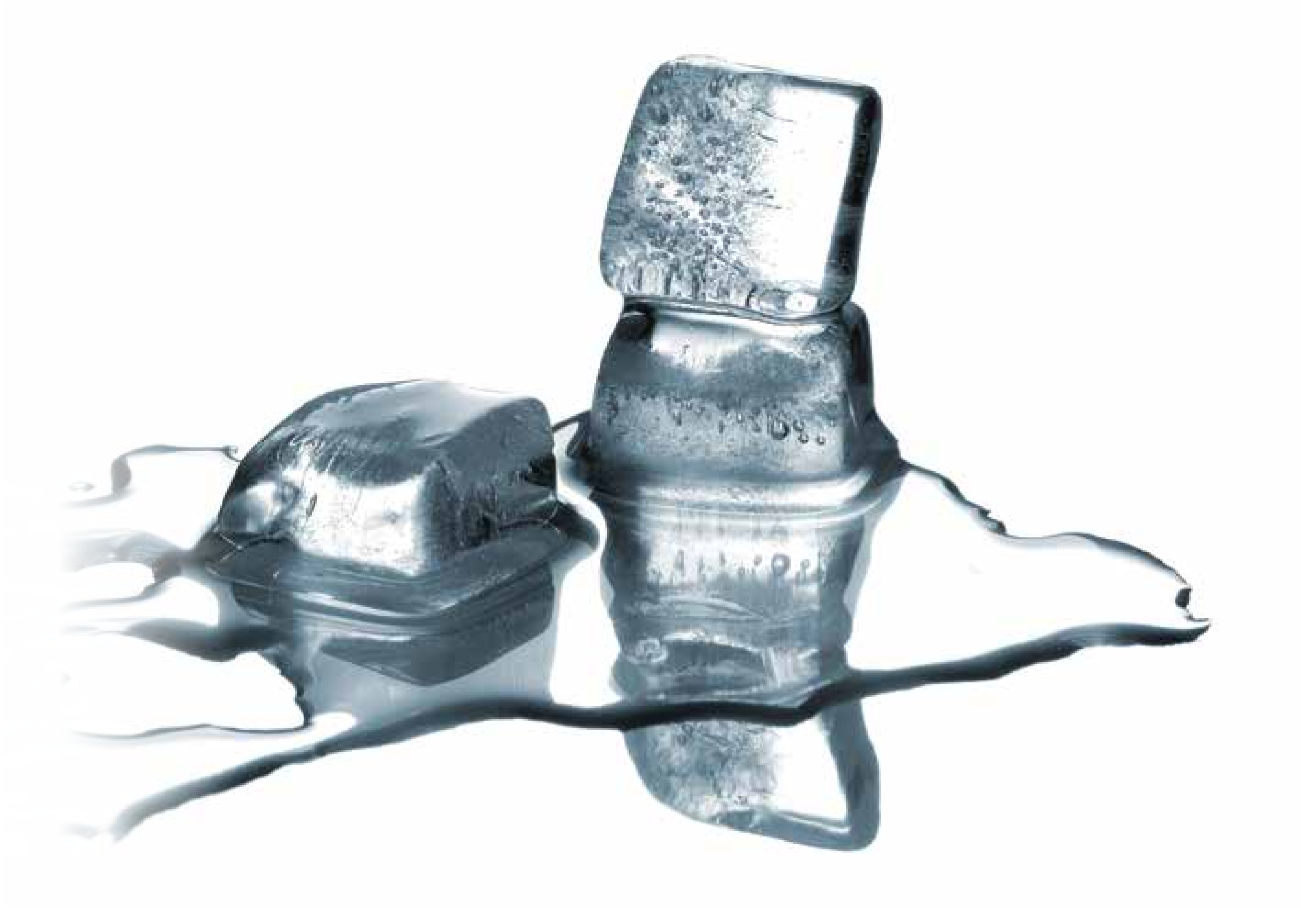


What's the Matter?

FUTURE MAKERS TEACHER RESOURCE

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers – creating a highly capable workforce for the future.

QUEENSLAND MUSEUM Queensland Government

Contents

Workshop Overview

Have you ever been asked the question, ‘What is the matter?’ Well, the answer is… everything!

All solids, liquids and gases are made up of matter. They have different observable properties and behave in different ways.

In this workshop, you will explore how you can use student-led demonstrations, hands-on scientific investigations and design challenges to examine the properties of solids and liquids, as well as how they change in response to different situations. You will also explore how understandings of states of matter and heat transfer can be used to create designed solutions and solve real-world problems.

Within this workshop, you will engage with various objects from Queensland Museum’s Cultures and Histories collection. This collection is comprised of objects that are significant to the people of Queensland. Cultural and historical collections provide a tangible link to human innovation and experience. The researching and collecting of our cultures and histories documents the present, and the past, for the future.

This workshop was also inspired by *SparkLab, Sciencentre*, Queensland Museum. In *SparkLab*, you can follow your curiosity and bring out your inner scientist as you question, investigate and wonder about the world around you. Explore interactive exhibits and discover how STEM affects your everyday world. Think creatively as you design in the Maker Space, get up close to experiments in the Science Bar and experience the wonder of our changing world with Science on a Sphere.

This workshop has been structured using the 5E’s instructional model. The following topics and concepts are explored in each aspect of the workshop:

ENGAGE **EXPLORE** **EXPLAIN**	**Melting Moments** Participate in a teacher-led demonstration to explore how you can change the way a solid melts, and test different solids to see how they compare. Plan and conduct scientific investigations to answer your questions.
EXPLORE **EXPLAIN** **ELABORATE**	**Evolution of the Esky: Object Analysis** Use objects from Queensland Museum’s Cultures and Histories collection to explore how understandings of science concepts (heat transfer and states of matter) have been applied to solve problems and create designed solutions.
ELABORATE **EVALUATE**	**Cool Inventions: Maker Space Challenge** Design and create an innovative device that can be used to keep an item or substance cold or to prevent it from melting.
EXPLORE **EXPLAIN** **ELABORATE** **EVALUATE**	**Evaporation Innovation: Design Challenge** Design an innovation that will reduce the rate of evaporation experienced by a body of water. Explore how people in design and technologies fields have responded to similar problems.

ENGAGE – EXPLORE – EXPLAIN

Melting Moments

Teacher Resource

In *Melting Moments*, students explore the properties of solids and liquids, as well as how they change in response to different situations.

Students firstly participate in a teacher-led demonstration where they investigate how they can change the way a solid melts and test different solids to see how they compare. This open-ended demonstration is designed to capture students' interest at the start of a unit of work and to find out what students think they know about changes of state from solid to liquid and liquid to solid. The demonstration encourages students to ask questions, make predictions, share their observations and suggest possible explanations for what they observe.

Students then identify questions for further inquiry before planning and conducting scientific investigations to explore their chosen topics.

Melting Moments: Demonstration

Materials required to complete the demonstration include:

- Ice cube trays of frozen substances (such as ice, chocolate, coconut oil, honey)
- Esky or cooler bag
- Metal and plastic melting plates with rubber rings (self-made or purchased from an educational resource supplier)
- A variety of surfaces made from different materials (such as plastic, metal, wood or foam; surfaces could include metal or plastic lids, plates, metal pie tins, pieces of Styrofoam, bubble wrap, corflute or wooden blocks)
- Jugs of cold, room temperature and warm water
- Clear plastic containers or beakers
- Resealable sandwich bags
- Trays or plates
- Thermometer (optional) – digital, conventional or infra-red
- Stopwatch (optional)
- Rolling pin (optional)
- Chopping board (optional)
- Hairdryer (optional)
- Food colouring (optional)
- Pipettes (optional)

Detailed step-by-step instructions can be seen on the following pages. It is recommended that you use these instructions to guide your students through the activity.

1. Gather students around a table or desk, ensuring that all students can see the demonstration. Show students a tray of ice cubes and inform them that you will be working together to investigate how solids can change over time.

   Explain to students that they will be scientists during the investigation. Encourage students to actively participate in the investigation by asking questions, making predictions, thinking of ideas which could be tested, sharing observations and suggesting possible explanations for what they observe.

2. Place the metal and plastic melting plates on the table (you could also use two other surfaces made from metal and plastic). Ask students to predict what they think will happen when you place an ice cube on each of the surfaces. You could pass the surfaces around to students to help them make their predictions. As the surfaces are passed around, ask students to discuss: ***What do you notice about the surfaces? How could this change or affect what happens to the ice cube? Why do you think this is?***

   Students then share their ideas with the class.

3. Place an ice cube on each of the surfaces and wait for observable changes to occur. Ask students: ***What do you notice?***

   Student responses may include that the ice cubes are melting and that they are melting at different rates.

4. Explain to students that the ice cubes are melting because of the movement (or transfer) of heat energy. Some materials (such as metals) are very good or very effective at moving (or transferring) heat to other objects; this is why the ice cube melted quickly on the metal plate. These materials are called conductors. Other materials (such as plastics) are not very good or very effective at moving (or transferring) heat to other objects; this is why the ice cube melted slowly on the plastic plate. These materials are called insulators.

5. Inform students that they are going to be using different materials to investigate how they can change the way ice melts. Show students available materials, including a range of surfaces (made from different materials), containers of water (different temperatures) and other equipment such as a rolling pin, a hairdryer, thermometers and stopwatches.

   Ask students to suggest what materials and equipment they would like to use in the investigation. Ask students how they could use these items to melt the ice and to predict how the ice might melt.

6. The following questions can be used to guide the investigation process. It is recommended that you repeat this process two to three times, investigating the effects of new materials or methods each time.

   Throughout this process, prompt students to make predictions about how each material or method could change the way the ice melts, before testing it out. Encourage students to share observations during each test and to discuss results, suggesting possible explanations for what they observe.

