Stage 4 Working Scientifically and Physical World - Cooling rate of water

## Outcomes

### Values and attitudes

* SC4-1VA student appreciates the importance of science in their lives and the role of scientific inquiry in increasing understanding of the world around them

### Working scientifically

**SC4-4WS** identifies questions and predictions that can be tested or researched and makes predictions based on scientific knowledge

* WS4 Students question and predict by:
	+ B. making predictions based on scientific knowledge and their own observations (ACSIS124, ACSIS139)

**SC4-5WS** collaboratively and individually produces a plan to investigate questions and problems

* WS5.1 Students identify data to be collected in an investigation by:
	+ B. proposing the type of information and data that needs to be collected in a range of investigation types, including first-hand and secondary sources
* WS5.2 Students plan first-hand investigations by:
	+ B. outlining a logical procedure for undertaking a range of investigations to collect valid first-hand data, including fair tests
	+ C. identifying in fair tests, variables to be controlled (held constant), measured and changed
* WS5.3 Students choose equipment or resources for an investigation by:
	+ A. identifying suitable equipment or resources to perform the task, including safety equipment and digital technologies
	+ B. selecting equipment to collect data with accuracy appropriate to the task (ACSIS126, ACSIS141)

**SC4-6WS** follows a sequence of instructions to safely undertake a range of investigation types, collaboratively and individually

* WS 6 Students conduct investigations by:
	+ C. selecting equipment to collect data with accuracy appropriate to the task (ACSIS126, ACSIS141)

### Knowledge and understanding

SC4-11 PW discusses how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations

* PW3 Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes changes within systems (ACSSU155)
	+ B. describe the transfer of heat energy by conduction, convection and radiation, including situations in which each occurs.

## Learning across the curriculum

### General capabilities

* Critical and creative thinking
* Information and communication technology capability
* Numeracy
* Personal and social capability

**Teacher notes**

This task is intended to be a formative skill-based task which aims at providing feedback to students as well as allowing students the opportunity to self-reflect on the completion of a practical task.

There is opportunity to use the scaffold and a brainstorming activity to differentiate for some learners.

Teachers can use the materials check sheet as either a shopping list or as a grab-bag of items brought to class so students can see what they may use when planning. The task can be extended or modified to include the conduction of an experiment in following lessons.

The rubric uses syllabus outcomes and outlines expectations from the [Science 7-10 course performance descriptors](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/science/cpd) for students for each of the outcomes. Teachers can assess student achievement level as basic, sound or high. The rubric may be duplicated or simplified for students to assess their peers and/or complete a self-reflection. The assessment rubric does not include presentation of data. The task is aimed at observing and giving feedback to students for producing a plan to investigate an identified problem. Conducting investigations (WS6), presentation of data (WS7) and writing scientific reports (WS9) can be added into the rubric if the task runs over several lessons. Collection of the results is a good opportunity for students to record measurements accurately and organise collected data. A class discussion about the results of different predictions can result in a number of conclusions that relate to the inquiry question, confirming that there is no single right answer.

This task can be extended beyond an in-class assessment to create a project based learning task within a unit of work where students can create a feasible product or device to increase the efficiency of energy conversions (Physical World strand).

## Introduction

Heat can be transferred in three ways, each involving heat moving from a hot object to a cold one. Heat will always transfer from hot to cold. Teachers could have students write definitions of these terms prior to the activity.

1. Conduction – the transfer of energy in a solid object by rapid vibration of atoms.
2. Convection – the transfer of heat energy through a liquid or gas by the movement of atoms.
3. Radiation – the emission of electromagnetic radiation from a source.

Keeping warm involves reducing the transfer of heat. To reduce the transfer of heat by conduction, an object can be insulated. Substances can either be conductors or insulators of heat energy.

1. Conductors allow energy to easily flow through them, for example metals.
2. Insulators decrease the flow of energy through them, for example plastics.

## Task – what affects the rate of cooling hot water?

Have you ever had to put up with a warm tea rather than a hot one? Or been disappointed by the quality of a hot chocolate because it’s gone cold?

Plan an investigation to answer what affects the rate of cooling hot water?

