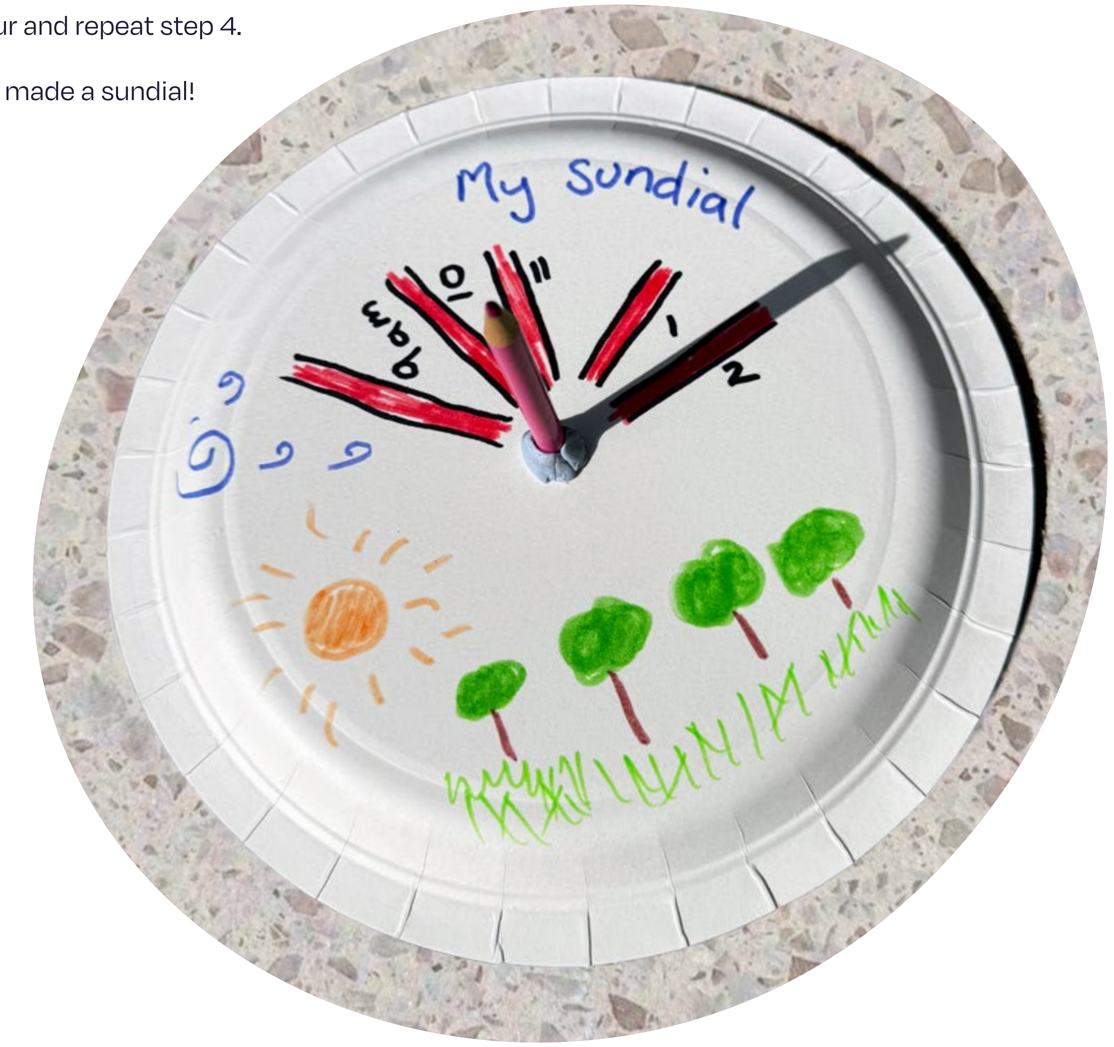
Student worksheet

Materials

- Paper plate
- A small pencil or stick (about 10 cm long)
- Blu-Tack
- Texta
- Sunny place outside

Instructions

1. Push the pencil through the middle of the paper plate so it pokes out the bottom.
2. Put the plate upside down in a sunny place. The pencil should cast a shadow on the plate.
3. Use Blu-Tack to secure the pencil in place. Use more Blu-Tack to stick the plate to the ground so it doesn't blow away.
4. Use the texta to mark the position of the shadow and write down the time.
5. Come back once an hour and repeat step 4.
6. Congratulations, you've made a sundial!



Name: ....

SCIENCE REPORT

Student worksheet

Draw a picture of the shadows in the box below.

Describe how the Sun's position in the sky changed during the day.

....

....

....

....

Describe how the shadows changed during the day.

....

....

....

....

Could you use the pattern of the shadows from today to tell the time:

- tomorrow?
- at night?
- when it's cloudy?

* ACTIVITIES
For Year 7 to Year 10

Activities align to the Australian Curriculum as follows:

			Decoding DNA	Decoding seed shapes	Laser interference
Year 7	Classification helps organise the diverse group of organisms	ACSSU111		✓	
Year 7 and 8	Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available	ACSHE119			✓
	Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures	ACSHE223	✓	✓	✓
	Measure and control variables, select equipment appropriate to the task and collect data with accuracy	ACSIS126			✓
Year 9	Energy transfer through different mediums can be explained using wave and particle models	ACSSU182			✓
Year 9 and 10	Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries	ACSHE158	✓		✓
	Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately	ACSIS166			✓
Year 10	Transmission of heritable characteristics from one generation to the next involves DNA and genes	ACSSU184	✓		
	The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence	ACSSU185		✓	

DECODING DNA

Teacher instructions

In this activity, students will work together to solve a mystery: Which animal is eating birds in the nature reserve? Using short sequences of DNA, they will match samples found at the nature reserve to DNA of different animals already on file. Students will need some prior knowledge about DNA, so it will best suit Year 9 and 10 students.

Learning objective

Students understand that species have different DNA that can be used to identify them.

Activity length

45 minutes

Success criteria

Students solve the mystery and can explain how the evidence supports their conculsion.

Materials to prepare in advance

- Print copies of the handouts on pages 46 to 49 for each group of three or four students.
- Put a handout pack into an envelope for each group so it looks like they are receiving information from a lab.

What to do

1. Watch the video What is environmental DNA? by EnviroDNA to introduce the concept. Then read the teacher script on page 45 to introduce the activity.
2. Split the class into groups of three or four and pass out the envelopes with handouts.
3. When groups have finished the activity, bring the class back together for a group discussion using discussion prompts on the teacher script.

More ideas

- Extract DNA from a strawberry.
- Make a DNA sculpture from lollies.
- Students can research the structure of DNA.
- Students can do further research or make a poster about environmental DNA, forensic DNA analysis or DNA barcoding.

DECODING DNA

Teacher script

Introduction

Today I received bad news from the A-T-C-G Nature Reserve. They have lost 30 birds to a predator in the past month, despite being protected by a predator-proof fence. This is a disaster, as the reserve is home to several endangered species and it's close to breeding season.

