Food Packaging and Waste

My name:	
My team:	
Our focus question:	

Student workbook and resources

Acknowledgement of Country

CSIRO acknowledges the Traditional Owners of the lands, seas and waters of the area that we live and work on across Australia. We acknowledge all Aboriginal and Torres Strait Islander peoples and their continuing connection to their culture and pay our respects to Elders past and present. CSIRO is committed to reconciliation and recognises that Aboriginal and Torres Strait Islander peoples have made contributions to all aspects of Australian life including culture, economy and science.

'Eternal Wisdom, Infinite Innovation'
artwork by Rachael Sarra, working with Gilimbaa.

Contents

Student reference sheet

The Australian Academy of Science Launch, Inquire, Act (LIA) framework helps us structure scientific investigations so that students:

- **Launch** by exploring and connecting to real-world phenomena,
- **Inquire** by investigating and analysing questions, and
- **Act** by applying, communicating and reflecting on our findings.

It's a way to learn science like real scientists do!

PHASE 1: LAUNCH	**Purpose:** get curious, connect to the world, and ask a great question. **What you'll do:** Explore a phenomenon or scenario. Think about your own experience and ask: "What's going on here?". Identify what you already know and what you wonder about. Discuss why the topic matters. **Key questions:** • What do I see or experience? • What might be happening? • Why is this important?	 Launch
PHASE 2: INQUIRE	**Purpose:** design and carry out an investigation to answer your question. **What you'll do:** Formulate a testable question. Plan your investigation: decide variables, controls, method. Collect data (measure, record, repeat). Graph and analyse results to spot trends or patterns. **Key questions:** • What variables will I change, and what will I measure? • How will I make it fair? • What do my results show?	 Inquire
PHASE 3: ACT	**Purpose**: use your findings to communicate, reflect, and apply to the real world. **What you'll do:** Draw conclusions based on your evidence. Reflect on your method: what worked, what could you improve? Apply your understanding: how does your investigation link to real-life scientific research or technology? Share your findings through a poster, presentation, or video. **Key questions:** • What did I learn and why does it matter? • How could I do better next time? • How can this knowledge be used in the real world?	 Act

Icons:

Throughout the investigation you will see these icons (below) to highlight the type of activity and guidance recommended.

About food packaging and waste

What do you know about food packaging and waste? Write the first thing that comes to mind to complete the sentence starter for each box below.

This topic is about…	**My initial thoughts…**
•	•
What I already know about this topic…	
•	

Pre and post assessment

What do you know about food packaging and waste? Answer the following questions at the start of your investigation and re-attempt at the end.

Question	Attempt 1	Attempt 2
Why is limiting food waste important?	•	•
What steps are involved in moving fruit and vegetables from farms to our homes?	•	•
In what ways can fruits and vegetables be bruised or damaged, and are these the same for all types?	•	•
What are the different ways that fruit and vegetables can be bruised or damaged during transport?	•	•