   - What could we test first?
   - Let's make a prediction. What do you think will happen to the ice when we place it on [material] or in [substance]?
   - What do you notice about the [materials], [substances] or [equipment] we are using?
   - What do you notice? Is this what you thought would happen?
   - Why do you think this has happened?
   - How could we measure any changes to the ice?
   - How does this compare to other materials, methods and/or substances we have tested?
   - What else could we test? How else could we try to melt the ice?

7. After exploring a number of different materials or methods for melting the ice, ask students: ***Do you think all solids melt in the same way?***

   Introduce different frozen solids (such as chocolate, coconut oil or honey). Use the materials and equipment from prior trials to test and compare how the solids melt in different situations. You may choose to discuss fair testing with the students and how students could ensure they are making fair comparisons.

8. Facilitate a think-pair-share discussion with students: ***What surprised you the most? What did you learn during the demonstration? What might you like to explore further?***

   Ask students to think of any questions that they have after participating in the demonstration. You could use the following questions to prompt student discussion: ***What else would you like to investigate? Do you have any questions that we didn't get to test? Is there anything else you would like to explore or discover?***

   Record students' questions on post-it notes for further investigation in *Melting Moments: Scientific Investigations*.

Melting Moments: Investigations

In this activity, students work collaboratively to plan and conduct scientific investigations to explore how substances can change from one state of matter to another by adding or removing heat. Students use the questions they brainstormed during *Melting Moments: Demonstration* to develop their scientific investigations.

Materials required to complete the scientific investigations will vary. It is suggested that each student group has access to the materials used in the *Melting Moments: Demonstration* (page 3). Additional or alternate equipment or materials may be required depending on the questions that you and your students choose to investigate.

Detailed step-by-step instructions on how to facilitate this activity can be seen below. It is recommended that you use these instructions to guide your students through the activity.

1. Ask students to reflect on the *Melting Moments: Demonstration* and think about the questions they identified at the end of the activity. Display student responses in a place where all students can see them.

   Inform students that you will be working together to plan and conduct scientific experiments to investigate their questions. As a class, work collaboratively to group similar questions together. Use these groups of questions to develop overarching inquiry questions that can be investigated. Example overarching inquiry questions could include:

   - How can we use different materials or methods to change how a solid melts?
   - What happens to different solids when they are heated or cooled?
   - How does changing the shape or size of a solid affect how it melts?

   You may wish for the whole class to identify an inquiry question to investigate, investigate multiple inquiry questions as a class or for student groups to choose their own inquiry question and develop individual investigations.

2. Share or negotiate any specific investigation requirements. These may include:

   - Size of student groups (three to four students per group)
   - Student roles
   - Available materials and equipment
   - Time limits students have to complete the challenge

3. Divide students into groups, ensuring each student knows their individual role if assigned.

   Discuss how students could investigate their inquiry question/s, and then plan and conduct a scientific investigation to answer the question/s using the template on page 10 (Year 3) or page 16 (Year 5).

Additional information regarding the types of inquiry questions and scientific investigations you could explore and conduct is provided below and on the following pages. You could conduct these investigations with your students or use this information to help you plan and conduct your own investigations.

Example Scientific Investigations

How can we use different materials or methods to change how a solid melts?

Students could investigate how different materials or methods affect how a solid melts. Students could conduct a number of tests where they use different materials or methods to try to melt a solid. Students may also like to modify or expand on tests conducted as part of the *Melting Moments Demonstration*. Students could measure the amount of time taken for the solid to completely melt or compare the appearance of the solids after a set period of time.

It is recommended that students keep the type of solid used for testing constant to allow for fair comparisons between tests. It is also important that the frozen solids are the same size.

Possible student investigations include:

- How do different methods of heating [solid] affect how it melts?
- Which method of heating [solid] causes it to melt the fastest?
- How do different surfaces or materials change the time it takes for [solid] to melt?
- How does water temperature affect how [solid] melts?

What happens to different substances when they are heated or cooled?

Students could investigate how different substances change when heated and cooled. This could include investigations comparing how substances (such as ice, chocolate, coconut oil or honey) change in response to different situations.

The methods used to heat or cool the substances could include:

- Using materials and equipment from the *Melting Moments Demonstration*
- Placing the substances in different locations (at room temperature, close to an air conditioner, in the shade, in sunlight, in the fridge, in the freezer etc.)

Students could record their observations of the characteristics of each substance for each test (whether they are a solid or liquid under selected conditions) or the time taken for noticeable changes to occur.

When completing investigations such as these, it is important that the amount of each substance – and the methods to heat or cool them - are kept constant to allow for students to make fair comparisons between tests.

Possible student investigations include:

- How does heating ice, chocolate and coconut oil affect its characteristics/state?
- What happens to different liquids when they are cooled?
- What happens to different solids when we place them in different locations around the school?
- Which substance will melt fastest when heated?
- Do all substances freeze in the same way?
- Do all substances melt at the same temperature?

How does changing the size or shape of a solid affect how it melts?

Students could investigate how changing the size or shape of a solid affects the time taken for it to melt. Students could break the solid up into different sized pieces (changing shape or surface area of solids) and compare how this affects the time taken for the solid to completely melt.

In order to allow for fair comparisons between tests, students should keep the type of substance (such as ice, chocolate, coconut oil), the amount of each substance and the method used to heat the substance the same.

Possible student investigations include:

- How does the size or shape of an ice cube affect how quickly it melts?
- Does crushing an ice cube change how quickly it melts?
- Will a large chocolate melt at a different rate than a small chocolate?

Curriculum Links (Version 8.4)

Science

YEAR 3

Science Understanding

A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)

Heat can be produced in many ways and can move from one object to another (ACSSU049)

Science as a Human Endeavour

Science involves making predictions and describing patterns and relationships (ACSHE050)

Science Inquiry Skills

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

With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSIS054)

Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately (ACSIS055)

Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (ACSIS057)

Compare results with predictions, suggesting possible reasons for findings (ACSIS215)

Reflect on investigations, including whether a test was fair or not (ACSIS058)

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

YEAR 5

Science Understanding

Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

Science as a Human Endeavour

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

Science Inquiry Skills

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)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Reflect on and suggest improvements to scientific investigations (ACSIS091)

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

General Capabilities

Literacy

Composing texts through speaking, writing and creating

Word knowledge

Numeracy

Estimate and measure with metric units

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social management

Melting Moments: Scientific Investigation

Student Activity

Year 3 Scientific Investigation

Inquiry Question:

Why are you conducting this investigation? What do you want to investigate?

What happens to ______ when we ______?

Prediction: What do you think will happen? Why?

Variables: How will you make sure the test is fair? Decide what you will...

Change	Measure/Observe	Keep the same

Materials: What equipment or materials will your group need to complete the experiment?

Method: How will your group investigate your question?

Safety: How will you work safely during this investigation?

Results: What did you observe? Record your observations in the table below.

	Test A: ____________	**Test B:** ____________	**Test C:** ____________
Before	Draw what ________________ looked like at the start of the experiment.		
		IMG BOXES	
	Describe what ________________ looked like at the start of the experiment.		
After	Draw what ________________ looked like after the experiment.		
		IMG BOXES	
	Describe what ________________ looked like after the experiment.		

Word Bank		
melted	liquid	warm
frozen	solid	cold
hard	soft	runny

Present your findings in a table and a graph.

	Test A: ________________	Test B: ________________	Test C: ________________
How long did it take the solids to melt? (seconds/ minutes)			

Title:

Time taken for solids to melt (seconds/minutes)

Test A: ________________ **Test B:** ________________ **Test C:** ________________

Questions:

1. How did your results compare with your prediction?

2. Explain your results and findings. What did you find?

3. Why do you think this happened?

4. Was the investigation fair? Why or why not?

5. Reflect on your investigation. What worked well and what was challenging?

6. How could you improve your investigation?

Melting Moments: Scientific Investigation

Student Activity

Year 5 Scientific Investigation

Aim: State why you are conducting this investigation. What do you want to investigate?

Hypothesis: Predict what you think will happen. Explain why you made this prediction.

Variables: Decide which variables should be changed, measured or kept the same in your investigation.

Independent variable What will you change?	**Dependent variable** What will you measure/observe?	**Controlled variables** What will you keep the same?

Consider the elements of a fair test. Explain how you will make your investigation as fair as possible?

Materials: Identify the equipment and materials your group will need to complete your experiment.

Method: Develop a method to investigate your question.

Diagram: Create a labelled diagram showing your experimental set up.

IMG BOX

Safety Considerations: What safety considerations must be made before, during and after this experiment? Identify at least four potential hazards and how to minimise them.

Potential hazards	How to minimise hazards

Results: Represent your results in a table and a graph. You could use a digital spreadsheet to complete this task.

Questions:

1. Describe what you observed when conducting your investigation.

2. Why do you think this happened? Apply your understanding of states of matter and the properties of solids, liquids and gases to explain your observations.

3. Create a diagram to support your explanation.

4. Compare your observations to your hypothesis. Was your initial prediction correct?

5. Explain any challenges you experienced when completing this investigation, and how you did or could overcome them.

6. Suggest how you could improve the investigation to make it more accurate or fair.

EXPLORE – EXPLAIN – ELABORATE

Evolution of the Esky: Object Analysis

Teacher Resource

Object-based learning is "a mode of education which involves the active integration of authentic or replica material objects into the learning environment"[1]. It can be used to prompt student investigation into a topic or concept and promote student inquiry. Queensland Museum collections can be used to facilitate object-based learning within the classroom. Objects can be viewed online or in-person at exhibitions on display across Queensland Museum.

In *Evolution of the Esky*, students engage in an object analysis task. They use objects from QMN's Cultures and Histories collection and other contemporary objects which have been used to preserve food products to explore how understandings of science concepts (i.e. heat transfer and states of matter) have been applied to create designed solutions that solve a community problem.