They have asked for our help to decode environmental DNA test results found at the reserve. They took samples of dirt from three places in the reserve and found DNA from multiple species. Inside these envelopes are the results from the lab that analysed the DNA.

In groups, you're going to analyse the results and, based on evidence, conclude which animal they think is killing the birds.

Answers (keep these secret!)

Predators on page 49 are dog, cat, fox, rat and northern quoll.

Results on page 48 will show DNA evidence of two predators: cat (site A) and fox site (B and C).

The cat's DNA is found only on the visitor path (site A).
The fox's DNA is found in two areas not accessible to visitors.

Therefore, it can be deduced that it is likely the cat DNA has come from a visitor who has a cat at home, who might have dropped some cat hair. Therefore it is most likely the killer is the fox.

Additional evidence that could be used to increase confidence on these results include camera traps, fur/hair, footprints, droppings and the type of injuries seen on bird remains.

Prompts for group discussion

- Which predators did you find at the reserve?
- Where was the cat DNA found? Is there any other way the cat DNA could have gotten there?
- Which predator do you think killed the birds?
- What other evidence could be collected in order to make you more confident about your conclusion?
- In what other real-life scenarios could this method of DNA matching be useful?

DECODING DNA

Student worksheet

Fill out this form to record your analysis of the DNA found at A-T-G-C Nature Reserve.

Environmental DNA was collected from soil samples at three environmentally different locations: Sites A on the visitor path, site B in the forest, and site C next to the lake.

The following animals were found at these locations:

A: ....

B: ....

C: ....

Of the unique species identifiers, the following animals are predators that might kill birds:

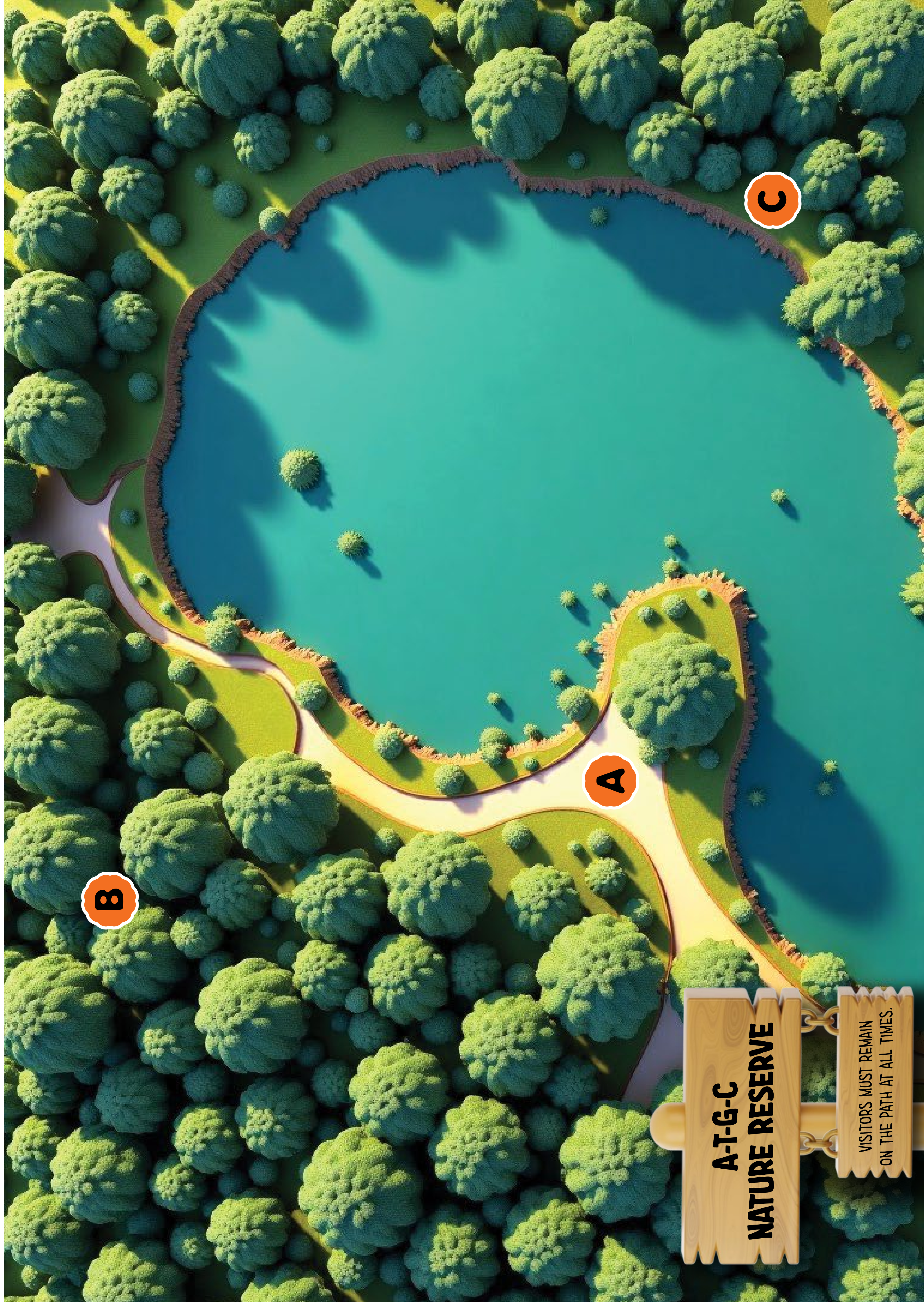
....

Based on our results, we think the birds were killed by this animal (list one animal only):

....

Provide at least three reasons for your conclusion, referencing the evidence you have found:

....



Genomic Labs has analysed the three samples and found the following species-identifying DNA codes. Human DNA was excluded.

Sample A results:

ACTGCAATC
AATACCGTA
CCACGTCAT
GGACTACCA
TGGTCCATT

Sample B results:

GGATTATCA
AATACCGTA
GTACCTACT
ACAGTCTAT

Sample C results:

GGATTATCA
AATACCGTA
CCACGTCAT
GGACTACCA
TGGTCCATT
ACAGTCTAT

The Incredible International Database for Species-Identifying DNA Codes provides unique species identifiers for more than 5,000 species.

CAT: ACTGCAATC

RAT: TTGGTTCTA

DOG: GTATGACCC

NORTHERN QUOLL: TGTGTGAAC

HOODED ROBIN: ACAGTCTAT

SWIFT PARROT: TGGTCCATT

REGENT HONEYEATER: GTACCTACT

GLOSSY BLACK COCKATOO: AATACCGTA

WALLABY: GGACTACCA

FOX: GGATTATCA

SOUTHERN EMU WREN: CCACGTCAT

DECODING SEED SHAPES

Teacher instructions

Seeds come in many shapes and sizes. Some stick to your socks, while others float across the ocean. In this activity, students will use a variety of different seeds to explore the adaptations that allow them to reach new places so they can grow and continue their lifecycle.

