



Solomon Islands Technology

Year **7**

Learner's Book



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Learner's Book

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To the learner,

The ***Solomon Islands Technology Year 7 Learner's Book*** is aimed at helping you develop knowledge and skills as a technologist. Each chapter has activities and practical tasks that will help you apply your knowledge and skills. This book also includes design problems, which set the context for each chapter.

You will need to use the design process as you work through the practical tasks. The design process is outlined in the first chapter of this book, which forms the basis for organizing your design portfolio.

There are fifteen chapters covering different topics. You do not have to start at the beginning of the book and work through it step-by-step to the end. Your teacher should talk to you about the chapters you will be doing, according to which ones are the most interesting and appropriate for your situation. Every chapter in this book will help you become a good technologist.

In each chapter you will find:

Activities

The headings next to each activity tell you what the activity is about. As indicated in each activity and with your teacher's help, you will be informed on whether these activities are to be done individually or in groups, and how it should be done.

New words

New words are printed in bold type in the text and are explained in the 'new words' section at the end of each chapter.

Design problems

The design problems in each chapter function as case studies. These highlight real situations in the Solomon Islands where there is a need for a product. The design problem appears early in the chapter; to find a technological solution for it, you need to acquire the knowledge and skills covered in each of the chapters.

How to ...

In each chapter you will find step-by-step instructions that will help you develop the necessary skills to undertake a technological task.

Practical task

There is a practical task at the end of each chapter. This is a project where you are required to apply the knowledge and skills you have learnt from the chapter in making a product. This technological task is based on the design problem given earlier in the chapter. In carrying out this task, we hope you will be able to design and make products that are solutions to real problems or satisfy real needs.

Assessments

In each chapter, the main assessment activity is the practical task. Some activities in each chapter will also be assessed by either you or your teacher. These assessments should help you check and consolidate what you have learnt in each activity.

Chapter 1

The design process

Learning outcomes

By the end of this chapter, you should be able to:

- 7.1.1.1** identify the steps of the design process
- 7.1.1.2** describe the steps of the design process
- 7.1.1.3** identify a technological solution
- 7.1.1.4** identify effective marketing strategies used in communicating technological solutions
- 7.1.2.1** sequentially follow the steps of the design process to make a solution for a specific need or opportunity
- 7.1.2.2** use the steps of the design process accurately when providing a technological solution or product
- 7.1.2.3** use criteria to make design decisions
- 7.1.2.4** identify solutions or outcomes in response to a need or opportunity
- 7.1.2.5** review outcomes or solutions using design specifications
- 7.1.2.6** communicate solutions or outcomes effectively
- 7.1.3.1** write two reasons why it is important to follow the steps of the design process in responding to technological needs or opportunities.

Introduction

In this chapter, you will **explore** the part that technology plays in Solomon Islands today, and its importance in solving problems in our everyday

lives. You will also learn about the steps or process to follow when solving a technology problem.

In *Technology Year 7*, each chapter begins with a design problem and ends with a practical task to solve that problem.

Activity 1: Finding out about technology



Figure 1.1 Examples of technology

- 1 Form into groups and look at the pictures above. They all show examples of technology.
- 2 Using the pictures, explain what technology is. (Use your own ideas—do not look in a dictionary.)
- 3 Share your definition of technology with your teacher and classmates.

What is technology?

From the examples in the pictures on page 2, you can see that technology involves one or more of the following:

- the use of some sort of tool or machine to help you do something useful
- the materials used to make products
- the knowledge and skills used to make products
- the process used to make the products.

Why learn about technology?

Technology is useful because it helps us to solve problems, such as catch more fish, defend ourselves from our enemies, make our canoes travel faster or light our houses at night.

In Technology lessons you will learn about new ways of solving problems. You will be asked to **investigate** technology problems and find out how you can solve those problems by:

- using different kinds of materials
- using knowledge and skills about how to use materials
- thinking of new ways to use materials.

The technology problems that you solve using **appropriate** materials can be very simple, or they may be very complicated.

Activity 2: Finding technology problems in the classroom

- 1 Look around your classroom. Make a list of five everyday problems that you or your teacher experience in your classroom. For example:
 - a There is no place to store books and classroom materials.
 - b The door does not close properly.

- 2 **Brainstorm** some solutions for each problem.
- 3 How would you solve these problems?
- 4 What knowledge and skills do you need to solve these problems?

The design process

There are different methods you can use to solve technology problems. In Technology you will use a method called the design process to solve technology problems.

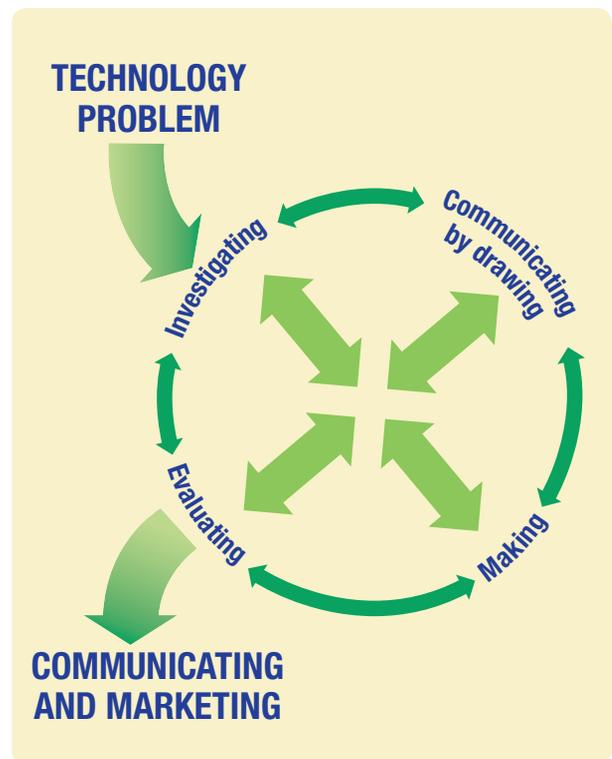


Figure 1.2 The design process

You should be able to recognize the different steps in the design process: investigating, communicating by drawing, making, evaluating, and communicating and marketing. However, these steps do not have to occur in the order shown in the diagram.

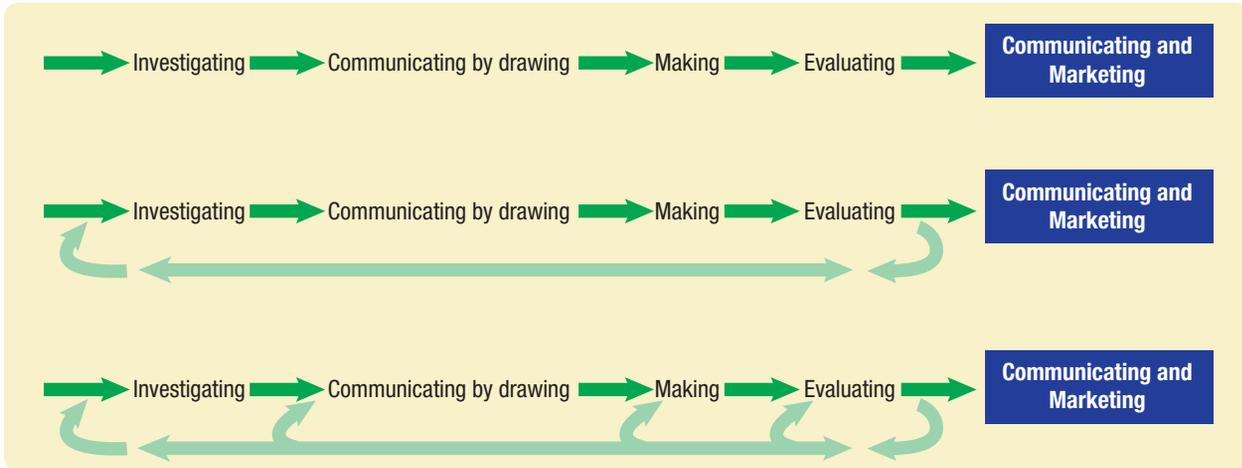


Figure 1.3 Different ways of carrying out the design process

Activity 3: Using the design process to solve a technology problem

- 1 Copy into your exercise book the three ways of carrying out the design process shown in Figure 1.3.
- 2 Next to each diagram write the correct matching statement from the list below:
 - After designing, you always make and **evaluate** the product.
 - After designing, you make and evaluate the product, then go back to investigating.
 - After designing, you make and evaluate the product, and can then go back to investigating, or designing or remaking it.
 - After designing, you usually make the product, but you can go back to investigating.

Investigating

Identify the problem or need

The first step in the design process is to identify a need or problem. The secret to identifying a problem or need is to be **observant**. Look at things people do every day then develop a design brief for the problem or need.

Design brief

The second stage is to write a design brief. A design brief is a statement about the task to be solved. It should be short and clear, for example:

- Design and make a clothes hanger.
- Design and make a serving spoon from wood.

Design specification

The next stage is to write a specification. This is a list of criteria—or targets—which must be met in whatever solution you decide upon.

A specification for a serving spoon might look like this:

- It must be made from wood.
- The handle must be small enough for children to use.

Activity 4: Investigating a technology problem

Below is a design problem. Read it carefully then answer the questions that follow.

The school librarian complains that the books placed on the library shelves fall down very easily. Some books even fall off the shelves onto the floor. Students complain about the disturbances caused by books sliding on the shelves. This problem is discussed by the librarian and your Technology teacher, and both agree that your class will make some bookends to solve this problem in the library.

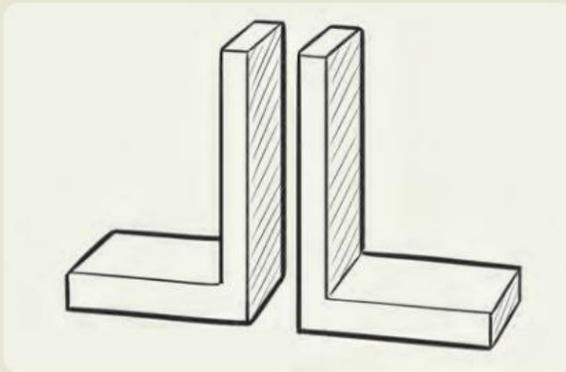


Figure 1.4 A pair of bookends

- 1 Write a simple design brief for the design problem above.
- 2 In groups, discuss and write down any two design specifications for the design problem above.
- 3 Write down an explanation of the term 'design problem'.

Communicating by drawing

We can communicate with each other in many ways. For example, we use language and sometimes we use signs. Another way we communicate is by drawing. In Technology, you will communicate your ideas in drawing. The type of drawing you will use is called technical drawing.



Figure 1.5 Drawing a technical drawing

Activity 5: Communicating ideas in technical drawing

- 1 Look at the technical drawings in Figure 1.6. They are two different types of drawings of the same chair.
- 2 There are two types of technical drawing: two-dimensional (2-D) and three-dimensional (3-D). Look at the drawings in Figure 1.6, and identify which is 2-D and which is 3-D.
- 3 Write down one main feature of 2-D drawings and one of 3-D drawings.

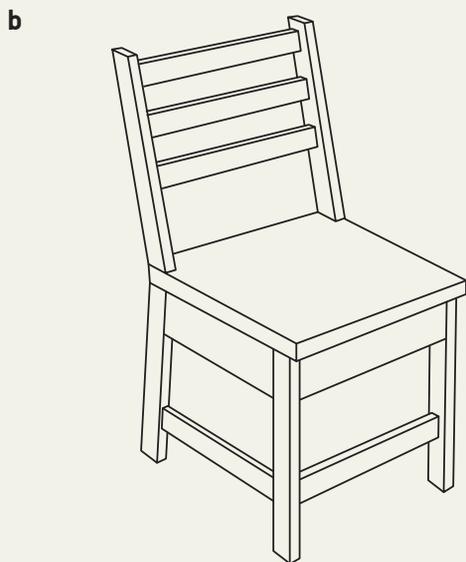
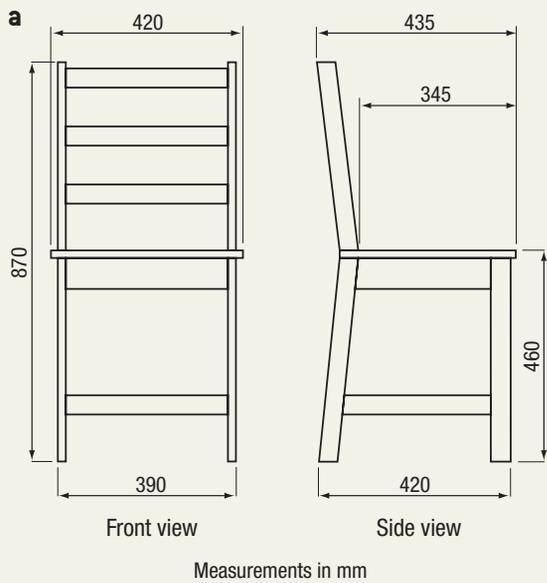


Figure 1.6 Two drawings of the same chair

Drawing in Year 7 Technology will be in 3-D. It is often useful to draw three or more rough sketches for each technical drawing. Once you have finished the drawings for your practical task, you need to look at your drawing and decide which you think will work best. Explain why you have chosen that drawing. Then do a final drawing and label it clearly.

You will need some criteria, or ideas, to help you make your choices. You could use questions such as the following to help you decide upon the criteria:

- Are the materials available and suitable?
- What are the costs?
- How difficult is it to make?
- Will people buy it?
- How well does it meet the specifications?

Making

Your plan

When you have decided on a final drawing, list the materials you will need, the steps for making your product and the tools you will need. You can use the following ideas for setting out this information.

Materials needed

(List the materials, and try to estimate the quantity of each material you list.)

- _____
- _____
- _____



Amount of work involved

(Try to work out exactly the steps involved in constructing your product. List them in order, and number them. Next to each step, list any safety requirements and the time the step will take.)

- 1 _____
- 2 _____
- 3 _____



Tools needed

(List the tools you will need. Next to each, list any safety requirements. Think about where to borrow or hire the tools that you don't have.)

- _____
- _____
- _____



You must carry out the working processes you have identified using the appropriate drawing guide and tools. Consider the time available for making your product, and make sure your product is finished on time.

Evaluating

When you evaluate your product, you determine how successful it is in solving the problem or need identified at the beginning of the practical task.

When preparing an evaluation report you need to look at your final product, and reflect on how well it satisfies the design specification. An evaluation report should be produced as a written statement, and include sketches and diagrams. The report should describe the strengths and weaknesses of the product and suggest how it can be improved.

Communicating and marketing

When you have developed a product you need to communicate information about it to others. There are two different ways of communicating information about your product in Technology. Firstly, once your product is completed, you inform others about it through talking to them about it. Secondly, through the presentation of a **design portfolio** (design journal) that you have compiled, you explain the development of your product. Your teacher will let you know how to do this.

You should explain the different things you do in the design process. This will help you in marketing your product to users. The users of the product are your target market. They need to be informed about the benefits of using the products and the selling price. This is a marketing **strategy**, or way, of convincing your buyers to buy your product.

New words used in this chapter

appropriate	suitable or correct
brainstorm	come up with
design portfolio or journal	report or diary
explore	find out about
evaluate	check how something worked, e.g. check if a product did what it was supposed to do
investigate	look into, examine
observant	on the look-out
strategy	plan

Chapter 2

Technical graphics

Learning outcomes

By the end of this chapter, you should be able to:

- 7.2.1.1** identify the different types of lines used in technical drawing
- 7.2.1.2** identify the process of freehand lettering in technical drawing
- 7.2.1.3** describe the two ways to present a pictorial drawing
- 7.2.1.4** differentiate isometric from oblique drawing with the use of different lines and angles that represent each drawing
- 7.2.2.1** identify the instruments used in technical drawing
- 7.2.2.2** describe the main features of a working drawing
- 7.2.2.3** identify the information that should be on a working drawing
- 7.2.3.1** develop working drawings for the design of a pair of bookends
- 7.2.3.2** practise sketching in technical drawing
- 7.2.3.3** draw the different types of lines used in sketching
- 7.2.3.4** practise freehand lettering in technical drawing
- 7.2.4.1** use the basic technical drawing instruments correctly
- 7.2.4.2** sketch an isometric and an oblique drawing correctly
- 7.2.5.1** appreciate the importance of lettering in technical drawing.

Introduction

We communicate with each other in many ways. Today in Solomon Islands we communicate through letters, radios, newspapers, books, television, internet and email. **In contrast**, Solomon Islands traditional means of communication are blowing of conch shells, beating of wooden drums, use of particular physical objects, etc. Drawing is a means of communication. In this chapter you will learn about the use of technical graphics (drawings) for communicating your ideas.

Activity 1: Communicating your ideas

A pair of learners plays the following game while the rest of the class observes.

- 1 One player is given the names of three things. He or she then has to communicate to the other player what those three things are. This can be done by signing, writing or drawing, but in silence and without writing the actual names.
- 2 After taking several rounds in playing the game, discuss this question: 'When is it easier to communicate by drawing rather than by writing or signing?'

Drawing is a method of recording and communicating ideas. The kind of drawing used in Technology is called technical drawing. It is used particularly to record and communicate ideas about objects that are to be made. Here are some examples of how technical drawing is used by different people in their workplaces.

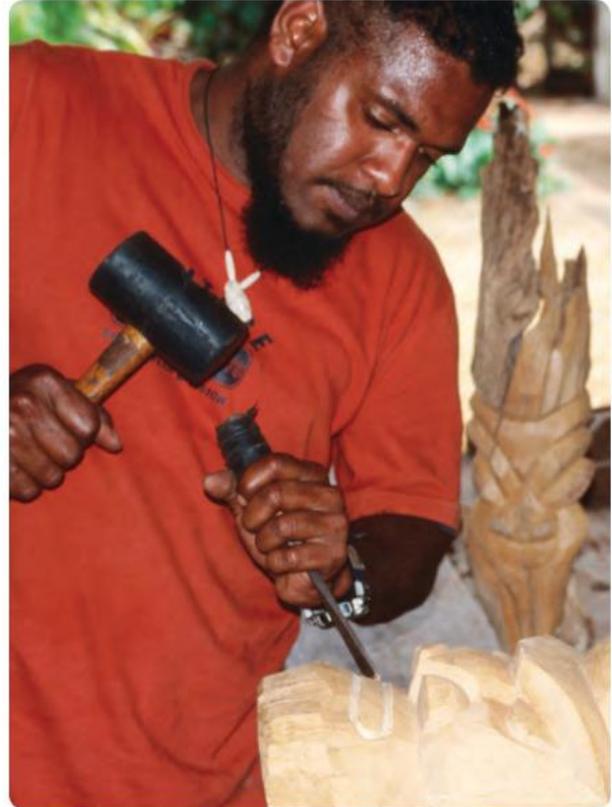


Figure 2.1 Carvers use technical drawings.



Figure 2.2 Architects use technical drawings when they make plans for a house.

Technical drawing is used by those who design things, such as **architects, engineers, industrial designers, drafters** and many others. They draw what they are going to make. Technical drawings provide information about objects to the people who will make them. In this chapter you will learn how to use basic technical drawing **tools and equipment**. You will also learn to do drawings using either of the methods given in Figures 2.3 and 2.4.



Figure 2.3 Freehand drawing

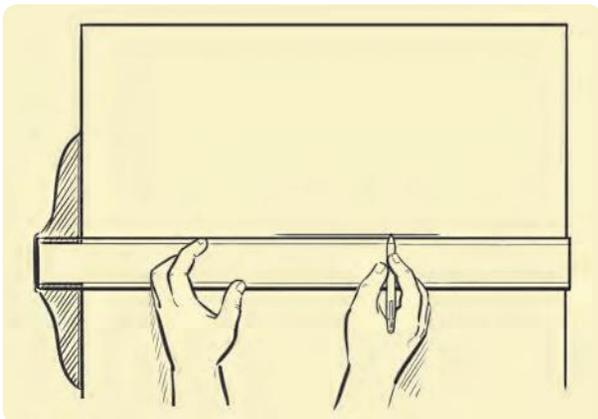


Figure 2.4 Drawings done by instruments are more accurate.

A technical drawing should be simple and provide accurate information. A product is always drawn up before it is actually made. Therefore, you must first draw the item you will make before you actually make it. In this chapter, you will learn about some of the basic ideas used in technical drawing.

In every design problem that you solve in Technology, you must do a drawing of what you will make. At the end of this chapter you will help to solve the design problem below.

Design problem: Bookends

Competition

* WIN * * WIN * * WIN *

A \$50 lunch money voucher for any student in Year 7 Technology.

The school will provide this prize.

The task is to design some bookends.
 These bookends will be used by teachers to hold their books in place on their tables. The bookends must be simple and able to be moved easily. Consider the material to be used when constructing this product.

Entries must be in by 1 April.

You will learn how to draw a bookend so that a person could use your drawing to make it. In order to help you make a drawing of a bookend, you need to learn about different types of drawings used in Technology. Furthermore, to transfer your ideas into a satisfactory drawing you will need proper drawing tools, equipment and materials. These tools, equipment and materials are listed below.

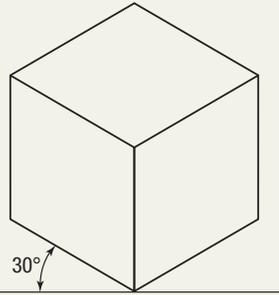
Tools and equipment used in this chapter	Materials used in this chapter
Drawing board	A4 paper
Protractor	A3 paper
Set square	HB pencil
• 30–60°	Paper clip
• 45°	Pencil eraser
T-square	

Activity 2: Finding out how to use the drawing instruments

You will need:

- 30–60° set square
- T-square
- drawing board
- A4 or A3 paper

- 1 Watch closely as your teacher draws a shape using the drawing equipment above. Take note of how your teacher draws the vertical and horizontal lines with the equipment.
- 2 Get the drawing equipment from your teacher and draw this object.



- 3 Copy and complete the following table in your exercise book.

Drawing instruments	Yes	No
Did I set the paper on the drawing board well?		
Did I draw the object on the centre of the paper?		
When I place my drawing on top of the drawing above, does it fit exactly onto the original drawing?		
I think our drawing can be improved by:		



Before you can use these instruments properly, you need to learn about freehand technical drawing, called **sketching**.

Freehand technical drawing – sketching

By the end of this topic, you should be able to:

- 7.2.1.1 identify the different types of lines used in technical drawing
- 7.2.3.2 practise sketching in technical drawing
- 7.2.3.3 draw the different types of lines used in sketching.

Freehand drawing, or sketching, is drawing without the aid of any instrument, using only pencil, paper and drawing board. Measurements are drawn to an approximate size without the use of a ruler. This type of drawing provides a quick and easy means of description or explanation. There are many different things that you must remember when you do your freehand drawing.

Drawing freehand lines

There are different types of lines used in freehand technical drawing. Freehand lines consist of a series of small, **overlapping** strokes.

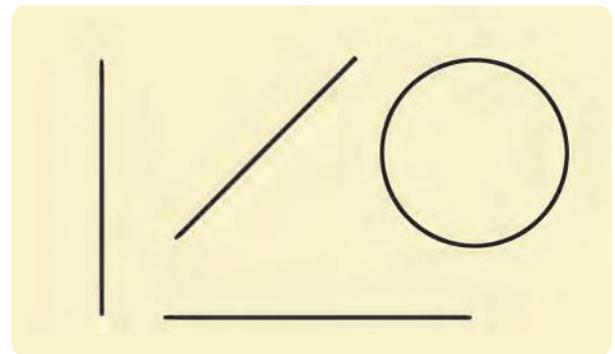


Figure 2.5 Freehand lines

Freehand lines may be horizontal, vertical, oblique, isometric or circular as shown in Figure 2.5.

Horizontal lines

The method of holding the pencil when drawing a freehand horizontal line is shown in Figure 2.6. The pencil is kept at right angles to the line being drawn and the line is sketched with an arm movement rather than a finger or wrist movement. Figure 2.8 shows this arm movement.

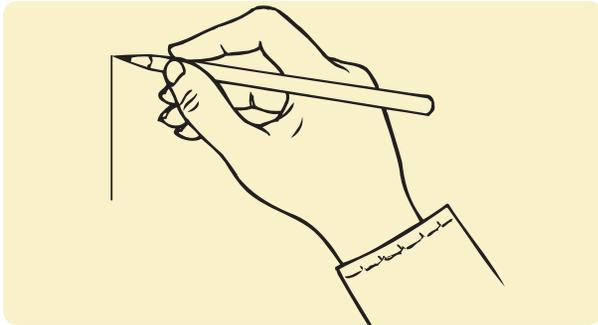


Figure 2.6 How to hold the pen when sketching

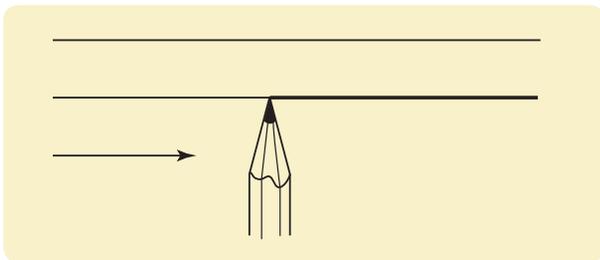


Figure 2.7 Horizontal lines

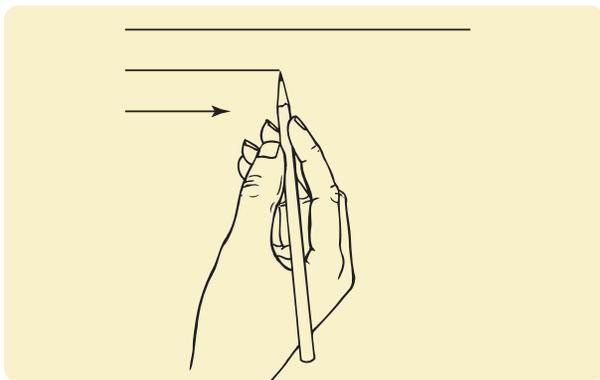


Figure 2.8 Drawing a freehand horizontal line

Vertical lines

Vertical lines are lines that go up or down. When you draw vertical lines, you should use the same method of holding the pencil as shown in Figure 2.6, with only your arm moving, as in Figure 2.9.

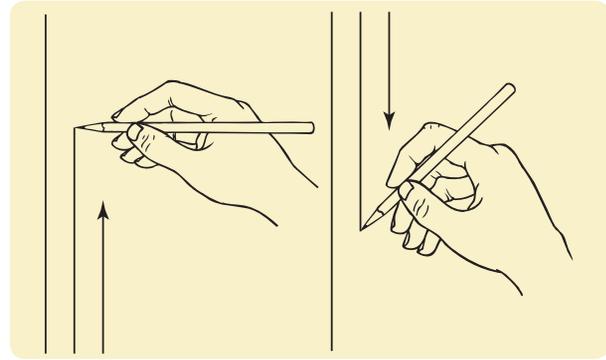


Figure 2.9 Drawing vertical lines

Oblique lines

Oblique lines are lines drawn at an angle of 45° to the horizontal. When you draw oblique lines, you should use the same method of holding the pencil as shown in Figure 2.6, with only your arm moving, as in Figure 2.10. It is best to turn the paper at an angle before drawing these lines.

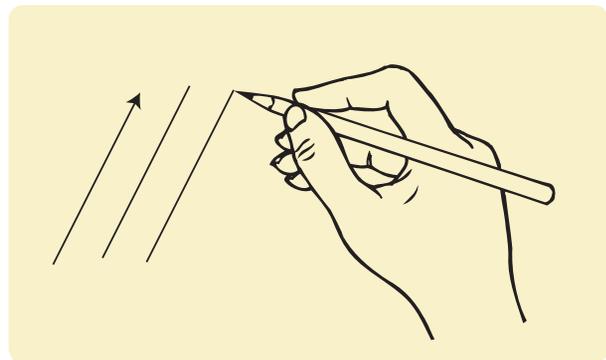


Figure 2.10 Oblique lines

Isometric lines

Isometric lines are lines that are drawn at 30° to the horizontal. When you draw isometric lines, you should use the same method of holding the pencil as shown in Figure 2.6, with only your arm moving, as in Figure 2.11. It is best to turn the paper at an angle before drawing these lines.

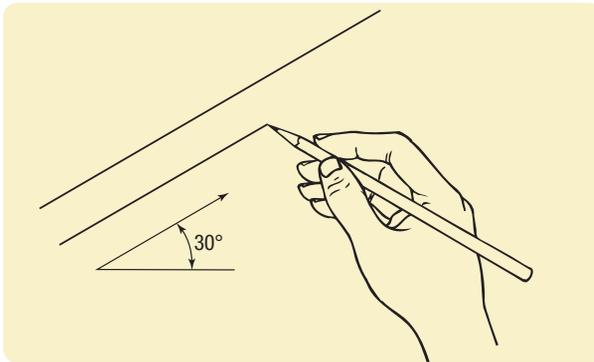


Figure 2.11 Isometric lines

Circles

When you draw circles, the pencil should be held as for horizontal lines. The hand is allowed to rest on the paper over the centre of the circle. As a guide, when drawing circles, draw horizontal, vertical and two oblique lines as shown in Figure 2.12. Mark off the radius on the length of each line from where all the lines meet. Then draw the circle using these points as guides.

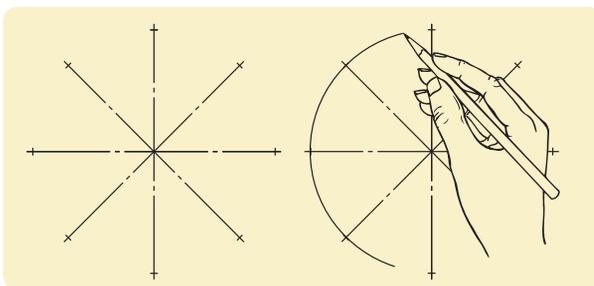


Figure 2.12 Circles

How to make a freehand drawing

- 1 Set out the drawing with light lines on the centre of the paper. Use the techniques outlined above when making these light lines. These light lines are called construction lines.

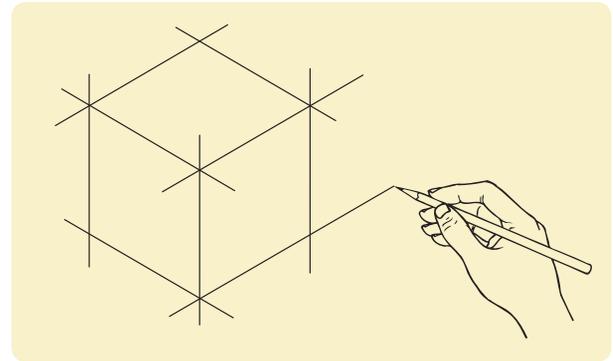


Figure 2.13 Construction lines

- 2 When you think that your drawing is accurate, **trace** over the light lines to make them darker. The dark lines that you have just drawn form the shape you want.

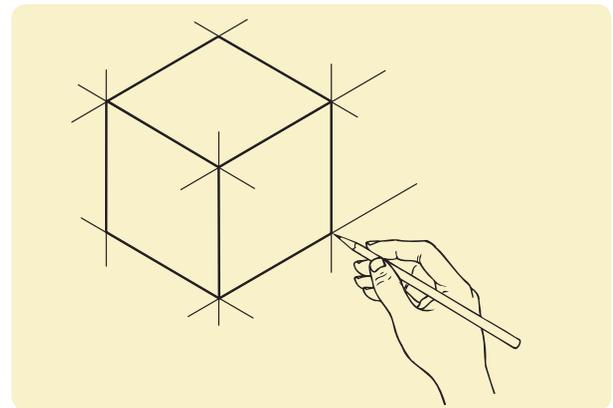


Figure 2.14 Darken the outlines to create the final shape.

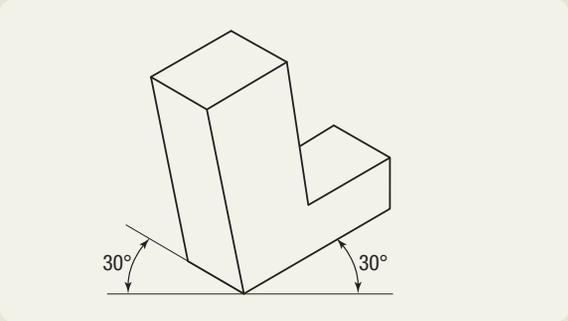
- 3 Use an eraser to rub out the light lines that are not part of the drawing.

Activity 3: Drawing freehand lines

You will need:

- sharp pencil
- pencil eraser
- blank A4 or A3 paper
- drawing board.

- 1 Read the section 'Drawing freehand lines' on page 11 and study the diagrams carefully.
- 2 Practise drawing parallel horizontal lines, parallel vertical lines, parallel oblique lines and circles. You should show your work to the teacher.
- 3 Read the section called 'How to make a freehand drawing' on page 13.
- 4 Using freehand technique, copy the shape below. Obtain measurements directly from the drawing using a ruler or compass.



5 Copy and complete the following table in your exercise book.

Drawing	Yes	No
Are the horizontal lines straight and parallel?		
Are the vertical lines straight and parallel?		
Are the oblique lines straight and parallel?		
I think the drawing can be improved by:		



Freehand lettering

By the end of this topic, you should be able to:

- 7.2.1.2 identify the process of freehand lettering in technical drawing
- 7.2.3.4 practise freehand lettering in technical drawing
- 7.2.5.1 appreciate the importance of lettering in technical drawing.

It is important, right from Year 7, to learn about the type of lettering used in technical drawing, whether you draw objects by sketching or using instruments. Lettering is used in drawings because it is more easily read than handwriting. All freehand lettering should be carried out with care. To assist in keeping the letter uniform (that is, the same height), you will find the use of guide lines helpful. You should draw three parallel light lines, and then use the sketching technique to print the letters within these parallel lines. There are two types of lettering used in technical drawing. Always remember to write your letters slowly and carefully.

How to sketch letters on a technical drawing

- 1 Draw two horizontal light parallel lines where you intend to place the **text**. The distance between the parallel lines should be approximately 4 millimetres. Then write the letters as shown in Figure 2.15. Write down each letter at a time.

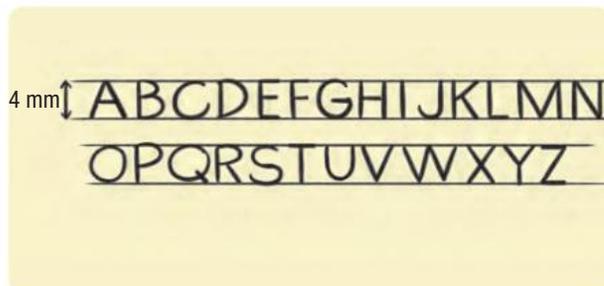


Figure 2.15 Horizontal lines

Remember that you should not write in lower case letters because this is not acceptable in technical drawing.

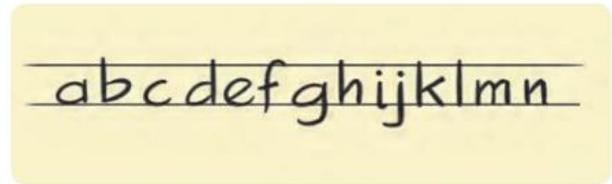


Figure 2.16 Lower-case letters. These are not acceptable in technical drawing.

- 2 Rub out part of your guide lines to clearly **expose** the letters that you have sketched, as shown in Figure 2.17.



Figure 2.17 Use an eraser to produce the final effect.

Activity 4: Doing freehand lettering

You will need:

- sharp pencil
- blank sheet of paper
- drawing board.

1 Read the information above and then use freehand sketches to copy the words below on a **blank** sheet of paper. Remember, when doing freehand lettering, always draw three light parallel lines and then copy the words.

DRAWING
 PAINTING
 VIEWS
 NUMBERS
 SKETCH
 TECHNOLOGY

As you can see, there are two types of lettering used in technical drawing. One type is the standard lettering used in the words ‘drawing’, ‘painting’ and ‘views’. The other type of lettering is the sloping lettering, known as ‘italics’, used in the words ‘numbers’, ‘sketch’ and ‘technology’.

- 2 Compare your lettering with the work of other learners. Are your letters neat and tidy? Your teacher will select four learners to come to the front, so you can see their work. As a group, decide whose lettering is neat, tidy and pleasant to look at.
- 3 Write down one reason why your lettering must be 4 millimetres high, and neat, tidy and pleasant to look at.

4 Copy and complete the following table in your exercise book.

Freehand lettering	Yes	No
Did I use three parallel lines in my freehand lettering?		
Are the parallel lines light?		
Did I print the letters as given?		
Is the height of the letters 4 millimetres?		
Did I rub out the parallel lines that are not part of the letters?		
Is my lettering neat and tidy?		
I think my freehand lettering can be improved by:		



You have learnt how to sketch an object, as well as letters on paper. You will now draw objects using the basic instruments that are normally used in technical drawing.

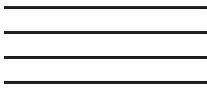
Activity 5: Using technical drawing instruments

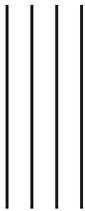
You will need:

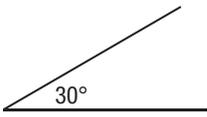
- blank A4 or A3 paper
- drawing board
- T-square
- set of big squares
- sharp pencil.

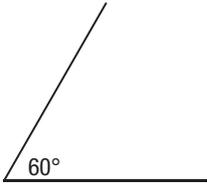
You will need a drawing set containing sets of squares, a T-square and a drawing board for this activity. Write your answers in your exercise book.

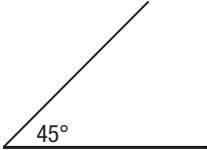
- 1 Set up a blank sheet of paper on a drawing board for drawing. Show your teacher what you have done. Your teacher will show you how to set up your drawing paper on a drawing board correctly.
- 2 Write down one reason why proper setting of paper for drawing is important in technical drawing.
- 3 Use a T-square, a set of big squares and a sharp pencil to draw the following lines and lines at the angles as indicated:

a 

b 

c 

d 

e 

- 4 Show your teacher your work. Your teacher will do a short demonstration of how to use the instrument to do the drawings above. See your teacher if you still need more practice in using the instrument.

- 5 Copy and complete the following table in your exercise book.

Using technical drawing instruments	Yes	No	If no, why?
Are the horizontal lines straight and parallel?			
Are the vertical lines straight and parallel?			
When I use a protractor to measure the angles, are they really: <ul style="list-style-type: none"> • 30° • 60° • 45° 			
Are the lines clean, tidy and fine?			
I think the drawings can be improved by:			

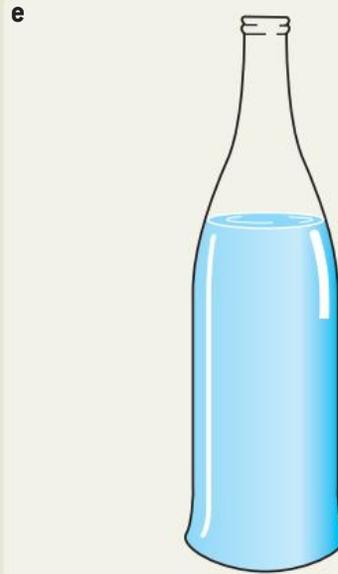
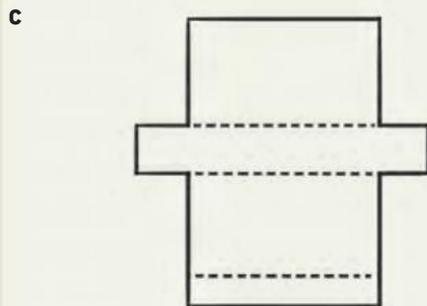
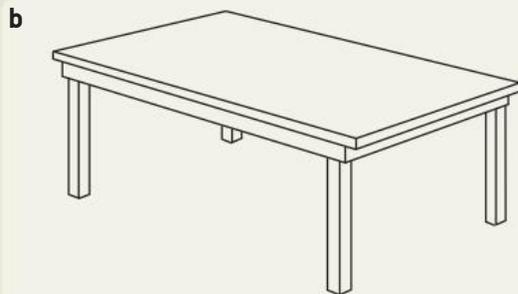
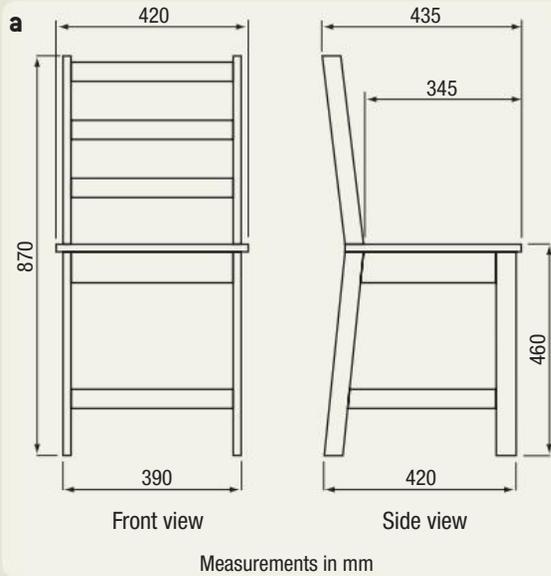


Types of drawing in technical drawing

There are three main types of drawing: orthographic drawings, pictorial drawings and development drawings.

Activity 6: Finding out about different types of drawing

- 1 Your teacher will show you some drawings in orthographic, pictorial and development drawing styles. Look at the following drawings and decide if they are orthographic, pictorial or development drawings. Write your answers in your exercise book.



- 2 Compare your answers with the answers of the learner next to you. List two similarities and two differences in your answers.
- 3 Show your answers to the teacher. Your teacher will give you more explanation about the different types of drawings.
- 4 Write down two features of a pictorial drawing in your exercise book.

You will learn more about the different types of drawing used in **technical graphics** in Years 8 and 9. In Year 7 you will learn only about pictorial drawing.

Sketching pictorial drawings

By the end of this topic, you should be able to:

- 7.2.1.3 describe the two ways to present a pictorial drawing
- 7.2.1.4 differentiate isometric from oblique drawing with the use of different lines and angles that represent each drawing
- 7.2.4.2 sketch an isometric and an oblique drawing correctly.

Pictorial drawing

A pictorial drawing is a three-dimensional (3-D) drawing. It shows the height, width and depth.

In 3-D drawings you see three sides of the object in one drawing. Figures 2.18 and 2.19 illustrate the two different ways of representing 3-D drawings: oblique and isometric.

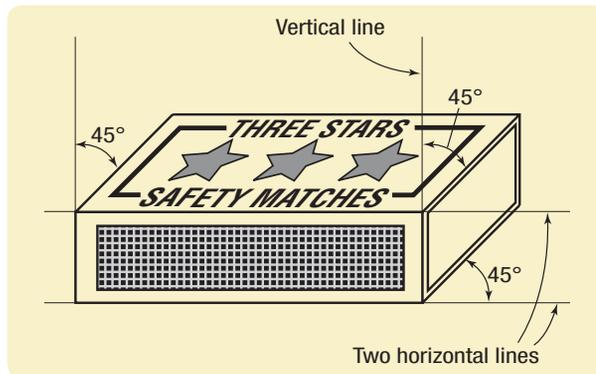


Figure 2.18 An oblique 3-D drawing

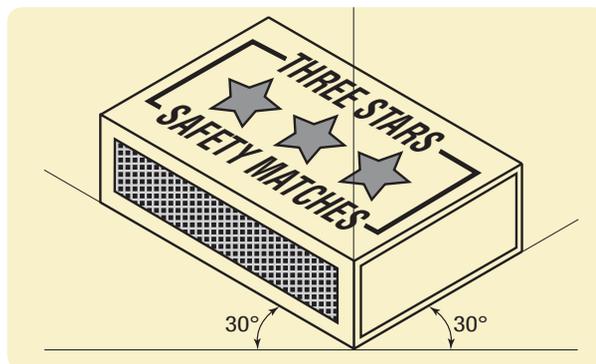


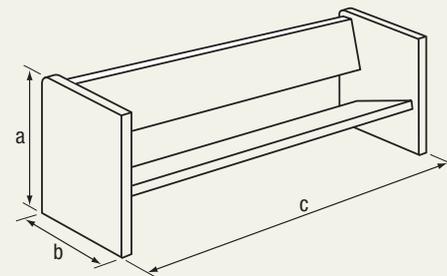
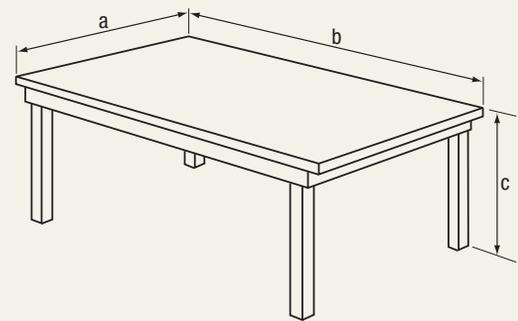
Figure 2.19 An isometric 3-D drawing

Activity 7: Finding out about pictorial drawings

Look at Figures 2.18 and 2.19. Can you list two main differences between the drawings?

Activity 8: Identifying dimensions of a drawing

- 1 Working in pairs, examine the following 3-D diagrams.



- 2 Identify which arrows show the length, height and width of the object in each drawing. Remember, length is how long something is, height is how tall it is, and width is how wide it is.
- 3 Identify the length, height and width of three objects in your classroom.

Oblique drawing

In an oblique drawing, draw the object from the front, as in a front view. But you also add the top and sides to the drawing. To do this you need to use three different drawing lines, as shown in Figure 2.20.

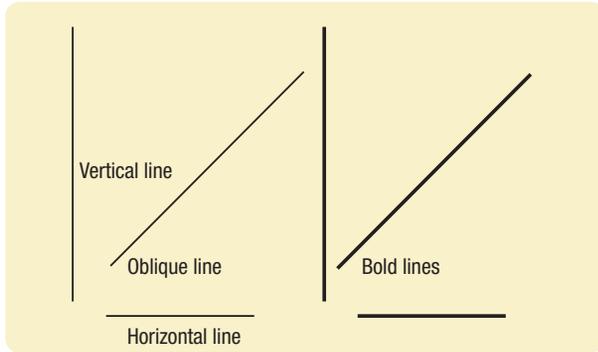


Figure 2.20 Lines needed for a 3-D drawing

Being vertical means to be upright—you are vertical when you stand up. Vertical lines go up and down.

Horizontal means to be flat and level—you are horizontal when you lie down. Horizontal lines go from side to side.

Construction lines are thin light lines that show the frame that you used to make your drawing.

Bold lines are dark lines that show the outline of the actual drawing.

How to make an oblique drawing

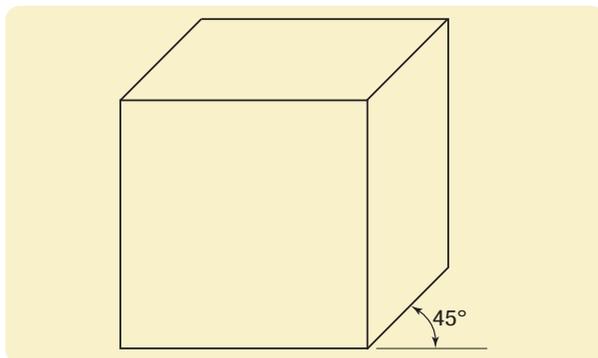


Figure 2.21 Oblique drawings

- 1 Draw one side of the box as seen from the front. Make sure you draw both the vertical and horizontal lines. Make sure the length and height of the object are correct.

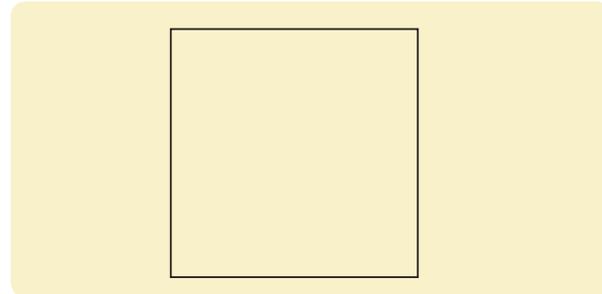


Figure 2.22 Drawing a box

- 2 Draw a line at 45° to show the width of the box. The 45° line should be half the width of the box, to make it look real.

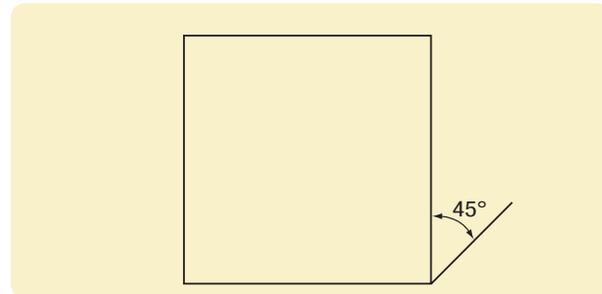


Figure 2.23 Drawing a 45° line

- 3 Draw another line at 45° to the horizontal as shown in Figure 2.24. Draw a vertical line to join the two lines drawn at 45° .

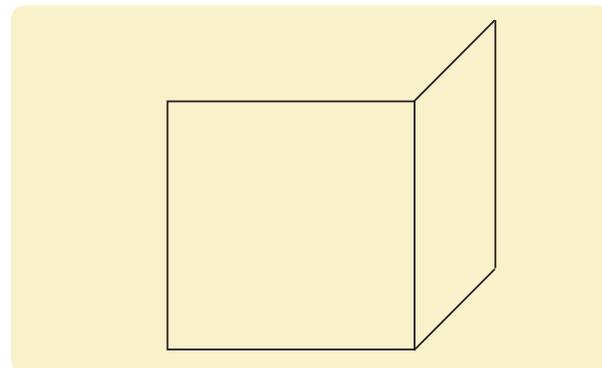


Figure 2.24 The side of an oblique drawing

- 4 Draw two more lines (construction lines) at 45° to show the other side of the box, as illustrated in Figure 2.25. They show how you constructed your drawing. Always draw all the construction lines for the object you are drawing. This makes your drawing more accurate. Complete the box by adding one vertical and two horizontal lines, as shown in Figure 2.25.

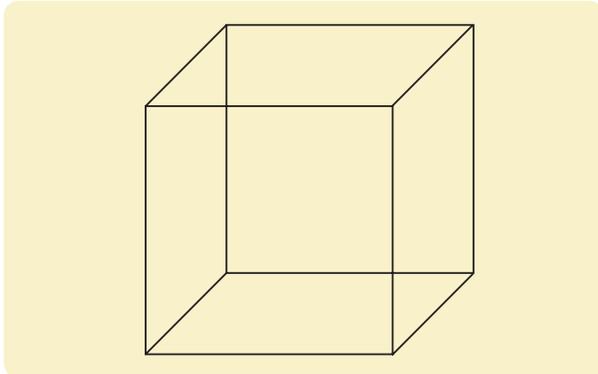


Figure 2.25 Construction lines used when drawing a box

- 5 Look at the drawing and the box again. On your drawing, draw over the lines that you see on the real object to make them darker. We call these bold lines. Using a pencil eraser, rub out the construction lines that do not make up part of the object that you can see, as shown in Figure 2.26.

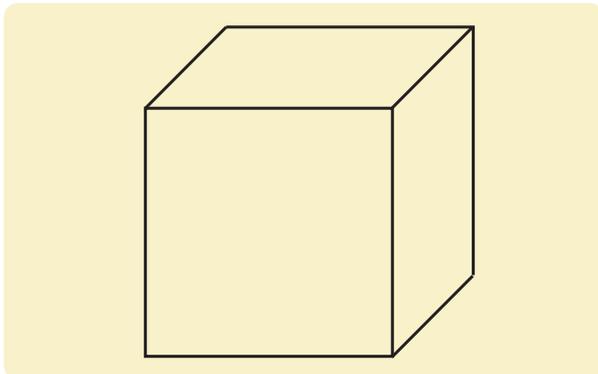


Figure 2.26 Mark the outlines of the drawing with bold lines.

Activity 9: Making oblique drawings

You will need:

- sharp pencil
- eraser
- protractor
- matchbox
- blank A4 or A3 paper
- drawing board.

For this activity you will need a sharp pencil, an eraser, a ruler, a protractor and a matchbox.

- 1 Follow the steps outlined in 'How to make an oblique drawing' on page 20, then carefully draw a matchbox.
- 2 Look at your drawing and copy and complete the following table in your exercise book.

Oblique drawing	Yes	No
Are the lines drawn at 45°?		
Are the horizontal (top and bottom) lines parallel to one another?		
Are the vertical lines (sides) parallel to one another?		
Did I connect the horizontal and vertical lines?		
Did I rub out the construction lines that are not part of the object?		
Is my drawing neat and pleasant to look at?		
I think the drawing can be improved by:		



Isometric drawing

In an isometric drawing, the object is drawn at an angle, as shown in Figure 2.27.

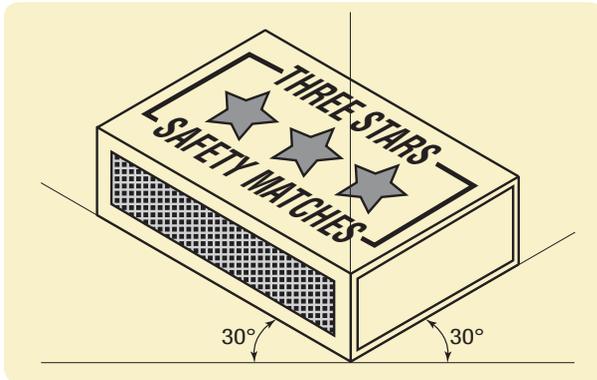


Figure 2.27 Isometric drawing

If you look at Figure 2.27, you will notice that:

- there are no horizontal lines
- there are three lines coming from a point
- the lines are either vertical or drawn at an angle
- the angled lines are drawn at 30° to the horizontal
- the lines that are going in the same direction are parallel to one another.

There are three ways in which you can make a 3-D isometric drawing:

- using set squares
- with a protractor
- using an isometric **grid** (your teacher will be give you a copy of this grid).

In Activity 5, you learnt about the use of T-squares in technical drawing. Now you will look at how a protractor and the isometric grid are used in an isometric drawing.

How to make an isometric drawing using a protractor

- 1 Draw a horizontal base line.



Figure 2.28 Horizontal line

- 2 Draw a vertical line of 10 millimetres on the base line.

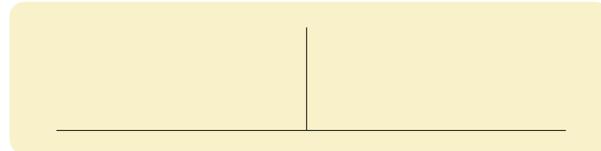


Figure 2.29 Vertical line

- 3 Measure an angle of 30° on each side of the vertical line with a protractor. Draw angle lines at 30° on either side of the vertical line. Make your lines 50 millimetres long.

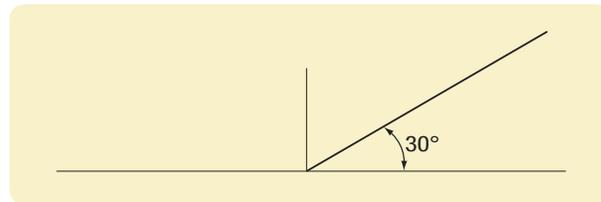


Figure 2.30 30° angle lines

- 4 At the top of the vertical line, draw a line parallel to each of the angled lines.

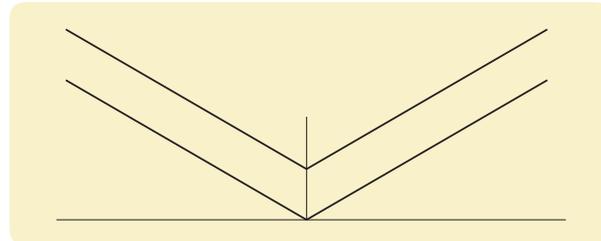


Figure 2.31 Vertical parallel lines

- 5 Draw vertical lines to join the top and bottom angled lines.

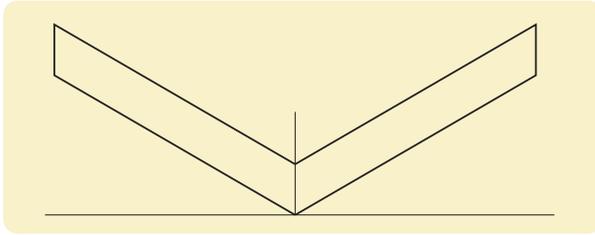


Figure 2.32 Vertical lines

- 6 Finish by drawing a line parallel to the left-hand angled line on the right-hand side, and another one parallel to the right-hand angled line on the left-hand side.

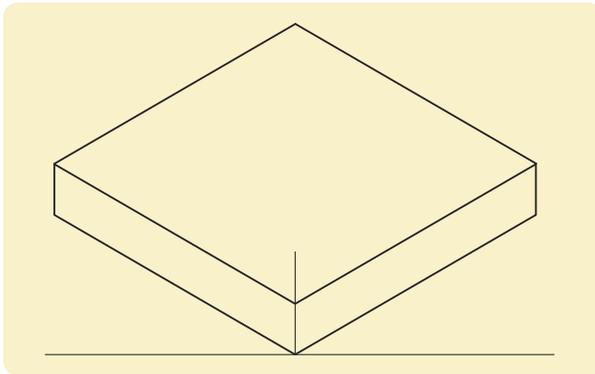


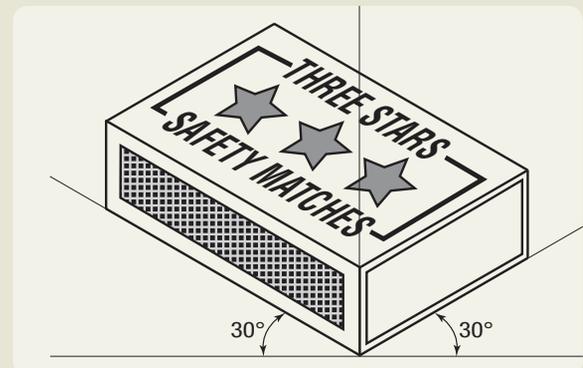
Figure 2.33 Angled parallel lines

Activity 10: Making isometric drawings using protractor

You will need:

- sharp pencil
- eraser
- ruler
- protractor
- blank A4 or A3 paper
- drawing board.

- 1 Study the section called 'How to make an isometric drawing using a protractor' on page 22.
- 2 Look at the following drawing of a matchbox drawn in 3-D. Measure the length, width and height of the matchbox.



- 3 Use these measurements to draw an isometric drawing of a matchbox. Follow the steps in the section called 'How to make an isometric drawing using a protractor'.

How to make an isometric drawing using a grid

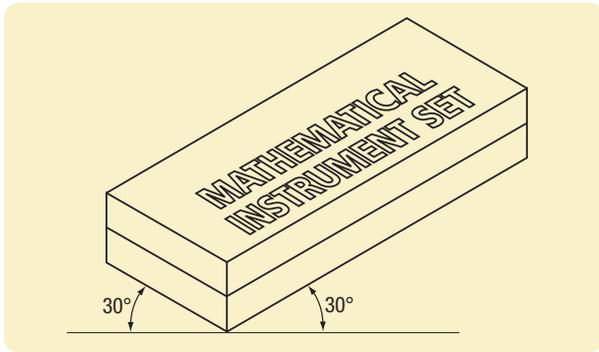


Figure 2.34 Isometric drawing of a pencil box

- 1 Draw the vertical line and two angled lines. These are called the principal lines. Count the number of blocks to make sure your drawing is the correct size. The **dimensions** on the drawing above give you the size of the pencil box. They show you how many blocks each line should be.

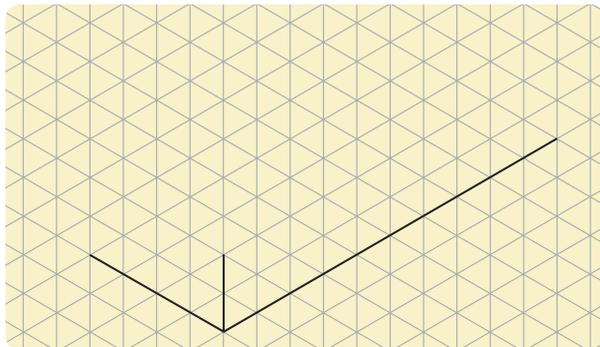


Figure 2.35 Principal lines

- 2 Draw all the other vertical lines.

