Sun Protection

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 sun protection

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

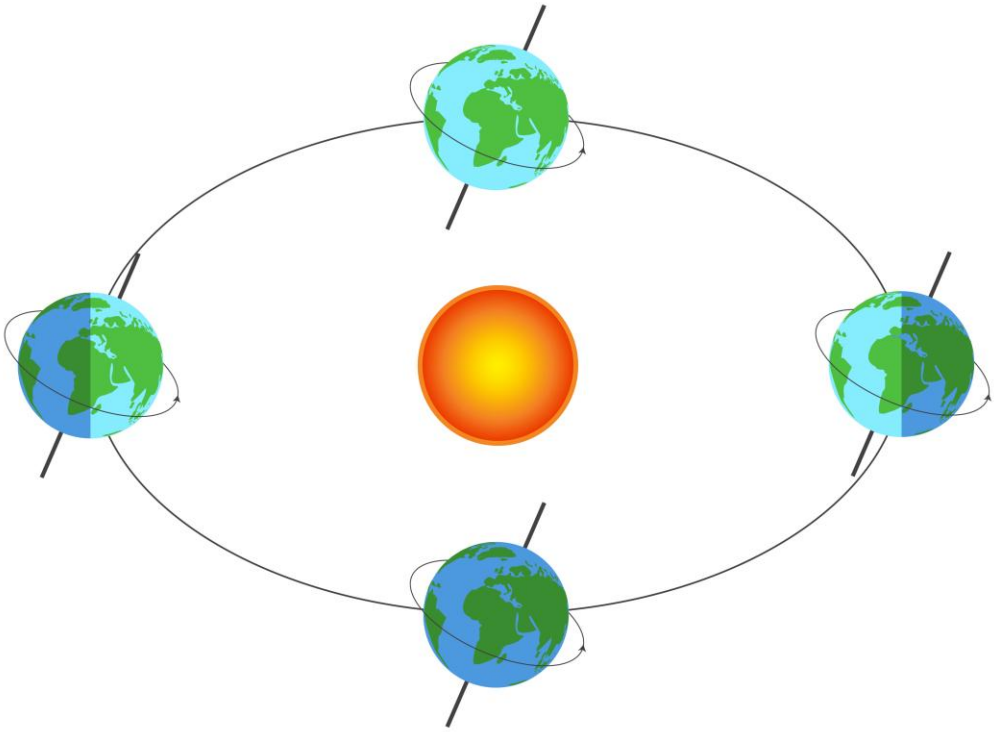
Question	Attempt 1	Attempt 2
Define and describe ultraviolet radiation.	•	•
How do you know which sunscreens are the most effective?	•	•
Define and describe SPF.	•	•
Explain how surface area affects the amount of sunscreen needed to maximise sun protection.	•	•

Earth and sun relationship labelling

Label the diagram below. Be sure to draw lines indicating the direction of the sun's radiation during summer and winter.