Learning objective

Students understand the role of seeds in the lifecycle of plants and how seeds disperse through the environment.

Success criteria

Students can explain how different adaptations facilitate seeds dispersal.

Activity length

30 minutes

Materials to prepare in advance

- Printouts of the worksheet on page 51
- Different seeds from nature or a grocery store (e.g. sunflowers, apple seeds, avocado seed, coconut)
- Magnifying glasses, hand lenses, or other tools for close observation (optional)

What to do

1. Introduce seeds as an important part of plant reproduction and seek information from students about seeds to establish prior knowledge.
2. Introduce the idea the seeds need the right environment to grow. Some plants don't grow well if they are close together, so they have seeds that allow them to be dispersed away from the parent plant.
3. Ask students to study the seeds and discuss differences between them. Prompt them to focus on size, texture and distinguishing features. You can use a 'think-pair-share' format to encourage meaningful discussion, and prompt with questions such as 'is there something you have never observed before?' and 'how might this seed spread through its environment?'
4. Hand out the worksheet on page 51 for students to complete.

Safety Be aware of potential allergies, and choose seeds that are not nuts.

More ideas

- Students can collect seeds from around the school to contextualise their learning.
- Collect or source native seeds and seed pods from your local area. Students can draw the seeds and label the adaptations they have for dispersal, and classify seeds based on the dispersal methods shown on page 51.
- Students can research seed biology and produce a poster or create a model.
- Students can design and conduct a fair test based on seed dispersal. They could use real seeds or models they create themselves.
- Read about how smoke can activate seeds, by ABC Science.
- See how Kangaroo Island recovered after the 2020 bushfires, by Gardening Australia.
- Watch how seeds become plants, by ABC.

DECODING SEED SHAPES

Student worksheet

Look at these seeds.

What adaptations might help a seed disperse:

- by wind to a nearby field?
- across the ocean to an island?
- on animal fur?
- by being eaten by an animal so it can grow out of the droppings?

Why might it be beneficial for a seed to grow out of animal droppings?

....

....

....

What would happen if seeds couldn't be dispersed at all?

....

....

....

Did you know?

Many seeds are delicious! People eat poppyseeds, sunflower seeds and different types of nuts. Flour is made from grinding down seeds of wheat, and porridge is made from oat seeds. First Nations people gather edible native seeds such as wattle seeds, kurrajong seeds and pencil yam seeds.

LASER INTERFERENCE

Teacher instructions

Observe the wave properties of light with this simple activity using a laser pointer and a hair. It creates an interference pattern that allows students to calculate the width of the hair. This is a good extension activity for a Year 10 class.

Learning objective

Students learn that light behaves as a wave and this can be used to make measurements.

Success criteria

Students can make observations and measurements that allow them to calculate the width of the hair.

Activity length

45 minutes

Materials to prepare in advance

- Printouts of the worksheet on page 53, 54 and 55
- The items listed on the worksheet for each group. Note the laser pointer should be low power and not exceed Class 2 (1 mW power output).
- Strands of hair, each at least 6 cm long. Students can use their own hair, or you may wish to collect spare samples from a hairbrush, hairdresser or a pet.

What to do

1. Introduce the idea that light can act like a wave, and when the wave bends around a small item, such as a hair, it creates an interference pattern. Use one of the videos in 'More ideas'.
2. Pass around the worksheet on page 54 and 55.
3. Assign students to small groups of two to four.
4. Each person in the group should follow the instructions on the worksheet and complete the activity. Students can take turns, and help each other to take measurements and record data.

Safety

Lasers are dangerous and can damage the eyes, so they should be used under supervision and only with older students, or as a demonstration. Arrange the classroom to prevent accidental exposure to eyes and reflective surfaces. Instruct students not to shine the laser at people's eyes.

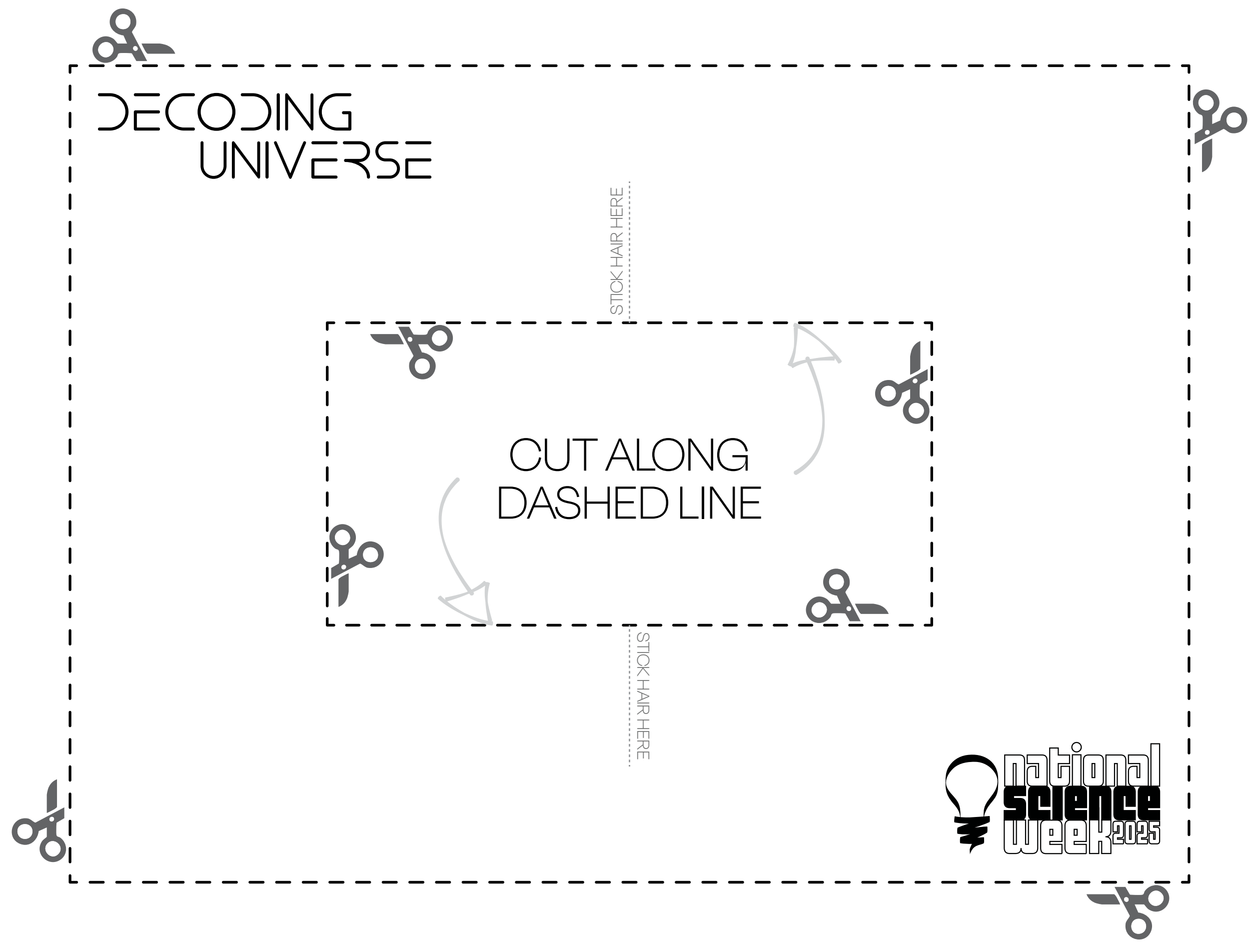
Safety information is available from Australian School Science Information Support for Teachers and Technicians.