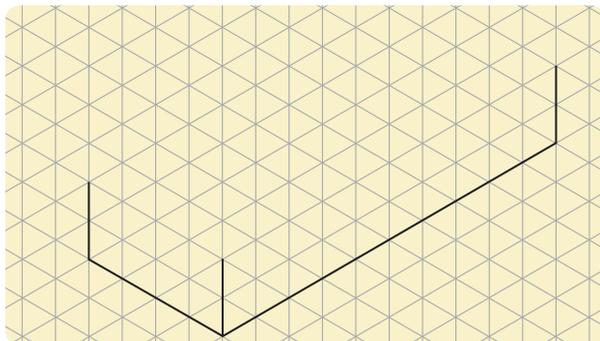


Figure 2.36 Adding vertical lines

- 3 Draw all the 30° lines to complete your drawing.

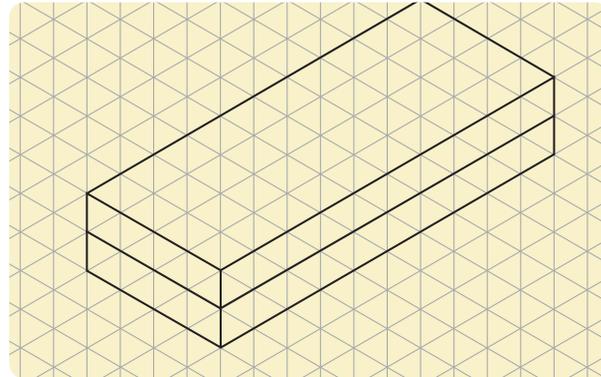


Figure 2.37 Adding isometric lines

Activity 11: Using grids in isometric drawing

You will need:

- sharp pencil
- eraser
- ruler
- grid paper
- drawing board.

- 1 Look at the illustration of the matchbox on page 23.
- 2 Using the steps outlined in the section above called 'How to make isometric drawing using a grid', draw an isometric drawing.
- 3 You have now completed two methods of drawing an isometric drawing. Which method do you prefer? Why?
- 4 Select the drawing you think is better. Swap this drawing with a partner.

- 5 Look at your partner's drawing. As you look, copy the following table in your exercise book and fill in the spaces. You should give back your partner's drawing (and the table) after you have completed the table.

	Yes	Partly	No
Is the drawing isometric?			
Are the vertical lines parallel to one another?			
Are the 30° lines in the same direction parallel to one another?			
Are the drawing lines joined to show the whole object in 3-D?			
Does the drawing look like the real object?			
Is the drawing neat?			
I think the drawing could be improved by:			



Activity 12: Checking what you have learnt

- 1 Choose an object from school or home. Your teacher will discuss your choice with you.
- 2 Make an oblique drawing of the object.
- 3 Make an isometric drawing of the object using the protractor method.
- 4 Make an isometric drawing of the object using an isometric grid.
- 5 Select the best drawing.
- 6 Write three or four sentences to say why you think this drawing is better than the other displayed drawings.

Technical drawing instruments

By the end of this topic, you should be able to:

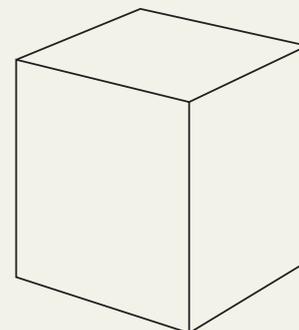
- 7.2.2.1 identify the instruments used in technical drawing
- 7.2.4.1 use the basic technical drawing instruments correctly.

Activity 13: Using technical drawing instruments

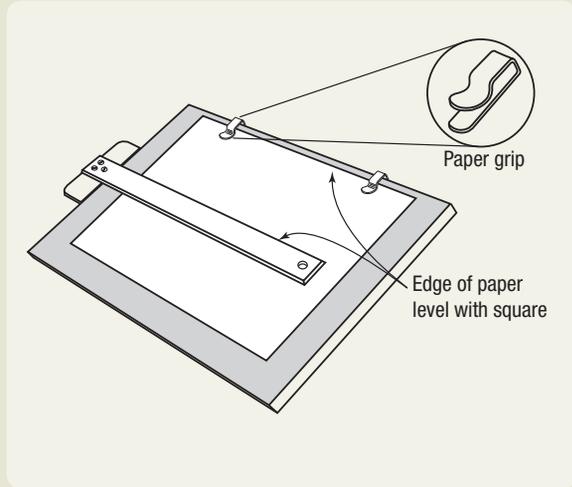
You will need:

- sharp pencil
- pencil eraser
- set of large protractors
- compass
- T-square
- blank paper
- drawing board.

- 1 Your teacher will do a simple demonstration of the different instruments used in technical drawing to draw the following object.
- 2 Watch carefully how your teacher uses each instrument.

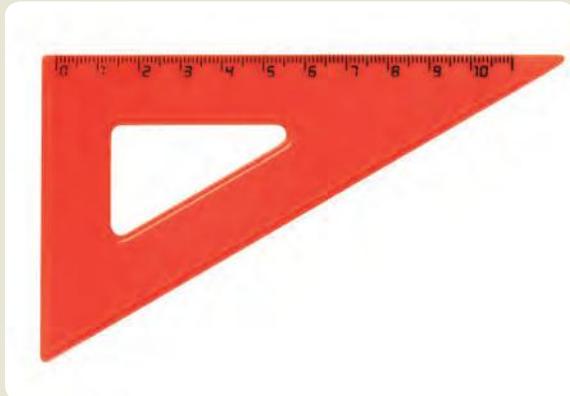
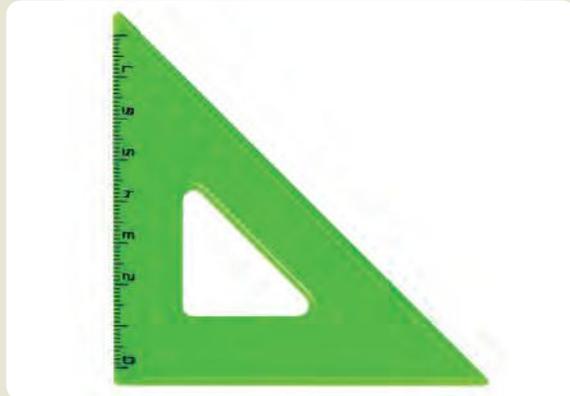
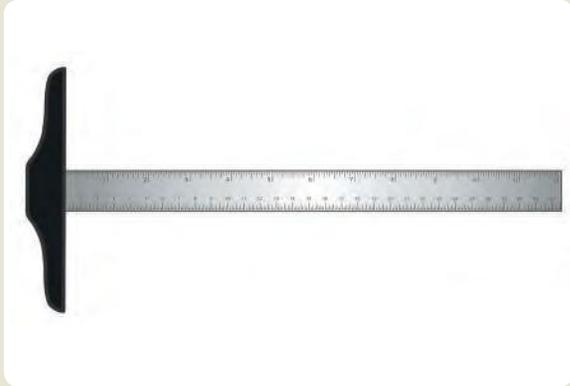


3 Your teacher will give you the same set of instruments he or she used to draw the object. You will draw the same object again, in pairs. Make sure to pin your paper tightly on the flat drawing board as shown.



- 4** Can you say what is good and bad about your drawing?
- 5** Are your vertical lines parallel with the bottom edge of paper?
- 6** Are your horizontal lines parallel with the side edge of your paper?
- 7** Is your drawing positioned in the centre of the paper?
- 8** Write one thing that is good and one thing that is bad about your drawing.
- 9** Show your drawings to the rest of the class. The class will look at each drawing and decide which is the best.

10 In order to make a good drawing, you must use the drawing instruments well. Pictured below are the instruments that you used when you made your drawings earlier. Look at each and write their uses.



Working drawings

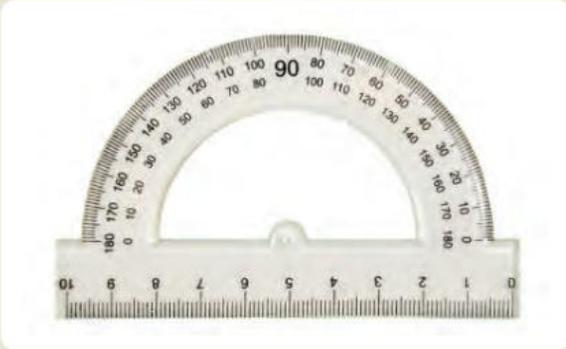
By the end of this topic, you should be able to:

7.2.2.2 describe the main features of a working drawing

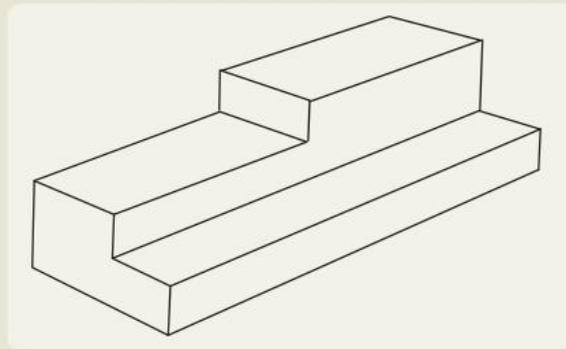
7.2.2.3 identify the information that should be on a working drawing.

When you are designing or making a working drawing you use an isometric drawing; that is, the drawing with all the labels with information that you will use to make your product. If you forget how to make these types of drawing, look back at pages 22–25. A working drawing has to provide all the information required to communicate your ideas to other people. The working drawing and other information must be accurate, so that someone else can make the product.

Working drawings must give a variety of information. Figure 2.38 shows all the information required in a working drawing.

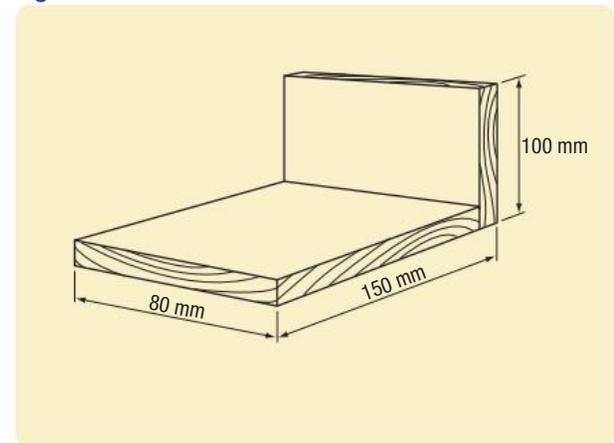


- 11** Using the technical drawing instruments shown above, draw the object below on a blank sheet of paper. Your drawing should be exactly the same as the object below.



- 12** Is your drawing exactly the same as the object above? How can you check? If it is different, list the ways in which it is different.
- 13** If your drawing is different, look for someone whose drawing is the same as the object above. Let them explain to you how they made theirs identical.

Figure 2.38 Bookends



Activity 14: Identifying information on a working drawing

Working in pairs, answer the following questions in your exercise book.

- 1 List the different materials and all the information in the working drawing in Figure 2.38. Do you think someone could make the bookend from the information given on the working drawing?
- 2 If you answered 'no' to the previous question, write down what additional information should be given.

Information on a working drawing

Working drawings like the one shown in Figure 2.38 give detailed information about what you must consider when constructing a bookend. These can include:

- shapes of parts
- materials needed
- sizes or dimensions of parts
- the way parts are joined
- names of parts
- the purpose of each part.

In Year 7, you will do your working drawings as isometric or oblique.

Activity 15: Identifying information

- 1 Read the section called 'Working drawings' on page 27.
- 2 Look at Figure 2.38 on page 27. Which information from the list above ('Information on a working drawing') is on this drawing?
- 3 Which information is missing?

Dimensions

A working drawing must provide as much information as possible. When you make a working drawing, it is useful to know the real measurements of the sides or dimensions of the object. Study Figure 2.39 to see the rules for labelling these dimensions with dimension lines.

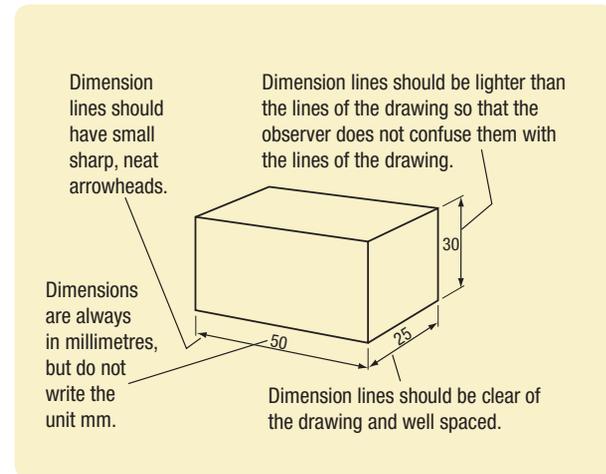


Figure 2.39 Dimensions add information to a drawing.

Look carefully at Figure 2.40. Both drawings look very much alike. However, one of the pictures shows dimensions much more clearly than the other.

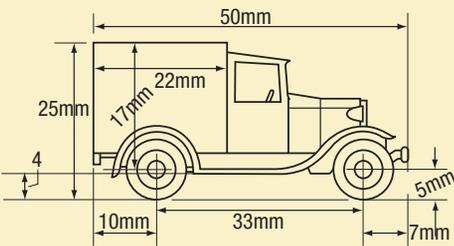
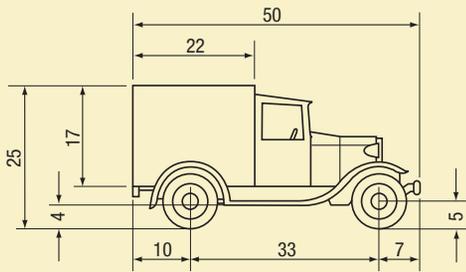


Figure 2.40 Both of these diagrams show the dimensions of a truck.

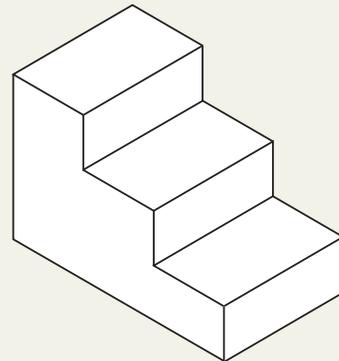
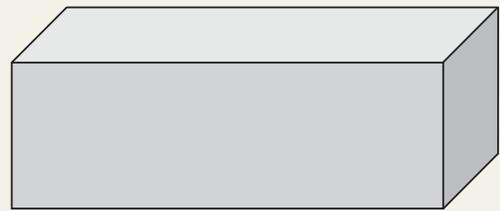
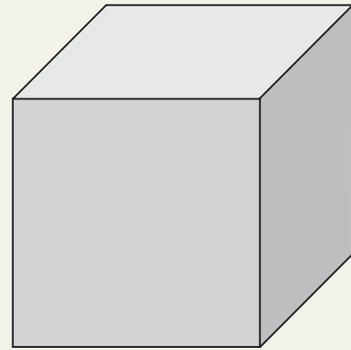
Activity 16: Adding dimensions to a drawing

You will need:

- sharp pencil
- eraser
- ruler
- blank paper
- drawing board.

1 Study Figure 2.40.

2 Look at the drawings below, then copy them onto a blank sheet of paper. Use a ruler to measure the length, height and width. Label your drawings clearly, as shown in the top diagram of Figure 2.40.



3 Make sure that you follow all the rules about providing dimensions.

Practical task

By the end of this practical task, you should be able to:

7.2.3.1 develop working drawings for the design of a pair of bookends.

Go back and read the design problem at the beginning of this chapter. You are going to solve that design problem.

Design problem: Bookends

Imagine that you are Tom and Linda. Make a set of working drawings, in pictorial style, for the bookends for the finals of the competition. You must begin by making a sketch of three types of bookends. Select one of these to develop a working drawing.

In your set of revised working drawings you must include:

- the three initial sketches—one for each type of bookend
- two reasons to **justify** your selection of one of the three sketches
- a labelled sketch drawing of your bookends
- an isometric drawing of your bookends

- an oblique drawing of your bookends
- a list of materials you will use for the bookends.

You must include dimensions and all other relevant information on the drawings for the person who will make the bookends.

Evaluating your drawings

Answer the following questions in your exercise book.

- 1 Are your drawings neat and clear?
- 2 Did your drawings have all the necessary information for someone else to make the bookends?
- 3 Which of your drawings is the most accurate? Why?
- 4 Did you identify all the materials needed to make the bookends?

Evaluating your work

- 1 Which of the drawings was the easiest to do?
- 2 Which of the drawings was the hardest to do?
- 3 Do you need practice at making 3-D drawings?
- 4 Did you label your drawings neatly?
- 5 Can you improve on this?

New words used in this chapter

architect	person who designs buildings
blank	empty, e.g. a sheet of paper that has nothing on it
dimensions	measurements or size
drafter	person who draws plans for buildings designed by architects or engineers
engineer	person who designs big structures, e.g. bridges
equipment	instrument used for a task
expose	show clearly, lay bare
grid	squares or isometric lines printed on paper
illustrate	show by drawing

in contrast	in comparison
industrial designer	person who designs industrial products
justify	give reasons for, e.g. for what you have written or said
overlapping sketching	extending beyond rough drawing or drawing using no instrument
technical graphics	technical drawing
text	wording
tool	instrument used to mark, cut, hold/support, drill etc. materials
trace	copy over the top of

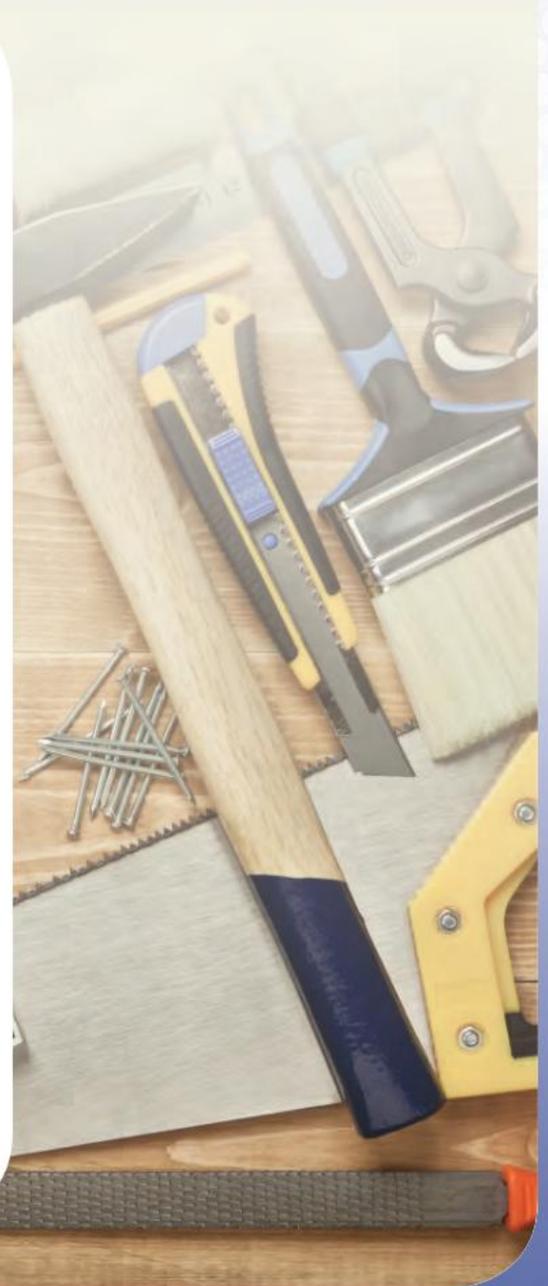
Chapter 3

Timber technology

Learning outcomes

By the end of this chapter, you should be able to:

- 7.3.1.1** describe the safety requirements of working with timber
- 7.3.2.1** describe how trees grow
- 7.3.2.2** identify and explain the functions or work of the different parts of a tree
- 7.3.3.2** explain the steps involved in preparing rough-sawn timber
- 7.3.3.3** identify and explain the common methods of joining timber
- 7.3.3.4** describe the types of timber finishes (e.g. paint, varnish and coconut oil) and their methods of use
- 7.3.4.1** identify and explain the operations of the basic woodwork tools
- 7.3.5.1** design and make any of the following timber products: coconut strainer, towel rail, etc. (or a similar product to suit own situation)
- 7.3.6.1** correctly, skilfully and safely use measuring, marking, cutting, fitting, assembling and finishing tools in woodworking
- 7.3.6.2** prepare, mark, cut and join or assemble timbers to make a timber solution to a design problem
- 7.3.7.1** use some of the basic hand tools to make timber joints
- 7.3.7.2** cut and join timber properly
- 7.3.7.3** use appropriate hand tools for preparing timber, such as a smoothing plane, marking gauge and try-square
- 7.3.7.4** prepare a piece of rough-sawn timber correctly and safely
- 7.3.8.1** investigate ideas about the importance of timber products in the home.



Introduction

In this chapter you will learn about timber and the processes involved in working with timber.

Activity 1: Finding out why timber is important

Answer these questions in your exercise book.

- 1 Walk around your classroom or school and write down five items that are made of timber.
- 2 In your groups, discuss why timber is used in the items that you have listed.
- 3 List three reasons why you think people prefer to use timber in the items you have listed rather than other materials.
- 4 Write down three traditional uses of timber in your society.
- 5 Write three reasons why people still use timber today to make things such as furniture and houses.

Timber is one of the most useful materials in Solomon Islands. It is now widely used for constructing houses and furniture. However, most traditional houses in Solomon Islands were built from **raw bush materials** such as bamboos and different-sized logs.

Timber comes from trees. The timber used for constructing furniture comes from mature round logs that are cut into small sizes in a process called timber conversion. Timber sawn into **planks** is one of our valuable natural resources and among our nation's main **exports** to overseas countries. Round timber logs are also exported. Although our country earns money from round-log exports, sawn timbers would provide much greater earnings. Because timber is a valuable **commodity** in Solomon Islands, trees must be continually planted, at least at the same rate as they are being cut down.

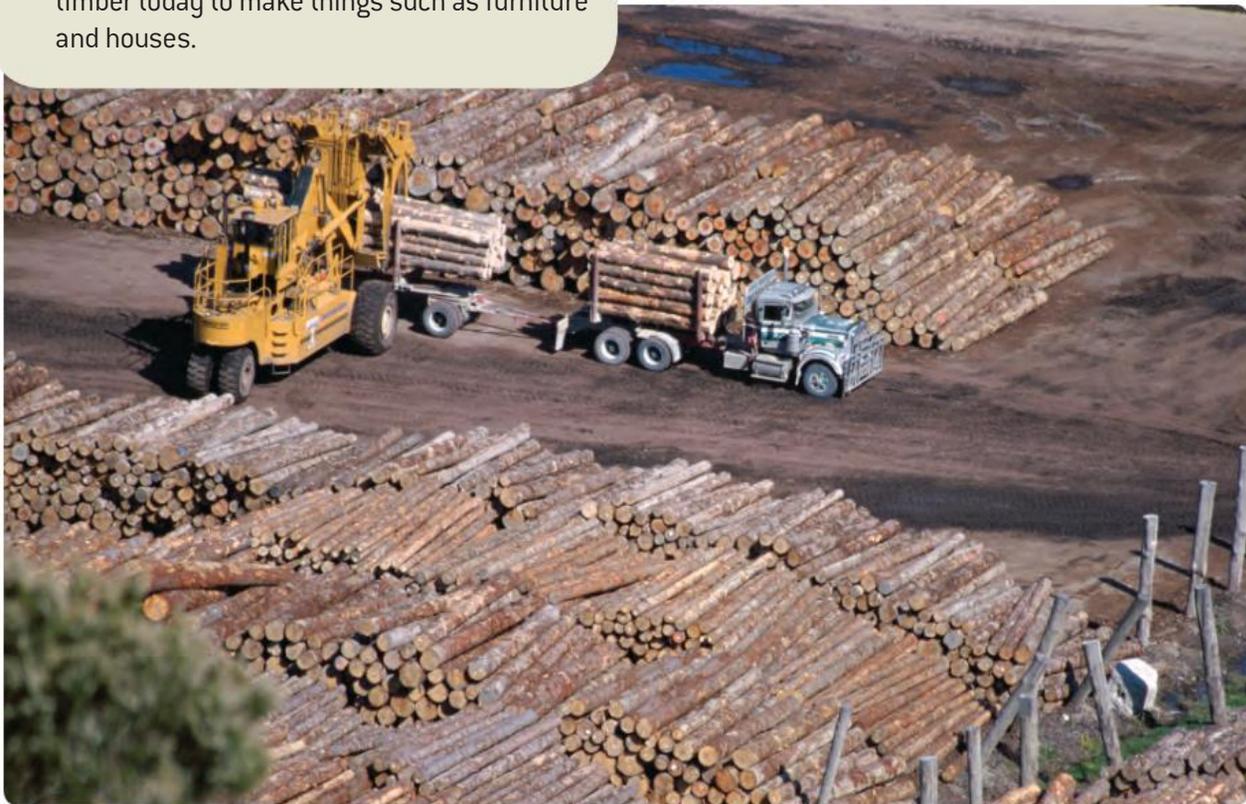


Figure 3.1 Logs piled at a log point

Activity 2: Planting and cutting down trees

Read the information above and answer the following questions in pairs.

- 1 What do you think is happening in our forests today? Do we plant as many trees as we cut down?
- 2 What will happen if we continue to cut down more trees than we plant?
- 3 Why is it important to plant more trees?

Study the following design problems. At the end of this chapter you will design and make a product as a solution to one of these problems. You will learn the skills and knowledge required to find a solution to one of these problems, using timber as the principal material.

Design problem 1: Coconut strainer

In Solomon Islands, coconut cream is one of the most common **ingredients** in cooking. The addition of quality coconut cream makes food tasty. One of the key **features** in the process of producing fine-quality coconut creams is the use of strainers. The strainer is used to trap the fine remains of the grated coconut in the cream and allows only the pure cream to pass through. While a coconut strainer can be bought from the shops, it can also be easily made from a range of materials. This task requires you to design and make a coconut strainer that consists of a timber frame and some kind of net.

Design problem 2: Pencil box



The focus of these two design problems is on using timber products as possible solutions. Before you do any work on timber, you need to learn about the basics of timber, such as the safety precautions required, the steps involved in making a timber product, and the tools required for working with timber. In order to solve each of these design problems a product needs to be made, and the **sequence** involved in making products must be understood. This sequence of steps that you will follow is called the working process.

Tools and equipment used in this chapter

- Bench hook
- Brush
- Crosscut saw
- Files
- Marking gauge
- Mitre cramp
- Rasp
- Rule
- Tenon saw
- Try-square

Materials used in this chapter

- A piece of rough timber and a timber made smooth, or 'dressed'

Before you go on to find out about the steps and the tools to be used in each step, you will first look at the **structure** of wood.

Structure of wood

By the end of this topic, you should be able to:

- 7.3.2.1 describe how trees grow
- 7.3.2.2 identify and explain the functions or work of the different parts of a tree.

Parts of a tree

Figure 3.2 shows the structure—or the different parts—of a tree.

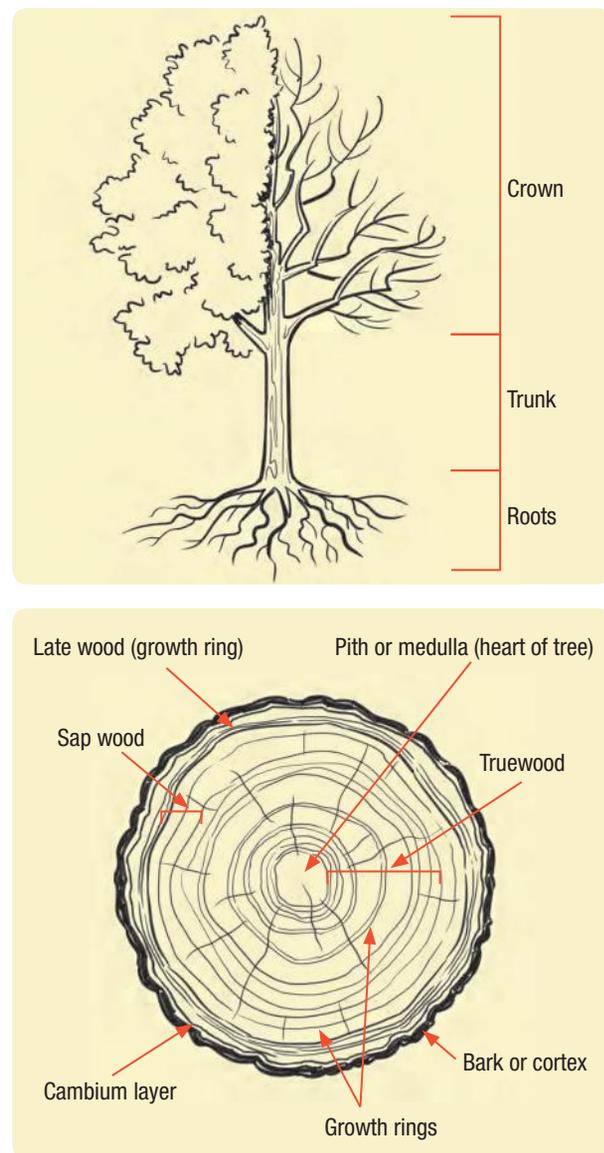


Figure 3.2 Parts of a tree

Activity 3: Discovering the inner parts of a tree

You will need:

- sharp pencil
- eraser
- blank paper
- drawing board.

- 1 Study Figure 3.2.
- 2 List the three main parts of a tree.
- 3 Go outside the classroom and find a **stump** from a tree that has been cut down. If you cannot see one, ask your teacher to cut a branch off a tree and look at that. Then answer the following questions.
 - a Draw the inside (**cross-section**) part of the tree that you saw. A cross-section of a tree is shown in Figure 3.3.



Figure 3.3 Cross-section of a tree

- b On the drawing, label the seven different parts of a tree. You can use the diagram in Figure 3.2 on page 34 to help you with this question. What are the functions or work of each part?
- c Can you explain how to tell the age of the tree?
- d Explain which part of the tree is suitable for timber. Give a reason for your choice.

- 4 Discuss why some trees change their direction of growth when other trees grow over them and block out the sunlight.

Activity 4: Finding out about types of saws

You will need:

- piece of timber about 30 centimetres long
- tenon saw
- crosscut saw.

This activity should be done in groups.

- 1 Measure 2 centimetres from each end of the piece of timber. Your teacher will give you a tenon saw to cut one end and a crosscut saw to cut the other end. These saws are shown in Figures 3.4 and 3.5.



Figure 3.4 Tenon saw



Figure 3.5 Crosscut saw

- 2 Look closely at the end part of the timber where you have made the cut. Is it fine or rough?
- 3 State two differences between how a tenon saw and a crosscut saw are used to cut timber. Write the main uses of each type of saw.
- 4 In order to cut a piece of timber as accurately as possible, can you suggest what you must look out for before and during cutting?
- 5 You have now used two types of saw: a tenon saw and a crosscut saw. Can you name another type of saw that people also use for cutting timber?
- 6 Your teacher will demonstrate how to make a good cut on timber. Take note of the use of a try-square and the idea of cutting on the waste side of timber. You will learn about this later.
- 7 Measure another 2 centimetres from the edge of the piece of timber. The 2 centimetre side is your waste side. Use a tenon saw to cut the timber on its waste side, as your teacher demonstrated.

Cutting timber as you did in the activity above is one of the steps in making a timber product. The steps that you will learn about in Year 7 are:

- preparing timber
- marking out
- cutting timber
- joining timber
- timber finishing.

Preparing timber

By the end of this topic, you should be able to:

- 7.3.3.2 explain the steps involved in preparing rough-sawn timber
- 7.3.7.3 use appropriate hand tools for preparing timber, such as a smoothing plane, marking gauge and try-square
- 7.3.7.4 prepare a piece of rough-sawn timber correctly and safely.

Preparing timber

Rough-sawn timber is timber that is sawn to approximately the size you need, but not yet planed to make it smooth. It can be planed to the correct size later. It is usually slightly thicker and wider than the required size. It is rough to touch and not easily finished with paint or similar materials. Most timber needs to be planed or dressed to size before use, so that the surfaces are made true (flat) and square and are without twists. This process is called preparing timber. Figures 3.6 and 3.7 show a piece of rough-sawn timber and a piece of dressed timber. On a timber that is completely dressed, you will see two marks. Figure 3.8 shows these marks.



Figure 3.6 Rough-sawn timber



Figure 3.7 Dressed timber

How to prepare timber

When rough-sawn timber is dressed to the actual size required, a set of steps must be followed.

- 1 Plane the face side perfectly flat. Use a ruler as shown below to test the flatness of the length of the face side. Use a try-square to test the flatness of the width of the face side. Look in the direction of the arrow in Figure 3.9. If there are no gaps under the ruler or try-square, the face side of the timber is flat. Mark the face side with the face side mark.

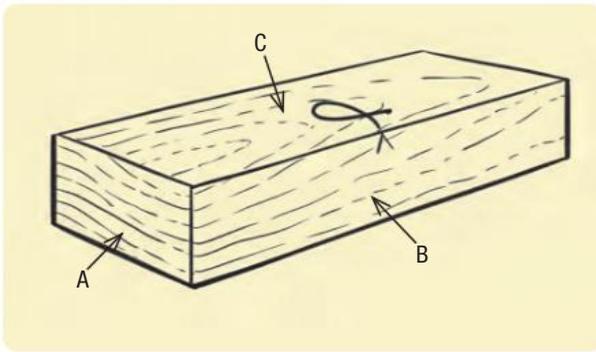


Figure 3.8 Dressed timber with the two finishing marks

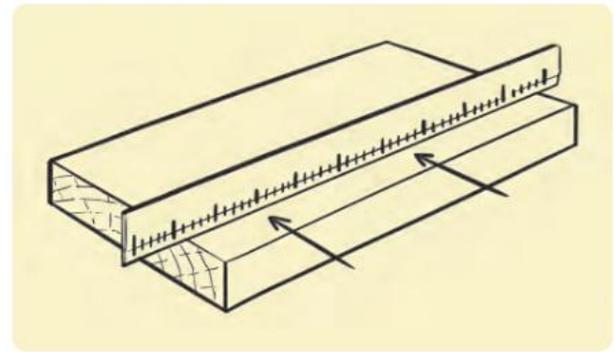


Figure 3.9 A rule is used to test the flatness of the length of the face side.

Activity 5: Using timber preparation marks

- 1 Your teacher will show you some rough-sawn and dressed timbers. Read the information above and list the main differences between these two types of timbers.
- 2 Study Figure 3.8. Which side of the timber is the face side of the timber and which is the **face edge** side?
- 3 Write the names of the finishing marks on these timber sides.

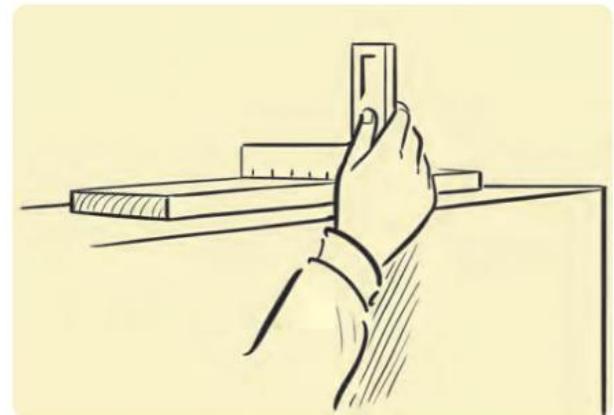


Figure 3.10 A try-square is used to test the flatness of the width of the face side.

- Plane the face edge and test it for squareness with a try-square. Mark the face edge with the face edge mark as shown in Figure 3.11.

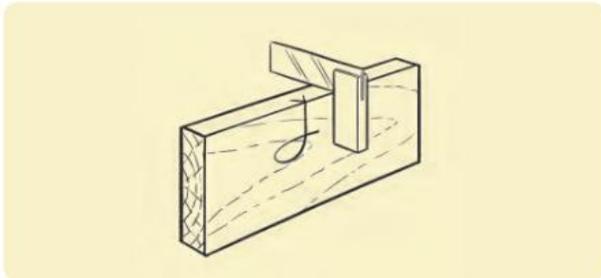


Figure 3.11 Testing the face edge for squareness with a try-square; note the face side mark

- Measure the **width** on both sides using the marking gauge from the face edge. This is called gauging to width. Mark the waste part with crosses. Plane to the width or gauge line.

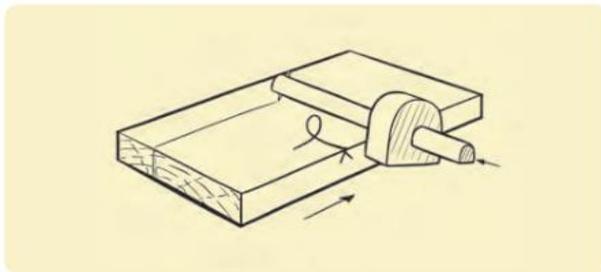


Figure 3.12 Gauging to width—arrows indicate direction of pressure on gauge.

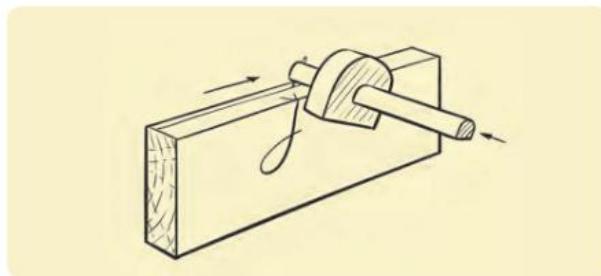


Figure 3.13 Gauging to thickness—arrows indicate direction of pressure on gauge.

- Measure the **thickness** from the face side down to both edges. This is called gauging to thickness. Mark the waste part with crosses. Plane to the thickness or the gauge lines.

- Square-cut one **end** with a saw.

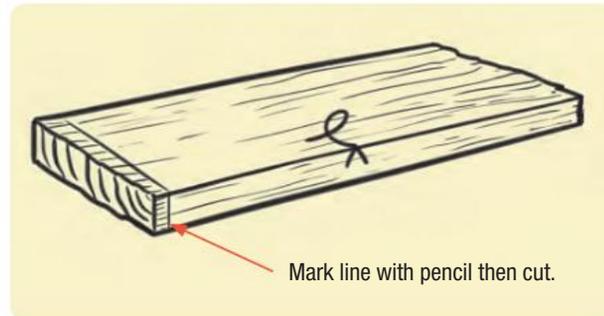


Figure 3.14 Marking the first timber end to be cut

- Measure the required **length** from the prepared end. Square and cut off the waste part of the timber.

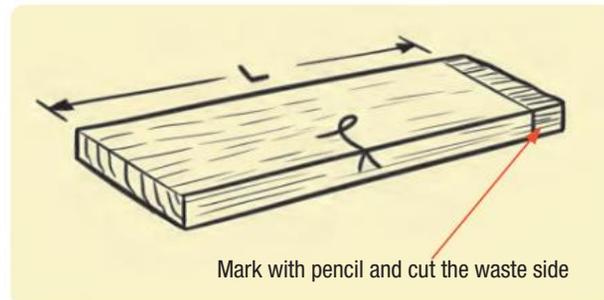


Figure 3.15 Marking the length of the timber and cut

The steps above can be summarized as 'FEWTEL', to help you remember them. Can you work out what this means?

Types of bench planes

Bench planes are sharp pieces of metal used for cutting. There are different kinds for different purposes, such as trying planes, jack planes and smoothing planes. Later on you will look at other types of planes.

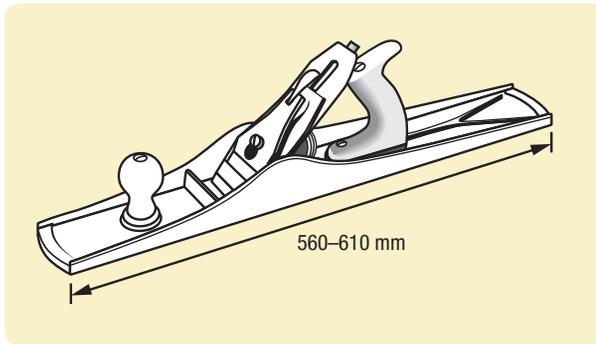


Figure 3.16 Trying plane

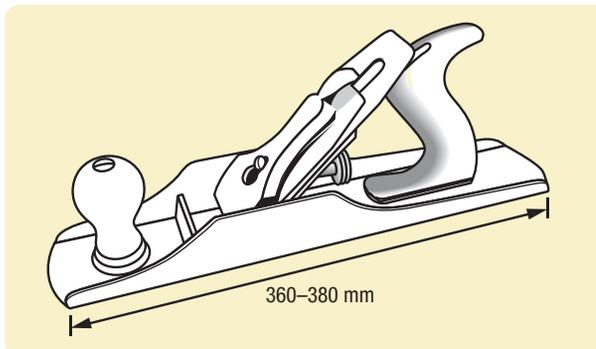


Figure 3.17 Jack plane

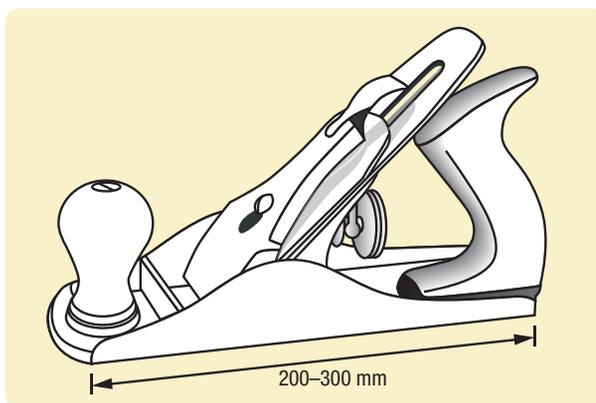


Figure 3.18 Smoothing plane

Your teacher will demonstrate the use of all three of the planes shown in Figures 3.16 to 3.18. However, in Year 7 you will learn about and use only the smoothing plane.

Smoothing plane

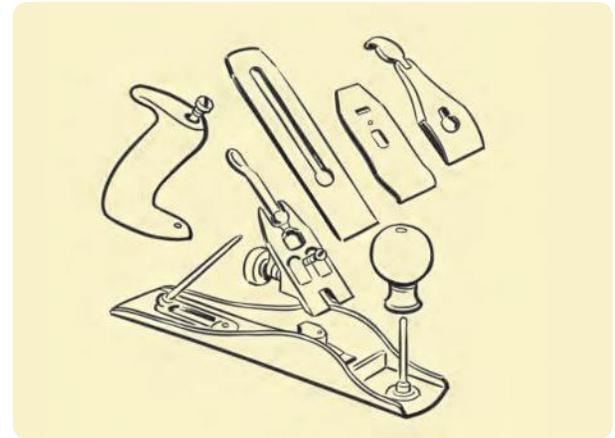


Figure 3.19 Dismantling of a smoothing plane

Your teacher will take the plane apart and assemble it as shown in Figure 3.19 so that you can see. Your teacher will also show you how to set the smoothing plane so that it cuts evenly and smoothly on the surface.

How to use a smoothing plane

When you use a smoothing plane, always remember to plane inwards from each corner. Figure 3.20 shows how to plane a timber surface.

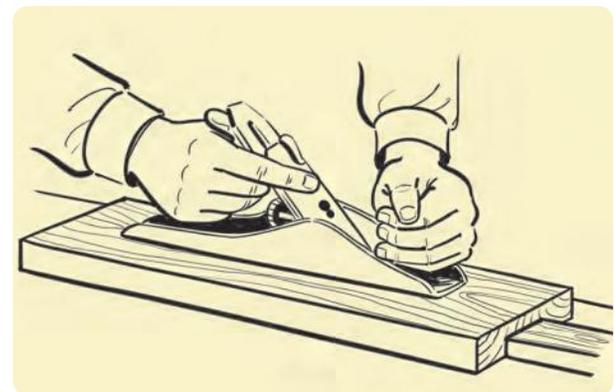


Figure 3.20 Planing a timber surface

Always remember the following:

- Plane the face side of the timber using a bench stop. A bench stop should be fixed firmly on the working bench.

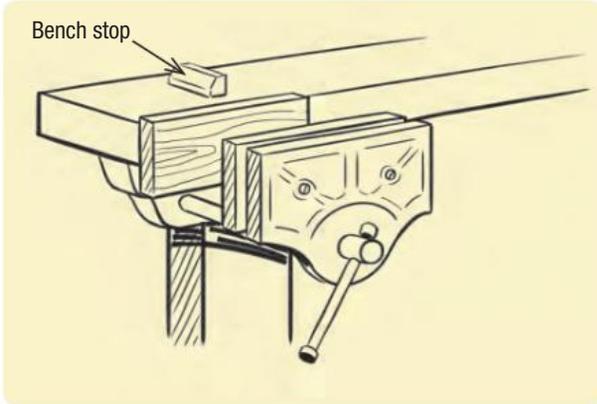


Figure 3.21 Using a bench stop

- Plane the face edge of the timber using a bench vice. The timber should be fixed firmly in the vice and planing should be done carefully. A bench vice is shown in Figure 3.22.

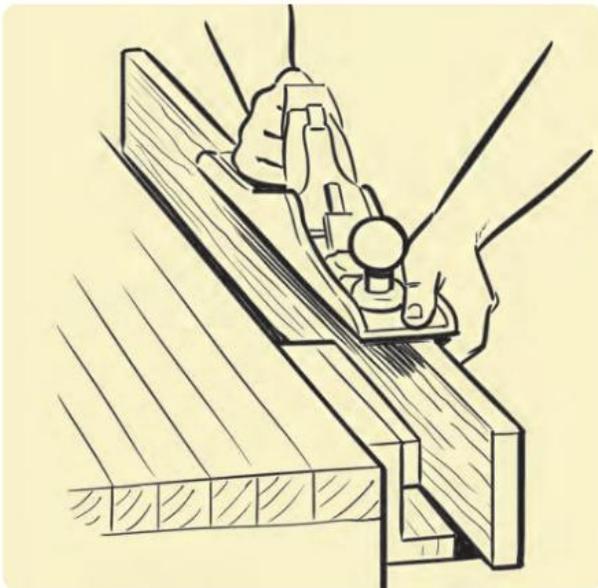


Figure 3.22 Once the timber is secured on the bench vice, use a smoothing plane.

Marking gauge

You have seen your teacher use a marking gauge. Figure 3.23 shows a marking gauge with the names of the parts labelled.

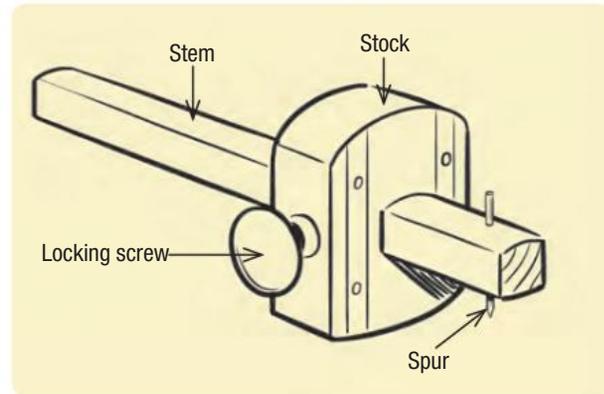


Figure 3.23 Parts of a marking gauge

How to use a marking gauge

- 1 Set the measurement that you wish to transfer onto the timber as shown below. Use the locking screw of the gauge to hold the distance from the spur to the stock firmly.

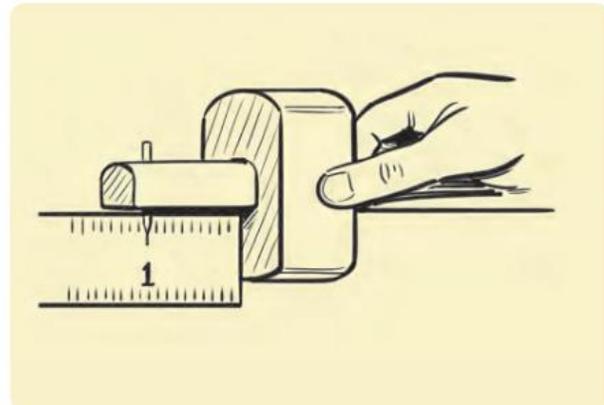


Figure 3.24 Using the locking screw

- 2 Press the stock against the timber firmly and **tilt** the gauge over the spur then drag or push forward with the thumb as shown in Figure 3.25.

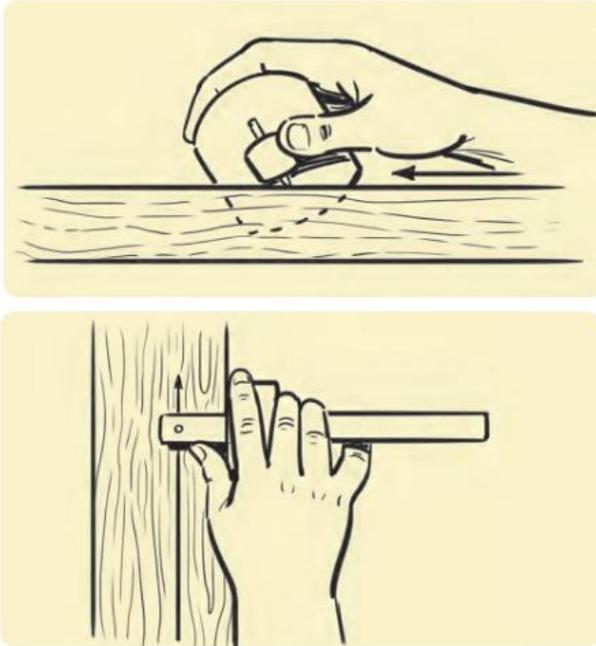


Figure 3.25 Positioning the marking gauge

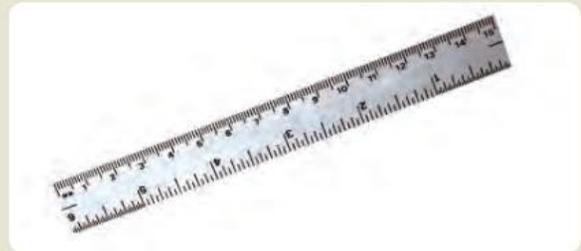
Activity 6: Finding out about timber preparation

You will need:

- long piece of timber
- pencil
- rule
- try-square
- marking gauge.

- 1 Read the section called 'How to prepare timber' on page 37. You are going to prepare some pieces of timber to be used in making a coconut strainer or pencil box.
- 2 Your teacher will demonstrate the preparation of rough-sawn timber. As you watch, **observe** the safety precautions required during the whole process of timber preparation. Look carefully as your teacher uses the tools.

- 3 You have seen the teacher use the following tools:

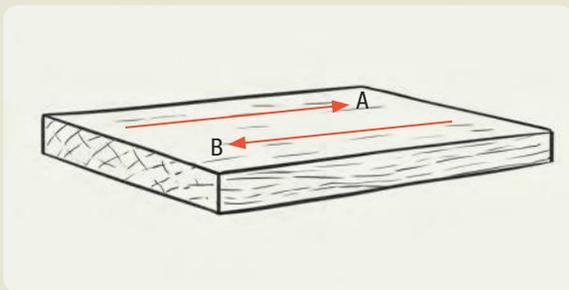


- a In your exercise book, write the names and uses of these tools.
- b From your observation of the timber preparation demonstration, list the required safety precautions to be taken when using these tools in the process of timber preparation.
- c The teacher used other equipment during the demonstration, such as a bench hook and a bench stop. What is the importance of this equipment in the timber preparation process? Figures 3.26 and 3.21 will help you.



Figure 3.26 Bench hook

- 4 Your teacher will show you more about the tools used for preparing timber. Make sure you use each of these tools as well as reading about them.
- 5 Did you hear the terms 'along the grain' and 'against the grain' during the demonstration above? Look at the picture below. Which arrow shows 'along the grain' and which 'against the grain'?



- 6 You are now going to prepare a long piece of timber. Your teacher will tell you more about this, and give you all the tools you need. When you plane your timber, look out for the direction that is 'along the grain' and the direction that is 'against the grain'. After you have prepared your timber, answer the following questions.
 - a Write down two reasons why it is important to plane 'along the grain' rather than 'against the grain'.
 - b Write down an explanation for the use of the bench vice and bench stop in timber preparation.
 - c How did you ensure that both the face side of the timber and the face edge of the timber were flat and squared?
 - d What do 'flatness' and 'squareness' refer to in timber preparation?
 - e What is the purpose of marking the face side and face edge of the timber?
- 7 The process of timber preparation must be followed correctly and accurately. Explain what might happen if you do not.
- 8 Explain the term 'dressed timber'. You should keep your dressed timber somewhere because you will need to use it again later.

9 Examine your dressed timber, then copy and complete the following table in your exercise book.

	Yes	No	If no, why not?
Did I follow the steps above when I prepared my timber?			
Do I know the meaning of 'face side mark' in timber preparation?			
Do I know how to test the face side of the timber?			
Do I know the meaning of 'face edge mark' in timber preparation?			
Do I know how to test the face edge of the timber?			
Do I know how to use the following marking tools safely? <ul style="list-style-type: none"> • Smoothing plane • Marking gauge • Try-square 			
Is the timber I dressed looking smooth on all sides?			
What is good about my dressed timber?			
I think the surfaces of my dressed timber can be improved by:			



Methods of joining timber

By the end of this topic, you should be able to:

- 7.3.3.3 identify and explain the common methods of joining timber
- 7.3.4.1 identify and explain the operations of the basic woodwork tools
- 7.3.7.1 use some of the basic hand tools to make timber joints
- 7.3.7.2 cut and join timber properly.

There are many methods for joining timbers and making timber products. Before you read any further, try the following activity, to see how much you know about this subject.

Activity 7: Identifying methods of joining timber

There are different methods of joining timbers. In groups, look around your classroom or school for three methods that have been used to join timbers. Write down a list of these methods and hand it to your teacher.

In this section you will look at four different methods of joining timber:

- using timber joints
- using nails
- using screws
- using adhesives or glues.

Joining timbers using joints

Timber joints are an important part of construction in almost any woodworking project. The **ability** to make sound, well-fitted joints is an indication of a good **craftsperson**.

All joints can be secured or held together either by nails, screws or glue, or by a combination of these. Always bore holes for screws and nails, especially when used in a timber that tends to split (such as *vasa*).

To make sure that joints are **assembled** or put together accurately, pay attention to keeping ends and edges of the timber square, and face sides and face edges true.

Joints are classified into three broad categories according to their application:

- 1 box or angle joints
- 2 framing joints
- 3 widening joints.

However, in Year 7, we will look only at simple joints: box or angle and framing joints. Figures 3.27 to 3.29 show box or angle joints while Figures 3.30 and 3.31 show framing joints.

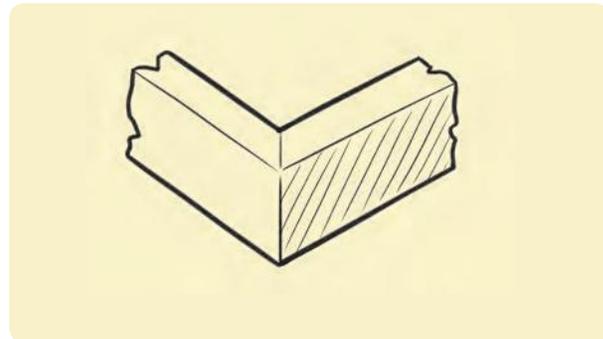


Figure 3.27 Mitre joint

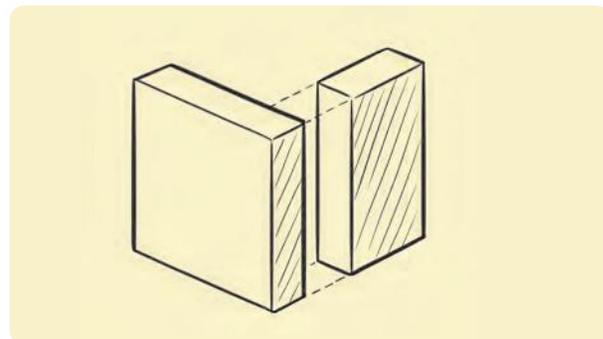


Figure 3.28 Butt joint

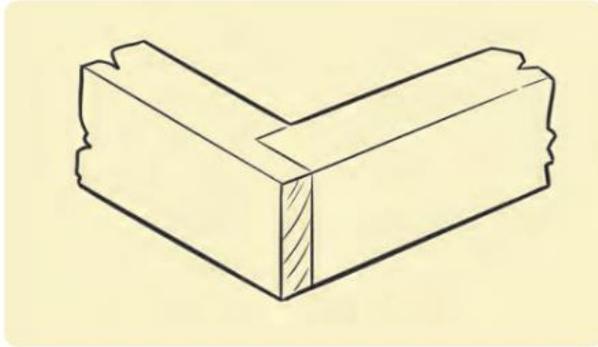


Figure 3.29 Rebate joint

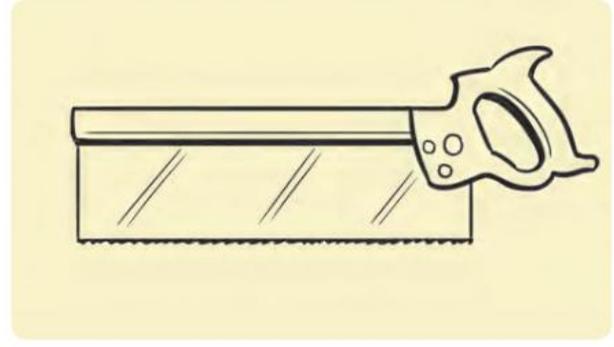


Figure 3.32 Tenon saw

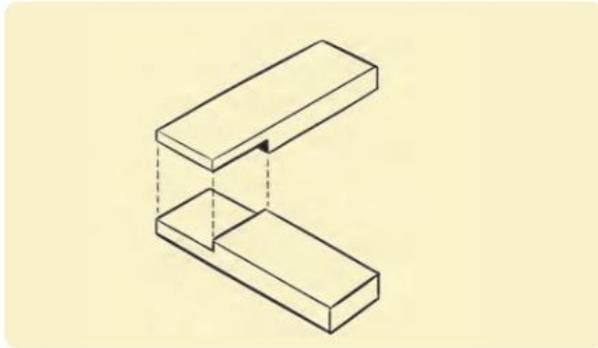


Figure 3.30 Corner halving joint

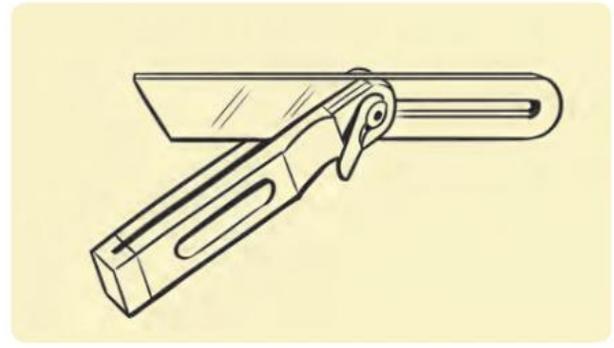


Figure 3.33 Sliding bevel

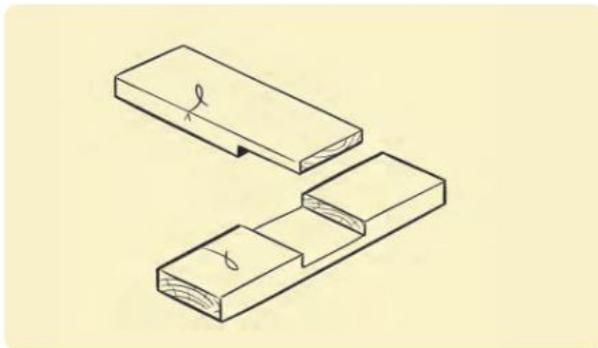


Figure 3.31 T-halving joint

You have learnt that there are different types of saws for cutting timbers. In Year 7, you learn only about the tenon saw. You will also learn about the sliding bevel.

Your teacher will show you how to measure a 45° mark on a piece of timber using a sliding bevel. You will use other tools such as a try-square and others that you have learnt about previously.

Activity 8: Finding out about mitre joints

You will need:

- the long piece of timber that you prepared in Activity 6
- try-square
- sliding bevel
- tenon saw.

- 1 Look carefully at the mitre joint in Figure 3.27. You are going to cut two pieces of timber from your long piece of timber to make a mitre joint. First, mark somewhere on the timber a 45° mark on the face edge of the timber. Use a try-square to transfer the end marks of the 45° mark onto the two face sides of the timber.
- 2 Your teacher will do a demonstration of the same activity you did above. Write down any new things that you learnt from the demonstration.
- 3 Write down the uses of the sliding bevel and the tenon saw.
- 4 Write down two safety rules that you must observe when using the tenon saw.
- 5 Copy and complete the following table in your exercise book.