Word Bank

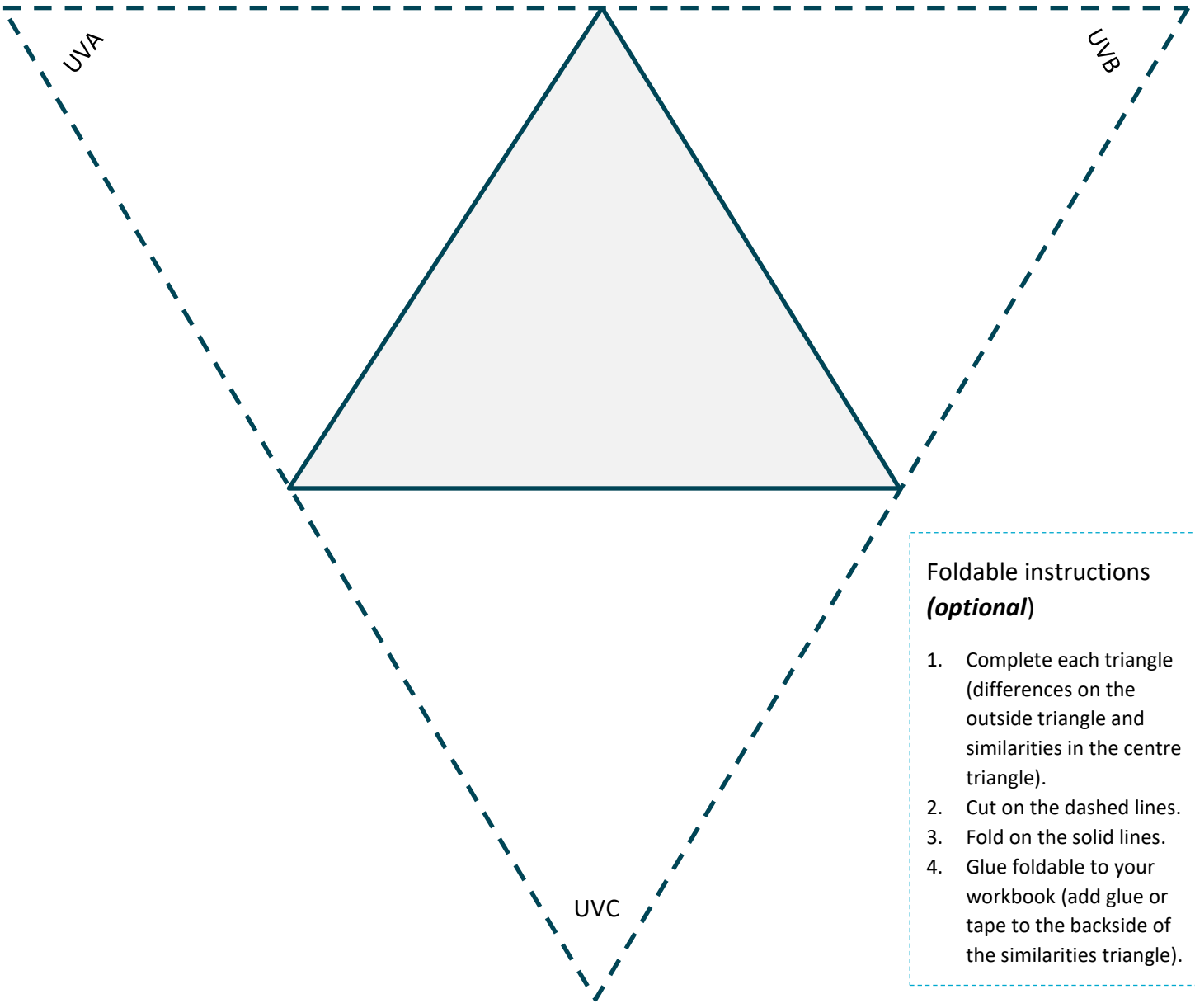
- Sun
- Earth
- Vernal (Spring) equinox
- Autumnal (Fall) equinox
- Summer solstice
- Winter solstice
- Northern Hemisphere
- Southern Hemisphere



Compare and contrast

Instructions

1. Write a sentence for each type of ultraviolet radiation explaining the difference between each type. (Outer triangles).
2. Write any similarities between the three types of ultraviolet radiation in the inner triangle.



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 (add glue or tape to the backside of the similarities triangle).

Investigation #1: Body surface area

Wearing sunscreen is one way to be 'sun-smart' and avoid exposure to ultraviolet (UV) radiation and getting sunburnt. The Cancer Council Australia recommends a water-resistant SPF 50+ applied 20 minutes before going outside and then re-applying every two hours, irrespective of the water resistance of the sunscreen, and should be reapplied after swimming, sport, sweating, and towel drying. For an adult, recommended sunscreen application is 5mL (approximately one teaspoon) for each arm, leg, body front, body back and face (including neck and ears). That equates to a total of 35mL (approximately seven teaspoons) for a full body application. Is this enough and does it confirm the Cancer Council's recommendation?

Aim:

In this investigation you will find approximations for the surface area of the human body using three-dimensional shapes and formulae in order to discover the optimal amount of sunscreen to apply.

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:

How large is your body's surface area?