During the object analysis, students will:

- Identify and describe the features and characteristics of each object.
- Examine the materials used to construct each object.
- Use their observations to suggest when each object was made and used.
- Use their observations to suggest what each object was used for.
- Consider how the objects were/are designed for their purpose.
- Compare collection items to explore how objects designed for similar purposes have changed over time.

The objects selected for this activity will vary in terms of recognition by students. For differentiation, you may like to provide some students with more recognisable objects (i.e. the modern Esky or cooler bag) and other students with less recognisable objects (i.e. the Coolgardie safe or ice chest).

Evolution of the Esky can be used as a stand-alone activity or incorporated into the *Cool Inventions Maker Space Challenge* (page 39).

1 Jamieson, A. (2017). Object-based learning: A new way of teaching in Arts West. Retrieved from https://rest.neptune-prod.its.unimelb.edu.au/server/api/core/bitstreams/c254c3a2-c6ce-5bb7-a41a-e441d4759c52/content.

Detailed step-by-step instructions can be seen below. It is recommended that you use these instructions to guide your students through the activity.

1. Divide students into groups of two or three. Distribute one object image to each group. Students use the See-Scan-Analyse strategy to observe and analyse the objects.

   See: Describe what you see.
   What materials is the object made from?
   What colour is the object?

   Scan: Look closely at the object.
   What extra details do you notice now that you didn't before?

   Analyse: When do you think the object was made and used? Why?
   What do you think the object was used for? Why?

   Ask groups to consider and respond to the above questions, and to then share their objects and responses with the class.

2. Following the class discussion, inform students that all objects have something in common. Provide students with time to discuss what this might be and to share their ideas with the class. If not already suggested, inform students that all objects were designed to preserve food products by keeping them cold.

3. Ask students to return to their groups and to focus on their original object. Ask students: ***Now that we know the object was designed to keep food cold, how do you think it worked? What might make it effective at keeping food cold?***

   Prompt students to think about their prior learning to help develop their responses. Facilitate a class discussion during which students share and justify their ideas.

4. After students have shared their responses, use the *Object Profile Cards* (page 31) to explore and explain how each of the objects worked.

   Alternatively, you may wish to provide students with a research task and ask them to locate and record this information themselves. An *Object Analysis Template* is provided to guide students' response to the task (page 38).

Possible Extension Activities

- Which objects do students think would be most effective at preserving foods and keeping them cold? Ask students to discuss this question, then arrange the objects in order from least effective to most effective. Ask students to explain and justify the sort.
- Students predict which objects would be the most effective at keeping food cold and/or stopping food from melting. Students could then design and complete a scientific investigation as a class to test their predictions.
- Students construct their own Coolgardie safes. They could either do this by following a set of instructions or by 'reverse engineering' a Coolgardie safe based on an image or a physical object. Students could then test how well the Coolgardie safe works in different conditions.

Curriculum Links (Version 8.4)

Science

YEAR 3

Science Understanding

A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)

Heat can be produced in many ways and can move from one object to another (ACSSU049)

Science Inquiry Skills

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

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

YEAR 5

Science Understanding

Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

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

Design and Technologies

YEARS 3 AND 4

Design and Technologies: Knowledge and Understanding

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

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

YEARS 5 AND 6

Design and Technologies: Knowledge and Understanding

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

General Capabilities

Literacy

Composing texts through speaking, writing and creating

Critical and Creative Thinking

Inquiring: Identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social management

Evolution of the Esky: Object Analysis

Teacher Resource

Object Images

Object A

QM, Peter Waddington

Object B

QM, Peter Waddington

Object C

QM, Peter Waddington

Object D

QM, Peter Waddington

Object E

Object F

Object G

Evolution of the Esky: Object Analysis

Teacher Resource

Object Profile Cards

Object A: Esky Portable Ice Box

Object Analysis	**Examples**	**Object**
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance,	Rectangular, green box, lid attached. Size: L: 41.5cm, W: 19.5cm, H: 35cm
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	Metal exterior, enamel coating, rubber seal, cork insulation (not visible)
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	Complete object, some rust and paint damage
DATE – when was it made and used?	Period of time (estimate)	1960
LOCATION – where was it used / found?	Country and/or region	Australia

History and Design	
How did the object work?	A layer of cork (placed between the metal casing) provided insulation. Cork is an effective insulator because it contains very small air bubbles; the air bubbles transfer heat very slowly. This slows the transfer of heat from the outside environment into the Esky. The rubber seal on the lid stops air from getting into the Esky and heating the food inside.
Is the object still used today? How has it changed over time, or what has replaced it?	Eskies are still used today. However their designs and the materials used to construct them have changed. Modern Eskies are made from a thick plastic casing instead of metal. Foam has also replaced cork as the main insulating material. These modifications mean that modern Eskies are lighter, more durable and more effective at keeping foods cold than older versions.

Object B: Esky Portable Cooler

Object Analysis	Examples	Object
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance,	Rectangular, blue box, removable white lid, rounded edges, handles, screw-in plug for drainage Size: L: 40cm, W: 23cm, H: 40cm
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	Metal exterior and handles, enamel coating, rubber seal, cork insulation (not visible)
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	Complete object, some rust and paint damage
DATE – when was it made and used?	Period of time (estimate)	1965 - 1970 (estimate)
LOCATION – where was it used / found?	Country and/or region	Australia

History and Design	
How did the object work?	A layer of cork (placed between the metal casing) provided insulation. Cork is an effective insulator because it contains very small air bubbles; the air bubbles transfer heat very slowly. This slows the transfer of heat from the outside environment into the Esky. The rubber seal on the lid stops air from getting into the Esky and heating the inside.
Is the object still used today? How has it changed over time, or what has replaced it?	Eskies are still used today. However, their designs and the materials used to construct them have changed. This Esky has new parts and features that were not included in past designs, including: a removable lid to improve accessibility, additional handles to improve portability and a screw-in plug to allow the Esky to be drained after use. Modern Eskies are made from a thick plastic casing instead of metal. Foam has also replaced cork as the main insulating material. These modifications mean that modern Eskies are lighter, more durable and more effective at keeping foods cold than older versions of the object.

Object C: Coolgardie Safe

Object Analysis	Examples	Object
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance,	Metal cabinet mounted on four feet, water tray on top, water trough around bottom, green, shelf, hanging wire hook at top, gauze ventilation around sides, front door Size: L: 52cm, W: 47cm, H: 56cm
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	Metal (tin), wire gauze
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	Complete object, rust and paint damage
DATE – when was it made and used?	Period of time (estimate)	Unknown (estimate: 1890 - 1930)
LOCATION – where was it used / found?	Country and/or region	Australia (particularly rural areas)

History and Design	
How did the object work and how well do you think it worked?	The Coolgardie safe used evaporation to keep food stored inside cool. A tray on top of the safe was filled with water. A wet hessian bag was placed over the safe and pressed into the tray. The hessian absorbed water from the tray, which kept the material damp. The safe was generally kept in an area with good airflow. As the breeze evaporated the water absorbed by the fabric, it also absorbed the heat from the surrounding air and kept the contents of the Coolgardie safe cool. The safe could be placed on the ground or it could be hung from a hook to further promote airflow and better protect the food inside from insects.
Is the object still used today? How has it changed over time, or what replaced it?	Coolgardie safes were replaced by ice chests from the early 1900's in cities and towns where ice was readily available. The Coolgardie safe continued to be used, particularly in rural areas, until the mid-20th century.

Object D: Ice Chest

Object Analysis	Examples	Object
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance, similar objects	Wood exterior, interior walls lined with metal, ornate handles Size: L: 1.2m, W: 60cm, H: 46cm
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	Wood, metal, insulation material – likely cork or charcoal (not visible)
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	Complete object, some wear to metal, wood in good condition
DATE – when was it made and used?	Period of time (estimate)	1820 (however not commonly used in Australia until 1900 - 1950)
LOCATION – where was it used / found?	Country and/or region	Australia

History and Design	
How did the object work and how well do you think it worked?	A large block of ice was placed in the compartment in the top of the box. Cold air circulated down and around the storage compartments in the lower section. A drip pan at the bottom of the chest caught the water from the melted ice. The drip tray had to be emptied regularly. Up until the mid-20th century, an ice man would deliver blocks of ice to houses for use in ice chests.
Is the object still used today? How has it changed over time, or what replaced it?	Ice chests were replaced by kerosene and later electric refrigerators. Ice chests were produced and used in Australia up until the 1950's.

Object E: Styrofoam Cooler

Object Analysis	Examples	Object
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance, similar objects	White foam box, rope handle
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	Styrofoam
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	Complete object, good condition
DATE – when was it made and used?	Period of time (estimate)	1940 - current
LOCATION – where was it used / found?	Country and/or region	N/A

History and Design	
How did the object work and how well do you think it worked?	Styrofoam is effective at keeping food cold because it is a good insulator. A closed Styrofoam container limits the amount of heat transferred into the cooler through its surfaces or the air. Styrofoam has good insulating properties because it has millions of tiny air bubbles that slow the rate of heat transfer through the material.
Is the object still used today? How has it changed over time, or what replaced it?	While Styrofoam coolers are still used today, their use is becoming less common. They are being replaced by coolers made from hard plastics (e.g. Eskies) which are more effective and durable.

Object F: Modern Esky

Object Analysis	Examples	Object
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance, similar objects	Hard plastic, blue container, white handle, removable lid
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	Hard plastic (polypropylene), insulation materials – polyurethane/foam (not visible)
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	Complete object, good condition
DATE – when was it made and used?	Period of time (estimate)	1970's - current
LOCATION – where was it used / found?	Country and/or region	N/A

History and Design	
How did the object work and how well do you think it worked?	Modern Eskies are made from insulators (plastics and foam). These materials slow the spread of heat and help keep the food stored inside the Esky cooler for longer. An Esky has thick walls made from plastic, and inside the plastic walls is a layer of foam. The thick walls further slows the movement of heat from the outside environment into the Esky. Air bubbles inside the foam also slow the transfer of heat. Eskies which have a tightly sealed lid also prevent air from outside getting into the Esky and heating the food inside.
Is the object still used today? How has it changed over time, or what replaced it?	Eskies made from plastics are still used today. Designs and construction processes continue to change to improve their effectiveness and usability.

