

Heat Energy: Powering our World – Year 3

Heat is a form of energy and is the energy of molecules moving, and is vital to our world. The sun is one source of heat energy with heat also being produced by fire, chemicals and electricity. Heat changes solids to liquids, raises the temperature of objects and can be used as an energy source for cooking.

This resource has been produced to align to the content descriptions of the Australian Science Curriculum for Year three students. It incorporates the 5Es instructional model to scaffold the learning of science. This resource suggests a sequence of lessons aligned to the 5Es (Engage, Explore, Explain, Elaborate and Evaluate). For each lesson in the sequence, the resource provides: a set of lesson-specific content descriptions; step-by-step guidance and support for classroom activities which develop the students' understanding of the content; and a set of learning outcomes for the lesson. When considered together, the lessons' outcomes represent unit outcomes that align with the standards of achievement defined in the National Curriculum.

Resource Overview

This resource has been designed to align to the content descriptions of the Australian Curriculum for Year Three, with a particular focus on Science. The resource includes the following elements, presented approximately in the order of appearance through this document:

- Those Australian Science Curriculum content descriptions which are directly relevant to the topic of Heat Energy have been identified, to match the topic. These content descriptions form the basis of this unit, and are referred to as the **unit-level content descriptions**.
- Based upon the unit-level content descriptions, a set of **unit outcomes** is defined. These outcomes have been phrased using similar language and expectations as defined in the Achievement Standard for Year Three found in the Australian Science Curriculum. These outcomes include not only those related directly science, but also those related to literacy and numeracy (i.e., how language and maths is used in science).
- The phases of the 5Es instructional model¹ have been used to sequence the lessons proposed in this unit. For each phase, one or more lessons are used to address the instructional aims of each phase. A **unit planner** is provided which summarises the correspondence between the phases of the 5Es instructional model, the sequence of lessons, the lesson-level content descriptions, and the assessment of learning outcomes.
- Provision of suitable **content summary**, including links to external resources, which may be used to guide the teacher's development and application of classroom activities.
- For each lesson:
 - One or more unit-level content descriptions are selected and refined with further detail to form the basis of the lesson, and are referred to as the **lesson-level content descriptions**.
 - A set of **lesson outcomes** is defined which complement the lesson-level content descriptions and which support the evaluation of the unit outcomes.
 - Elaboration of the **content matter** covered in the lesson.
 - A **preparation list** of those resources and activities that should be prepared prior to the lesson.
 - Proposition of a step-by-step **task sequence** for the lesson, and where appropriate the splitting of lessons into two or more **sessions**.
 - The integration of diagnostic, formative and summative **assessment tasks** into the lesson's activity sequence, such that suitable evidence is generated by which to evaluate the achievement of the lesson's outcomes, and ultimately the unit's outcomes.
 - Suggestions of possible ways of **linking to other learning areas**, including Mathematics, English and ICT (i.e, other tasks that would complement and support the achievement of outcomes proposed in this unit).

¹ Bybee, R.W. (1997). Achieving Scientific Literacy: From purposes to practical action. Portsmouth, NH: Heinemann.

- Provision of **classroom resources** used in the suggested task sequences (including summaries of useful websites, black line masters, wall charts etc).
- ➊ Provision of **additional resources** which may assist the design and delivery of classroom activities, including content-related material and guidance for the use of pedagogical tools.

Unit-level Content Descriptions

The following table identifies, for each of the three strands of the Australian National Science Curriculum, the Year Three content descriptions that are directly relevant to this unit. Additionally, each of the identified content descriptions has been re-phrased in the context of the topic 'Heat energy', and so together constitute the unit-level content descriptions that are the basis for learning in this unit.

Science Inquiry Skills	Science as Human Endeavour	Science Understanding
Work in groups to discuss things that might happen during an investigation (SIS-E)	Understand that science involves making predictions and describing patterns and relationships. (SHE)	Heat can be produced in many ways and can move from one object to another. (SU)
Identify questions in familiar contexts that can be investigated scientifically and predict what might happen, based on prior knowledge (SIS)	Science knowledge helps people to understand the effects of their actions (SHE)	Predict the effect of heat on different materials (SU-E)
Reflect on the investigation, including whether a test was fair or not (SIS)		Identify changes that occur in everyday situations due to heating (SU-E)
Represent and communicate ideas and findings in a variety of ways such as diagrams, and physical representations (SIS)		Understand that a change of state between solid and liquid can be caused by adding...heat. (SU)
		Investigate how liquids and solids respond to changes in temperature. (SU-E)
		Explore how changes from solid to liquid can help us produce and recycle materials (E)
		Recognise that we can feel heat and measure its effects using a thermometer. (E)

Unit Outcomes

Based upon the Achievement Standard statements for year three found in the Science, English and Mathematics Australian National Curricula, the following science, literacy and numeracy outcomes for this unit have been defined.

Science Outcomes

In Year Three, students observe heat and its effects on solids and liquids and begin to develop an understanding of energy flows through simple systems. Students order their observations by classifying and begin to realise that classifications are not always easy to define or apply. They begin to quantify their observations to enable comparisons and learn more sophisticated ways of identifying and

Literacy Outcomes

In Year Three, students communicate with peers and teachers from other classes and schools in a range of face-to-face and online/virtual environments. Students engage with a variety of texts for enjoyment. They listen to, read, view and interpret spoken, written and multimodal texts that include texts designed to inform and persuade. Informative texts present new content about topics of

Numeracy Outcomes

In Year Three, students measure, order and compare objects using familiar units of measurement. They identify questions or issues for categorical variables, identify data sources and plan methods of data collection and recording. Students collect data, organise it into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital

representing relationships including the use of tables and graphs to identify trends. They use their understanding of relationships between components of simple systems to make predictions.

interest and topics being studied in other areas of the curriculum. These texts use complex language features, including varied sentence structures, some unfamiliar vocabulary as well as illustrations and diagrams that both support and extend the printed text. Students create a range of informative and persuasive types of texts including procedures, reports and expositions.

technologies, then interpret and compare data displays.