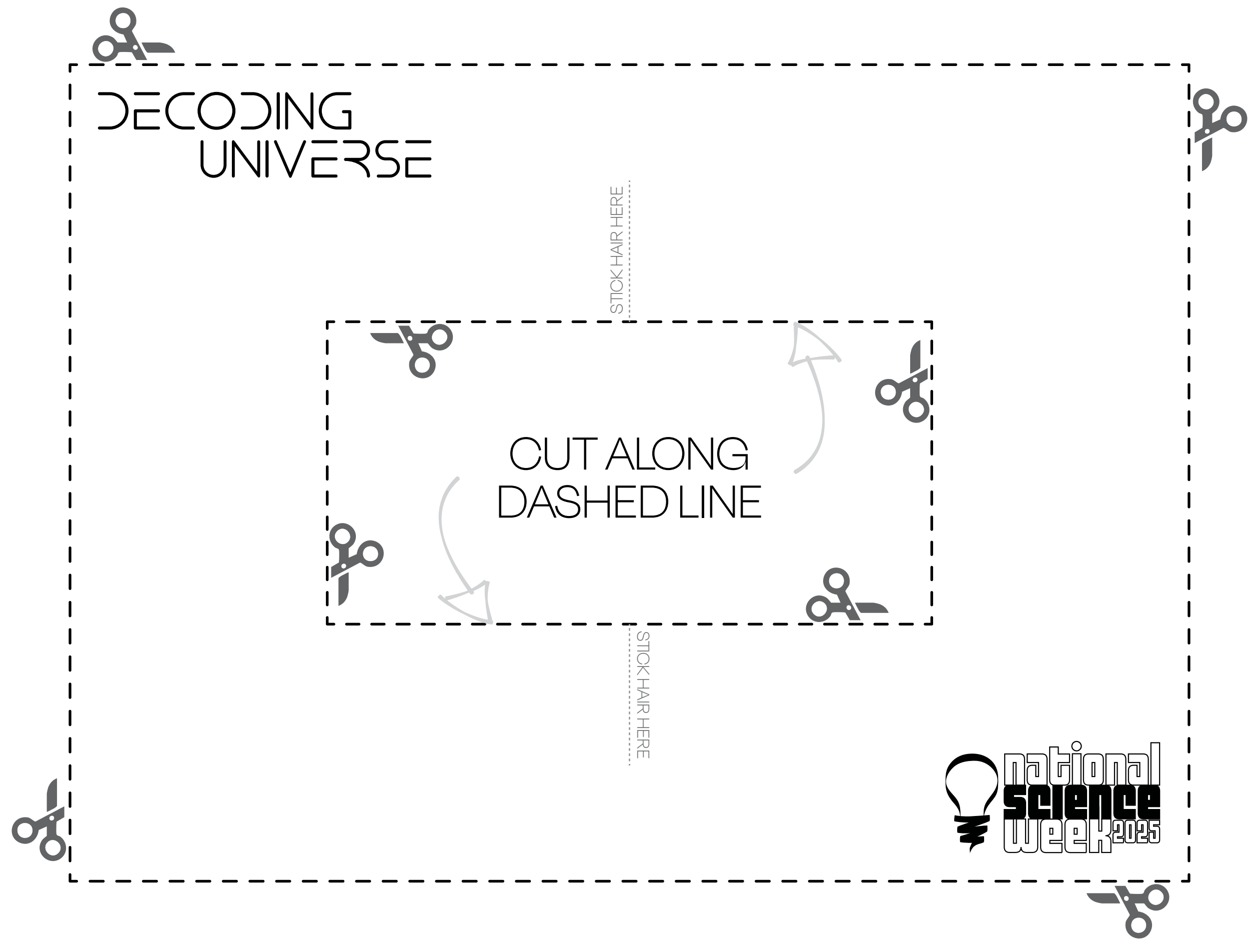
Tips

- The room needs to be dark enough to see the diffraction pattern.
- Teachers can watch this instructional video for more guidance.

More ideas

- Use this activity as a springboard into the special quantum section on page 56.
- Watch a video explaining the interference of waves by Elearning.