Food packaging and waste brainstorm

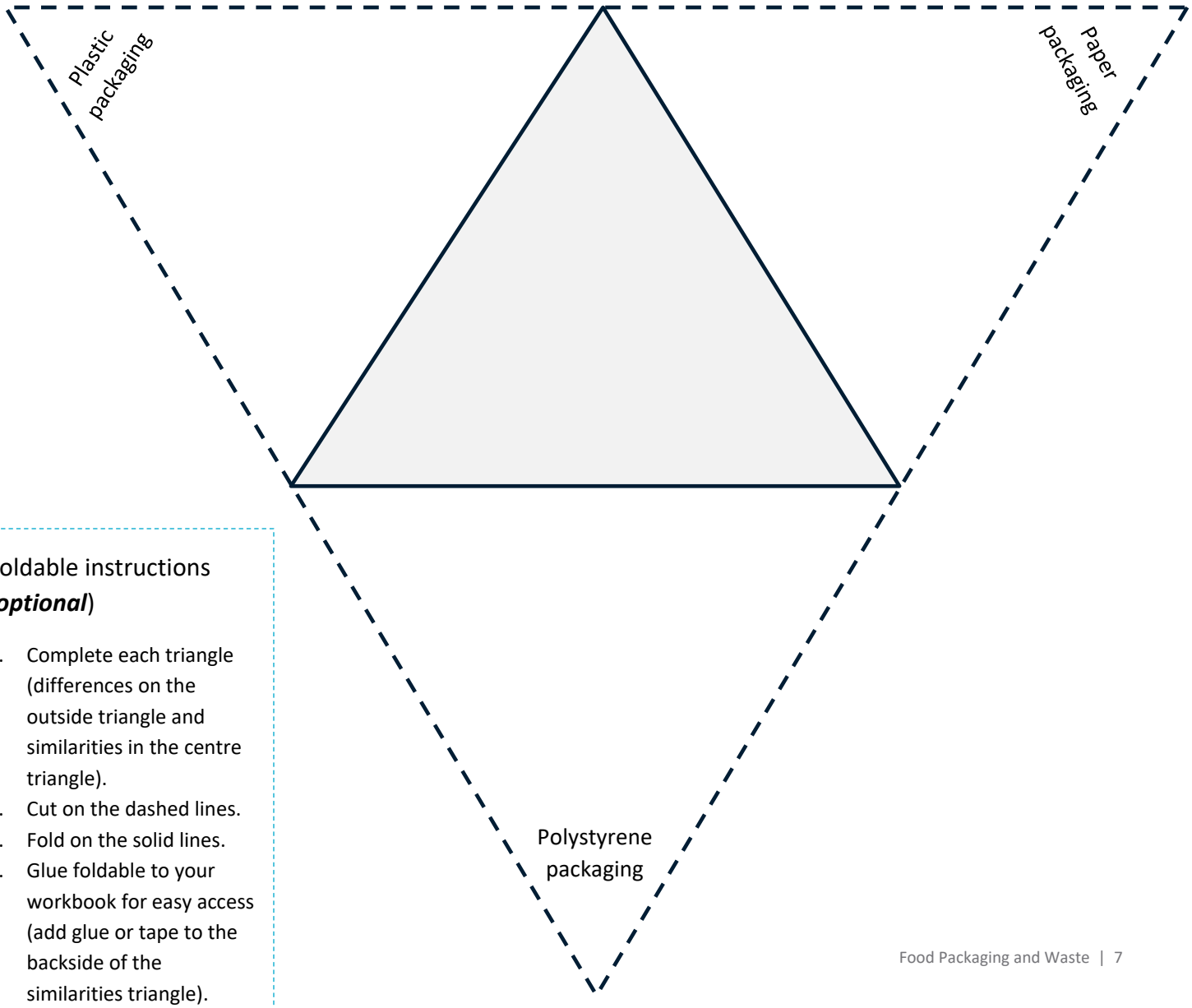
Think about a time when a fruit or vegetable you packed in your lunchbox was bruised or damaged by the time you opened it. What happened, and how did it make you feel?

Write as many fragile or difficult to transport fruits and vegetables as possible: •	List three items you've seen at the supermarket recently: 1. 2. 3.
Is there one item from your list of three that you have seen bruised or damaged more than the others? Describe the type of packaging it is usually transported in: •	
Choose one item that you would like to use for the packaging investigation: •	

Compare and contrast

Instructions

- Think about the different types of packaging you've seen at the supermarket for different products.
- What are some of strengths and weaknesses of each type of material?
- For each of the outer triangles write differences for each type of packaging.
- In the centre triangle write a sentence on how all three types are all similar.
- Now think about the packaging you've seen in the produce section for the fruit or vegetable you have chosen. How can you change or improve the design to reduce damage while the item is being transported from farm to supermarket?



Foldable instructions ***(optional)***

1. Complete each triangle (differences on the outside triangle and similarities in the centre triangle).
2. Cut on the dashed lines.
3. Fold on the solid lines.
4. Glue foldable to your workbook for easy access (add glue or tape to the backside of the similarities triangle).

Investigation focus question

Produce - **What questions do you have about the two stimulus images?**

Write as many questions about the stimulus images as you can. Do not worry about spelling or perfection, just write the first question that comes to mind. Change any statements to questions.