Unit Planner

Phase	Lesson	Lesson-level Content Descriptions	Assessment of Lesson Outcomes
Engage	Lesson 1 How about heat	Students show what they think that they know about heat by responding to images, objects and statements that relate to heat.	Diagnostically assess whether students are able to write or draw what they think that they know about heat energy, by responding to stimulus statements, objects and images.
Explore	Lesson 2 Surface search	Students develop understandings about the effect of heat on a range of surfaces.	Formatively assess whether students are able to record observations about the apparent temperatures of surfaces and data about the actual temperature of surfaces in different locations.
Explore	Lesson 3 Solid to liquid	Students explore the effect of heat in causing changes in states of matter.	Formatively assess whether students are able to complete observation record sheets and write reason to explain changes or any lack of change in materials being tested.
Explore	Lesson 4 Colours are cool	Students explore the relationship between colours and rates of heating.	Formatively assess whether students are able to use thermometers accurately and record data including temperatures and time intervals.
Explore	Lesson 5 Melt it quickly	Students explore the effect of colours and heat energy in changing solids to liquids.	Formatively assess whether students are able to record observations and share and discuss data with other students.
Explain	Lesson 6 Rock to can	Students develop explanations about how heat is used to change solids to liquids and the amount of heat necessary to cause changes in states of matter.	Formatively assess whether students are able to produce labelled flow-charts showing at least two processes (a simple process and a more complex process) where heat is used to cause a change of state.
Elaborate	Lesson 7 Cook with the sun	Students design, make and use solar heaters to change the appearance and state of edible solids or liquids.	Formatively assess whether students are able to design, make, use and evaluate the effectiveness of a solar heater, give a brief oral presentation then produce a labelled diagram with written comments about the functioning of the heater.
Evaluate	Lesson 8 Heat helpers	Students show and share their understandings and knowledge about heat energy, through producing a literacy product.	Summatively assess whether students are able to produce a literacy product to demonstrate what has been learnt about heat energy and its applications in the local community.



Engage

Lesson 1 : How about heat

In this lesson, students will

- show what they think they know about heat by responding to images, objects and statements that relate to heat.

Lesson-level Content Descriptions

Objects and images related to heat, and statements including both scientific and everyday language will form the basis of the Engage lesson, as well as a teacher demonstration of a heat source. Students will be expected to respond to the statements, objects and images as a way of showing what they think they know about heat.

Lesson Outcomes

Science Outcomes

Understand that heat can be produced in many ways and can move from one object to another. (SU)

Literacy Outcomes

Listen to and contribute to conversations and discussions to share information and ideas (ACELY 1676)

Content Matter

When responding to images, objects and statements, students may demonstrate misconceptions or alternative conceptions about heat and its transfer. Misconceptions may include thinking that heat is not a form of energy and that materials that keep things warm are sources of heat instead of understanding that materials trap or insulate heat. (National Science Education standards)

During the Engage phase, accept students' responses and ensure that lessons in the Explore phase provide experiences about heat sources, heat energy and heat transfer.

Preparation List

Preparation prior to lesson

- Source images and objects.
- Place each image and statement on a separate piece of A3/ chart paper with space around the edges for students to place post-it notes.
- Ensure that any electrical appliances have been tested and tagged (WHS requirements)
- Source spirit thermometers, preferably in safety packaging. Note that mercury thermometers are not to be used, due to hazard risks
- Set up displays of objects, images and statements as task stations around the room, for groups to move to in turn.
- Display the continuum headings and place several thermometers in the room including at points along the continuum.
- Ensure that the purpose of the Engage phase occurs during the lesson.



Equipment

- Images placed on A3 / chart paper(see Resource Sheet # 1/2 for suggested ideas)
- Objects related to heat e.g. gloves, warm jacket, kettle, hairdryer
- Statements on A3 paper (see Resource Sheet #1/1 for suggested statements)
- Post-it notes
- Candle
- Matches
- Metal tray to stand candle on
- Metal spoon with plastic handle
- Chart paper to display images, statements and students' ideas
- Thermometers (spirit)

Task Sequence

1. Ask students to decide whether they feel hot, warm or cold and tell them that they are going to stand wherever they want to along a continuum that ranges from hot to cold. Tell the students that they do not have to be in a conventional line but can group anywhere along the continuum.
2. Show students the A3 sheets with the headings that have been placed at opposite ends of the teaching space and tell them to move to a position on the continuum.
3. Discuss where the students have positioned themselves and ask them to describe how they feel and to give reasons why they have selected their particular position on the continuum.
4. Read each thermometer to measure the room temperature and the temperature at various points along the continuum to find out whether there are any temperature variations within the room. Record locations and temperatures and discuss with students that despite consistency in temperatures, people may feel different. Ask students to suggest reasons for this.
5. Tell the students that they will be rotating around the room to each of the task stations and that they can write and draw ideas on post-its and place the post- its at each task station. Post-its should be placed securely on the actual images and statements. Give minimal information about the task stations e.g. "there are images and objects, and statements, write what you know about them," to maintain the intent of the Engage phase.
6. When the students have completed step five, discuss what they have written or drawn, and display all post-it responses, images and statements on a display board for future reference.
7. Show students a candle, ask students for their ideas about the candle and record their responses on an Ideas Map. Light the candle and select students to feel whether there is any heat coming from the candle. Try heating various substances and observe what happens.
8. Conclude the lesson by introducing the phrase "heat energy" and ask students to reflect on what they have observed and recorded during the lesson.



