Level

| F | 1 | 2 | **3** | **4** | **5** | 6 | B6 |
|---|---|---|---|---|---|---|---|

# Changing materials to make them useful

**Strand**
Natural and Processed Materials

**Key concept**
The uses of materials are determined by their properties, some of which can be changed.

## Purpose

Activities in this module are designed to help students understand the scientific ideas about matter being made up of particles. Students have opportunities to:

- investigate relationships between the properties of materials and their usefulness;
- investigate, draw conclusions and generalise about how combining materials affects their properties;
- select and justify combinations of materials that best suit a given purpose;
- create presentations related to changing materials and uses of materials;
- explain ideas and decisions relevant to assessing changes to materials and the usefulness of materials.

## Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

| Introductory ► | Developmental ► | Culminating |
|---|---|---|
| Why was this material used? | Cooking pikelets | Strengthening plaster |
| Indigenous technology | Examining wood | Making damper |
| | Comparing metals and alloys | Using materials to make simple tools |
| | Industrial processes | |

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## Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

**Natural and Processed Materials**

**3.3** Students collect information to illustrate how combining different materials influences their usefulness.

**4.3 Students examine and assess ways that materials can be changed to make them more useful.**

**5.3** Students devise tests and interpret data to show that the properties and interactions of materials influence their use.

## Discretionary learning outcome

Activities in this module also focus on the following discretionary learning outcome:

**Natural and Processed Materials**

**D4.4** Students recognise, and report on, the environmental impact of some manufacturing processes.

## Core content

This module incorporates the following core content from the syllabus:

**Natural and Processed Materials**

**Natural materials**

- organic — plants: wood, fibres
- inorganic — rocks

**Processed materials**

- metals — alloys
- paper
- cement

**Uses**

- tools
- food

**Changes made to properties of materials to meet required uses**

## Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

Natural and Processed Materials

**3.3 Students collect information to illustrate how combining different materials influences their usefulness.**

Students may:

- make observations and inferences that suggest a relationship between properties of materials and their usefulness for particular purposes;
- suggest different combinations of materials to improve their usefulness;
- make new combinations of materials that are more useful than previous combinations.

Natural and Processed Materials

**4.3 Students examine and assess ways that materials can be changed to make them more useful.**

Students may:

- describe different types of changes used to improve materials;
- attempt a variety of changes to improve materials;
- describe how changes have improved a material's usefulness.

Natural and Processed Materials

**5.3 Students devise tests and interpret data to show that the properties and interactions of materials influence their use.**

Students may:

- describe properties of materials that suit given requirements;
- test materials and select one that fits given requirements.



# Background information

## Current scientific conceptions

All materials have characteristic properties. Materials can be changed or combined in ways that change their properties. Some materials that are combined will have a different structure and different properties from the original materials. Since early times, humans have been processing materials to change their properties to suit particular purposes.

Processing materials means changing them; these changes can be categorised as either physical or chemical. One important example of a physical change is the creation of 'composites' or materials composed of parts held together by a matrix or 'glue'. There are various forms of composites, ranging from very low-level technology (for example, mud bricks and concrete), to very high-level technology (for example, fibre-reinforced plastics). Investigation and discussion of composites can help to develop the concept that the properties of materials depend on the underlying structure of the materials.

Alloys are another example of composites. They are mixtures made by fusing at least two elements, one or both of which are metals. It is not always easy to distinguish an alloy from a pure metal. One of the earliest alloys that humans made was bronze, a mixture of copper and tin. At first, this probably formed by chance from rocks used to make fireplaces. Later, humans made the alloy deliberately. Another early alloy was cast iron, a mixture of iron and carbon (a non-metal). Because of systematic investigation of the properties of alloys and their underlying atomic structure, alloys can now be created to meet specific requirements.

There are also many chemical changes that result in useful materials. For example, vulcanisation is a chemical process that makes rubber hard-wearing and increases its heat resistance. As a result, it is more useful for making car tyres.

## Students' prior understandings

Students' prior understandings may differ from current scientific conceptions in a range of ways.

Some students may think that:

- 'properties' are possessions or land, or related to computers;
- 'materials' are clothing fabrics or building materials;
- 'combining materials' refers to weaving or intertwining fibres.

Students may never have considered:

- why materials are combined;
- the role of specific materials in combinations.

Teachers can help students develop their understandings by providing them with activities that expand their experiences relating to the use of materials. They can encourage students to ask pertinent questions about, and evaluate, current uses of materials.

## Terminology

Terms associated with materials and their properties are essential to the activities in this module — for example:

| | | |
|---|---|---|
| cement | natural material | rubber |
| chemical change | physical change | synthetic material |
| composite material | property | technology |
| concrete | | |

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

## School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers need to consider safety issues relating to:

- use of moderate concentrations of strong acids;
- handling heavy objects;
- use of hot materials.

Cultural issues need to be considered when dealing with Aboriginal and Torres Strait Islander artefacts. Such issues include restrictions on the handling of some artefacts by women, uninitiated boys and non-custodial people.

## Support materials and references

Aboriginal and Torres Strait Islander Education Unit, Sub Centre South Resource Centre. Available URL: http://education.qld.gov.au/tal/atsi/html/reso/reso.htm (accessed September 2000).
Searches can be conducted on key words and subjects.

Chamber of Minerals and Energy of Western Australia Inc. Available URL: http://www.mineralswa.asn.au/ (accessed September 2000).

Clarke, I. & Cooke, B. 1996, *Introduction to Australia's Minerals (ITAM): Gold*, Minerals Council of Australia, Adelaide.

Clarke, I. & Cooke, B. 1997, *Introduction to Australia's Minerals (ITAM): Lead/Zinc*, Minerals Council of Australia, Adelaide.

Cooke, B. & Clarke, I. 1997, *Introduction to Australia's Minerals (ITAM): Copper*, Minerals Council of Australia, Adelaide.

Forest Education Foundation 1988, *Project Forest: Learning about Our Forests — A Resource for Schools and Teachers*, Hobart.

Queensland Department of Education 1996, *Aspects of Science Management: A Reference Manual for Schools*, Brisbane.

Queensland Department of Primary Industries 1998, *The Queensland Forest Industry*, Brisbane.

Reeves, K. 1993, *The Amazing Book of Treasures from the Earth*, Queensland Museum, Brisbane.

Stannard, P. & Williamson, K. 1993, *Science Alive: Book 3*, Macmillan Education Australia, Melbourne.