Object G: Insulated Cooler Bags

Object Analysis	Examples	Object
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance, similar objects	Rectangular, zip, blue, fabric handles, foil interior, fabric exterior, lunchbox
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	Polyester exterior, foil interior, dense thin foam (not visible)
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	Complete object, good condition
DATE – when was it made and used?	Period of time (estimate)	1980's - current
LOCATION – where was it used / found?	Country and/or region	N/A

History and Design	
How did the object work and how well do you think it worked?	Insulated cooler bags work similarly to modern Eskies. A dense, thin layer of foam (placed in between layers of other materials) provides insulation and limits heat transfer, which keeps the food inside cold.
Is the object still used today? How has it changed over time, or what replaced it?	Insulated cooler bags continue to be used today. The bags are lightweight, easily transported, durable and waterproof.

Evolution of the Esky: Object Analysis

Student Activity

Object Analysis Sheet

Object Analysis	Examples	Object
DESCRIPTION – what does it look like?	Colour, shape, size, parts, appearance, similar objects	
MATERIALS – what is it made of?	E.g. metal, wood, cardboard, plastic, clay	
CONDITION – what condition is it in?	Complete object or part of object, parts replaced, broken	
DATE – when was it made and used?	Period of time (estimate)	
LOCATION – where was it used / found?	Country and/or region	

History and Design	
How did the object work and how well do you think it worked?	
Is the object still used today? How has it changed over time, or what replaced it?	
What other interesting features do you notice about this object?	

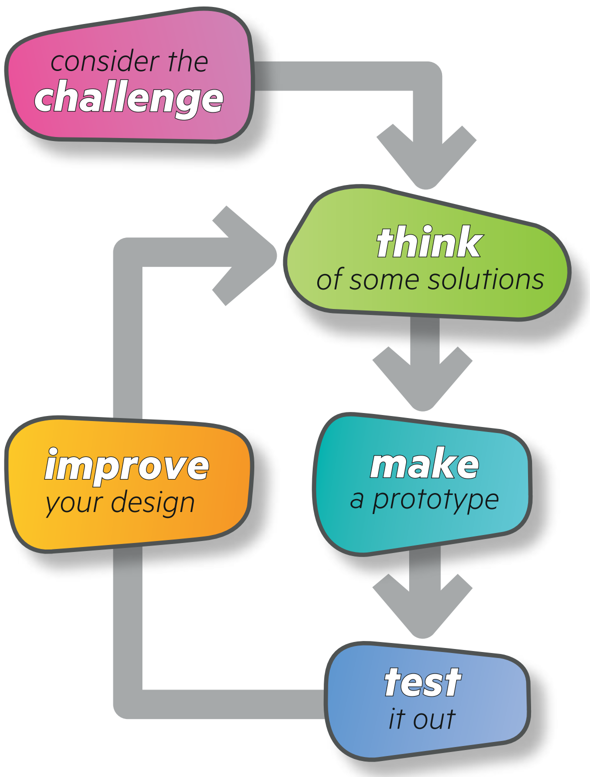
Research	
What further questions would you like to answer?	

Cool Inventions: Maker Space Challenge

Teacher Resource

In this activity, students apply their understanding of science concepts to design and construct a device that can be used to keep an item or substance cold and/or prevent it from melting. After students have designed their device, they create an advertisement that persuades an audience to purchase their product. Students could produce a print, television, radio or digital advert.

In Maker Space challenges, students follow a design process (see below). Additional information regarding specific aspects of the *Cool Inventions* challenge, as well as prompts and questions that you can use to guide students through this activity, are provided on the following pages.



The design process students will follow to complete this design challenge.

Maker Space

Maker Spaces are "creative spaces where people gather to tinker, create, invent, and learn."[2] They promote the development of problem-solving skills, critical and creative thinking, inquiry capabilities, design thinking skills, the ability to work collaboratively and autonomously, scientific understanding, technological capabilities, communication skills, reflective thinking and resilience.[3]

2 Hughes, J. (2017). Meaningful Making: Establishing a Makerspace in Your School or Classroom. Ontario Ministry of Education. Accessed from: https://tuit.tech/data/documents/meaningful_making_en.pdf

3 Bower et al. (2018). Makerspaces in Primary School Settings: Advancing 21st Century and STEM Capabilities using 3D Design and 3D Printing. Macquarie University. Accessed from: https://primarymakers.com/

The Maker Space at *SparkLab, Sciencentre* encourages visitors to get hands on and design and create solutions to challenging questions. User-centred design is a key aspect of *SparkLab's* Maker Space. Here, children design a solution for a specific user – whether that be a person who needs to travel down a zip line, take a seat on a chair or fulfil a different requirement.

In a Maker Space, children firstly think of some possible solutions for their user. They then select a solution, make a prototype of the solution, test it out, improve their design and then test their design again to explore the effects of any modifications. You can learn more about *SparkLab's* Maker Space by watching the *SparkLab*: Design Process video.

A variety of materials from which children can construct a prototype should be provided in a Maker Space. There should be enough materials to allow for a range of different solutions, but not too many materials so that choices become overwhelming.

The Shake It Up Maker Space in action at SparkLab, Sciencentre. QM, Peter Waddington

Consider the Challenge

1. Introduce students to the challenge. Explain that they are engineers who are tasked with designing and constructing a device that can keep a substance or item cold and/or prevent it from melting.

2. Share or negotiate any specific challenge requirements. These may include:
   - Size of student groups (recommended three to four students per group)
   - Student roles
   - Available materials and equipment
   - Time limits students have to complete the challenge

3. Divide students into groups and prompt them to consider the following questions:
   - What items or substances need to be kept cold or prevented from melting? Brainstorm as many examples as you can.
   - Why would we want to keep these items and substances cold or stop them from melting?
   - How do we keep these items and substances cold or frozen? What are some examples of devices we use?
   - How are these devices used and who uses them?

   Ask students to share their ideas and responses as part of a class discussion. Throughout this process, encourage students to listen attentively and build on and connect ideas.

4. Ask students to think about the device they are going to design and construct. Prompt students to consider what their device will be used for, what it will be designed to keep cold or prevent from melting, who will use their device (the user) and any other specific challenge requirements.

5. Work with students to develop success criteria for their innovations. The following questions and prompts may be useful in guiding your students through this stage of the design process:
   - How could you test your design?
   - How will you know if your device is effective at keeping items or substances cold and/or stopping them from melting?
   - How could you measure your success?
   - How will you know if your design meets the needs and requirements of the user?

Think of Some Solutions

1. Students explore and test different materials to determine how effective they are at keeping items or substances cold and/or preventing them from melting. Students could test materials by:
   - Measuring the time taken for an item or substance to melt.
   - Measuring changes to the temperature of an item or substance over time.

   You may wish for students to explore and test a number of materials. Students can then place the materials on a continuum from least to most effective.

2. Students explore how people in design and technologies fields have responded to similar issues by researching an innovation designed to keep substances or items cold or to prevent them from melting. Students could research a device from the *Evolution of the Esky* activity and complete the *Object Analysis Template* (page 38). Students could also create a diagram of their chosen innovation, label the materials it is constructed from and describe its design.

3. Provide students with time to brainstorm ideas for their own device. Students create diagrams of possible designs, consider the different parts of their designs and identify what materials they could use to construct them.

Make a Prototype

1. Ask students to discuss their initial ideas and select a design they would like to develop further.

2. Students create a labelled diagram of their design and identify the materials required to construct their prototype. They consider the properties of these materials and justify their selections.

3. Students then work collaboratively to construct a prototype of their innovations using everyday materials. Materials required to complete the design challenge will vary depending on students' designs.

   The following questions and prompts may be useful in guiding your students through this stage of the design process:

   - What materials could you use in your design?
   - How will the properties of different materials affect what you use?
   - How will you work safely?
   - Now that you are making your design, how suitable are the materials? What changes might you need to make to your innovation's design?

Test It Out

Students plan and conduct a scientific investigation to test the effectiveness of their designed solution. During this process, students should consider:

- What they will use to test the effectiveness of their device. The item or substance selected should be based on the purpose of their device. Tested items or substances could include: ice, chocolate, butter, ice cream, ice blocks, can of soft drink, frozen water bottle etc.
- How they will collect data and measure innovation effectiveness. For example, students might measure the: time it takes for a solid to melt; variation/changes in temperature over time; volume of melted liquid etc.

Improve Your Design

Students reflect on their scientific investigation and evaluate the effectiveness of their designed solution. Students suggest how they could improve their design.

If time allows, students could modify their prototype and repeat the scientific investigation to determine the impacts of any changes.

Evaluate and Reflect

Encourage students to reflect on their experiences (either within their teams or as a class group) after they have completed the design challenge. Students may like to think about the following questions to assist with their reflection:

- What scientific knowledge helped you make decisions about your innovation design?
- What aspects of your innovation are you very satisfied with? Why?
- If you had more time, what would you do next?
- If you started again, what would you do differently?
- Consider the main challenges you experienced during the design process. How did you overcome these challenges?
- What have you learnt about science or design from this activity?
- Is there anything that you would like to keep exploring or find out more about?

Cool Inventions: Make Me Want That Device!

After students have designed and tested their prototype, they could create an advertisement that persuades people to purchase their device. Students could explain how their device works and highlight important features of their design.

In this task, students could:

- Identify their target audience and advertising medium (i.e. print, television, radio or digital).
- Consider how they will advertise their device to their target audience.
- Explore how they can use persuasive language and visual effects, such as images, fonts and colours, to present their device as a 'must have' item and to convince their target audience to purchase the device.