Resource sheet #1/1

Statements that could be used to stimulate students' thinking.

- I feel hot today.
- Let's go outside where it is warm.
- Water is hot some times.
- I've just ironed your shirt, so don't burn yourself on the iron.
- My ice-cream is melting.
- I need my shoes because the ground is hot.
- Be careful, the gas will burn you.
- Candle flames are very hot and so is the wax.
- Open the window, the car is so hot.
- My gloves and beanie are very warm.
- Turn the fans on to cool down the room.
- The weather forecaster said that it's not going to be very hot tomorrow.
- I feel so cold, please give me my warm jumper.
- This classroom is the hottest place that I've been in.
- Black cars are hotter than white ones.
- This shirt makes me feel cold.



Resource sheet # 1 /2

Images / objects that could be used to stimulate students' thinking:

- Image of sun
- Image of fire
- Thermometer
- Heater
- Hairdryer
- Gloves
- Jacket
- Woollen hat
- Sun-hat
- Image of desert environment
- Image of arctic environment
- Polar bear
- Esky
- Image of volcano erupting
- Sunscreen
- Image of beach on a hot day.
- Candle
- Stove
- Frypan
- Hot food
- Cold food



Explore

Lesson 2: Surface search

In this lesson, students will:

- develop understandings about the effect of heat on a range of surfaces.

Lesson-level Content Descriptions

In the Engage phase, students contributed their ideas about heat through responding to stimulus statements, images and objects, participating in a continuum task and observing a lit candle. Having discovered that their perceptions of heat may be different, students will be testing surfaces to find out if the surfaces appear to be hot or not. In addition students will be exploring how surfaces feel if the students are wearing gloves. They will have the opportunity to compare the amount of heat sensed on surfaces, by using thermometers as standard measuring instruments.

Lesson Outcomes

Science Outcomes

Recognise that we can feel heat and measure its effects using a thermometer. (E)

Understand that science involves making predictions and describing patterns and relationships. (SHE)

Literacy Outcomes

Listen to and contribute to conversations and discussions to share information and ideas (ACELY 1676)

Numeracy Outcomes

Collect data, organize into categories and create displays using lists and tables (ACMSP069)

Interpret and compare data displays (ACMSP070)

Recognise the importance of using common units of measurement (E)

Content Matter

Surfaces react to heat in various ways. Some surfaces reflect heat while others absorb heat.

Preparation List

Preparation prior to lesson

- Locate surfaces (indoors and outside, including surfaces in sunlight and shade) for students to explore.
- Ensure that students know how to use a thermometer (this skill may need to be taught either prior to or during the lesson).

Equipment

- Glove or sock (to use as a glove) per student
- Thermometer per group
- Heat Search Resource sheet 2/1
- Enlarged copy of Resource sheet 2/1



Task Sequence

1. Refer to students' ideas about heat from the Engage lesson, particularly any ideas about the perceived temperature of surfaces, or ideas relating to fabrics and clothing appearing warm.
2. Ask students to suggest temperature-related words that can be used to describe surfaces e.g. warm, cool, scorching, freezing
3. Ask students to suggest what makes surfaces feel warm, cool etc. Responses might include hot or cold weather, and heat sources including electric heaters, the sun and fire.
4. Discuss with students whether wearing a glove might change the perceived temperature of a surface. Record students' responses and ask students to give reasons to explain their responses.
5. Tell the students that they will be exploring surfaces to determine whether the surfaces feel hot, cold etc and will be recording their observations.
6. When the students have completed step five, give each student a glove or sock and ask them to repeat the above step by using a bare hand and the other hand with a glove on it. Alternatively students might be able to use their feet depending on what surfaces are being explored.
7. Students record and discuss what they have discovered. Discuss the reliability of the data and a way that data could be standardized (using thermometers to measure the temperature of a surface.)
8. Conclude the lesson by discussing how surfaces are heated by heat energy from the sun, and why the surface may feel a different temperature if a glove is worn, yet be the same temperature.

Links to Other Key Learning Areas and Cross Curricula Priorities

- ▶ Numeracy- using thermometers.
- ▶ Numeracy/literacy - using local data and weather reports in newspapers to find out about daily temperatures in other places
- ▶ SOSE- locating places on map to show their proximity to each other or distance from each other, to explain similarities or differences in temperature.
- ▶ Numeracy- calculating the differences in temperature between places including within the school environment.



Resource sheet #2/1 Surface search

Surface	Location	How it feels with bare hand/ feet	How it feels with glove on hand/ sock on foot	Measured temperature of surface	Reason for temperature
Table top	In covered area	Warm	Cooler	23 degrees	It's in the shade



Explore

Lesson 3: Heat from the sun

In this lesson, students will:

- explore the effect of heat in causing changes in states of matter.

Lesson-level Content Descriptions

In the previous lesson, students explored how heat energy from the sun can warm surfaces, with the apparent level of heat depending on the materials that the surfaces are made of. In this lesson students will be placing objects in sunny areas and observing any changes in the objects, particularly if the objects feel warmer, or change in state from solid to liquid.