	Yes	No	If no, why
Do I know how to use the tenon saw?			
Do I know how to mark the 45° lines at the two ends of the timber?			
When the two timbers are cut and joined together, do they form an angle at 90°?			
Does my mitre joint perfectly meet to form 90°?			
What is good about my mitre joint?			
What is bad about my mitre joint?			
I think the mitre joint that I made can be improved by:			



Activity 9: Finding out about other timber joints

- 1 Walk around your classroom or school to identify where a mitre joint is used. Can you give a reason why the joint is used in that area?
- 2 Look back at the Figures 3.27 to 3.31. In groups of five, look around your workshop or classroom or other school area and look for places where a butt joint, rebate joint, corner halving joint or T-halving joint are used. Write down which of the joints above you think is the strongest and give reasons for your choice.

How to prepare a corner halving joint

- 1 Plane face side (P) and face edge (Λ) to the required flatness and squareness **respectively**. Apply the finishing mark symbols to the face side and face edge.

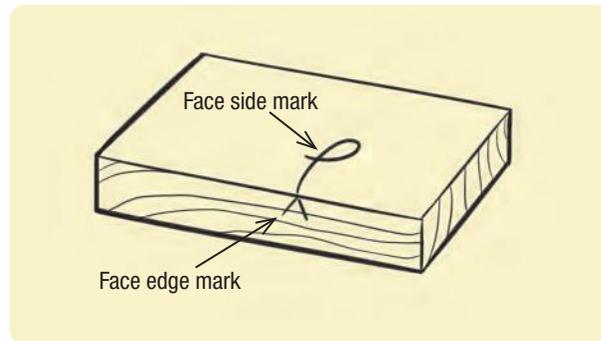


Figure 3.34 Dressed timber with the two finishing mark symbols

- 2 Mark an extra 1.5 millimetres from the end, using a try-square and a pencil. Square all round.

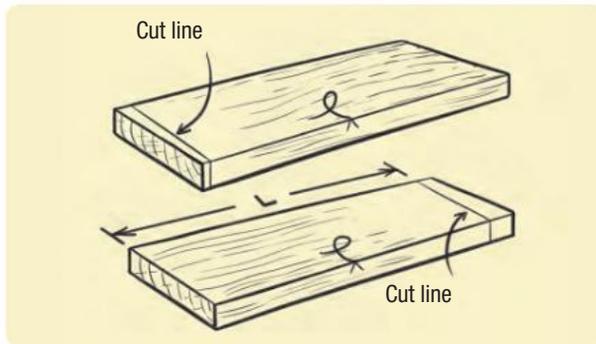


Figure 3.35 Use a try-square and a pencil to mark the ends of each piece of timber.

- 3 Measure the length of the halving joint with a steel rule and a try-square. Hold the try-square in position and mark with the pencil.

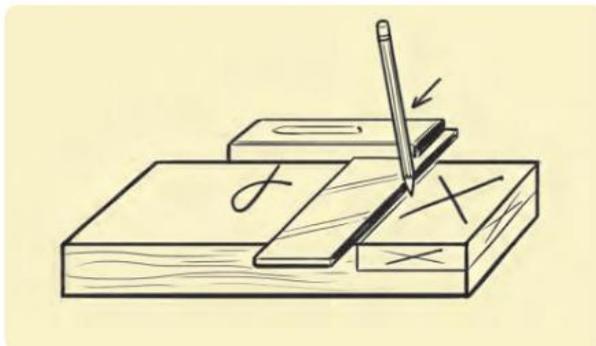


Figure 3.36 Mark the halving joint.

- 4 Transfer the marked line across the sides with a pencil and try-square.

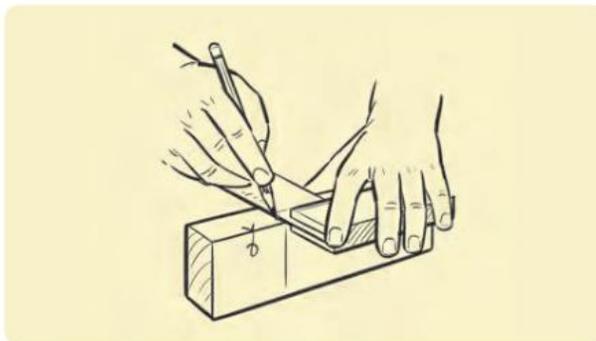


Figure 3.37 Transfer pencil marks.

- 5 Set the marking gauge to a distance equal to half the thickness of the timber with the help of a steel rule. Gauge the lines on both the edges and the end grain.

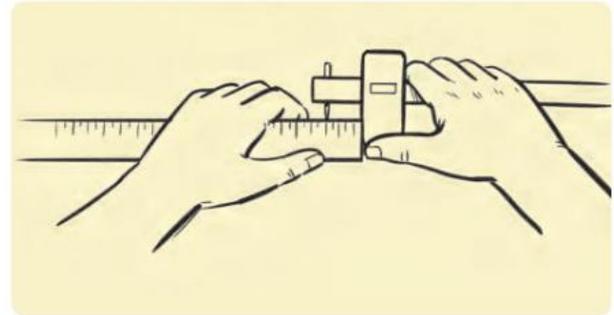


Figure 3.38 The marking gauge should be set to half the thickness of the timber.

- 6 Cross out the waste material with a pencil.

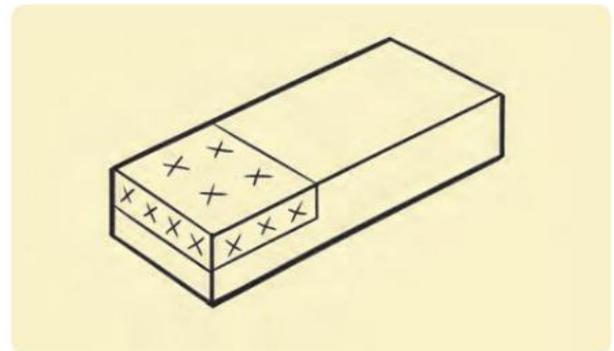


Figure 3.39 Cross out the timber that will not be used with a pencil.

- 7 Repeat steps 1 to 6 for the other piece of timber.

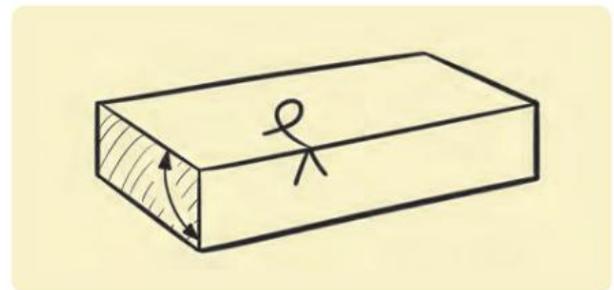


Figure 3.40 Timber ready for the other half of the joint

Activity 10: Finding out about corner halving joints

You will need:

- the long piece of timber that you prepared in Activity 6
 - marking gauge
 - chisel
 - bench vice
 - bench hook.
- 1 Read through the section above called 'How to prepare a corner halving joint'.
 - 2 Your teacher will demonstrate how to prepare a corner halving joint. During this demonstration, look at how the teacher uses the tools shown in Figure 3.41.

- 3 After the demonstration, sketch each tool in your exercise book and write its name. To help you further, read the details about the tools given after this activity.
- 4 There are two different types of chisel shown in Figure 3.41. Write down why you have to use one type of chisel rather than the other.
- 5 Write down the **safety measures** you must observe when making a corner halving joint.
- 6 Write down two safety measures required when using chisels.
- 7 Following the steps listed in the section above called 'How to prepare a corner halving joint', make a corner halving joint. You will need your piece of timber later so you must keep it safe somewhere.



Figure 3.41 Tools for making a corner halving joint.

8 When you have completed your corner halving joint, copy and complete the following table in your exercise book.

	Yes	No	If no, why not
Do I know how to use the marking gauge?			
Do I know how to use the chisel?			
Do I know how to use the bench vice?			
Do I know how to use the bench hook when sawing?			
Do I know the uses of these tools? <ul style="list-style-type: none"> • Marking gauge • Chisel • Bench vice • Bench hook 			
Were the two halves of my joint flush and do they fit perfectly when assemble together?			
When the two timbers are cut and joined together, do they form an angle at 90°?			
What is good about my corner halving joint?			
What is bad about my corner halving joint?			
I think the corner halving joint that I made can be improved by:			



Paring tools

The term 'paring' refers to the process of removing waste wood from a piece of timber using a chisel, without a mallet. There are many types of chisels used in woodworking, but in Year 7 you will learn to use the bevelled-edge chisel and the mortise chisel. All chisels consist of two main parts: the blade and handle. Figures 3.42 and 3.43 show the two types.

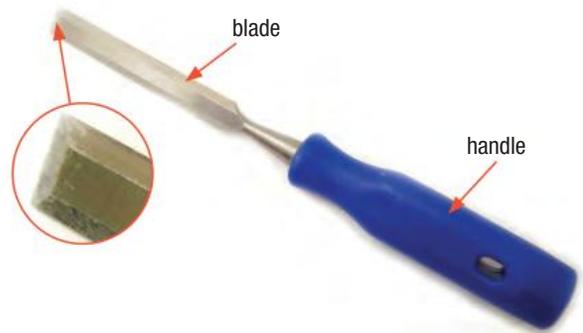


Figure 3.42 Bevelled-edge chisel

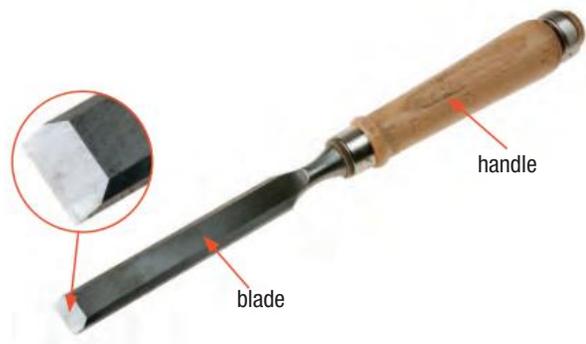


Figure 3.43 Mortise chisel

Percussion tools

The Warrington hammer, the claw hammer and the mallet are called percussion tools. 'Percussion' means 'impact of two objects striking each other' and therefore percussion tools are those used for striking other tools.

The common woodwork hammers are the Warrington hammer and the claw hammer.



Figure 3.44 Warrington hammer



Figure 3.45 Claw hammer

Note: When using a hammer, always **grip** the handle at the back as shown in Figure 3.46.

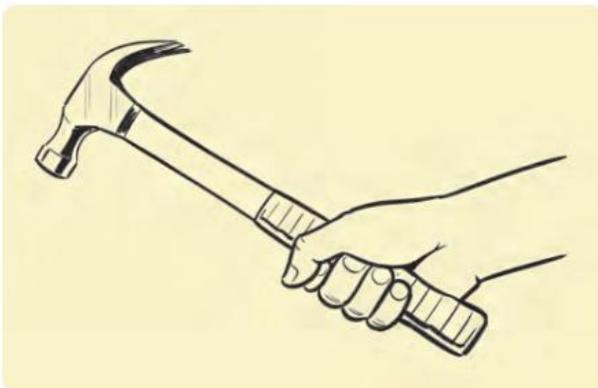


Figure 3.46 Hold the hammer by the handle

Joining timbers using nails

Nails are used commonly in joining timber work. Most nails in use today are made from steel wire (mild steel); some are made from copper. There are different types of nails available in Solomon Islands. Some are shown in Figures 3.47 to 3.50.



Figure 3.47 Jolt head nails



Figure 3.48 Flat head nails



Figure 3.49 Panel pin



Figure 3.50 Cut tack

Activity 11: Finding out about nails

- 1 Read the information about nails on page 50.
- 2 Walk around the school and try to find examples of each type of nail shown above. Copy and complete the following table in your exercise book.

Name of nail	Where it is used	One reason why the nail is used in that particular place
A		
B		
C		
D		



How to drive nails

- 1 Hold the hammer near the end of the handle and use it with a direct 'hitting' (not 'pushing') action. Bend your wrist to drive small nails (such as panel nails); use your whole arm and shoulder to drive larger nails.

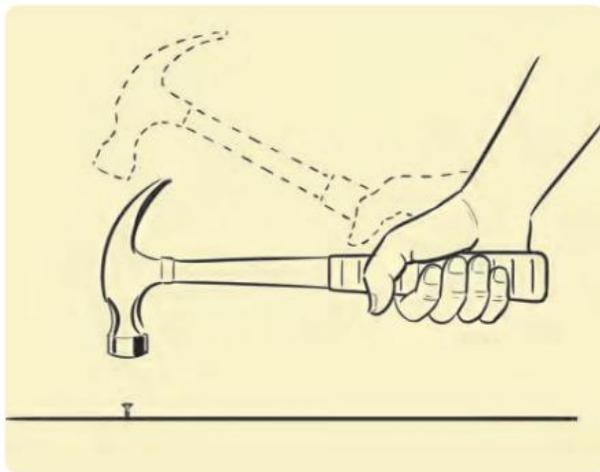


Figure 3.51 Driving a small nail

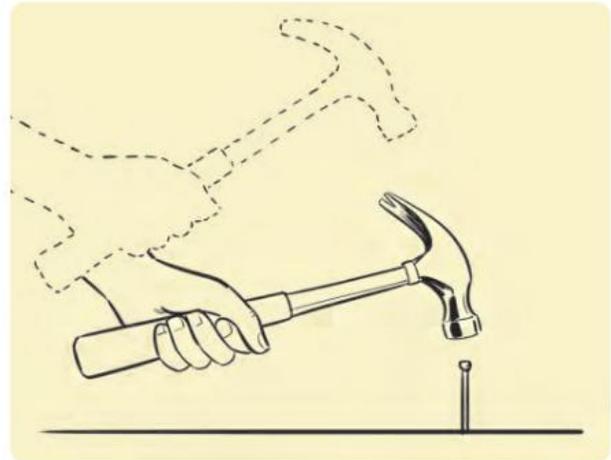


Figure 3.52 Driving a large nail

- 2 Drive nails right into the timber, taking care not to damage the timber.
- 3 Use a nail punch of correct size to punch heads slightly below the surface. If no punch is available, use the flat head of another nail. Nails that are lightly lubricated or covered with oil drive more easily.
- 4 To guard against splitting the timber, reverse the nail, drive the head just below the surface, withdraw it and drive the nail in the normal way.

Alternatively:

- a flatten the nail point so that it punches, rather than pierces, the timber
- b drill a small **pilot hole** for the nail: use a wood drill in hard wood, then punch the nail in this pilot hole.

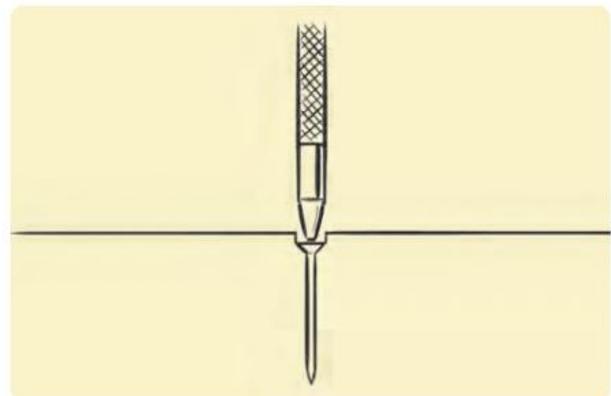


Figure 3.53 Nail heads are punched into timber.

How to withdraw nails

The claw of a claw hammer is shaped to withdraw nails from timber. The claw should not be bent in any way or it will be useless for withdrawing small nails.



Figure 3.54 Extracting a nail with a hammer

Pincers may be used for pulling nails. For pulling out big nails, you can use a pinch bar. A piece of timber should be placed between the timber and the pincer or the pinch bar to avoid damaging the timber surface. This is important also for **extracting** the nails easily. Figures 3.55 and 3.56 show these methods.



Figure 3.55 Using pincers to extract small nails



Figure 3.56 Using a pinch bar to extract large nails

Activity 12: Finding out about methods of nailing

You will need:

- timber
- nails
- hammer.

1 Figures 3.57 to 3.59 show common methods of nailing timbers together.

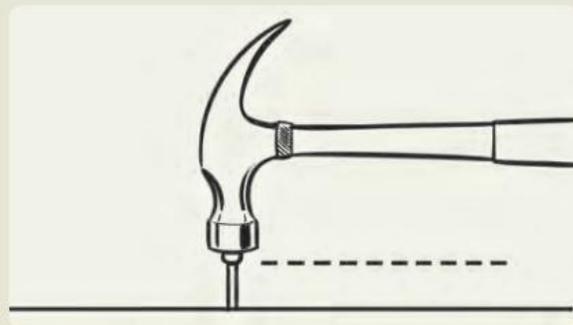


Figure 3.57 Parallel nailing

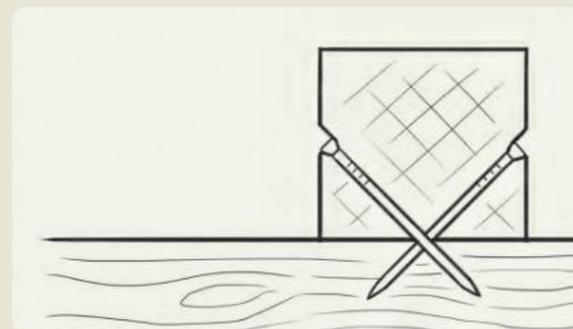


Figure 3.58 Skew nailing

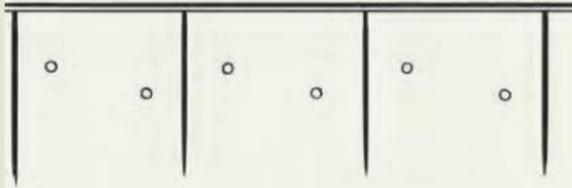


Figure 3.59 Staggered nailing

- 2 Read the section above called 'How to drive nails'.
- 3 Cut six pieces of timber, then join two pieces of timber for each method shown in Figures 3.57 to 3.59.
- 4 Write down two advantages and one disadvantage of each of the methods of nailing.

Joining timbers using screws

A screw bores into timber by means of a **spiral thread**. The following figure shows the common types of screws used when working with timber at this level.

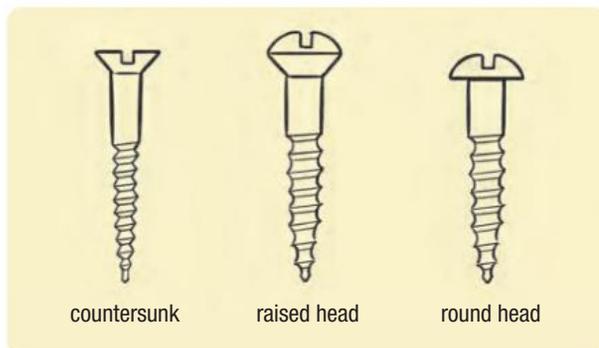


Figure 3.60 Different types of wood screws

How to drive screws

- 1 Screws must always be turned in with a screw driver and never driven with a hammer.
- 2 Use timber drills of appropriate sizes to bore holes to guide the screw. This is important, so that the screw can easily be driven into the timber. The hole should be big enough so that the screw grips the timber tightly. You will find it easier to drive the screws if you put some oil or wax on the thread.



Figure 3.61 Holes must always be bored for screws.

- 3 For a neat appearance, turn the screws so that the **slots** are all in line along the grain of the timber. This is called 'heading the screws'.

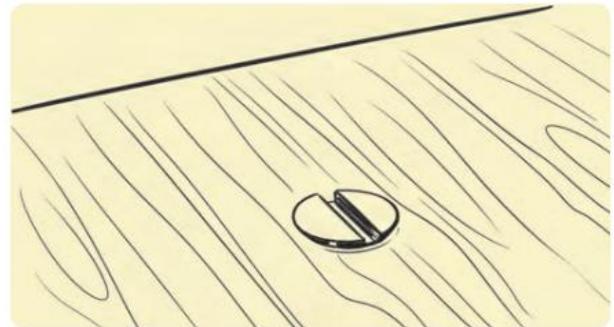


Figure 3.62 Heading the screws

Activity 13: Finding out about screws

- 1 Read the section above called 'Joining timbers using screws'.
- 2 In groups of four or five, find examples of the two types of screws described. Can you explain where and why the different types of screws are used?
- 3 Your teacher will present two different types of screw drivers. Can you identify which type of screw driver is used for driving the different types of screws you have collected?
- 4 Figure 3.63 shows a screw that has been driven into timber with a hammer. What are two effects of driving a screw into timber with a hammer?

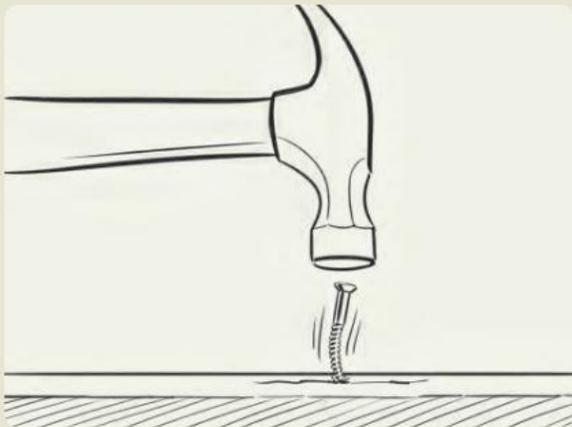


Figure 3.63 A countersunk screw driven in wood by a hammer

- 5 Write down two reasons for using a screw for joining timber rather than a nail.

Joining timbers using adhesive or glue

Timbers can be joined using adhesive or glue. Glue is a substance used to bond or join two surfaces together, either timber to timber, or timber to other materials. Choosing the right adhesive and applying it correctly are important

when working with timber. There are many different types of glues used in workshops today. In Year 7, you will learn only about polyvinyl acetate (PVA) glue.

PVA glue

PVA glue is one of the most important glues used in timber work. It is ready for use and does not require any hardener. Although PVA takes longer to dry than other synthetic human-made glues, it is suitable for gluing timber to timber, timber to metal, timber to glass, etc.



Figure 3.64 Some products in which PVA glue is used

When you apply PVA glue to a surface, you must remember the following:

- Do not use it near a fire. It is flammable or able to burn easily.
- Wash the glue brush with a **solvent**, which will **dissolve** away any extra glue, immediately after gluing (you should consult your teacher if you are not sure about this).
- Dry the brush well before giving it back to the teacher for safekeeping.

Using PVA glue

- 1 Spread PVA glue evenly on the surfaces to be joined.
- 2 Clamp the parts together until the glue is set.

Activity 14: Checking what you have learnt about joining timber

- 1 Look around your school workshop or school area. Identify and list the different methods of joining timbers.
- 2 If you were making a frame for a coconut strainer, what joining method would you use? Explain your choice.
- 3 In pairs, read the text on nails and study the diagrams. Copy and complete the following table in your exercise book.

Common nails	Main uses
Jolt head	
Flat head	
Panel pin	
Cut tack	



- 4 Which method of nailing do you think is the strongest for joining timbers together?
- 5 Which glue should you use when:
 - a joining timbers together?
 - b gluing materials onto a table top?
- 6 How do you extract, or take out, small and big nails from timber? Explain.

Finishing on timber

By the end of this topic, you should be able to:

- 7.3.1.1 describe the safety requirements of working with timber
- 7.3.3.4 describe the types of timber finishes (e.g. paint, varnish and coconut oil) and their methods of use.

There is a **series** of steps involved in making a timber product. You have learnt about preparation of timbers and joining of timbers together to form a product. Now, you will look at the final step of constructing a timber product—timber finishing. Timber finishing refers to the application of paint, varnish or coconut oil to the surface of a timber product before the product is used.

Finish application

Before a finish is applied on timber, the following must be carried out.

- a *Surface preparation*—before any finish is applied, the timber surfaces must be **thoroughly** cleaned. Surfaces should be perfectly smooth and free from any dust. All marks caused by the plane, gauge, sand paper or other tools must be removed.
- b *Surface treatment*—before any finish is applied the surface may require some treatment, which will vary according to the nature of the timber and the type of finish.

There are various types of clear finishes and methods of applying them. The type of clear finish applied should be appropriate for the material used. Following is information about common timber finishes and their application.

Paint

There are many types of paint. An **undercoat** is applied first, followed by **enamel paint**. Paint adds colour to your project.



Figure 3.65 Applying a coat of undercoat followed by a coat of enamel paint will ensure that the coloured paint looks smooth and even.

How to paint timber

- 1 Smooth the surface with glass paper.
- 2 Clean up dust from the surface.



Figure 3.66 Prepare the surface that is being painted.

- 3 Apply undercoat paint. Allow it to dry. Use glass paper to lightly smooth down surface. Clean off dust.



Figure 3.67 The first layer of paint is called the undercoat.

- 4 Apply enamel paint. Allow it to dry.
- 5 Clean the brush that you use with a cleaning solvent—that is, a chemical that will dissolve the paint. Check with your teacher for this.

Varnish

How to apply varnish

- 1 Clean the timber surface. Cleaning the timber provides a smooth and even surface on which to paint.



Figure 3.68 Applying varnish

- 2 Place the product on an empty case or some old newspapers to prevent varnish from spilling onto the floor. Apply varnish along the grain from the centre towards the edge. Leave it to dry.
- 3 Clean the brush with an appropriate cleaning solvent. Check with your teacher for this.

Coconut oil

Coconut oil can be applied to any surface to improve appearance. It can be re-applied once the finish starts to fade. You can use a piece of cloth to run the coconut oil over the surface once the timber surfaces are properly prepared.

Activity 15: Finding out about timber finishes

- 1 In groups of five, look at a piece of furniture. What type of finish has been applied to the surfaces of the furniture—that is, paint, varnish or even oil?
- 2 In your groups, discuss how the surfaces of the furniture should be prepared before any of the finish is applied. Can you explain how the finish was applied? What are the tools used to apply the finish?
- 3 What is the process of preparing a surface to apply finish? List the materials to use when preparing the surface. Suggest what types of safety measures would need to be taken when applying finish on a timber product.
- 4 Report back to the class about your group's observations of the furniture.
- 5 What do you think would happen if there was no finish applied on the surfaces of the furniture?
- 6 What would a room look like if the furniture in it had no type of finish?

Activity 16: Applying finishes

You will need:

- your corner halving joint from Activity 10
 - clear finish
 - clean hand brush
 - rag
 - old newspaper.
- 1 Look carefully at your joint. Are there any plane, gauge and cross sanding marks on the surfaces of the timber joint? If there are any, remove them so that the surfaces are smooth from any marks.
 - 2 Show your teacher when your joint is ready for the final finishing. Your teacher will check that you have prepared the surface well and advise you on how to apply the finish.
 - 3 Why do you think it is important to prepare a surface properly before an appropriate finish can be applied?

Now you have acquired all the skills and knowledge that you require to solve one of the design problems outlined at the beginning of this chapter. Remember: you should solve only one design problem.

Practical task

By the end of this practical task, you should be able to:

- 7.3.1.1 describe the safety requirements of working with timber
- 7.3.5.1 design and make any of the following timber products: coconut strainer, towel rail, etc. (or a similar product to suit own situation)
- 7.3.6.1 correctly, skilfully and safely use measuring, marking, cutting, fitting, assembling and finishing tools in woodworking
- 7.3.6.2 prepare, mark, cut and join or assemble timbers to make a timber solution to a design problem
- 7.3.8.1 investigate ideas about the importance of timber products in the home.

Go back and read the design problems at the beginning of this chapter. You are going to solve one of those design problems.

Design problem 1: Coconut strainer

Design expectations

The following must be considered in the development of the coconut strainer:

- The coconut strainer must be light in weight so it can be hung up easily when not in use.
- The frame must be square and rigid—that is, not likely to bend.
- The coconut strainer must be strong and **convenient** to use. This **implies** that it will not be too small or too big.
- The net used must produce a fine coconut milk.
- The coconut strainer must be a convenient size to use in a kitchen. You should discuss appropriate measurements with your teacher.

Investigating

- Select appropriate timbers and prepare them for use.
- Investigate the type of timber joint that you will use to hold the frame together.
- Consider which other materials you will need to make the coconut strainer.
- Look around your home or your neighbourhood for a coconut strainer that is made from timber and a coconut strainer that has been bought from a shop. Identify the strengths and weaknesses of each coconut strainer.
- Identify how the coconut strainers you have found are designed.

Designing your coconut strainer

- Write the design brief for the coconut strainer.
- Discuss with a friend how you are going to make your coconut strainer—the steps, tools and safety issues involved.
- Make a pictorial drawing of your coconut strainer. Include in your drawing the dimensions of the coconut strainer. Make sure to indicate the type of joints that you will use.

Making your coconut strainer

- Prepare the timber for the rails of the coconut strainer.
- Cut the joints.
- Apply PVA glue to the joints.
- Use appropriate tools when marking, cutting and applying finish.

Testing your coconut strainer

- Is the frame square, rigid and strong?
- Can the coconut strainer be hung up easily?
- Can the grated coconut be strained easily?
- Is the coconut strainer light and easy to move?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Are the type of joint(s) you used strong enough for this coconut strainer?
- 2 Does this coconut strainer serve the purpose for which it is designed?
- 3 Is the whole structure of the coconut strainer strong and neat?
- 4 Does the size of the strainer suit its purpose?
- 5 Is the design pleasing to look at?
- 6 Did the construction or making of the coconut strainer take a long time? If yes, why?
- 7 What have you learnt from others' coconut strainer projects?
- 8 What would you change in your design if you were to make another coconut strainer?

Communicating and marketing

- 1 Who are the **potential users** of the coconut strainer?
- 2 How much would you sell your coconut strainer for?
- 3 What benefit/s does your coconut strainer have for users?
- 4 What marketing technique/s would you use to sell your coconut strainer?

Design problem 2: Pencil box

Design expectations

The following must be considered in the development of the pencil box:

- The pencil box must be light in weight and able to be moved easily.
- The frame must be square and rigid—that is, not likely to bend—and strong.
- The pencil box must be convenient to use—that is, it must not be too small or too big.
- The pencil box should not be covered.

- The pencil box must be of **standard size**. You should discuss this with your teacher for appropriate measurement.

Investigating

- Decide upon the type of timber you will use for making the pencil box.
- Select the type of timber joint that you will use to hold the frame together.
- Decide which other materials that you will use to make the pencil box.
- Look around your home or your neighbourhood for a pencil box that is made from timber and a pencil box that has been bought from a shop. Identify the strengths and weaknesses of each pencil box.
- Identify how the pencil boxes you have examined are designed.

Designing your pencil box

- Write the design brief for the pencil box.
- Discuss with a friend about how you are going to make your pencil box—the steps, tools and safety involved.
- Make a pictorial drawing of your pencil box. Include in your drawing the different dimensions of the pencil box. Make sure to include the type of joints that you will use.

Making your pencil box

- Prepare the timber.
- Cut the joints.
- Apply PVA glue to the joints.
- Use appropriate tools when marking, cutting and applying finish.

Testing your pencil box

- Is the frame square, rigid and strong?
- Can the pencil box be hung up easily?
- Is the pencil box light and easy to move?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Is the type of joint you used strong enough for this product?
- 2 Does the product serve the purpose for which it is designed?
- 3 Is the whole structure of the pencil box strong and neat?
- 4 Does the size of the pencil box suit its purpose?
- 5 Is the design pleasing to look at?
- 6 Did the construction or making of the pencil box take a lot of time? If yes, why?

- 7 What have you learnt from others' pencil box projects?
- 8 What would you change from your design if you were to make another pencil box?

Communicating and marketing

- 1 Who are the potential users of the pencil box?
- 2 How much would you sell your pencil box for?
- 3 What benefits does your pencil box have for the users?
- 4 What marketing techniques would you use to sell your pencil box?

New words used in this chapter

ability	skill or talent	raw bush materials	natural bush materials
alternatively	on the other hand	respectively	in that order
assembled	put together	rough-sawn timber	timber with rough 'body'; not yet planed
commodity	product	safety measures	steps taken for safety reasons
convenient	easy, suitable	sequence	progressive steps
craftsperson	person who makes things by using their hands	series	progression
cross-section	cut-across view	slot (of a screw)	hole in the head of a screw in which the end of the screwdriver is placed for turning
dissolve	break up	solvent	special liquid or chemical used for cleaning brushes, tools, etc.
enamel paint	special form of paint that gives a shiny finish	spiral	twisting
export	sell products to other countries	standard size	common size
extracting	removing or taking out	structure	arrangement or organization
face edge	side of a timber that shows the thickness	stump	remains of a log
feature	main point	thoroughly	properly
grip	hold	thread (of a screw)	spiral ridge on a screw that gives it its holding power
implies	means, suggests	tilt	lift a little at one edge or end
ingredient	part, component	undercoat	first layer of paint
observe	watch		
pilot hole	small drilled hole in timber to assist in driving a nail		
plank	board or piece of timber		
potential user	likely user		

Chapter 4

Building construction

Learning outcomes

By the end of this chapter, you should be able to:

- 7.4.1.1** identify and describe a house plan and its specifications
- 7.4.1.2** identify and describe the natural factors to consider when planning a new building
- 7.4.2.1** identify the tools used for constructing a new building profile
- 7.4.2.2** identify the materials used for building profiles and footings
- 7.4.2.3** read building plans and describe the setting-out process of a building profile
- 7.4.3.1** design and construct a building profile for a small bungalow that will address the increasing eco-tourism needs in the rural communities in Solomon Islands
- 7.4.4.1** mark and lay out a simple building profile for a new building
- 7.4.4.2** follow appropriate procedures to lay out a building profile
- 7.4.4.3** mark out a new building profile properly
- 7.4.4.4** prepare a new construction site
- 7.4.4.5** mark out the footing for a new building on a profile
- 7.4.5.1** use appropriate tools and materials to lay out a new simple building profile
- 7.4.6.1** discuss the importance of design factors when planning a new building in Solomon Islands.

Introduction

In this chapter you are going to learn about setting up a square **foundation** for a house. Before any work can be started on a building, the **site** has to be prepared to enable work on and around the building. This involves clearing trees, removing any wood and rocks, levelling the site and any other form of work that will make the site ready for the setting out.

The setting out, which involves making an outline of the building on the ground, is the first step in the construction of a house. This outline is called a profile. The **task** is not difficult but it needs to be done with care and attention. Accuracy is most important, as all the tasks that follow are based on this step. If the foundation ends up a little short or oversized, or not squared because it was not laid out correctly, there could be serious problems with the structure of the building.

To learn how to build a profile, choose a flat area where there are no particular difficulties. Figure 4.1 shows how this task is carried out using corner profiles. Corner profiles are constructed at the four corners of the house to be built. Alternatively, continuous profiles, which are constructed all around the house foundations, can be used.

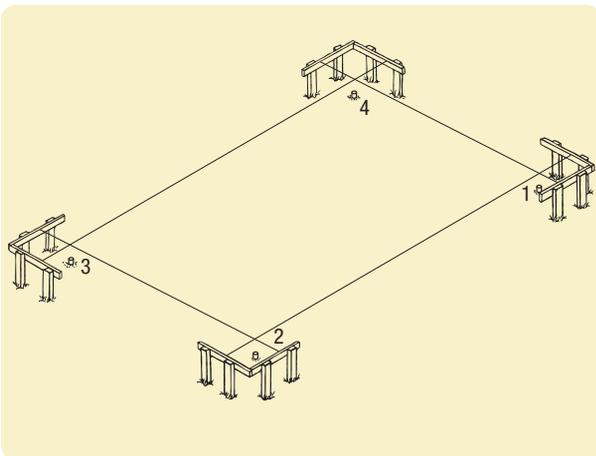


Figure 4.1 A building profile erected as an outline for a new building

Activity 1: Explaining why the foundation of a building is important

- 1 Write down two reasons why you will have problems if the foundation is a little short, oversized, or not squared.
- 2 Accuracy is the most important factor when building profiles; explain why.

Design problem: Building profile

Most villagers in Solomon Islands do not set up proper building profiles when building traditional houses. However, setting up a proper building profile is very important when building a **permanent house**, and contributes significantly to the quality of construction. Nowadays, quality building construction is in demand in both rural areas and urban centres in Solomon Islands. All school buildings are required to be built from proper building profiles.

Investigate a building need in your school. For example, for a practical subject like Agriculture you might need a proper storage room or shed for tools and equipment. If you do not have a shed, you may be required to build one. Use this opportunity to set up a building profile for this tool shed. At the end of this chapter you will carry out this task so that the setting out is ready for the next stage.

In this chapter you will learn about the basic skills and principles of building construction to help you build a new storage building. You will learn about the initial stage of constructing a new building and be able to set up a building profile using a simple building plan.

Tools and equipment used in this chapter

Builder's square
Builder's tape measure
Claw hammer
Hand saw
Line level
Plumb bob
Sledge or maul hammer

Materials used in this chapter

Nails
Profiles
String
Wooden pegs

House plans and their specifications

By the end of this topic, you should be able to:

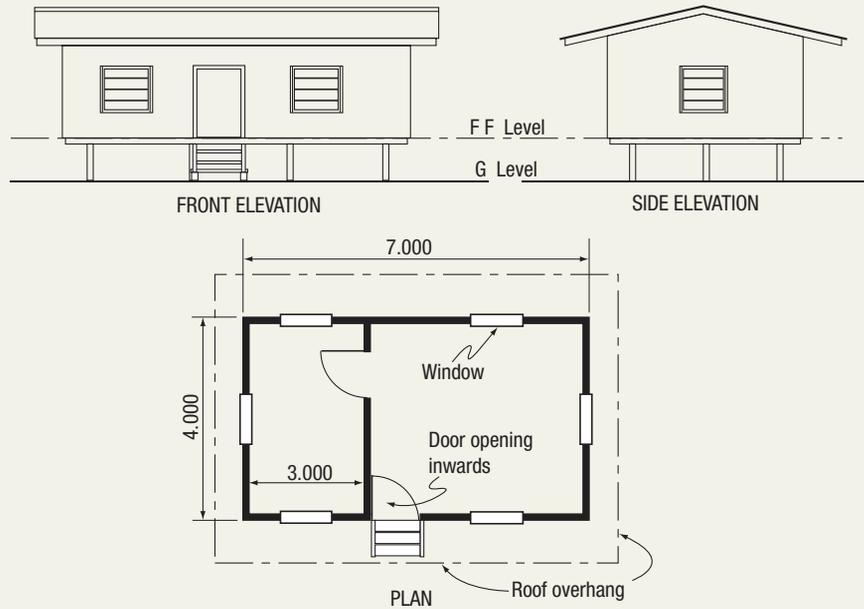
7.4.1.1 identify and describe a house plan and its specifications.

House plans (working drawings)

Before a house or other building can be built, a set of drawings must be made that provide all the information needed.

Activity 2: Finding out about house plans

- 1 Look at the drawing on page 64. It is a house plan for a single-bedroom house. A house plan should have three drawings, called elevations or views. Write down the names of these elevations in your exercise book.
- 2 Write down two advantages and two disadvantages of using a house plan to build a house.
- 3 Write down what a house plan shows.
- 4 A person who draws house plans as a job is called an _____.
- 5 Using the house plan on page 64, **identify** the following in the drawing:
 - a a floor plan, showing sizes of rooms and positions of windows and doors
 - b front and side (end) elevations.



Building specifications

Building specifications are important written details and information which cannot be all shown on the building plans. The building specifications **state**:

- 1 materials to be used, for example:
 - floor
 - slab (that is, concrete floor on the ground)
 - raised (that is, timber floor raised on posts or 'legs')
 - wall
 - bricks or timber frames
 - fibro sheet
 - timber (using weatherboards)
 - plywood
 - roof
 - corrugated iron sheets
 - patch roll iron sheets
 - ridge cap iron sheets
- 2 items to be included, for example number of rooms, doors, windows, and their sizes
- 3 techniques of construction, for example:
 - joints to be used in the frame
 - studs (vertical timbers running between top and bottom plates) to be fitted/placed inside

the top and bottom plates (timbers running horizontally above and below the studs)

Note: Building plans together with specifications ensure that the house can be constructed according to expectations.

Activity 3: Finding out about building specifications

- 1 There are other important details and information that are not shown on a house plan, such as the type of materials to be used. These are called building specifications. In your exercise book, identify three materials needed for the construction of a house. State where the materials you have identified would be used in a building.
- 2 Write down where you would buy the materials you have listed.
- 3 Besides the materials, what else would be included under 'building specifications'?
- 4 Both the house plan and the building specifications ensure that a proper house is to be constructed according to expectations. Explain how.

Setting up a building foundation

By the end of this topic, you should be able to:

- 7.4.2.1 identify the tools used for constructing a new building profile
- 7.4.2.2 identify the materials used for building profiles and footings
- 7.4.2.3 read building plans and describe the setting-out process of a building profile.

There are many steps to follow in order to construct a new house. In Year 7 you will learn only about site preparation and foundation layout.

Site preparation

Before you set out an outline for a new building foundation, you must carry out site work. This involves clearing the area on which the house is to be built and may include:

- 1 removing trees, stumps and roots, and anything else likely to block the progress of work. Natural features, such as trees, may be retained as indicated on the house plan for shade and **beautification** of the site.
- 2 removing **topsoil** from areas to be filled
- 3 levelling the land where required.

Activity 4: Laying out a profile

- 1 Read the section above called 'Site preparation'. Using the information, prepare a site for a new building. Your teacher will give you more details.
- 2 When you have cleared the site completely you are ready to construct a building profile. Before building a profile, read the following section called 'How to do a building profile layout'.

How to do a building profile layout

Setting out a foundation is very easy. However, it needs to be done with accuracy so that the foundation layout is square. In order to achieve a square foundation, the profile (the framework or temporary guide placed outside the corners of the building which lines are fitted to for marking out the foundation) must be set out accurately. Figure 4.2 shows the steps that you will use to set up the corner profiles. This involves using pegs or pieces of wood hammered into the ground.



Figure 4.2 The corners of the new profile are numbered.

- 1 At the first corner, drive Peg 1 into the ground using a sledge or maul hammer.



Figure 4.3 Sledge hammer



Figure 4.4 Maul hammer

- Use a tape measure to measure the length from Peg 1, and place Peg 2.



Figure 4.5 Tape measure

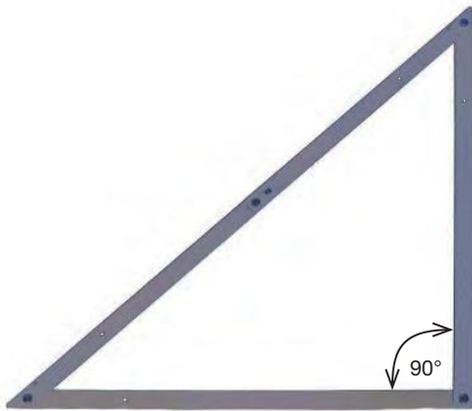


Figure 4.6 Builder's square

Note that the position of the two pegs must be away from the road or other house boundary, as shown in Figure 4.7.

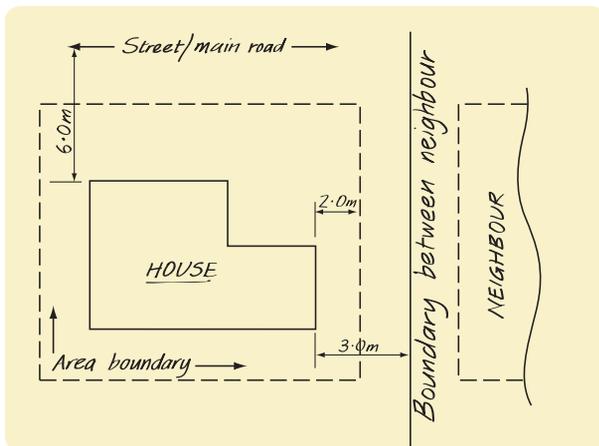


Figure 4.7 Legal distance from other private or public boundaries

- Use a tape measure to measure the width from Peg 2, and place Peg 3. Peg 2 and Peg 3 should be at right angles, or 90° , to each other. You should use a builder's square (see Figure 4.6) to measure the right angle formed by these pegs.

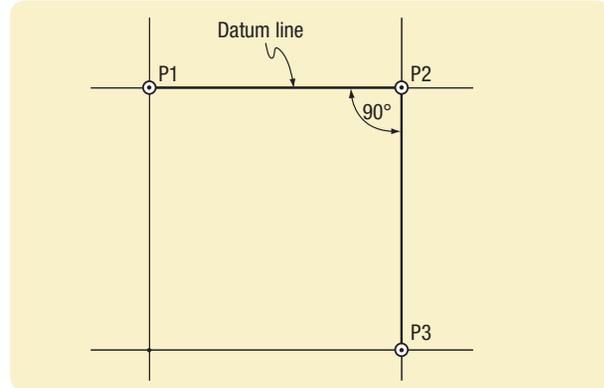


Figure 4.8 Placement of Peg 3

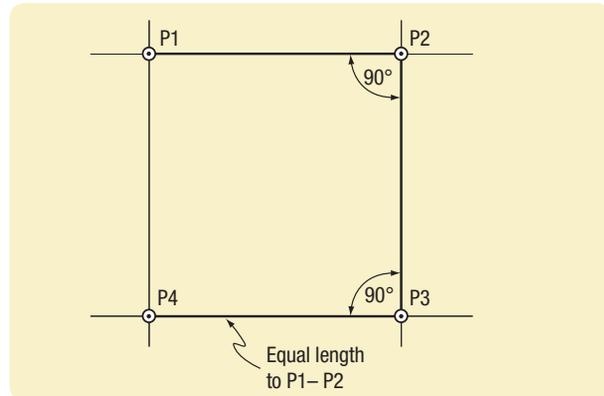


Figure 4.9 Placement of Peg 4

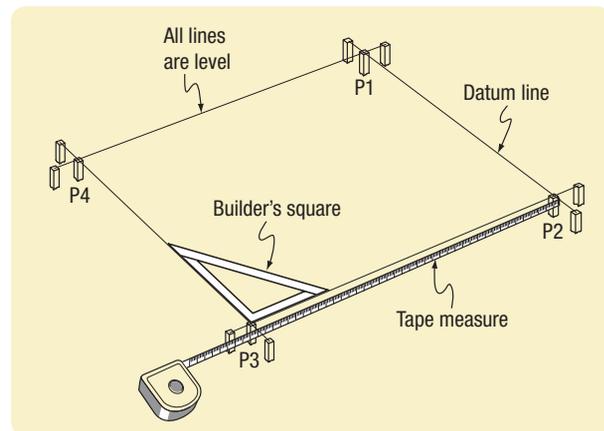


Figure 4.10 Using a builder's square and a tape measure to place Peg 4

- Use a builder's square and tape measure to measure the length from Peg 3, and place Peg 4 (see Figure 4.10).
- Check the width, using a tape measure, from Peg 4 to Peg 1. The distance should be equal to the distance between Peg 2 and Peg 3.

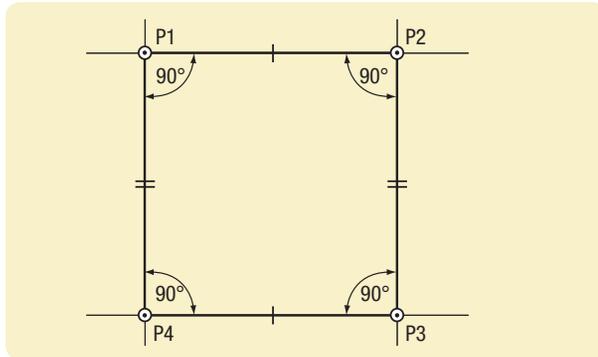


Figure 4.11 Checking the width from Peg 4 to Peg 1

- Check accuracy and squareness by using two pieces of strings to measure the two diagonals, which are the distances between Peg 1 and Peg 3, and Peg 2 and 4. Figure 4.12 shows this. These distances must be the same in length. If they are not equal, the setting out is not square; this must be corrected before corner profiles are constructed.

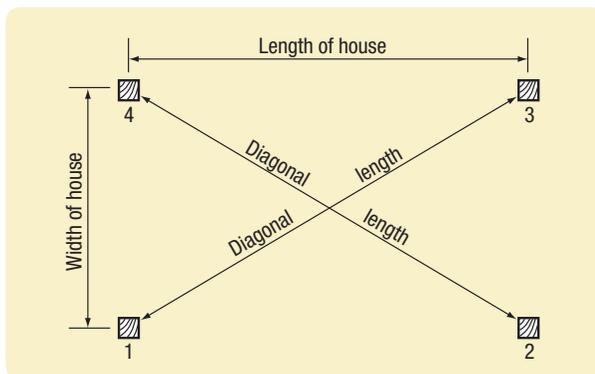


Figure 4.12 Measuring diagonally to check that the dimensions are accurate

- Set up profiles (corner or continuous/fencing profiles) about 600 millimetres clear of wall position. Make sure these profiles are of equal

height so that the setting out will be level. If you wish to make a continuous or fencing profile, drive in more pegs and nail the profile boards onto the pegs—check for the level of all profiles.



Figure 4.13 All corner profiles are set out 600 millimetres clear of wall position.

- Mark out the length and width of the building on the setting out or profiles, then drive in nails on the profiles so that string lines can be easily hooked onto them.
- Set out the size of the foundation by means of stretching the string lines on the marks where the nails are positioned. Use a **plumb bob** to mark the position on the ground.

Figure 4.14 shows a completed setting out for a building foundation in which corner profiles are used.

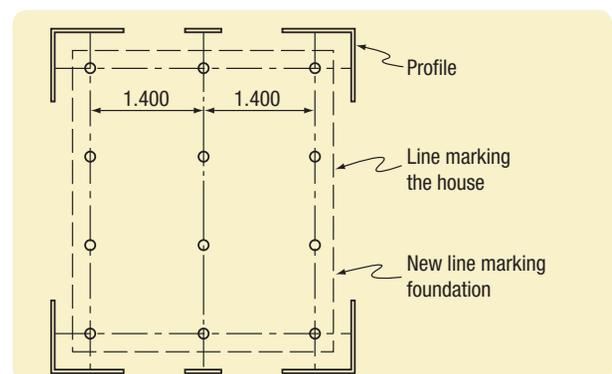


Figure 4.14 A completed setting out

Activity 5: Setting up a raised floor foundation

You will need:

- line level
 - builder's tape measure
 - builder's level
 - hand saw
 - sledge or maul hammer
 - claw hammer.
- 1 Watch carefully as your teacher demonstrates the steps outlined in the section called 'How to do a building profile layout' on page 65.
 - 2 In groups of five, using the same house plan and the steps above, **erect** its profile. In your groups, report to your teacher after you finish with each step. Your teacher should check your work before you **proceed** to the next step.
 - 3 What is a building profile?
 - 4 What is a building foundation?
 - 5 Copy the table in your exercise book and complete it.

	Yes	No	If no, explain why
1 Are the two diagonals equal in length?			
2 Do I know the uses of the following tools? <ul style="list-style-type: none"> • line level • builder's tape measure • builder's level • hand saw • sledge or maul hammer • claw hammer 			
3 Do I know when the tools above are used in erecting a profile?			
4 Is the profile line level throughout—that is, between the different pegs?			

Our profile could be improved by:



Setting out for a concrete slab foundation

It is not difficult to set out a site for a **concrete slab foundation**. The principles are the same as for the raised floor foundation. However, there may be a few differences in terms of the number of profiles to be erected, the ways in which lines are stretched and the use of **continuous trenches** instead of holes. **Legal requirements** must be met, as problems may be caused at a later stage if you ignore them. Figure 4.15 shows a setting up of a concrete slab foundation. Note that the 10 mm rods are cut off at corners and wall joints. Make sure that the ends of the 10 mm rods do not touch the walls of the trench.

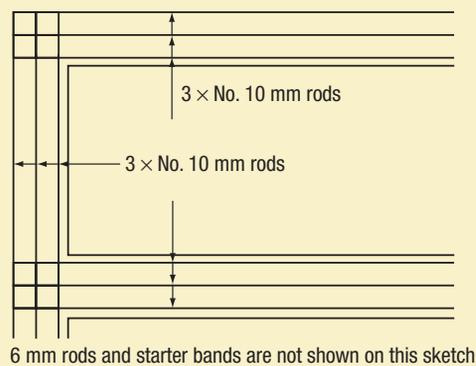


Figure 4.15 Setting out a concrete slab foundation

Figures 4.16 and 4.17 show the setting out in more detail.

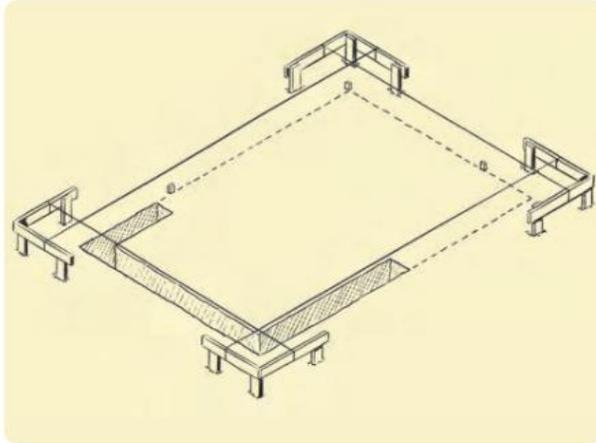


Figure 4.16 Digging of trenches should be along the datum lines.

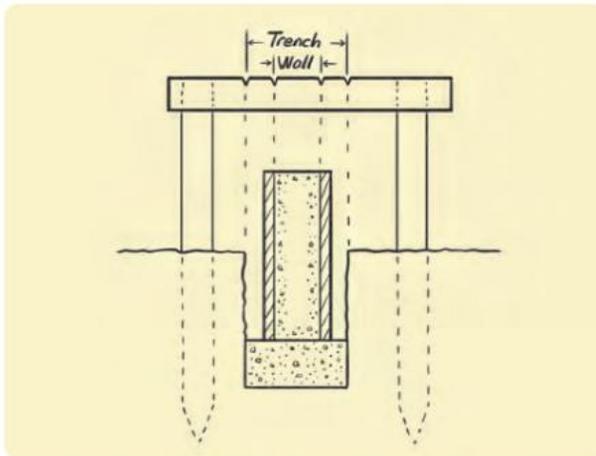


Figure 4.17 Position of trench and walls marked with V cuts

Activity 6: Setting up a concrete slab foundation

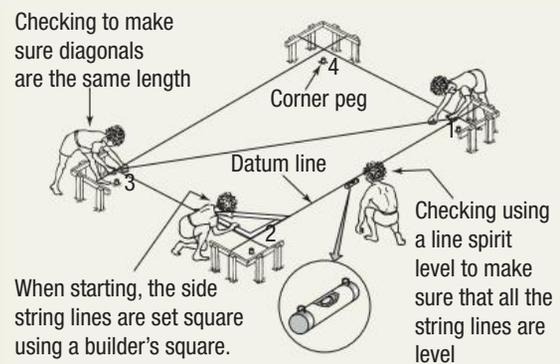
- 1 Study the section called 'Setting out for a concrete slab foundation' on page 68.
- 2 List the steps involved.
- 3 Compare the level of difficulty in setting out for a floor foundation with setting out for a concrete slab foundation. Share your ideas with the class.

Squaring corners of profile

All corners of a profile line must be squared—that is, 90° to each other. It is best to make a wooden square, called a builder's square. The square must be marked in the ratio of 3:4:5 or 1800:2400:3000. Your teacher will explain what this means.

Activity 7: Checking what you have learnt about building profiles

Study the following illustration of a group of workers setting up a building profile. Then answer the questions that follow.



- 1 How would you know that the profile above is squared? Write down one reason why the profile must be squared.
- 2 How would you know that the length and width of the profile are equal on both sides? Write down one reason why it is important that the length sides are equal and the width sides are also equal.

Factors affecting planning a new building

By the end of this topic, you should be able to:

7.4.1.2 identify and describe the natural factors to consider when planning a new building.

You have already learnt about and made a building profile. As you can see, a building profile is the initial stage of constructing a house. However, before a building is designed by an architect and constructed by builders, there are some important **factors** that should be taken into consideration. These factors will vary between countries and even within countries.

Activity 8: Finding out about planning a new building

- 1 In groups of five, list some of the things that you must consider when building a new house.
- 2 Interview an experienced builder about what they must consider before building a new house.
- 3 List ways in which the following three natural factors could influence house construction in Solomon Islands.
 - a climate
 - b cyclones
 - c earthquakesHow might you take these factors into account?
- 4 When building a house, consideration should be given to:
 - a land forms—that is, the shape of the land
 - b the position of the land, for example on top of a hill, beside the sea or a river
 - c the position of the house on the land
 - d the house design.

Imagine you were going to build a house in your village. Write a sentence describing how each of the above factors would affect the way you build the house.

Practical task

By the end of this practical task, you should be able to:

- 7.4.3.1 design and construct a building profile for a small bungalow that will address the increasing eco-tourism needs in the rural communities in Solomon Islands
- 7.4.4.1 mark and lay out a simple building profile for a new building
- 7.4.4.2 follow appropriate procedures to lay a building profile
- 7.4.4.3 mark out a new building profile properly
- 7.4.4.4 prepare a new construction site
- 7.4.4.5 mark out the footing for a new building on a profile
- 7.4.5.1 use appropriate tools and materials to lay out a new simple building profile
- 7.4.6.1 discuss the importance of design factors when planning a new building in Solomon Islands.

Go back and read the design problem at the beginning of this chapter. You are going to solve that problem.

Design problem: Building profile

Design expectations

In doing this task, you are expected to help the agriculture teacher by setting up a new profile for her storage house. Your teacher will give you more details about this. The following must be considered in the development of the profile:

- The profile should have four profile boards and profile lines.
- The profile lines must be level.
- The corners of the profile must be square.

Investigating

- Decide how the site should be cleared and the level for the new profile.

- Work out the steps required to set out the profile.
- List the tools and materials you will use in each step.
- Decide on the size of your setting out.
- Work out how to transfer house plans into profile.
- List the factors you must consider before setting out a new profile.

Designing

- Write a short design brief for the design problem.
- Draw up a simple weekly plan with regard to the steps to take until a profile is erected.

Making your profile

- Clear the site on which you will erect your new profile.
- Mark out the position and size of the house as shown in Figure 4.18, using your house plan.

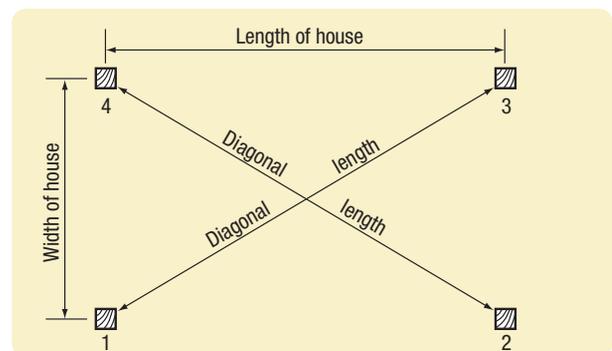


Figure 4.18 Plans for the size and position of the house

The numbers 1, 2, 3 and 4 are the pegs. When placing Pegs 2, 3 and 4, check that the setting out is squared. Check also that the distances between the pegs are correct and the same as the distances given on the house plan.

Setting up profiles

- 1 Erect the corner profile boards approximately 600 millimetres clear of wall position. Make sure the profiles are the same height so that the setting out is level.

- 2 You are now ready for marking out the sizes so that lines can be stretched out as shown in Figure 4.19.

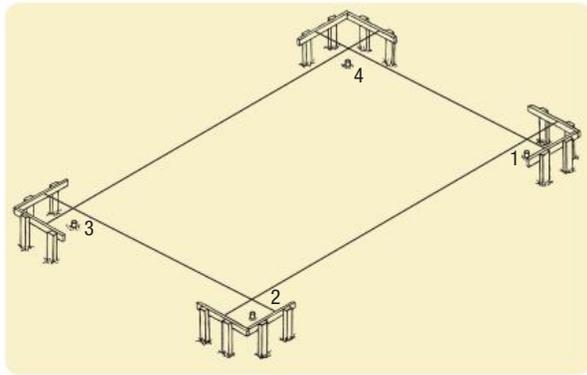


Figure 4.19 Setting out the profiles

Testing your setting out

- Is the setting out squared and level?
- Does the setting out **reflect** the house plan?
- Is there enough space to walk around the profile?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Is your profiling work done neatly and strongly?
- 2 Does your profiling work reflect what is given in the house plan?
- 3 How long did you spend on this setting out? Was it time-consuming? If yes, why?
- 4 Was the process costly? If yes, why?
- 5 Was this task difficult to carry out? If yes, why?
- 6 Was there any way you could improve this task?
- 7 How would you make another setting out if you were asked to do another one?
- 8 Choose the best of the profiles that all the groups have constructed. Write down three reasons for your choice.