This task supports the Year 3 and 5 English Achievement Standards, in which students create persuasive texts for different purposes and audiences and make presentations which include multimodal elements for defined purposes.

Curriculum Links (Version 8.4)

Science

YEAR 3

Science Understanding

A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)

Heat can be produced in many ways and can move from one object to another (ACSSU049)

Science Inquiry Skills

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

With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSSU054)

Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately (ACSSU055)

Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (ACSIS057)

Compare results with predictions, suggesting possible reasons for findings (ACSIS215)

Reflect on investigations, including whether a test was fair or not (ACSIS058)

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

YEAR 5

Science Understanding

Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

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

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)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Reflect on and suggest improvements to scientific investigations (ACSIS091)

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

Design and Technologies

YEAR 3 AND 4

Design and Technologies: Knowledge and Understanding

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

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

Design and Technologies: Processes and Production Skills

Critique needs or opportunities for designing and explore and test a variety of materials, components, tools and equipment and the techniques needed to produce designed solutions (ACTDEP014)

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

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

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

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

YEAR 5 AND 6

Design and Technologies: Knowledge and Understanding

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

Design and Technologies: Processes and Production Skills

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

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

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

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

English

YEAR 3

Literacy

Identify the audience and purpose of imaginative, informative and persuasive texts (ACELY1678)

Plan, draft and publish imaginative, informative and persuasive texts demonstrating increasing control over text structures and language features and selecting print, and multimodal elements appropriate to the audience and purpose (ACELY1682)

YEAR 5

Literacy

Plan, draft and publish imaginative, informative and persuasive print and multimodal texts, choosing text structures, language features, images and sound appropriate to purpose and audience (ACELY1704)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Estimating and calculating with whole numbers

Using measurement

ICT Capability

Creating with ICT

Critical and Creative Thinking

Inquiring – Identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social management

Cool Inventions: Maker Space Challenge

Teacher Resource

Prompts and Questions

The following prompts and questions can be used to guide students through this activity. Students are expected to cycle through this process, and between the test and improve stages, multiple times.

Consider the Challenge

- What are examples of items or substances that need to be kept cold? What do we need to prevent from melting?
- Why do we need to keep items or substances cold? Why do we need to prevent them from melting?
- Who will use your device? What are their needs?
- What will your device be used for?
- How will you know if your device is effective?
- How will you know if your design is successful?
- How could you measure success?

Think of Some Solutions

- Investigate real-world examples of devices that are used for this purpose.
- How do these devices work?
- What materials are used in these designs?
- What ideas do you have for a design? Brainstorm different possibilities.
- Think about the different parts of your design and what these parts could be constructed from.
- How would these designs work?

Make a Prototype

- Select an idea and create a labelled diagram of your design. Explain and justify your ideas.
- What materials could you use to create your device?
- How can you use the different properties of materials in your design?
- How will the properties of different materials affect what you use?
- How would you describe these materials? What could they be used for?
- How can you change or modify the materials to make them more useful?
- How will you connect your materials together?
- How will you work safely?

- Is there something we don't have that you want to use to make your device? Are there any materials that are similar? How could we make something like that (using these materials)?
- What ideas have you had? What have you tried so far?
- What parts of your design are you finding tricky to build?

Test It Out

- Test out your device. What do you notice?
- Does your device meet the needs of the user?
- Does your prototype look and work the way you wanted it to?
- What did you learn from your tests? Has testing your device given you any more ideas?

Improve Your Design

- How could you improve on your design?
- How could you make your device more effective?
- What would happen if you used different materials, added other features or a new part?
- What ideas could you incorporate from someone else's device?
- Continue to test and refine your design until you are satisfied with your device.
- If you started again, what would you do the same? What would you do differently?
- How can you change your design to move a different object?

Evaluate and Reflect

- What aspects of your device are you very satisfied with, and why?
- If you had more time or made another device at home, what would you do next?
- What were the main challenges you experienced during the design process? How did you overcome these challenges?
- If you started again, what would you do differently?
- What have you learnt about science or design from this activity?
- Has this activity given you any other questions that you want to explore or find out more about?
- Is there anything that you would like to keep exploring or finding out about?
- How could your device be used in the real world? What changes would you make to your prototype in the full-scale model?

Cool Inventions: Maker Space Challenge

Student Activity

Year 3 Challenge

Task:

Design and construct a device that can be used to keep something cold or prevent it from melting.

You will:

- **Consider the challenge:**

  Identify what your device will be used for and who will use it.

  Consider how you could test your device. How will you know if it is effective?

- **Think of some solutions:**

  Investigate real-world devices that are used for a similar purpose. Explore how these devices work and what materials are used in their designs.

  Brainstorm possible ideas for your device. What ideas do you have?

- **Make a prototype:**

  Select a design to create and construct a prototype out of everyday materials.

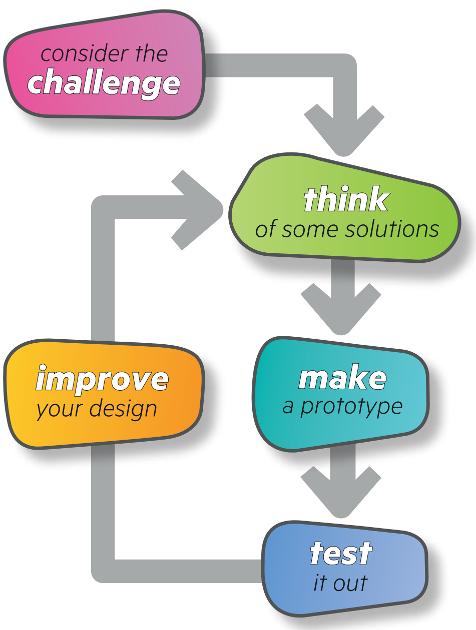
- **Test it out:**

  Test your prototype by conducting a scientific investigation. How effective is your prototype?

  Apply what you have learnt about solids and liquids and the movement of heat to explain your observations.

- **Improve your design:**

  Identify opportunities to improve your device. How can you make your device more effective?



Consider the Challenge

Think about the device that you are going to design and construct.

1. What will your device be used for? What will it keep cold or prevent from melting?

2. Who will use your device? What are their needs and requirements?

3. How could you test your design? How will you know if your device is effective?

Think of Some Solutions

1. How do different materials affect how quickly something warms up or melts? What materials are good at keeping things cold or stopping things from melting?

   Explore and test different materials. Record the results of your tests below.

2. People who work in design and technology fields across the world have designed devices to help keep items and substances cold or to prevent them from melting.
   - Select and research a device that is used for this purpose.
   - Create a diagram of your device.
   - Add labels to identify the different parts of the device, the materials these parts are made from and how the device works.

IMG BOX

Now it's time to brainstorm some designs! What ideas do you have for devices that could keep things cold or prevent them from melting?

3. Draw diagrams of your possible designs below. At this stage, you could also think about what parts your design will have and what materials these parts could be constructed from.

IMG BOX	IMG BOX
IMG BOX	IMG BOX

Make a Prototype

1. Work with your group to examine the designs you have brainstormed. Which design do you think would be most effective at preventing an item or substance from melting?

   Work with your group to develop a design for your prototype. This could be one of the designs you have worked on or a combination of different designs.

   Draw a diagram of your prototype design below.

IMG BOX

2. What materials will you use to construct your prototype? Consider the properties of these materials and explain why you have selected them.

Material	Reasons for selecting material

Now, create a prototype of your device!

Test It Out

Conduct a scientific investigation to test the effectiveness of your prototype.

Aim: To investigate how effective your prototype is at ____________________ .

Variables: How will you make sure the test is fair? Decide what you will:

Change	Measure/Observe	Keep the same

Materials: Identify the equipment or materials your group will need to complete your investigation.

Method: How will your group investigate your question? List the steps below:

Diagram: Draw a labelled diagram of your experiment.

IMG BOX

Safety: How will you work safely during this investigation?

Results:

1. Record your results in a table.
2. Present your results in a graph.

Control Test	Prototype Test

Control Test:	Prototype Test:

Questions:

1. Explain your results. What did you observe?

2. How effective was your prototype? Compare the results of the control test and the test that used your prototype.

3. Explain how your device works. Apply what you have learnt about the properties of solids and liquids and the movement of heat.

4. Was the investigation fair? Why or why not?

5. Reflect on your investigation. What worked well and what was challenging?

6. How could you improve your investigation?

Improve Your Design

How could you change or modify your design to make your device even better? You may like to draw a labelled diagram of your new and improved design.

Modification	How would this improve your device?

IMG BOX

You could make these modifications to your prototype and then repeat the scientific investigation to determine the impacts of these changes.

Evaluate and Reflect

Reflect on the design challenge and the design process with your team or class. You might like to think about the following questions to assist with your reflection:

- What scientific knowledge helped you make decisions about your design?
- What aspects of your device are you very satisfied with? Why?
- If you had more time, what would you do next?
- If you started again, what would you do differently?
- Consider the main challenges you experienced during the design process. How did you overcome these challenges?
- What have you learnt about science or design from this activity?
- Is there anything that you would like to keep exploring or find out more about?

Cool Inventions: Make Me Want That Device!

You have designed your cooling device, and now it is time to sell it! Create an advertisement that persuades people to purchase your product. Consider:

- Who is your target audience?
- How will you advertise your device? Will you produce a print, television, radio or digital advert?
- What persuasive language will make your device a 'must have' item?
- What visual effects will you use? Think carefully about images, fonts and colours.

Describe or draw your advertisement in the space below.

IMG BOX

Cool Inventions: Maker Space Challenge

Student Activity

Year 5 Challenge

Task:

Design and construct a device that can be used to prevent an item or substance from melting.