Lesson Outcomes

Science Outcomes

Understand that a change of state between solid and liquid can be caused by adding...heat. (SU)

Investigate how liquids and solids respond to changes in temperature. (SU-E)

Work in groups to discuss things that might happen during an investigation (SIS-E)

Reflect on the investigation, including whether a test was fair or not (SIS)

Literacy Outcomes

Listen to and contribute to conversations and discussions to share information and ideas (ACELY 1676)

Represent and communicate ideas and findings in a variety of ways such as diagrams, and physical representations (SIS)

Numeracy Outcomes

Collect data, organize into categories and create displays using lists and tables (ACMSP069)

Interpret and compare data displays (ACMSP070)

Content Matter

This lesson provides an excellent opportunity for students to either consolidate their understanding of a 'fair test' or to begin to develop an understanding of the need for fair testing so that data is accurate. It is suggested that initially, students are given unequal amounts of each material or substance to explore the effect of heat energy from the sun on the materials or substances. When allocating time for this lesson, allow time for students to check their materials and record observations at regular intervals and then to repeat the task using equal amounts of each material to ensure fair testing. Coal, bauxite and aluminium are included, as in the Explain phase students will further develop their understanding about the use of heat energy by finding out about the processes to produce metals from mineral ores including producing aluminium from bauxite. The source used to facilitate this process (coal) will also be briefly examined. Candles have been included as a candle was used in the Engage lesson while marshmallows have also been included as they may be the focus for the Elaborate lesson.

Preparation List

Preparation prior to lesson

- Source additional materials and substances if possible
- Decide whether each group will have all the materials or substances or whether groups will explore several materials only.
- Try the task to determine approximate melting times for the ice, chocolate, jelly etc.



Equipment

- Plastic plates or lids or foam trays per group
- Chocolate
- Ice cube
- Pre-made jelly
- Tile
- Piece of bauxite
- Piece of aluminium e.g. aluminium can
- Water
- Ice-cream
- Candle
- Marshmallow
- Thermometer per group
- *Materials table* (Resource Sheet 3/1) per group
- *Heat Observation* (Resource Sheet 3/2) per group
- *Fair Test* (Resource Sheet 3/3) per group
- Enlarged copy of each resource sheet

Task Sequence

1. Review the previous lesson where students explored how the temperature of surfaces may vary according to their positions (e.g. shade, direct sunlight) and according to the materials that the surfaces are made of.
2. Ask students to suggest materials and substances that may be affected by heat energy from the sun, whether the materials change in appearance, and other ways that they might change. Record students' responses on the *Materials Table* (Resource Sheet # 3/1).
3. Show the students the materials and substances that they will be exploring and as a class, describe several materials and record descriptions on the table. Predict what might happen to several of the materials or substances when they are placed in direct sunlight.
4. Tell students that they will be placing materials on trays, leaving them in direct sunlight and recording observations at regular intervals.
5. Students set up the trays of materials, record initial observations and predictions and check at regular intervals.
6. Students compare and discuss what happen and record any visible changes in the material and substances.
7. Ask students which materials showed the greater amount of change and use statements such as 'ice changed more than chocolate because the ice changed to water and the chocolate only began to melt.'
8. Ask students whether they think that this is a true and fair statement, by mentioning the quantity of each material or substance that the students used in their tasks.
9. Discuss with students how they could make the test fair. Provide an equal amount of at least one substance or material for each group to conduct a fair test to find out if the material changes when placed in direct sunlight.
10. Students set up the materials that they are testing, and check and record at regular intervals.
11. Discuss with students which materials and substances showed the greatest amount of change and how they changed.
12. Students complete the recording sheets and write reasons for the changes or lack of change in the materials or substances that they tested under fair test conditions.

Links to Other Key Learning Areas and Cross Curricula Priorities

- Numeracy- measuring volume, dimensions of materials and substances before and after testing.



Resource sheet #3/1 Heat from the sun-Materials

Name of material or substance	Description	Predict- what will happen if it is put in direct sunlight	What happened	Reasons to explain what happened



Resource sheet # 3/2 Heat from the sun- observations

In each column, write or draw what you observe at specific times.

Time interval	Material #1 Ice	Material #2 Wood	Material #3 Chocolate	Material #4
e.g. after 5 minutes	Beginning to melt	No change	A bit soft	



Resource sheet # 3/3 Heat from the sun–Fair testing

In each column, write or draw what you observe at specific times.

Before commencing the task, ensure that all materials or substances are the same size, so that you are conducting a fair test.

Time interval	Material #1 Ice-cream	Material #2 Bauxite	Material #3 Candle wax	Material #4
e.g. after 5 minutes	Beginning to melt	No change	A bit soft	



Explore

Lesson 4: Colours are cool

In this lesson, students will:

- explore the relationship between colours and rates of heating.

Lesson-level Content Descriptions

In previous lessons, students have explored how surfaces may appear to be hot or cool when exposed to heat energy from the sun, and how materials and substances can be affected and changed by exposure to heat energy from the sun. This lesson provides the opportunities for students to explore whether colours can impact on changes in water temperature.