Communicating and marketing

- 1 How would you **communicate** the **importance** of the skills you have learnt from this chapter to a person who needs to build a permanent house?
- 2 How would you communicate the importance of a **career** in house construction to your **classmates**?

New words used in this chapter

beautification	making look good	legal	laws or rules to be followed
career	long-term job or occupation	requirements	
classmates	those whom you are in class with	permanent house	house built from modern materials
communicate	tell others about something	plumb bob	instrument used by builders to find right angle line
concrete slab foundation	concrete floor of a building	proceed	move on
continuous trenches	long shallow holes dug in the soil	reflect	show
erect	put up, construct	site	place or land
factors	important points to be considered	state	point out
foundation	base of a building	task	job, activity
identify	find, make out	topsoil	first layer of soil or ground
imagine	see or create in your mind		
importance	value, meaning		

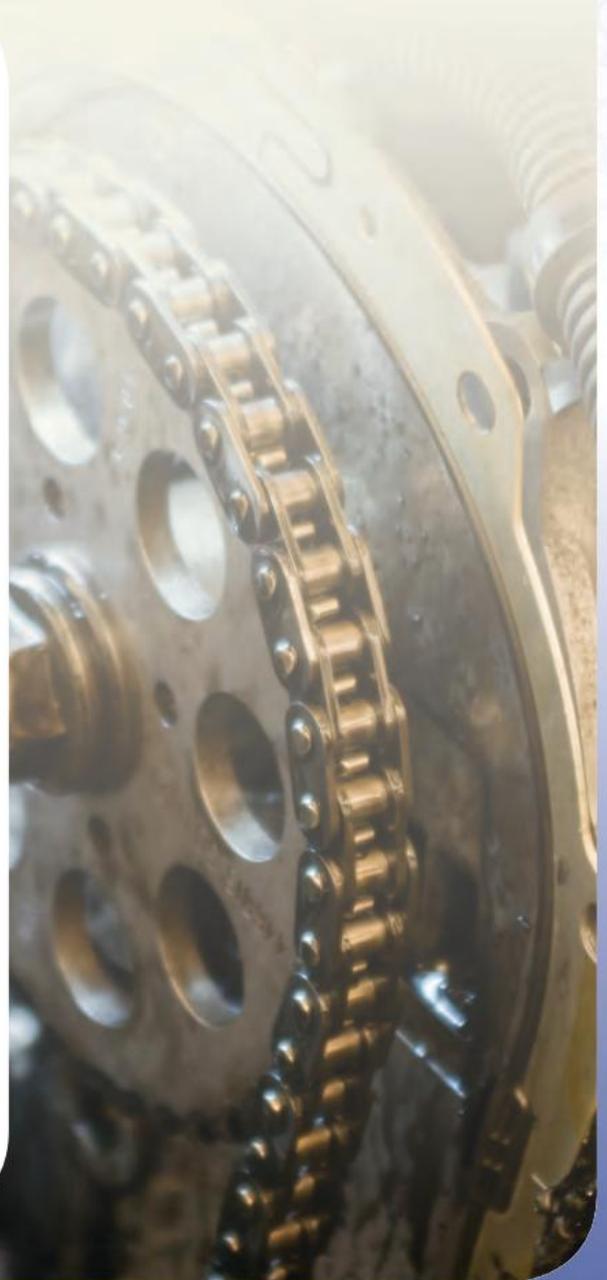
Chapter 5

Small engines

Learning outcomes

By the end of this chapter, you should be able to:

- 7.5.1.1** write an energy conversion statement to summarize the principles of combustion in an engine
- 7.5.2.1** explain that the internal combustion in a small engine is an I-P-O system
- 7.5.3.1** draw a diagram to show what a cylinder, piston, rod and shaft look like
- 7.5.3.2** compare the piston up-and-down stroke to the circular movement of the shaft
- 7.5.3.3** state, in the correct sequence, what happens during the operation of a two-stroke engine
- 7.5.4.1** list four essential sub-systems of the two-stroke engine
- 7.5.5.1** show that moving a force through a distance causes work to be done
- 7.5.6.1** appreciate that engine cylinders of different sizes have different powers
- 7.5.7.1** use the design process to make a model engine to solve a technology problem
- 7.5.7.2** use your senses to check if an engine is running normally
- 7.5.8.1** label correctly the parts of an engine, including the ports and piston plug
- 7.5.8.2** draw a simple diagram to illustrate that a two-stroke engine makes one turn of the shaft
- 7.5.8.3** make a simple model to illustrate the two main components of an internal combustion engine
- 7.5.9.1** discuss the benefits of small engines in your community.



Introduction

In this chapter you will learn about small engines. Engines are machines that do useful work. Figure 5.1 shows various engines at work.



Figure 5.1 Types of engines

As you can see, engines may be found in big and small machines. They are used in outboard motors, lawnmowers, grass cutters, chainsaws, ships, airplanes and many other machines. The small engines shown in Figure 5.1 have a range of parts that work together. These parts are called **sub-systems**. All the machines shown use two-stroke engines. In this chapter you will learn about some of the main parts of a two-stroke engine and how they work.

Design problem: Small engine model

Betty is a new Technology teacher. She is trying to explain how a small engine works; as a Technology teacher, she needs to make a simple **model** machine using local materials so that that she can use it for her teaching. At the end of this chapter, you will help solve Betty's problem.

Materials used in this chapter

- Balloons
- Bicycle
- Bottle
- Bowl
- Cardboard cylinder (for example a toilet roll core)
- Circular piece of thick cardboard
- Drawing pin (thumb tack)
- Piece of flat wood
- Safety pin
- Small hook
- Small nail
- Tape or a rubber band
- Wooden stick with the same diameter as the cardboard cylinder

What is a small engine?

By the end of this topic, you should be able to:

7.5.2.1 explain that the internal combustion in a small engine is an I-P-O system.

An engine is a machine that carries out a series of energy conversions. It is an energy-conversion system with an *input*, a *process*, and an *output*.

The input is the fuel—chemical potential energy. This is a chemical such as petrol which has the potential or ability to produce **energy**.

The output is the movement—movement energy.

The process is the burning of the fuel—combustion.

The output is the movement energy that does the work.

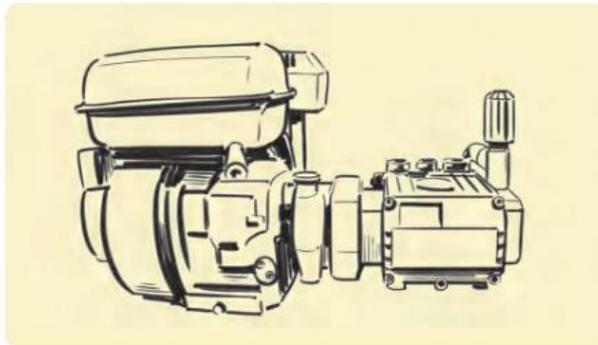


Figure 5.2 Two-stroke engine attached to small pump

Figure 5.2 shows a simple engine on a platform. This engine drives a small water pump. The pump pushes water through a hose at high speed. The work done is ‘pushing water’.

Some engines are simple. Others are very **complicated**. Some **generate** large amounts of energy. Others generate small amounts of energy.

Small engines drive such things as chainsaws, small motor bikes, outboard motors, grass cutters, concrete mixers and small electricity generators.



Figure 5.3 Lawnmower



Figure 5.4 Grass trimmer



Figure 5.5 Small motor bike

How does a small engine work?

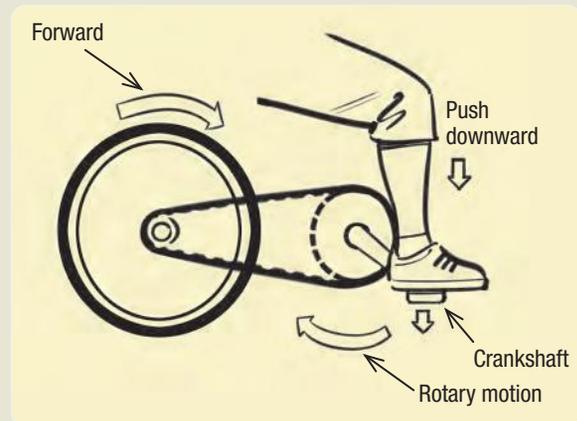
By the end of this topic, you should be able to:

- 7.5.1.1 write an energy conversion statement to **summarize** the **principles** of combustion in an engine
- 7.5.3.1 draw a diagram to show what a cylinder, piston, rod and shaft look like
- 7.5.3.2 compare the piston up-and-down stroke to the circular movement of the shaft
- 7.5.8.3 make a simple model to illustrate the two main **components** of an internal combustion engine.

Activity 1: Finding out what a bicycle does

- 1 Arrange for two people to hold the **rear wheel** of a bicycle off the ground.

One small person sits on the **saddle** and pushes downwards on one **pedal** with one leg, like this:



- 2 Describe everything that happens. What does the leg do? What does the pedal do? What does the chain wheel do? What does the chain do? What does the rear wheel do? The illustration will help you with the answers.

To understand what an engine does, look at what a bicycle does.

- The downward **force** of the leg pushes on the pedal.
- The pedal turns the lever. The lever is the steel arm attached to the pedal.
- The lever turns the chain wheel.
- The chain wheel moves the chain.
- The chain drives the rear wheel of the bicycle.

Figure 5.6 shows the series of energy changes involved in pedalling the bike. Start with the person on the saddle. The person's body gives the energy. What kind of energy does a person's body have? There are four types of energy.

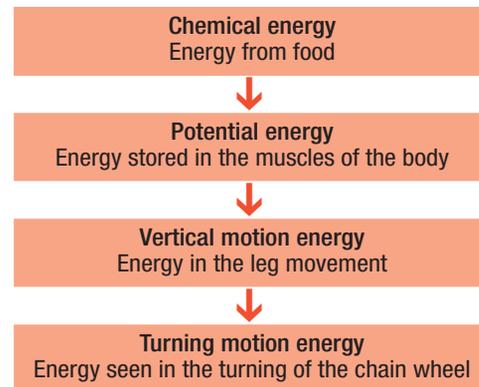


Figure 5.6 Four types of energy

The pedal lever changes the vertical motion energy of the leg to the turning motion of the chain wheel. This is the key concept of the bike.

Imagine that we can replace the leg on the bike with an engine. Look at Figure 5.7. This is the bike again, but there is a machine doing the work—not a person. The connecting rod replaces the person's leg. The steel **shaft** links to the connecting rod by a bolt, instead of a pedal.

Instead of a person's leg, a machine provides the energy to push the pedal downwards.

This is the idea of the fuel-burning engine. It converts the energy of the fuel to downward motion. Special connecting bars change the downward motion to **circular motion**.

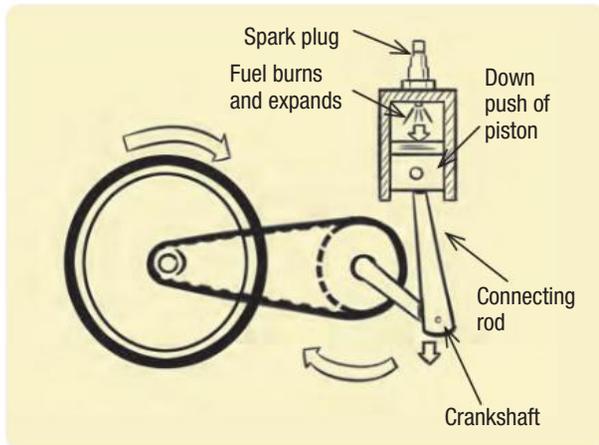


Figure 5.7 A fuel-burning engine. The actions shown in this illustration are the same as the actions of the person on the bike.

Where does the energy come from? In the steel container, fuel **explodes** and causes hot gases to expand. The expanding hot gases force the piston downwards, in the same way as a cyclist's leg does. The piston pushes the connecting rod downwards. The chain wheel then turns.

This is exactly what happens in an engine. Hot gases expand, and push the piston.

To clarify how expanding gases work, do this simple activity.

Activity 2: Finding out how hot air works

You will need:

- balloons
- bottle
- container for bottle.

- 1 Stretch a balloon over the neck of a bottle. Observe the balloon.
- 2 Pour some boiling water into a container.
- 3 Set the bottle with balloon into the boiling water. Hold it upright.
- 4 Observe the balloon for a couple of minutes. What happens?

5 Figures 5.8 and 5.9 show the 'before' and 'after' situations. Describe what has happened to the balloon. What is inside the bottle and balloon?

6 Why has this happened?



Figure 5.8 Bottle with balloon

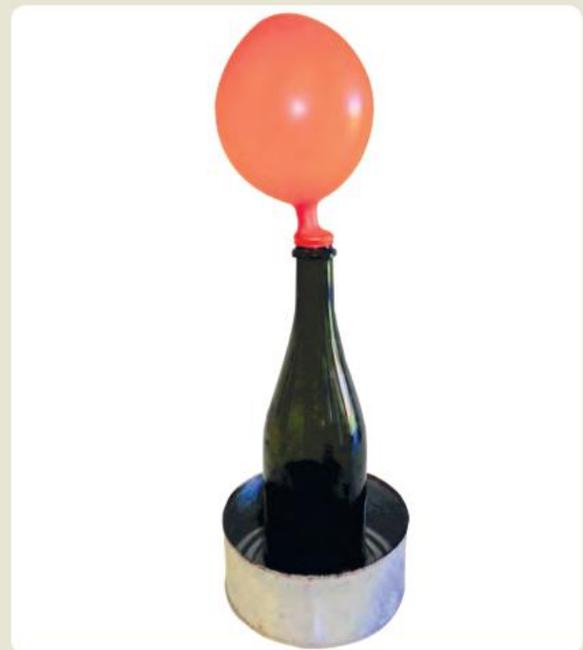


Figure 5.9 Bottle with balloon, in a bowl of boiling water

This simple investigation shows what happens when the air inside the bottle is heated. Air is a gas. The gas expands. It takes up more volume. So it expands to fill the balloon. It pushes against the balloon. The balloon stretches.

The energy to stretch the balloon comes from the expanding air. The expanding air does work. This is similar to what happens in an engine. In the engine, explosions in the steel container make gases expand.

The engine produces the energy by burning fuel and air inside a steel container. When the fuel burns, it explodes. The **explosion** makes the gases expand. The force pushes a piston downwards inside the container.

The piston is attached to a rod. The rod connects to a crankshaft, which turns. The rod moves up and down, and keeps the shaft turning.

Figure 5.10 shows the piston pushing down as it turns the crankshaft.

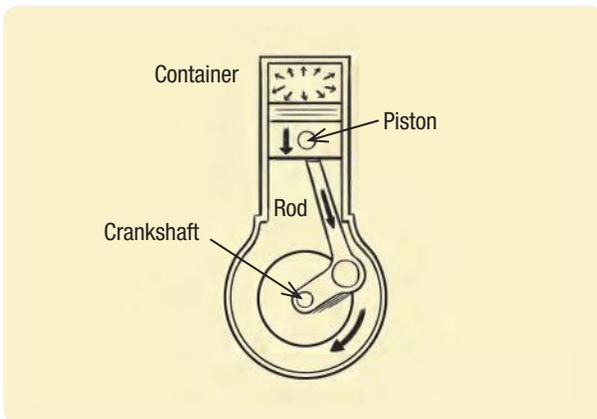


Figure 5.10 A crankshaft and a piston

To understand this idea, make a model of the container, piston rod and crankshaft.

Activity 3: Making a model machine



Figure 5.11 A model engine

You will need:

- piece of flat wood
- cardboard cylinder (for example a toilet roll core)
- wooden stick with the same diameter as the cardboard cylinder
- circular piece of thick cardboard
- small hook
- drawing pin (thumb tack)
- safety pin
- small nail
- tape or a rubber band.

- 1 Connect all the pieces together, as shown in Figure 5.11. The small hook screws into the end of the stick, and the safety pin connects to the hook. The other end of the safety pin connects to the nail, which sticks through the piece of cardboard, near the edge.
- 2 Support the cardboard cylinder on the piece of wood with the tape (or rubber band). Stick the cardboard circle to the wood with the drawing pin.
- 3 Put all the pieces together, so that the wooden stick is inside the cardboard cylinder. The cardboard cylinder models the steel container of the engine. The stick is the piston. The safety pin is the connecting rod. The cardboard circle is the shaft.
- 4 Hold the model vertically. Push downwards on the stick in the cylinder.

- 5 What happens to the stick (the piston)?
- 6 What happens to the safety pin?
- 7 What happens to the circular piece of cardboard.

The important thing about this model is that it shows how the vertical or upward and downward motion of the piston and the connecting rod change to the circular motion of the shaft.

This is what the engine is all about—changing vertical or upward and downward motion to circular or turning motion.

An engine is designed to make sure that the process of changing one motion to another is continuous. The shaft must turn all the time. Think about the bike again. It takes two legs to keep the chain wheel turning. One leg pushes downward. The other one rises up to get ready to push again.

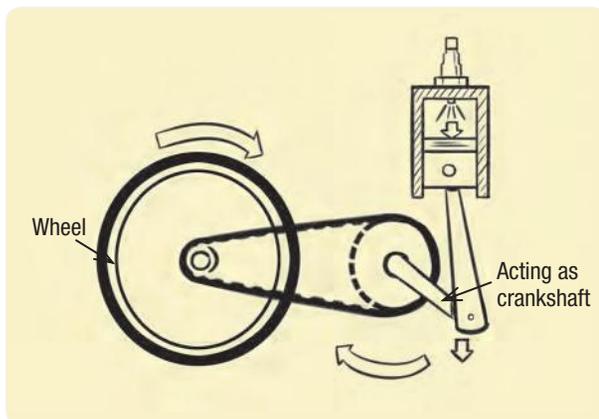


Figure 5.12 A rotating crankshaft spinning the wheel

In an engine, the rotating shaft connects to the thing that needs the power for movement. This might be a wheel, a propeller, a pump or cutting blades.

The engine at work

By the end of this topic, you should be able to:

7.5.3.3 state, in the correct sequence, what happens during the operation of a two-stroke engine.

To get the energy for the movement of the connecting rod, an engine uses fuel. The fuel has chemical potential energy. The engine releases this energy by burning the fuel.

In an engine cylinder, a fuel reacts with oxygen from the air. This causes an explosion. The explosion makes hot gases and the gases expand. These explosions must continue. They must happen hundreds of time per minute so that the shaft keeps turning.

We call an engine like this an internal combustion engine. The process of the fuel burning is called combustion. So combustion is the burning process of fuel. The burning takes place inside the cylinder.

Look at Figure 5.13. This **sequence** of diagrams shows what happens inside the simplest kind of engine. One piston moves *down* and then *up* in one cylinder. This type of engine is called a two-stroke engine: *down* stroke, *up* stroke.

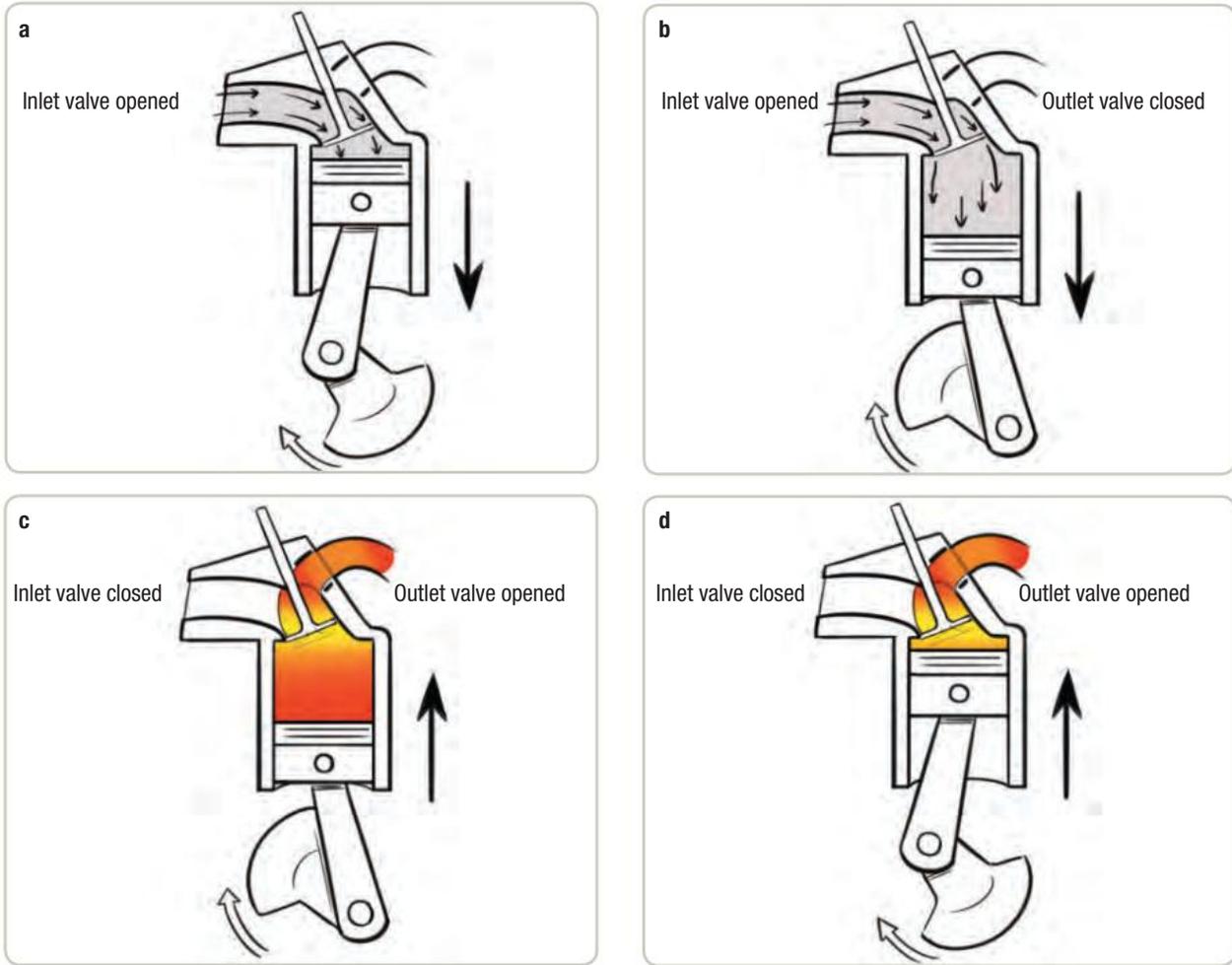


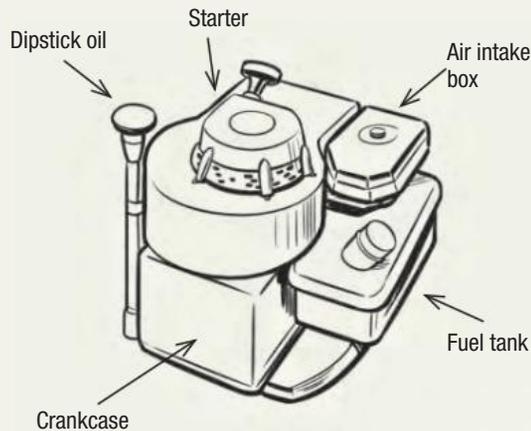
Figure 5.13 Strokes of the internal combustion of an engine



Figure 5.14 Piston starting another cycle of combustion

Activity 4: Finding out about engines

- 1 Find a real engine. Ask the operator to help you to identify the important parts of it. The following diagram will help you.
- 2 With the help of an engine operator, find the parts labelled on the following diagram.



The cylinder is inside the crankcase; the explosion happens inside the combustion chamber.

The fuel tank holds the fuel.

The air intake box sucks air into the cylinder.

The operator pulls the starter to start the engine.

Grass mowers and cutters, chainsaws and small outboard motor engines all have these parts.

Inside a two-stroke engine

By the end of this topic, you should be able to:

7.5.4.1 list four **essential** sub-systems of the two-stroke engine

7.5.8.1 label correctly the parts of an engine, including the ports and piston plug.

The various parts of the two-stroke engine make the explosions happen continuously in the steel cylinder.

Imagine that we cut through the engine shown in Activity 4. In that way, we can see inside, and look at the parts that do the work. Figure 5.15 shows the working parts. As you study this diagram, think of the person pushing the pedal of the bike. The idea is the same.

The two-stroke engine operates so that all these parts work together. The explosions inside are non-stop. The crankshaft keeps turning.

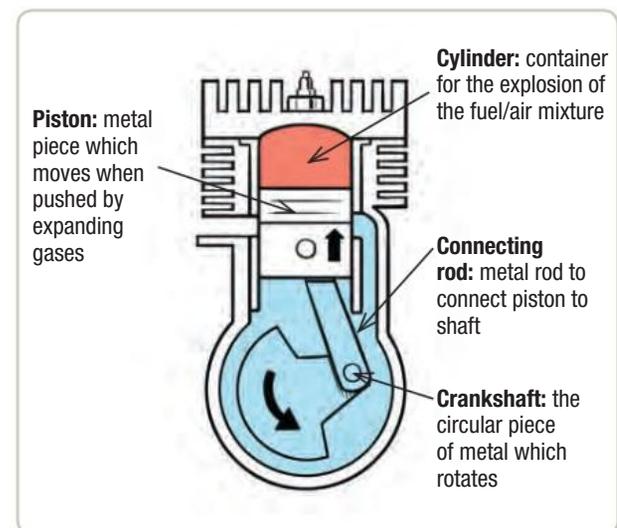


Figure 5.15 Working parts of a two-stroke engine

Activity 5: Identifying the parts of a two-stroke engine

- 1 Examine a two-stroke engine. Ask the operator to help you to identify the parts shown in Figure 5.15.
- 2 Ask the operator to start the engine.
 - a How does it start?
 - b What part of the engine is the starter?
- 3 All the parts are moving near each other. Ask the operator why the parts are not damaged when the engine runs.
 - c Where is the fuel?
 - d Where do the used gases come out?
 - e Why is there noise?

1 Ignition/power. All three ports are closed. In the cylinder, a spark ignites the fuel–air mixture. The mixture explodes. The expanding gases push the piston downwards. The crank turns. At the same time, a new volume of fuel–air mixture is being squeezed by the piston moving downwards. This compressed fuel–air mixture moves towards the transfer port.

2 Intake and 3 Exhaust. Exhaust and transfer ports are open. As the piston moves down, it opens the exhaust port and the transfer port. The fuel–air mixture rushes through the transfer port. This is the intake. It pushes the waste gases out through the exhaust port.

4 Compression. Exhaust and transfer ports are closed; intake port is open. The piston compresses the fuel–air mixture as it moves upwards. The mixture is ready for the next spark. New fuel–air mixture flows into the intake port.

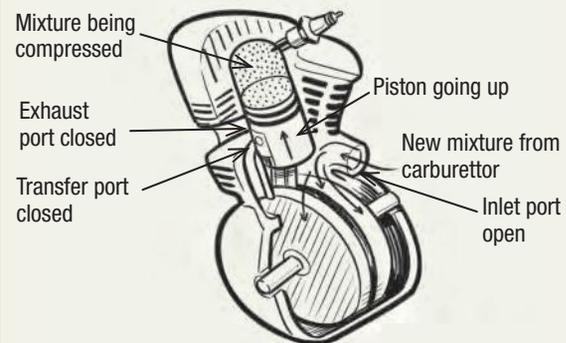
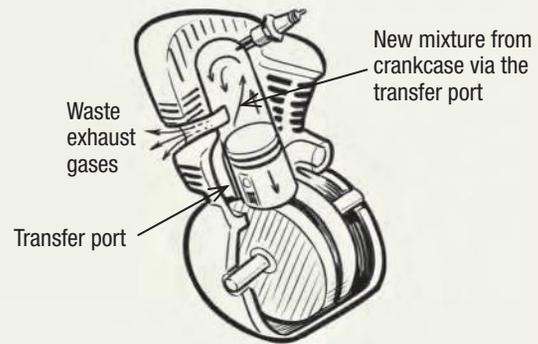
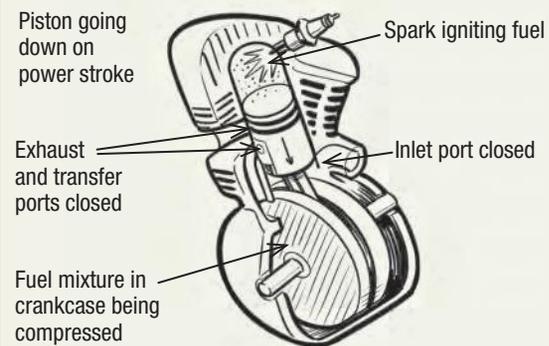


Figure 5.16 All the parts of an engine work smoothly together.

Use Figure 5.16 to help you understand how all the parts of an engine work smoothly together. The diagrams are realistic. They show an ‘opened-up’ engine.

Remember that the purpose of the engine is to make the process of changing one type of energy into another smooth and continuous.

Sometimes, people use ordinary words to describe the stages of this cycle, such as in Figure 5.17.

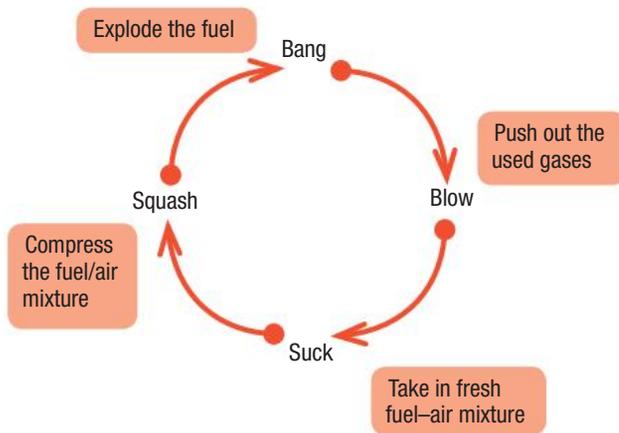


Figure 5.17 Two-stroke cycle. The downward movement of the piston, after the ‘bang’ is the power stroke.

Advantages of the two-stroke engine

At the end of this topic, you should be able to:

7.5.8.2 draw a simple diagram to illustrate that the two-stroke engine makes one turn of the shaft.

The advantages of the two-stroke engine are as follows:

- 1 The shaft turns once for every power stroke.

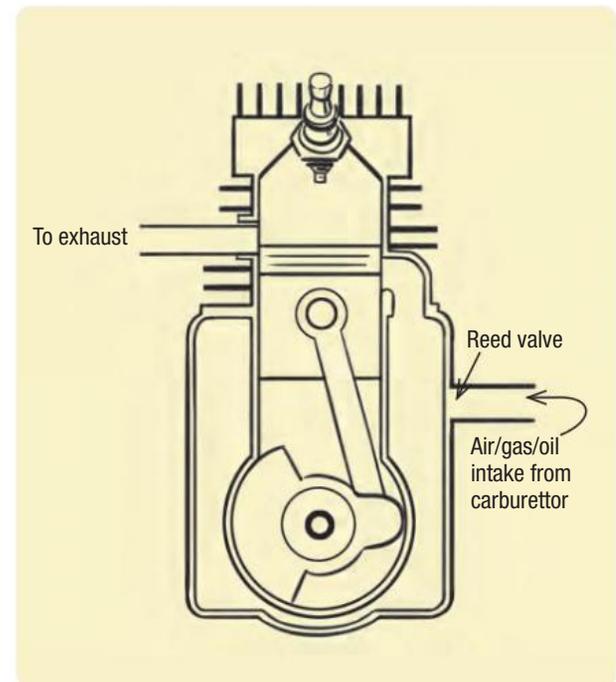


Figure 5.18 Power stroke of a two-stroke engine

- 2 It can work in any position—horizontal (for example grass cutter); vertical (for example outboard motor); at an angle (for example chainsaw)
- 3 The piston does three jobs at once—power, compression, exhaust and intake.

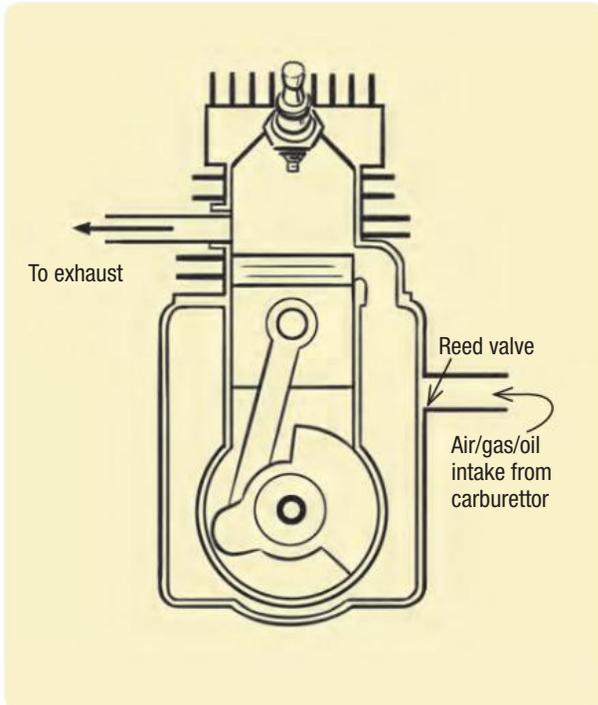


Figure 5.19 Compression stroke of a two-stroke engine

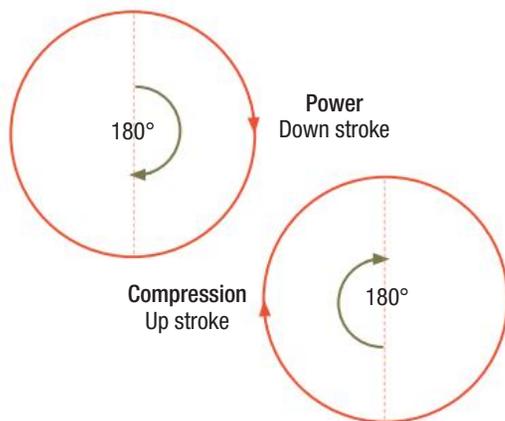


Figure 5.20 Two strokes for 360°

- 4 The oil for lubrication, or making things run smoothly, comes into the crankcase with the fuel.
- 5 It is small and light in weight.

The power of engines

By the end of this topic, you should be able to:

7.5.5.1 show that moving a force through a distance causes work to be done.

A piece of technology like an engine must do the job it is designed for efficiently. The two-stroke engine is simple and **efficient**. In technology language, we say that it has a good power-to-weight ratio. This means that it is able to do a lot of work for its size. To think about an engine in a technological way, you must understand the connection between work and power.

First, remember an important principle: work is done whenever we apply a force to an object and that object moves.

An object must move (that is, change position) for us to consider that work is done.

The lifter in Figure 5.21 is doing work. He is lifting the steel bar and balls. He moves them to a new position above his head. The change in height is two metres (2 m). The weight of the bar and balls is 100 kilograms force (100 kgf).

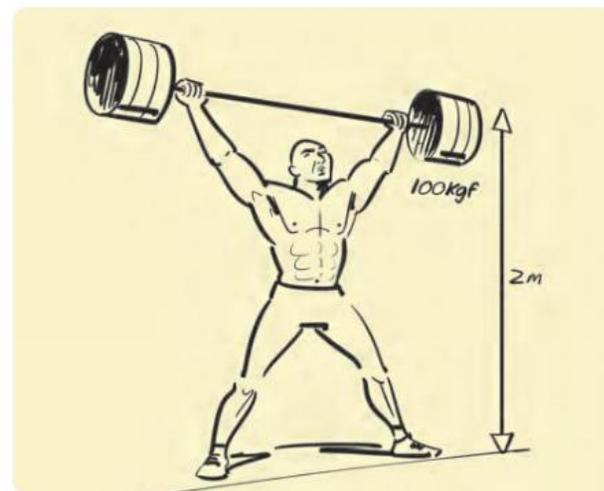


Figure 5.21 At sea level, a mass of 100 kg weighs 100 kgf (that is, **gravity** pulls it downward with a force of 100 kgf).

We apply a force.

An object moves a distance.

Work is done.

The lifter moves the 100 kgf through 2 metres.

The work he does is $2 \times 100 \text{ kgf.m}$; that is, 200 kgf.m.

The engine does work. We want an engine to do the work efficiently. We need to think about how fast it can do work. The engine's power gives the speed at which it can do work. The power of an engine is the work done in a specific period of time.

Think of the lifter above. He did 200 kgf.m of work. Suppose he took 4 seconds to do this. We can find out the lifter's power by dividing the work done by the time (in seconds). So, the lifter's power is $200 \text{ kgf.m} / (4 \text{ seconds})$; that is, 50 kgf.m each second.



Figure 5.22 A tall coconut tree

Consider the power of a boy who climbs a tall coconut tree in 20 seconds.

Boy's mass = 40 kg

Boy's weight = 40 kgf

Height of tree = 30 metres

Work done = force \times height

Work done by the boy = $40 \text{ kgf} \times 30 \text{ m}$
= 1200 kgf.m

The boy climbed the 30 metre tree in 20 seconds. So, the boy's power is 1200 kgf.m divided by 20 seconds. He can do 60 kgf.m of work in one second. This is the boy's power.

If another boy took 40 seconds to climb the same tree, he would have only half the power, that is 30 kgf.m in one second.

An engineer called James Watt developed the first unit of power in 1750. He was working with horses in a coalmine. He called this unit a horsepower. The power of some engines is still marked in horsepower. The modern unit of power is the watt, named after James Watt, the engineer.

Capacity of engines

At the end of this topic, you should be able to:

7.5.6.1 appreciate that engines of different cylinder sizes have different powers.

Usually, the bigger the cylinder of an engine, the more power it has. The amount of space in the cylinder is the space for the burning of the fuel. The amount of space in any container is its **capacity**.

The capacity of the cylinder depends on how wide the cylinder is. This is its diameter. It also depends on how far the piston goes down in the cylinder.

Look at the fuel intake position of the two-stroke engine, shown in Figure 5.23.

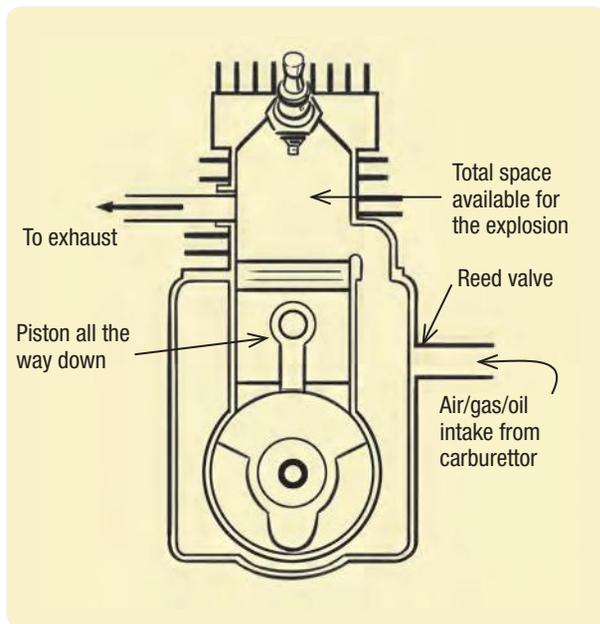


Figure 5.23 Fuel intake position of a two-stroke engine

The capacity of an engine is given in cubic centimetres (cc) or litres (L):

- A small grass cutter or chainsaw has a capacity of 30 cc.
- A small outboard motor has a capacity of 60 cc.
- A small car engine has a capacity of 1000 cc (1 litre).
- A can of soft drink. It has a capacity of 330 cc.

Figure 5.24 show the actual capacity of cylinders of 30 cc and 60 cc.

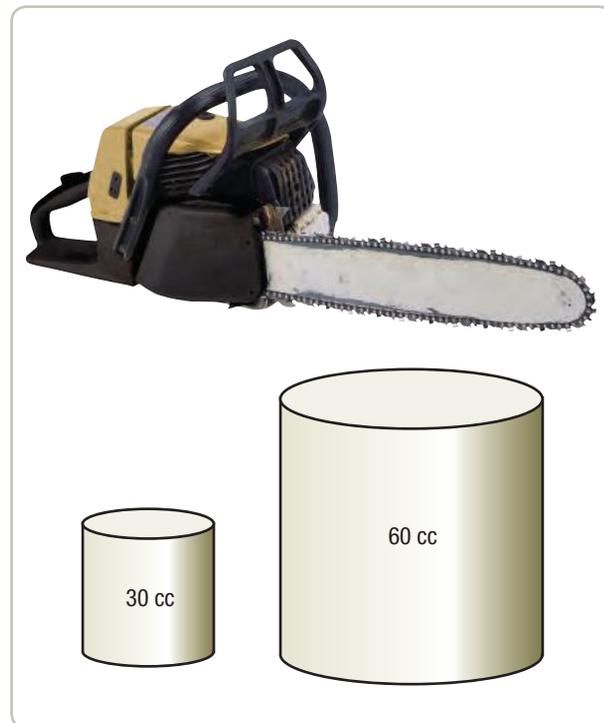


Figure 5.24 This small chainsaw has a cylinder capacity of 30 cc. It has a power of 1 HP. A small outboard engine may have a cylinder capacity of 60 cc. It has a power of 2 HP.

Activity 6: Finding out about engines



- 1 Find some small engines.
 - a Ask the operators to help you find the label that describes their power. Do the labels give the power in horsepower (HP) or in watts?
 - b List some of the power labels you find. For example, a large outboard motor shows a power of 40 HP. The engine capacity would be about 1200 cc (that is, 1.2 L).
- 2 Think about a 40 HP outboard motor and a 25 HP engine driving a canoe through the water. What do you notice?

Looking after engines

By the end of this topic, you should be able to:

7.5.4.1 list four essential sub-systems of the two-stroke engine.

You have learnt how an engine works. If you own an engine, you need to make sure it runs well.

You learnt that the explosions inside the cylinder generate lots of heat. This means there must be a way of cooling the engine as it runs—a cooling system.

The metal parts move against each other as the engine runs. So, there has to be a way of lubricating these parts, or preventing them from rubbing them against each other. Normally, oil is used on each part so they do not rub against each other.

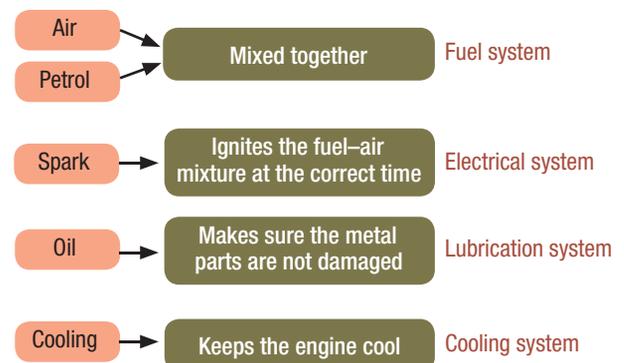
There must be a way of lighting the fuel and air mixture in the cylinder. So, the engine needs a system to make a spark in the cylinder—an electrical system.

The engine needs a **constant** supply of fuel to the cylinder. So, there has to be a fuel supply system.

Look at the summary in Figure 5.25.

Figure 5.25 The four sub-systems of an engine

For an engine to start up, and run properly, there must be:



If any one of these systems does not work well, the engine will run poorly. It might break down—or it may not start at all. If you look after the systems, the engine, will:

- start and run better
- give more power
- use less fuel
- keep going
- last longer.

These systems need servicing at regular times. This is called engine maintenance.

Before looking at maintenance rules, remind yourself about some of the parts that need maintenance. Figures 5.26 and 5.27 show some parts of an engine. Figure 5.26 shows an engine in one piece; Figure 5.27 shows some of the parts inside an engine.

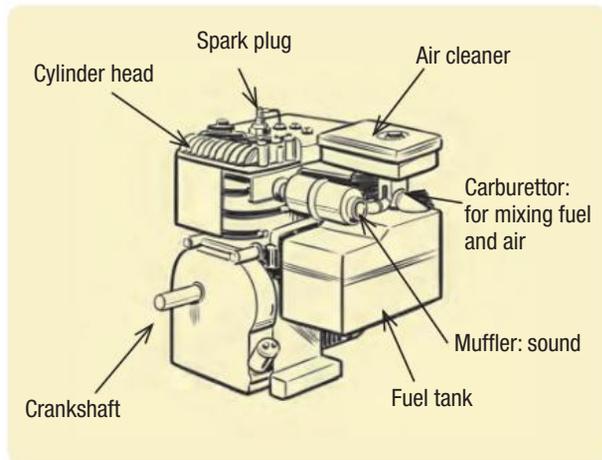


Figure 5.26 A four-stroke engine

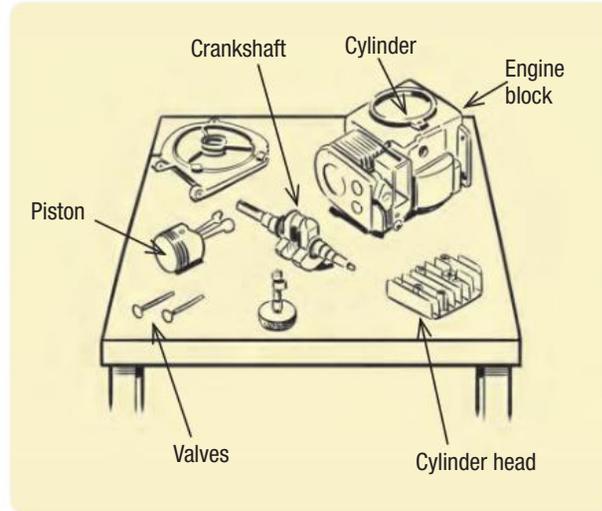


Figure 5.27 The parts of a two-stroke engine

Try to identify the parts shown above in Figure 5.28.



Figure 5.28 A two-stroke engine

Engine condition checks

Any person can do these general checks on an engine. These checks can tell you a lot about an engine. They can help you to describe to a **mechanic** what is wrong.

Look

- Search for any oil or fuel leaks. Where are they coming from?
- Search for anything broken.
- Check if the engine is still running.
- Check if there is more smoke than usual from the exhaust. If the smoke is blue, there is too much lubricating oil. If the smoke is black, the fuel mixture is too rich.

Smell

- Does something smell as if it is too hot?
- Is oil burning?

Listen

- Check for unusual noises—are there unusual noises inside the engine, or in the system that the engine is driving (in the propeller, pump, cutters, or blades)?

Feel

- Is anything hotter than it should be?
- Is the engine shaking or vibrating more than normal?

Activity 7: Checking what you have learnt about two-stroke engines

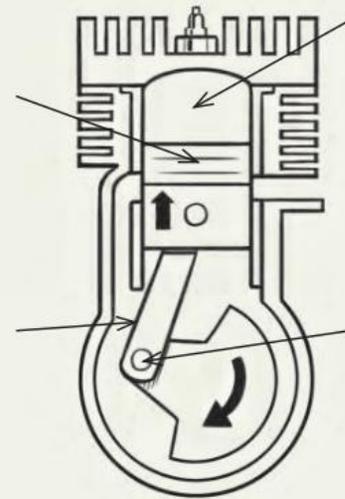
The following diagram shows the inside of a two-stroke engine. The parts of the engine are labelled with arrows. The list below shows the label titles. Study the diagram and draw a simple version of it, correctly labelled, in your exercise book.

Piston

Connecting rod

Crankshaft

Cylinder



Practical task

By the end of this practical task, you should be able to:

7.5.7.1 use the design process to make a model engine to solve a technology problem

7.5.9.1 discuss the benefits of small engines in your community.

Go back and read the design problem at the beginning of this chapter. You are going to solve that design problem.

Design problem: Small engine model

Design expectation

The following must be considered in the development of the engine model:

- The model machine must be laid down on a flat piece of timber.
- You must label the parts of the model engine.
- The functions of each of the labelled parts must be written underneath each label.

Investigating

- Ask a mechanic to explain how the two-stroke cycle occurs in a small engine.
- Find out what materials you will use to use construct your model machine.

Designing

- Sketch a 3-D drawing of the model machine and show where you want to place each component.

Making your model machine

- Build the model machine, based on your 3-D sketch drawing.
- Connect the different parts in the model.

Testing your model machine

- Have you labelled the parts of the model machine?
- Have you explained the work of the different parts on the model machine?
- Have you indicated on the model machine how the sub-systems are connected?

Evaluating your model machine

Answer the following questions in your exercise book.

- 1 What did you do to build your model machine?
- 2 Is the structure of the model machine strong and neat?
- 3 How did you decide to position the different parts of the model machine?
- 4 What have you learnt from the model machines built by others in your class?
- 5 Is there any way in which you think you could improve your model machine?

Communicating and marketing

- 1 How would you communicate the importance of the skills you have learnt from this chapter to people who have small engines that are not working?
- 2 How would you communicate the usefulness of becoming a mechanic to your classmates?

New words used in this chapter

capacity	volume, contents
circular motion	moving in a circle
complicated	not easy, hard
components	parts
constant	continuous, same
efficient	well organized or not wasteful
energy	inner power to move or make actions
essential	necessary, important
explodes	blows up or bursts
explosion	bursting with a loud noise
force	power, strength
generate	produce
gravity	force that the Earth exerts on objects near its surface
mechanic	person who fixes engines
model	representation, or a small 'look-like' image
motion	movement
pedal	part of a bicycle on which you place your legs to rotate the wheels
principles	main ideas
rear wheel	back wheel
saddle	place to sit on a bicycle
sequence	progressive steps
shaft	rod that provides power for a machine
sub-system	related arrangement in the parts of an engine
summarize	list the main points

Chapter 6

Coconut products

Learning outcomes

By the end of this chapter, you should be able to:

- 7.6.1.1** describe the different parts of coconut husk fibre
- 7.6.2.1** explain how different products are made from coconut husks
- 7.6.3.1** explain the working processes of making a coconut husk product
- 7.6.4.1** explain how tools are used in the working processes of making a coconut husk product
- 7.6.5.1** design and make a coconut husk product to address the need for locally made products to meet domestic and industrial needs in Solomon Islands
- 7.6.5.2** make one of the following products: a coconut husk broom, a coconut husk board duster, or similar product
- 7.6.6.1** use the correct procedures for making a coconut husk product
- 7.6.6.2** use the correct method to apply an appropriate finish on a coconut husk product
- 7.6.7.1** use tools correctly when marking, cutting and applying finish on a coconut husk product
- 7.6.8.1** discuss the benefits of using coconut husk as an improvised material in your community.



Introduction

In this chapter, you are going to look at coconut husks as a potential natural material for making products.

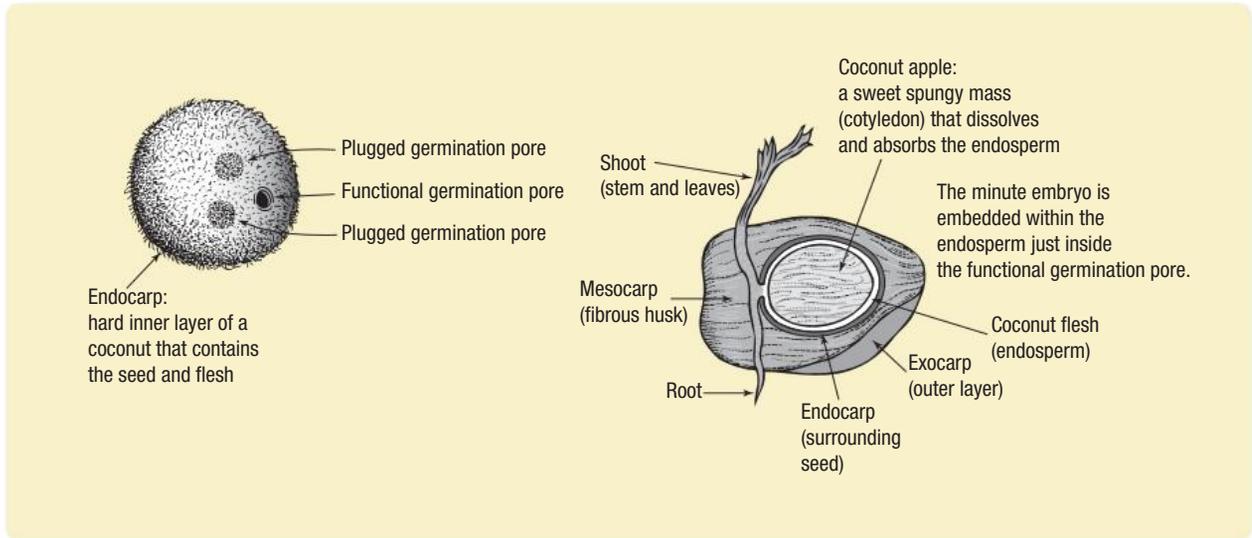


Figure 6.1 Parts of a coconut fruit

Coconut husk is the outside part of the coconut fruit. It covers the inner shell, which holds the coconut flesh and water. A coconut can be found on a coconut tree.

Although coconut husk is found everywhere in Solomon Islands, it is not used for making products as **frequently** as it is in other countries.

Coconut husk is used for many things.



Figure 6.2 The husk of a coconut can be used for many purposes.

Activity 1: Using coconut husks

- 1 Look for a coconut somewhere in your school or bring some from home. Draw a diagram of the coconut in your exercise book. Identify the main parts, including the husk, and name each part.
- 2 Write down three uses of coconut husk in Solomon Islands.
- 3 Suggest at least three things you can make from coconut husk to solve some of your needs at school or home.
- 4 Suggest which of these you could sell to make money.

Each of the three design problems given below involves making something from coconut husks. Read through them and then chose one that you would like to find a solution for. Discuss with your teacher how you are going to solve the design problem that you have selected. At the end of this chapter, you will be given series of steps which will help you solve the design problem of your choice.

Design problem 1: Floor broom

All Solomon Islanders use some kind of broom to clean their houses. While some people get their brooms from shops, others make their own brooms from local materials. A broom is a useful **household product** and is used mainly for maintaining cleanliness, which promotes a healthy lifestyle at home. In Solomon Islands, people made brooms from a range of local materials, including coconut husk. At the end of this chapter you will be able to make a broom using coconut bristles which come from coconut husk. You will learn the knowledge and skills required for making this product.

Design problem 2: Blackboard duster

Most of the time, school cleaners use paper and other materials to clean the blackboard instead of a proper blackboard duster. This makes some irregularities on the surface of the blackboard. When the teacher writes on the board with chalk, she experiences some difficulties. She always complains about her experiences with the blackboard. You are going to help her solve this problem using coconut husks.

Design problem 3: Door mat

Solomon Islands is situated in the tropics and has a **maritime tropical climate**, with heavy rainfall. Therefore, keeping a house free from dirt and dust is quite a difficult task for most home owners in Solomon Islands. This problem can be reduced by having a good door mat placed in front of the doorway. You are going to solve this problem by making a door mat from coconut husk, as modern door mats are hard to get and very expensive.

Tools and equipment used in this chapter

Wooden mallet

Materials used in this chapter

Coconut husk

Parts of the coconut husk

By the end of this topic, you should be able to:

7.6.1.1 describe the different parts of coconut husk fibre.

Activity 2: Looking at the coconut husk structure

- 1 Look for a piece of coconut husk, and bring it to the class.
- 2 Draw your piece of husk in your exercise book. It has three different parts: hard-skin fibre, soft-skin fibre and coconut husk dust. Write these names on your drawing.

Working with coconut husk

By the end of this topic, you should be able to:

7.6.3.1 explain the working processes of making a coconut husk product

7.6.4.1 explain how tools are used in the working processes of making a coconut husk product.

There are a number of steps involved in making a product from coconut husk. However, not all steps will be discussed in this chapter—other steps are described in other chapters, such as those on timber and metal. To use a coconut husk, you need to:

- 1 de-husk the dried coconut fruit
- 2 **soak** the coconut husk in water
- 3 extract the fibres from the coconut husk.

De-husking



Figure 6.3 White and brown coir fibres

De-husking is the process of removing the coconut husk from the coconut shell. Brown coir fibre is extracted, or taken, from fully **matured coconut** ready to be processed into copra. White coir fibre is extracted from immature (or green) coconut.

In Solomon Islands, there are different methods of de-husking. The most common is to separate the husk from the coconut shell with a sharp tool.



Figure 6.4 De-husking a coconut

Soaking the coconut husk in water

The process of softening the husk is called retting.

Brown coir fibre

The fibrous husk of the coconut is soaked in water for some time.



Figure 6.5 Brown coconut husk being soaked in salt water

Normally, the coconut husk is wrapped in cloth before it is soaked, so that the whole coconut husk swells and is softened. The long fibres inside the coconut husk are then separated from the mattress fibres underneath the outer skin of the coconut husk. The mattress fibres are sifted to remove dirt and other rubbish. These fibres are dried in the sun for some time. When most of the water is removed from the fibres, it can be packed in bales. Some mattress fibre may retain some of its moisture so that it can be twisted easily.

White coir fibre

The white fibre is placed in a container filled with either fresh water or seawater for at least ten months. During these months the immature coconut husk will break down and the outer part of the husk will loosen easily.

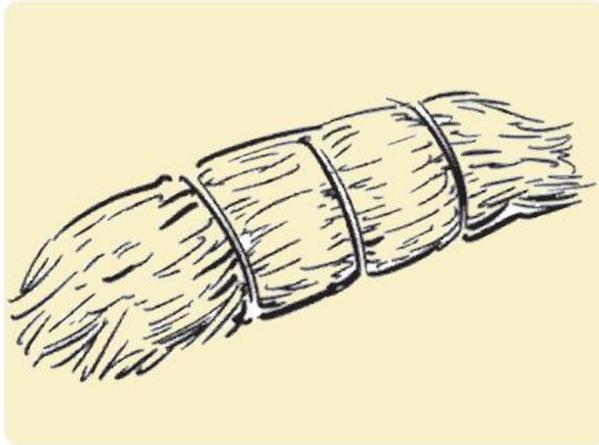


Figure 6.6 Retting of white coconut fibre

Beating and twisting process

Twisting of the loosened fibres after retting is done by hand or machine in order to make a fine, dried and long fibre, called a coir fibre. When a number of coir fibres are put together and twisted, a type of rope is produced. The longer bristle fibre is washed in clean water and then dried before being tied together in bundles or hunks. A steel comb can be used to straighten the long fibres and remove the shorter ones. To obtain white fibre, coir bristle fibre can also be put in snow-white bleach and left to dry.

With white fibre, **segments** of the husks are beaten by hand to separate out the long fibres that have been dried and cleaned. Clean fibres are ready for spinning into yarn using a simple one-handed system or a spinning wheel.

Activity 3: Working with coconut husk fibre

You will need:

- brown coconut husk
- container for husk
- wooden mallet.

Listen to your teacher for other instructions before you do this activity.

- 1 Read the previous section.
- 2 In groups, soak a piece of brown coconut husk in a container of water for two weeks.
- 3 As a group, observe what happens to the coconut husk daily. You should keep a record of your observations.
- 4 Take the soaked coconut husk out from the water and beat it with a wooden mallet. You should get fibres easily as you beat. What are these fibres called?
- 5 What useful product could you make from the coconut husk collected after the soaking process?
- 6 Look around your class or school and suggest any product for which you could use coconut bristle instead.
- 7 Copy and complete the following table in your exercise book.

	Yes	No	If no, why not?
1 Did we soak our coconut husk in water?			
2 Was the amount of time we soaked our husk enough to soften the whole coconut husk?			
3 Did we manage to obtain coconut bristle?			
4 Can we make a product from this coconut bristle?			

Can the quality of the coconut bristle be improved? If yes, explain how.



The following activity helps you to **assess** you how well you have understood:

- the basic information about coconut husks
- the processes involved in making a coconut husk product
- how to use various tools during the working processes of making a coconut husk product.

Activity 4: Checking what you have learnt about coconut husks

Answer these questions in your exercise book.

- 1 Write down the names of the different parts of a coconut husk.
- 2 Give two advantages of using coconut husk to make a product such as a brush for sweeping dirt into a dust pan.
- 3 Select one of the products below, and list the steps you would take to make any of them. This product should be displayed somewhere in front of the class.
 - a coconut broom
 - b blackboard duster
 - c door mat
- 4 Write down three **benefits** of using coconut husk products in your community.

Practical task

By the end of this practical task, you should be able to:

- 7.6.2.1 explain how different products are made from coconut husks
- 7.6.5.1 design and make a coconut husk product to address the need for locally made products to meet domestic and industrial needs in Solomon Islands
- 7.6.5.2 make one of the following products: a coconut husk broom, a coconut husk board duster, or similar product
- 7.6.6.1 use the correct procedures for making a coconut husk product
- 7.6.6.2 use the correct method to apply an appropriate finish on a coconut husk product
- 7.6.7.1 use tools correctly when marking, cutting and applying finishing on a coconut husk product
- 7.6.8.1 discuss the benefits of using coconut husk as an improvised material in your community.