Surface area pre-investigation

Equipment (Per Group)

- Sheets of paper
- Scissors
- Ruler/measuring tape
- Pencil/pen

Procedure and reflection questions

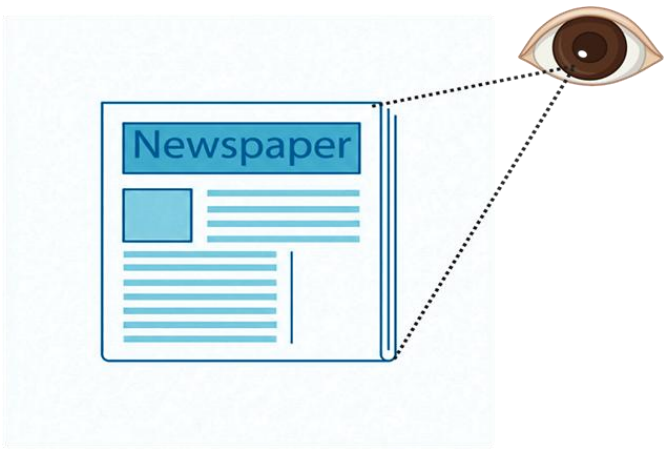
Part 1: Eyeball measuring

1 Cut out a square with an area of $1m^2$ with newspaper. You are not allowed to use any measuring equipment.

2 Stick the newspaper squares on the board or around the classroom and have the whole class vote on which square was the best approximation, justifying with reasons.

3 One student from each group will measure the sides of the newspaper in centimetres and write this information on their paper square (for example 97cm x 98cm).

4 As a class, discuss who had the closest measurement and identify what strategies they used for their successful approximation.



Part 2 – Calculate the surface area of this rectangular humanoid

You will notice there are no measurements here. You will need to create a reasonable approximation from your own body.

Hint: Do you notice any symmetries to help make efficient calculations?