Lesson Outcomes

Science Outcomes

Work in groups to discuss things that might happen during an investigation (SIS)

Identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge (SIS)

Predict the effect of heat on different materials (SU-E)

Recognise that we can feel heat and measure its effects using a thermometer (E)

Reflect on the investigation including whether a test was fair or not. (SIS)

Literacy Outcomes

Listen to and contribute to conversations and discussions to share information and ideas (ACELY 1676)

Represent and communicate ideas and findings in a variety of ways such as diagrams, and physical representations (SIS)

Numeracy Outcomes

Collect data, organize into categories and create displays using lists and tables (ACMSP069)

Interpret and compare data displays (ACMSP070)

Recognise the importance of using common units of measurement (E)

Content Matter

Dark colours absorb light from the sun converting light into heat energy, resulting in water reaching a higher temperature than water in cans covered with light colours or paint. Lighter colours including silver (alfoil) reflect the heat and therefore the water remains cooler. As dark colours absorb and retain heat, they are more appropriate for warm clothing. As light colours reflect heat, light-coloured clothing tends to be cooler and appropriate for warmer weather.



Preparation List

Preparation prior to lesson

- Locate a sunny area for the task to occur in.
- Check accuracy of thermometers.
- Ensure that students know about not looking directly at the sun nor at a shiny surface that is in sunlight (e.g. alfoil covering on a container).
- It is suggested that this lesson begin early in the day so that water temperatures can be measured and recorded at regular intervals during most of the day.

Equipment

- Coloured paper including black, white, alfoil, red and other assorted colours or coloured paint- per group
- Tins or glass jars per groups, one container per colour
- Thermometers- per group
- Examples of coloured clothing e.g. black, white
- Images of cars representing a range of colours similar to the coloured paper used in the Explore task
- Water
- Rubber bands to hold paper on the containers
- Resource sheet # 4/1 *Colours are cool*
- Enlarged copy of Resource sheet # 4/1

Task Sequence

1. Review previous lessons where students placed objects in direct sunlight and observed the effect of heat energy on the objects, and what students discovered when they explored the effect of the sun's energy on surfaces.
2. Show students images of cars (or actual cars) and ask them which cars they think might feel hotter, and to give reasons to support their ideas.
3. Show students a selection of clothing items including items that might be appropriate for wearing in cool weather and items that might be more appropriate for wearing in hot weather. Ask students about the possible appropriateness of the items in varying air temperatures and to give reasons to support their responses.
4. Ask students whether they think that colours can make a difference in keeping people cool or warm.
5. Tell that students that they will be following a procedural text to explore the effect of the sun's energy on different colours and that they will be recording the temperature of water in different coloured containers to find out which colours may impact on an increase in the temperature of the water.
6. Read the procedural text with the students.
7. Students set up equipment and take and record initial temperatures.
8. Students check and record water and air temperatures at regular intervals.
9. Discuss students' observations including data and whether particular colours impact on an increase in the temperature of water. Relate data and observations to colours of clothing and cars.

Links to Other Key Learning Areas and Cross Curricula Priorities

- Numeracy- graphing temperatures for each colour
- Numeracy- reading a thermometer accurately
- Technology- researching to find out about building materials that are appropriate for keeping houses either warm or cool



Resource sheet # 4/1 Procedural text Colours are cool

What you need:

- Jars or tins of same size
- Coloured paper, to cover the sides and top of each container
- Rubber bands to secure paper on jar
- Thermometer
- Recording sheet
- Water to half-fill each container.

What to do:

- Cover the sides of each jar with a piece of coloured paper and cut a piece of coloured paper for the top of each jar but leave one jar uncovered to use as a control.
- Half-fill each jar with water
- Cover the top of each jar with its coloured paper top
- Make a small hole in the top to insert a thermometer
- Measure and record the temperature of the water in each jar
- Predict which colour(s) will impact on the water increasing in temperature.
- Place the jars in a sunny area
- Check and record the temperature at regular intervals, and check the air temperature each time.



Resource sheet # 4 /2 Recording sheet- Colours are cool

Time	Colour-white temperature	Colour-silver temperature	Colour-black temperature	Colour-name temperature	Colour-name temperature



Explore

Lesson 5 : Melt it quickly

In this lesson, students will:

- explore the effect of colours and heat energy in changing solids to liquids.

Lesson-level Content Descriptions

In previous lessons in the Explore phase, students have explored heat absorption and reflection properties of different surfaces, and whether colours make a significant difference in the absorption and reflection of heat. In this lesson, students reflect on what they have experienced in the previous lessons, to explore the possible effect of colours combined with heat energy in changing states of matter.

Lesson Outcomes

Science Outcomes

Understand that a change of state between solid and liquid can be caused by adding (or removing) heat (SU)

Work in groups to discuss things that might happen during an investigation (SIS)

Identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge (SIS)

Reflect on the investigation including whether a test was fair or not. (SIS)

Literacy Outcomes

Listen to and contribute to conversations and discussions to share information and ideas (ACELY 1676)

Represent and communicate ideas and findings in a variety of ways such as diagrams, and physical representations (SIS)

Numeracy Outcomes

Collect data, organize into categories and create displays using lists and tables (ACMSP069)

Interpret and compare data displays (ACMSP070)

Recognise the importance of using common units of measurement (E)

Content Matter

This lesson can be approached in at least three different ways, to explore which colours absorb or reflect heat energy from the sun. Coloured paper can be put on top of ice cubes, under ice cubes or could be wrapped around ice cubes. Teachers may select how to present this Explore shared experience or alternatively arrange to have the three ways being tested simultaneously by allocating different ways of testing to groups.

Dark colours absorb heat while lighter colours including alfoil reflect heat.

