Cool Inventions: Maker Space Challenge

YEAR 3 AND 5
CHEMICAL SCIENCES
PHYSICAL SCIENCES
DESIGN AND TECHNOLOGIES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum Network 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 NETWORK

Queensland Government

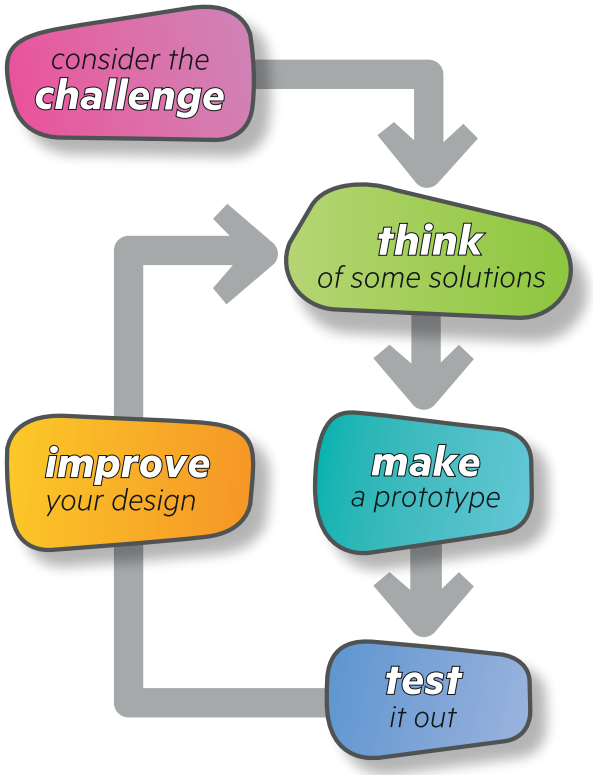
ELABORATE - EVALUATE

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*. 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

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.

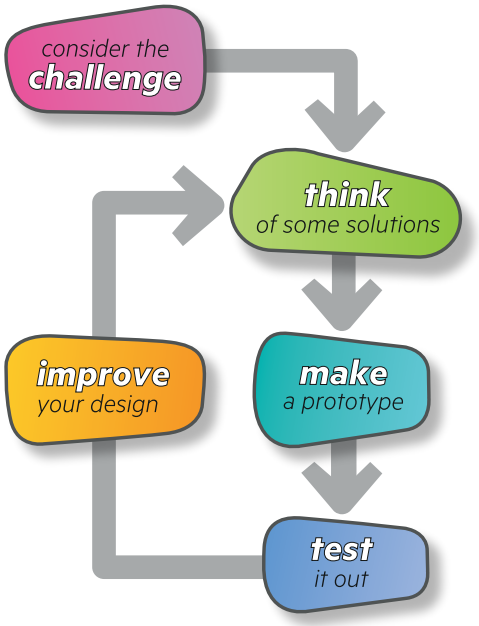
- **Test it out:**

  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.

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.

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.

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.

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?

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.

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.

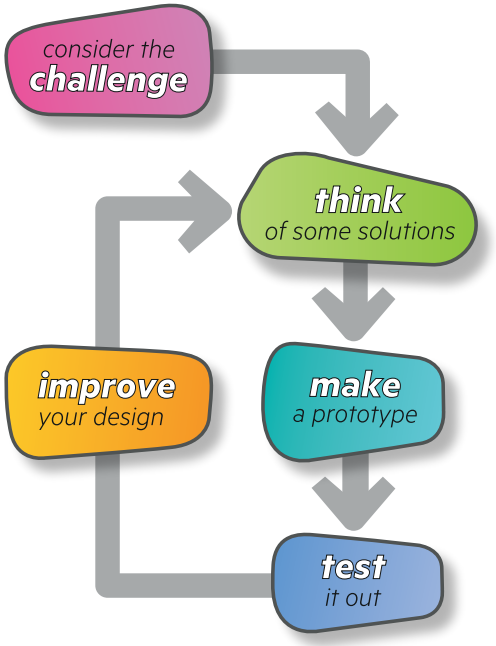
- **Test it out:**

  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.