Wilson, L. 1993, *Kerkar Lu: Contemporary Artefacts of the Torres Strait Islanders*, Queensland Department of Education, Brisbane.

Wilson, L. 1988, *Thathilgaw Emeret Lu: A Handbook of Traditional Torres Strait Islands Material Culture*, Queensland Department of Education, Brisbane.

*Wood Products from the Forest Environment* (ForEd Resource 2) 1983. Sponsored by Queensland Department of Forestry, Queensland Department of Education, and Timber Research and Development Advisory Council, Brisbane.

**Organisations**

Queensland Museum Education Resource Service
75 Grey St, Southbank
South Brisbane Q 4101
Tel: (07) 3840 7606
Fax: (07) 3840 7610
Email: loans@qm.qld.gov.au

Queensland Mining Council Ltd
7th Floor, Santos House
60 Edward Street
Brisbane Q 4000
Tel: (07) 3221 8722
Fax: (07) 3229 4564
Email: mincomm@qmc.com.au

**Suppliers**

Materials such as metals and acids can be purchased from suppliers listed in the Yellow Pages telephone directory under 'Biological supplies', or 'Laboratory equipment &/or supplies'. A supplier with an Education Queensland 'preferred supplier agreement' will probably give the best prices.

ACTIVITY

# Why was this material used?

*Introductory*



## Focus

This activity provides opportunities for students to observe, infer and discuss why materials are used for particular purposes.

## Materials

Each student is to bring to class either:

- objects made of a number of materials — e.g. a skateboard or toy; or
- objects made of one material — e.g. paper bags, plastic toys.

Collectively, the objects brought by all students should contain at least five different materials.

## Teaching considerations

Students can carry out this activity individually, in pairs or in small groups.

Organise students beforehand to bring objects from home.

The Think, Pair, Share procedure could be used in this activity. After time spent thinking individually, students form pairs or groups to discuss and clarify their ideas, which can then be listed.

***Safety***
Be alert to safety issues relating to items brought to school by students. Set clear guidelines for students to select appropriate items.

## Working scientifically

Time: 30 minutes

**Formulating questions**
**Handling materials**
**Seeking reasons**
**Drawing conclusions**
**Examining and evaluating**
**Making and judging deductions**
**Suggesting**
**Describing**
**Discussing thinking**

▶ As a class, students discuss the concept that the intended use of a material will determine whether its properties are deemed desirable or undesirable.

A question to initiate discussion could be:

- Why is a skateboard not made out of cardboard when this has desirable properties — for example, it is easy to cut and shape, and is cheap?

▶ Students examine the object that they brought, noting:

- each constituent material of the object;
- the use of that material in the object;
- all of the desirable qualities or properties of the material that enable the object to be used effectively.

▶ Students discuss and group the materials and examine the range of properties of each material. The information about the objects can be collated.

## Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' notebooks.

ACTIVITY

# Indigenous technology

*Introductory*



## Focus

This activity provides opportunities for students to observe and infer that materials used by indigenous peoples are often combined and processed in some way to improve their properties.

## Materials

For each group of students:

- Aboriginal and Torres Strait Islander artefacts, or photographs of artefacts — e.g. stone and wood tools, digging sticks, nets, woven bags, baskets, musical instruments

## Teaching considerations

Students can carry out this activity individually or work in small groups.

The Think, Pair, Share procedure could be used in this activity. After time spent thinking individually, students form pairs or groups to discuss and clarify their ideas, which can then be listed.

Aboriginal and Torres Strait Islander students may have artefacts that they could share with the class.

***Cultural note***

Indigenous people have protocols about the handling of objects or artefacts. Invite an appropriate community member to explain the purpose and use of the chosen artefacts. Discuss with the visitor beforehand the types of questions that may be asked, and the manner in which they may be asked, so that clear guidelines can be set for students.

Recently made artefacts may have been made with synthetic materials and glue whereas, in the past, natural materials and fixatives would have been used.

***Safety***

Inform students of safe practices when handling the artefacts.

## Working scientifically

Time: 30 minutes

**Collecting information**
**Handling materials**
**Constructing meaning**
**Drawing conclusions**
**Making and judging inductions**
**Suggesting**
**Explaining ideas and decisions**
**Relating**

▶ Students examine the artefacts, identify the materials these are made of and how the materials are used. They reflect on their evaluation of the materials and record their thoughts.

Questions to guide students' thinking could include:

- How is the artefact used?
- How many different materials have been used to make the artefact?
- What do you think is the purpose of each material in the artefact?
- Are any of the materials changed from their natural state?
- In what ways have the materials been changed?
- Why do you think each of the materials was changed in the way it was?

- How would you describe the way indigenous peoples used the materials in making tools and other artefacts? Choose the statement that best reflects your ideas:
  - 'They found the materials and used them as they were.'

    or
  - 'They found the materials and chose the best ones to use.'

    or
  - 'They found the materials and changed them to make them more useful.'

  Justify your choice.

**Gathering information about student learning**

Sources of information could include:

- students' contributions to discussions;
- students' notebooks;
- students' answers to questions.

ACTIVITY

# Cooking pikelets

*Developmental*



## Focus

This activity provides opportunities for students to investigate the changes in materials that occur when raw ingredients are mixed and cooked.

## Materials

For each group of students:

- Resource Sheet 1, 'Cooking pikelets'
- materials listed on Resource Sheet 1

## Teaching considerations

The process of pikelet making is safe, easily viewed, and offers opportunities for many useful observations, reflections and generalisations.

Students carry out this activity in small groups.

If possible, let students mix the raw ingredients to make the batter. This process is in itself a valuable demonstration of changes in materials.

***Safety***

Inform students of safe practices for using electrical appliances, stoves and hot cooking utensils.

Pikelets may be eaten if all rules of safety and hygiene are followed. Note that some students may have food intolerances. Diabetics need to monitor the sugar content of their food.

## Working scientifically

Time: 90 minutes (45 minutes if the teacher prepares the batter in advance)

**Designing and performing experiments**
**Handling materials**
**Identifying and controlling variables**
**Predicting**
**Analysing**
**Drawing conclusions**
**Making comparisons**
**Describing**
**Using scientific report genres**

Resource Sheet 1

▶ Students make pikelets following the recipe on Resource Sheet 1. They observe and record the properties of the ingredients at the following stages:

- before mixing;
- immediately after mixing;
- just before cooking;
- during cooking;
- just after cooking.

Questions and statements to guide observations (made using all the senses) could include:

- What are the materials like when they are first mixed?
- What changes can be observed in the mixture after it has been made for a while?
- Describe changes you can see during cooking.
- Describe the inside of the pikelets after they are cooked.