LASER INTERFERENCE

Student worksheet

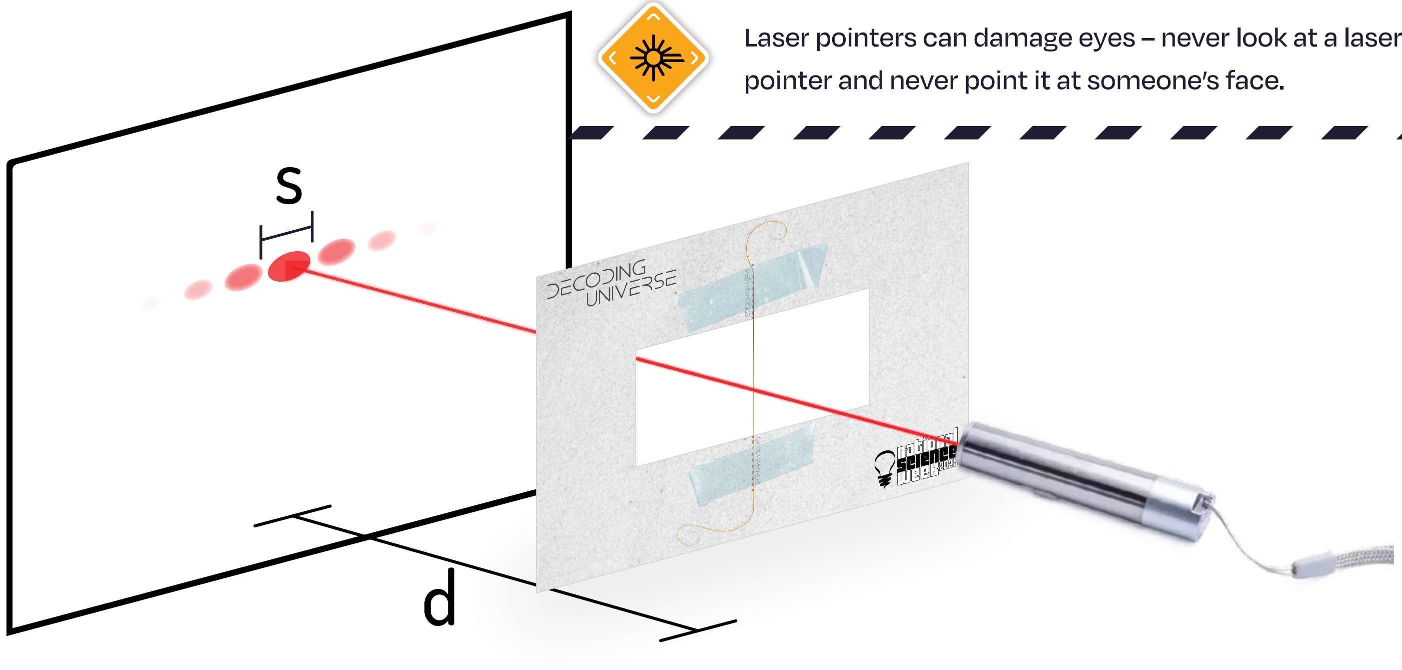
Materials

- Scissors
- Sticky tape
- Laser pointer
- A strand of hair at least 6 cm long
- Blu-Tack
- Measuring tape
- Ruler
- Scientific calculator

Instructions

1. Do this activity in a room where it will be relatively dark when the lights are switched off. This activity should be done in pairs with one person to line up the hair and one to take measurements, or groups of three with the third person to record data.
2. Cut out the rectangle printed below along the dotted lines to create a window.
3. Tape the strand of hair to the rectangle. The hair needs to be vertical, straight and tight.
4. Use Blu-Tack to attach the laser pointer to a steady surface, such as a chair or desk. Arrange it so the laser is well below eye level for safety, and will point at a blank wall about 2 metres away.
5. Turn the laser pointer on. Note: You need the room to be dark for the next step.
6. Hold the cutout rectangle so the hair is about 10 centimetres in front of the laser. Move it to line up the laser light and the hair until the light makes a pattern on the wall. Hold the rectangle very steady for step 7.
7. Measure the distance from the hair to the wall (call this 'd' for distance) and measure the separation between two adjacent dark spots on the wall (call this 's' for separation). See the diagram below. Record your results.

Laser pointers can damage eyes – never look at a laser pointer and never point it at someone's face.



Record your results

Distance from hair to wall (d) = ... cm

Separation between dark spots on the wall (s) = ... mm

Wavelength of laser light (λ) = ... nm (Not sure? It's usually written on the laser pointer somewhere. If not, a red laser pointer is usually between 630 and 680 nanometres (nm), so you can estimate it as the average: 655 nm)

Explanation

When the laser light hits the hair, it creates an interference pattern on the wall. This is because light acts like a wave and has diffracted around the hair into two waves, which then interfere with each other. This is similar to waves on the ocean bending around a boat or small island.

When the two waves combine, they create a pattern of constructive and destructive interference. Constructive interference is when the waves are in phase with each other (e.g. both are going 'up'). This makes a bright spot. Destructive interference is when the waves are out of phase and cancel each other out (e.g. one goes 'up' and one goes 'down'). This makes a dark spot.

The interference pattern you see is symmetrical – meaning it looks the same on both sides of the centre. This happens because the hair splits the incoming laser beam into two identical wave patterns. The waves spread out the same amount on both sides of the hair. When they overlap, matching points on either side of the centre are travelling the same distance from the hair. Because they travel the same distance, matching points will interfere in the same way. This creates identical bright and dark bands at equal distances on both sides of the centre.

Decode your pattern!

You can use this activity to measure the width of the hair. Why? Compared with a thicker hair, a thinner hair will cause light waves to spread out more, creating a wider interference pattern with more space between dark bands.

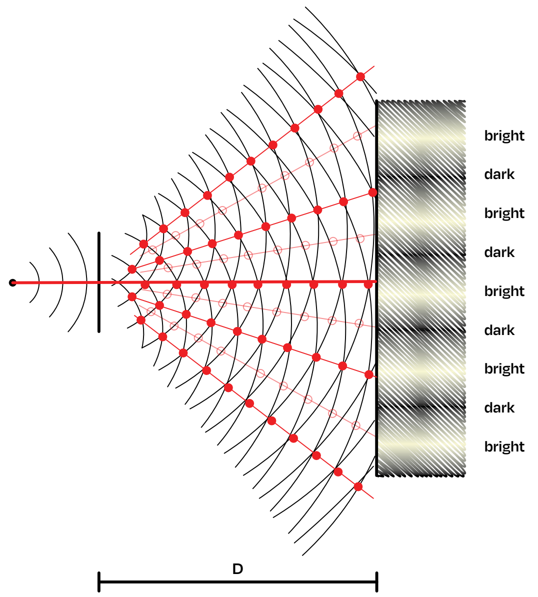
There's a mathematical relationship between how much the waves spread and how wide the hair is.

The equation you need is:

Hair width = (λ * d) / (s * 0.5)

Use a factor of 0.5 because the two waves cancel out (creating a dark band) when one wave has travelled half a wavelength further than the other wave.

Interference Patterns



Make sure you use the same units of measurement when calculating the equation. For example, lambda (λ) is usually in nanometres, your distance may be in centimetres, and your separation might be in millimetres. You can convert everything to metres and put it into a calculator.

The width of the hair will be very small. It should be in the order of 10–200 micrometres (μm).

Your answer (include the units): ....

2025 is the International Year of Quantum Technologies.

SMALL, WEIRD, PHYSICS STUFF

By Owen Cumming

WHAT'S A QUANTUM?

What do scientists mean when they say quantum? Quantum mechanics, quantum particles...we seem to hear it all the time, in news about scientific discoveries and in science-fiction movie titles.

The word quantum comes from the idea that there's a smallest amount of 'stuff' that can exist, known as a 'quantum'. For example, a quantum of water is a single molecule of H_2O – anything smaller isn't really water any more. A quantum of static electricity is an electron. Even light comes in tiny quantum pieces, called photons.

WEIRD PHYSICS

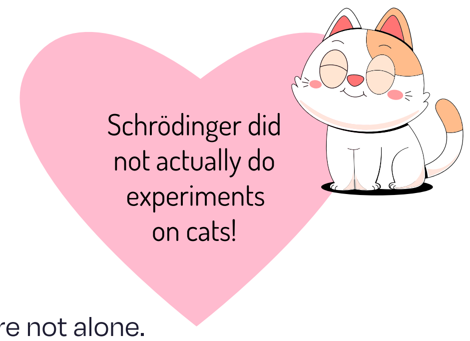
Quantum particles do weird things. In 1801, a scientist called Thomas Young shone light through two very narrow slits onto a wall behind them. The pattern of light on the wall looked like waves of light coming from the two slits, combining and cancelling like ripples on the surface of a pond.

Strange: how do light particles suddenly turn into a wave? But it gets weirder. If we measure the light energy hitting the wall, the measurements show that it's definitely particles hitting the wall, not waves.

And weirder still, even if you fire off light particles one at a time, you still get the wave pattern – as if each particle is going through both slits!