You will:

- **Consider the challenge:**

  Identify what your device will be used for and who will use it.

  Consider how you could test your device. How will you know if it is effective?

- **Think of some solutions:**

  Investigate real-world devices that are used for a similar purpose. Explore how these devices work and what materials are used in their designs.

  Brainstorm possible ideas for your device. What ideas do you have?

- **Make a prototype:**

  Select a design to create and construct a prototype out of everyday materials.

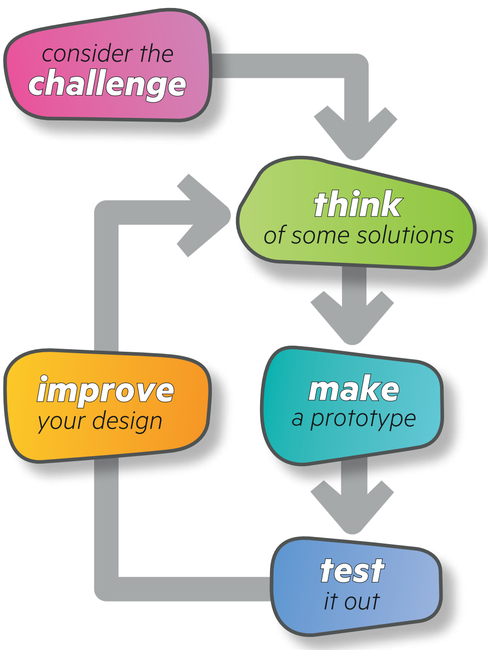
- **Test it out:**

  Test your prototype by conducting a scientific investigation. How effective is your prototype?

  Apply your understanding of the properties of solids, liquids and gases to explain your observations.

- **Improve your design:**

  Identify opportunities to improve your device. How can you make your device more effective?



Consider the Challenge

Think about the device that you are going to design and construct.

1. What will your device be used for? What items or substances will it prevent from melting?

2. Who will use your device? What are their needs and requirements?

3. How could you test your design? How will you know if your device is effective?

Think of Some Solutions

1. Explore and test different materials to determine how effective they are at preventing items or substances from melting.

   Record the results of your tests below.

2. People who work in design and technology fields across the world have designed devices to prevent items or substances from melting.
   - Select a device and research how it was designed for this purpose.
   - Create a diagram of your device. Add labels to provide information about the device's design and the materials it is made from.

IMG BOX

3. Explain how the device prevents items or substances from melting.

Now it's time to brainstorm some designs! What ideas do you have for devices that could prevent items or substances from melting?

4. Draw diagrams of your possible designs below. At this stage, you could also think about what parts your design will have and what materials these parts could be constructed from.

IMG BOX	IMG BOX
IMG BOX	IMG BOX

Make a Prototype

1. Work with your team to examine the designs you have brainstormed. Which design do you think would be most effective at preventing an item or substance from melting?

   As a team, select a design that you would like to explore further. You will construct a prototype of this device.

   Draw a labelled diagram of this design.

   IMG BOX

2. What materials will you use to construct your prototype? Consider the properties of materials and explain why you have selected them.

Material	Reasons for selecting material

Now, create a prototype of your device!

Test It Out

Conduct a scientific investigation to test the effectiveness of your prototype.

Aim: To investigate how effective your prototype is at ____________________.

Variables: Decide which variables should be changed, measured or kept the same in your investigation.

Independent variable What will you change?	**Dependent variable** What will you measure/observe?	**Controlled variables** What will you keep the same?

Materials: Identify the equipment and materials your team will need to complete your investigation. Remember to include numbers and amounts.

Method: Develop a method to investigate your question. List the steps you will take to conduct your investigation.

Diagram: Draw a labelled diagram of your experimental setup.

IMG BOX

Safety: Explain how you will work safely during this investigation.

Results:

1. Record your results in a table.
2. Present your results in a graph.

Control Test	Prototype Test

Questions:

1. Explain your results. What did you observe?

2. How effective was your prototype? Compare the results of the control test and the test that used your prototype.

3. Explain how your device works using your scientific understanding of states of matter and/or heat transfer.

4. Was the investigation fair? Why or why not?

5. Reflect on your investigation. What worked well and what was challenging?

6. How could you improve your investigation?

Improve Your Design

How could you change or modify your design to make your device more effective? You may like to draw a labelled diagram of your new and improved design.

Modification	How would this improve your designed solution?

IMG BOX

You could make these modifications to your prototype and then repeat the scientific investigation to determine the impacts of these changes.

Evaluate and Reflect

Reflect on the design challenge and the design process with your team or class. You might like to think about the following questions to assist with your reflection:

- What scientific knowledge helped you make decisions about your design?
- What aspects of your device are you very satisfied with? Why?
- If you had more time, what would you do next?
- If you started again, what would you do differently?
- Consider the main challenges you experienced during the design process. How did you overcome these challenges?
- What have you learnt about science or design from this activity?
- Is there anything that you would like to keep exploring or find out more about?

Cool Inventions: Make Me Want That Device!

You have designed your cooling device, and now it is time to sell it! Create an advertisement that persuades people to purchase your product. Consider:

- Who is your target audience?
- How will you advertise your device? Will you produce a print, television, radio or digital advert?
- What persuasive language will make your device a 'must have' item?
- What visual effects will you use? Think carefully about images, fonts and colours.

Describe or draw your advertisement in the space below.

IMG BOX

Evaporation Innovation: Design Challenge

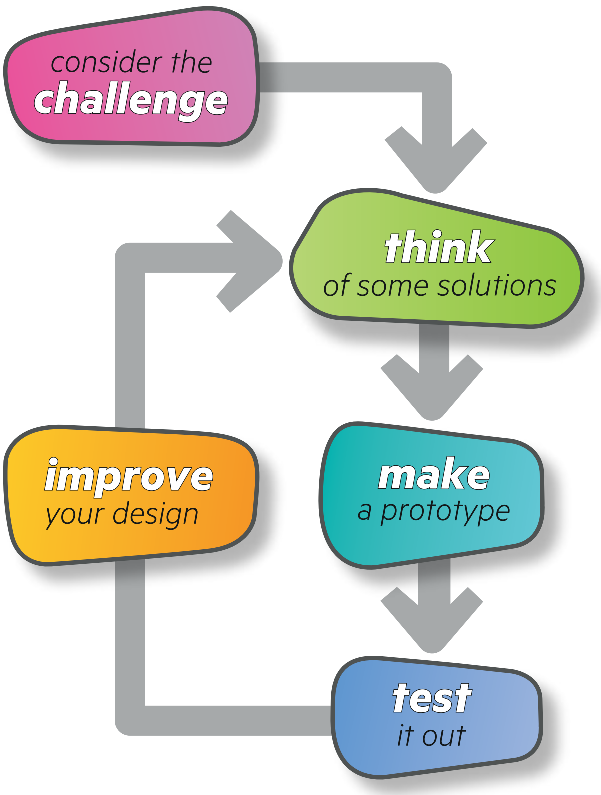
Teacher Resource

Australia is the world's driest populated continent, receiving low average annual rainfall that is both unevenly distributed across the continent and highly variable. The conservation of water is therefore an important strategy to ensure the effective and sustainable management of water now and into the future.

In this activity, students are engineers tasked with developing an innovative solution that will reduce the amount of evaporation experienced by a local dam, reservoir or weir. Evaporation can result in the loss of large volumes of water. For instance, Brisbane's three main water supply reservoirs (Wivenhoe, North Pine and Somerset) can lose 248 GL/year to evaporation[4]; this is equivalent to 99,200 Olympic sized swimming pools!

Students may develop their solution for a real or imagined dam, reservoir or weir. Information about various operational dams, reservoirs and weirs across Queensland is provided on page 78.

Students follow a design process (see below) to complete this activity. Additional information regarding specific aspects of the design challenge can be found on the following pages.



The design process students will follow to complete this design challenge.

4 Burn, S. (2011). Future urban water supplies. In Prosser, I (Ed.), Water (pp. 89-104). Australia: CSIRO Publishing. Retrieved from: https://www.publish.csiro.au/ebook/download/pdf/6557

Consider the Challenge

1. Students explore the importance of water resources and how water is used in their local community. They work collaboratively to identify factors that impact the availability of water and methods used to conserve water resources.

   Here, you may wish to facilitate a class discussion by conducting a Think-Pair-Share where students consider the following questions:

   - Why is water important?
   - How is water used in our local community?
   - What might impact the availability of water?
   - How could we, or do we, conserve water resources?

   Throughout this process, encourage students to listen attentively, build on and connect ideas, respect the thoughts of others and disagree reasonably and respectfully.

   After discussing these questions with students, highlight how the process of evaporation impacts water resources and that finding ways to reduce evaporation is one strategy that could help to ensure the effective and sustainable management of water now and into the future.

2. Introduce students to the design challenge, explaining that: ***A regional council has selected your engineering company to design a solution that will reduce the amount of evaporation currently experienced by a local dam.***

3. Students research key information about a local dam, including factors that could influence their innovation designs. This could include information on the location, size, current evaporation rates and the environmental importance of the dam and how it is used by the community. To complete this task, students could:

   - Locate relevant information about various state waterbodies from the *Queensland Dams, Reservoirs and Weirs Information Sheet* (page 78) or via other online resources.
   - Locate and upload a photo of the local dam for which they are designing their solution in the *Student Activity*. Students could use digital resources such as Google Maps to include a satellite image showing the location of the waterbody.
   - Hold a 'community meeting' where students discuss their experiences with the waterbody as a class group. Prompt students to consider any concerns they may have about the use of potential innovations (environmental impacts or community concerns).

4. Work with students to develop success criteria for their innovations. The following questions and prompts may be useful in guiding your students through this stage of the design process:

   - What are the requirements of the design challenge?
   - How will you know if your design is effective at reducing evaporation?
   - How will you know if your design is suitable for the local area? (Consider potential environmental or social/community impacts).
   - What factors would you have to consider when designing your innovation?