Go back and read the design problems at the beginning of this chapter. You are going to solve one of those design problems.

Design problem 1: Floor broom

Design expectations

The following must be considered in the development of the floor broom:

- It must be made of coconut husk.
- It must be joined onto a piece of timber.
- It must be strong.
- It must be able to remove both small and big particles from the floor.
- It must be an appropriate size for the job you want it to do.

Investigating

Work through each step below. Consult your teacher if you have any difficulty.

- Look for two types of brooms somewhere in your home or elsewhere. Look at each one and identify its weaknesses and strengths.
- Do you think these brooms perform their tasks well? Are they easy or difficult to use?
- The broom you are going to make is made from coconut husk. Decide which of two types of coconuts you are going to use. List the different steps you will follow to make your broom. Make a list of the tools that you will use in each step.
- Which part of the coconut husk are you going to use for your broom?

Designing

- Write a short design brief for the coconut husk broom.
- Make two 3-D drawings of your broom. Show how you are going to join the coconut husk to the timber. Select which one you will use and give two reasons for your choice. Include measurements on your selected drawing.
- List the things that you will need to make your coconut husk broom.

Making your product

- Collect all the things that you will need to make your broom.
- What are the safety issues involved in making your broom?
- Use your 3-D drawing to make your broom.
- Use appropriate tools and equipment to make your broom.

Evaluating your work

Answer the following questions in your exercise book.

- 1 What did you do to make your broom?
- 2 Is the structure of the broom strong and neat?

- 3 Did your broom reflect the labelled drawing you made?
- 4 What did you do to make sure what you made was similar to what you drew?
- 5 Is the broom safe to use?
- 6 Have you learnt anything from other people's designs that could help you to improve your broom?
- 7 What would you change on your design if you were to make another broom?

Communicating and marketing

- 1 Who are the **potential users** of the broom?
- 2 How much would you sell your broom for?
- 3 What benefit/s does your coconut husk broom have for the users?
- 4 What **marketing technique/s** would you use to sell your broom?

Design problem 2: Blackboard duster

Design expectations

The following must be considered in the development of the blackboard duster:

- It must be made of coconut husk.
- It must be joined to some other material.
- It must be strong.
- It must clean the blackboard without scratching it.
- It must be an appropriate size.

Investigating

Work through the steps below one by one. Consult your teacher if you have any difficulty.

- Look for two types of blackboard duster (if you can) somewhere in your school or elsewhere. Look at each one and identify its weaknesses and strengths.
- Do you think these dusters carry out their tasks well? Are they easy or difficult to use?

- The blackboard duster is to be made from coconut husk. Which part of the coconut husk are you going to use? List the steps you will follow to make your duster. Make a list of the tools that you will use in each step.

Designing your blackboard duster

- Write a short design brief for the blackboard duster.
- Make two 3-D drawings of your blackboard duster. Show how you are going to join the coconut husk to the material of your choice. Select which 3-D drawing you will use and give two reasons for your choice. Include measurements on your selected drawing.
- Write down the steps you will take to make your blackboard duster.
- List the different things that you will need to make your blackboard duster.

Making your blackboard duster

- Collect all the things that you will need to make your blackboard duster.
- What are the safety issues involved in making your blackboard duster?
- Follow the steps you have written to make your blackboard duster.
- Use appropriate tools and equipment to make your blackboard duster.

Evaluating your work

Answer the following questions in your exercise book.

- 1 What did you do to make your blackboard duster?
 - 2 Is the blackboard duster strong and neat?
 - 3 Look at the 3-D drawing of your blackboard duster and your actual blackboard duster. Does your blackboard duster reflected your drawing?
 - 4 What did you do to make sure that what you made was similar to what you drew?
 - 5 Is the coconut husk blackboard duster safe to use?
- 6 Have you learnt anything from other people's designs that will help you to improve your blackboard duster?
 - 7 What would you change in your design if you were to make another blackboard duster?

Communicating and marketing

- 1 Who are the potential users of the blackboard duster?
- 2 How much would you sell your blackboard duster for?
- 3 What benefit/s does your blackboard duster have for users?
- 4 What marketing technique/s would you use to sell your blackboard duster?

Design problem 3: Door mat

Design expectations

The following must be considered in the development of the door mat:

- It must be made of coconut husk.
- It must be strong and remove dust and dirt easily from the feet.
- It must not trap dust and dirt easily.
- It must not hurt someone who will use it.
- It must be of an appropriate size for the door.

Investigating

- Look for two types of door mats if possible from somewhere in your home or elsewhere (you can look for pictures of door mats from magazines). Look at each one and identify its weaknesses and strengths.
- Do you think the door mats are useful for keeping dirt out of the house? If not, what problems might they cause?
- The door mat you are going to make is made from coconut husk. Which part of the coconut husk are you going to use?

Designing your door mat

- Write a short design brief for the door mat.

- Make two 3-D drawings of your door mat, showing how you are going to join the coconut husk to another material. Select which drawing you will use and give two reasons for your choice. Include measurements on your selected drawing.
- Make a list of the different things that you need to make your door mat.

Making your door mat

- Collect all the things that you will need to make your door mat.
- What are the safety issues involved in making your door mat?
- Use your 3-D drawing to make your door mat.
- Use appropriate tools and equipment to make your door mat.

Evaluating your work

Answer the following questions in your exercise book.

- 1 What did you do to make your door mat?
- 2 Is the structure of the door mat strong and neat?
- 3 Does your door mat reflect your labelled drawing?
- 4 What did you do to make sure that what you made was similar to what you drew?
- 5 Is the door mat safe to use?
- 6 Have you learnt anything from other people's design that will help you to improve your door mat?
- 7 What would you change in your design if you were making another door mat?

Communicating and marketing

- 1 Who are the potential users of the door mat?
- 2 How much would you sell your door mat for?
- 3 What benefit/s does your door mat have for users?
- 4 What marketing technique/s would you use to sell your door mat?

New words used in this chapter

assess	check performance
benefit	help, assistance
frequently	often
household product	item made for use in the house
maritime tropical climate	hot climate
marketing techniques	ways to sell products
matured coconut	old coconut
potential user	likely user
segments	divisions, parts
soak	insert into water, make wet

Chapter 7

Bamboo products

Learning outcomes

By the end of this chapter, you should be able to:

- 7.7.1.1** describe the different bamboo species in Solomon Islands
- 7.7.1.2** describe the different uses of bamboo
- 7.7.2.1** explain the working processes of bamboo
- 7.7.3.1** identify the tools that are used for making bamboo products
- 7.7.4.1** describe the safety measures required when making a bamboo product
- 7.7.5.1** design and make a bamboo product to address the need for locally made products to meet domestic and industrial needs in Solomon Islands
- 7.7.5.2** select and make a bamboo drinking trough for chickens or a similar product to suit the situation
- 7.7.6.1** select and use other appropriate materials that can be used along with bamboo to make a bamboo product
- 7.7.7.1** use tools correctly when making a bamboo product
- 7.7.7.2** apply appropriate safety procedures when working with bamboo
- 7.7.8.1** discuss and list the benefits of bamboo products in Solomon Islands homes.

Introduction

Bamboo is among the greatest of nature's gifts to **humankind**. Bamboo is an evergreen grass found nearly everywhere in the world. It grows well in the mountains and along the coast of the **tropics**. It can also be grown in almost any wet climate.



Figure 7.1 Bamboo in Solomon Islands

Today, bamboo can be used for making many different things because of its low cost, great strength and general availability. It is also easy to work with.

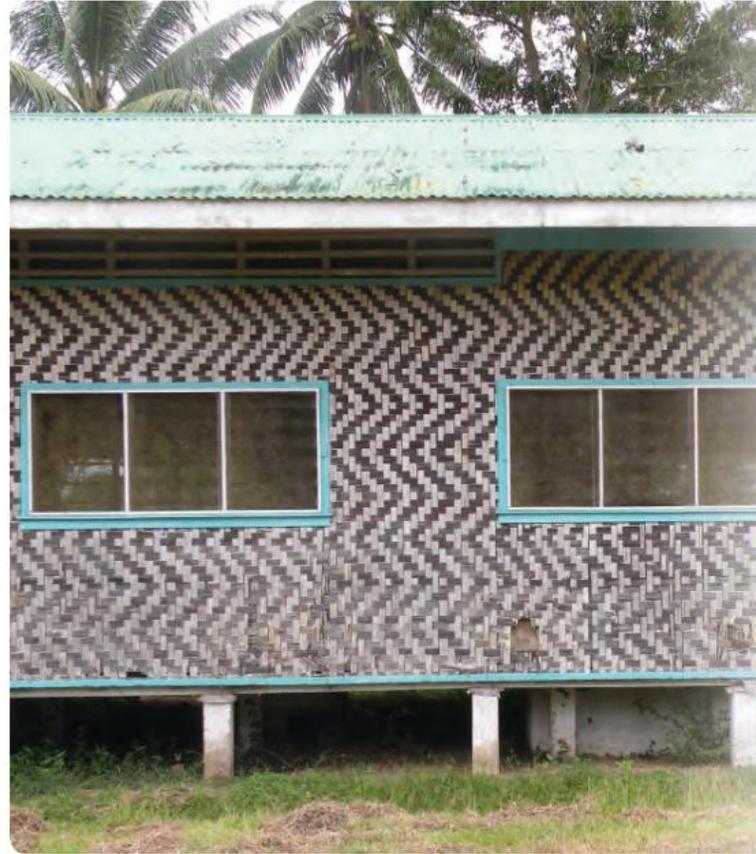


Figure 7.2 A house in St Martin in which bamboo is used as a building material

Following are some problems that you could solve using bamboo. Your teacher will discuss with you how to solve these problems.

Design problem 1: CD rack

A **hi-fi system** is used by people for watching videos and listening to music on DVDs and CDs. People who own hi-fi systems often build up collections of DVDs and CDs, which then have to be stored safely and **conveniently**. You are required to find a solution for this design problem by making a bamboo rack to hold DVDs and CDs neatly and attractively.

Design problem 2: Sleeping mat

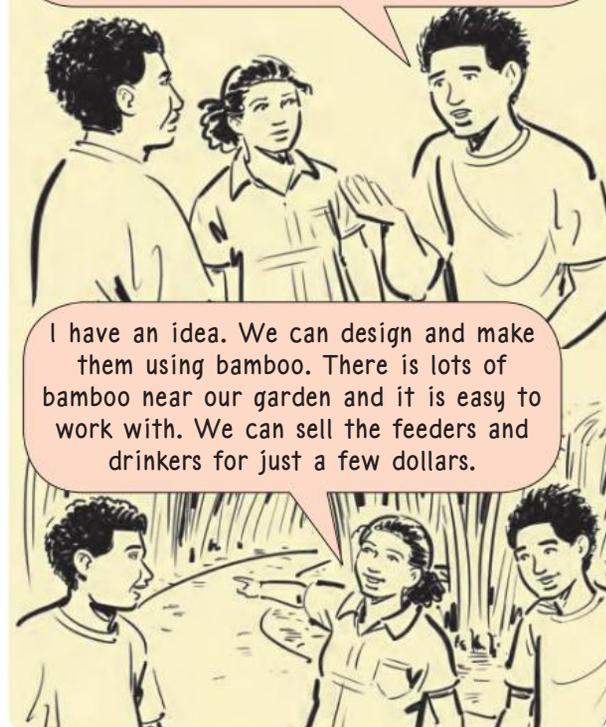
People in Solomon Islands use various kinds of mats in their homes, made from a range of materials. Mats are used in the sitting rooms and for sleeping in the bedrooms. Mats used by Solomon Islanders are either imported and sold in shops or locally constructed by skilful craftspeople. Some imported mats are made of bamboo, while most of the locally constructed mats are made of pandanus leaves. However, the ready availability of bamboo in most parts of Solomon Islands means that it could be used as an alternative material for mat construction. This is an opportunity to investigate the potential of using bamboo for mat construction.

Design problem 3: Chicken feeding troughs

Listen, Suzie and James, did you know that our school's Agriculture department bought some day-old chickens from a chicken supplier in town yesterday? I heard the teacher tell her students that they don't have enough money to buy new feeders and drinkers. They are very expensive. We can make some new feeders and drinkers for them.



John, we can make new feeders and drinkers for them but we don't have the materials and tools to make modern feeders and drinkers similar to the ones sold in the shop.



I have an idea. We can design and make them using bamboo. There is lots of bamboo near our garden and it is easy to work with. We can sell the feeders and drinkers for just a few dollars.

The story related above reflects the real situation in Solomon Islands. Most chicken farmers cannot afford the expensive feeding troughs sold in the shops. Therefore, you are going to design and make a sample drinking and feeding trough using bamboo. This sample **feeding trough** can be marketed to chicken farmers in Solomon Islands as a cost-cutting measure. To be able to do that you need to learn more about bamboo.

Tools and equipment used in this chapter

Bench hook
Bench vice
Bevel-edge chisel
Chisel
Coping saw
Engineer's vice
F-clamp
Hand saw
Steel ruler
Tape measure
Tenon saw
Wooden mallet

Materials used in this chapter

Bamboo
Pencil

About bamboo

By the end of this topic, you should be able to:

7.7.1.1 describe the different bamboo species in Solomon Islands

7.7.1.2 describe the different uses of bamboo.

Types of bamboo

There are about one thousand bamboo **species** in the world. They range from short groundcover bamboo to 30 metres (or 100 feet) tall. Bamboo can be categorized as:

- quick-spreading species, or
- slow-spreading species.

Figures 7.3 and 7.4 show two types of bamboo that grow in Solomon Islands.



Figure 7.3 Bamboo grown near Nukukaisi village in Makira province



Figure 7.4 Bamboo grown in most parts of Solomon Islands

Bamboos come in different types, colours, sizes and **textures**. The roots are called rhizomes. The culms, or stalks, can be **zigzag** or straight.

In Solomon Islands there are about five different types of bamboo, and they have different names in each area. In most parts of Malaita Province, au'u is the general term used for bamboo. The specific names are based on the general term— au'u + name of species 1, and so on.

The five types of bamboo are shown in Figures 7.5 to 7.9.



Figure 7.5 Hard, yellowish stalk



Figure 7.6 Hard, green stalk



Figure 7.7 Hard, green small-diameter stalk



Figure 7.8 Quick-spreading long stalk



Figure 7.9 Thin grass-like stalk

Activity 1: Finding out about bamboo

- 1 Read the section called 'Types of bamboo' on page 105.
- 2 In groups of five, look around your environment for bamboo stalks. If possible, collect three samples of different types.
- 3 What do people in your area call these bamboos that you have collected?
- 4 What are the traditional uses of these bamboos?

Uses of bamboo

People in Solomon Islands have used bamboo for many years as a material to make many things. Bamboo is used for many indoor and outdoor products that make our lives easier. For example, people commonly use bamboo for outdoor activities and tools such as house walling, water bottles, fishing spears and lines and many more. For indoors, bamboo is used for rafters and walling in traditional houses, in the making of baskets, and for many other purposes.

Protecting bamboo from insects

Bamboo is a natural plant and once it is cut down it is at risk of insect attack, just like any other plant, if it is not protected. There are several things you could do to protect bamboo from insect attacks. One is to treat the bamboo with salt water if you are in a coastal area. You should leave the bamboo in the sea for at least two days, so that insects do not attack the bamboo product once it is used. However, you should not need to do this if you are making items such as eating utensils and drinking troughs for animals or humans. But you must use this treatment for any other products.



Figure 7.10 Bamboo is placed in the sea for at least two days before it is seasoned.



Figure 7.11 Bamboo is dried in the sun to remove moisture.

Activity 2: Treating bamboo

- 1 Read the section called 'Protecting bamboo from insects' on page 106.
- 2 Explain why you have to soak the bamboo in the sea.
- 3 You are not allowed to treat bamboo that you will be using for making eating and drinking utensils. Can you explain why?
- 4 When bamboo is used for external purposes, it is best to treat it. Write down two reasons for this.

Activity 3: Finding out about the properties of bamboo

- 1 In groups, collect the various types of bamboo grown in your local area. Write down the names of the different types of bamboo in your own language. Can you suggest why English has only one word for bamboo but local languages have many words?
- 2 In your groups, look at your bamboo collection. Break the pieces of bamboo open. Is any of your bamboo soft or very hard? What are the names of each type in your language?
- 3 Do people in your area use bamboo products? Write down the various products made from any species of bamboo by the people in your area.
- 4 If people are still using bamboo in your area, write down two reasons why they use bamboo products.
- 5 Do you think we should use bamboo more than modern **manufactured materials** in our communities? What are the advantages of using bamboo rather than manufactured materials like plastic?

Tools used in bamboo work

By the end of this topic, you should be able to:

- 7.7.2.1** explain the working processes of bamboo
- 7.7.3.1** identify the tools that are used for making bamboo products
- 7.7.4.1** describe the safety measures required when making a bamboo product.

Your teacher will show you some of the common tools used in the workshop and how they will be used to make interesting bamboo products.

When you make a bamboo product you must follow the these steps:

- marking out
- cutting and shaping
- joining
- finishing.

Your teacher will demonstrate each step. Before you mark, cut and join bamboo, it is important to check that the bamboo is dried properly.

Activity 4: Working with bamboo

Look at the tools shown in Figure 7.12. Suggest how each of them might be used in working with bamboo.

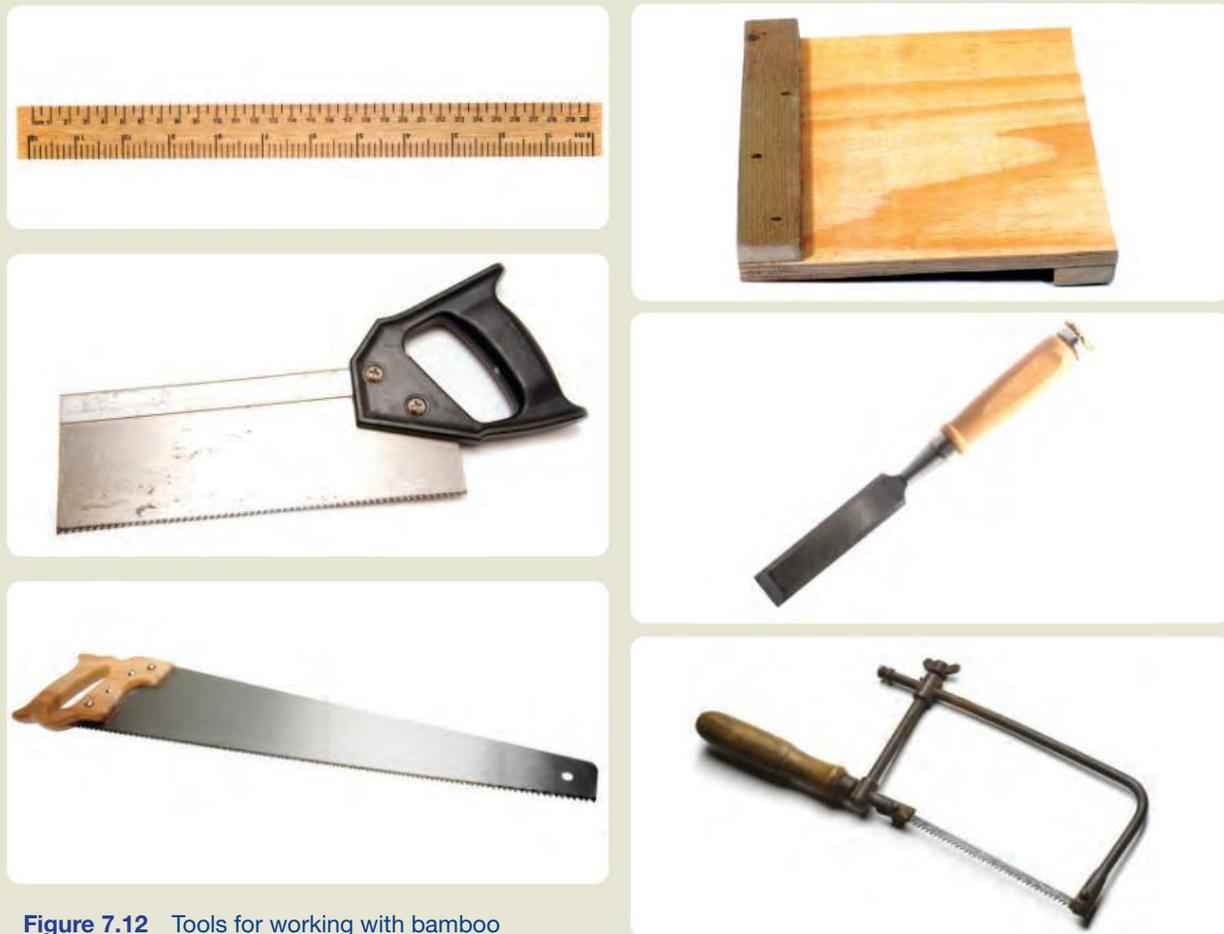


Figure 7.12 Tools for working with bamboo

Marking out

When you are working with bamboo, the first thing you must do is mark it out. If you do not mark out the material, you may make mistakes while cutting or bending it. Figures 7.13 to 7.15 show some marking-out tools used in bamboo products.



Figure 7.13 Steel ruler



Figure 7.14 Tape measure



Figure 7.15 Pencil

Cutting and shaping

People have discovered that they can work better with the help of hand tools. Our hands and legs are excellent for holding onto a piece of work. However, in many situations, a tool may do the job better. You will look at some of the tools used for sawing, holding, chiselling, cutting, drilling, filing and planing bamboo.

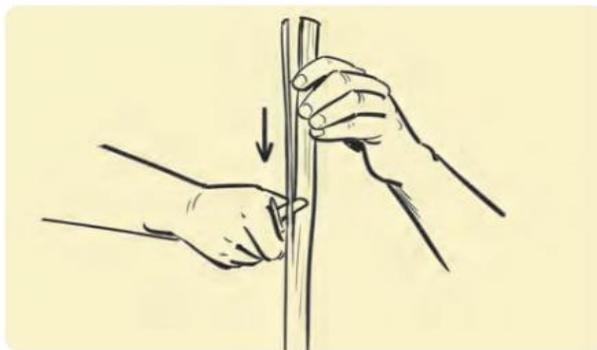


Figure 7.16 Using hands to hold onto bamboo while cutting

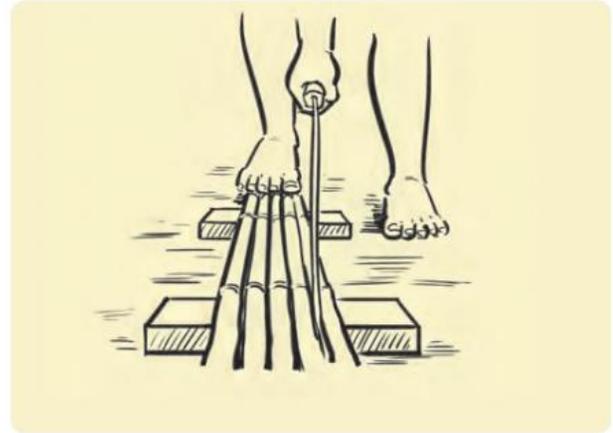


Figure 7.17 Using legs and hands to hold onto bamboo

Sawing

Saws are commonly used for removing waste material from a work piece. Different saws are used for cutting different materials. You have to use the correct saw, otherwise both the saw and the work piece may become damaged. The most common saws used to cut bamboo are a tenon saw and a hand saw.



Figure 7.18 Tenon saw



Figure 7.19 Hand saw

When sawing bamboo, always remember to use a bench hold. Figure 7.20 shows the proper method of sawing using a tenon saw.

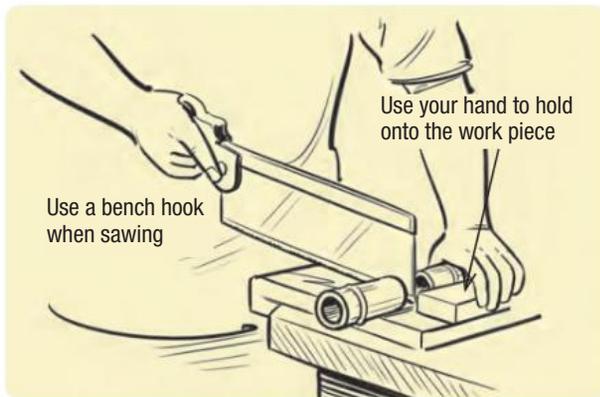


Figure 7.20 How to saw using a bench hook

Holding tools

When you are cutting or shaping bamboo, hold it firmly and securely. This will make your work easier. Figures 7.21 to 7.23 show some of these holding tools.



Figure 7.21 A bench vice



Figure 7.22 Engineer's vice



Figure 7.23 F-clamp for holding a piece of bamboo on a bench top

You use a coping saw for cutting **curves** on bamboo. It has a narrow blade with very fine teeth. You must adjust the blade to cut at an angle. However, it must not be **twisted** or it may break.

When you use a coping saw to cut a curve, always remember to hold the saw with both hands as shown in Figure 7.24.

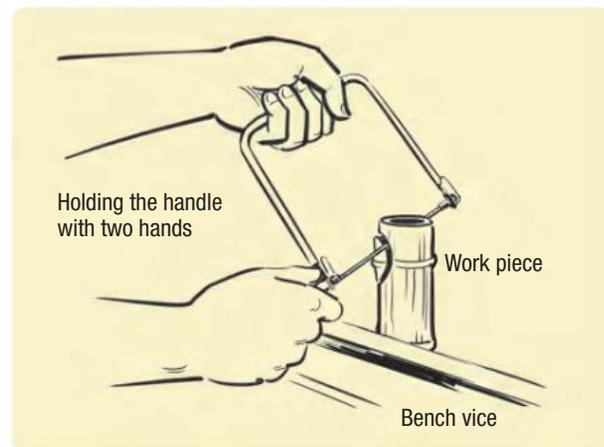


Figure 7.24 Using a coping saw to cut a curve

Chiselling

Chiselling is a quick way of removing waste from bamboo. For chiselling bamboo, you will use either a firmer chisel or a bevel-edge chisel. You learnt about these types of chisels when you studied the chapter on timber. Your teacher will show you these types of chisels. They are used for different purposes.

The firmer chisel is used to remove waste bamboo from a work piece.



Figure 7.25 Using a firmer chisel. Notice the wooden mallet being used to strike the chisel handle lightly.

The bevel-edged chisel is used for cleaning up corners, as shown in Figure 7.26.

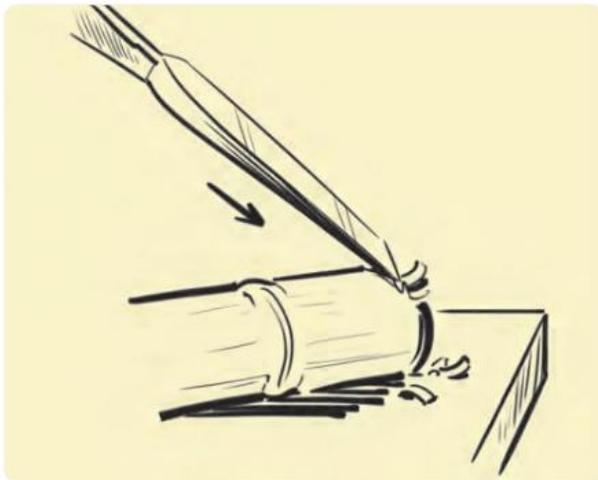


Figure 7.26 Using a bevel-edge chisel

Always remember:

- keep your hands and fingers away from the cutting edge
- never chisel towards yourself.

There are also other tools that you can use, such as screw drivers, files and hammers.

Joining

There are different ways of joining bamboo materials. You can use rope or nails. Which method you use depends on where you are and the availability of these materials. However, there are advantages and disadvantages to these methods.

Finishing

In order to make a bamboo product that is pleasant to look at and will last a long time, you must apply an appropriate finish to it. First, though, the surface must be prepared. Then you can apply varnish, paint or coconut oil. Read 'Finishing on timber' on page 55 for more on this.

Safety issues

The bamboo's woody stalk, or culm, takes 3 to 4 years to mature. At this stage, the culm is strong and heavy. One person would not be able to carry it. Bamboo is very sharp when it splits and can cause injury. Safety measures must be **implemented** in order to avoid injuries or accidents.



Figure 7.27 When a bamboo stem splits, the edges are very sharp.

Observe the following safety precautions when working with bamboo.

- 1 Carry a long and mature bamboo with another person—never carry it alone.
- 2 Use the right tool to measure, cut and shape, and join a bamboo work piece.
- 3 When splitting or working with bamboo, always smooth the sharp edges of the stem.
- 4 Do not use **blunt tools** to cut the bamboo culms.
- 5 Study the general safety rules displayed in your classroom about hand tools and bad habits. When you work with bamboo, remember to observe these safety rules.

Practical task

By the end of this practical task, you should be able to:

- 7.7.5.1 design and make a bamboo product to address the need for locally made products to meet domestic and industrial needs in Solomon Islands
- 7.7.5.2 select and make a bamboo drinking trough for chickens or a similar product to suit the situation
- 7.7.6.1 select and use other appropriate materials that can be used along with bamboo to make a bamboo product
- 7.7.7.1 use tools correctly when making a bamboo product
- 7.7.7.2 apply appropriate safety procedures when working with bamboo
- 7.7.8.1 discuss and list the benefits of bamboo products in Solomon Islands homes.

Go back and read the design problems at the beginning of this chapter. You are going to solve one of those design problems.

Design problem 1: CD rack

Design expectations

The following must be considered in the development of the CD rack:

- It must be made from bamboo.
- It must be able to store up to ten CDs.
- It must move easily.
- Its frame must be square, **rigid** and strong.
- It must be strong and convenient to use—it must not be too small or too big.
- It should not be covered.
- It must be of standard size. You should discuss appropriate measurements with your teacher.

Investigating

- Select the type of material (bamboo) you will use for making the CD rack.
- Measure the size of a normal CD.
- Identify the type of joints that you will use to hold the CD frame together.
- Identify the other materials you will use to make the CD rack.
- Look around your home or your neighbours' homes to find two types of CD racks, made from plastic or metal. Identify the strengths and weaknesses of each CD rack.
- Identify how the CD racks you found are designed.

Designing your CD rack

- Write the design brief for the CD rack.
- Discuss with a friend about how you are going to make your CD rack, including the steps, tools and safety issues involved in making the CD rack.
- Make a pictorial drawing of your CD rack. Include in your drawing the dimensions of the parts of the CD rack. Make sure to include the type of joints that you will use.
- Make a list of the things that you will need for the CD rack.

Making your CD rack

- Prepare the bamboo and other materials that you will need to make the CD rack.
- Cut the joints for the CD rack.
- Use PVA glue/or any other method of making joints on your CD rack.
- Use appropriate tools when marking, cutting and applying finish on the CD rack.

Testing your CD rack

- Is the CD frame square, rigid and strong?
- Can the CD rack be moved easily?
- Can CDs fit nicely into the rack?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Are the type of joint(s) you used strong enough for this CD rack?
- 2 Does this CD rack serve the purpose for which it is designed?
- 3 Is the whole structure of the CD rack strong and neat?
- 4 Does the size of the CD rack suit its purpose?
- 5 Is the design pleasing to look at?
- 6 Did the construction or making of the CD rack take a lot of time? If yes, why?
- 7 What have you learnt from others' CD rack projects?
- 8 What would you change from your design if you were making another CD rack?

Communicating and marketing

- 1 Who are the potential users of the CD rack?
- 2 How much would you sell your CD rack for?
- 3 What benefit/s does your CD rack have for users?
- 4 What marketing technique/s would you use to sell your CD rack?

Design problem 2: Bamboo mat

Design expectations

The following must be considered in the development of the bamboo mat:

- It must be made from bamboo.
- It can only be used for sleeping.
- It can be folded easily.
- It must be square and strong.
- It must be strong and convenient to use.
- It should not be covered.
- It must be of appropriate size. You should discuss appropriate measurements with your teacher.

Investigating

- Select the type of material you will use for making the bamboo mat.
- Investigate the size of a mat from a shop.
- Select the type of joints that you will use to hold the bamboo pieces together.
- Decide on the other materials you will use to make the bamboo mat.
- Look around your home or your neighbours' homes to find two types of bamboo mats, made from plastic or metal. Identify the strengths and weaknesses of each bamboo mat.
- Identify how the bamboo mats you found are designed.

Designing your bamboo mat

- Write the design brief for the bamboo mat.
- Discuss with a friend about how you are going to make your bamboo mat, including the steps, tools and safety issues involved in making the bamboo mat.
- Make a pictorial drawing of your bamboo mat. Include in your drawing the dimensions of the parts of the bamboo mat. Make sure to include the type of joints that you will use.
- Make a list of the things that you will need for the bamboo mat.

Make your product

- Prepared the bamboo and other materials that you will need to make the bamboo mat.
- Cut the joints for the bamboo mat.
- Use PVA glue/or any other method of making joints on your bamboo mat.
- Use appropriate tools when marking, cutting and applying finish on the bamboo mat.

Testing your bamboo mat

- Is the bamboo mat square, rigid and strong?
- Can the bamboo mat be moved easily?
- Can people use the bamboo mat safely?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Are the type of joint(s) you used strong enough for this bamboo mat?
- 2 Does this bamboo mat serve the purpose for which it is designed?
- 3 Is the whole structure of the bamboo mat strong and neat?
- 4 Does the size of the bamboo suits its purpose?
- 5 Is the design pleasing to look at?
- 6 Did the construction or making of the bamboo mat take a lot of time? If yes, why?
- 7 What have you learnt from others' bamboo mat projects?
- 8 What would you change from your design if you were making another mat from bamboo?

Communicating and marketing

- 1 Who are the potential users of the bamboo mat?
- 2 How much would you sell your bamboo mat for?
- 3 What benefit/s does your bamboo mat have for users?
- 4 What marketing technique/s would you use to sell your bamboo mat?

Design problem 3: Chicken feeding trough

Design expectations

The following must be considered in the development of the chicken feeding trough:

- It must be made from bamboo.
- It can only be used for big chickens.
- It can be carried easily.
- It must be rigid and strong.
- It must be strong and convenient to use.
- It should be made so that chickens can't climb into it.

- It must be of appropriate size. You should discuss appropriate measurements with your teacher.

Investigating

- Select the type of material you will use for making the feeding trough.
- Select the type of joints that you will use to hold the bamboo pieces and or other materials together.
- Decide on the other materials that you will use to make the feeding trough.
- Look around your home or your neighbours' homes to find two types of feeding troughs, made from plastic or metal. Identify the strengths and weaknesses of each feeding trough.
- Identify how the feeding troughs you found are designed.

Designing your feeding trough

- Write the design brief for the feeding trough.
- Discuss with a friend about how you are going to make your feeding trough, including the steps, tools and safety issues involved in making the feeding trough.
- Make a pictorial drawing of your feeding trough. Include in your drawing the dimensions of the parts of the feeding trough. Make sure to include the type of joints that you will use.
- Make a list of the things that you will need for the feeding trough.

Making your feeding trough

- Prepare the bamboo and other materials that you will need to make the feeding trough.
- Cut any joints that you might use for the feeding trough.
- Use PVA glue/or any other method of joints on your feeding trough.
- Use appropriate tools when marking, cutting and applying finish on the feeding trough.

Testing your bamboo feeding trough

- Is the feeding trough rigid and strong?
- Can the feeding trough be moved easily?
- Can chickens use the feeding trough safely?
- Does the feeding trough hold food well?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Are the type of joint(s) you used strong enough for this feeding trough?
- 2 Does the feeding trough serve the purpose for which it is designed?
- 3 Is the whole structure of the feeding trough strong and neat?
- 4 Does the size of the bamboo feeding trough suits its purpose?
- 5 Is the design pleasing to look at?
- 6 Did the construction or making of the feeding trough take a lot of time? If yes, why?
- 7 What have you learnt from others' feeding trough projects?
- 8 What would you change from your design if you were making another bamboo feeding trough?

Communicating and marketing

- 1 Who are the potential users of the feeding trough?
- 2 How much would you sell your feeding trough for?
- 3 What benefit/s does your feeding trough have for users?
- 4 What marketing technique/s would you use to sell your feeding trough?

New words used in this chapter

blunt tool	tool with cutting blade that is not sharp
conveniently	suitably
curves	lines that are not straight, or parts of lines that are not straight
feeding trough	container (made from bamboo) used to place animal feed in, e.g. chicken feed
hi-fi system	electronic sound system
humankind	people
implemented	applied, or put into practice
manufactured materials	human-made products, e.g. plastic
rigid	firm, unbending
species	type
texture	feel of a surface
tropics	region of the Equator, and so relatively hot
twisted	out of shape, not straight
zigzag	not straight, going one way then the opposite way

Chapter 8

Basic electricity

Learning outcomes

By the end of this chapter, you should be able to:

- 7.8.1.1** distinguish between the two circuit arrangements—series and parallel
- 7.8.2.1** identify the basic components, such as a battery, bulbs and switches, and how they are represented in a circuit diagram
- 7.8.3.1** explain the uses of a battery and switches in an electric circuit
- 7.8.3.2** identify the components of a torch
- 7.8.4.1** describe the proper method of joining wires to electric components
- 7.8.5.1** identify the main parts of a systems diagram
- 7.8.6.1** identify the uses of electricity in Solomon Islands
- 7.8.7.1** design and construct an electric circuit model to address the need for light in traditional kitchens in both rural and urban settings in Solomon Islands
- 7.8.8.1** apply appropriate safety procedures when cutting and terminating wires in an electric circuit
- 7.8.8.2** draw components correctly in a circuit diagram
- 7.8.8.3** connect up a plug correctly
- 7.8.8.4** use electric components to build a simple electric circuit
- 7.8.9.1** use components, cables and connections to build simple circuits correctly and safely
- 7.8.9.2** apply appropriate safety procedures when connecting wires and components in a simple circuit
- 7.8.10.1** investigate the impact of electricity in Solomon Islands society.



Introduction

Electricity is used everywhere in the villages and provincial towns in Solomon Islands. It is used in most houses in town, as well as in a few homes and schools in the rural areas in the form of solar power and generators.

Understanding how electricity is used in the different parts, or **components**, in products such as those illustrated in Figure 8.1 will help in understanding how the products work. In this chapter, you will **investigate** the basic **concepts** about electricity.



Figure 8.1 Some uses of electricity

Design problem: Model electric circuit

Many town houses in Solomon Islands have electricity, but do not have lights in the traditional kitchens, which are small huts built beside the main houses. Traditional kitchens are used mainly for cooking as well as for social meetings by people both in the villages and towns. Traditional kitchens are used just as much as the main house.

At the end of this chapter you will design and build a **model electric circuit** with two lights to be used in a traditional kitchen in town, or in a house in the village. To be able to do that, you need to learn more about electric components and some simple electric ideas.

Tools and equipment used in this chapter

Hammer
Wire strippers
Scissors

Materials used in this chapter

Block of wood
Bulb holders
Cells
Covered copper wire
Crocodile clip
Drawing pins
Insulating or sticky tape
Nails
Paper clips
Paper fasteners
Pieces of cardboard from an old carton
Pieces of wire
Rubber bands
Sticky tape
Three-pin plug
Torch
Torch bulbs
Wooden clothes pegs

A simple electric circuit

By the end of this topic, you should be able to:

7.8.3.2 identify the components of a torch.

To help you understand how electric circuits work you will explore a simple electric circuit in a torch. This will help you to learn what to check when things go wrong with electric circuits.



Figure 8.2 There are many uses for electricity in our homes.



Figure 8.3 Electricity use in an office



Figure 8.4 The Marara clinic in Guadalcanal uses electricity supplied from a solar panel.

A torch is an example of a working electric circuit. The components in the torch make up the electric circuit. When the components are connected correctly, the light comes on as the switch is turned on. When the torch switch is turned on, the electricity flows. What makes the electricity flow?

Activity 1: Finding out about torches

You will need:

- torch with cells.
- 1 Open a torch. Take out the **cells**. Unscrew the glass and take out the bulb.
 - 2 Identify the following parts of the electric circuit of the torch:
 - a bulb
 - b battery
 - c switch
 - d metal case.

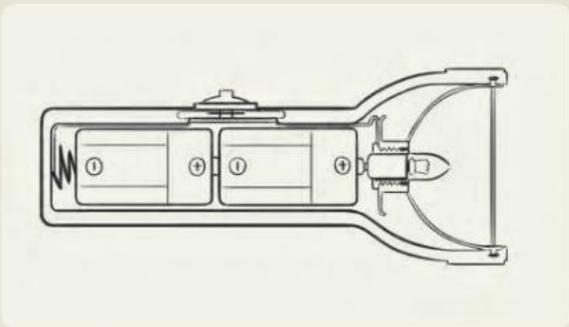


Figure 8.5 Components of a torch

- 3 What is the function of each part?
- 4 Assemble all the parts again. **Switch** on the torch. Have you assembled it correctly?

Electric circuits

By the end of this topic, you should be able to:

- 7.8.3.1 explain the uses of a battery and switches in an electric circuit
- 7.8.4.1 describe the proper method of joining wires to electric components
- 7.8.8.1 apply the safety procedures of cutting and terminating wires in an electric circuit
- 7.8.8.4 use the different electric components to make a simple electric circuit
- 7.8.9.2 apply the safety procedures of connecting wires and components in a simple circuit.

To investigate circuits, you need to make some simple components. You will make two simple components to use in your investigations.

How to join wires

You will need some pieces of covered copper wire.

- 1 Remove about 2 centimetres of the outer covering at each end of the wires.



Figure 8.6 Removing **insulation** from a wire

- 2 If the wire type is multi-strand, twist the strands together as shown in Figure 8.7.

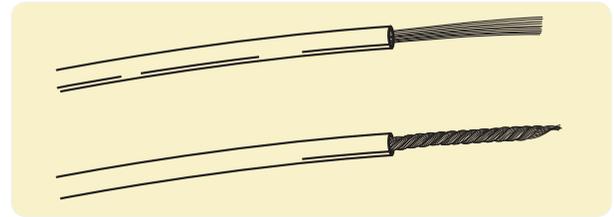


Figure 8.7 Twisting multi-strand wires together

- 3 To join two wires together, twist the two ends together as shown in Figure 8.8.



Figure 8.8 The two ends of the stripped wire are now ready for joining.

- 4 Fold the twisted wires back around one of the wires to make a strong joint, as shown in Figure 8.9.

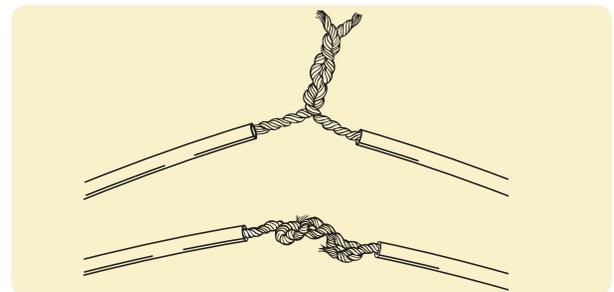


Figure 8.9 Two wires joined together

- 5 Cover the joint with insulating or sticky tape so that there is no bare wire.

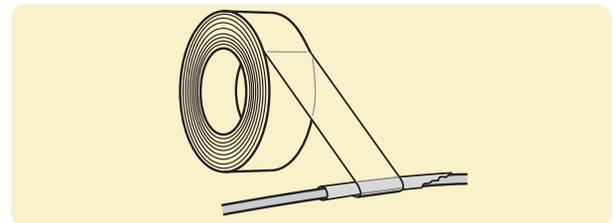


Figure 8.10 Taping a wire joint

Connecting wires to components

There are some simple methods of attaching wires to components. Figures 8.11 to 8.13 show three simple connecting clips:

- a wire is connected to a paper fastener by **wrapping** the wire end tightly to the metal fastener

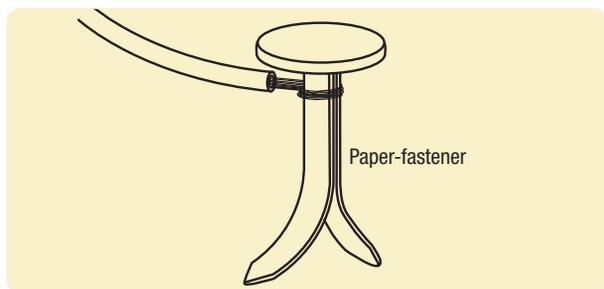


Figure 8.11 Wire attached to a paper fastener

- a wire is connected to a paper clip by wrapping the wire end tightly around the metal paper clip

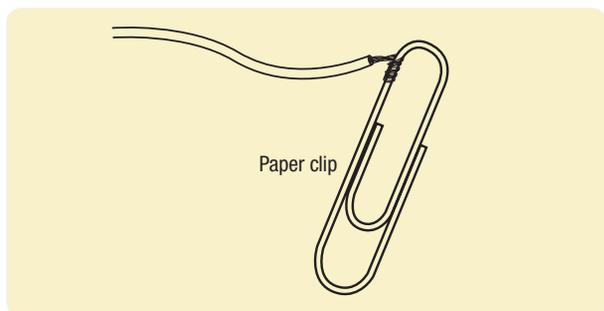


Figure 8.12 Wire attached to a paper clip

- a wire is connected to a crocodile clip by using a screw, or by wrapping the wire tightly to the end.

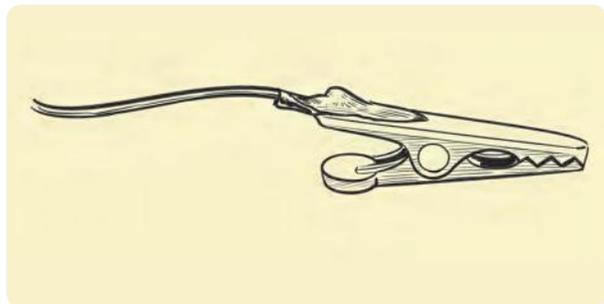


Figure 8.13 Wire attached to a crocodile clip

Activity 2: Making a simple on/off switch

You will need:

- 2 pieces of wires (with ends stripped)
- 2 drawing pins
- hammer
- wooden clothes peg
- piece of card.

- 1 Connect a piece of wire to a drawing pin as shown in Figure 8.14. You need two of these.

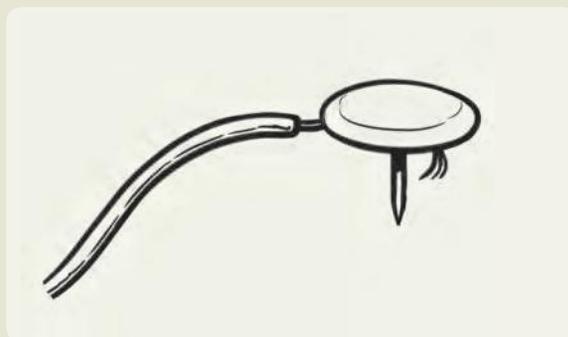


Figure 8.14 Stripped wire attached to a drawing pin

- 2 Hammer the two drawing pins tightly onto the arms of the clothes peg, as shown in Figure 8.15. The peg opens and closes. The heads of the drawing pins can touch. This makes a simple switch. Use a piece of card to slide between the drawing pins. This opens the switch.

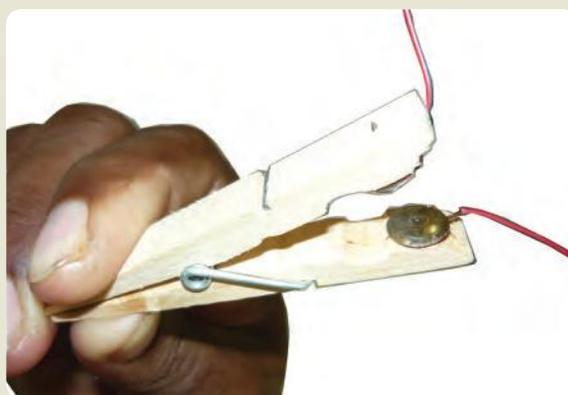


Figure 8.15 Two drawing pins on a clothes peg

You can also make a switch from bamboo tongs.



Figure 8.16 Bamboo tongs can be used as a switch.

Activity 3: Making a simple bulb holder

You will need:

- drawing pin
- 2 wires with ends stripped
- block of wood
- nail
- hammer
- wooden clothes peg
- torch bulb.

- 1 Press a drawing pin with connecting wire into the block of wood, as shown in Figure 8.17.

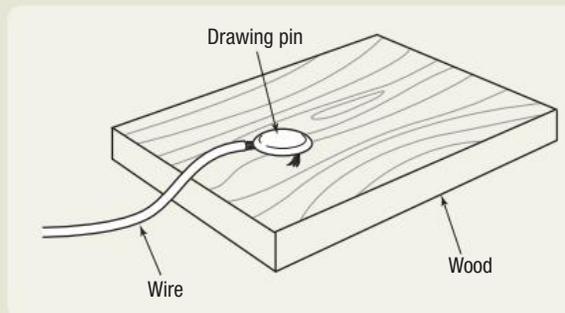


Figure 8.17 Drawing pin pressed firmly onto a piece of wood

- 2 Nail the clothes peg into the wood, so that the hole of the peg is directly above the drawing pin, as shown in Figure 8.18.

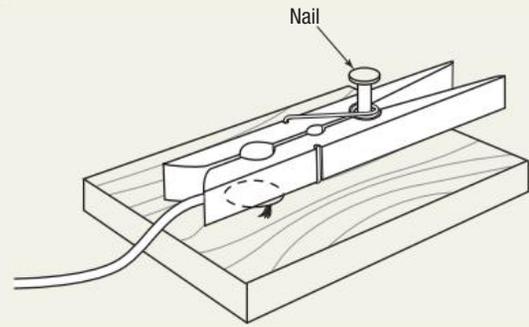


Figure 8.18 Fix the clothes peg to the timber with a nail.

- 3 Wrap the stripped end of a piece of wire round the barrel of the bulb. Twist tightly.

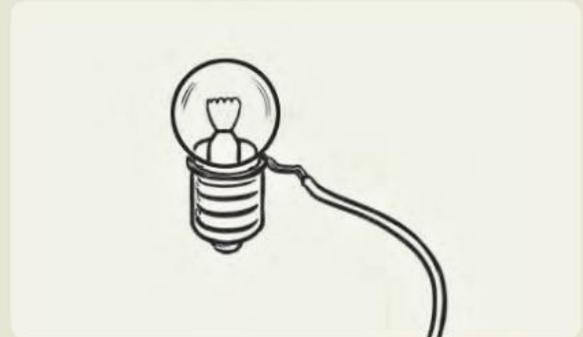


Figure 8.19 The stripped wire wrapped around the barrel of the bulb

- 4 Grip the barrel of the bulb in the clothes peg. The base of the bulb should touch the drawing pin.

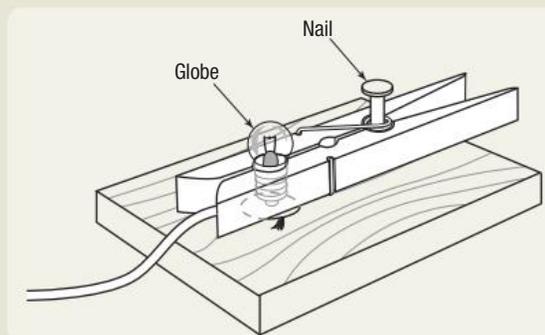


Figure 8.20 The bulb is complete and in its holder.

You have made a **bulb holder**. It should look like the holder in Figure 8.20.

Connecting wires to cells

You can use one or two or three cells together to provide power for a circuit. Figures 8.21 to 8.23 show how to connect them. You need some simple materials—sticky tape, rubber bands, pieces of cardboard from an old carton.

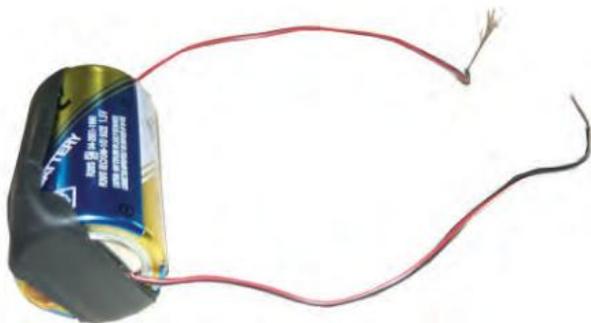


Figure 8.21 A cell connected with wires



Figure 8.22 Two cells with wires attached to them



Figure 8.23 Three cells mounted onto timber

What should you remember when connecting two or more cells to make a battery?

A cell supplies electrical energy to a circuit. A torch cell supplies electrical energy to a circuit so that a bulb can light.

A battery is a number of cells connected together—for example a car battery. In everyday English, we use the word ‘battery’ incorrectly. What we call a battery is really a cell.

Switches

A switch is used to break or control the flow of current in wires. There are many different types of switches that are made to do different things. A switch turns a current on or off. A switch is the component that controls the flow of electricity.

Activity 4: Finding out how switches work

- 1 Look around your school area for different types of switches. What do these switches control?
- 2 Make the circuit shown in Figure 8.24. Use the simple components you made earlier.

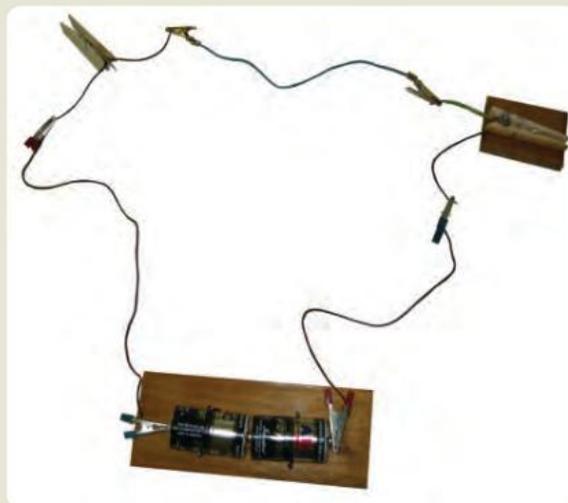


Figure 8.24 Simple circuit

- a How do you switch the bulb on?
- b How do you switch the bulb off?

How to find faults in an electric circuit

If there is a gap in a circuit, the circuit will not work, as the electricity cannot flow. Here are some checks you can make to find the fault.

- 1 Check that all the components are connected properly in the circuit. Disconnect the battery, then make sure that all the components are connected. Check that the connections are in contact. Check that the cells are connected properly in the battery.

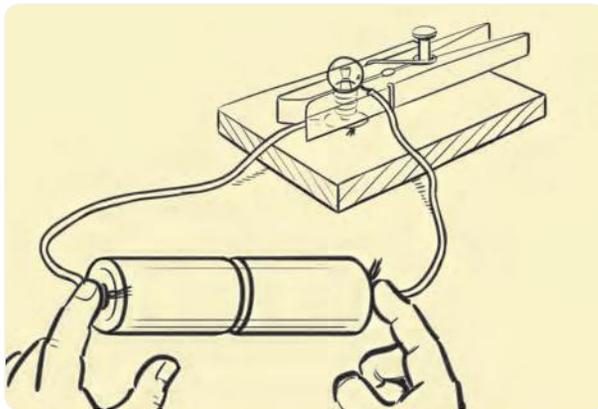


Figure 8.25 Two cells testing connectivity

- 2 Check if the cell is working by placing it in another circuit that you know is working properly.

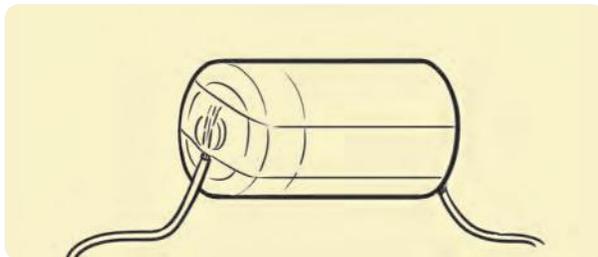


Figure 8.26 Tape can be used to hold the wires.

- 3 If you are connecting two or more cells, are they connected the right way round? Electricity needs to flow in one direction round a circuit, from the positive side of the cell (the side of the cell marked with a '+' sign) to the negative side (the side of the cell marked with a '-' sign).

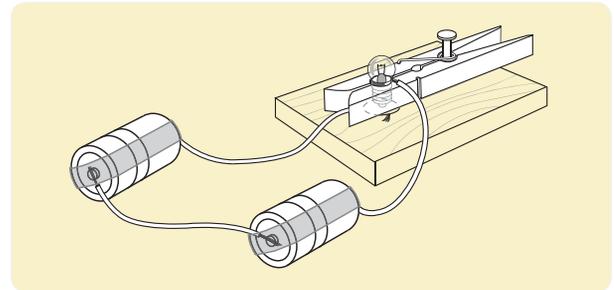


Figure 8.27 Testing whether the cells are working and connected properly

- 4 Check if any connecting wires are touching—this is called a short circuit. A short circuit happens when connecting wires touch in the wrong place (see Figure 8.28). The electricity does not pass through the component.

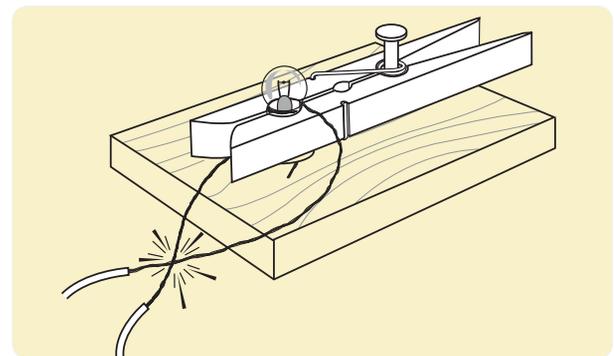


Figure 8.28 Bare wires can be shorted.

- 5 Check each component one at a time in a circuit that you know is working. This is called a test circuit. For example, is the bulb working? If it works in the test circuit, check whether the wires are connected properly to the bulb.
- 6 When you have checked each component, reconnect them all. Try again. Does your circuit work properly?

Types of circuits

By the end of this topic, you should be able to:

- 7.8.1.1** distinguish between the two circuit arrangements—series and parallel
- 7.8.9.1** use components, cables and connections to build simple circuits correctly and safely.

There are two ways to connect components in an electric circuit: in series or in parallel.

Series circuit

Activity 5: Finding out how a series circuit works

You will need:

- 2 cells
- 3 bulbs
- 3 bulb holders
- wire
- peg switch.

- 1 Use two cells, a bulb (call it Bulb 1) and a peg switch to make the circuit shown in Figure 8.29.



Figure 8.29 Series circuit

- 2 Turn on the switch. Check if the bulb lights. Note its brightness.
- 3 Connect Bulb 2 into the circuit as shown in Figure 8.30.

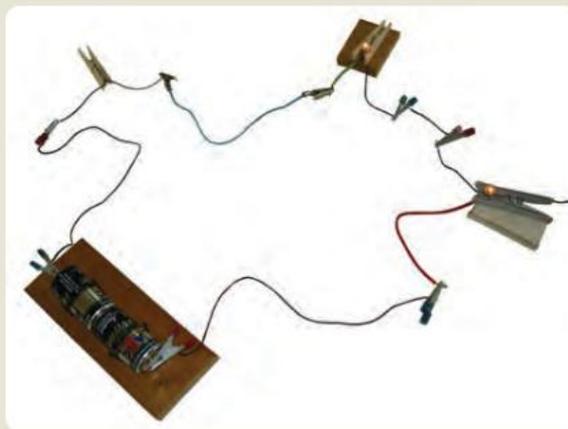


Figure 8.30 Two bulbs connected in series

- 4 Turn on the switch. Do both bulbs light? Are the bulbs brighter than, less bright than or the same brightness as the single bulb in the first circuit?
- 5 Remove one of the bulbs while the switch is still on. What happens? Can you explain why?
- 6 Put Bulb 2 into its place again. Check the brightness of the two bulbs. Now add another bulb (call it Bulb 3) as shown in Figure 8.31. Check the brightness of the three bulbs.

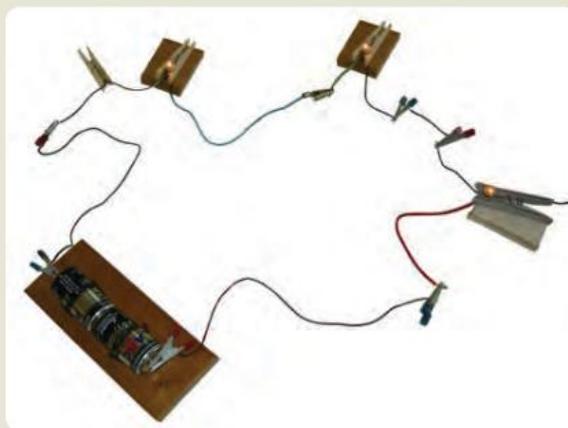


Figure 8.31 Three bulbs connected in series

- 7 What conclusion can you draw?