Quantum particles do lots of things all at the same time. Electrons can spin up and down at the same time, and radioactive atoms can stay stable and also decay. It's all very strange.

THE FAMOUS CAT



If you think this sounds ridiculous, you're not alone.
In 1935, an Austrian physicist named Erwin Schrödinger joked with his friend Albert Einstein to show how ridiculous this 'blurred model for representing reality' was.

"Albert, imagine I put a cat in a box with some poison. What? No, not a real cat, Albert, a hypothetical cat!

"Imagine the poison was set to kill the cat when something quantum happened, and it was impossible to know if the cat was alive or dead until you opened the box.

"If I went around saying 'until we open the box, that cat is both alive AND dead', you'd think I was bonkers! Honestly mate, that's how ridiculous all this quantum stuff is."

Little did Schrödinger know that he and his hypothetical cat would go down in history as one of the best descriptions of exactly how quantum superposition does work. Probably a bit embarrassing for him.

It only gets WEIRDER

Weird and confusing as it all may be, quantum mechanics has helped us to create amazing things! The semiconductors in computer chips, the fibre-optics that bring you the internet, and even the MRI machines that scan your body for diseases all work because of quantum mechanics.

As for how and why quantum particles behave the way they do, and how it fits with other things like gravity, we're still not really sure. But some of the theories trying to explain things sound insane!

One theory is that there are an infinite number of worlds, and quantum stuff happens when these universes bleed into each other. Another theory has invisible 'pilot waves' that gently guide particles where they need to go. A third possibility is that you, the person reading this, are the centre of the universe, and things only stop being weird when you hear about them!

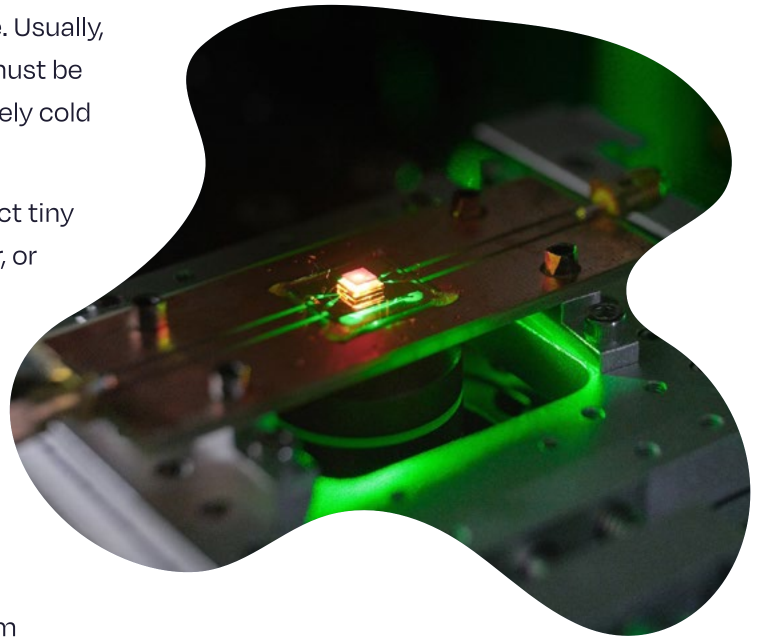
Welcome to the world of quantum. It's full of small, weird, physics stuff!

DIAMONDS ARE FOR SENSORS

By Ariel Marcy

Quantum sensors use atoms and light to make extremely precise measurements of the world. CSIRO scientists are working on new quantum sensors – made from diamonds!

Quantum mechanics describes the basic behaviours of atoms and light, such as how these tiny particles are spinning in space. But these quantum behaviours are very fragile. Usually, the particles must be kept at extremely cold temperatures and protected from the environment.



Quantum sensors take advantage of this fragility to detect tiny changes, such as places where gravity is slightly stronger, or where metal underground affects Earth's magnetic field.

"We can measure how fast the quantum spins rotate, and that will tell us exactly the strength of the magnetic field," says CSIRO quantum physicist Chris Vale.

The next step is getting quantum sensors to work at room temperature. CSIRO researchers are working with diamonds, which are super hard. Their strong atomic arrangement mimics how atoms behave when they are extremely cold. That way, we can run super-sensitive quantum sensors without needing a super-expensive scientific freezer!

The articles Small, weird, little stuff and Diamonds are for sensors came from Double Helix, CSIRO's science magazine for kids.

For free science news, activities, quizzes and more [sign up to their newsletter] and [visit their blog].

COMPUTERS AND DIAMONDS

Computers have changed the world dramatically. The first electronic computer was made in 1942 and was as big as a whole room! A lot has changed in 80 years. Now we use computers every day for solving problems, performing tasks, creating models of how things work, and more. The next big thing in computing is predicted to be quantum computers: computers that use quantum mechanics.

"Our company is trying to make quantum computers that you can put in your pocket," says Andrew Horsley, a co-founder of Quantum Brilliance. Headquartered in Australia, Andrew's company uses diamonds to create a quantum system.

"Inside the diamonds we put individual atoms exactly where we want them," Andrew explains. "There's an insane level of control in bringing all these different parts of science and technology together."

No one has invented a quantum computer that works to solve your problems faster – yet. But it's an exciting field with a lot of potential.

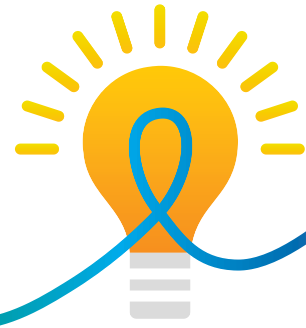
"Right now there's a mysteriousness about this new technology," says Andrew. "We have an opportunity to work on something that could be a huge technology for the next 100 years, and that's really cool."

"If you think back 100 years, people didn't really use electricity. Today, we flick a light switch and don't think about how it works. The same way we don't think about how a computer chip works; you just want it to play games and type. Quantum computers will be the same."

Andrew received the 2024 Prize for New Innovators for his groundbreaking innovations towards making quantum computing an everyday technology. But he doesn't do it alone.

"I love this job because I work with so many people. We have software engineers, designers and people who know how to make diamonds. It's nice having a big team."

Did you know? Quantum computers are likely to be very good at modelling chemical reactions and designing new medicines. This could improve the way we discover and make medicines.



Meet Andrew Horsley

[Watch a video about Quantum Brilliance.]