Think of Some Solutions

1. Students explore how people in design and technologies fields have responded to similar issues by researching an innovation that has been designed to reduce evaporation. Students read about and/or analyse images of one of the following designed solutions:
   - News article/video: Those 96 million black balls in LA's reservoir are not just there to save water
   - News article: Millions of little plastic balls could stop evaporation from water storages
   - Radio interview: Using recycled plastic bottles to reduce evaporation
   - News article: Floating discs have evaporation covered
   - News article: First solar canal project is a win for water, energy, air and climate in California

   You may wish to facilitate a class discussion for students to share information about their chosen innovation, suggest explanations for how their innovation reduces evaporation and evaluate the potential environmental and social impacts of the innovation.

   Students could then work in pairs or small groups to compare and contrast the designed solutions they researched. After comparing and contrasting in small groups, students could return to a full class discussion and share any ideas as a larger group.

2. Share or negotiate any specific challenge requirements. These may include:
   - Size of student groups (recommended three to four students per group)
   - Student roles
   - Available materials and equipment
   - Time limits students have to complete the challenge

3. Divide students into groups and provide them with time to brainstorm ideas for innovations. Students create diagrams of possible designs, consider the different parts or components of their designs and identify what materials they could be constructed from.

Make a Prototype

1. Ask students to discuss their initial innovation designs and to select a design they would like to further develop.

2. Students create a labelled diagram of their design, identifying the materials required to construct their prototype. Students should consider the properties of these materials and justify their selections.

3. Students then work collaboratively to construct a prototype of their innovations using everyday materials. Materials required to complete the design challenge will vary depending on students' designs. Suggested materials for the *Evaporation Innovation Design Challenge* are listed on the following pages.

The following questions and prompts may be useful in guiding your students through this stage of the design process:

- What materials could you use in your design?
- How will the properties of different materials affect what you use?
- How will you work safely?
- Now that you are making your design, how suitable are the materials? What changes might you need to make to your innovation's design?

Test It Out

Students plan and conduct a scientific investigation to test the effectiveness of their designed solutions. Details about suggested methods for testing student prototypes can be found below.

1. Students fill two identical plastic containers with the same volume of water (shallow containers with large surface areas are recommended as they will provide the fastest results).
2. Students attach their prototypes to one of the containers.
3. Students place the two containers in a location outside (in full sunlight) where they are unlikely to be disturbed.
4. Students measure and record the amount of evaporation that occurs in each container over a period of time. This could be achieved by creating a scale on the side of the container (to measure and compare water height) or by measuring the volume of water in each container. Students may take a number of measurements (on separate days) or one measurement at the end of the experiment.
5. Students compare collected data to determine how effective their innovation was in reducing evaporation.

Improve Your Design

Students reflect on their scientific investigation and evaluate the effectiveness of their designed solutions. Students suggest changes that could be made to further improve their designs. Such changes could include modifications to further reduce evaporation or to improve environmental or social outcomes of the designed solution.

If time allows, students could make modifications to their prototypes and repeat the scientific investigation to determine the impacts of any changes.

Evaluate

Encourage students to reflect on their experiences (either within their teams or as a class group) after they have completed the design challenge. Students may like to think about the following questions to assist with their reflection:

- What scientific knowledge helped you make decisions about your designed solution?
- What aspects of your designed solution are you very satisfied with and why?
- Describe any further changes you could make to improve the designed solution.
- If you started again, what would you do differently?
- What were the main challenges you experienced during the design process? How did you overcome these challenges?
- What have you learnt about evaporation and the design process from this activity?
- How could you apply this knowledge and understanding to your learning in other contexts?
- What more would we like to know about evaporation?

Pitching Your Evaporation Innovation: Optional Extension Task

After students have designed and tested their prototypes, they could pitch their final innovation to the regional council (you and your class). Students could explain how their design conserves water (providing evidence from their scientific investigation) and aim to persuade the council to invest in and construct a full-scale version of the innovation.

This task supports the Year 5 English Achievement Standard, during which students create persuasive texts for different purposes and audiences and make presentations which include multimodal elements for defined purposes.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

Science as a Human Endeavour

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

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

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

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)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Reflect on and suggest improvements to scientific investigations (ACSIS091)

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

Design and Technology

YEARS 5 & 6

Design and Technologies: Knowledge and Understanding

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

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

Design and Technologies: Processes and Production Skills

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

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

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

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

English

YEAR 5

Literacy

Use interaction skills, for example paraphrasing, questioning and interpreting non-verbal cues and choose vocabulary and vocal effects appropriate for different audiences and purposes (ACELY1796)

Plan, rehearse and deliver presentations for defined audiences and purposes incorporating accurate and sequenced content and multimodal elements (ACELY1700)

Plan, draft and publish imaginative, informative and persuasive print and multimodal texts, choosing text structures, language features, images and sound appropriate to purpose and audience (ACELY1704)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Estimating and calculating with whole numbers

Using measurement

ICT Capability

Investigating with ICT

Creating with ICT

Critical and Creative Thinking

Inquiring – Identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social awareness

Social management

Cross Curriculum Priorities

Sustainability

Sustainable futures result from actions designed to preserve and/or restore the quality and uniqueness of environments (OI.9)

Evaporation Innovation

Teacher Resource

Information Sheet – Queensland Dams, Reservoirs and Weirs

Note: Approximate figures are used for surface area, depth and residential water use.

Name	City	Surface Area[5] (m^2)	Depth[6] (m)	Evaporation Rate[6] (mm/year)	Total Evaporation[7] (ML/year)
Wivenhoe Dam	Brisbane	108,000,000	59	1600	172,800
Copperlode Falls Dam	Cairns	3,327,000	45	1800	5,989
Chinchilla Weir	Chinchilla	3,580,000	9.2	1800	6,444
Fairbairn Dam	Emerald	150,000,000	46	2000	300,000
Awoonga Dam	Gladstone	67,800,000	53	2000	135,600
Hinze Dam	Gold Coast	9,720,000	62	1600	15,552
Borumba Dam	Gympie	4,800,00	43	1600	768
Lenthalls Dam	Hervey Bay	7,000,000	32	1600	11,200
Wivenhoe Dam	Ipswich	108,000,000	59	1400	151,200
Wivenhoe Dam	Logan	108,000,000	59	1600	172,800
Dumbleton Weir	Mackay	1,510,000	15	2000	3,020
North Pine Dam	Moreton Bay	21,800,000	45	1600	34,880
Moondarra Dam	Mount Isa	21,900,000	27.5	2800	61,320
Peter Faust Dam	Proserpine	43,250,000	51	1800	77,850
Fitzroy River Barrage	Rockhampton	16,120,000	10	2000	32,240
Storm King Dam	Stanthorpe	830,000	10	1400	1,162
Ewen Maddock Dam	Sunshine Coast	3,710,000	11.4	1600	5,936
Baroon Pocket Dam	Sunshine Coast	3,820,000	58	1600	6,112
Cressbrook Dam	Toowoomba	5,170,000	59	1600	8,272
Cooby Creek	Toowoomba	3,014,000	30	1600	4,822
Perseverance Dam	Toowoomba	2,200,000	53	1600	3,520
Ross River Dam	Townsville	82,000,000	34.4	2400	196,800
Leslie Dam	Warwick	12,880,000	33	1600	20,608

5 Australian National Committee on Large Dams Incorporated. (2010). Register of large dams in Australia. Retrieved from https://www.ancold.org.au/wp-content/uploads/2012/10/Dams-Australia-2010-v1.xls

6 Bureau of Meteorology. (2003). Average evaporation map – Annual. Retrieved from http://www.bom.gov.au/climate/map/evaporation/evap_ann.shtml

7 Calculated using surface area and evaporation rate data. Sample calculation for Wivenhoe Dam provided below.
Dam Evaporation (/year) = Surface Area x Evaporation Rate
= 108,000,000 m2 x 1.6 m
= 172,800,000 m3
= 172,800 ML

Evaporation Innovation

Teacher Resource

Material Suggestions

We recommend the following materials for use when facilitating this design challenge in your classroom. You can substitute some materials for others or provide additional materials that are not listed below.

Surface Materials:

- Fabric
- Aluminium foil
- Recycled plastics
- Cellophane
- Milk bottle lids or similar
- Cardboard
- Paper
- Foam
- Table tennis balls
- Netting or mesh

Structural Materials:

- Paddlepop sticks
- Straws
- Skewers
- Marbles
- Lego/Meccano

Connecting Materials:

- Pipe cleaners
- Rubber bands
- String
- Masking tape
- Blu-Tack

Evaporation Innovation: Design Challenge

Student Activity

Task:

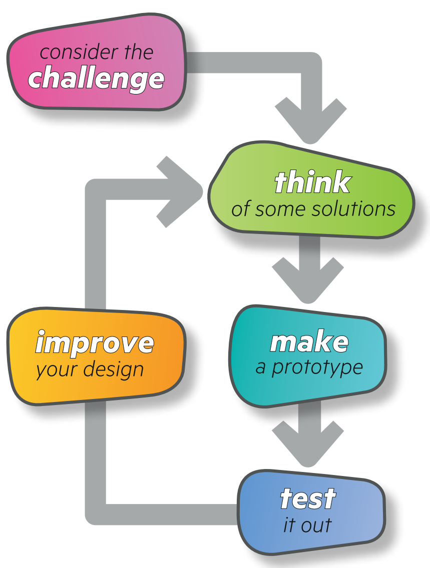
A regional council has selected your engineering company to design a solution that will reduce the amount of evaporation currently experienced by a local dam. The regional council is located in a drought prone area. The council hopes the solution developed by your company will help to conserve water. You will present your final solution to representatives from the council (your class and teacher).