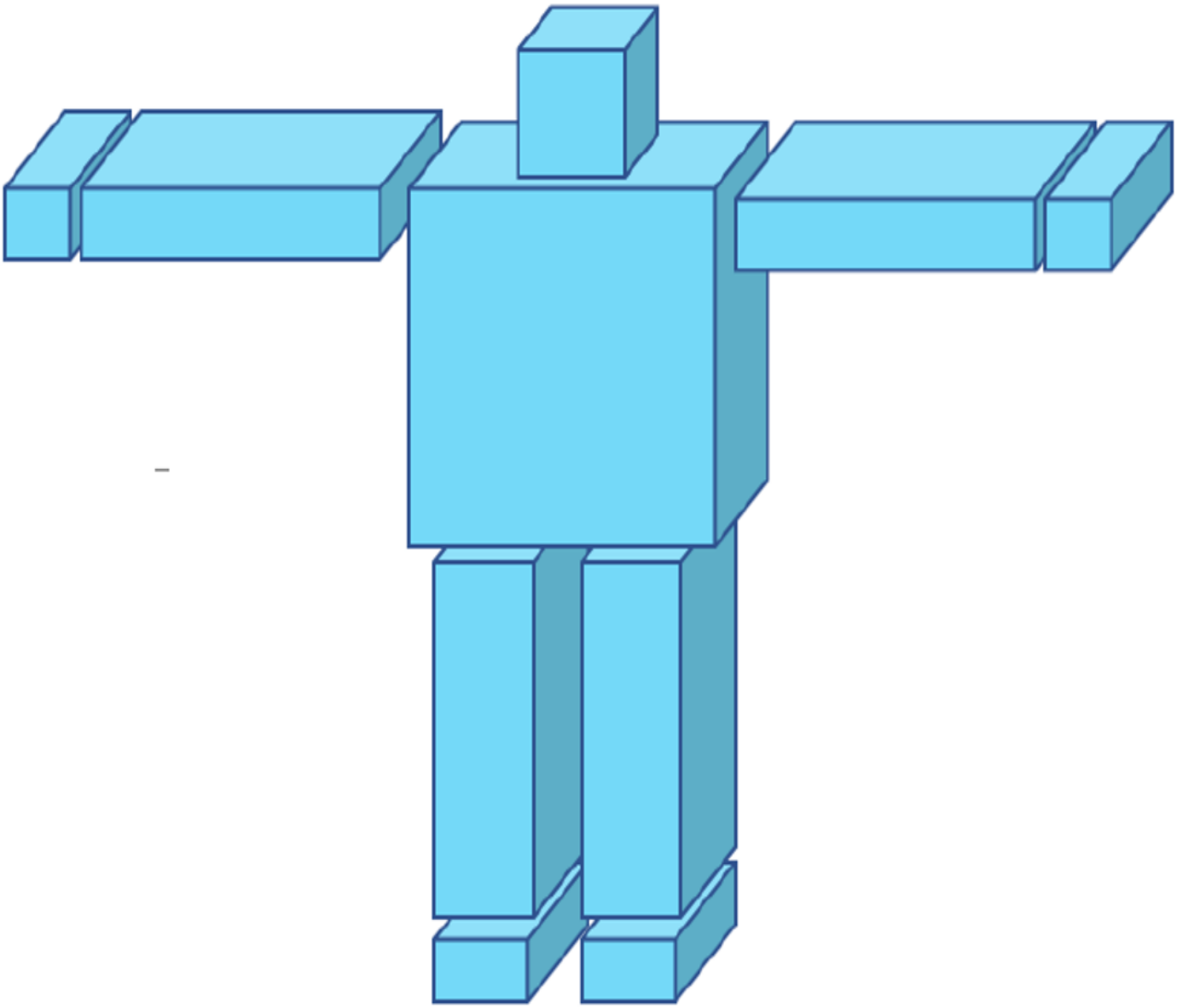


Figure 1 Rectangular humanoid.

Once completed, use this information, make a prediction of your body's total surface area. (we asked this above).

Part 3 – A better model

1. Choose a volunteer from your group – this person will be the 'body'
2. Assign roles – one person will wrap paper around different parts of the body, another person will measure the shapes, and another person will record the data.
3. . Create shapes using paper, use the paper to wrap around each body part to model a 3D object

   Examples:
   Arms and legs → cylinders
   Torso → cylinder or rectangular prism
   Neck → cylinder
   Head → cylinder or prism

4. Measure each shape – for each body part, measure the height or length, measure the circumference (for cylinders) or width and depth (for prisms) and record your measurements in centimetres.

Body Part	Shape	Dimensions	Surface Area
Torso: shoulders to top of legs	Rectangular prism	L: W: H:	(Formula: SA = 2(lw+lh+wh)
Head	Cylinder or sphere	B: (r=2dπ) H:	(Formula: $SA=2\pi rh$)

5. Find the total surface area of the body: $Total\ body\ surface\ area\ =\ sum\ of\ all\ body\ parts$

6. **Find the proportion of each body part**

$$Proportion = \frac{\text{surface area of limb}}{\text{total body surface area}}$$

How much sunscreen to apply?

The Cancer Council recommends that each person apply 35mL of sunscreen to their entire body. How much sunscreen will you need to apply to each body part?

7. Calculate the sunscreen needed:

Multiply the proportion by 35mL - $Sunscreen\ needed\ =\ proportion\ x\ 35$

This gives the amount of sunscreen (in mL) needed for that body part. E.g.

If:

- Total body surface area = 10,000 cm²
- One arm = 1,200 cm²

Then:

$$\frac{1200}{10000} = 0.12$$

So the arm is **12% of the body**.
Sunscreen needed:

$$0.12 \times 35 = 4.2 \text{ mL}$$

So that arm would need **about 4 mL of sunscreen**.
Write your answers below:

Body part:								
Total body surface area								
% of Total Body Surface Area								
Proportion of 35mL								

Analysis and conclusion

Analysis

What is your total body surface area? How do the results compare with your initial prediction?

Evaluation

What challenges did you encounter? Describe any problems you encountered or mistakes you made during the investigation.

How well did the investigation help to answer the investigation question, ‘How much screen do you need to apply to protect against UV radiation’?

If you were to repeat the investigation, what changes would you make?

Conclusion

A sunscreen manufacturer has come to you and asked you to provide application advice on their bottles. What will you write?