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.

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.

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.

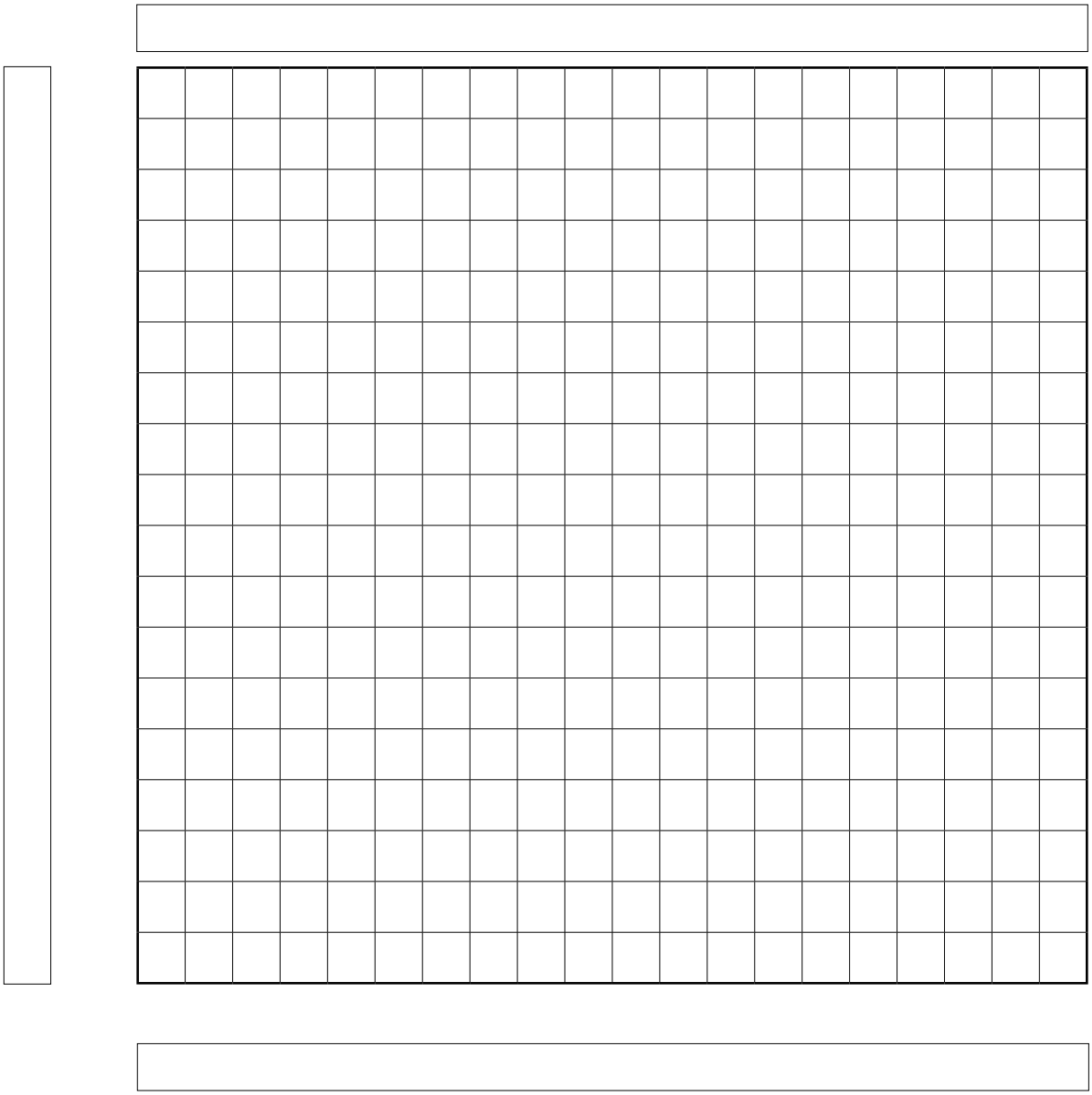
Diagram: Draw a labelled diagram of your experimental setup.

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?

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?
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