### **Instructions:**

1. You will have one lesson to plan your investigation.
2. You do not have to write an experimental report, but will need to provide reasons for all your choices. Use the scaffold provided to cover the skills outcomes being developed.
3. You do not need to perform an experiment for this task, however your plan may be used later for you to demonstrate your skills in conducting an investigation

The following range of materials are suggested only.

* Foam cups
* Plastic cups
* Paper cups
* 50 mL glass beakers
* 100 mL glass beakers
* 250 mL glass beakers
* 50 mL conical flasks
* Aluminium cans
* Plastic bottles
* Plastic containers of various shapes
* Cotton wool
* Aluminium foil
* Silk
* Flannel, wool or similar material
* Sticky tape or masking tape
* Thermometers: digital and/or analog
* Stopwatches
* 50 and 100 mL measuring cylinders
* Other

**To achieve the outcomes, you will need to show evidence that you have:**

* Brainstormed some of the things which may affect how fast hot water cools down.
* Listed your ideas in your log. A log is a record of all the thinking, planning and conducting of your investigation.
* Chosen one to investigate during your practical assessment. Rewrite your idea as a prediction,
* You will need to have chosen the equipment for your investigation after you have identified your changed and measured variables and the variables that need controlling. Considering the data to be collected and then using all of this information, your method or procedure will be written.
* Described how you would measure, and record any collected data
* Discussed how you will make your investigation safe by identifying any risks and how they will be addressed.

**Starting hint**: only use hot water from the tap to minimise harm from scalding.

### Brainstorming

1. What things might affect the way water cools down? You may like to review the information provided on heat transfer or think about objects in everyday life that allow cooling rate to be faster or slower.
2. Which one will you be investigating? What is the variable you will change?
3. What will you be comparing to improve your understanding of how this affects the way water cools down? How will you know? What type of information can you collect that will provide evidence for your prediction?
4. What will you be measuring? What is the variable that will be measured?
5. What type of data or information will you be collecting?
6. What things are you keeping the same to make your investigation fair? What are your controlled variables?

### Investigation log scaffold

1. **Brainstorming:** Jot down your brainstorming ideas
2. **Prediction:** Rewrite the idea you will be investigating as a prediction, or an if/then statement. For example: “If I stir the sugar in the tea, then the sugar will dissolve more quickly”.
3. **Identifying variables:** Identify the changed variable and the measured variable and which variables must be controlled.
4. **Making and representing measurements:** Describe how you will accurately measure and record any collected data
5. **Procedure:** Outline the procedure you will be using. You can use a flow chart, labelled diagram or written procedure format.
6. **Risk assessment:** What risks are there and what steps are you taking to make sure the investigation is safe?

**Starting hint**: only use hot water from the tap to minimise harm from scalding.

## Marking guideline/rubric

This marking rubric can be replicated or simplified for student self-reflection and peer review.

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| Outcomes description | Task expectation | Achievement Level |
| WS4b Making predictions based on scientific knowledge and their own observations | Makes a logical prediction based on evidence from scientific knowledge and/or their own observations | BasicSoundHigh |
| WS5.1b Proposing the type of information and data that needs to be collected | Shows clear evidence of selection of the type of data required to gain relevant information about the dependent (measured) variable | BasicSoundHigh |
| WS5.2c Identifying in fair tests, variables to be controlled (held constant), measured and changed. | Competently produces a plan to investigate a question that shows evidence of: * Identifying a single variable to change.
* Identifying the related variable to measure.
* Identifying factors to be controlled.
 | BasicSoundHigh |
| WS5.3b and WS6c Selecting equipment to collect data with accuracy appropriate to the task | Competently produces a plan to investigate a question by considering the method of the accurate measurement and units of both the independent (changed) and dependent (measured) variables | BasicSoundHigh |
| WS5.2b Outlining a logical procedure for undertaking a range of investigations to collect valid first-hand data, including fair tests | Creates, plans and organises safe first-hand investigations showing evidence of accurately measuring the independent (changed) and dependent (measured) variables and controlling all others to ensure a fair test. (Optional: Measurements are repeated to improve reliability of data and evidence that the investigation may be replicated) | BasicSoundHigh |
| WS5.3a Identifying suitable equipment or resources to perform the task, including safety equipment | Identifies risks and hazards and describes ways to minimise the risk | BasicSoundHigh |