Preparation List

Preparation prior to lesson

- Make ice cubes.
- As ice cubes may melt very quickly, it may be advantageous to make bigger blocks of ice.
- Try the task prior to the lesson to determine time intervals for observing and recording.



Equipment

- Pieces of coloured paper
- One ice cube per piece of paper
- Extra ice cube per group- as a control
- Trays to stand ice-cubes and paper on

Task Sequence

1. Review previous Explore lessons where students explored the effects of heat energy on colours, surfaces and substances including ice.
2. Ask students to predict what might happen if ice cubes are placed on different colours and placed in sunlight. Record students' predictions and their reasons to support their predictions.
3. Each group has one additional ice-cube as a control, with control cubes stored in a freezer until required.
4. Students set up the task, observe and record at regular intervals, check and compare their melted products with the control cube, then share their data with the class.
5. Discuss with students the practical applications of this task including keeping things cool and applications of utilizing heat energy from the sun to change states of matter.

Links to Other Key Learning Areas and Cross Curricula Priorities

- Technology- use of colours in design e.g. suitable colours for housing roofs, colours for clothing
- Numeracy- measuring dimensions of ice blocks during the melting process to ascertain rate of melting.



Explain

Lesson 6: Rock to can

In this lesson, students will:

- ▶ develop explanations about how heat is used to change solids to liquids and the amount of heat necessary to cause changes in states of matter.

Lesson-level Content Descriptions

In the Explain phase, students are bringing together what they have discovered and experienced in the Explore phase. Collaboratively, with teacher scaffolding, students develop explanations and understandings about heat energy and how heat energy can cause changes in states of matter. Changes in states of matter depend on varying intensities of heat. This can be applied to the processing of ore sources to produce metals used for the manufacture of everyday objects.

Lesson Outcomes

Science Outcomes

Understand that a change of state between solid and liquid can be caused by adding (or removing) heat. (SU)

Explore how changes from solid to liquid can help us produce and recycle materials (E)

Literacy Outcomes

Listen to and contribute to conversations and discussions to share information and ideas (ACELY 1676)

Represent and communicate ideas and findings in a variety of ways such as diagrams, and physical representations (SIS)

Content Matter

Matter can change from solid to liquid when heat is applied to it. Some solids will change easily to a liquid state with minimal amounts of heat while other solids require intense heat to change to liquid states. An example of a change from solid to liquid requiring minimal heat is ice to water or jelly to liquid. In contrast, intense heat is required in the stages to process aluminium from bauxite. The first stage in processing is the crushing stage where bauxite is crushed then mixed with caustic soda at both high temperatures and high pressure. After the settling and precipitation stages, the calcination process occurs where heat is used to remove water from aluminium hydrate to produce pure alumina. Alumina is converted to aluminium by running an extremely high electrical voltage through the mixture with aluminium forming at 900 degrees Celsius. One tonne of aluminium requires two tonnes of alumina. Although recycling used aluminium to produce re-usable aluminium requires heat of about 700 degrees Celsius, to produce liquid aluminium that is cast into blocks and manufactured into new products, making aluminium cans from recycled aluminium reduces both the amount of bauxite to be mined and the amount of energy required compared with producing aluminium cans direct from bauxite.

Heat produced from the burning of coal, to heat water to make steam to produce the electricity for the making of aluminium is also part of this process.



Preparation List

Preparation prior to lesson

- Source resources about production of metals from ores
- Source sample of bauxite from local high school or Serrata Supplies
- Source samples of bauxite/ alumina from Queensland Alumina Limited

Equipment

- Chocolate
- Ice cube
- Pre-made jelly
- Tile
- Piece of bauxite
- Piece of aluminium e.g. aluminium can or aluminium building material
- Alfoil
- Aluminium can
- Sample of alumina
- Water
- Ice-cream
- Candle
- Marshmallow

Task Sequence

1. Show the students the materials and substances that they used in lesson three and review what they observed when they placed each substance in a warm area.
2. Review lessons four and five where students explored how colour can impact on water heating or changing from a solid (ice) to water.
3. Show the students the bauxite and the aluminium and ask them whether they think that there is any connection between bauxite and aluminium.
4. Show students the alumina and draw a set of arrows connecting the bauxite to the alumina and to the aluminium building material and can.
5. Explain that heat is used to change the bauxite to aluminium and ask students to suggest how this might happen.
6. Explain how intense heat is required and explain the process to students.
7. Ask students to suggest what might be the source of energy used to make the intense heat
8. Ask students to give examples that they know of in everyday life where heat is used to change solids to liquids and how the removal of heat (or cooling) can cause something to solidify e.g. welding, soldering, honey extraction.
9. Ask students what they can do when they have finished with aluminium cans, and talk with students about the recycling process that results in saving both energy and bauxite supplies.
10. Students produce labelled flow-charts showing at least two processes (a simple process and a more complex process) where heat is used to change a solid to a liquid-for example a simple 'ice to water' flowchart and complex 'bauxite to can' flow-chart.



Links to Other Key Learning Areas and Cross Curricula Priorities

- Sustainability- recycling to reduce use of raw materials
- Sustainability- find out about recycling programs in the local community particularly for products produced from mineral ores, investigate viability of setting up and managing can and glass recycling programs in the local community.
- Technology- systems and production processes
- SOSE/ history - use of materials at different times and how products were recycled e.g. glass jars and bottles, reasons for the need for recycling including shortages, economic circumstances.