Discussion questions

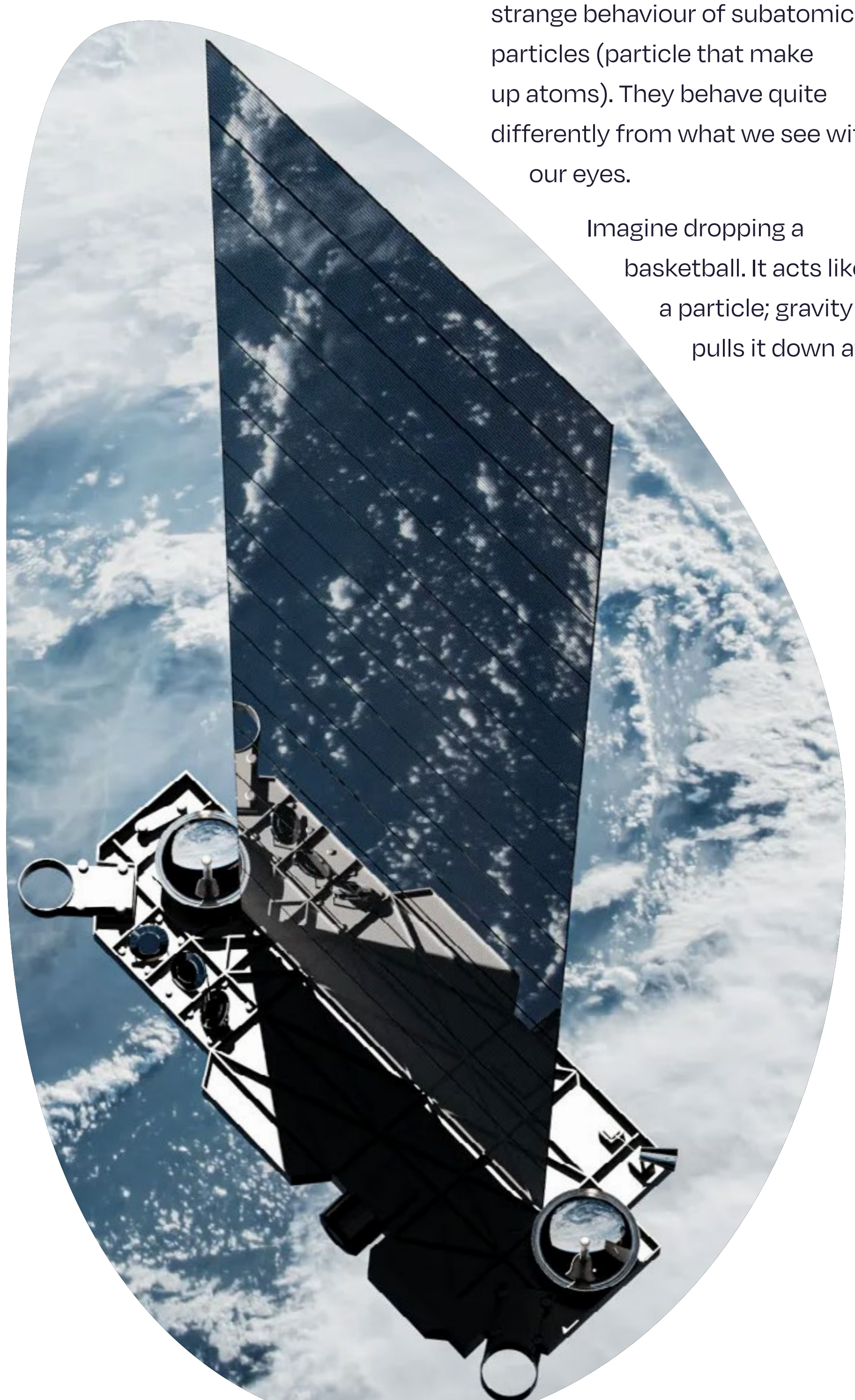
What would the world be like if we didn't have electricity?

Do you think the inventors of computers imagined all the things computers do now?

Are you curious about how computers and computer programs work? How could you find out?

FUTURE CAREERS

Quantum technology is all about creating new ways to model, compute, decode and sense the world. It is based on the peculiar features of quantum mechanics: the physics hidden within what we see day to day.



To learn about quantum mechanics, let's take a look in the mirror. You are made of a billion billion billion atoms. Most of them are hydrogen, oxygen and carbon. These make our DNA, our cells, our organs – everything! In turn, atoms are made of subatomic parts, such as protons, neutrons, electrons and quarks. These are seriously small things.

Scientists discovered quantum mechanics by observing the strange behaviour of subatomic particles (particle that make up atoms). They behave quite differently from what we see with our eyes.

Imagine dropping a basketball. It acts like a particle; gravity pulls it down at a predictable rate; and it lands where you would expect (after a bounce or two).

But when you picture something subatomic, you need to imagine something that is both a wave and a particle, with energy that can only be held in discrete levels, and actions based on uncertainty and probability. It's very difficult to imagine this at all. To decode this world, mathematics is essential.

People generally only observe quantum effects when a system is isolated from its environment – for example, a single atom or subatomic particle that doesn't interact with the rest of the world. That doesn't mean quantum mechanics only applies to the very small things, explains Peter Turner, Chief Executive Officer at Sydney Quantum Academy.

"As far as we know, quantum mechanics is a more accurate description of the universe than classical mechanics," he says. "We have every reason to believe the universe is quantum."

New advances in science, technology, engineering and mathematics are allowing people to explore – and now exploit – the peculiar features of quantum mechanics like never before. This is creating a new industry: the quantum industry.

"The quantum industry will offer careers in all sorts of areas: physics, computer science, mathematics, electrical engineering, finance, marketing, product development and more," says Peter.

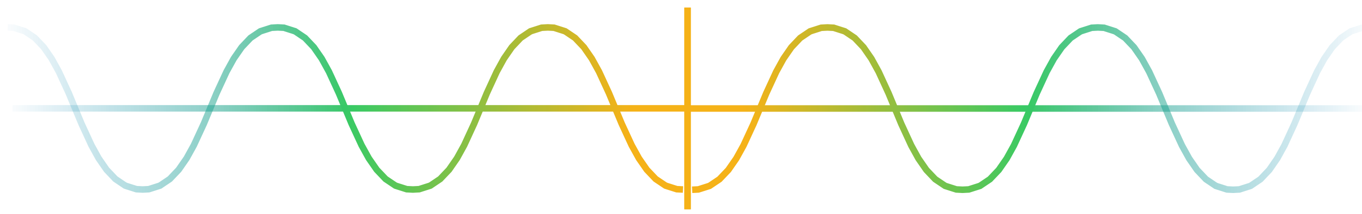
"You don't have to have a PhD in physics for these careers, but the more you know about quantum, the more ready you'll be."

Sydney Quantum Academy is a partnership between Macquarie University, University of NSW, University of Sydney and University of Technology. Follow them on socials @sydneyquantum.

Their website features a dedicated section on quantum careers and pathways, including resources such as a video created in partnership with NSW Department of Education that explains quantum technologies, its usage and impact: https://sydneyquantum.org/quantum-careers/

What are the chances? One of the peculiar things about quantum is that it acts not with probabilities but with amplitudes. These can be negative, and therefore cancel out a positive probability. In other words, they make something impossible that would otherwise be possible.

Engineering such interference effects is key to many quantum technologies, such as computing.



Quantum technologies are already making their mark in several fields, with some applications commercially available today, while others are still in the research phase.
Here are a few areas where quantum technology is set to have a major impact:

Quantum communications

This field applies quantum physics to the secure encoding and transmission of information.