•

Improve, refine, prioritise - **Rewrite one closed question to an open question and one open question to a closed question.**

Open: encourages a unique detailed answer. Closed: short, specific answers.

•

Focus question breakdown - **What questions are within your focus question?**

Break your focus question down into smaller questions that you will need to explore, and any skills you will need to learn.

•	•	•
•	Write focus question here. •	•
•	•	•

Investigation focus question

Have you ever wondered why fruits and vegetables come in different types of packaging? Apples are usually transported in plastic moulded trays, whilst berries are in small punnets.

Fruits and vegetables are an incredibly important part of our diet. Have you ever opened your lunch box and discovered that your fruit had become a bit bruised or mushy? Many fruits and vegetables are soft and prone to being crushed, bruised, damaged or growing mould if stored incorrectly. Fruits and vegetables often come in shapes which are difficult to pack. Food waste is a huge problem in society, and vast amounts of bruised or damaged fruits and vegetables are thrown out every year. Coming up with solutions that allow fruit to be transported safely in large volumes is important.

Aim:

To design, build and test a packaging solution that can safely transport your chosen fruit or vegetable while minimising damage. Students will investigate how different materials, structures and design features protect their chosen fruit or vegetable from forces such as pressure, movement and impact, and use evidence from testing to improve their design.

Focus question:

Plan and conduct a reproducible investigation:

A scientific experiment must have to ability to get consistent results. That means, the experiment must get the same results if repeated under the same conditions. Therefore, only one variable is changed, at least one is measured, and as much as possible, all other variables are kept the same.

How will you ensure this experiment has a high reproducibility?

In this investigation, I am going to:

Change ___ and measure
___, while keeping
___ the same.

Prediction:

Predict how effective your design will be at protecting your chosen fruit or vegetable.
Include an estimated percentage of fruits or vegetables you expect to remain undamaged after testing.

Investigation: Better packaging

Equipment

- Glue
- Tape
- String
- Scissors
- Ruler
- Egg cartons
- Cardboard
- Foam
- Plastic bags – (e.g., small or medium snap lock bags)
- Packaging materials (e.g., packing peanuts, air bags, woodchips, bubble wrap)
- Straws
- Popsicle sticks
- Pipe cleaners
- 3 or more of your chosen fruit or vegetable

Procedure

Part 1 – Preparing for design

Considering the focus question, investigation aim, equipment provided, the chosen fruit or vegetable, brainstorm different design options. Use the following questions to help guide you.

Think about how your packaging can protect your chosen fruits or vegetables.

How will it reduce bruising and help stop mould from growing?

Decide how your design will carry the fruits or vegetables safely.

How many pieces can it hold without causing damage?

Choose the most important goal for your design.

Circle or tick the one you think matters most:

- ☐Protecting the fruits or vegetables from damage
- ☐Carrying more fruits or vegetables
- ☐Making the packaging reusable
- ☐Keeping the design low-cost

Explain your choice.

Why is this goal important for your design?

Part 2 – Draw your design

What does your package design look like? Label your design in centimetres and label specific materials. Make a list of the materials needed and an approximation of how much for each material.

Once you are satisfied with your design, and the teacher has approved it, it's time to create! Safely use the equipment to construct your design. Try to use only the materials you need and share with others.

Draw design here:

Materials needed:

-

Investigation: Package testing

To make sure that your design works, you will need to perform several different tests. These tests will simulate what happens to fruit when it is carried to school. For each test, you will test your packaging design and compare the results to unprotected produce. To ensure that each test is fair, the only thing that should change between the tests is whether it uses your packaging design to protect the produce.

Test 1: Drop Test

Step 1. Place a number of your chosen fruits or vegetables into a plastic bag.

Step 2. Hold the plastic bag so that the bottom of the bag is 1 metre above the ground.

Step 3. Drop the plastic bag

Step 4. Count how many of your chosen fruits or vegetables have been bruised or otherwise damaged.

Step 5. Record the number of your chosen fruits or vegetables that were damaged, describing the ways they were damaged.