▶ Students record their observations in their notebooks.

▶ Students consider the role of each of the ingredients used in making pikelets. They could put forward hypotheses, then make predictions based on their ideas. For example, they might predict that the pikelets will not rise if sodium bicarbonate is not added.

▶ Students then design tests to check their hypotheses and predictions, focusing on controlling the tests scientifically. Planning and reporting worksheets (see the sourcebook guidelines, appendix 3) will help students design a fair test.

▶ After students have finished their investigations, they discuss their results as a class. Discussion questions could include:

- In what ways are the pikelets similar to or different from the pikelet batter?
- How were the raw materials processed to make pikelets?
- What properties of pikelets make them more useful than pikelet batter?
- Can you see the separate ingredients within the pikelets before or after they are cooked?

▶ Students either answer the questions on the planning and reporting worksheets or write a report of their investigation, focusing on the series of changes that occurs and on their evaluation of the process.

**Gathering information about student learning**

Sources of information could include:

- students' contributions to discussions;
- students' answers to questions;
- students' records of their observations;
- students' report notes, final reports and evaluation.

ACTIVITY

# Examining wood

*Developmental*



## Focus

This activity provides opportunities for students to investigate ways in which wood is modified for a variety of purposes.

## Materials

Samples of:

- veneer
- plywood
- medium density fibreboard (MDF)
- hardboard
- particle board
- wood

## Teaching considerations

Students carry out this activity in small groups.

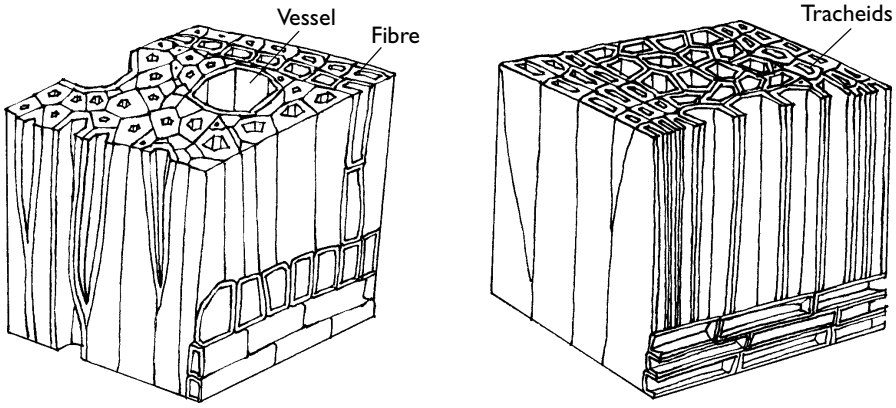
***Structure of timber***

One of the tissues found in plants is xylem. A function of this tissue is to transport water and minerals from the soil to the living tissues of the plant. The types of cells present in the xylem of woody plants that bear cones are different from those in the xylem of trees that bear flowers. It is the differences in the xylem that causes the wood in these two types of trees to be different.

Trees that bear cones produce wood with a simple structure. Most of the wood consists of tracheids — long, narrow cells up to 7 mm long with a thickened cell wall. The tracheids carry water and dissolved nutrients up from the roots, provide support for the tree and give the wood strength. Wood composed mainly of tracheids is known in the timber industry as 'softwood'.

The most distinctive cells in the xylem of trees that bear flowers are 'vessels' and 'fibres'. Vessels are long, hollow tubes with thickened walls. Their function is to carry water and dissolved nutrients from the roots. Fibres provide the strength in wood. They are short cells — usually about 1 mm long — with thick walls. Wood made up of xylem vessels and fibres is known as 'hardwood'.

The elasticity of timber depends on the length of the thick-walled cells. The density of the timber is closely related to the thickness of the cell walls. Timber strength depends on both the length of the cell and thickness of the cell wall.



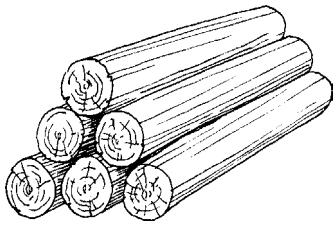
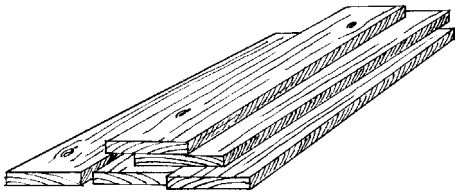
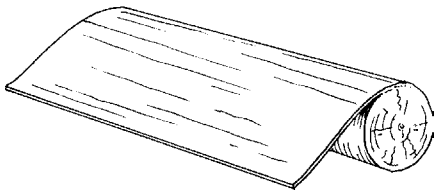
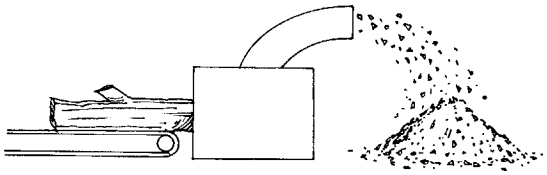
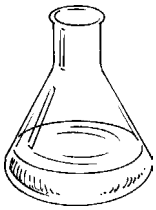

Hardwood
Magnification x 250

Softwood
Magnification x 250

**The structure of hardwood and softwood**

***Uses of timber***

As the following table shows, timber has many different uses. Depending on how it is to be used, timber is modified in various ways after it is harvested.

| Timber | Uses |
|---|---|
| Round timber  | Landscaping, electricity poles, mining industry |
| Saw logs  | Flooring, house construction, furniture, boats |
| Ply logs  | Veneers for furniture and plywood |
| Pulp logs  | Hardboard, particle board, medium density fibreboard (MDF), paper and cardboard |
| Derivatives  | Chemical products for rayon, cellophane, alcohol, plastics, fertilisers, explosives, glue and tanning |

Some useful references for this activity are listed in 'Support materials and references', p. 5.

## Working scientifically

Time: 20 minutes for initial discussion; extended time for research

**Accessing resources**
**Collecting information**
**Designing and performing investigations**
**Formulating questions**
**Suggesting**
**Synthesising**
**Clarifying ideas and concepts**
**Creating presentations**
**Discussing thinking**
**Summarising and reporting**

▶ Students list items made of wood that are used at home or at school — for example, chairs, fences, drumsticks. They discuss the uses made of the products and why wood is a suitable material in each application.