Investigation #1 focus question

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 come to mind. Change any statements to questions.
•
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.
•

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 your focus question here. •	•
•	•	•

Investigation #2: Sunscreen types

Wearing sunscreen is one way to be 'sun-smart' and avoid exposure to ultraviolet (UV) radiation, getting sunburnt and potentially causing permanent skin damage. There are so many different types of sunscreens.

Aim

In this investigation, you will compare the effectiveness of two different types of SPF30+ sunscreens (creams vs aerosol) against UV radiation from the sun.

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:

Which sunscreen provided the most protection and why?

Investigation #2: Investigating sunscreen types

Equipment

- 45 Ultraviolet beads
- small snap lock bags
- Timing device
- Paper towels
- Clipboard or hard cardboard
- different types of SPF30+ sunscreens (cream and aerosol)
- Teaspoons
- Permanent marker
- Small medicine measuring cup
- Pegs/bulldog clips
- Camera (digital/smart device/instant cam

Procedure

Part 1: Equipment set-up

1. Choose the two sunscreens, one liquid and one aerosol, that you want to test from sunscreens 1, 2, 3 or 4.
2. Using the permanent marker, label the snap-lock bag (on the top section above the snap- lock) with the number of your sunscreen and your group name. Repeat with another snap lock bag for the second sunscreen. Then label a third bag: C (control) and add your group name.
3. Place 15 UV beads in each bag, remove any excess air and securely seal by pressing the snap locks together
4. Using the pegs, attach the bags to the clipboard.
5. Take a photograph of all the bead bags together. Make sure the labels can be seen.

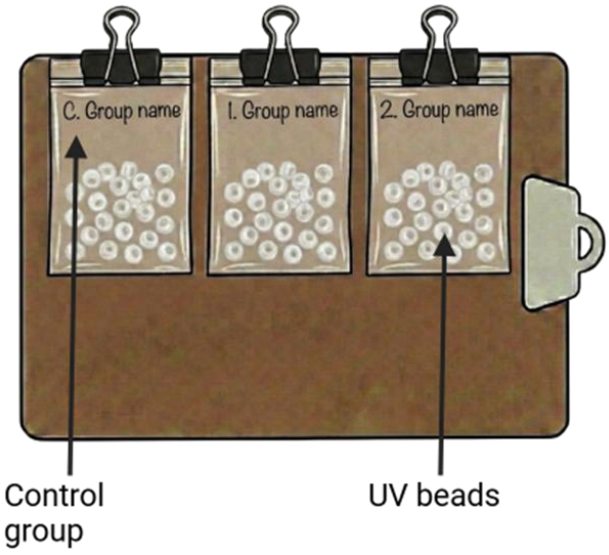


Figure 2 UV beads.

Part 2: Apply sunscreen

6. Cover the control and liquid sunscreen bags to ensure none of the aerosol sunscreen contaminates the other two bags.
7. Once the bags are covered properly, spray the sunscreen on to the topside of the corresponding labelled bag. Make sure to spray enough to cover the beads. Note how long you sprayed the aerosol sunscreen.
8. Using the teaspoon and/or measuring cup, measure out a quantity of the cream sunscreen. This needs to be enough to smear one whole side of the snap-lock bag. Note the volume of the sunscreen.
9. Transfer the sunscreen to one side of the corresponding labelled bag and smear evenly all over.
10. Wipe and wash off any excess sunscreen from your measuring cup and hands.