Did you notice that when two bulbs are connected one after another, they do not burn as brightly as a single bulb? This is because the amount of electricity flowing through the three bulbs is shared.

When you took one bulb out, the other bulb did not light. The circuit was broken and the electricity did not flow.

This type of circuit is a series circuit. The bulbs are connected in series—like links in a chain.

Parallel circuit

Activity 6: Finding out how a parallel circuit works

You will need:

- 2 cells
- 3 bulbs
- 3 bulb holders
- wire
- peg switch.

- 1 Use two cells, one bulb, a peg switch and some wires to make the circuit shown in Figure 8.32.



Figure 8.32 A switch, one bulb and two cells connected in series

- 2 Turn on the switch and note the brightness of the bulb.
- 3 Connect a second bulb (Bulb 2) to the first bulb (Bulb 1) as shown in Figure 8.33.

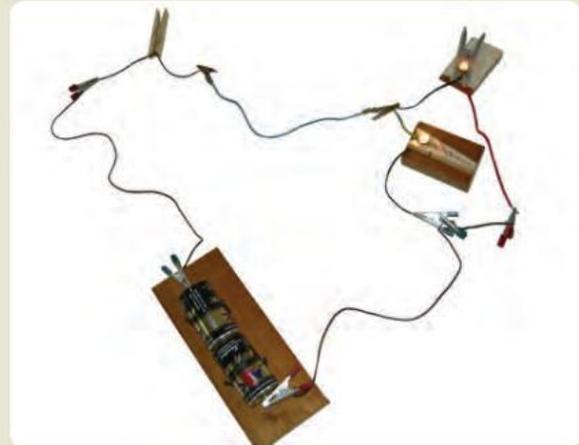


Figure 8.33 A switch, two bulbs and two cells connected in parallel

- 4 Turn on the switch. Do any of the bulbs light up? Are they brighter, less bright or the same brightness as the single bulb?
- 5 Connect a third bulb (Bulb 3) into the circuit as shown in Figure 8.34.

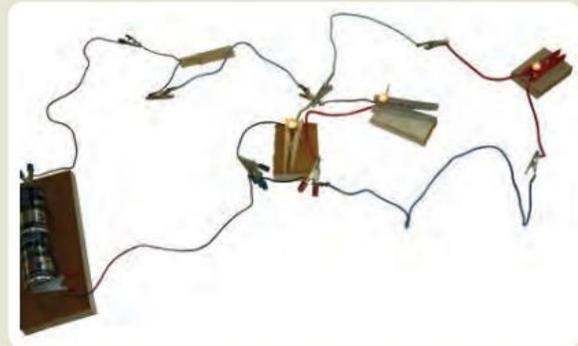


Figure 8.34 A switch, three bulbs and two cells connected in parallel

- 6 What do you observe when you turn on the switch?
- 7 Keep the switch on and remove one of the bulbs. What happens?
- 8 Connect this bulb again. Remove a different one. What happens?
- 9 What conclusion can you draw?

Comparing series and parallel circuits

Series circuits

- The electricity always flows through the whole circuit.
- Adding more bulbs makes bulbs burn less brightly.
- Removing a bulb breaks the circuit. No electricity can flow and all the bulbs go out.

Parallel circuits

- The electricity flows through all the parallel branches.
- Adding more bulbs creates more branches for the electricity to flow through.
- Removing a bulb causes a break in only one branch. The electricity can still flow through the other branches. The bulbs stay lit.

Circuit diagrams

By the end of this topic, you should be able to:

- 7.8.2.1** identify the basic components, such as a battery, bulbs and switches, and how they are represented in a circuit diagram
- 7.8.5.1** identify the main parts of a systems diagram
- 7.8.8.2** draw components correctly in a circuit diagram.

A drawing of an electric circuit using **symbols** is called a **circuit diagram**. It is difficult to do real-life drawings of complicated circuits with many different components. Consequently, in circuit diagrams we use symbols to represent the components.

In a circuit diagram, a symbol is used for each component in a circuit. Figure 8.35 shows some symbols for the basic components you have learnt about so far.

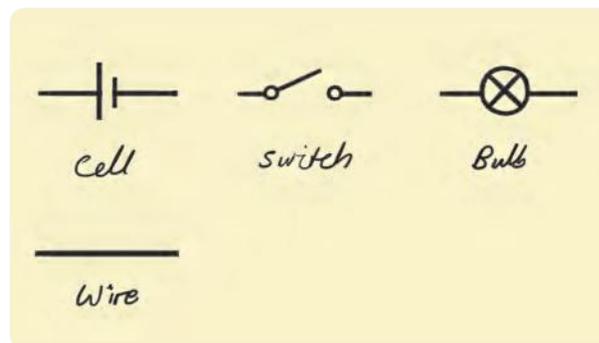


Figure 8.35 Component symbols

Look at the real-life circuit shown in Figure 8.36. The standard symbols for the components are shown beside each. Then look at Figure 8.37, which shows the same circuit drawn as a diagram.

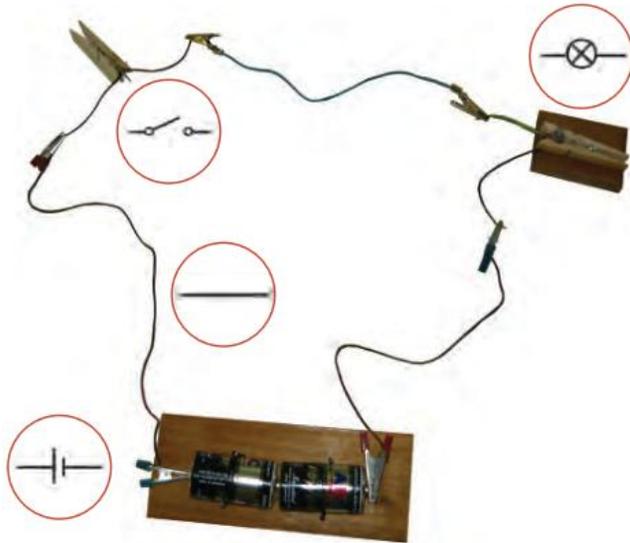


Figure 8.36 Simple circuit

How to draw a circuit diagram

To make the circuit diagram, you draw lines between the components. Figure 8.37 is the completed circuit diagram. The lines joining the components represent the connecting wires.

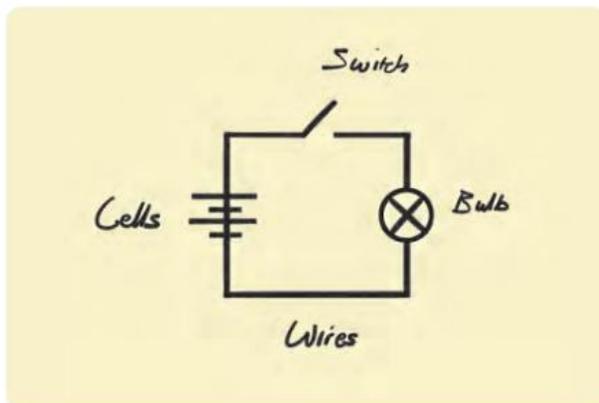


Figure 8.37 Circuit diagram

Activity 7: Drawing a circuit diagram using standard symbols

The circuit shown in Figure 8.38 uses real-life components.

- 1 Is this a series or a parallel circuit?
- 2 How many cells are in the battery?
- 3 What controls the circuit?
- 4 If the circuit works properly, how many bulbs will light?
- 5 In your exercise book, draw a circuit diagram for Figure 8.38, using symbols for the cells, bulb, wires and switch.
- 6 Compare your diagram with those of your friends. Talk about the differences in your diagram. Would they be able to make the circuit work, using your circuit diagram?

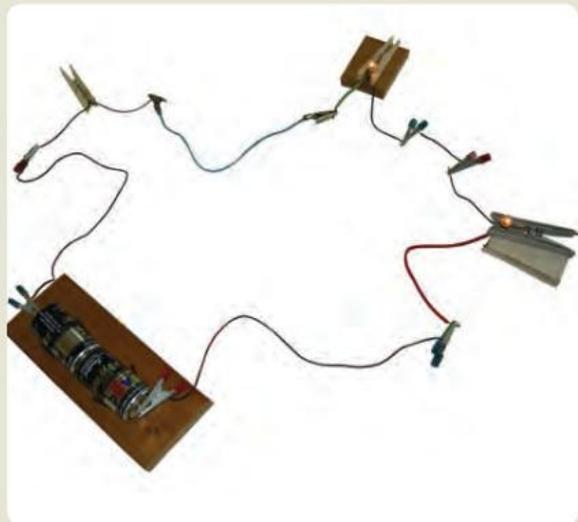


Figure 8.38 Two cells and two bulbs connected in series

Activity 8: Designing, making and evaluating circuits

You will need:

- 2 cells
- 2 torch bulbs
- 2 bulb holders
- wire.

- Imagine that you want two lights in your room, so that:
 - you can switch them both on and off at the same time
 - they are as bright as possible
 - if one bulb breaks or is removed, the other remains on.
 - Design a circuit that meets your needs.
 - Draw a circuit diagram of the circuit.
- Indicate with arrows where you will put a switch that allows either one or two bulbs to be lit up.
- Test your ideas on the circuit you have described.
- Which type of circuit is this—series or parallel?

Systems diagrams

When you connect the components in a simple circuit, energy stored in the cells make electricity flow. The result is heat and light. This is called an **electrical system**. What you put into a system is



called the input. In the case of the simple electric circuit, the input is the energy from the cell or battery. There is also an output. This could be light and heat from a bulb. You can control the output by using switches. This is called the process. An electrical system is made up of various components, such as wires, switches, bulbs and cells.

You can show a system by drawing a systems diagram.

As in every system, an electrical system has three parts.

- 1 input: what goes into the circuit;
- 2 output: what comes out of the circuit;
- 3 process: how the input changes into the output.

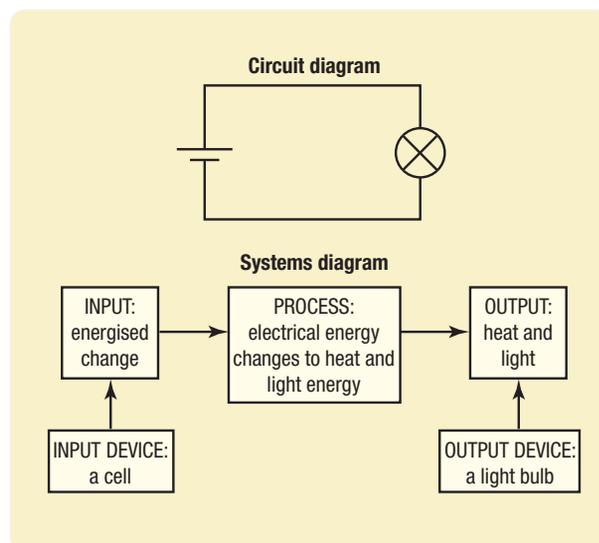
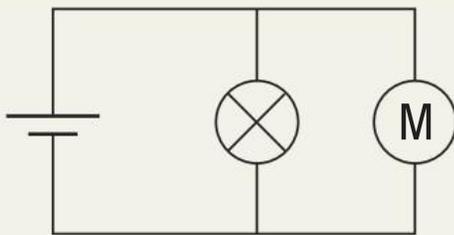


Figure 8.39 Diagram for a simple circuit

Electricity is the flow of particles in a wire. These particles are called **electrons**. The electrons get the energy for movement from the cell. So the cell that provides the energy is the input device. When the electricity flows through the light bulb, the energy stored in the cell is changed into heat and light. Heat and light are the output. The light bulb is the output device.

Activity 9: Drawing a systems diagram

Look at the systems diagram shown in Figure 8.39 and study the circuit below. The only difference between this circuit and the systems diagram is that there are two output devices. Are the output devices connected in series or in parallel? Draw a system diagram for the circuit shown below.



Uses of electricity

By the end of this topic, you should be able to:

7.8.6.1 identify the uses of electricity in Solomon Islands

7.8.8.3 connect up a plug correctly.

In this chapter, you have worked with simple electric circuits. You have used cells as the source of electricity.



Figure 8.40 Some types of cells

We obtain the electricity for our houses and shops from power stations or from **solar panels**. In towns, most electricity comes from a power station. In the power station, a machine called a **generator** is used to **convert** energy from fuel into electrical energy.



Figure 8.41 A generator in a Honiara power station

In most villages, electricity is obtained from solar panels.



Figure 8.42 A solar panel at Marara Clinic

Figure 8.43 shows a diagram of a solar panel, which is a collection of **photovoltaic cells**. Each cell has two layers of different materials. When light falls on the cell, electrons move from one layer to the other. This is the electric current.

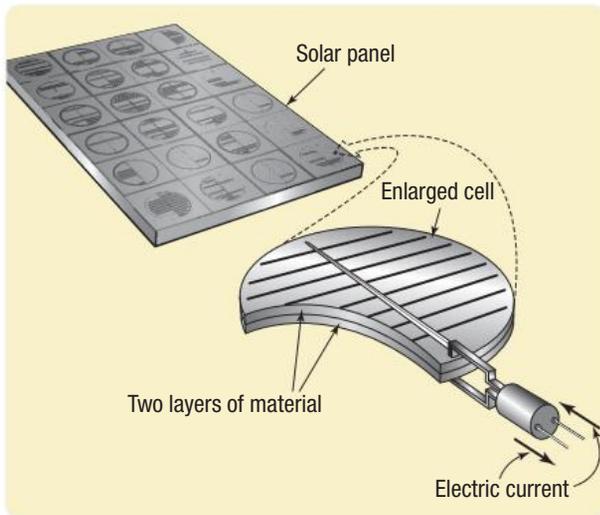


Figure 8.43 A solar panel

How do the devices get their electrical energy? In the simple circuits that you constructed earlier, you connected the device (a bulb) to a cell with wires. We also connect the devices in our houses and shops to the electrical supply, using wires.

There is a special way of connecting the devices to the **electrical supply network**—we use a plug.



Figure 8.44 Some common devices for which electricity is the energy source

Figure 8.45 shows an electric kettle. Notice the wire running from the back of the kettle to the power point in the wall.



Figure 8.45 Electric kettle

The power point is the connection point to the source of the electricity. The plug from the device goes into the power point. How does electricity come to the power point? As in a simple circuit, wires carry the electricity to the power point. The wires come from the power station.

In towns, there is a big network of wires (**electric cables**) carrying electricity from the power station to all the houses that need it. The Solomon Islands Electricity Authority (SIEA) uses special equipment to connect the cables to houses. Figure 8.47 shows the **electric poles** and electric cables running to a building. You must never touch any of these poles, cables or boxes. The electricity in the cables is very dangerous because it has high energy. Always pay attention to signs such as the one in Figure 8.46.



Figure 8.46 Step-down transformer and warning sign

The box on the wall in Figure 8.47 is where the cables connect to the wires in the building. You can see the ends of the cable in the box. The cables in the building run to all the power points—where you connect electrical devices to the electrical circuit.



Figure 8.47 SIEA power lines connected to a building

Activity 10: Wiring a plug

You will need:

- three-pin plug
- three-ply cable
- scissors or pliers.

1 Figure 8.48 shows a three-pin plug.



Figure 8.48 Three-pin plug

Take a three-pin plug apart. You will see that it consists of three parts (base with connection, cover and lock screw).



Figure 8.49 Three-pin plug disassembled



Figure 8.50 The insulation removed from the three-ply wire

You will see three wires uncovered; brown, blue and green/yellow.

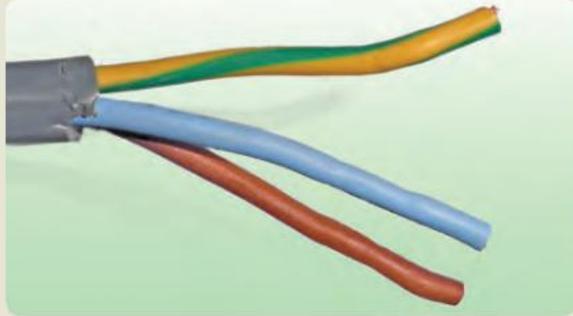


Figure 8.51 Three wires uncovered

2 Slide the lock screw onto the cable, then slide the cover on.



Figure 8.52 Sliding the cover and lock screw in the cable

3 Uses scissors or pliers to make a small cut around the insulating cover of each wire.



Figure 8.53 Cutting the insulator from each wire

4 Twist each multi-strand wire tightly.

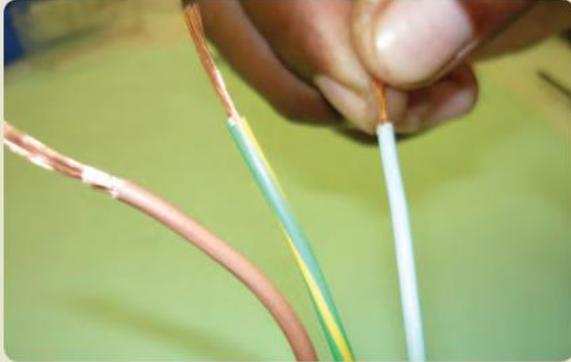


Figure 8.54 Once the multi-strand wires are twisted tightly and securely they are ready for use.

5 Loosen each screw in the plug base, but not so much that they come out.



Figure 8.55 Loosening the screw in the base of the plug

6 Feed the wire into the top of each connector.



Figure 8.56 Inserting wires into the top of connectors

7 Tighten each screw onto each connector. This keeps each wire secure.

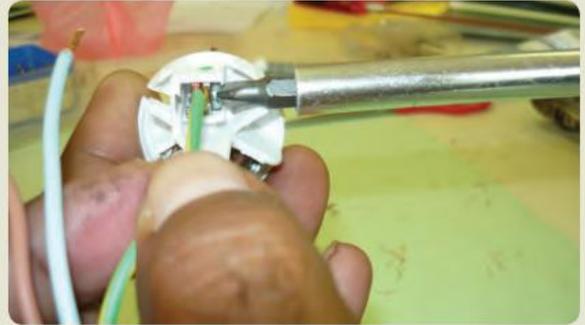


Figure 8.57 The screws are secured and tightened into the connectors of the plug.

You have made a plug with all three wires securely connected.

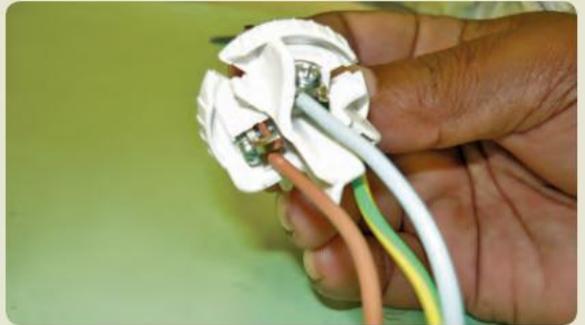


Figure 8.58 Wires secured firmly into the connectors of the plug

8 Loop each wire round its safety holder.



Figure 8.59 The wires should be looped around the holder on the base of the plug.

- 9 Press the cover over the base and wires until the base is fully inside the edge of the cover.



Figure 8.60 Pressing the cover over the base of the plug

- 10 Screw the lock screw onto the end of the cover.



Figure 8.61 Lock the screw tightly at the end of the plug cover ready for use.

- 11 The plug is now ready for use in a power point.



Figure 8.62 The plug in use

In Book 8, you will learn more about town and village electrical systems. You will also learn about electricity generation.

Practical task

By the end of this practical task, you should be able to:

- 7.8.7.1 design and construct an electric circuit model to address the need for light in traditional kitchens in both rural and urban settings in Solomon Islands
- 7.8.10.1 investigate the impact of electricity in Solomon Islands society.

Go back and read the design problem at the beginning of this chapter. You are going to solve that design problem.

Design problem: model electric circuit

Design expectations

The following must be considered in the development of the model electric circuit:

- The kitchen must have one door.
- The room must be wired for two lights—one on the roof and one on the wall.
- That the lights can be turned on/off either separately or together.

Investigating

- Select the materials that you will use in constructing your model kitchen.
- Look for the type of switch you will use. Look for the possible type of circuit you will use.
- Look at different types of battery that are available in your community.

Designing

- Draw the circuit diagram(s) of the circuit you want to use.
- Make a 2-D drawing of the kitchen and decide where you want to place each component.
- Make a list of the things you will need for the model kitchen and your circuit.

Making your model electric circuit

- Build the model of the kitchen.
- Connect the circuits and fix them in your model kitchen.

Testing your model electric circuit

- Can both lights be switched on at the same time?
- Can each light be switched on individually?
- Are the lights fixed securely and safely?

Evaluating your work

Answer the following questions in your exercise book.

- 1 What did you do to build your model kitchen?
- 2 Is the structure of the model kitchen strong and neat?
- 3 Make a labelled drawing showing the materials you used to make the door and how you fixed it to the wall or frame.
- 4 How did you decide to position the two lights?
- 5 Is the wiring in the model kitchen neat? Did you hide the wires in some way?
- 6 Is the wiring safe?
- 7 What kind of switch did you use for the two lights? Why?
- 8 Have you learnt anything from other people's designs that will help you to improve your circuits?
- 9 What would you change from your design if you were wiring a real kitchen?

Communication and marketing

- 1 How would you communicate the importance of the skills you have learnt from this chapter to people who are in need of electricity?
- 2 What **marketing strategy** would you use to communicate the importance of a career in electricity to your classmates?

New words used in this chapter

barrel	thread-like part at the bottom of a light bulb
bulb holder	special item used to hold a bulb when in it is in use
cells	dry batteries similar to those seen in shops
circuit diagram	drawing of an electrical system and its path/route
components	parts
concepts	ideas
convert	change
electric cables	wires used to transfer electricity to households etc.
electric circuit	route/path of electricity
electric pole	tall galvanized pipe used to support electric cables
electrical supply network	electricity system
electrical system	flow of electricity
electrons	floating part of an atom that has a negative charge
generator	engine or mechanical device used to produce energy
insulation	material used to protect the user from electrical shock, e.g. rubber
investigate	look into, examine
loop	circle
marketing strategy	plan used to sell a product or solution
model	representation, or a small 'look-like' image
photovoltaic cells	black part of the solar panel that changes light into electricity
plug	electrical part that gives the current access to the product
power stations	buildings that house the generators for electricity
solar panels	specially made packages used to store sunlight energy
switch	electrical part used to turn on or turn off the electricity
symbol	sign
wrapping	covering, packaging

Chapter 9

Graphic design

Learning outcomes

By the end of this chapter, you should be able to:

- 7.9.1.1** identify the basic elements of design
- 7.9.1.2** explain the design elements
- 7.9.2.1** identify the tools used in graphic design
- 7.9.3.1** produce shading on simple three-dimensional objects
- 7.9.4.1** identify how colour patterns are created
- 7.9.5.1** design and make a graphic design product to address a home or office or business need
- 7.9.5.2** make one of the following product: a small calendar, a small advertisement, a small pocket notebook, or a similar product to suit school or community situations
- 7.9.6.1** use colours from the colour chart to develop colour patterns
- 7.9.6.2** make shadings on signs and symbols drawn
- 7.9.7.1** use instruments and equipment correctly in a graphic design production
- 7.9.8.1** investigate the impact of graphic designed products as a communication tool in your community.

Introduction

Look at the signs in Figure 9.1. You can see them in most public places in Honiara. Do you know what they mean?



Figure 9.1 Signs in public places in Honiara



The signs in Figure 9.1 are called **graphics**. Graphics like these give information. This way of giving information is called **graphic communication**. In Solomon Islands we also have our traditional graphics, which in the past were used to communicate messages especially in a rural community. However, some of them are still used today, such as traditional tattoos, and patterns woven on traditional baskets and mats.

The design and the type of shading are the basic elements of modern graphic communication.

Design problem: Calendar

A calendar is an important and useful item. Some people use calendars for record keeping, for example recording dates of events, while others may use them for planning future events. Calendars are normally bought from shops but they can also be made. You can make your own calendar and use it at school for recording dates for assignments, tests and projects. At the end of this chapter you should be able to design and make a calendar to be used by students for school purposes.

Elements of graphic design

By the end of this topic, you should be able to:

- 7.9.1.1 identify the basic elements of design
- 7.9.1.2 explain the design elements
- 7.9.3.1 produce shading on simple three-dimensional objects
- 7.9.4.1 identify how colour patterns are created
- 7.9.6.1 use colours from the colour chart to develop colour patterns
- 7.9.6.2 make shadings on signs and symbols drawn.

Activity 1: Making decisions

- 1 Look at the this photo of different types of wristwatches.



- 2 Select the wristwatch you would like to buy. Write down two reasons for your choice.

For most people a watch is actually more than just a device for **tracking time**. It is also a **fashion accessory** or a sign of personal wealth, and has an appeal for the user that affects his or her feelings and **emotions**. The user gains satisfaction and enjoyment from wearing a watch. The qualities of a product that affect our feeling and emotions are called its **aesthetics**.

Aesthetics are not just about the way something looks. They are also about the feel of the product, such as its weight, the sound it makes, the **environment** it creates and so on.

It would be impossible to design and make a product that is pleasing to everyone because we all have different likes and dislikes. What are some factors that affect a person's likes and dislikes, or taste?

Our taste can be **influenced** by a range of factors. When designing a product, it is therefore important to have a good understanding of the type of people who will be using it as well as the basic ideas of aesthetics. This year, you will learn only about line, shape, form, colour and shading.

Activity 2: Using lines for communication

Look at the following photos. The items can be represented by simple lines. Using as few lines as possible for each item, communicate the idea presented in each photo in your exercise book.



Lines

Lines can be thought of as the basic element of aesthetics. A line indicates position and direction as the eye moves along it to see where it is leading. The arrangement of lines can suggest movement and can cause various feelings, such as excitement, calmness and so on.



Figure 9.2 Use of line in the design of a building

Shape

When lines enclose an area, a shape is created. A shape has two dimensions: length and breadth.

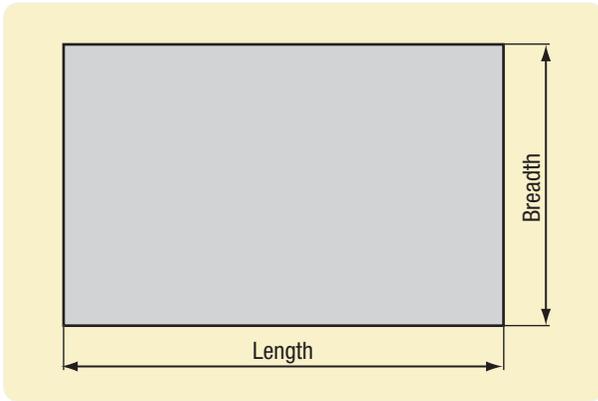


Figure 9.3 A shape has length and breadth.

Regular shapes, such as squares, circles and triangles, are balanced and appear static—that is, not moving.

Form

A shape that is given a thickness is a form. A form has three dimensions: length, breadth and depth.

The sphere, cone, cylinder and rectangular block are common geometric forms. These forms are sometimes called primitives. Primitives can be combined in various ways to create a **complex** object.

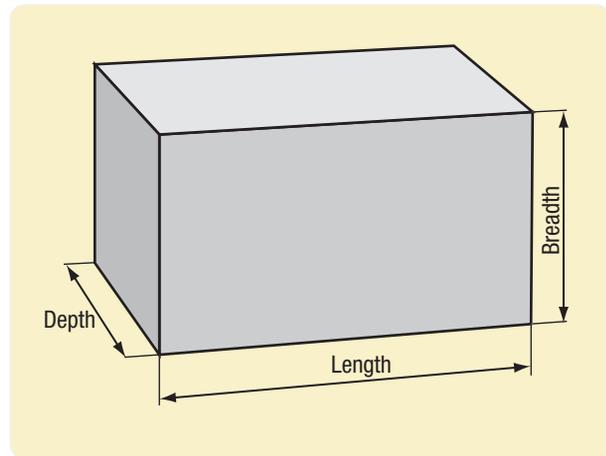


Figure 9.4 A form has length, breadth and depth.

Activity 3: Making a shape

You will need:

- blank sheet of paper
- pencil
- scissors.

- 1 Take a piece of blank paper and a pencil. Draw a line randomly on the paper to create a number of interlocking shapes.
- 2 Use your pencil and shade one or two shapes that you think interesting.
- 3 Select one of the shapes and transfer it onto another paper and cut a number of that shape out. Can you join these shapes to form another larger shape?

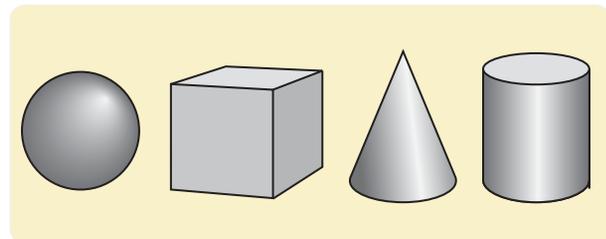


Figure 9.5 Common primitives

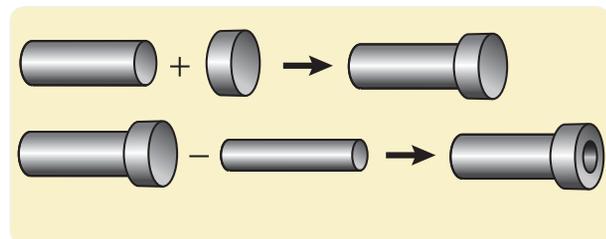


Figure 9.6 Complex object made from the common primitive shapes

Using shading to show light and dark

Figure 9.7 shows what an object looks like when light shines on it. The surfaces that face light appear brighter than the other surfaces. To make drawings of an object look **realistic**, we use shading to show which surfaces are brighter and which are darker. Shading indicates the shape of an object clearly. The cylinder in Figure 9.8 is more realistic than the cylinder in Figure 9.9.

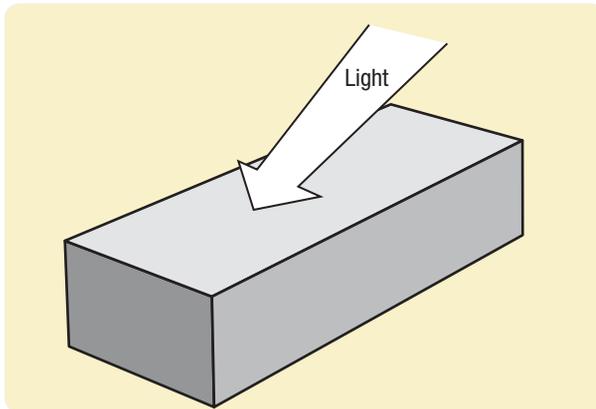


Figure 9.7 The light is shining from above the block, so the top surface is brighter than the sides.

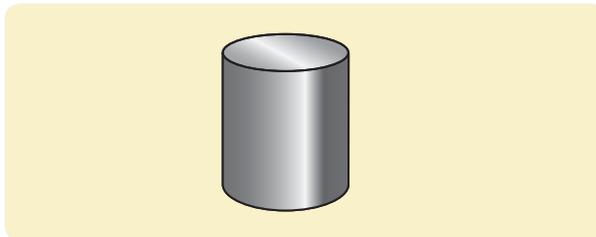


Figure 9.8 Shading indicates the shape of an object clearly.

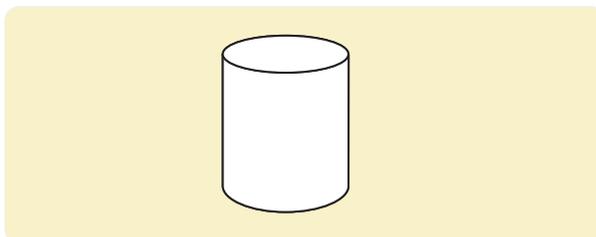


Figure 9.9 Without shading, this cylinder does not look realistic. It looks flat, like a 2-D drawing.

Different types of shading

By using different types of shading, drawings can be made to look more realistic (like the real thing) and easier to understand. Look at the different types of shading in Figures 9.10 to 9.12.

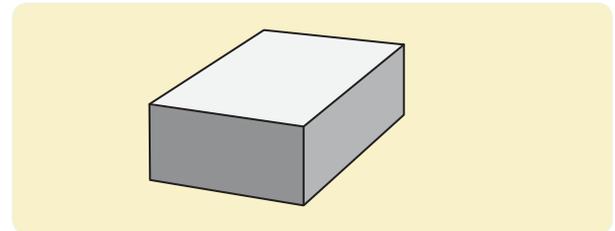


Figure 9.10 This type of shading gives an even effect.

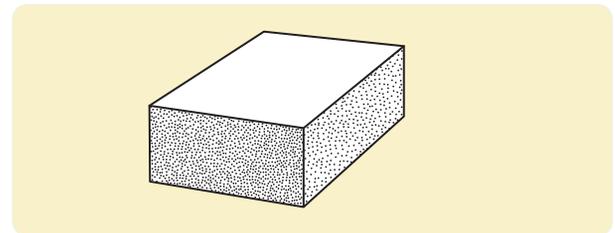


Figure 9.11 This type of shading uses **dots** and different spaces between the dots.

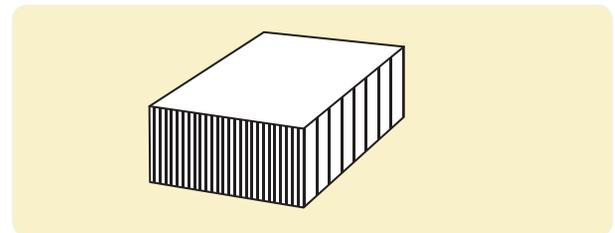


Figure 9.12 This type of shading uses straight lines and different spaces between the lines.

How to shade with pencil

- 1 If you are drawing an object, look for bright areas on the object and draw what you see. If there is no **obvious** bright or shaded areas, or if you are not drawing an actual object, you can decide from which direction the light will fall on your object.

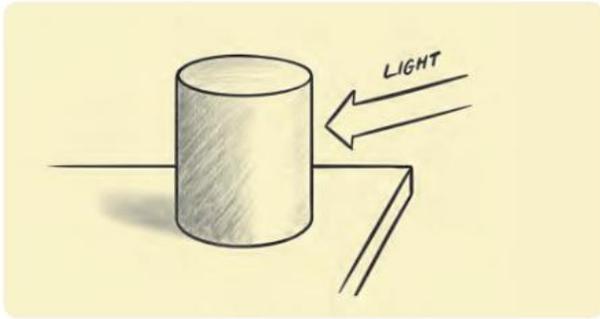


Figure 9.13 Light casting on a cylinder

- 2 Use a pencil with a round blunt point. This will give you a thick line for shading.



Figure 9.14 A round, blunt tipped pencil is best used for shading.

- 3 Hold the pencil higher up than you would for writing. Relax your hand.



Figure 9.15 When drawing, the way in which you hold your pencil is important.

- 4 Press down on the pencil gently, using small movement in small flat loops or parallel lines. Keep moving your pencil over the paper.



Figure 9.16 Shading the cylinder

- 5 Do not shade using **patches** of parallel (side-by-side) lines.

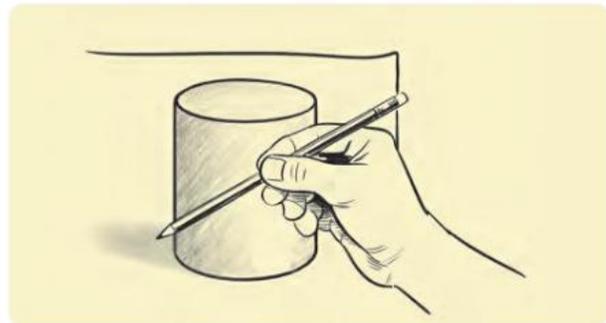


Figure 9.17 Use the side of the pencil tip to create the illusion of a shadow.

- 6 If you want areas of darker shading, go over the drawing again and again. Or you can press down slightly harder when you shade.

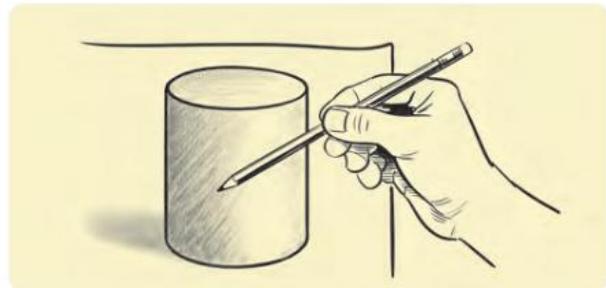
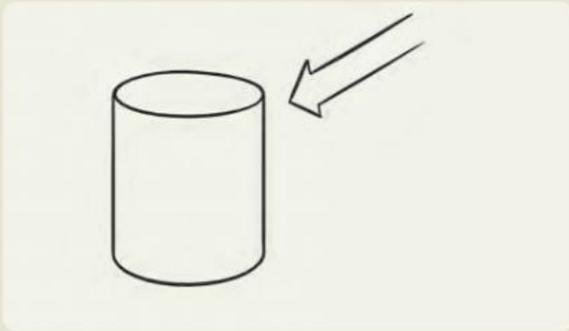
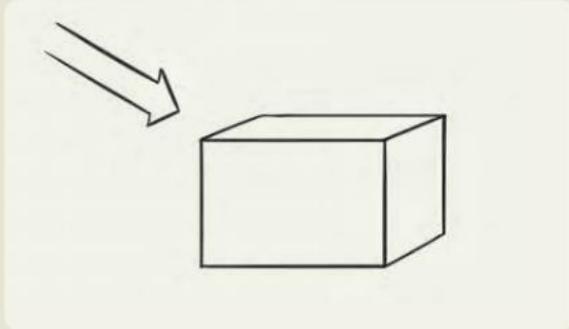


Figure 9.18 Darken your shading in some areas by pressing harder with the pencil.

Activity 4: Applying simple shading

- Copy the following illustrations into your exercise book. Use the technique described in the section called 'How to shade with pencil' on page 143 to apply shade to the illustrations. The arrows indicate the direction of light.



- Give your work to another learner and complete the table below.

	Yes	No
1 Did the shading follow the direction of light?		
2 Does the drawing look realistic?		
3 Do you think the shading on the object needs improvement?		

DO NOT WRITE IN THIS BOOK

Colour

Colour plays a large role in making a design look attractive. It can be key to the success or failure of a product. Colour may be used to draw our attention to some things and hide other things. Different colours have different meanings or associations. Certain colours can help to create an environment that has a warm or a cool feel to it.

Different colours can be produced by combining the primary colours of red, blue and yellow. When two primary colours are mixed in equal amounts, a secondary colour is produced. The secondary colours are green, violet and orange.

When a primary and a secondary colour are mixed, a tertiary colour is produced, giving a total of six tertiary colours.

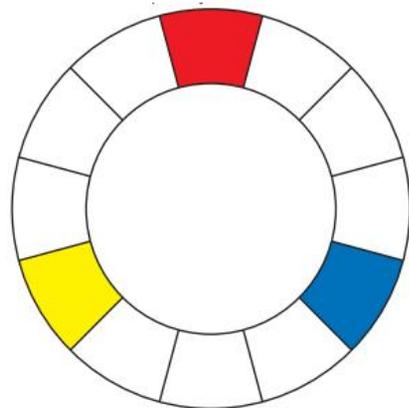


Figure 9.19 Primary colours

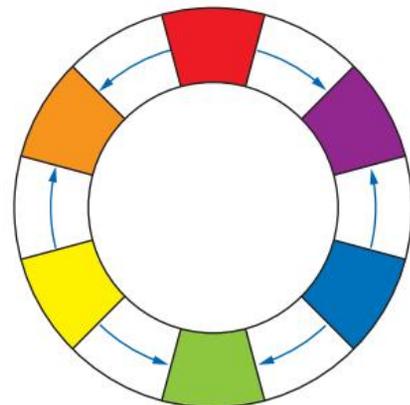


Figure 9.20 Secondary colours

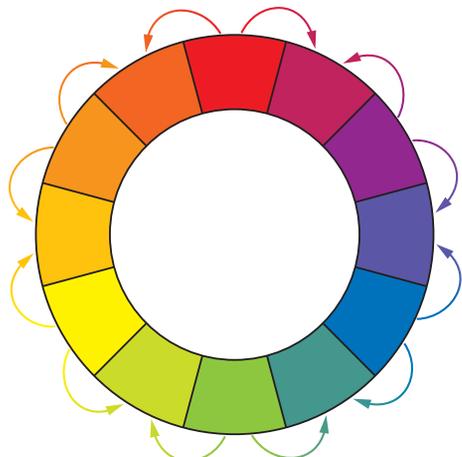


Figure 9.21 Tertiary colours

Activity 5: Finding out about colour

- 1 Make a chart to explain colour, using a blank sheet of paper.
 - a Collect examples of the three primary colours and paste them on the sheet of paper under the heading 'The primary colours'.
 - b Collect examples of the three secondary colours and paste them on the sheet of paper under the heading 'The secondary colours'.
 - c Collect examples of the six tertiary colours and paste them on the sheet of paper under the heading 'The tertiary colours'.
- 2 Show which primary and secondary colours mix to make each tertiary colour, using arrows to join the colours.

Practical task

By the end of this practical task, you should be able to:

- 7.9.2.1 identify the tools used in graphic design
- 7.9.5.1 design and make a graphic design product to address a home or office or business need
- 7.9.5.2 make one of the following product: a small calendar, a small advertisement, a small pocket notebook, or a similar product to suit school or community situations
- 7.9.7.1 use instruments and equipment correctly in a graphic design production
- 7.9.8.1 investigate the impact of graphic designed products as a communication tool in your community.

Go back and read the design problem at the beginning of this chapter. You are going to solve that design problem.

Design problem: Calendar Design expectation

The following must be considered in the development of the calendar:

- All the months of the year must be included.
- All the public holidays of the year must be marked. Holidays should be marked differently from the days of the year.
- Each month should have some form of design element.

Investigating

- Look for three different types of calendars in your community.
- Write down three strengths and three weaknesses of each calendar.
- Look at how each calendar marks the public holidays .
- Look at the designs on each calendar.
- Decide who would use each calendar.
- Work out how each **publisher** made the calendar.

Designing

- Write a simple design brief for the calendar.
- Do at least three different sketches for the pages of each type of calendar. Then select which one you are going to make. Write down two reasons for your choice.
- Use design drawing instruments to draw the overall layout of the selected design. Make sure to write notes on your drawing.
- Write down the steps you will follow when making your calendar. List the tools you are going to use in each of the steps. You should discuss this with your teacher or a friend.
- Write down the safety precautions you will take in the steps you have listed. Again, you should discuss this with your teacher or a friend.
- Write down a simple plan for how long each stage will take.

Making your calendar

- Using your drawing as your guide, make your calendar.
- Follow the steps you listed above. Always check with your teacher at each step.
- Use appropriate tools in each step.

Testing your calendar

- Place the calendar somewhere in the classroom for your class to see.
- Does it do the work it is supposed to do?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Does the colour you selected for the pages look good or bad?
- 2 How do you feel when you look at the calendar?
- 3 What are the strengths of your calendar?
- 4 What are the weaknesses of your calendar?
- 5 Look back at the design expectations. Does the calendar fit the design? In what ways?
- 6 Does your calendar look neat?
- 7 Is the size of the calendar appropriate for its purpose?
- 8 Did the construction or making of the project take a lot of time? If yes, why?
- 9 What have you learnt from others' calendars?
- 10 What would you change from your design if you were going to make another calendar?

Communicating and marketing

- 1 Who are the possible users of the calendar?
- 2 How much would you sell your calendar for?
- 3 What benefit/s does your calendar have for the users?
- 4 What marketing technique/s would you use to sell your calendar?

New words used in this chapter

aesthetics	relating to ideas of beauty
complex	difficult, or not easy
dots	points, spots
emotions	feelings
environment	surroundings or situation
fashion	fashionable clothing or related
accessory	product
graphic	way of giving information
communication	

graphics	symbols or signs that identify or give information
influenced	affected
obvious	evident, noticeable
patches	areas
publisher	person who produces a book
realistic	practical, sensible
tracking time	checking time

Chapter 10

Plastics technology

Learning outcomes

By the end of this chapter, you should be able to:

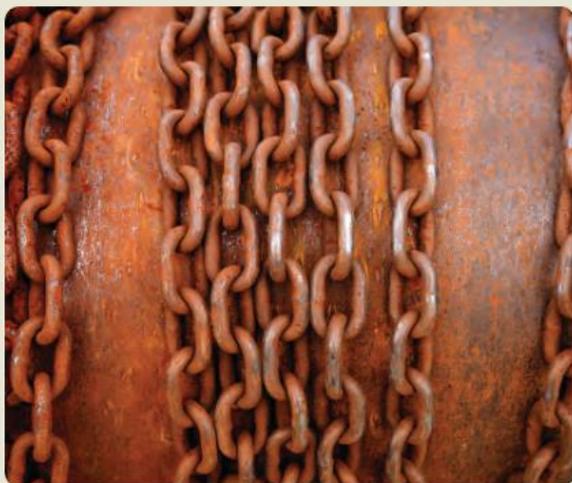
- 7.10.1.1** list some of the properties of plastic materials
- 7.10.1.2** list the different types of thermoplastic
- 7.10.1.3** explain the uses of the different types of thermoplastic
- 7.10.2.1** describe the physical properties of the different types of thermoplastic
- 7.10.3.1** explain the working processes of thermoplastics
- 7.10.4.1** describe the tools used in the working processes of plastics
- 7.10.5.1** describe the general safety procedures related to plastics
- 7.10.6.1** describe some thermoplastic materials
- 7.10.6.2** explain the working processes of thermoplastics
- 7.10.7.1** design and make a plastic product to address a personal need
- 7.10.7.2** make one of the following products using PVC pipe: toothbrush and paste holder, clothes hanger or similar product to suit a school or community situation
- 7.10.8.1** apply the correct safety measures when working with PVC pipe
- 7.10.8.2** measure, mark, cut, apply appropriate finishing and assemble plastic parts correctly
- 7.10.9.1** use tools correctly during the working processes of PVC pipe
- 7.10.10.1** investigate and discuss the advantages and the disadvantages of thermoplastic products in your community.

Introduction

In the past, many things were made of wood. Slowly people begin to **search** for new materials to make things that would last longer, be more useful and be easier to handle.

Activity 1: Comparing plastics with other materials

Look at the following photos then answer the questions in your exercise book.



- 1 As you can see, wood and metals have certain disadvantages. Write down three disadvantages.
- 2 List three reasons why plastic may be a better material for making certain things than wood or metal.

Most plastics are obtained from a combination of chemicals and **crude oil**. Crude oil is a naturally occurring **flammable liquid** found in rocks. Petrol and diesel are made from crude oil. Different types of plastics can be obtained by slightly altering the production process. Plastics can be divided into two groups: **thermoplastics** and thermosetting plastics. You will learn about thermoplastics in this chapter.

Today plastics are used in the production of nearly all types of products, from chairs, tables, shoes and clothing to buildings, cars, aircraft and boats.

Design problem 1: Toothbrush and soap holder

Peter and his wife complain that everyone leaves the soap, toothpaste and toothbrushes lying around in their bath area. They have to look for the soap, the toothpaste and their toothbrushes every time they want to use them.

Design problem 2: Clothes hanger

Family members need to have some clothes hangers in order to keep their clothes neatly in their rooms—however, clothes hangers in the shops are very expensive.

At the end of this chapter, you will select one of the design problems described and solve it. In order to help you solve any of these design problems, you must learn some of the basic knowledge, skills and the processes required to make a product in response to the design problem. You will use a thermo-plastic to make a product in response to one of the design problems above.

Tools and equipment used in this chapter

Drill
Files
Hacksaw
Mallet
Mould
Primus/candle

Materials used in this chapter

Glass paper
Pencil or scribe
Piece of 50 mm PVC pipe
pipe

Types of plastics and their properties

By the end of this topic, you should be able to:

7.10.1.1 list some of the properties of plastic materials.

The term 'plastics' is used for a family of materials. Each branch of the family has certain characteristics. However, whatever the properties or form, all plastics fall into one of two groups: thermoplastic and thermosetting. Figures 10.1 and 10.2 show examples of products made from these groups.

Thermoplastics soften when heated and harden when cooled. When heated, they can be shaped or moulded. They can change to a different shape quite easily when heated and change back to its original shape or form when reheated.



Figure 10.1 A product made from thermoplastic in Solomon Islands



Figure 10.2 A product made from thermosetting in SI

Thermosetting plastics, are cured (set) into permanent shape by heat. They become soft or burn if reheated, but cannot be reshaped.

In Year 7, you will learn about thermoplastics. Some types of thermoplastics can be heated to high temperatures without being changed very much. However, if temperature is too high, thermoplastics will melt. Some of them may even burn.



Figure 10.3 If a thermoplastic is overheated, it will burn and melt.

Activity 2: Finding about the properties of thermoplastics and thermosetting plastics

- 1 Look Figures 10.1 and 10.2. Explain why the product in Figure 10.1 is made from thermoplastic and the product in Figure 10.2 is made of thermosetting plastic.
- 2 In groups of three or four, collect three plastic products from your classroom, school or home. Name the products. In your groups, copy and complete the following table in your exercise book.

Product name	Thermoplastic or thermosetting?	One reason why

- 3 Write down three useful things about this product. How may they spoil the environment?



There are many types of thermoplastics. You will learn about two of them:

- acrylic
- polyvinyl chloride (PVC).

Types of thermoplastics

By the end of this topic, you should be able to:

7.10.1.2 list the different types of thermoplastics

7.10.1.3 explain the uses of the different types of thermoplastics

7.10.2.1 describe the physical properties of the different types of thermoplastics.



Acrylic

We can buy **acrylic** in the form of sheets, which may be clear or coloured. Clear acrylic is like glass, but it does not break as easily as glass. Coloured acrylic can be **tinted** so you can see through the colour, or **opaque**, so you cannot see through it.

Acrylic is easy to work with. It is light and strong, and can be used outdoors. Figure 10.4 shows you some of its uses.

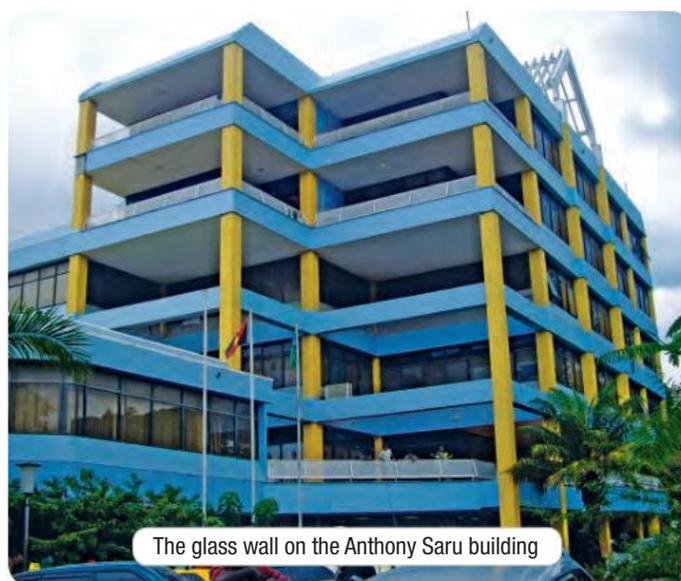


Figure 10.4 Uses of acrylic plastic

PVC

Many items are made of PVC, which is a very useful material. Some types of PVC are soft and can be bent easily because they are **flexible**.

There are also other types of PVC, which are hard. These are used to make water or liquid containers, and electrical trunking (small PVC pipe in which electricity cabling is carried).

Electricity cannot pass through PVC—PVC is an insulator and therefore is used to cover electrical wires.



Activity 3: Softening and straightening PVC pipe

You will need:

- piece of 50 mm PVC pipe
- hacksaw
- primus/candle
- mallet.

- 1 Measure the PVC pipe to the correct length.
- 2 Use a hacksaw to cut the PVC pipe to the required length.

Figure 10.5 Uses of thermoplastics

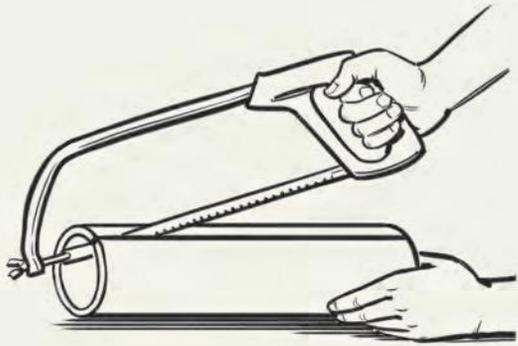


Figure 10.6 A hacksaw cutting a piece of round PVC pipe

- 3 Apply heat underneath the opening as shown in the photo below. As you apply heat, hit the heated part with a mallet so that the round PVC can bend and flatten. Applying too much heat will burn the PVC pipe. Repeat this until the round PVC pipe is flattened as shown in Figure 10.7.

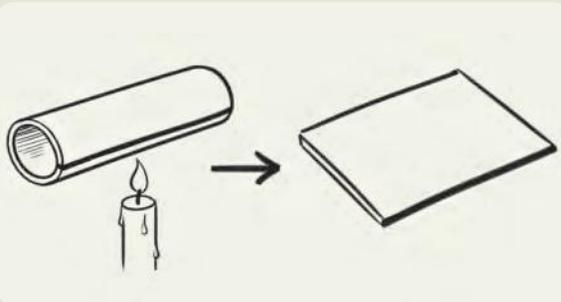


Figure 10.7 Heat from a candle will flatten a round PVC pipe.

- 4 Keep the flattened piece of PVC pipe in a safe place, as you will need to use it later.

Working with PVC pipe

By the end of this topic, you should be able to:

- 7.10.3.1 explain the different working processes of thermoplastics
- 7.10.4.1 describe the tools used in the working processes of plastics
- 7.10.5.1 describe the general safety procedures related to plastics
- 7.10.6.1 describe some thermoplastic materials
- 7.10.6.2 explain the working processes of thermoplastics.

In the next activity you will work through the following steps to make a product successfully: marking out, cutting, shaping and drilling and finishing. You will work individually with the **appropriate** tools, observing safety precautions when necessary.

How to make a clothes peg with PVC pipe

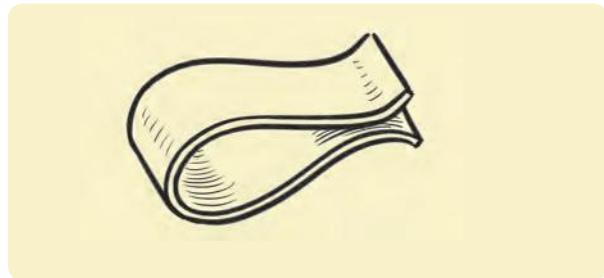


Figure 10.8 A clothes peg made from PVC pipe

- 1 Using a hacksaw, cut the required length of PVC pipe.
- 2 Cut along the length of the PVC pipe as shown in Figure 10.9.

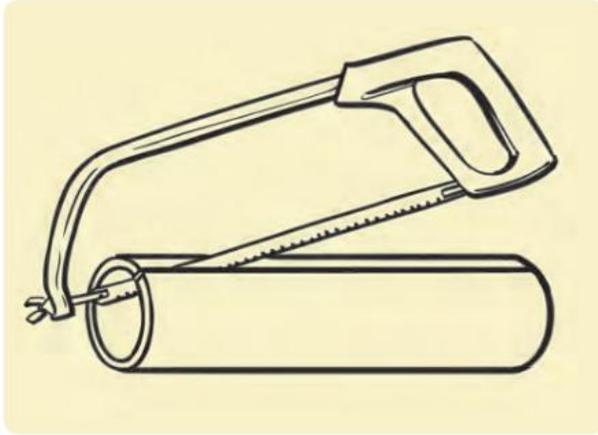


Figure 10.9 A round PVC pipe cut along the length

- 3 Apply heat at the centre of the of the cut PVC pipe as shown in Figure 10.10. You can use a primus, stove or candle as your source of heat. Another way to flatten a round PVC pipe is by using hot water. Check with your teacher if you wish to use this method.

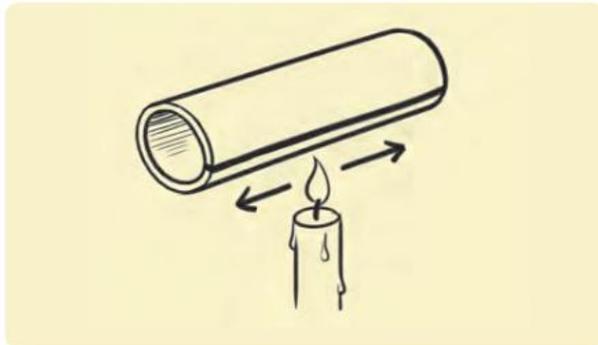


Figure 10.10 Applying heat to PVC pipe

- 4 When heat is applied to the PVC pipe, the part of the pipe that is in contact with the heat becomes softened and can be flattened easily. Apply heat evenly until the pipe is flat and straight as shown in Figure 10.11.

Note: The heated PVC pipe is very hot. Make sure you use gloves when you hold this pipe.

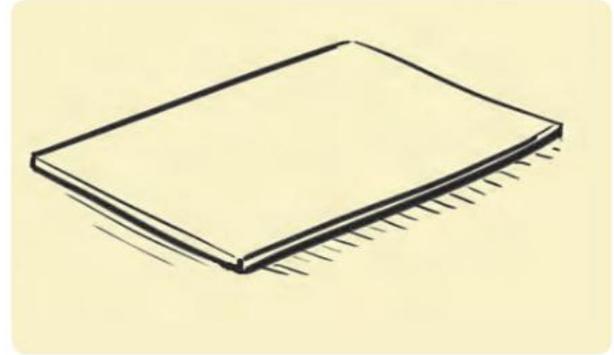


Figure 10.11 A flat piece of PVC pipe

- 5 Use a hacksaw to cut the required length of the flat PVC pipe.
- 6 Apply heat again and bend the shape in a mould, and leave it to cool. Figure 10.12 shows a peg after it is heated in a mould.

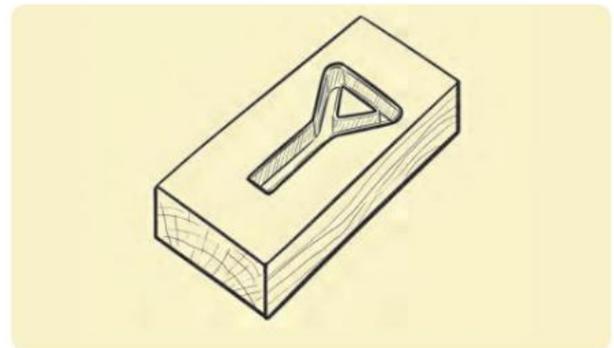


Figure 10.12 The peg is formed once in the mould.

- 7 Use a drill and an appropriate drill bit to make a hole as indicated in Figure 10.13. This is to improve the holding capacity of the peg.

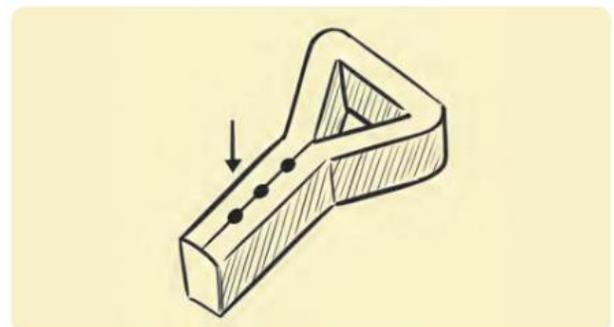


Figure 10.13 Drilling through

- 8 Use a hacksaw to cut the legs so that they are equal in length.

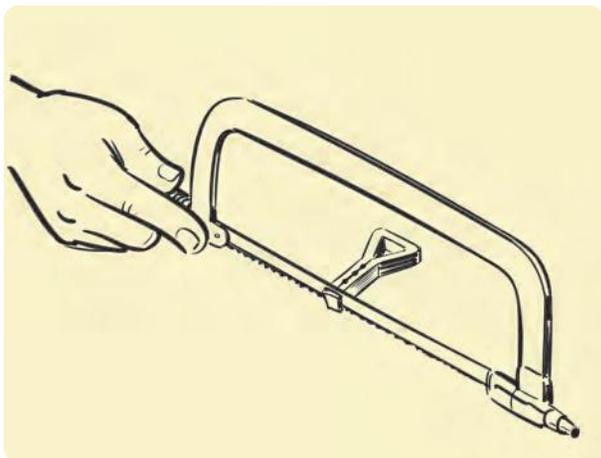


Figure 10.14 Using a hacksaw to cut the legs evenly

- 9 Use files and glass paper to shape the edges and clean the surfaces of the peg to improve its appearance.