Repeat Test 1, but this time place the same number of your chosen fruits or vegetables into your packaging design before placing them into the plastic bag. Every other step in the test should be repeated in exactly the same way.

Test 2: Carry Test

Step 1. Place a number of your chosen fruits or vegetables into a plastic bag.

Step 2. Hold the plastic bag in your hand.

Step 3. Run 20 meters as fast as you can, then run back to where you started from.

Step 4. Count how many of your chosen fruits or vegetables have been bruised or otherwise damaged.

Step 5. Record the number of your chosen fruits or vegetables that were damaged, describing the ways they were damaged.

Take some time to rest, and repeat Test 2, but this time place the same number of your chosen fruits or vegetables into your packaging design before placing them into the plastic bag. Every other step in the test should be repeated in the same way.

Test 3: Crush Test

Step 1. Place a number of your chosen fruits or vegetables into a plastic bag.

Step 2. Carefully place the plastic bag on the ground.

Step 3. Gently place a heavy book on top of the plastic bag and leave it there for 1 minute.

Step 4. Remove the book.

Step 5. Count how many of your chosen fruits or vegetables have been bruised or otherwise damaged.

Step 6. Record the number of your chosen fruits or vegetables that were damaged, describing the ways they were damaged.

Repeat Test 3, but this time place the same number of your chosen fruits or vegetables into your packaging design before placing them into the plastic bag. Every other step in the test should be repeated in exactly the same way, using the same book.

Create a data table

Use the table to record your observations:

	Unprotected Test		Protected Test		Percentage Damaged	Percentage NOT Damaged
	Number Damaged	Description	Number Damaged	Description		
Test 1: Drop Test	•	•	•	•	•	•
Test 2: Carry Test	•	•	•	•	•	•
Test 3: Crush Test	•	•	•	•	•	•

Investigation process diary

Here is where you are going to keep track of your progress towards your goals. You will reflect on what you have learned, your progress, and what you need to do in future lessons to stay on track.

Lesson date	Reflection
	Today I:
	Next lesson I will:
	Today I:
	Next lesson I will:

Lesson date	Reflection
	Today I:
	Next lesson I will:
	Today I:
	Next lesson I will:

Teamwork Check-in

(rate your group's skills out of 5 stars)

We are listening carefully to each other's ideas: ☆☆☆☆☆

We are sharing the work: ☆☆☆☆☆

We are staying on task: ☆☆☆☆☆

Lesson date	Reflection
	Today I:
	Next lesson I will:
	Today I:
	Next lesson I will:

Teamwork Check-in

(rate your group's skills out of 5 stars)

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We are staying on task: ☆☆☆☆☆

Lesson date	Reflection
	Today I:
	Next lesson I will:
	Today I:
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Teamwork Check-in

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We are listening carefully to each other's ideas: ☆☆☆☆☆

We are sharing the work: ☆☆☆☆☆

We are staying on task: ☆☆☆☆☆

Lesson date	Reflection
	Today I:
	Next lesson I will:
	Today I:
	Next lesson I will:

Teamwork Check-in

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We are listening carefully to each other's ideas: ☆☆☆☆☆

We are sharing the work: ☆☆☆☆☆

We are staying on task: ☆☆☆☆☆

Lesson date	Reflection
	Today I:
	Next lesson I will:
	Today I:
	Next lesson I will:

Teamwork Check-in

(rate your group's skills out of 5 stars)

We are listening carefully to each other's ideas: ☆☆☆☆☆

We are sharing the work: ☆☆☆☆☆

We are staying on task: ☆☆☆☆☆

Analysing your results

Analysis

How effective was your packaging design at protecting the fruits or vegetables during testing? Was your prediction accurate? Why or why not?

Compare the level of damage with and without packaging. Include the percentage of fruits or vegetables that were damaged and not damaged to support your explanation. Include a description of how accurate your prediction was.

Did any of the tests show weaknesses in your design where the fruits or vegetables could still be damaged?

Explain which test revealed this and how likely this type of damage would be in real-world transport situations.

Discussion

How effectively did you use the materials available to you?

Explain whether the materials were used in the best way possible or if they could have been used differently to improve protection.