You will:

- **Consider the challenge:** Why is important to reduce evaporation and conserve water resources? Research the local dam and develop criteria that solutions would need to meet to successfully address the problem (success criteria).
- **Think of some solutions:** Explore how people in design and technologies fields have responded to similar issues. Research, analyse and evaluate an innovation that has been designed to reduce evaporation.

  Brainstorm possible ideas for your innovation. When thinking of solutions, you should consider:

  - Success criteria (what will your innovation need to achieve to be successful).
  - The materials and equipment used to construct your design, including their characteristics, properties and costs.
  - The sustainability of your solution, as well as its impacts on the environment and the local community.
- **Make a prototype:** Design an innovative solution that will reduce the amount of evaporation experienced by the dam. Construct a prototype out of everyday materials.
- **Test it out:** Test your innovation by conducting a scientific investigation. How effective is your design at reducing evaporation?
- **Improve your design:** Evaluate your innovation against the success criteria, and suggest changes to improve the effectiveness of your design.



Consider the Challenge

1. Why is water important?

2. What factors impact the availability of water?

3. How is water used in our local community?

4. How could we conserve water resources?

5. Research the following information about the local dam. What information do you need to know before designing your innovation?

IMG BOX	
Dam Name	
Location	
Surface Area (m^2)	
Depth (m)	
Evaporation (ML/year)	
Environmental Importance	
Community Use	

6. Use this information to develop criteria your designed solution would need to meet to successfully address the problem (success criteria).

Think of Some Solutions

Innovation Analysis

1. People in design and technologies fields from around the world have designed innovations to reduce evaporation. Select an innovation from the list below and research how it is designed to conserve water.

   a. News article/video:: Those 96 million black balls in LA's reservoir are not just there to save water

   b. News article: Millions of little plastic balls could stop evaporation from water storages

   c. Radio interview: Using recycled plastic bottles to reduce evaporation

   d. News article: Floating discs have evaporation covered

   e. News article: First solar canal project is a win for water, energy, air and climate in California

   Describe your chosen innovation. Your description should include information about the innovation's design and the materials it is made from. You may like to include a diagram.

IMG BOX

2. There are a number of factors that influence how much evaporation is experienced by a waterbody. The table below lists some of these factors and the effects that they have on evaporation.

Factor	**Effect on Evaporation**
Temperature	Higher temperatures increase evaporation.
Surface Area	Waterbodies with large surface areas experience more evaporation than those with smaller surface areas.
Wind Speed	Movement of air over the waterbody increases evaporation.
Humidity	Evaporation is affected by the amount of moisture in the air (humidity). Humid environments experience less evaporation than dry environments.

Use this information to suggest how your chosen innovation reduces evaporation.

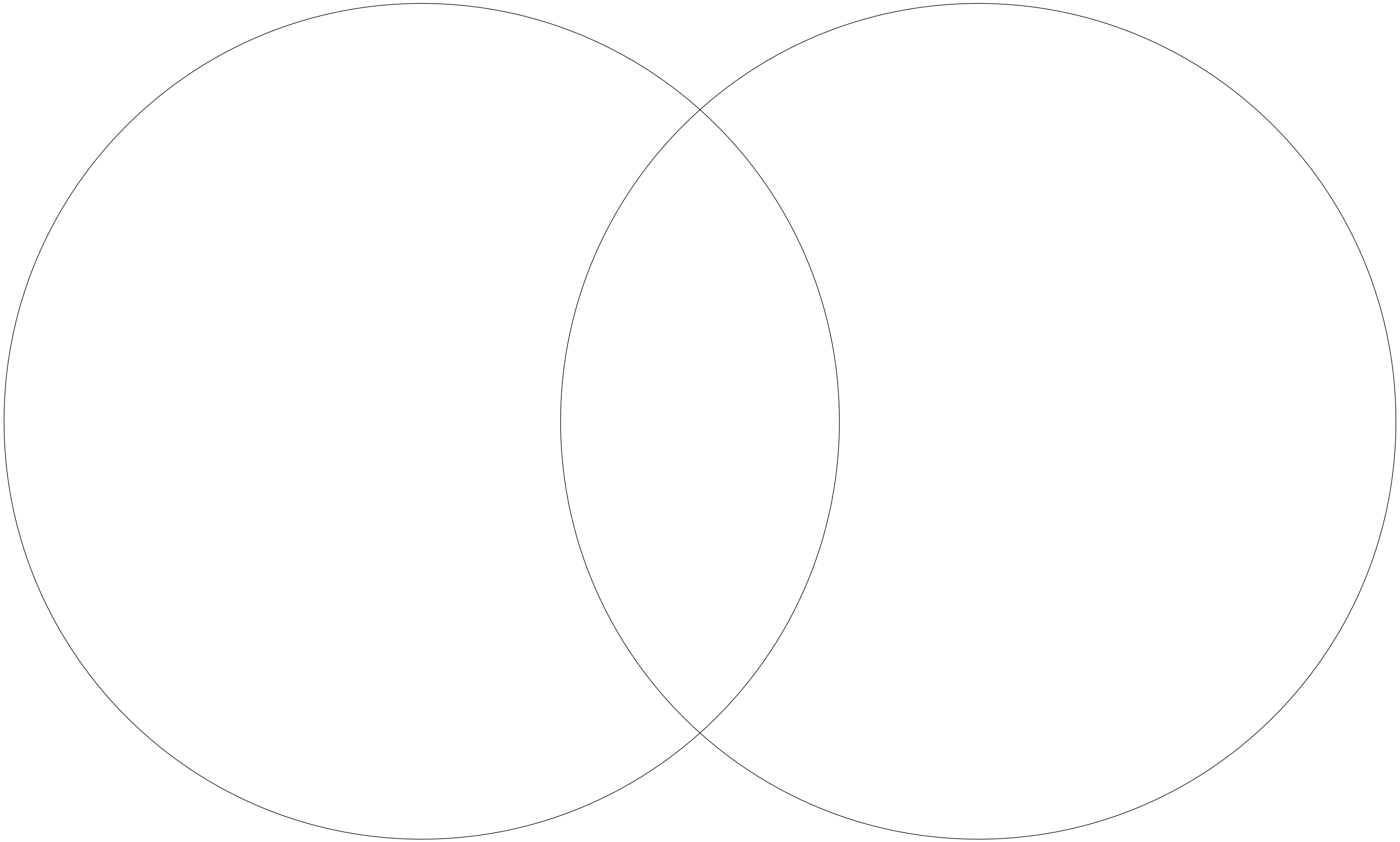
3. Evaluate the sustainability of the innovation and any impacts it may have on the environment or the local community. List any advantages or positive aspects in the plus column, any disadvantages or negative aspects in the minus column, and any other interesting thoughts or questions in the interesting column

Plus	**Minus**	**Interesting**

4. Compare your chosen innovation with an innovation selected by another group. How are the designs similar or different?

Innovation 1:

Innovation 2:



5. Now it's time to brainstorm some designs!

   What ideas do you have for innovations that could reduce evaporation?

   Draw diagrams of your possible designs below. At this stage, you could also think about what parts your design will have and what materials these parts could be constructed from.

IMG BOX	IMG BOX
IMG BOX	IMG BOX

Make a Prototype

1. Work with your team to examine the designs you have brainstormed. Which design do you think would be most effective at reducing evaporation and most suitable for your local dam?

   As a team, select a design that you would like to explore further. You will and construct a prototype of this design. Draw a labelled diagram of this designed solution.

IMG BOX

2. What materials will you use to construct your prototype? Consider the properties of materials and explain why you have selected them.

Material	**Reasons for selecting material**

Now, create a prototype of your innovation!

Test It Out

Conduct a scientific investigation to test the effectiveness of your prototype.

Aim: To investigate how effective your prototype is at reducing evaporation.

Variables: Decide which variables should be changed, measured or kept the same in your investigation.

Independent variable What will you change?	**Dependent variable** What will you measure/observe?	**Controlled variables** What will you keep the same?

Materials: Identify the equipment and materials your group will need to complete your investigation. Remember to include numbers and amounts.

Method: Develop a method to investigate your question. List the steps you will take to conduct your investigation.

Diagram: Draw a labelled diagram of your experimental setup.

IMG BOX

Risk Assessment: How will you use equipment and materials safely during this investigation? Identify at least four potential risks and how to minimise them.

Potential risks	How to minimise risks

Results:

1. Record your results in a table (you may wish to use Excel for the table and graph).
2. Present your results in a graph.

Control Test	Prototype Test

Discussion:

1. Explain your results. What did you observe?

2. Justify the effectiveness of your prototype. Compare the results of the control test and the test which used your prototype.

3. Explain how your innovation works using your scientific understanding of states of matter. Why do you think you observed these results?

4. Explain any challenges you experienced completing this investigation. How did or could you overcome them?

5. Suggest how you could improve the investigation to increase the fairness of the test.

Improve Your Design

1. Evaluate your designed solution against the success criteria.

2. Suggest how you could modify your design to improve its effectiveness.

Modification	How would this improve your designed solution?

You could make these modifications to your prototype and then repeat the scientific investigation to determine the impacts of these changes.

Evaluate and Reflect

Reflect on the design challenge and the design process with your team or class. You might like to think about the following questions to assist with your reflection:

- Explain how scientific knowledge helped you make decisions about your innovation design.
- What aspects of your innovation are you very satisfied with? Explain why.
- Describe any further changes you could make to improve your innovation.
- Consider the main challenges you experienced during the design process. How did you overcome these challenges?
- Describe what you have learnt about evaporation from this activity.
- Discuss what you learnt about the design process from this activity.
- How could you apply this knowledge and understanding to your learning in other contexts?
- What more would you like to know about evaporation?

Pitching Your Evaporation Innovation

Pitch your final innovation to the regional council (your class and teacher). Explain how your design conserves water and why the council should move ahead with and construct a full-scale version of your innovation.