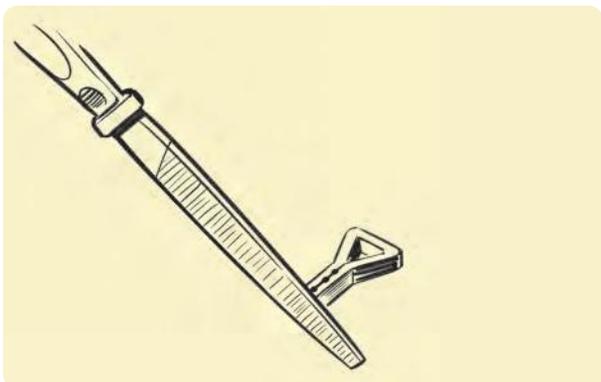


Figure 10.15 A flat file is used to file the edges of the PVC peg.

- 10 If you wish, you can use an appropriate finish on the peg. The peg is now ready for use.

Activity 4: Working with a flat PVC pipe: making a clothes peg

You will need:

- piece of 50 mm PVC pipe
- mould, or pencil or scriber

- 1 Read the section called 'How to make a clothes peg with PVC pipe' on page 153.
- 2 Your teacher will do a demonstration of the steps outlined in the section 'How to make a clothes peg with PVC pipe'. Watch carefully, and write down the safety measures that you must observe when working with PVC.
- 3 Flatten your piece of round PVC pipe. Make sure you observe the safety rules you have identified above. Cut the required length of flat PVC. If it has some unwanted marks on it, use a glass paper to clean and smooth the surface.
- 4 Apply heat to your flat PVC and bend it in a mould, which your teacher will supply. Leave it to cool. Alternatively, you can use a pencil or a scriber to mark the shape you need on the piece of flat PVC pipe. Once the marks are visible and the shape can be identified easily, use a hacksaw and cut along the line.
- 5 Finish off your peg by following steps 7 to 10 of the section 'How to make a clothes peg with PVC pipe'.

Practical task

By the end of this practical task, you should be able to:

- 7.10.7.1** design and make a plastic product to address a personal need
- 7.10.7.2** make one of the following products using PVC pipe: toothbrush and paste holder, clothes hanger or similar product to suit a school or community situation
- 7.10.8.1** apply the correct safety measures when working with PVC pipe
- 7.10.8.2** measure, mark, cut, apply appropriate finishing and assemble plastic parts correctly
- 7.10.9.1** use tools correctly during the working processes of PVC pipe
- 7.10.10.1** investigate and discuss the advantages and the disadvantages of thermoplastic products in your community.

Go back and read the design problems at the beginning of this chapter. You are going to solve one of those design problems.

Design problem 1: Toothbrush and soap holder

Design expectations

The following must be considered in the development of the toothbrush and soap holder:

- The material to be used is PVC pipe.
- The toothbrush and soap holder will be used by all the family members.

Investigating

- **Investigate** the types of plastics available in your community.
- Investigate the types of thermoplastics available in your community.
- List the steps involved in flattening a round PVC pipe.
- List the tools you will need for working with PVC plastic.

- Consider the safety precautions that you must take when working with PVC plastic.
- Look around your home or your **neighbourhood** for two types of toothbrush and soap holder. You can look for pictures of them as well. Identify two strengths and two weaknesses of each.
- Consider who will use the toothbrush and soap holder.

Designing your toothbrush and soap holder

- Write a simple design brief for the toothbrush and soap holder.
- Do different sketches of your toothbrush and soap holder. Then select which one you are going to make. Write down two reasons for your choice.
- Use technical drawing instruments to make a pictorial drawing of your toothbrush and soap holder. Make sure to write notes on your drawing.
- Write down the steps you will follow to make a PVC toothbrush and soap holder. List the tools you are going to use in each of the steps. Discuss this with your teacher or a friend.
- Write down the safety issues that you must observe in the steps you have listed. Discuss this with your teacher or a friend.
- Write down a simple time plan for making your toothbrush and soap holder.

Making your toothbrush and soap holder

- Using your drawing as your guide, make your toothbrush and soap holder.
- Follow the steps you listed above. Always check with your teacher as you go through the steps.
- Use appropriate tools to make your toothbrush and soap holder.

Testing your toothbrush holder

- Do you think the toothbrush and soap holder will fit somewhere easily?
- Place some toothbrushes in the holder. Do they fall out easily?

- Place some soap in the place to hold the soap. Does the soap slide out easily from its holder?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Is the type of joint you used to attach the toothbrush and soap holder strong enough?
- 2 Does the toothbrush and soap holder serve the purpose for which it is designed?
- 3 Look back at the design expectations. Does the toothbrush and soap holder fit the design? In what ways?
- 4 Is your toothbrush and soap holder strong and neat?
- 5 Is the size of the toothbrush and soap holder appropriate for the needs of the whole family?
- 6 Is your toothbrush and soap holder pleasant to look at?
- 7 Did the construction or making of your toothbrush and soap holder take a lot of time? If yes, why?
- 8 What have you learnt from other learners' toothbrush and soap holders?
- 9 What would you change from your design if you were to make another toothbrush and soap holder?

Communicating and marketing

- 1 Who are the potential users of the toothbrush and soap holder?
- 2 How much would you sell your toothbrush and soap holder for?
- 3 What benefit/s does your toothbrush and soap holder have for users?
- 4 What marketing technique/s would you use to sell your toothbrush and soap holder?

Design problem 2: Clothes hanger

Design expectations

The following must be considered in the development of PVC your clothes hanger:

- The material to be used is PVC pipe.

- The clothes hanger is to be used for both dry and wet cloth.
- The clothes hanger is to be used by all the family members.

Investigating

- Investigate the types of plastics available in your community.
- Investigate the types of thermoplastics available in your community.
- List the steps involved in flattening a round PVC pipe.
- List the tools you will need for working with PVC plastic.
- Consider the safety precautions that you must take when working with PVC plastic.
- Look around your home or your neighbourhood for two types of clothes hanger. You can look for pictures of them as well. Identify two strengths and two weaknesses of each.
- Consider who will use the clothes hanger.

Designing your clothes hanger

- Write a simple design brief for the clothes hanger.
- Do different sketches of your clothes hanger. Then select which one you are going to make. Write down two reasons why you have selected that design.
- Use technical drawing instruments to make a pictorial drawing of your clothes hanger. Make sure to write notes on your drawing.
- Write down the steps you will follow to make a PVC clothes hanger. List the tools you are going to use in each of the steps. Discuss this with your teacher or a friend.
- Write down the safety precautions that you must take in the steps you have listed. Discuss this with your teacher or a friend.
- Write down a simple time plan for making your clothes hanger.

Making your clothes hanger

- Using your drawing as your guide, make your clothes hanger.

- Follow the steps you listed above. Always check with your teacher as you go through the steps.
- Use appropriate tools to make your clothes hanger.

Test your clothes hanger

- Do you think the clothes hanger can be fitted easily somewhere for use?
- Place some adult clothing on the clothes hanger. Does it slide off easily?
- Place some child's clothing on the clothes hanger. Does it slide off easily?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Is the type of joint you used in the clothes hanger strong?
- 2 Does the clothes hanger serve the purpose for which it is designed?
- 3 Look back at the design expectations: does the clothes hanger fit the design? In what ways?
- 4 Is your clothes hanger strong enough to hold wet clothes for a long period of time?
- 5 Is the size of the clothes hanger appropriate to serve the needs of the whole family?
- 6 Is your clothes hanger pleasant to look at?
- 7 Did the construction or making of your clothes hanger take a lot of time? If yes, why?
- 8 What have you learnt from other learners' clothes hangers?
- 9 What would you change from your design if you were to make another clothes hanger?

Communicating and marketing

- 1 Who are the potential users of the clothes hanger?
- 2 How much would you sell your clothes hanger for?
- 3 What benefit/s does your clothes hanger have for users?
- 4 What marketing technique/s would you use to sell your clothes hanger?

New words used in this chapter

acrylic	type of plastic material that can be heated and reshaped
appropriate	suitable or correct
crude oil	mixture of natural oils taken from rocks and turned into petrol or diesel
flammable liquids	liquids that catch fire easily
flexible	easily bent, bendable
investigate	look into
neighbourhood	area around your house
opaque	not able to be seen through
search	look for, try to find
thermoplastics	plastic materials that are changeable in shape when heat is applied
tinted	slightly coloured

Chapter 11

Metals technology

Learning outcomes

By the end of this chapter, you should be able to:

- 7.11.1.1** describe the safety measures required when working with metal
- 7.11.2.1** compare the different types of metals used in Solomon Islands
- 7.11.2.2** distinguish between the working processes of metal
- 7.11.2.3** describe the proper method of applying metal finishing
- 7.11.3.1** describe the methods of joining metals together
- 7.11.4.1** explain the function of the following tools: rule, scribe, cold chisel, vice, ball peen hammer, drill and drill bits, tin-snip and files
- 7.11.5.1** design and make a metal product to address a home need
- 7.11.5.2** design and make a coconut scraper, a bottle opener or a similar product to suit your own situation
- 7.11.6.1** prepare, measure, mark, bend and cut metal correctly
- 7.11.7.1** apply correct safety procedures when working with metal
- 7.11.7.2** use tools correctly during the working processes of metal
- 7.11.8.1** investigate and discuss the impacts of metal on the environment and the people in your community.

Introduction

Our great-grandparents used sago palm, bamboo and other local materials for making houses and household items and tools. Today, with the availability of metals, life is different. People use

metal tanks to collect water from metal roofing systems, and metal spoons for eating. The standard of living has improved significantly, as most things that we use today are made from metal.



Figure 11.1 Metal comes in a number of different types and it is widely used. We use metals to build all types of objects, from small kitchen utensils to heavy machinery.

Activity 1: Imagining life without metals

Imagine that metals have not yet been discovered, and the things shown in Figure 11.1 do not exist. What do you think we would use instead?

In this chapter, you will look at two products commonly used in Solomon Islands: steel and aluminium or galvanized sheet metal. Understanding how simple metal products are made and learning the skills required to make these products will help you to make simple products that make your life easier. Metal products can be used to solve many problems.

The study of Technology is about finding solutions to problems. Below are two design problems. With the help of your teacher, select one problem to solve. You will use either steel or aluminium or galvanized sheet metal to solve one of these design problems.

Design problem 1: Coconut scraper

The coconut scraper is an important product used in processing coconut cream. It is used for grating dry coconut meat into small pieces which are then squeezed together to produce the coconut cream. This product is an important item in almost every home in Solomon Islands, in both villages and towns. However, due to the level of skill required to make it and difficulties in obtaining the right materials, not all homes have a coconut scraper. You are to design and make a coconut scraper using an appropriate metal and a wooden frame. This is an opportunity for you to make a number of coconut scrapers and sell them to communities around you.

Design problem 2: Bread tray

John and Sera own a small bakery business. They would like to increase their production to meet the demand; that is, they need to produce more bread. In order to make more bread they must have more bread trays. Bread trays are made from various types of sheet metal, such as aluminium, galvanized iron and stainless steel. At the end of this chapter, you will help John and Sera to design and make a bread tray. You will choose the appropriate type of sheet metal to do the job.

In order to successfully make a product in response to the design problems, you must understand the sequence of making the product. This sequence of steps is called the working process.

Tools and equipment used in this chapter

Brush
 Curved tin-snips
 Divider
 Files
 Mallet
 Odd-leg caliper
 Rivet gun
 Ruler
 Scriber
 Straight tin-snips

Materials used in this chapter

Rivets
 Sheet metal
 Stake
 Wires

About metals

By the end of this topic, you should be able to:

7.11.2.1 compare the different types of metal used in Solomon Islands.

Metals have varying properties, making some more suitable than others for a specific purpose. Observe closely the different metals in your surroundings. Note the appearance and be able to identify each metal and explain why it is used for that purpose.

Activity 2: Identifying metals

1 The following table lists some of the metals commonly used in our communities. Some are pure metals. Some are alloys; that is, they consist of two or more metals mixed together. Some are **coated** metals; that is, one metal is coated with another.

2 In groups, walk around the school and try to identify the metals listed in the table above. Copy the table and complete the last column in your exercise book.

Note: The metal we normally refer to as 'copper' in Pijin is not really copper but galvanized iron.

Metal	Appearance	Composition	Where you will find it
Pure metals			
Aluminium	Light grey colour	Aluminium	
Copper	Red-brown colour	Copper	
Alloys			
Stainless steel	Shiny silver appearance	Iron, carbon, chromium and nickel	
Brass	Yellow colour	Copper and zinc	
Coated metals			
Tin plate	Shiny silver appearance (similar appearance to stainless steel, but usually thinner)	Mild steel coated with tin	
Galvanized iron	Grey spangled appearance; uneven in colour	Mild steel coated with zinc	



Activity 3: Finding out about metals

- 1 Look around your classroom or surroundings and collect or identify three different types of metals. Make sure to include one pure metal, one alloy and one coated metal. Check with your teacher that the metals you have collected or identified are the required types. If not the teacher will help you.
- 2 Copy and complete the following table in your exercise book.

Type of metal collected or identified	Appearance	Uses



- 3 Display the metal samples you have collected (or drawings of the metals you have identified) on a desk at the front. Are any of them harmful to people and the environment?
- 4 In your groups, write down what you think people should do with scrap or unwanted metals that are lying around in your school or community.

Safety in metal work

By the end of this topic, you should be able to:

7.11.1.1 describe the safety measures required when working with metal.

It is important to know about safety before you can enjoy and be able to relate to metals and tools properly. Metals can be cut, folded, bent, shaped etc. During this process, safety must be observed carefully and should be part of your work habits. You must recognize the importance of safety when you are working with metal.

Activity 4: Working safely with metals

- 1 Study small pieces of sheet metal and suggest two ways you might hurt yourself when you are working with them.
- 2 Your teacher will show you some tools used in working with metal. Suggest how you might get hurt if you do not use these tools properly.
- 3 If possible, your teacher will organise a visit to a workshop or invite a guest speaker to give a talk.
- 4 List some safety measures that you learnt from the visit or talk.

Types of metal

By the end of this topic, you should be able to:

7.11.2.1 compare the different types of metal used in Solomon Islands.

You have seen different types of metal products around you. In this section you will look at two that are commonly used in Solomon Islands: steel and aluminium or galvanized sheet metal.

Steel

Steel is commonly used in our country, for a variety of purposes.



Figure 11.2 Steel metal stored in a warehouse

Aluminium or galvanized sheet metal

Sheet metals are mostly alloys (a mixture of two or more metals), which come in the form of sheets. Sheet metals come in different thicknesses, or gauges, and have various properties.



Figure 11.3 Sheet metals of different gauges



Figure 11.4 Types of sheet metals—copper and aluminium

Activity 5: Finding out about sheet metals and steel

You will need:

- 2 pieces of sheet metal of different gauges
- piece of steel
- caliper.

Write your answers to the following questions in your exercise book.

- 1 In groups of three or four, walk around your school and identify where aluminium or galvanized sheet metals and steel are used. From what you have observed, explain why aluminium or galvanized sheet metals are preferred to steel for use for particular jobs.
- 2 In your same group, use a caliper to measure the thickness of the three metals. Your teacher should explain to you how to use the caliper.



Figure 11.5 A caliper

- 3 Write down the use(s) of a caliper in metal work.
- 4 Answer the following questions:
 - a Which thickness of sheet metal is suitable for making a water tank and which is best for bread tray (that is, the sheet metal with the thinner gauge or the one with thicker gauge)?
 - b Explain your choice in **a** above.

Methods of joining metals

By the end of this topic, you should be able to:

7.11.3.1 describe the methods of joining metals together.

There are various ways of joining sheet metals and steel. For sheet metals you can use seams, rivets, bolts and nuts, and you can solder and or weld them. In Year 7 you will use only seams and rivets. When you work with steel, you use only bolts and nuts.

Seams

In the following activity you will look around your school and home environment to find out about how seams are used in metal products.

Activity 6: Finding out about seams in sheet metal

- 1 Look at the picture of the tank below. Can you suggest how the different parts are joined together?



2 In groups, look at the different types of seam joints that can be used for joining sheet metals, shown in Figures 11.6 to 11.10. Look around for examples of where these seam joints are used.

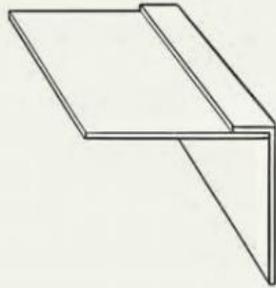


Figure 11.6 Corner lap joint in sheet metal

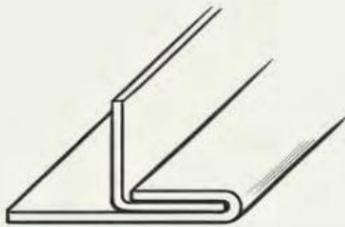


Figure 11.7 Paned down joint in sheet metal



Figure 11.8 Safe edge joint in sheet metal

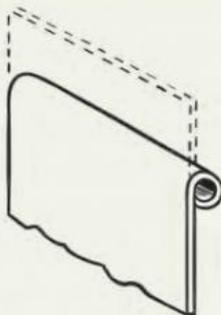


Figure 11.9 Wire edge joint in sheet metal

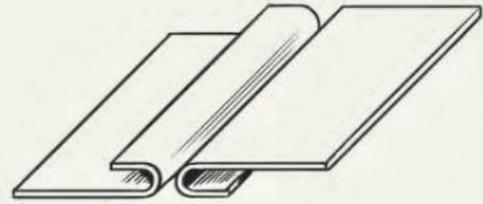


Figure 11.10 Folded joint in sheet metal

3 Define a seam in metal work. Write your definition in your exercise book.

Pop riveting

Pop riveting is a **technique** that is commonly used to join two pieces of sheet metal. Figures 11.11 to 11.13 show the tools used in pop riveting.



Figure 11.11 Drill and bits



Figure 11.12 Pop rivet gun



Figure 11.13 Rivets

Activity 7: Finding out about rivets

- 1 Read the section called 'Pop riveting' on page 167.
- 2 Watch carefully while your teacher does a simple demonstration of joining sheet metals with rivets.
- 3 Look at some objects in your classroom or school. Write down two reasons why riveting is used in these objects.

Screws

There are many types of screws available in shops nowadays. You learnt about two types of screws in Chapter 3, 'Timber technology': the round head screw and the countersunk or Phillips head screw. When joining two pieces of metal, you can use two kinds of machine screws: the round head machine screw and the countersunk head machine screw. They are available in a range of diameters.



Figure 11.14 Round head wood screw

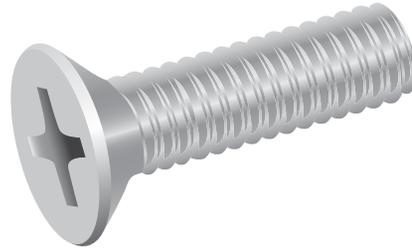


Figure 11.15 Countersunk head machine screw

Activity 8: Finding out about machine screws

- 1 In groups, find an example of a machine screw being used to join two metals together. Write down two reasons why the screws below were not used instead.



Figure 11.16 Round head screw



Figure 11.17 Countersunk head screw

- 2 List the tools used when working with machine screws.
- 3 Listen carefully as your teacher explains to you how the machine screws are fitted together.

Bolts and nuts

There are different types of bolts and nuts available in shops in most urban centres, such as Gizo, Auki or Kirakira. Most of the bolts and nuts are made from steel. The most common bolts and nuts are in Figures 11.18 to 11.21.



Figure 11.18 Countersunk bolts and octagonal nuts



Figure 11.19 Countersunk nib bolts and octagonal nuts

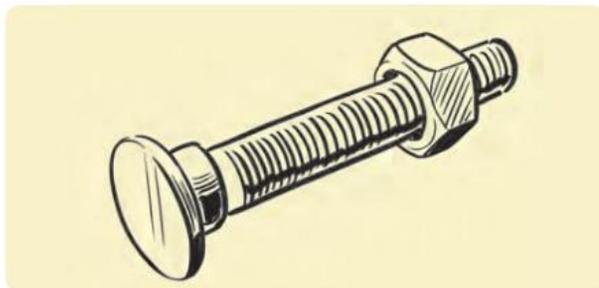


Figure 11.20 Cup square bolts and octagonal nuts

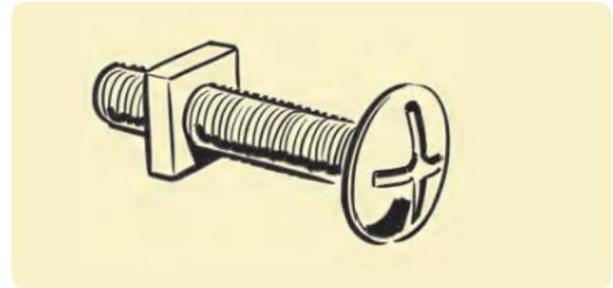


Figure 11.21 Slotted mushroom head gutter bolts and square nuts

Activity 9: Finding out about bolts and nuts

- 1 Read the section above called 'Bolts and nuts'.
- 2 Look around your classroom, workshop, school or community for examples of the various ways of joining sheet metal. Copy and complete the following table in your exercise book.

Method of joining metal	Place in which the particular type of joint is used	Why that joint is used for that particular job
Seams	1 _____	1 _____
	2 _____	2 _____
Rivets	1 _____	1 _____
	2 _____	2 _____
Screws	1 _____	1 _____
	2 _____	2 _____
Bolts and nuts	1 _____	1 _____
	2 _____	2 _____

- 3 Seams and rivets are commonly used to join sheet metals. Suggest two reasons why seams and rivets are normally used in sheet metal rather than screws and bolts and nuts.
- 4 Suggest why a certain type of bolt and nut is suitable only for a particular job.
- 5 When is it suitable to use bolts and nuts rather than the other methods of joining discussed earlier?

DO NOT WRITE IN THIS BOOK

Tools used in metal work

By the end of this topic, you should be able to:

7.11.4.1 explain the function of the following tools: rule, scribe, cold chisel, vice, ball pein hammer, drill and drill bits, tin-snip and files.

Tools are important in work life. Use of the correct tools results in quality work and products, so knowledge about how to use and care for tools is important.

There are two types of tools used in metal work: hand tools and power tools. In addition, in metal work, tools are divided into different categories based on their function: marking-out tools, cutting tools, forming tools and percussion tools. Each of these tools has a specific use and should not be used for any purpose other than that which it was made for.

Marking-out tools

When you want to cut a piece of metal, you should first measure its size and put marks where the metal should be cut. In order to cut accurately, your mark should be clear. The process of putting marks on the metal is called marking out. The tools used in the marking-out process are called marking-out tools. A **scriber** is a commonly used marking-out tool. You will learn about it and use it whenever you are working with metal.

How to use a scribe

- Hold the scribe like a pencil, with the point against the edge of the rule.
- Lean the body of the scribe slightly away from the ruler and towards yourself.
- Drag the scribe along the ruler towards yourself.

- Scribed lines should be drawn once, otherwise it is possible to draw multiple lines, which could be confusing.

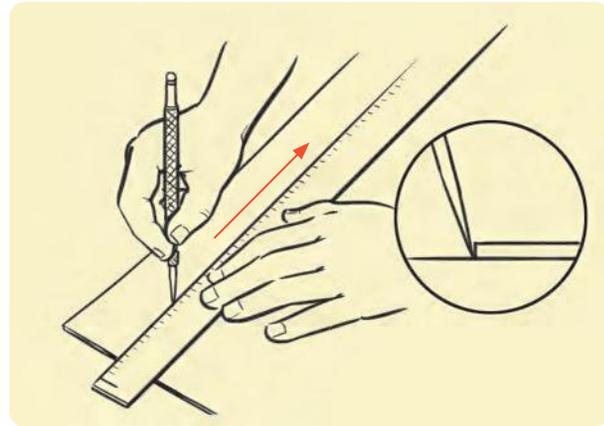


Figure 11.22 How to use a scribe. The arrow shows the direction in which to drag the point of the scribe.

Activity 10: Finding out about marking-out tools

You will need:

- engineer's scribe
- piece of sheet metal.

- 1 There are three types of scribes used in metal work: ring scribes, blade scribes and engineer's scribes. The last is the most popular. Look at Figures 11.23 to 11.25 and list three things that you must do to prevent injury when you are using these scribes.

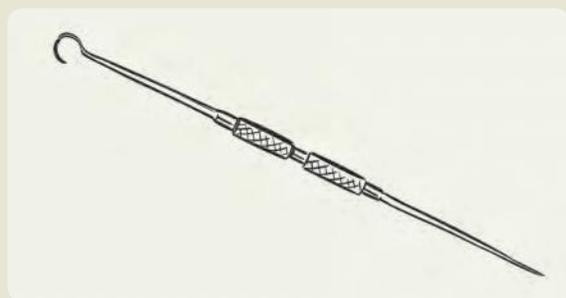


Figure 11.23 Ring scribe

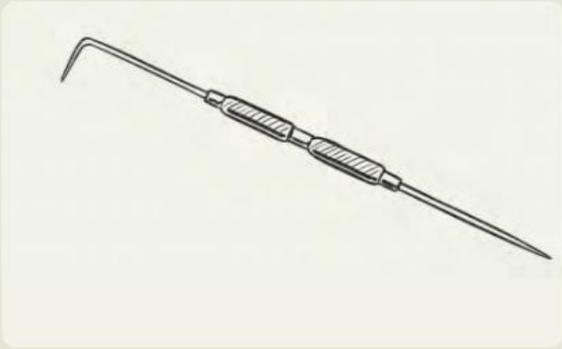


Figure 11.24 Blade scribe

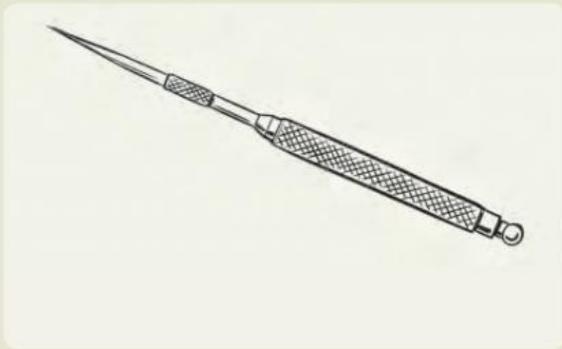


Figure 11.25 Engineer's scribe

- 2 Look carefully at Figure 11.26. Your teacher will demonstrate how to use this tool. After the demonstration, write down the uses of the odd-leg caliper.



Figure 11.26 Odd-leg caliper

- 3 Look at Figure 11.27. Write down the main use of this tool.



Figure 11.27 Centre punch

- 4 Read the section called 'How to use the scribe' on page 170. Follow the instructions and use an engineer's scribe to mark out a development shape on a piece of sheet metal. Your teacher will give you some information about this. After marking out, keep the piece of sheet metal, as you will need it later.
- 5 When you mark out on a metal, you should always use a scribe. Why not use pencil?
- 6 There are other tools that you might use, such as a wing divider, when you mark out on sheet metal.



Figure 11.28 Wing divider

Your teacher will do a short demonstration of how to use a wing divider.

- 7 Write down three safety rules that you must follow when using the tools above.

Cutting tools

There are many tools used for cutting in metal work. An important one is the tin-snips, a tool used for cutting galvanized sheet metal.

How to use tin-snips

- When holding the snips, keep one finger between the handles so you can open them between cuts.
- Check that the inside edge of the snips blade lies along the cutting line.

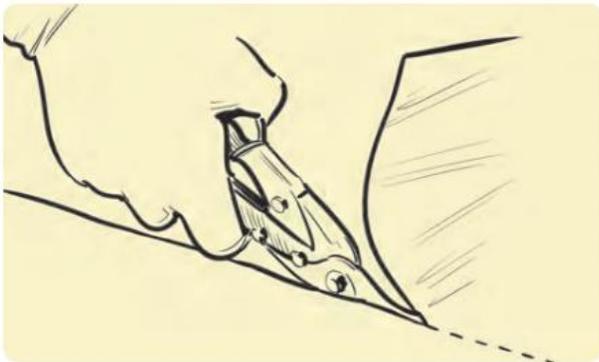


Figure 11.29 Setting the inside edge of the tin-snips blade along the cutting line

- Hold the snips stationary and feed the work into them. Do not close the blade completely, as this will distort the cut edge.
- When cutting into a corner (for example cutting out a notch), the blades may be completely closed, but do not let them extend beyond the corner.



Figure 11.30 Cutting out shapes in sheet metal

- If cutting is difficult, one handle may be held in a vice to give greater cutting power, as shown in Figure 11.31.

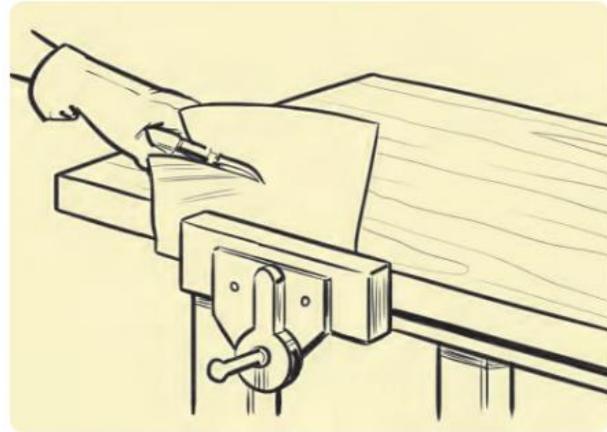


Figure 11.31 Cutting sheet metal using a vice

Activity 11: Using tin-snips

You will need:

- the piece of sheet metal from Activity 10
- straight tin-snips
- curved tin-snips.

- 1 Read the section above called 'How to use tin-snips'.
- 2 Watch carefully while your teacher does a demonstration on how to use tin-snips to cut sheet metal.
- 3 List three safety rules that you must observe when cutting sheet metal.
- 4 Use both straight and curved tin-snips to cut the shape you drew on the sheet metal in the last activity.
- 5 Copy and complete the following table in your exercise book.

My finished sheet metal shape	Yes	Partly	No	If partly or no, why?
1 Did I know how to use the: <ul style="list-style-type: none"> • straight tin-snips? • curved tin-snips? 				
2 Did I use the tin-snips safely?				
3 Did I cut on the waste side of the sheet metal?				
4 Is any side of my sheet metal very sharp and likely to cause injury? Can I make it safe?				
5 Do I know of any other tools that can be used to further smooth the sharp edges?				
6 What is good about my work?				
7 What is not good about my work?				
My work can be improved by:				



Working processes with metal

By the end of this topic, you should be able to:

7.11.2.2 distinguish between the different working processes of metal.

Marking out from a datum edge

It is difficult to achieve accuracy when cutting a sheet metal from a large sheet. To overcome this difficulty, the piece of sheet metal to be cut should be cut out slightly over its required size. This will allow the metal to be accurately marked to size from a **datum edge**.

A datum edge is a straight edge, running the length of the piece of sheet metal, from which the project is marked to size.

How to prepare a datum edge

A datum edge, in thin sheet metal, may be prepared as follows:

- 1 Rule a straight line along the length with a steel ruler and a scriber.

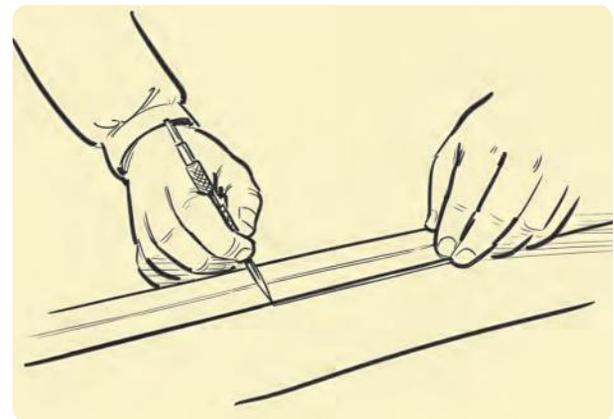


Figure 11.32 Using a scriber and a ruler to scribe a line

- Carefully cut along the line with straight tin-snips.

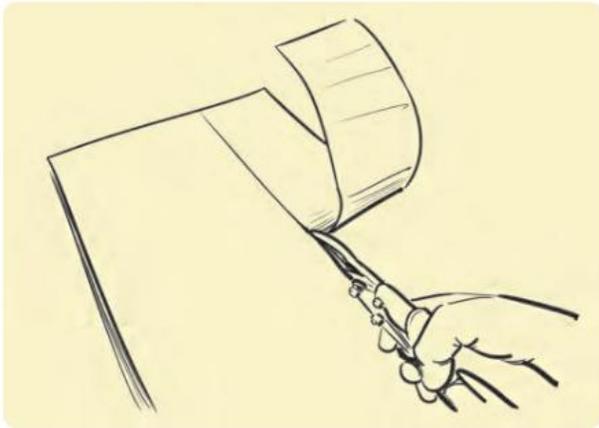


Figure 11.33 Cut along the waste edge of the sheet metal.

- Test for **squareness** with a ruler or try-square.

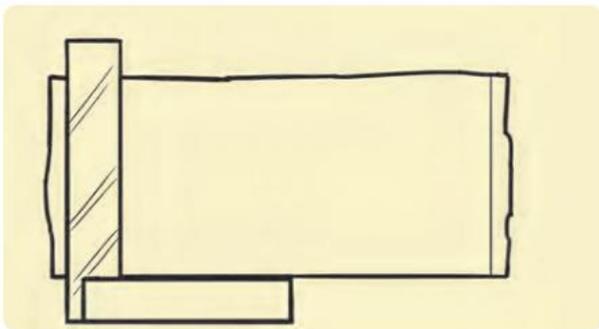


Figure 11.34 A ruler or try-square will indicate whether your edges are straight.

- Mark the edge with a datum edge mark.

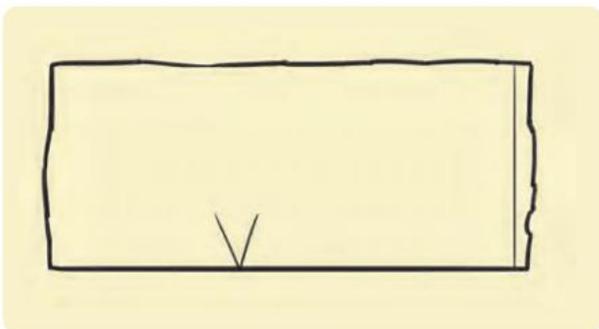


Figure 11.35 Mark the datum edge on the flat side of the sheet metal

How to mark out to size from a datum edge

- Place the stock (see Figure 11.36) of a try-square **firmly** against the datum edge and scribe a line close to the end of the sheet metal.

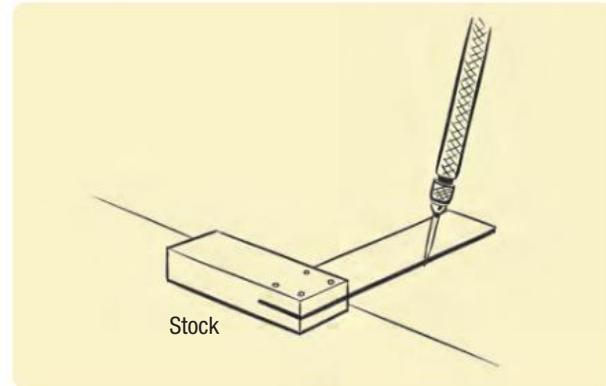


Figure 11.36 Using a try-square and a scribe to create a straight edge

- Using a steel ruler and a scribe, mark off the required length. With the stock of the try-square firmly against the datum edge, scribe a line through the mark and square to the datum edge.

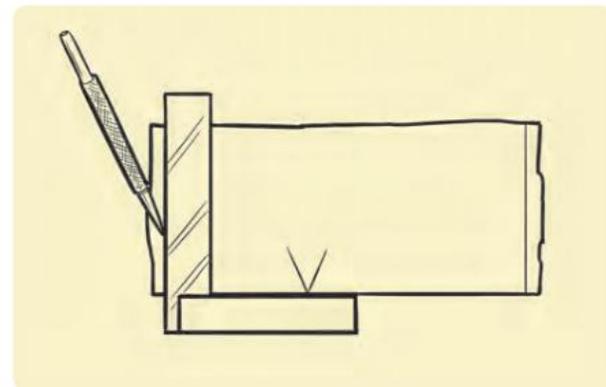


Figure 11.37 Mark the length of the project using a ruler or try-square.

- Set an odd-leg caliper to the width required. With the butt of the odd-leg caliper against the datum edge, mark the width on the sheet metal.

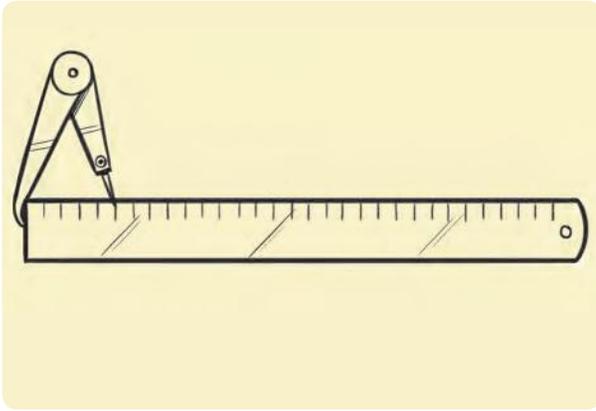


Figure 11.38 Measure the width of the project using an odd leg caliper.

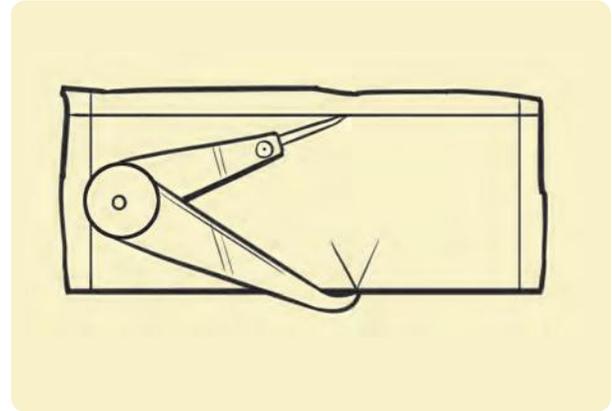


Figure 11.39 Transferring the measurement on the odd leg caliper to the sheet metal

Activity 12: Marking out from a datum edge

You will need:

- the piece of sheet metal from Activity 10
- engineer's scribe
- steel ruler
- straight tin-snips.

1 Read the section called 'Marking out from a datum edge' on page 173 and look at the information about marking-out tools on pages 170–171.

- 2** Following the previous instructions, mark a smaller shape on the same piece of sheet metal you cut in the previous activity. Use the tools to cut out your shape.
- 3** When you **finish** cutting, copy and complete the following table in your exercise book.

	Yes	Partly	No	If partly or no, give reason(s)
1 Did I mark out the datum edge of the sheet metal accurately?				
2 Is the edge of the datum edge straight?				
3 Do the edges meet at 90°?				
4 Did I use the tools in this activity correctly and safely?				
5 Is the edge of the shape safe to work with?				
My work can be improved by:				



Edges, joints and seams

Projects when made out of sheet metal have sharp exposed edges which need to be **strengthened** and made safe to handle. This may be done by means of one of the following edge treatments: the folded edge or the wired edge.

Folding an edge

- 1 Mark the width of the folded edge with an odd-leg caliper.

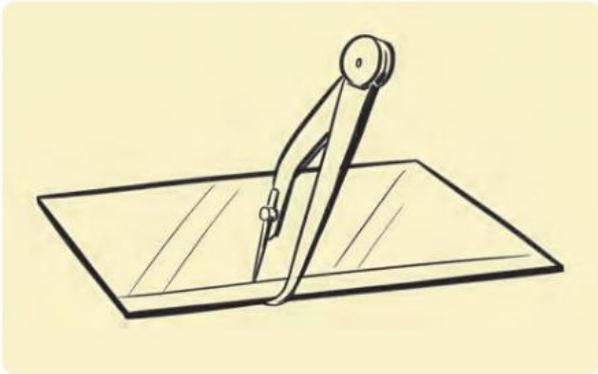


Figure 11.40 Scribing a line parallel to the edge

- 2 Bend the edge to a right angle. This may be done with mallet working on a stake, or with bars.

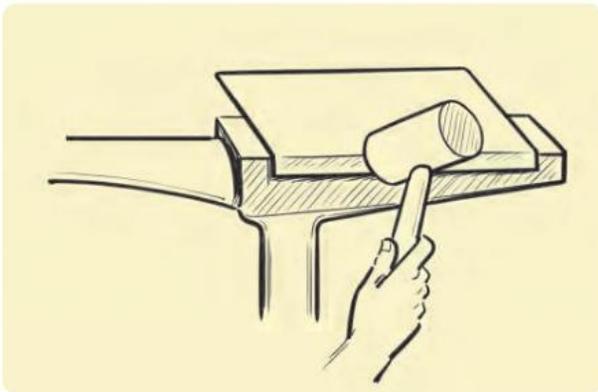


Figure 11.41 Using a mallet to bend an edge on a big iron stake

- 3 Bend the edge to an acute angle on a hatchet stake.

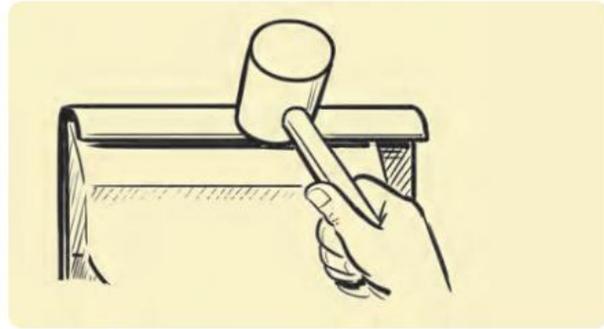


Figure 11.42 Bending over a hatchet stake

- 4 Carefully tap the sharp edge down until it touches the surface of the metal. Do not flatten the folded edge. A rounded edge has greater strength and is safer.

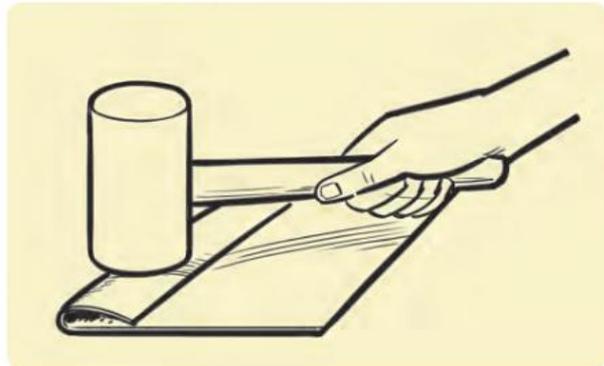


Figure 11.43 Using a mallet to gently beat down the folded edge

Greater strength may be gained by wiring an edge.

Wiring an edge

Mark off the edge to be wired 2.5 times the diameter of the wire, using an odd-leg caliper. Proceed as for a folded edge.

When the edge is bent to an acute angle, insert the wire. While holding the wire firmly in place with a piece of scrap metal, wrap the sheet metal around the wire.

Finish the edge neatly, working it on the edge of a stake.

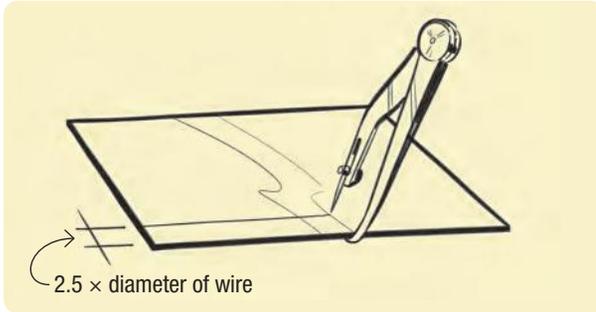


Figure 11.44 Marking allowance for lap

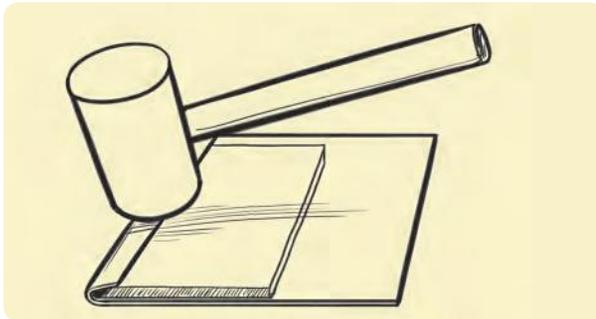


Figure 11.45 Folding the lap over the bevelled end of the timber

Activity 13: Making a wire edge joint

You will need:

- the piece of sheet metal from Activity 12
- tin-snips
- stake
- wooden mallet
- wires.

- 1 Read the sections called 'Folding an edge' and 'Wiring an edge' on page 176.
- 2 Watch carefully as your teacher does a demonstration of the different steps in the above sections. As the teacher demonstrates, list down three safety measures that you must observe.
- 3 Using your sheet of metal from the previous activity, follow the instructions in the sections called 'Folding an edge' and 'Wiring an edge' on page 176.

Surface finishing of metal

By the end of this topic, you should be able to:

7.11.2.3 describe the proper method of applying metal finishing.

All articles made from metal must be finished in a way that enables them to perform the function for which they are designed. Metal surfaces may be finished to provide functions such as decoration, protection, **hygiene** and **wear resistance**.

Activity 14: Finding out about methods of metal finishing

- 1 In pairs, look at the four metal products that your teacher has placed in front of the class. Can you see what is meant by metal finishing?
- 2 Look at a product with a proper metal finish. Why is metal finishing important in metal work?
- 3 What must be done before applying metal finish?

Paint

The most common finish applied to metal products is paint. Paint provides both protection and decoration. It forms a film, or protective cover, which keeps the **atmosphere** from the metal surface. Before painting, the metal should be **thoroughly** cleaned. All rust, grease and dirt must be removed, using sandpaper, in order to enable a firm bond or join between the paint and metal.

How to prepare a surface for painting

- 1 Remove all file marks and scratches on the surface of the metal. If necessary, remove sharp edges of metal by draw filing (see Figure 11.47).



Figure 11.46 Sandpaper can be used to remove any scratches on a metal surface

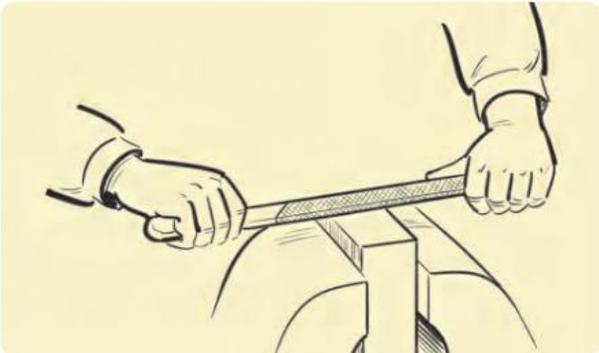


Figure 11.47 Draw filing on the edge of a metal surface

- 2 Wipe off dirt and oil from the surface of the metal with an old cloth.



Figure 11.48 Use a wet cloth to remove dirt and oil



Figure 11.49 The final result

How to paint metal surfaces

Apply the paint with a brush on the metal surface. Take care to apply the paint evenly.

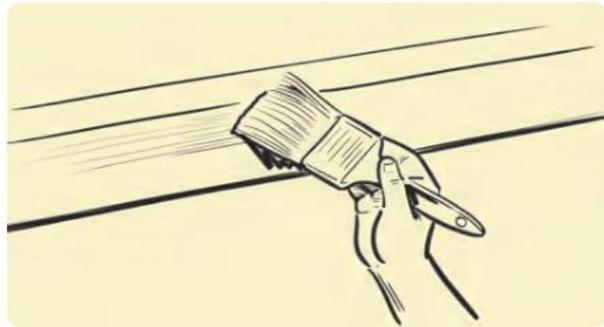


Figure 11.50 Painting a metal surface

How to clean paint brushes

- 1 Remove excess paint from the brush so it can be cleaned easily.



Figure 11.51 Wipe the brush as dry as possible

- 2 Use kerosene to clean the brush. Make sure the bristle of the brush is not bent or pulled off as you clean the brush.



Figure 11.52 Wash the brush with kerosene to ensure that it is completely clean.

- 3 Store the brush neatly in your workshop.

Activity 15: Finding out about painting

- 1 In pairs, suggest one reason why it is important for a metal surface to be completely free of any particle before paint is applied.
- 2 From what you have observed, write down two safety rules you must follow when applying paint.
- 3 Write down two reasons for applying paint to metal surfaces.

Practical task

By the end of this practical task, you should be able to:

- 7.11.5.1** design and make a metal product to address a home need
- 7.11.5.2** design and make a coconut scraper, a bottle opener or a similar product to suit your own situation
- 7.11.6.1** prepare, measure, mark, bend and cut metal correctly
- 7.11.7.1** apply correct safety procedures when working with metal
- 7.11.7.2** use tools correctly during the working processes of metal
- 7.11.8.1** investigate and discuss the impacts of metal on the environment and the people in your community.

Go back and read the design problems at the beginning of this chapter. You are going to solve one of those design problems.

Design problem 1: Coconut scraper

Design expectations

The following must be considered in the development of the coconut scraper:

- The materials to be used are stainless or mild steel and timber.
- The **grated** coconut meat produced by this coconut scraper must be fine.

Investigating

- Find and examine three coconut scrapers. Look at the different grated coconut outputs of each coconut scraper. Identify two strengths and two weaknesses of each.
- Identify the best joints for joining the steel onto timber.
- Decide if any joint is needed in the timber structure. If one is needed, investigate the best joint to be used.

- Identify what must you do in order for the scraper to produce fine grated coconut meat.
- List the steps involved in making the coconut scraper.
- List the tools used in each step.
- Consider the safety requirements of each step.

Designing your coconut scraper

- Draw some preliminary sketches (pictorial drawings) of the coconut scraper.
- Select the appropriate 3-D sketch (with major dimensions) of the coconut scraper.
- Make a list of materials (and their cost) that you will need to make the coconut scraper.

Making your coconut scraper

- Measure and mark the sizes of the timber and steel metal for the coconut scraper.
- Cut the timber and steel metal for the coconut scraper.
- Join the timbers.
- Shape the steel for the scraping part
- Join the cutting steel onto the timber structure.
- Check for accuracy, neatness and strength of the coconut scraper after it is completed.

Testing your coconut scraper

- Is the timber structure that supports the coconut scraper strong and firm? Is the timber frame square and balanced?
- Does the coconut scraper produce rough or fine coconut meat?
- Does the coconut milk produced meet a satisfactory standard?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Why do you use the type of joint in the timber?
- 2 Is the timber structure strong? Why?
- 3 Is the coconut scraper safe to use?

- 4 What have you learnt from other learners that might help you improve your coconut scraper?
- 5 If you were to make another coconut scraper, what would you change?
- 6 What impact does your coconut scraper have on people and the environment?

Communicating and marketing

- 1 How much did it cost you to make the coconut scraper? What will be the cost of the coconut scraper if you sell it?
- 2 How much profit will you make when you sell your coconut scraper?
- 3 What benefit/s does your coconut scraper have for users?
- 4 What marketing technique/s would you use to sell your coconut scraper?

Design problem 2: Bread tray

Design expectations

The following must be considered in the development of the bread tray:

- The material to be used is aluminium or galvanised sheet metal.
- The sheet metal must be of good gauge so that the bread tray will be long-lasting.

Investigating

- Identify the best joints to use for joining the sheet metal.
- List the steps involved in making the bread tray.
- List the tools used in each step.
- Consider the safety requirements of each step.

Designing your bread tray

- Draw some preliminary sketches (pictorial drawing) of the bread tray.
- Select the appropriate sketch and draw the plan (with major dimensions) of the bread tray.
- Make a list of the materials (and their cost) that you need to make the bread tray.

Making your bread tray

- Measure and mark the size of the tray.
- Use a straight edge to join the points to form the plan.
- Use straight-edge tin-snips to cut the waste out.
- Use stakes and mallets to bend the seams to hold the edges tightly together in position.
- Check for accuracy, neatness and strength after the product is completed.

Testing your bread tray

- 1 Is the bread tray strong and firm? Is it square and balanced?
- 2 Will the tray hold standard-size breads?
- 3 Will it allow the bread to be cooked in normal time?

Evaluating your work

Answer the following questions in your exercise book.

- 1 What influenced your selection of materials and design?
- 2 Is the structure of the bread tray strong? Why?
- 3 Describe the safety and neatness of the bread tray.
- 4 What have you learnt from others' bread trays that might help you improve your bread tray?
- 5 If you were to make another bread tray, what would you change?
- 6 What impact does your bread tray have on people and the environment?

Communicating and marketing

- 1 How much did it cost you to make the bread tray?
- 2 How much will you receive when you sell your bread tray?
- 3 What benefit/s does your bread tray have for users?
- 4 What marketing technique/s would you use to sell your bread tray?

New words used in this chapter

atmosphere	air above in space
coated	covered
datum edge (timber)	first edge (of timber) normally prepared
finish	final stage of making something
firmly	strongly
grate	break food into small pieces by rubbing it against something
hygiene	practice of being clean in order to avoid disease
scriber	tool used to make marks on metal
squareness	at a right angle throughout
strengthened	made stronger
surroundings	things around you
technique	method
thoroughly	very well; carefully and completely
wear resistance	ability to resist damage

Chapter 12

Rainwater systems

Learning outcomes

By the end of this chapter, you should be able to:

- 7.12.1.1** identify the different parts of a rainwater unit
- 7.12.1.2** describe the proper care and maintenance of parts of the rainwater collection system
- 7.12.2.1** identify the parts of a rainwater tank
- 7.12.2.2** identify and describe the types of materials used in rainwater systems
- 7.12.3.1** calculate the volume of a rainwater tank
- 7.12.4.1** calculate the circumference of a rainwater tank
- 7.12.5.1** correctly identify and use tools
- 7.12.5.2** correctly measure the circumference of a rainwater tank
- 7.12.5.3** correctly cut parts of a rainwater tank
- 7.12.5.4** join the ends of a rainwater tank using rivets correctly
- 7.12.6.1** measure and fabricate the bottom and top covers of a rainwater tank
- 7.12.6.2** measure and fabricate a rainwater tank
- 7.12.7.1** correctly apply soft-solder to a rainwater tank joint
- 7.12.7.2** observe safety rules when applying soft solder
- 7.12.8.1** correctly cut a hole for the tap outlet of a rainwater tank
- 7.12.8.2** correctly apply soft solder on a socket fitting
- 7.12.8.3** correctly and safely cut a hole for rainwater entry
- 7.12.8.4** test a rainwater tank for water leakage
- 7.12.8.5** correctly and safely apply rust paint onto soft-soldered joints
- 7.12.9.1** discuss the importance of using water collected from a rainwater source.

Introduction

It is very important to have clean water supplies and drainage systems in towns and villages throughout Solomon Islands. Plumbing is a trade that safeguards the health of the community by supplying these services.

Plumbing is the work of connecting and supplying various services to a building, for example designing and installing cold and hot water supplies, installing roofing and guttering, making water tanks and sheet metal products, connecting water pumps, laying sanitary and drainage pipes, installing gas fittings, and welding.

To maintain high levels of public health and ensure that diseases such as **typhoid** and **cholera** do not spread, the plumbing work must be carried out to the highest possible standard.

In this chapter you will study how to collect safe drinking water from rain. Water is important for life. People who live in towns obtain water from water supply systems, but people in isolated communities may not have access to continuous supplies of water. These people have to collect their own water.

Design problem: Rainwater tank

You become aware that water supply shortages are a big problem in your community. Your aim is to make a storage tank, so that your family will be able to collect and store rainwater.

At the end of this chapter, you are required to do one of the following:

- design and make a small model of a water tank, constructing it from paper
- design and make a real water tank, constructing it from sheet metal. However, this option will very much depend on your subject teacher helping you to carry out the task.

Tools and equipment used in this chapter

Centre punch
Cold chisel
Cross-pin hammer
Divider
Electric drill
Hammer
Heating furnace or gas fire
Large radius compass
Multi-grip pliers
Plain soldering iron or an electric solder
Pop rivet gun
Small hand brush
Soldering stick
Square
Steel wool
Tape measure
Tin-snips
Wooden mallet

Materials used in this chapter

Clean cloth
Flat head rivet
Flux (hydrochloric acid and zinc chloride)
Galvanized socket
Hand stake or block of wood
Pop rivet

Rainwater collection systems

By the end of this topic, you should be able to:

- 7.12.1.1 identify the parts of a rainwater unit
- 7.12.1.2 describe the proper care and maintenance of parts of the rainwater collection system.

Regardless of the size of your tank, the basic principle of water collection is to catch the rainwater that falls onto your roof and into the guttering, **channelling** it along the **downpipe** and filtering it into your tank, where it is collected for later use.

Figure 12.1 shows the components of a rainwater collection system.



Figure 12.1 Rainwater system

Activity 1: Finding out about a rainwater collection system

- 1 In groups, look for a water collection system in your school area and study the parts of the rainwater collection system.
 - a roof
 - b gutter
 - c downpipe
 - d water tank.
- 2 In your exercise book, write down the name of the material that each of the following parts is made from:
- 3 Report your findings to your teacher.

Maintenance of rainwater collection systems

Traditionally, rainwater is used for drinking. Roofs that are used for water collection must be kept clean and free, if possible, from anything that could cause dirty drinking water. Roof, **gutters** and downpipes should be checked for cleanliness regularly—at least once a month.

How to maintain and clean the roof and gutter

- 1 Disconnect the downpipe from the tank.



Figure 12.2 Downpipe being disconnected from the rainwater system

- 2 Climb over the roof and sweep all dirt and leaves away. Wash the inside of the gutter thoroughly with clean water.



Figure 12.3 Cleaning the gutter of a rainwater system



Figure 12.4 Cleaning dirt inside gutter



Figure 12.5 Clean gutter

- 3 Reconnect the downpipe to the tank.



Figure 12.6 Reconnecting the downpipe to the rainwater collection system

- 4 Tie a clean cloth around the end of a downpipe to trap dirt coming from the roof and gutter. It is important to wash the cloth regularly to get rid of the dirt.



Figure 12.7 A cloth can be fastened and used as a filter

Activity 2: Finding out how to clean a tank

- 1 Write down at least five things that may be found on a roof which might affect the water supply.
- 2 Explain what would happen to the drinking water if dead rats or other animals were found on the roof.

Foul water separator

A foul water separator is a piece of equipment used to prevent dirt from entering the water tank. The purpose of the foul water separator is to collect objects that are washed down in the **'first wash'** of rain from the roof and gutter, in order to prevent them from entering the rainwater collection system.

Figure 12.8 shows the parts of the foul water separator and the water tank.

The foul water separator is a small tank located near the large water tank. Water from the roof flows into the separator tank. Inside this small tank is a ball floater, which acts as a stopper. As the water from the 'first wash' rises in the separator tank, the ball also rises. On reaching the neck of the separator, the ball blocks the entry of water



Figure 12.8 Foul water separator with a water tank

into the separator. The remaining rainwater then passes into the large water tank.

Figure 12.9 shows the flow of rainwater in the foul water separator.

The water in the foul water separator is best for washing, cleaning plates, pots etc. It is important that the foul water separator is always emptied before the next occurrence of rain. If the separator

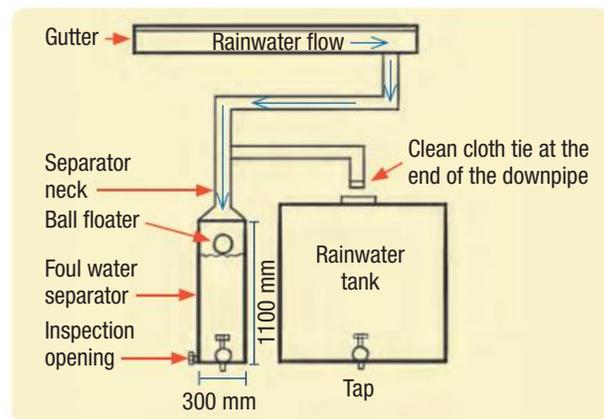


Figure 12.9 The parts of a foul water separator connected into a rainwater collection system

is still full of water when the next rain comes, it will not do its job because the 'first wash' of rain, which collects dirt from the roof, will have to bypass the foul water separator tank and enter the rainwater tank.