Evaluation

What changes or additions could be made to your design to improve its effectiveness?

Explain how these changes would reduce damage or improve protection.

Could your packaging design be scaled up to transport a larger quantity of fruits or vegetables at the same time?

Describe what changes would be needed to make this possible.

Could your design be adapted to carry different types of fruits or vegetables?

Explain what modifications would be required and why.

If you were to repeat this investigation, could any of the materials be replaced to make the design cheaper or more sustainable?

Consider cost, availability, and environmental impact in your response

Conclusion

What will happen to your packaging after the investigation?

Explain whether it will be reused for further testing, dismantled, recycled, or repurposed.

Real-world example exploration

Circular Economy

What is the Circular Economy?

The circular economy is a way of designing systems so that materials and resources are:

- used for as long as possible,
- reused or repaired instead of thrown away,
- recycled or regenerated at the end of their life.

This helps reduce waste, save resources, and protect the environment.

Pick an item and draw a diagram of the linear and circular economy and what steps that item would take in each type of economy.

Linear economy	Circular economy

In small groups, choose one focus area:

- Food & canteen
- Paper & stationery
- Uniforms & textiles
- Technology & e-waste
- Packaging & plastics.

Answer the following questions about your focus area:

Question	Observations
What materials are used most?	•
What gets thrown away?	•
What could be reused or recycled?	•
Who is affected by this issue?	•

What evidence do you have?

- observations
- photos or sketches
- data from a survey
- school policies or rules.

Grassroots campaign

Create a campaign to promote a circular economy at your school. With your group decide on a theme, slogan, possible images, and what actions steps people can take. Include two campaign products (e.g. poster, merch, website, mini booklet, commercial jingle, etc.) Be creative, memorable, unique, catchy, colourful, anything it takes to encourage people to participate.

Your goal is to **create change at your school.**

Campaign title:

The problem we want to solve:

Why this matters:

Our circular solution:

Reduce > Reuse > Repair > Repurpose> Recycle > Regenerate

Explain how:

Target audience:

- Students
- Teachers
- School leaders
- Parents/community

How will you share your message?

- Poster or infographic
- Video campaign
- Assembly or presentation
- Prototype or model
- Merchandise
- Website
- Commercial jingle or song

Presentation plan

How will your team present your project? What is the best way to share everything you have learned?

Use this table to plan your presentation, including who is responsible for each task/section.

Task	Team member/s responsible	Due date
•	•	•
•	•	•
•	•	•
•	•	•
•	•	•

Presentation notes

Use this space to plan your presentation. You might like to draw what your set-up will look like or write a script and some dot points to talk about.

Investigation reflection

What parts of the investigation were successful? Why were they successful?

•

If your school. wanted to reduce food waste or improve packaging sustainability, what ideas from your investigation could realistically be applied and what challenges might need to be considered?

•

Describe two challenges you had to overcome during this investigation. What steps did you have to take to overcome them?

•

What would you do differently if you had to complete this investigation again? What could have made this investigation even better?

•

Where will you use what you have learned in your life outside of school? How can you use your knowledge from this investigation to make a difference (big or small)?

•

Take it further: extension activity

How can you test to see which designs protect against damage to the fruit? How can you create a test that reflects the different ways that fruit is handled when it is transported?

Design a test that will simulate the conditions that fruit, and vegetables are placed under when it is transported. It is important to remember that testing should include severe conditions (e.g. transporting on gravel road) as well as normal conditions (e.g. transporting on asphalt road).

- What aspect of transport are you testing?
    - Carrying the fruit from the tree during picking?
    - Transport by truck?
    - Moving it around a store?
    - Carrying the fruit home?
- How have you simulated the transport conditions?
- How accurate does your test reflect the real-world conditions of transport?
- How will you measure how well the design performed in testing?

It is important to note that a scientific investigation must be a fair test. That means that in the investigation, only one variable is changed, at least one is measured, and as much as possible, all other variables are kept the same. How will you ensure your testing phase is a fair test?

Consider all the variables that can be changed in your design and how you can conduct a fair and reliable investigation.