▶ Students discuss ways in which wood is changed to make it more useful in particular situations. Questions and ideas to guide discussion could include:

- How does the shape of the wood used for _____ (*name the use*) relate to the size and shape of a tree trunk?
- What do you think was done to the tree trunk to make something of that size and shape?
- Suggest some timber products that are approximately the same shape and size as a tree trunk.
- Describe any timber products that have a structure very different from that of wood as it comes from a tree.
- Why is wood painted, varnished or treated chemically in some situations?

▶ Students examine and describe samples of modified timber — for example, plywood and medium density fibreboard (MDF). They collect information about the manufacture and use of each of the products.

▶ Students design and perform investigations to compare natural wood with a piece of modified timber. Comparisons that could be made include:

- strength;
- ease of cutting, smoothness and neatness of the cut edge;
- water absorbency and the effect of water on structure;
- resistance to damage from hammering, flexing or twisting.

Students present the results of their investigations to the class.

▶ Students collect information about ways of modifying wood — for example, producing paper, MDF or particle board. Aspects for study could be:

- the part of the tree that is used and whether waste timber is utilised in the manufacture;
- the manufacturing process and whether physical or chemical processes, or both, are involved;
- how the product is used.

Students present their information to the class.

▶ Students discuss the variety of products that are made or derived from wood. They create a display that could be placed in the library or used at an open day to inform others about this variety.

### Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' presentations about the results of their investigations;
- students' collection of information.

ACTIVITY

## Comparing metals and alloys

*Developmental*

### Focus

This activity provides opportunities for students to investigate how combining metals to form alloys changes the metals to suit different purposes.

Students either research the properties of metal alloys or make a metal alloy.

### Materials

For all groups of students (option 1):

- small pieces of copper, zinc, bronze and brass
- pictures of items made from each metal or alloy

For each group of students doing the practical activity (option 2):

- Resource Sheet 2, 'Making brass from copper and zinc'
- materials listed on Resource Sheet 2

### Teaching considerations

Students can carry out this activity individually or work in small groups.

Alloys are formed by combining different metals — for example, brass is an alloy of copper and zinc. Some alloys contain small amounts of one or more non-metals such as carbon, manganese silicon, sulfur and phosphorous. For example, tungsten carbide is an alloy where carbon is combined with tungsten. Steel is an alloy of iron with up to 1.7 per cent carbon and sometimes with other elements, such as manganese, silicon, sulfur or phosphorous.

Pictures and information about metals and alloys are available in booklets such as the *Introduction to Australia's Minerals* (ITAM) series, which can be obtained from the Queensland Mining Council, or the Queensland Museum's *The Amazing Book of Treasures from the Earth*. The website of the Chamber of Minerals and Energy of Western Australia Inc. may also be useful: http://www.mineralswa.asn.au/ (see 'Support materials and references', p. 5).

For information about management of chemicals and the preparation of solutions refer to *Aspects of Science Management: A Reference Manual for Schools* (see 'Support materials and references', p. 5).

There are two options suggested for this activity:

1. Students research information about alloys and how they are made, and compare the properties of small pieces of copper, zinc, brass and bronze.
2. Students make an alloy and compare the properties of the component metals with those of the alloy. This option involves students' handling and heating a corrosive acid and a corrosive base and should be done only in a laboratory (see 'Safety' below).

***Safety***

Inform students of safe practices for handling acids and bases — for example:

- Nitric acid and sodium hydroxide, even in dilute solutions, are very corrosive and dangerous, especially when hot.
- Have an eyewash bottle filled and at hand.
- Use only small quantities of nitric acid and sodium hydroxide solutions.
- All students must wear safety glasses; those working with nitric acid or sodium hydroxide must wear aprons and disposable gloves.

## Working scientifically

Time: 60 minutes

**Handling materials**
**Hypothesising**
**Making and judging observations**
**Drawing conclusions**
**Making comparisons**
**Reflecting and considering**
**Describing**
**Expressing points of view**
**Illustrating**
**Summarising and reporting**

### Option 1

▶ Students examine small pieces of copper, zinc, brass and bronze. They record physical properties that relate to how the metal is useful to humans — for example, its colour, lustre and hardness, and measure how much force is required to bend a strip of each metal. They compare the physical properties of each metal.

▶ Students examine pictures of familiar metal items, components and historical artefacts. They research the properties of pure metals and of alloys, and collect information about bronze, the Bronze Age, iron and the Iron Age.

Questions to guide research could include:

- When was the Bronze Age?
- What is bronze? What does bronze have in it?
- Why was bronze important to people in early times? What were its uses?
- When was the Iron Age?
- In what ways did people find iron to be more useful than bronze?
- What is the composition of iron?
- Why do you think the Iron Age came after the Bronze Age?
- How did scientists find out about the ways that people in early times made bronze and iron?
- Would you describe bronze and iron as natural or processed materials?
- What is the general term for materials like bronze and iron?

▶ Students prepare a summary of information about each metal and alloy that they researched, and compare the properties of each alloy with the properties of the separate constituents of that alloy. They explain how each metal or alloy is used, and the advantages of using that metal or alloy for those particular purposes.

### Option 2

▶ Students examine small pieces of copper and zinc. They record physical properties that relate to how the metal is useful to humans — for example, its colour, lustre and hardness, and measure how much force is required to bend a strip of the metal.

Resource Sheet 2

▶ Students alloy zinc with copper to make brass by following the instructions on Resource Sheet 2. They compare the properties of the brass alloy with those of copper.

Questions to guide observations and conclusions could include:

- How are copper, zinc and brass different? (Consider physical properties such as colour, hardness, lustre, and how 'bendable' a strip of the metal is.)
- Brass is an alloy of copper and zinc. Can you see the separate metals that make up brass?
- Do you think brass is more useful or less useful than copper, or just different from copper? Give reasons for your answer.
- What are some uses of brass?

▶ After considering the results of their activity, students discuss and research more general questions that could include:

- Can you tell an alloy from a pure metal just by looking at it?
- Can you see the separate parts of alloys easily?
- Why are alloys made?
- Do alloys seem easy or hard to make?
- Why was bronze so important that the Bronze Age was named after it?

▶ Students reflect on the process of making brass, the discussion that followed and the generalisations they made. They prepare a short report in which they discuss the relative usefulness of metals and alloys and the reasons for the apparent changes in properties when metals are combined to form alloys. The report should progress from specific examples to a hypothesis about the changes in properties of metals when they are combined to form alloys.