Additional Resources

- Copper [fact sheet](#)
- Copper Processing – Anode Pouring short [movie](#)
- Copper [interactive](#)
- Copper Processing [image](#)



Elaborate

Lesson 7: Cook with the sun

In this lesson, students will:

- 1 design, make and use solar heaters to change the appearance and state of edible solids or liquids.

Lesson-level Content Descriptions

In the Elaborate phase, students are extending and applying the understandings and knowledge that they have developed through common shared and structured experiences in the Explore phase, and through the explanations that they have collaboratively developed in the Explain phase. Students will be working in groups and using their newly gained knowledge and understandings about heat energy, materials and the impact of colours and surfaces on the rates of temperature change, to design, make and use solar heaters to heat either solids or liquids.

Lesson Outcomes

Science Outcomes

Work in groups to discuss things that might happen during an investigation (SIS)

Identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge (SIS)

Recognise that we can feel heat and measure its effects using a thermometer.(SU-E)

Understand that a change of state between solid and liquid can be caused by adding (or removing) heat (SU)

Literacy Outcomes

Listen to and contribute to conversations and discussions to share information and ideas (ACELY 1676)

Represent and communicate ideas and findings in a variety of ways such as diagrams, and physical representations (SIS)

Numeracy Outcomes

Recognise the importance of using common units of measurement (E)

Content Matter

Solar energy is a form of renewable energy. Solar power can be used in two different ways as a heat source and as an electricity source. The sun's heat energy can be captured by a number of different collectors and turned into hot water. This type of power is called solar thermal. Flat plate collectors are the most common form of solar thermal power used for instance in home hot water system. These flat plate collectors are like greenhouses that trap and use the sun's heat to raise the temperature of water up to about 70 degrees Celsius. Because dark colours absorb more heat than light colours, the collectors are usually painted black to absorb as much heat from the sun as possible. This helps water circulating through the panel to absorb as much heat from the sun as possible. This helps water circulating through the panel to reach a higher temperature. Some collectors have a special surface which reduces the amount of heat re-radiated from the collector. These produce even hotter water.



Parabolic dishes are concave-shaped discs which remain constantly focused on the sun with the aid of sun-tracking devices. The curve of each dish concentrates the sun's rays to a small central point, thus reducing heat losses and enabling water (or other fluid) passing through that point to be heated to a high temperature.

A small percentage of solar energy is used in Queensland, primarily for heating water with at least 4.8% of households in Queensland using solar hot water systems.

Preparation List

Preparation prior to lesson

- Source images of solar panels, solar cars and solar heaters as examples of how solar energy can be used.
- Decide whether all teams are going to heat the same solid or liquid. Examples could include water, marshmallows, or other foods suitable for cooking and eating.
- Write a design brief that reflects the intent of the lesson.
- Decide whether students are going to have a choice of materials and whether materials will be provided by the teacher or sourced from other places including homes.
- Be sensitive and aware of students whose parents for various reasons, may not be able to assist with providing materials.
- Warn students of the danger of looking directly at the sun or at reflective surfaces
- Find out about solar energy use in the community, where there is a community member who can visit to talk with students and if there are sites that students can visit to see solar energy in use.

Equipment

- Alfoil, foil trays
- Cardboard
- Coloured paint
- Black plastic
- Edible solids or liquids to heat
- Container for holding solids and liquids
- Thermometers
- Two containers of water (per team) to use as both controls and indicators of the intensity of the heat generated by the solar heaters.

Task Sequence

1. Review previous lessons and pose the question about whether and how heat energy from the sun could be used to heat or cook food and liquids.
2. Ask students if they know whether and how heat energy from the sun (solar energy) is used in their homes and local community.
3. If possible, invite a community member to visit and talk with students about solar energy and its applications. Alternatively students might be able to go to places in the community where solar energy is being used.
4. Tell the students that their design brief is to design, make and use a solar heater to cook or heat a specified food or liquid.
5. Explain that it is important to use as much heat energy as possible and discuss ways of ensuring the heat is intense. Refer to material, colours, angles of materials etc.
6. Discuss with the students how they can measure the effectiveness of their heater, by using a control. Suggest that students need to measure the air temperature when they begin their investigation, and have a container of water close to the heater structure so that they can measure the temperature of the water to see if it is increasing.
7. Students produce a design and a list of materials that they require, before commencing to construct the solar heaters. Their design must include an explanation of how they think the heater will work and a description of its special features.
8. Students use their solar heater to cook or heat whatever has been specified and evaluate the success of their design, suggesting modifications, if necessary to improve the function of the solar heater.
9. Students give a brief oral presentation about their heaters to the class then produce a labelled diagram with written comments about the functioning of the heater.



Additional Resources

- Solar Energy [fact sheet](#)
- Renewable Energy [fact sheet](#)
- Solar Shower short [movie](#)

Evaluate

Lesson 8: Heat helpers

In this lesson, students will:

- show and share their understandings and knowledge about heat energy, through producing a literacy product.

Lesson-level Content Descriptions

The Evaluate lesson provides the opportunity for summative assessment of the understandings and knowledge that students have developed during the unit. Students will be able to use the information that they have collected, communicated and represented in various forms including their design task, to demonstrate what they have learnt about heat energy and how it is used in their community.