Answer these questions:

- What will you change? This is called the independent variable.
- What will you measure or observe? This is called the dependent variable.
- How will you make sure everything else is the same? These are called control variables. List the controlled variables.

Science investigation planner

Inspiration for investigations can come from anywhere; curiosity, observations, problems or things you've seen in the world around you! Use this planner to help design and carry out your own investigation.

- When planning your investigation, remember it should be:

Reproducible

☐Only change one thing – independent variable.

☐Measure at least one thing - dependent variable.

☐Keep everything else the same – controlled variable.

- Keeping your investigation fair makes sure your results care caused by the things you change, not by something else.

Repeatable

☐Write your method clearly and in order so another person can follow it exactly.

☐Include all materials, measurements and steps.

- If another person repeated your procedure, they should get similar results.

Reliable

☐Collect enough data to make sure your results are accurate.

☐Repeat your experiment several times to check for consistency.

- Record all measurements carefully – if repeated attempts show similar results, your data is more reliable.

Valid

☐Your procedure and data must match your investigation/focus question.

☐Make sure what you are testing answers your question.

- If your experiment measures something unrelated, your results won't be valid.

Scientists always check their investigations for fairness, repeatability, and validity before they share their findings. Use the list (above) as you plan, test and evaluate your work.

Introduction

Name _____

Date _____

Group members _____

What are you going to investigate? Write the focus question for the investigation:

What do you think will happen? Make a prediction and explain why:

Let's explore!

It's time to find out some more information about the topic.

Research the topic online and record the most important parts below so you can communicate them back to your team once you're done.

Resource name	What I found out (facts, statistics, interesting information)
•	•
•	•
•	•

Note: a resource is something that can be used to help you. Here, we can use news articles, blogs, books and images as resources to find out more about heat.

Reflect

What new questions do you have about the topic? Where might you find the information, you need to answer these? Who could you ask?

Question/s	Where will I look for information?
•	•

Our team timeline

Now that you know more about the topic, it is time to make a plan for your team's project.

Week/Lesson	Task/Activity	Resources, materials or support needed
•	• Choose our team's focus. •	•
•	•	•
•	•	•
•	•	•
•	•	•
•	• Finalise our presentation. • Prepare for presentation. •	•

Investigation planning

What variables are relevant to your investigation? List as many as you can think of:

•	•
•	•
•	•
•	•
•	•
•	•

Which variable are you going to:

Change? **This is the *independent* variable.**	**Measure?** **This is the *dependent* variable.**	**Keep the same?** **This is the *controlled* variable.**
•	•	•

List the equipment you will use and draw a diagram of how it will be set up:

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List the method you will follow in your investigation:

How many times will you repeat your method to ensure reliability?

_____

(Hint: The more times you repeat your method, the more reliable your data will be)

Risk assessment

When designing an investigation, it is important to think about safety. A risk assessment will help you to identify the hazards (something that could potentially cause harm) and record the actions/controls that you are going to put in place to reduce the risk.

Activity ***e.g. Cutting templates with scissors.***	**Hazard identification (type/case)** ***e.g. Cut to skin.***	**Level of risk (high, medium or low)** ***e.g. Medium.***	**Elimination or control measures** ***e.g. When using scissors, cut in direction away from body.***
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•

Results

Record your data in a table in your science journal (workbook). Don't forget to include headings for each of your table columns.

You can also record your results using words and sentences, by drawing diagrams, taking photos or videos, or using digital devices.

Optional: Communicate your results using graph paper. Draw your axes, label the features of the graph and include a title.

Explaining your results

What happened to the dependent variable when you changed the independent variable?

Why do you think this happened?

Did the results support your prediction? If not, how were they different?

What challenges did you encounter in completing the investigation?

How could you improve the fairness, reliability or validity of this investigation?

Glossary page and notes

Use this space to note down any words or scientific terms you discover as you conduct your investigation.

Word	Definition
•	•
•	•
•	•
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Notes

Research journal

Use this space to write down any resources you find and use in your investigation/s:

Resource name	What I found out
•	•
•	•
•	•
•	•
•	•
•	•

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Graph paper (5mm)

Graph paper (10mm)