**Gathering information about student learning**

Sources of information could include:

- students' contributions to discussions;
- students' reports, summaries and generalisations;
- students' answers to questions;
- students' research notes.

ACTIVITY

# Industrial processes

*Developmental*



## Focus

This activity provides opportunities for students to research an industrial process and to consider the changes made to materials involved in the process.

## Materials

- resource materials about a relevant industrial process

## Teaching considerations

Students work on this activity individually.

The specific topic of this activity will be dictated by what is relevant to students (particularly in relation to the local area) and by the availability of information.

Before students begin the research task, negotiate with them how they will present their findings — for example, oral presentation, poster, model, formal report or booklet. Oral presentations should take 10–15 minutes per student. Explain clearly to students the criteria by which the task will be assessed.

Support students in their research by:

- discussing issues with them;
- prompting them to ask pertinent questions for which they can find answers in a reasonable time;
- asking questions that they may not have considered.

Exploration of issues such as re-using and recycling changed materials can be a context in which students have the opportunity to demonstrate discretionary outcome 4.4 of the Natural and Processed Materials strand: 'Students recognise, and report on, the environmental impact of some manufacturing processes'.

## Working scientifically

Time: 4 periods each of 35 minutes

**Collecting information**
**Formulating questions**
**Looking for patterns and meanings**
**Making plans**
**Constructing meaning**
**Examining and evaluating**
**Making links**
**Synthesising**
**Creating presentations**
**Describing**
**Illustrating**
**Retelling and restating**

▶ Students identify materials that are important in their lives. They discuss how these materials are used and how they have been processed. They focus discussion around 'changes that make materials more useful' for particular purposes.

▶ Students choose and research an industrial process involving changes to materials. In their research they focus on the idea that 'materials are changed to make them useful'. Some of the changes will be physical, some chemical.

Industrial processes that students could choose to research include the manufacture or processing of:

- aluminium
- cement
- cotton
- glass
- natural rubber
- nylon
- petrol
- plastics
- plywood
- synthetic rubber
- wool

Questions to guide research could include:

- What raw materials are used in the process?
- What are the products of the process?
- What is done to the raw materials to change them?
- What are the important differences in properties between the raw materials and the final product?
- What is the reason for each change made to the materials?

► Students discuss various formats for the presentation of their findings. They present their findings, explanations and conclusions to the class using their preferred format.

**Gathering information about student learning**

Sources of information could include:

- students' contributions to discussions;
- students' notes;
- students' final research reports.

ACTIVITY

# Strengthening plaster

*Culminating*



## Focus

This activity provides opportunities for students to examine, assess and change a material using their understanding of composites, and to design tests to evaluate the changed material.

## Materials

For each group of students:

- Resource Sheet 3, 'How can plaster be made stronger?'
- materials listed on Resource Sheet 3
- safety glasses
- planning and reporting worksheets (sourcebook guidelines, appendix 3)

## Teaching considerations

Students carry out this activity in small groups.

Use planning and reporting worksheets (see the sourcebook guidelines, appendix 3) to develop students' ability to work scientifically during their investigation. These worksheets will help students focus on the problem, consider the variables and evaluate their products.

Regulate the size and shape of the mould that students make and fill with plaster, as they may test the strength of the plaster casts by loading them with weights until they break. All proposed strength tests must be discussed with, and approved by, the teacher.

***Safety***

Inform students about precautions for:

- preventing eye damage;
- handling heavy weights.

## Working scientifically

Time: 90 minutes

**Designing and performing experiments**
**Handling materials**
**Identifying and controlling variables**
**Predicting**
**Analysing**
**Drawing conclusions**
**Making comparisons**
**Describing**
**Using scientific report genres**

▶ Led by the teacher, students discuss the types of changes in materials that they have investigated recently. They review both natural changes, particularly those that make materials mechanically stronger, and changes made by people for a particular purpose. Students are then challenged to make a composite plaster that is stronger than an unmodified plaster.

▶ Students examine possible strengthening materials and describe their properties before predicting which ones would be best. They consider the dimensions of the strengthening materials so that they fit into the mould.

▶ Students choose which materials they think would be best for strengthening plaster and justify their choices in terms of their knowledge about materials being made up of different parts.

Resource Sheet 3

▶ Students make the plaster samples according to the method described on Resource Sheet 3. They make three or four test samples as follows:

- a control sample without any strengthening material;
- a sample with their first choice of strengthening material;
- a sample with their second choice of strengthening material;
- a sample with their third choice of strengthening material.

▶ Students discuss how to test the strength of the plaster. They identify controls and variables and then design a test method. Discussion questions could include:

- What is plaster used for? What is it that you need to test?
- Apart from the type of strengthening material used, what else might change the results of the experiment?
- What do you need to do to keep everything in the samples the same, apart from the type of strengthening material put in the plaster?
- What can you measure in the test to tell you the strength of the plaster?
- What safety issues need to be considered?

▶ Students perform their tests on the plaster and record the results. They analyse the results and draw conclusions about the types of materials that can be used to strengthen plaster. They discuss which material they found to be best for this purpose. Questions to guide analysis of results could include:

- Did the material strengthen the plaster?
- Which material gave the most strength to the plaster?

▶ Students discuss whether their test was fair. Discussion questions could include:

- Did your experiment really test what it was intended to test (that is, the strength of the plaster)?
- Were your tests fair tests?

▶ Students make generalisations based on their findings. Discussion questions could include:

- What type of material is plaster?
- In what way did you process plaster to improve its properties?
- What properties did the process improve?
- Did the process result in any undesirable changes to any properties?
- What general sorts of materials seem best for strengthening plaster?

▶ Students write a report to summarise their findings and conclusions, or complete the planning and reporting worksheets.

### Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' observations;
- students' notes or their planning and reporting worksheets;
- students' test designs and descriptions;
- students' final reports.

ACTIVITY

# Making damper

*Culminating*



## Focus

This activity provides opportunities for students to apply their knowledge of changes in materials during a chemical reaction to assess the role of, and find an appropriate substitute for, certain materials in a recipe. Students investigate using baking powder mixed with plain flour as a substitute for self-raising flour.

## Materials

For each group of students:

- Resource Sheet 4, 'Making damper'
- materials listed on Resource Sheet 4, but with plain flour substituted for self-raising flour
- baking powder (in a container labelled 'Baking powder: sodium bicarbonate and phosphate aerator')
- planning and reporting worksheets (sourcebook guidelines, appendix 3)

## Teaching considerations

Students carry out this activity in small groups.