Quantum chemistry

Using quantum technologies to advance the study of large chemical structures and reactions.

Quantum sensing

Developing new kinds of detectors that take advantage of the extreme sensitivity of quantum systems.

Quantum simulation

Using tailored quantum systems to understand complex natural phenomena.

Quantum computing

Developing new hardware and software that leverages quantum mechanical effects to process information in fundamentally new ways.

Quantum metrology

Harnessing quantum mechanical properties to improve the precision and accuracy of measurements.

Nanofabrication

Fabricating components such as circuits and other devices at the scale of nanometres.

Artificial intelligence

Using quantum algorithms to enable more powerful machine learning and optimisation.

* ACTIVITIES

For all year levels

Project-based learning and competitions

Decoding your world – Activity aligns to the Australian Curriculum as follows:

Foundation	Living things have basic needs, including food and water	ACSSU002
	Participate in guided investigations and make observations using the senses	ACSIS011
	Engage in discussions about observations and represent ideas	ACSIS233
Year 1	Share observations and ideas	ACSIS012
	Living things live in different places where their needs are met	ACSSU211
Year 1 and 2	People use science in their daily lives, including when caring for their environment and living things	ACSHE022
	Use informal measurements to collect and record observations, using digital technologies as appropriate	ACSIS026
	Participate in guided investigations to explore and answer questions	ACSIS025
Year 3 and 4	Science knowledge helps people to understand the effect of their actions	ACSHE051
	Science involves making predictions and describing patterns and relationships	ACSHE050
	Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends	ACSIS057
	Represent and communicate observations, ideas and findings using formal and informal representations	ACSIS060
Year 4	Living things depend on each other and the environment to survive	ACSSU073
Year 5 and 6	Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks	ACSIS086
	Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts	ACSIS093
Year 7	Interactions between organisms, including the effects of human activities can be represented by food chains and food webs	ACSSU112
	Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable	ACSSU116
Year 7 and 8	Measure and control variables, select equipment appropriate to the task and collect data with accuracy	ACSIS126
Year 9	Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems	ACSSU176
Year 10	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere	ACSSU189
Year 9 and 10	Formulate questions or hypotheses that can be investigated scientifically	ACSIS164
	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
	Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies	ACSIS169

DECODING YOUR WORLD

Teacher instructions

This project-based learning activity introduces the idea of decoding environmental data and creating models that help people make predictions. It focuses on Earth observations for land management. Small groups, a class or a whole school can work together to improve their local community.

Getting Started

Project-based learning is a student-led approach to teaching and learning based on authentic, real-world contexts. There is a useful guide on the New South Wales Department of Education website.

Activity length

From one week to one term

Background

We live in an ecosystem of interconnected parts. Water, soil, plants, animals and people depend on each other to survive. Our homes, schools and communities are part of this world.

There is so much we can learn about our world by observing and collecting data. And we can access data that other people have collected. Scientists use data in models and predictions to prepare for the future. For example, they can model how diseases spread, where waterways will flood and when extreme weather events will occur. This helps people in emergency response situations.

Students can also engage with data and use it to create models and make predictions in many ways.

Driving questions

Younger students: What animals live near our school, and what do they need to survive?

Older students: What can we learn about our ecosystem to help us prepare for the future?

Entry event

An excursion to a botanic gardens or nature reserve is an excellent way to connect students to the ecosystem. Or you can start by collecting data around the school. For example, you can search for birds, lizards and insects in your local area, install a rain gauge to collect rainfall data, or record and monitor daily temperature.

The Atlas of Living Australia has community and school resources to help you explore biodiversity in your area, record sightings and run your own surveys.

If organising an excursion to a botanic garden or nature reserve is not feasible, here are some free and accessible alternatives to connect students with ecosystems and encourage data collection.

1. Virtual tours of botanical gardens and nature reserves

Google Arts & Culture – Gardens.

Explore famous gardens around the world, including Kew Gardens in London

2. Backyard biodiversity surveys

Use free apps such as iNaturalist. Students can photograph plants, animals and fungi, upload observations, and learn more about their local species.

3. Atlas of Living Australia citizen science projects

Engage students in real citizen science by contributing observations of local biodiversity. Visit Atlas of Living Australia and click on the Community and schools tab.

4. Interactive climate and nature exploration tools

NASA Earth Observatory provides visual data and stories about Earth's climate and ecosystems.

Using Google Earth Timelapse, students can explore satellite imagery to see how their local area has changed over time.

5. Schoolyard or local park surveys

Organise a nature scavenger hunt where students look for common birds, insects or plants in their schoolyard or a nearby park. Provide a checklist based on local flora and fauna, or use apps such as Seek by iNaturalist for identification.

6. Weather and environmental data collection

Use the Bureau of Meteorology website to explore rainfall, temperature and climate patterns in your local area.

CSIRO Educational Datasets: Access real-world datasets, including environmental monitoring and climate data, tailored for Australian classrooms.

7. DIY mini-ecosystems

Create small terrariums in glass jars using soil, plants and small decorations. Students can monitor changes in their ecosystems over time. Instructions are widely available online, such as on the NASA Climate Kids website.

Connections with the community

You can bring many different community members or organisations in to discuss the local ecosystem or how they use data and models in their work, such as:

- Landcare
- ecologists
- First Nations Knowledge holders
- volunteers in community gardens or land management
- staff working in nature reserves or the botanic gardens
- local government (the department for environment or planning).

Possible products

Students can create a model that illustrates how different parts of the ecosystem are connected. For example:

Up to Grade 4: Record observations and create represent findings with pictures.

Grades 5–6: Use basic charts or visualisations.

Grades 7–10: Incorporate coding and data manipulation.

Once students have made a model of the ecosystem as it currently works, they can make predictions about what might happen if something drastic occurred. For example:

- all the bees disappear
- the river becomes contaminated
- a natural disaster strikes, such as fire or flood.

Different data might be needed to predict these changes. Ask them what data would help, and how they might collect it or source existing data. Students can change their models to make them better as they find new data or test predictions.

As a culminating event, students can share their models in a science fair during National Science Week.

COMPETITIONS

Teacher instructions

Would you like to explore and extend mathematics learning in your class?
Each year, the Australian Maths Trust runs competitions for primary and secondary students.
Here's a snapshot of the competitions that you can participate in.

Years 3–12

Australian Mathematics Competition is Australia's best known maths competition.

Bebras Computational Thinking Challenge is a computational thinking and problem-solving challenge that promotes computer science.

Kangourou sans Frontières is the largest maths competition in the world.

Years 5–12

Computational and Algorithmic Thinking Competition is a problem-solving competition designed to encourage curiosity.

Oxford University Computing Challenge is a programming competition to develop computational thinking skills.

More information: [Australian Maths Trust]

DECODING THE UNIVERSE

Exploring the unknown with nature's hidden language

national science week 2025

9 - 17 AUGUST

An Australian Government Initiative

Inspiring AUSTRALIA