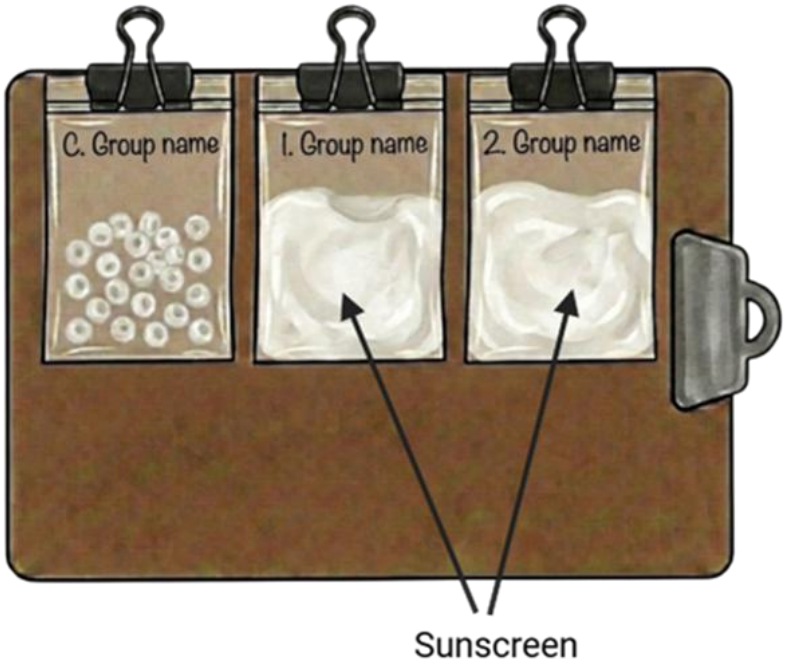


Figure 3 UV beads with sunscreen applied.

Part 3: Testing and data collection

11. Bag C will be left without sunscreen – this is the control.
12. Keeping the three bags covered with the second clipboard, ensuring not to remove any sunscreen, gently carry them outside into sunlight.
13. Have the timer ready and start it when the clipboard with all three bags topside up are placed into direct sunlight
14. After any amount of time over 2 minutes, take the clipboard out of direct daylight and quickly but gently flip the bags and take a photograph of the beads from the bottom side.
15. Write down the colour of the beads in each snap-lock bag. Try not to remove any sunscreen.
16. Take the bags indoors to 'reset' the beads.
17. Reapply sunscreen if required, ensuring the same even coverage across the outside of the bag.
18. Repeat steps 10 – 14 so that you have three trials for each sunscreen and control.

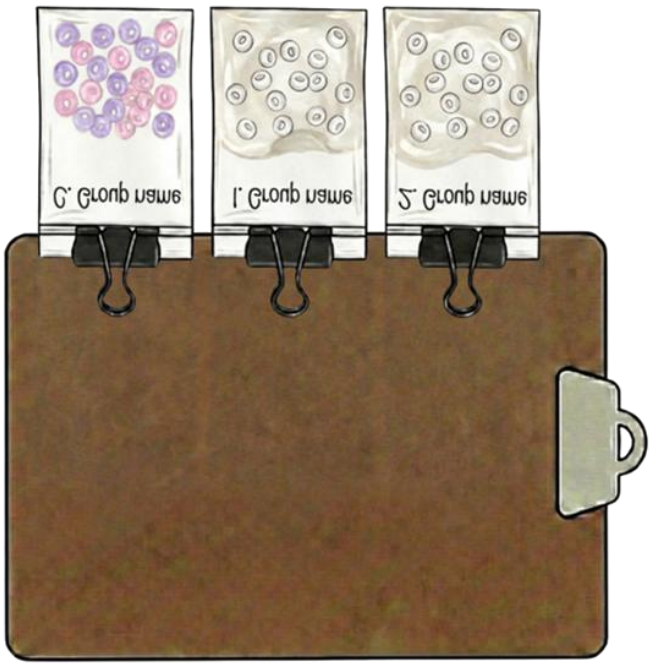


Figure 4 Figure 3 – UV beads flipped.

Ultraviolet (UV) exposure data table

Use the table to record your observations using both descriptive words and or images as well as numerical data. Using the control bag develop a number colour rating scale to record the amount of colour in the beads starting from white or colourless to the deepest possible colour.

	Trial 1		Trial 2		Trial 3	
	Observations (Images, descriptions)	**Colour rating scale**	**Observations (Images, descriptions)**	**Colour rating scale**	**Observations (Images, descriptions)**	**Colour rating scale**
Sunscreen type						
C-Control						

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)

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:
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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

(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)

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

We are sharing the work: ☆☆☆☆☆

We are staying on task: ☆☆☆☆☆

Analysing your results

Analysis

Examine the control (C) sample beads and compare these with the beads from your two sunscreen choices. What is the difference?