'Cooking pikelets' (see p. 10) is a suitable developmental activity for students to engage in before undertaking this culminating activity. The activity may be set up as a problem-solving scenario.

***Safety***

Inform students about safe practices for using electrical appliances, stoves and hot cooking utensils. Instruct students to turn their faces away when opening the oven door.

As taste tests may be part of the evaluation, this activity should be carried out in a food preparation area. All rules of safety and hygiene must be followed — for example, students are to wash their hands before handling ingredients.

Some students may have food intolerances. Diabetics may need to monitor the sugar content of their food.

## Working scientifically

Time: 60–120 minutes

**Designing and performing experiments**
**Engaging with problems**
**Handling materials**
**Hypothesising**
**Looking for patterns and meanings**
**Making plans**
**Predicting**
**Applying ideas and concepts**
**Dealing in an orderly manner with the parts of a complex whole**

### Scenario

Students are to make a damper. Unfortunately, the recipe calls for self-raising flour and the school has only plain flour and baking powder. Students have to make damper using the substitute ingredients.

### The task

Students are to:

- hypothesise how the baking powder can be used;
- test their ideas if necessary;
- predict a suitable mixture of baking powder and plain flour to substitute for self-raising flour;
- test their substitute mixture;
- change the proportions used in the recipe and repeat the test.

**Examining and evaluating**
**Generalising**
**Making links**
**Clarifying ideas and concepts**
**Summarising and reporting**


▶ Students record their hypotheses, predictions and test plans in their notebooks. They may find it helpful to use the planning and reporting worksheets (see the sourcebook guidelines, appendix 3).

▶ Students follow the instructions on Resource Sheet 4 to make damper. They may need to make several batches of damper before their recipe is perfected.

▶ Students record their test results and any adjustments they made to the recipe.

▶ Students make final presentations that could be either or both of:

- revised recipes that reflect the findings of their experiments, accompanied by illustrations and explanations;
- a written report of their experiments.

### Gathering information about student learning

Sources of information could include:

- students' hypotheses, predictions, observations, test plans and test results recorded in their notebooks, or their planning and reporting worksheets;
- students' explanations of how they revised the recipe;
- students' modified recipes;
- students' final reports.

ACTIVITY

# Using materials to make simple tools

*Culminating*



## Focus

This activity provides opportunities for students to design and make a simple tool, then improve it using understandings of materials technology developed in previous activities.

## Materials

For the whole class:

- pictures of simple tools (optional)
- materials suggested by the students for the tools they are designing

For each group:

- Resource Sheet 5, 'Simple tools'

## Teaching considerations

Tools to be discussed and made in this module could include:

- axe
- basket
- bow and arrows
- earthenware pot
- fishing hook
- fishing spear
- hammer
- pulley
- string bag
- umbrella
- water wheel
- wheelbarrow

Pictures of tools used by Torres Strait Islander people are available in *Thathilgaw Emeret Lu: A Handbook of Traditional Torres Strait Islands Material Culture* by Lindsay Wilson (see 'Support materials and references', p. 5).

Students could use the planning and reporting worksheets (sourcebook guidelines, appendix 3) for guidance with planning, refining and evaluating their tools.

***Safety***

Inform students about safe practices for:

- handling materials and equipment to be used;
- constructing and testing their tools.

The teacher must check design and the test plans for feasibility and safety. Students must be given guidance on the safe construction and testing of their tools.

## Working scientifically

Time: 4 periods each of 35 minutes

**Designing and performing experiments**
**Handling materials**
**Identifying and controlling variables**
**Predicting**
**Analysing**
**Drawing conclusions**
**Making comparisons**
**Describing**
**Using scientific report genres**

**Resource Sheet 5**

▶ Students review the nature of changes in materials that they have investigated, focusing on materials used in the manufacture of tools. They discuss what they know about versions of tools constructed in different historical periods. They also discuss tools they might be able to make in class. Resource Sheet 5 could be used as stimulus material. Points for discussion could include:

- the ways that wheels have changed and why these changes were made;
- different materials and methods of construction for an umbrella, a hammer or an axe;
- making fibres and threads;
- changing threads into a fabric;
- the treatment of clay pots used for different purposes;
- the materials used to make pointed implements.

▶ Students, working in small groups, choose a simple tool to design, make and test. Questions to guide the selection and design of the tool could include:

- What is the purpose of the tool that you are going to design and make?
- What are the essential characteristics of this tool?
- What materials were used in the past to make this tool?
- How were the materials used in the past changed to make them more useful?
- How could you change or combine materials to make them more useful in the construction of the tool that you have chosen to make?

▶ Students make their tools and discuss ways of testing their effectiveness. Questions to guide discussion could include:

- How will you know if your tool has worked?
- How can you test the tool in a way that simulates the way the tool is normally used?
- What measurements can you take to make the test more precise?

▶ Students test their tools and record the results. They use the results of their tests to refine the design and remake the tools. Several different versions could be made and the improvements compared.

▶ Students carry out their tests and collect and record data on the performance of their tools.

▶ Students discuss ways of reporting their findings to the class. In their reports students could:

- explain why the tests they devised provided a valid comparison between the tools;
- describe ways in which the tool could be improved further if more money or time were available;
- compare the different versions of the tools and the ways in which the component materials were used to make the different versions;
- describe how the test procedure could be improved if more money or time were available.

▶ Students present their reports.

**Gathering information about student learning**

Sources of information could include:

- students' contributions to discussions;
- students' designing, testing, refining and retesting of the tools;
- students' reports.

# Cooking pikelets





**Safety**

*Take great care when using a hotplate or electric frying pan.*

*Follow the rules of safety and hygiene for food preparation. Pikelets should be made in a food preparation area.*

## Ingredients

- 1 cup plain flour
- $^1/_2$ teaspoon sodium bicarbonate
- 2 tablespoons sugar
- $^1/_2$ cup milk
- 1 teaspoon vinegar
- 1 egg
- 1 dessertspoon butter (melted)

## Equipment

- small frying pan and hotplate, or electric frying pan
- small bowl in which to beat the egg
- whisk or fork
- medium bowl in which to mix ingredients
- dessertspoon
- cooking spatula

## Method

1. Place all the dry ingredients in the larger bowl. Make a well in the centre.
2. Break the egg into the smaller bowl and whisk. Stir the milk and melted butter into the beaten egg.
3. Pour the liquid into the dry ingredients and stir gently until the mixture is smooth.
4. Heat the frying pan to a medium heat then turn the heat to low. Place spoonsful of batter in the pan.
5. Cook on one side until numerous bubbles appear on the upper surface. Turn the pikelet over. Continue cooking until the pikelet is lightly brown on the underside. Remove from pan.