Lesson Outcomes

Science Outcomes

Science knowledge helps people to understand the effects of their actions (SHE)

Identify changes that occur in everyday situations due to heating (SU-E)

Understand that a change of state between solid and liquid can be caused by adding (or removing) heat. (SU)

Literacy Outcomes

Represent and communicate ideas and findings in a variety of ways such as diagrams, and physical representations (SIS)

Content Matter

It is suggested that the literacy product selected as the culminating task be one which is required in another area of the curriculum e.g. ICT, Literacy genre. Products could include a PowerPoint presentation, digital story, poster, board game or report. The product could also be a way of students relating their new learning to an area such as sustainability (ACARA). A focus in students' presentations is on students showing what they have learnt about heat energy and the applications of their knowledge beyond the classroom. *Science as a human Endeavour* is an important feature of the final product, with the following ACARA elaborations- "considering how hearing affects materials used in everyday life" and "investigating how science helps people."



Preparation List

Preparation prior to lesson

Nil

Equipment

- Dependent on the literacy product selected as the culminating task.

Task Sequence

1. Review what students have experienced and discovered throughout the unit of work.
2. Explain to students that they are expected to produce a specified literacy product to show what they have learnt about heat energy and its applications in their local community.
3. Ensure that any necessary skills are taught e.g. constructing a PowerPoint presentation, features of a poster, report etc.
4. Students work as individuals on their final assessment task.

Links to Other Key Learning Areas and Cross Curricula Priorities

- Literacy- genres
- ICT- products

Additional Resources

- Coal fired power station [interactive](#)
- Coal fired energy plant [interactive](#)
- An overview of underground mining [fact sheet](#)



Appendix 1: The 5Es Instructional Model

The Australian Curriculum: Science describes the discipline of science as an empirical way in which to answer interesting questions about the biological, physical and technological world in which we live. The answers to such questions then form the basis for our actions as we participate in the activities of the world. Importantly, science is perceived to be a dynamic organisation of ideas, formed through collaborative processes, and based upon humans' creative response to the world in which they live.

Thus, learning science should reflect those characteristics – student's should be encouraged to actively participate in this human endeavour as they collaboratively make sense of their own lived world, under the guidance of their teacher. Classroom experiences should nurture curiosity and creativity and develop a deep understanding of the world, upon which the student's future participation in activities may be based. Put simply, science inquiry should be the over-arching organiser of learning science.

Numerous more specific models of inquiry-based science learning have been proposed, including the 5Es model proposed by Bybee and which has seen numerous variations. In this unit, Bybee's model has been used as the basis for organising the material. A key feature of the 5Es model is that students actively, under the guidance of the teacher, make sense of experiences and thus develop conceptual understanding. That is, classroom activity reflects the nature of science practice. This is in contrast to more traditional science teaching, in which concepts are first presented by the teacher and then students participate in activities that put those concepts into action.

It should be noted that the model used to organise this material is only a guideline – this science material is the basis for good classroom teaching that is responsive to the particular needs of the students. Thus, whilst the materials present a generally linear sequence of learning activities, the teacher should be prepared to routinely return to previous activities and associated learning aims, and so traversing the 5Es model in a somewhat iterative fashion.

The 5Es model organises learning activities into five distinct phases: Explanation, Exploration, Elaboration, and Evaluation. In the following sections, the variant of the 5Es model used in these science materials is presented. Specifically, each of the five phases is described, including the nature of the learning activities and outcomes expected in each phase. The structuring of the unit around these 5 phases is then summarised.

Phase 1: Engage

The general aim of the Engage phase is to spark the students' curiosity and to reveal their existing understanding of the concepts to be developed across the unit. Short activities are used with which to engage the students in the content matter and to start develop questions that may be addressed in the activities of future phases. Thus, in the engage phase assessment has a diagnostic nature and generates evidence upon which the teacher can draw to tailor future activities that will extend and/or refine the students' conceptual understanding.

Phase 2: Explore

The general aim of the Explore phase is to involve students in hands-on experiences of the scientific phenomena to be understood. The students will draw upon existing knowledge and understanding to conduct investigative activities that generate data which will be analysed and discussed in the Explain phase. These activities constitute formative assessment that focuses primarily upon investigative skills, which may then be further developed in subsequent activities of this and future phases.

Phase 3: Explain

The general aim of the Explain phase is to analyse the data generated in the Explore phase's investigative activities, to identify and discuss patterns or relationships in that data, and thus construct generalisations that advance their conceptual understanding. This analysis may focus upon a particular aspect or sub-set of the data or experiences, or may span all activities of the Explore phase. Hence, then Explore and Explain phases may be quite tightly linked as the students iteratively develop their conceptual understanding. To make such sense of the observed phenomena, the students may look to external sources, including expert scientific opinion. Such construction of meaning may involve significant scaffolding by the teacher to reveal, shape and formalise these generalisations. Key to this phase is the student's expression of their developing conceptual understanding, and thus this phase embeds the formative assessment of such conceptual understanding.



Phase 4: Elaborate

In the preceding phase(s), students have experienced the relevant phenomena, have gathered data, and have then formed generalising concepts that explain their observations and experiences. In the Elaborate phase, the students draw upon this new-found conceptual understanding to plan and conduct an investigation in a new, previously un-experienced context. This investigative activity should challenge students, and thus elaborate upon both their investigative skills and conceptual understanding. In terms of assessment, this phase of learning provides an opportunity for the teacher to summatively ascertain the investigative skills of the learner.

Phase 5: Evaluate

In this final phase of the instructional model, emphasis is placed upon the student expressing their conceptual understanding by way of some written, oral or visual artefact. Not only does this expression of understanding provide an opportunity to summatively assess the learner's conceptual understanding, it also provides an opportunity for the student to reflect upon their own learning.