Compare the two bags of beads with different sunscreens, what is the degree of colour change? Describe what is similar or different?

Which sunscreen sample caused the least amount of colour change in the beads?

Which type of sunscreen did you predict would work the best? Was your prediction accurate? Were these results expected?

Discussion

What do your results tell you, what evidence do you have?

Evaluation

How well did the investigation help to answer your groups focus question?

What suggestions do you have on how to improve this investigation?

Did this investigation raise any new questions? What new research question could you possibly investigate following on from this experiment?

Conclusion

Can you determine from your results which type of sunscreen you tested would offer better protection against UV radiation?

Cultural Knowledge exploration

Ochre Sun: from Country to the global stage graphic organiser

Instructions:

Choose a topic from below and research one of the following: (circle the topic of choice):

- Ochre as protection.
- Traditional native plant oils (e.g., eucalyptus, tea tree, quandong, emu bush).
- Environmental conditions experienced on Country.
- Modern Ochre Sun product ingredients.

What is it?	**How it works?**
How it supports health and wellbeing?	**Why it's culturally important?**

Grassroots campaign

Create campaign to promote sun safety at your school. With your group decide on a theme, slogan, possible images, and what actions steps people can take to stay safe in the sun. Include two campaign products (e.g. poster, merch, social media post, mini booklet, commercial jingle, etc.) Be creative, memorable, unique, catchy, colourful, anything it takes to get people to pay more attention to sun safety. Make sure both products are aligned with a theme and key message.

Brainstorm space: •	
Product 1: •	**Product 2:** •

Presentation plan

How will your team present the 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?

•

How could technology or design help people apply the right amount of sunscreen?

•

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

- Design challenge / biomimicry task: Present the pollen-based sunscreen research. Materials scientists from NTU Singapore have invented the world's first pollen-based sunscreen derived from Camellia flowers. Scientists develop coral safe cooling sunscreen from pollen | NTU Singapore.
- Challenge students to design their own 'eco-friendly sun protection' product or material (shade cloth, sunscreen, clothing) that balances human safety and environmental impact.
- The impact of sunscreen on Vitamin D production and how to manage Vitamin D deficiency while protecting the skin from skin cancer. New research on Vitamin D and sunscreen empowers Australians to be sun safe | Cancer Council.

Additional investigation task

- Conduct the same investigation with different SPF protection (SPF 10, 15, 20, 25, 30, 45, 50).
- Investigate how different materials (cotton, neoprene, etc) and their thickness protect the best from UV radiation.
- Real world case studies that students could research and find potential solution.

Example scenarios:

- Design a sun-safety program for a coastal town whose economy depends on both tourism and a healthy coral reef. Sunscreen's potential impact on marine life needs urgent investigation, new study reveals - Plymouth Marine Laboratory.
- Scientists in Australia have measured higher ultraviolet radiation in some regions due to climate and atmospheric changes. Schools are reporting more students with sunburn, even on cooler days. The Department of Education wants recommendations for new sun safety rules for playgrounds. NSW DoE Sun safety.
- A team restoring bushland must work outside for long hours in harsh sunlight. Their chemical sunscreen works well but feels hot and sticky, and workers often don't reapply. A new pollen-based cooling sunscreen has been developed, but it's still expensive and not widely available:

- Student challenge: Which sunscreen option should the ranger team choose, and why? What combination of sun protection might keep workers safest?
- Use global-UV + skin cancer research to have students map UV change over time and region. Then predict future risk and propose sun-protection strategies
- Chemical vs Natural Sun Protection - How do different sun-protection technologies keep us safe—and which options protect the planet too?

– Chemical sunscreens are made with ingredients that absorb ultraviolet radiation before it can damage the skin. Examples include oxybenzone, avobenzone, octinoxate, and homosalate.
– Natural sunscreens often use mineral UV filters, such as zinc oxide or titanium dioxide, or rely on nature-inspired materials like pollen-based gels.

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 dad to make sure your results are accurate.

☐Repeat you 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 much 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)