# Making brass from copper and zinc





**Safety**

*Nitric acid and sodium hydroxide, even in dilute solution, are very corrosive and dangerous, especially when hot.*

*During this activity everyone in the room must wear safety glasses. People working with nitric acid and sodium hydroxide must also wear gloves and aprons.*

*This activity should be conducted next to a sink with running water.*

## Materials

- small piece of thin copper sheet (about the size of a 5-cent coin)
- powdered or granulated zinc
- 1 M nitric acid (63 g nitric acid in 1L of water)
- 1 M sodium hydroxide (40 g sodium hydroxide in 1L of water)
- hotplate
- Bunsen burner
- 2 evaporating dishes
- glazed tile (preferably white)
- tongs (suitable for gripping the evaporating dish safely and securely when lifting it onto and off the hotplate)
- safety glasses (for all present)
- disposable gloves and waterproof aprons for all those handling any vessel containing nitric acid or sodium hydroxide

## Method

1. Half-fill one evaporating dish with the nitric acid.
2. Hold the piece of copper with the tongs and dip it into the nitric acid for about 20 seconds. Remove the sample from the nitric acid and wash the sample and tongs thoroughly under running water.
3. Place about one teaspoonful of zinc powder or granules into the second evaporating dish. Carefully pour dilute sodium hydroxide over the zinc until the evaporating dish is about half full.

*(continued)*

## Making brass from copper and zinc (*continued*)





4. Use the tongs to place the piece of copper on top of the zinc in the dish containing sodium hydroxide.
5. Turn the hotplate to medium heat.
6. Place the dish containing the metals in sodium hydroxide on the hotplate and heat it, but don't let the sodium hydroxide boil or boil over. (Be prepared to lift the dish off the hotplate if you think it is going to boil. Turning the hotplate down will not prevent boiling because the hotplate will not cool fast enough.) Leave the metal in the sodium hydroxide until you see a change in the appearance of the copper. Remove the dish from the hotplate.
7. Use the tongs to remove the copper, rinse it (and the tongs) in water and allow it to cool and dry.
8. Light the Bunsen burner and set it to a quiet blue flame.
9. Hold the piece of copper with the tongs and heat it gently until it changes colour. Place it on the tile to cool. The piece of metal is now brass, an alloy of copper and zinc.

# How can plaster be made stronger?





**Safety**

*Handle all the materials with care. Be especially careful when handling, pouring or stirring the plaster of Paris so that the least possible amount of dust escapes into the air. Some people may be sensitive to this fine dust. If you know or think that you may be affected by the dust, tell your teacher before you take part in this activity.*

*Before carrying out strength tests on the plaster, you must discuss the tests with your teacher. Do not carry out any tests until the teacher has approved them.*

## Materials

For each group of students:

- plaster of Paris
- a selection of materials that may be suitable for strengthening plaster — for example:
  - fishing line
  - grass
  - straw
  - toothpicks
  - wire mesh
- scissors
- stirring rod or spoon
- 250 mL beaker or other container for mixing
- small shallow trays or dishes to use as moulds (e.g. a bar shape about 10 cm x 2 cm x 1 cm)
- aluminium foil (to line the moulds)
- equipment for a strength test devised by students (e.g. brass weights on a hook)
- safety glasses

**Note:** The trays or dishes to be used as moulds need to be similar in size and shape, and deep enough to hold two layers of plaster of Paris. A rectangular mould will give a bar-shaped piece of plaster that is suitable for testing.

*(continued)*

## How can plaster be made stronger? (*continued*)





### Method

1. Gently place four dessertspoonsful of plaster of Paris powder in a beaker or bowl. Stir in sufficient water to make a mixture that is only just thin enough to be poured.
2. Line each mould with aluminium foil.
3. Fill one mould completely with the plaster of Paris mix only. This is the control.
4. Fill each of two or three more moulds with plaster and place a different strengthening material in each. To do this:
   - pour into the mould just enough plaster to cover the bottom of the mould;
   - place some strengthening material (cut to fit if necessary) in the mould;
   - use a stirring rod to press the strengthening material into the plaster until the material is just covered;
   - add more plaster, about the same quantity as you used in the first pour;
   - if there is sufficient space left in the mould, put in more of the same strengthening material, press it into the plaster and then pour some more plaster on top;
   - continue adding strengthening material and plaster until the mould is filled.
5. Use a toothpick to write your name in the wet plaster and the type of strengthening material that you put in this bar.
6. Allow the plaster to dry overnight.
7. Lift the foil-lined samples out of the mould. Remove the foil and test the properties of the samples.

# Making damper



Safety

*Follow the rules of safety and hygiene for food preparation. Wash your hands before starting.*

*Take great care when using the hotplate, electric frying pan or oven.*



## Ingredients

- 4 cups self-raising flour
- 1 teaspoon salt
- 30 grams butter
- 1 cup milk
- water for mixing
- butter or syrup (to spread on the cooked damper)

## Equipment

- oven or electric frying pan with lid, or camp oven and hotplate
- mixing bowl
- baking tray
- knives
- measuring spoons and cups

## Method

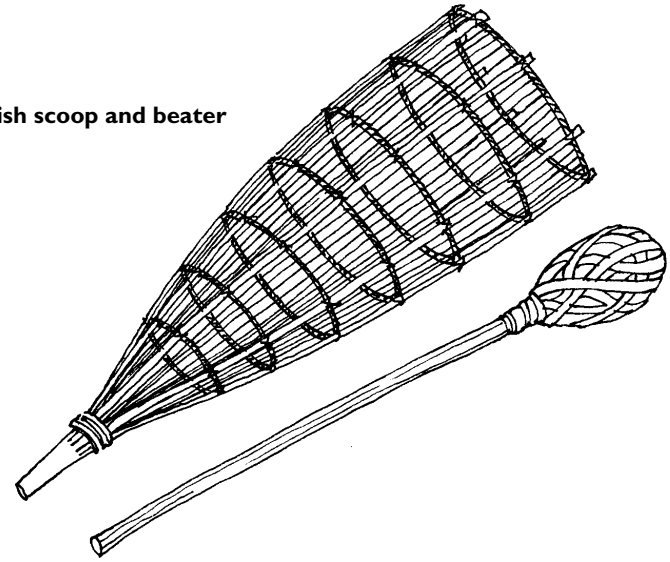
1. Sift together the flour and salt, rub in the butter with your fingers; then make a well in the centre of the mixture.
2. Pour the milk into the well and mix with a knife. Add water a little at a time and keep mixing until the dough leaves the sides of the bowl.
3. Knead the dough lightly.
4. Place the dough on a greased tray and shape it into a 20 cm circle.
5. Bake at 220°C for 25 minutes; then reduce the heat to 180°C. Bake for a further 10–15 minutes until the damper sounds hollow when tapped.
6. Remove the damper from the oven and allow it to cool.
7. Spread butter or syrup (or both) onto a piece of the damper before eating it.

# Simple tools

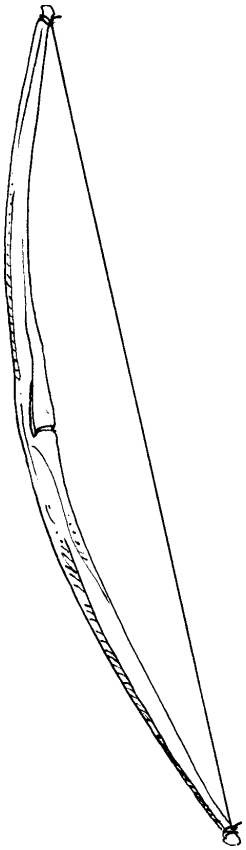




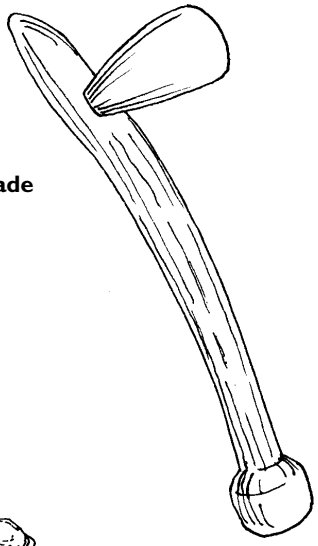
**Fish scoop and beater**



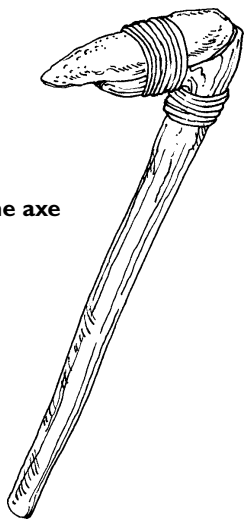
**Bow and arrow**



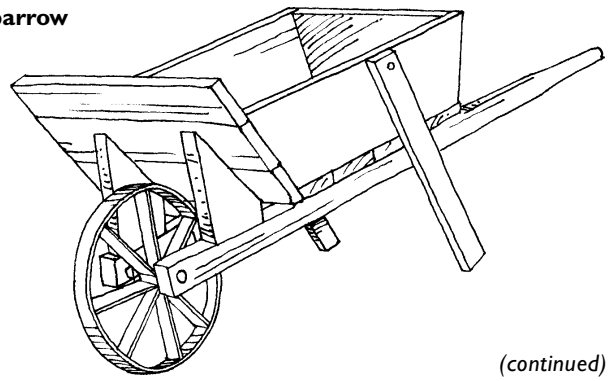
**Axe with clamshell blade**



**Stone axe**



**Wheelbarrow**



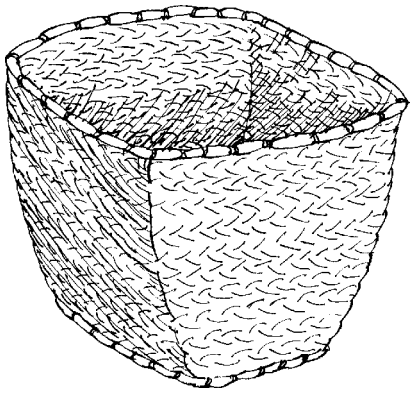
*(continued)*

Source: Illustrations of the axe with a clamshell blade, fish scoop and beater are reproduced with permission from Wilson, Lindsay 1988, *Thathilgaw Emeret Lu: A Handbook of Traditional Torres Strait Islands Material Culture*, Queensland Department of Education, Brisbane.

# Simple tools (*continued*)

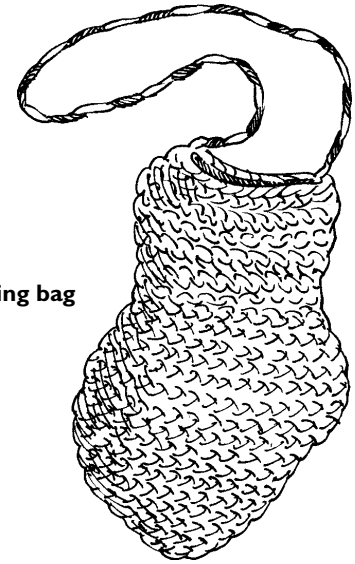


**Basket**

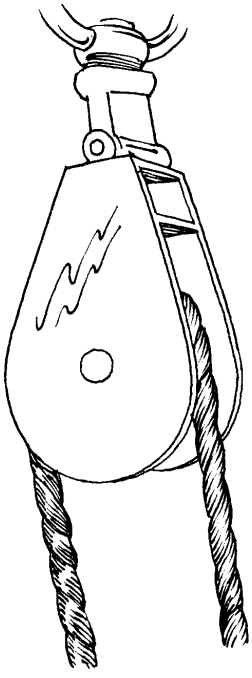


**Clay pot**

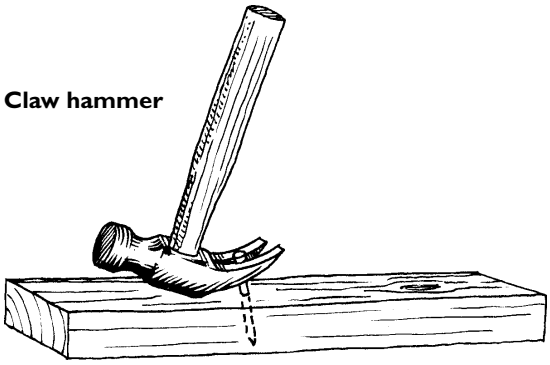
**String bag**



**Pulley**



**Claw hammer**



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Queensland Department of Education for material from *Thathilgaw Emeret Lu: A Handbook of Traditional Torres Strait Islands Material Culture*.

**This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:**

***Years 1 to 10 Science Syllabus***

***Years 1 to 10 Science Sourcebook: Guidelines***

***Science Initial In-service Materials***

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