It is a good idea to put an inspection opening at the bottom of the foul water separator, to allow cleaning of the inside of the separator tank.

Activity 3: Finding out about the parts of a rainwater collection system

- 1 Why is it important to clean the roof and gutter regularly?
- 2 List the two methods used to prevent dirt from entering the water tank.
- 3 Explain how the foul water separator works.
- 4 How often should the roof and gutter be checked and cleaned?
- 5 What is the best and simplest way to clean the gutter?

Activity 4: Cleaning the roof and gutter

You will need:

- broom
 - clean cloth.
- 1 In groups, find a roof in your school area from which rainwater is collected.
 - 2 In groups, climb the roof, using a proper ladder. When climbing the roof, think of safety at all times.
 - 3 Inspect the gutter for dirt and other foreign objects.
 - 4 Clean the gutter (refer to the section called 'How to maintain and clean the roof and gutter' on page 185).

Types of rainwater tanks

By the end of this topic, you should be able to:

- 7.12.1.1 identify the parts of a rainwater tank
- 7.12.2.2 identify and describe the types of materials used in rainwater systems.

Rainwater tanks are installed to collect and store water where mains water or other sources of water supply are not available.

The following types of water tanks are commonly used in Solomon Islands:

- galvanized steel
- aluminium
- fibreglass
- plastic
- concrete.

Galvanized steel tanks

Galvanized steel tanks are very common. These tanks are easy to make and **inexpensive**. Galvanized steel is coated with zinc to prevent rust. Galvanized steel tanks should not be used near the sea, as salt water can cause rust.



Figure 12.10 Galvanized steel tank

Aluminium tank

The aluminium tank is rated as the best for collecting water. This is because the material can last for many years. It will not rust and so is suitable for use near the sea. However, it is very expensive and difficult to make.



Figure 12.11 Aluminium tank

Fibreglass tank

The fibreglass tank is **rust resistant** and strong, and so very suitable for storing water near the sea. It is expensive but long-lasting. However, it can be damaged by sharp or heavy objects.



Figure 12.12 Fibreglass tank

Plastic tank

Plastic tanks are increasingly popular in rural areas. These tanks are light in weight, easy to install and come in a variety of colours. Plastic tanks are now the most common for household use, especially near the sea. They are long-lasting, but expensive and difficult to make. Sharp objects may damage them.



Figure 12.13 Plastic tank

Concrete tank

Concrete tanks are widely used, especially in rural areas. They are tough, very heavy and long-lasting. Concrete tanks are constructed mostly on site, because of their size and weight. They are expensive and their construction and installation require a lot of heavy work.



Figure 12.14 Concrete tank

Calculating the volume of a tank

By the end of this topic, you should be able to:

7.12.3.1 calculate the volume of a rainwater tank.

Before making a water tank, you need to know the amount of water it will hold. This is called **volume**.

How to calculate the volume of a tank

You use the following formula to calculate volume:

$$V = \pi r^2 \times h$$

Where:

V = volume of tank

π = 3.142

r = radius of tank

h = height of tank

Your answer should be in cubic metres (m^3). To change cubic metres into litres, you must multiply by 1000. For example:

$$0.9426 \text{ m}^3 \times 1000 = 942.6 \text{ litres}$$

Activity 5: Finding out about tanks

- Copy and complete the following table in your exercise book. Read the section called 'Types of rainwater tanks' on page 187 to help you.

Types of water tanks	Advantages	Disadvantages
1		
2		
3		
4		
5		

- Which type of water tank is easiest to make?
- Which water tanks should not be located near the sea and why?
- Which water tanks are best for use near the sea?
- Why do concrete tanks involve a lot of heavy work?
- Which tank would you choose for your home and why?



Activity 6: Calculating the volume of a tank

You will need:

- tape measure.

- In groups, find a rainwater tank in your school area. Measure its:
 - diameter (in metres)
 - height (in metres).
- Return to your class and work out the volume of the tank that you have just measured (refer to the section above called 'How to calculate the volume of a tank').

Calculating the circumference of a tank

By the end of this topic, you should be able to:

7.12.4.1 calculate the circumference of a rainwater tank.

Before any tank is ready to build, you need to work out its total length, or **circumference**.

How to calculate the circumference of a tank

The formula for finding the circumference of a tank is:

$$C = \pi \times D$$

Where:

C = circumference

$\pi = 3.142$

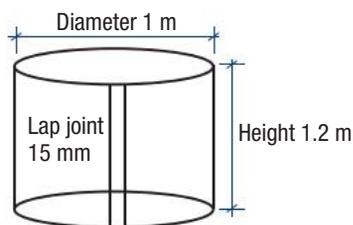
D = diameter of tank

For example, the measurements of a tank are:

$$C = \pi \times D$$

$$C = 3.142 \times 1.000 \text{ m}$$

$$C = 3.142 \text{ m}$$



NOTE: Don't forget to add 15 millimetres **allowance** to allow joining of the tank. Before you add 15 millimetres, first convert it to metres.

Dividing 15 millimetres into 1000 gives 0.015 metres. So:

$$3.142 \text{ m} + 0.015 \text{ m} = 3.157 \text{ m}$$

Now we know that the total circumference of the tank is 3.157 metres.

Measuring out the circumference of a tank

By the end of this topic, you should be able to:

7.12.5.1 correctly identify and use tools

7.12.5.2 correctly measure the circumference of a rainwater tank

7.12.5.3 correctly cut parts of a rainwater tank.

Before you begin the measuring, you will need to collect the tools shown in Figures 12.15 to 12.20.



Figure 12.15 Tape measure



Figure 12.16 Tin-snips



Figure 12.17 Divider



Figure 12.18 Cross-pein hammer

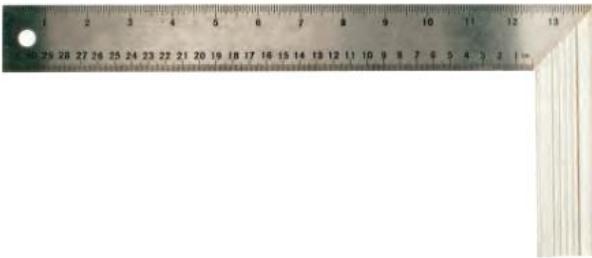


Figure 12.19 Square



Figure 12.20 Centre punch

Note: Your teacher will show you how to do the measuring but some of you should help so that you learn by practice.

How to measure the circumference of a tank

- 1 Measure the length to 3.157 metres. Mark the end and square it. Cut with tin-snips.

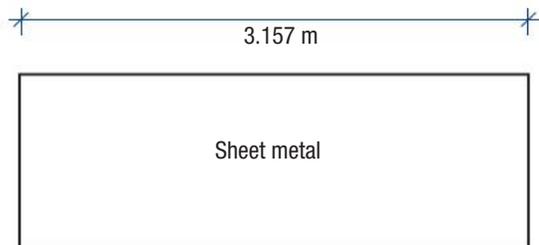


Figure 12.21 Mark the length of the tank with a tape measure.

- 2 Measure 15 millimetres on the right side of the sheet metal. Set the divider tool to 15 millimetres and scribe it.

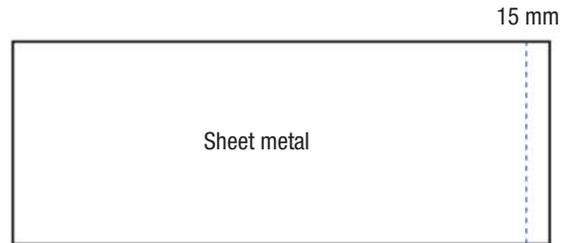


Figure 12.22 Mark out the position of lap joint.

- 3 Measure 15 millimetres as shown and trim off the ends for both top and bottom edges of the sheet metal.

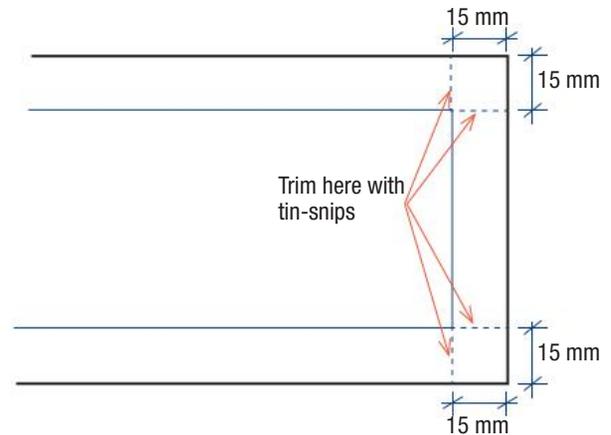


Figure 12.23 Trim off top and bottom ends for lap joint.

- 4 Still on the same side of the sheet metal, measure every 50 millimetres along the joint at the centre of the 15 millimetres joint. Centre punch these to make a hole (see example Figure 12.24)

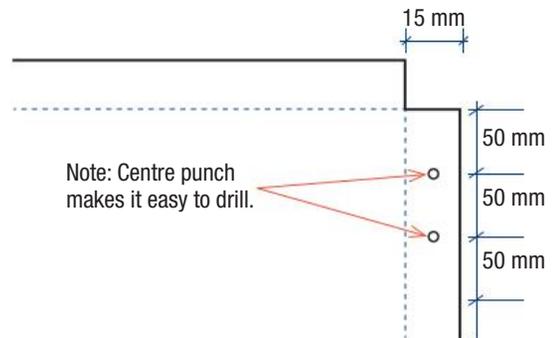


Figure 12.24 Measure position of rivet joint.

Joining the ends of a tank

By the end of this topic, you should be able to:

- 7.12.5.1 correctly identify and use tools
- 7.12.5.4 join the ends of a rainwater tank using rivets correctly.

Before joining the ends of the tank, you will need to collect the tools shown in Figures 12.25 to 12.27.



Figure 12.25 Electric drill



Figure 12.26 Pop rivet gun



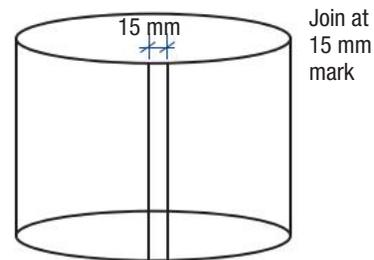
Figure 12.27 Multi-grip pliers

You will also need:

- 4 millimetres drill bit
- flat head rivet (sometimes known as tank rivet)
- pop rivet.

How to join the ends of a tank

- 1 Roll the two ends together and place the joint on a 15 millimetre mark.



Hold the joint of the tank in position with the multi-grip pliers.



Figure 12.28 Using multi-grip pliers

Stand the tank in an upright position to allow proper riveting.

- 2 Drill the centre punch mark at the top, centre and bottom, and use a pop rivet to hold the joint in place. The purpose of using a pop rivet is to hold the tank joint in position before the tank rivet is applied.

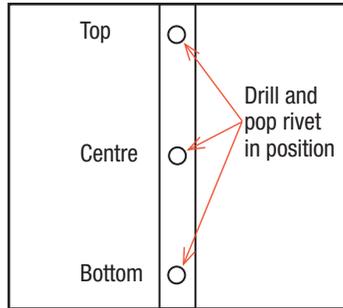


Figure 12.29 Drill and pop rivet tank in position.

Pop rivets are used primarily for joining sheet metal. They are manufactured from aluminium **alloy**, copper and mild steel. They are available in various sizes, ranging from 3 to 4 millimetres in diameter.



Figure 12.30 Pop rivet nail

The pop rivet is named for the ‘pop’ sound it make when it is applied to the joint.

- 3 Drill all the centre-punched marks along the joint. Use a flat head rivet (known as a tank rivet), to form a strong joint. Start from the top of the tank and work downwards. Figure 12.31 shows how to insert the rivet to form the joint.

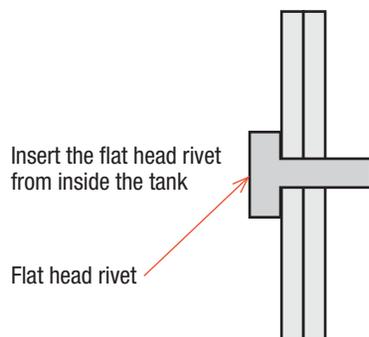


Figure 12.31 Insert rivet from inside tank.

Flat head or tank rivets are made of a soft **malleable** steel which does not crack during riveting. Most rivets are coated with tin or galvanized to prevent corrosion. Figure 12.32 shows the shape of the flat head rivet.



Figure 12.32 Flat head rivet

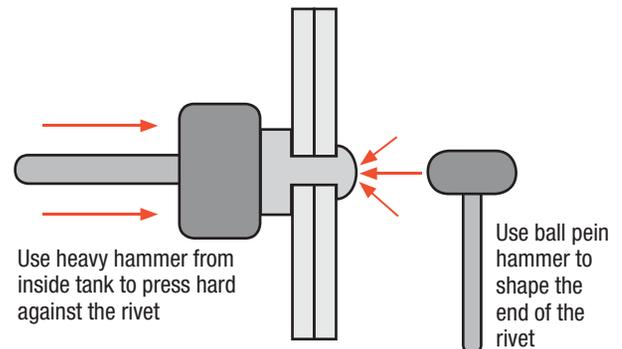


Figure 12.33 How to shape the end of the flat head rivet

Your teacher will demonstrate to you how to form a complete rivet joint.

When you are doing this task, don’t forget to drill out the pop rivets joint and replace it with a tank rivet.

Making and fitting the bottom and top covers of a tank

By the end of this topic, you should be able to:

- 7.12.5.1 correctly identify and use tools
- 7.12.6.1 measure and fabricate the bottom and top covers of a rainwater tank
- 7.12.7.1 correctly apply soft solder to a rainwater tank joint
- 7.12.7.2 observe safety rules when applying soft solder

- 7.12.8.1 correctly cut a hole for the tap outlet of a rainwater tank
- 7.12.8.2 correctly apply soft solder to a socket fitting
- 7.12.8.3 correctly and safely cut a hole for rainwater entry
- 7.12.8.4 test a tank for water leakage
- 7.12.8.5 correctly and safely apply rust paint onto soft-soldered joints.

The method of making the covers is the same for bottom and top.

To fit the bottom and top covers of the tank, you will need the tools shown in Figures 12.34 to 12.37.



Figure 12.34 Pliers

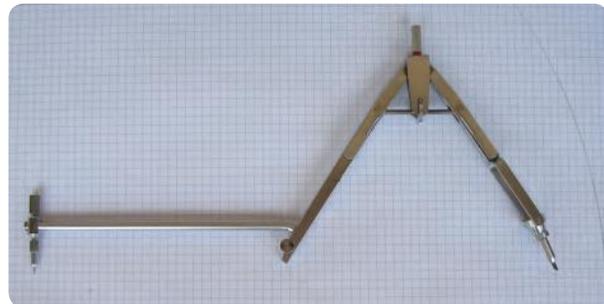


Figure 12.36 Large radius compass



Figure 12.35 Wooden mallet



Figure 12.37 Hand stake or block of wood

How to make and fit the bottom and top covers

- 1 Stand the tank in an upright position and measure and mark 15 millimetres around both edges of the tank using a divider compass.

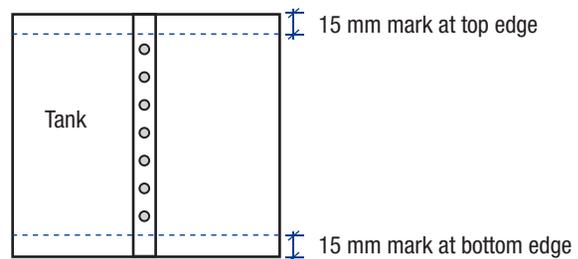


Figure 12.38 Mark bottom and top edges.

- Bend the edge at top and bottom at 90°, using pliers to make a **rim**.

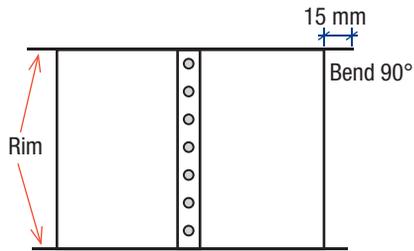


Figure 12.39 Bend bottom and top edges 90° with pliers.

- Straighten the edge with a wooden mallet and hand stake.

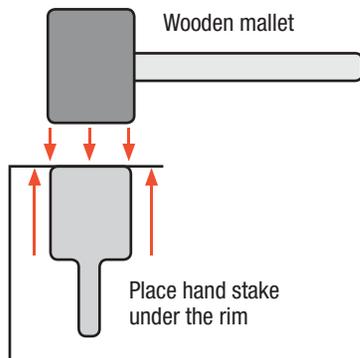


Figure 12.40 Straighten tank edge with mallet and stake.

- Measure and mark the full diameter of the cover (in this case, bottom cover). Note the measurements below.

The required diameter of the cover is calculated by adding the following:

- 1000 millimetres for actual diameter of the tank
- 15 millimetres on each side of the rim you have just made
- 7 millimetres on each side so that the cover can be bent over the rim.

So, the diameter is:

$$1000 + 15 + 15 + 7 + 7 = 1044 \text{ mm}$$

or 1.044 m

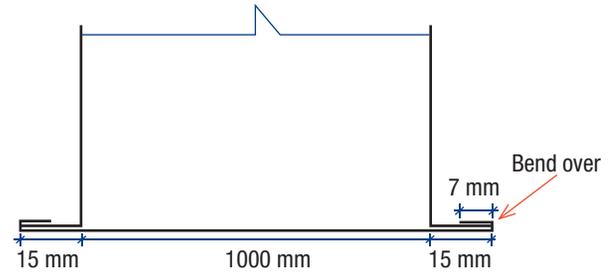


Figure 12.41 How to mark bottom cover of tank

- Using a large radius compass, measure and mark the round circle on a flat piece of sheet metal. Remember, the diameter of the cover is to be 1044 millimetres.

Note: To measure out the circle, you need its radius. In order to get the radius, you must divide 1044 millimetres by 2. So:

$$1044 \div 2 = 522 \text{ mm}$$

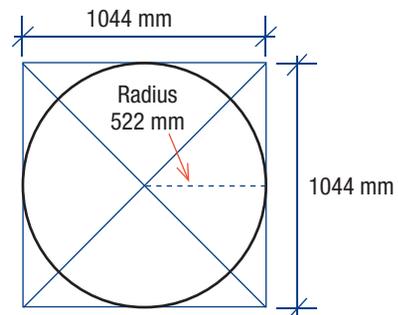


Figure 12.42 How to mark radius of the tank

- Set the large radius compass to 522 millimetres. Position one end of the compass at the centre of the metal and draw the full circle to 360°.
- Using the tin-snips, cut off the outside of the round circle.
- Position the metal on the bench. Measure and mark 7 millimetres around the metal with the divider compass, and turn the edge at 90° using pliers.



Figure 12.43 Turn bottom edge 90° with pliers

- 9 Place the tank body on the finished bottom cover. The tank body should fit neatly on the cover.

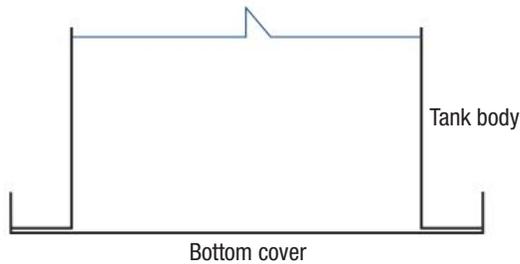


Figure 12.44 Position tank inside bottom cover

- 10 Gently hammer the edge flat with the ball pein hammer. It is important to bend the sides of the round tank to prevent it from sliding off the cover.

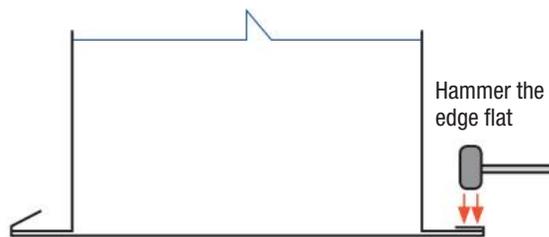


Figure 12.45 Flatten the edge with mallet or ball pein hammer.

This type of joint is called a pan-down seam.

The tank is ready to soft-solder.

Finishing

To finish the tank and to ensure there are no leaks, all the joints must be soft soldered. A soft-soldered joint is called a watertight joint.

Soft solder is a method of joining metal surfaces with a metal alloy. (An alloy is a mixture of two or more metals.) The metal alloy is called **solder**. Solder is designed to melt at a temperature lower than the melting point of the metals it joins. The solder is melted and applied over the parts being joined; when it becomes solid it binds the ends together.

You will need the following soldering devices:

- a plain soldering iron or an electric solder
- a soldering agent called **flux (hydrochloric acid and zinc chloride)**
- a soldering stick
- a heating furnace or gas fire (used only for heating a plain soldering iron).



Figure 12.46 Plain soldering iron



Figure 12.47 Flux (hydrochloric acid)



Figure 12.48 Soldering stick



Figure 12.49 Gas fire

Soldering safety

Special safety measures must be taken when using soldering equipment.

Observe all the safety rules in your workshop or work area and develop safe working habits when using soldering equipment. Pay particular attention to the following points:

- 1 Protect your eyes from splash solder and flux.
- 2 Do not touch joints that have just been soldered.
- 3 Treat cuts and burns quickly.
- 4 Be careful when storing hot soldering irons after use. Improper storage may result in burns or a fire.
- 5 Always wash your hands properly after using solder.
- 6 Always solder in a well-ventilated area.
- 7 Check that all gas valves have been turned off after the completion of the job.

Activity 7: Finding out about safety in soft soldering

Answer the following questions in your exercise book.

- 1 Why should you protect your eyes from splash solder and flux?
- 2 What will happen if you do not wash your hands after using the solder?
- 3 Explain why it is always important to solder in a well-ventilated area.
- 4 Why should you not touch joints that have just been soldered?

Flux

All metals oxidise (rust) to some extent when exposed to the atmosphere. Rust is the thin layer that forms on metal surfaces when they are exposed to the air. This layer must be removed before the solder will stick. To do this, flux is applied to the joint.

The flux has three jobs. It:

- 1 removes the rust from the metal surface
- 2 forms a liquid cover on the metal surface to prevent further rust from forming
- 3 enables the solder to flow more easily into the joint and stick on the metal surface.

Activity 8: Finding out about flux

Answer the following questions in your exercise book.

- 1 Explain what will happen to the soldered joint if you don't apply the flux.
- 2 State the name of the flux used for soft solder.
- 3 What would happen if the metal to be joined had a lower melting point than the solder stick being used? If you cannot answer this question, ask your teacher to help you.

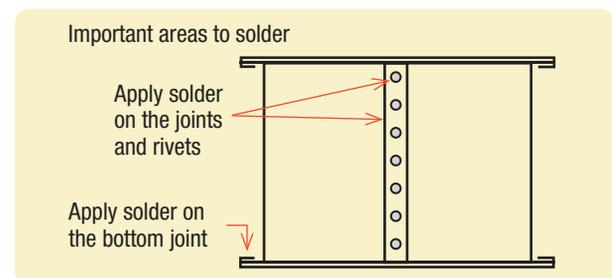


Figure 12.50 Important areas to solder

Note: The top cover should be just tacked in place at four positions, so it can be removed when the tank is cleaned.

Technique for soft soldering

The following techniques are important to follow when soldering.

- Clean the joint with steel wool.



Figure 12.51 Use a steel wool cloth to clean the surface being soldered.

- Apply a coat of flux with a small hand brush along the joint.



Figure 12.52 Flux being applied to a metal surface that is ready for soldering

- Heat the soldering iron to the correct temperature. To identify the correct temperature, melt the solder stick onto the soldering iron. If the solder stick melts freely then the temperature is correct.



Figure 12.53 A soldering iron being heated in a soldering heating fire

- Apply the soldering stick together with heated iron and allow it to melt on the coated flux joint.



Figure 12.54 Applying solder onto a metal surface

- Move your hand very slowly along the joint and keep applying a small amount of solder directly in front of the soldering iron point.



Figure 12.55 Applying a soldering iron to a soldering work

- Keep applying the soldering stick until you have completed every joint. If the soldering iron becomes cool, place it again on the heated gas fire to get the right melting temperature.



Figure 12.56 Apply more solder on the joint.

- When the joint is cool, clean it with a clean wet rag.



Figure 12.57 Clean the finished soldered surface with a cloth.

Your teacher will demonstrate to you how to soft solder the bottom cover and the body joint.

Cutting a hole for the tap

A tank always need a tap, so you can get the water out of it. To fix a tap you do the following:

- 1 Measure 50 millimetres above the bottom line of the tank.



Figure 12.58 The initial marking process of the hole for the tap position

- 2 Mark the hole size using 15 millimetre galvanized **socket** as a guide. A galvanized socket is a fitting used to tighten the tap.



Figure 12.59 The diameter of the hole being marked with a galvanized socket

- 3 Punch a hole using a hammer and cold chisel. A cold chisel is a hand tool used for cutting metal.

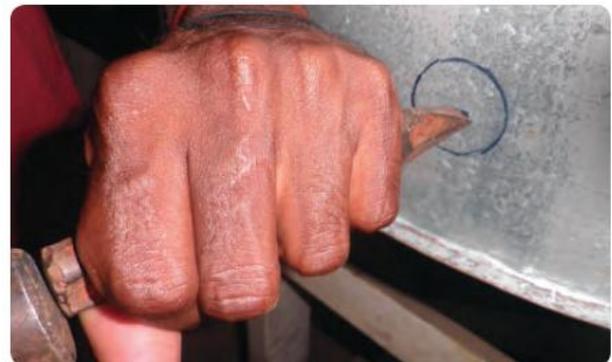


Figure 12.60 Punching the hole

- 4 Cut the round hole using small curved tin-snips.



Figure 12.61 The hole should be cut with tin-snips.

- 5 Fit the galvanized socket in the hole, with approximately 5 millimetres sticking out. Make sure the socket is not falling inside the tank.



Figure 12.62 Fitting the galvanized socket

- 6 Apply the coat of flux around the fitting.



Figure 12.63 Flux being applied to the fitting

- 7 Soft-solder the socket until the joint is completely sealed.



Figure 12.64 Solder being applied to the fitting

- 8 Clean the joint with a clean, wet rag.

Cutting a hole for rainwater entry

A tank also needs a hole at the top for the rainwater to enter. To cut the hole you do the following:

- 1 Measure and mark the centre of the tank cover.



Figure 12.65 The centre of the hole is marked on the top of the tank.

- 2 Set the divider compass to 100 millimetres.



Figure 12.66 Use a ruler and a divider to find the diameter of the hole.

- 3 Draw a full round circle.



Figure 12.67 The marks for the tank hole being inscribed with a divider

- 4 Punch a hole using a cold chisel.



Figure 12.68 Punching the hole with a cold chisel

- 5 Cut the hole using curved tin-snips.



Figure 12.69 A curved tin cutter is used to cut the top hole of the tank

- 6 Check the hole for correct size. It can range from 100 to 300 millimetres in diameter.



Figure 12.70 The finished top hole of the tank

Test for leakage

The tank must be tested to ensure that no leakage is detected on the joints. The following is the suggested procedure.

- 1 Fit the tap at the outlet and turn it to the closed position.
- 2 Using a water hose, fill the tank to the top level.
- 3 Check for any sign of leakage along the bottom and side joints.
- 4 If no leak is detected, empty all water in the tank. If a leak is detected, it must be repaired immediately.

Finishing off with rust paint

Joints should be covered with paint to protect the tank from quick rusting. The areas needing paint are the soft-soldered areas—that is the bottom cover and the body joint.

Practical task

By the end of this practical task, you should be able to:

7.12.6.2 measure and fabricate a rainwater tank

7.12.9.1 discuss the importance of using water collected from a rainwater source.

Go back and read the design problem at the beginning of this chapter. You are going to solve that design problem.

Design problem: Rainwater tank

Design expectations

The following must be considered in the development of the rainwater tank:

- The rainwater tank is to be made to the measurements shown in Figure 12.71:

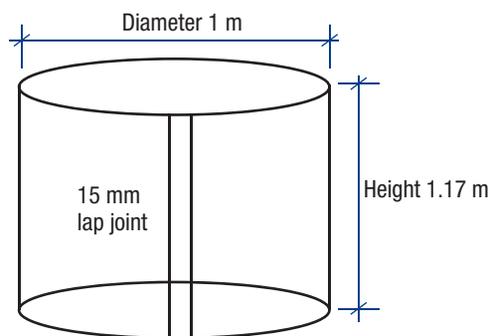


Figure 12.71 Tank to be fabricated

Materials required

1 length of 3.157 m \times 24 (gauge) galvanized sheet metal (for the body)

1 length of 2.400 m \times 24 gauge galvanized sheet metal (bottom and top covers)

30 tank rivets

10 pop rivets

3 soldering sticks

1 \times 15 mm galvanized socket

Steps

- List all materials and tools you take from the store person.
- Work out the circumference of the tank to get the total length, plus the lap joint.
- Measure the correct length and cut the required metal.
- Prepare the ends and roll the sheet metal to make a joint.
- Prepare top and bottom edge of the metal by bending to 90°.
- Mark and cut the bottom and top covers.
- Fit both bottom and top covers.
- Soft solder bottom and body joint.
- Mark and cut tap hole and soft solder it.
- Mark and cut hole for rain entry.
- Test tank for leak.

Your teacher will guide you through the making of the tank.

Checklist

- Is the diameter of the tank correct?
- Is the height of the tank correct?
- Has the bottom cover been soldered?
- Has the body joint been soldered?
- Has the tap outlet been soldered?
- Has the rain entry been cut on the top of the tank?
- Is the tank sound and watertight?
- Have the bottom and side joints been covered with anti-rust paint?

New words used in this chapter

allowance	extra measurement allowed, e.g. for joining metals together
alloy	mixture of two or more metals, e.g. a soft solder may be half tin and half lead
channelling	directing
cholera	disease caused by contaminated water and food
circumference	distance around a circle
downpipe	pipe that carries roof water from the gutters to the drains or storage tank
first wash	first fall of rain after a long period of time
flux	chemical substance used to prevent oxides or rust during solder
gutter	open pipe used for the collection of rainwater from the roof
hydrochloric acid	extremely active and poisonous chemical substance. It is used as a flux when soldering galvanized sheet metal.
inexpensive	cheap in price, low-cost
malleable	soft or flexible, e.g. plastic is malleable
rim	edge
rust resistant	not likely to rust
socket	female thread end of a pipe used to join another pipe, pipe fitting or tap
solder	alloy used in molten state for joining certain metals
typhoid	disease caused by contaminated food and water. Symptoms are high fever, spots and abdominal pain.
volume	amount of water stored in a container or water tank

Chapter 13

Tap installation and maintenance

Learning outcomes

By the end of this chapter, you should be able to:

- 7.13.1.1** identify and describe the materials used for making taps
- 7.13.1.2** identify the types of taps used in Solomon Islands
- 7.13.2.1** identify the types of loose-valve screw-down taps
- 7.13.2.2** describe the situations in which loose-valve screw-down taps are used
- 7.13.3.1** explain how a loose-valve screw-down tap works
- 7.13.3.2** identify the basic parts of a loose-valve screw-down tap
- 7.13.4.1** list the safety precautions to be taken when working with taps
- 7.13.4.2** identify male and female threads on a tap
- 7.13.5.1** identify and describe common faults with taps
- 7.13.5.2** describe the process to install a tap
- 7.13.5.3** repair taps that have faults in them
- 7.13.6.1** replace a faulty washer and cracked valve seat
- 7.13.7.1** calculate the charge for repairing a tap
- 7.13.8.1** discuss the benefits of maintaining taps at home and in other Solomon Island communities.



Introduction

Taps are used to control the flow of water through the water pipes. They are available in many different designs to meet various purposes. The main types of taps are:

- plug taps
- spring taps
- loose-valve screw-down taps.

In this chapter, you will learn about all these types of taps but in you will study only the loose-valve screw-down tap in detail. This type of tap is very common. You will find these taps in your house or at the village water supply stand pipes.

Design problem: Fixing a tap

Your design problem is to fix and repair a tap. By the end of this chapter you will know about loose-valve screw-down taps, and be able to operate, repair and maintain them.

Tools used in this chapter

Flat-head screw driver
Pliers
Shifting spanner

Materials/equipment used in this chapter

Old taps
Thread seal tape

Activity 1: Finding out about taps

Answer the following questions in your exercise book.



- 1 What is the purpose of a tap?
- 2 What would happen to the water supply if we did not have taps?

Taps

By the end of this topic, you should be able to:

- 7.13.1.1 identify and describe the materials used for making taps
- 7.13.1.2 identify the different types of taps used in Solomon Islands.

Taps are made from brass. Brass is used because it is long-lasting and will not rust. Most taps are now coated with **chrome plating**. This chrome plating is applied in the factory. Chrome-plated taps are designed for use in houses in kitchen sinks, hand basins, baths and showers, as they have a good finish and good appearance.



Figure 13.1 Chrome-plated tap

In Honiara, cheap taps are sold in many shops. These taps are made from very low-grade metal and are easily damaged.



Figure 13.2 A cheap tap is easily damaged.

Types of taps

Plug taps

Plug taps are used only in low-pressure systems, for example in an outlet to a rainwater tank.



Figure 13.3 Plug tap on a tank

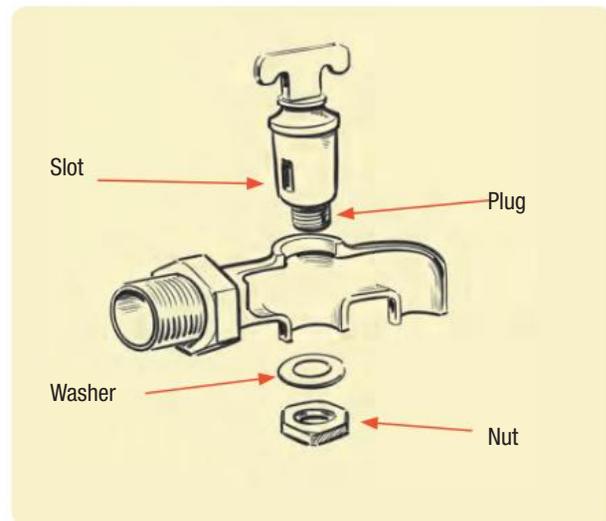


Figure 13.4 Open view of a plug tap

When plug taps are used in town water supplies they cause a 'water hammer' action because of the sudden stop to the flow of water. The water hammer action causes a loud banging noise when a sudden flow of water stops.

Spring taps

Spring taps, or self-closing taps, are used for drinking fountain in public places where there is a danger of water being wasted from taps left on.

The tap is operated by depressing the button against the spring tension. This action causes the valve to lift from its seat, allowing water to flow to the outlet.



Figure 13.5 Drinking fountain

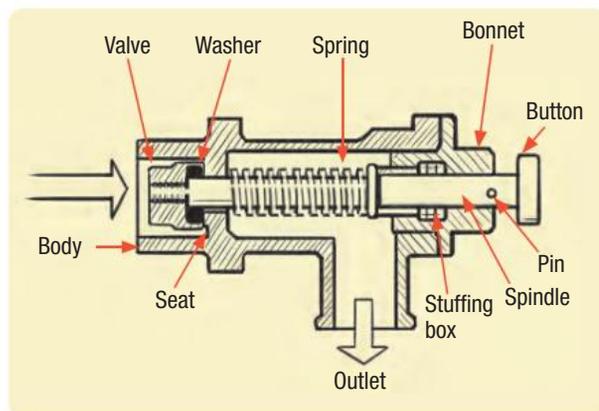


Figure 13.6 Construction of a simple spring tap

Loose-valve screw-down taps

You will learn about loose-valve screw-down taps in the next section.

Loose-valve screw-down taps

By the end of this topic, you should be able to:

- 7.13.2.1 identify the types of loose-valve screw-down taps
- 7.13.2.2 describe the situations in which loose-valve screw-down taps are used.

Loose-valve screw-down taps are used in high-pressure systems connected to town water supplies. There are various types of loose-valve screw-down types:

- a A stop tap controls water from a tank.



Figure 13.7 Stop tap control on a tank

- b A hose tap controls water for the garden stand pipe and laundry.

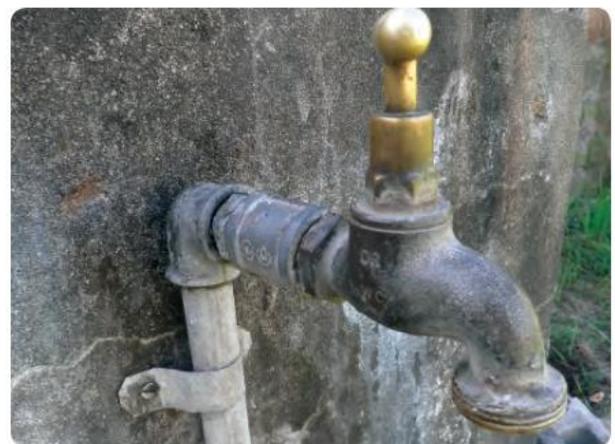


Figure 13.8 Hose tap

c A pillar tap controls water to the hand basin.



Figure 13.9 Pillar tap

d A bib tap controls water to the kitchen sink.



Figure 13.10 Bib tap

e A shower tap controls water to the shower.



Figure 13.11 Shower tap

Activity 2: Identifying taps

Answer the following questions in your exercise book

- 1 Why are taps made out of brass materials?
- 2 Name the tap that controls the flow of water to the tank.
- 3 Name the tap that controls the flow of water to the garden area.
- 4 Name the tap that controls the flow of water to the kitchen sink.
- 5 Name the tap that controls the flow of water to the shower outlet.

Activity 3: Finding out more about taps

- 1 Your teacher will divide you into groups.
- 2 Walk around your school compound or other area and make a list of the type of taps you see.
- 3 In your exercise book, write down the name of each tap and the place in which you found it.
- 4 In your free time, look for some old thrown-away taps and bring them to your next Technology class.

How loose-valve screw-down taps work

By the end of this topic, you should be able to:

- 7.13.3.1 explain how a loose-valve screw-down tap works
- 7.13.3.2 identify the basic parts of a loose-valve screw-down tap.

The loose-valve screw-down tap is designed so that the closing or opening of the tap is gradual, in order to minimise noise and vibration (shaking) caused by the water hammer.

Open position

The handle of the tap turns in an anti-clockwise direction, allowing the top part of the tap to be raised. Water comes from the inlet as the handle is raised. Pressure is released from the **valve seat**, where the washer is, and the water pressure acting on the underside then lifts the valve, allowing the water to pass through the outlet.



Figure 13.12 Open position of the loose-valve screw-down tap

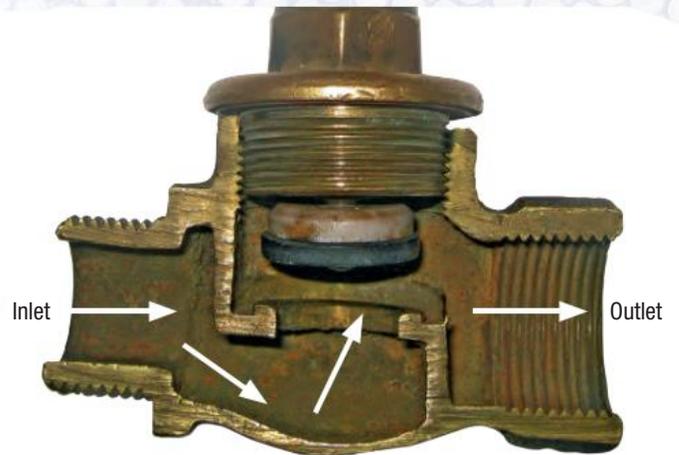


Figure 13.13 How the loose-valve screw-down tap works

Closed position

To close the tap, the handle is turned clockwise. This moves the **spindle** down towards the seat and pushes the valve into its seat against the pressure of the water, shutting off the flow of water.

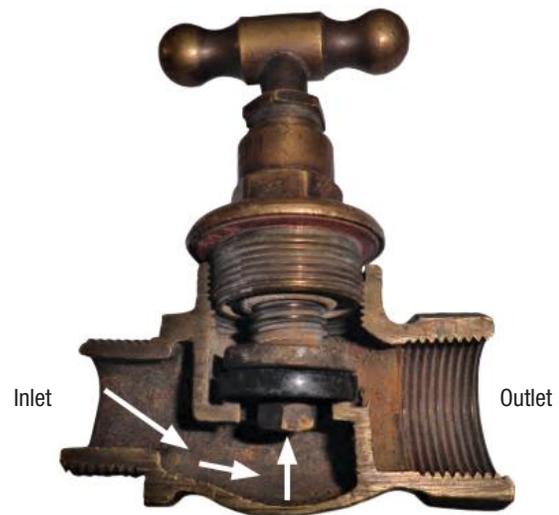


Figure 13.14 Close position of the tap

Loose jumper valve

The **loose jumper valve** may be **manufactured** of brass or plastic. The brass taps have a **replaceable** rubber washer. This washer is fixed to the valve body by a brass nut.

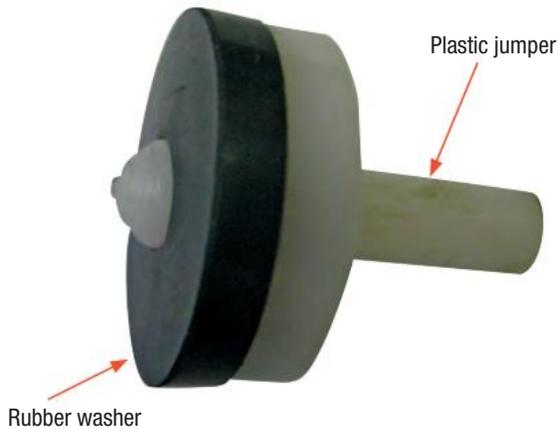


Figure 13.15 Plastic jumper valve

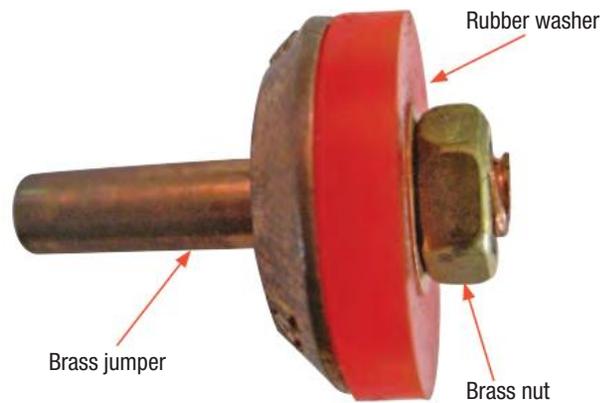


Figure 13.16 Brass jumper valve

Basic parts of the tap

The basic parts of a tap are shown in Figure 13.17.

A plastic packing gland and **rubber 'O' ring** are placed inside the tap to stop the water from leaking out through the spindle.

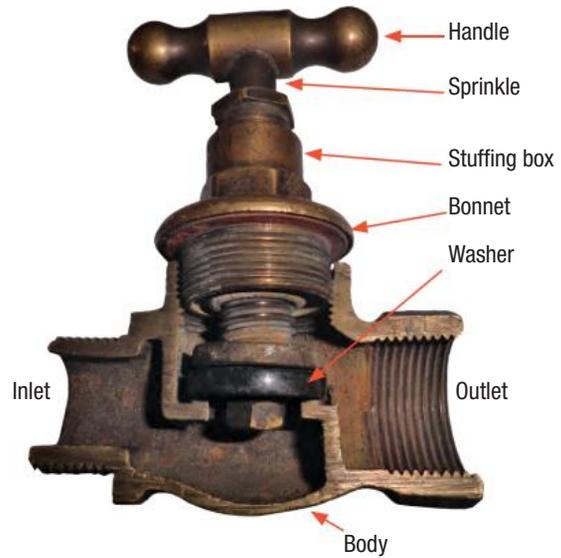


Figure 13.17 Inside a tap



Figure 13.18 Tap that uses an 'O' ring

Activity 4: Finding out about the parts of a tap

Answer the following questions in your exercise book.

- 1 Why do you think the washer is made of rubber?
- 2 What would happen if the washer was made of metal?
- 3 Which part of the tap is likely to wear out and need replacing?
- 4 What would happen if there was no packing gland or rubber 'O' ring?

Safety

By the end of this topic, you should be able to:

7.13.4.1 list the safety precautions to be taken when working with taps.

Special safety measures must be taken when working with taps. It is important to observe all the safety rules in your workshop and develop safe working habits when installing or maintaining taps.

- 1 Always turn water off before installing or repairing taps.
- 2 Wear protective equipment such as safety eye glass when installing taps.
- 3 Use correct tools when unscrewing or tightening taps.
- 4 Do not over-tighten taps—they may break and you may twist your wrist.
- 5 When dismantling taps, be careful to put the parts in a good safe place.
- 6 Keep old taps in your tool box.

Activity 5: Finding out about tap safety

Answer the following questions in your exercise book.

- 1 Why is it important to turn off the water supply before you repair the tap?
- 2 Why is it important to wear safety glasses when installing or repairing taps?
- 3 Why should you not over-tighten taps?
- 4 State the best place to keep your tools and old taps.

Common faults with taps

By the end of this topic, you should be able to:

7.13.5.1 identify and describe common faults with taps.

The most common faults found in taps are:

- dripping water when the tap is turned off
- handle continually slipping when the tap is turned off.

The causes and the solutions for these two faults are listed in the following table.

Fault	Cause	How to fix
Dripping tap	Worn washer	Fit new washer
	Cracked valve seat	Reseat valve seat
Handle slips	Spindle thread badly worn	Renew whole tap

Activity 6: Finding out about tap faults

- 1 Form into groups and look for taps in your school compound or elsewhere. See if you can find a tap that has a dripping problem or a tap handle that continually slips.
- 2 In your group, discuss the likely causes of the faults.
- 3 Report your findings to your teacher in the classroom.

Activity 7: Dismantling old taps

You will need:

- old tap
- shifting spanner
- pliers
- flat-head screw driver.

- 1 Watch carefully as your teacher demonstrates how to **dismantle** a tap.
- 2 Select an old tap to dismantle. To dismantle a tap, you need the tools shown in Figures 13.19 to 13.21.



Figure 13.19 Shifting spanner



Figure 13.20 Pliers



Figure 13.21 Flat-head screw driver

Dismantle (or take apart) your tap and check for the following faults:

- worn washer
- cracked valve seat
- tap handle that continually slips.

- 3 In your exercise book, write down your findings for that particular tap. Your teacher will help you to identify the faults.

Tap maintenance

By the end of this topic, you should be able to:

- 7.13.6.1** replace a faulty washer and a cracked valve seat.

The main causes of dripping taps are worn washers and cracked valve seats.

Tap washers

Replacing worn tap washers takes only a short time and is generally a very simple job. It is a good idea also to check the valve seat before you replace the washer.

How to replace a worn tap washer

- 1 Turn off the water supply at the water meter, as shown in Figure 13.22.



Figure 13.22 Water supply meter

- 2 Unscrew the **bonnet** or tap from the tap body, using a spanner.



Figure 13.23 Unscrewing the bonnet of a tap

- 3 Remove the bonnet (cover) from the body of the tap as shown in Figure 13.24.



Figure 13.24 Tap bonnet being removed from a tap

- 4 Remove the loose valve from its seat and check the condition of the washer.



Figure 13.25 Inside a tap



Figure 13.26 Tap washer

Note: The loose valve is made out of plastic material.

- 5 If the washer is worn and damaged, you will need to replace it.

Lever the washer away from its seat using a flat screw driver. Replace it with a new washer and push it back to its seat.



Figure 13.27 Inserting a new tap washer

If you do not have a new washer, you can turn the old washer over to its good side and place it back on its seat.

Sometimes new tap washers may not be available. You can make your own washer from old car tyre rubber by cutting it to the size of the existing tap washer. Ask your teacher to demonstrate how to do this.

- 6 Place the loose valve back into the bonnet of the tap, as shown in Figure 13.28.



Figure 13.28 Washer being fitted into the base of the bonnet of a tap

- 7 Screw back the bonnet and tighten it with the spanner.



Figure 13.29 Bonnet fitting into position within the tap



Figure 13.30 Bonnet being tightened with a shifting spanner

Note: Some loose valves are made of brass. To replace this type of washer you need to do the following:

- 1 See step 1 and Figure 13.22 on page 212.
- 2 See step 2 and Figure 13.23 on page 212.
- 3 See step 3 and Figure 13.24 on page 213.
- 4 Remove the brass loose valve from its seat and check the condition of the washer.



Figure 13.31 Malfunctioning washer

- 5 If the washer is worn and damaged, unscrew the brass nut using a spanner. If the brass nut is too hard to unscrew, use pliers to grip the brass stem and unscrew the nut.



Figure 13.32 Loosening the brass nut with a spanner

- 6 Remove the worn washer and replace it with a new washer. You can turn the washer onto its good side.



Figure 13.33 Removing the washer

- 7 Screw back the nut and tighten it firmly with the spanner.



Figure 13.34 The washer being held into position after cleaning

- 8 Screw back the bonnet and tighten it with the spanner.



Figure 13.35 Tap bonnet fitting into the base of a tap



Figure 13.36 Tightening the tap bonnet using a shifting spanner

Valve seat

Sometimes the tap in which you have just replaced the washer may still drip. The problem is likely to be a crack in the valve seat. If the valve seat is damaged a new washer will not fix the dripping tap.



Figure 13.37 Cracked valve seat

Cracked valve seats are caused by little bits of lime scale that get trapped between the washer and the seat and then grind away at it. The easy way to check is to put your finger inside the tap and feel around the valve seat. If you can feel a crack you will need to reseal the valve. To reseal the valve you use a special tool called a tap reseater.



Figure 13.38 Tap reseater

How to reseal a cracked valve

- 1 Unscrew the bonnet from the tap and remove the loose valve.



Figure 13.39 Bonnet of tap being removed



Figure 13.40 Tap with bonnet removed

- 2 Screw in the tap reseater against the valve seat.

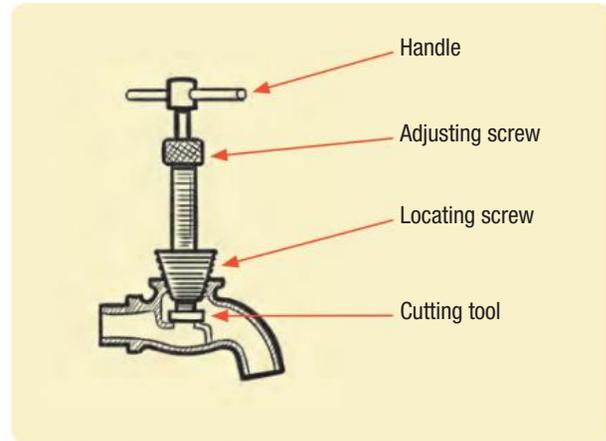


Figure 13.41 Refacing the valve seat

- 3 Watch carefully as your teacher demonstrates how to use the tap reseater.
- 4 Turn the handle of the tap reseater clockwise for one or two turns. Continue grinding by turning the handle clockwise until the surface of the valve seat is smooth again and there is no sign of the crack.



Figure 13.42 Tap reseater being twisted inside tap

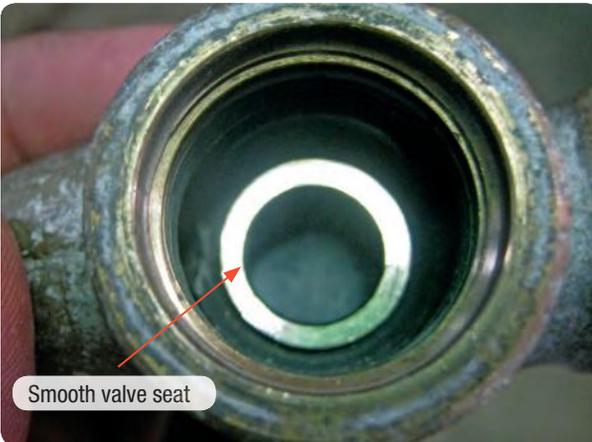


Figure 13.43 Smooth valve seat

- 4 Remove all the grinding grains that are left inside the valve seat before screwing back the bonnet of the tap.

Installing a tap

By the end of this topic, you should be able to:

7.13.4.2 identify male and female threads on a tap

7.13.5.2 describe the process to install a tap.

The most common method of installing a tap is by the use of a threaded joint. Threads may be 'male' or 'female'.

A male thread is found on the outside part of the tap.



Figure 13.44 A tap with a male thread

A female thread is found inside the tap.



Figure 13.45 A tap with a female thread

Connecting a tap with a male thread

- 1 Check to make sure that the thread of the tap is not damaged. Damaged thread will make it very difficult to screw, and the chance of leaking is high.



Figure 13.46 Male thread

- 2 Apply thread seal tape on the male thread end. Thread seal is a plastic tape that ensures the joint will not leak. Your teacher will demonstrate to you how to apply thread seal tape.



Figure 13.47 Applying thread seal tape

- 3 Screw the male thread tap into the female joint in a clockwise direction. Screw the tap tightly by hand until no further movement is possible.



Figure 13.48 Joining the male thread to a female joint

- 4 Tighten the tap firmly, using a shifting spanner, but be careful not to over-tighten. Do not use a pipe wrench to tighten the tap, as it will damage the body of the tap with its sharp gripping teeth.



Figure 13.49 Tightening the tap with a shifting spanner

Communicating and marketing

By the end of this topic, you should be able to:

7.13.7.1 calculate the charge for repairing a tap.

Repairing a tap is a plumber's job. The **plumber** must ensure that the tap is working properly. The plumber charges the customer when the work is completed.

Costing a tap repair job

If you charged a person for replacing their tap, how would you work out how much to charge? You would need to consider:

- how many hours you spent on the repair job
- how much you would like to earn for each hour of your labour
- the cost of the materials you used for the repair job
- overhead and profit ('overhead' means the cost of electricity, tools etc.)

This is the formula you would use to work out the charge:

$$C = (LT \times LR) + MC + OP$$

where:

C is the total charge to the customer

LT is labour time

LR is labour rate

MC is materials cost

OP is overhead and profit

For example:

The replacement tap cost \$350.00. You spent nearly one hour fixing the tap. Your labour rate is \$50.00 per hour with 15% overhead and profit. What is your charge?

You need to work out:

$$C = (LT \times LR) + MC + OP$$

$$C = (1.0 \text{ hour} \times \$50.00) + \$350.00 + 15\%$$

$$= \$50.00 + \$350.00 + 15\%$$

$$= \$400.00 + 15\%$$

$$= \$460.00$$

Note: If the owner supplied the tap, you wouldn't include the materials cost in your charge.

Activity 8: Promoting a tap repair service

Answer the following questions in your exercise book.

- 1 Who are the likely users of taps?
- 2 What benefits does a tap have for users?
- 3 What marketing techniques would you use to promote your tap repair work?

Activity 9: Calculating the cost of a tap repair job

In groups, work out the charge for replacing washers on five leaking laundry taps. Using the formula given in the section above called 'Costing a tap repair job', calculate the charge for repairing the five taps. Here are the costs that you need to include:

- materials cost: \$5.00 for one washer
- labour time: 5.0 hours
- labour rate: \$50.00 per hour
- overhead and profit: 10% for overhead and 5% for profit

Your teacher will guide you through the process.

Practical task

By the end of this practical task, you should be able to:

7.13.5.2 describe the process to install a tap

7.13.5.3 repair taps that have faults in them

7.13.8.1 discuss the benefits of maintaining taps at home and in other Solomon Island communities.

Go back and read the design problem at the beginning of this chapter. You are going to solve that design problem.

Design problem: Fixing a tap

You are required to:

- 1 repair
 - worn or damaged washers
 - cracked valve seats
 - a tap handle that continually slips off.
- 2 install a tap.

Materials required

Old thrown-away taps (mainly screw-down taps)

Steps

Follow the steps in the section 'Tap maintenance' on pages 212–217. Your teacher will guide you through the process of dismantling and repairing. Your teacher will also locate a suitable test point for you to test the tap.

Checklist

- 1 Have you properly identified the problem with the tap?
- 2 Did you check the tap washer?
- 3 Did you check the valve seat for a cracked valve?
- 4 Did you check that the tap spindle was working well?
- 5 Did you change the washer of the tap?
- 6 Did you reseal the cracked valve seat using a tap reseating tool?
- 7 Did you test the tap and check that there was no more dripping from the tap?
- 8 Are you satisfied that the tap is properly repaired?
- 9 Did your teacher check your tap before you disconnected it?

Since you own the tap, you are allowed to take it home and keep it for future use.

New words used in this chapter

bonnet	cover screwed onto the body of a tap	rubber 'O' ring	ring attached to the spindle of the tap to stop water leaking through the handle of the tap
chrome plating	high silver polish coating, e.g. on a tap	spindle	part that is attached to the handle of the tap and the loose valve. It is raised and lowered when the handle turns clockwise and anticlockwise.
depressing	pressing or pushing down	stem	end part of a loose valve that is inserted in the bonnet of the tap
dismantle	take apart, e.g. take a tap apart	valve seat	area in which the washer rests for closing and opening the water
loose jumper valve (of a tap)	part that consists of stem and washer	water hammer	loud banging noise that can be heard when a sudden flow of water stops
manufactured	process of making a product from raw materials		
plumber	person who installs and repairs water, drainage and gas pipes		
replaceable	able to be substituted, e.g. a tap that can substitute for an old one		

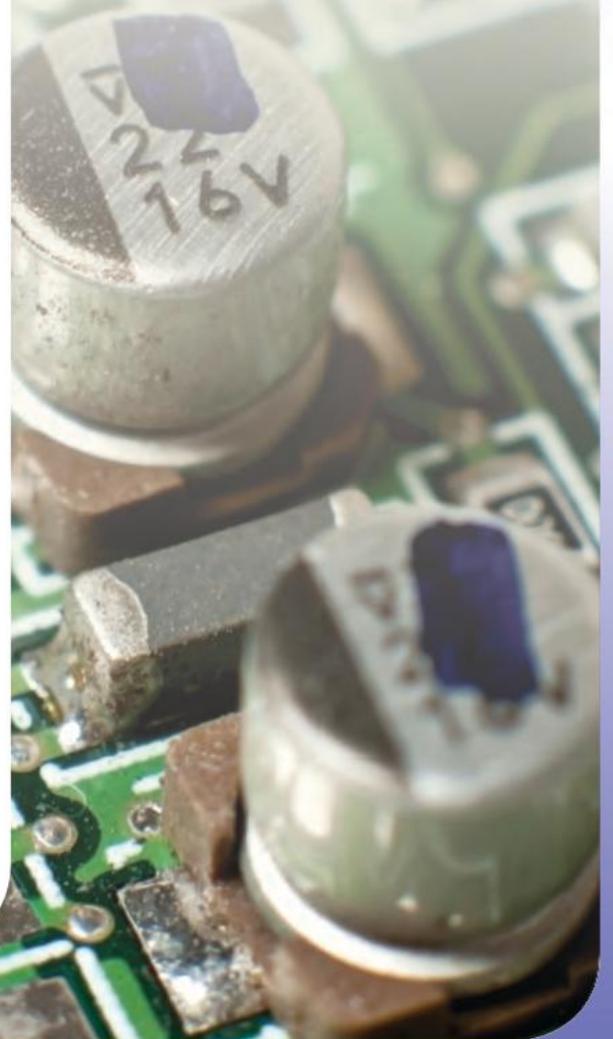
Chapter 14

Electronics

Learning outcomes

By the end of this chapter, you should be able to:

- 7.14.1.1** describe the proper method of cutting and joining wires and components in a circuit
- 7.14.2.1** describe the safety requirements when cutting wires and joining electronic components
- 7.14.2.2** identify the basic components, such as battery, bulbs, switches and resistors (and their symbols), that can be used in a simple circuit
- 7.14.2.3** explain the uses of battery, switches and resistors in a circuit
- 7.14.3.1** identify the different types of tools used in electronic work
- 7.14.4.1** design and make an electric circuit to address a home need
- 7.14.5.1** use electronic components to make a simple electric circuit that can be used at school or home
- 7.14.5.2** apply appropriate safety measures when connecting components in a simple electric circuit
- 7.14.6.1** use the correct methods of working with wires
- 7.14.6.2** handle electronic components with care when assembling a circuit
- 7.14.6.3** use tools and equipment safely and appropriately
- 7.14.6.4** use a real-life circuit to draw a circuit diagram
- 7.14.6.5** draw components correctly in a circuit diagram
- 7.14.7.1** share ideas and views about the impact of electronic products on your own life.



Introduction

It is difficult to imagine what life would be like without electronic products such as wristwatches, radios, computers and navigation systems in ships and planes.

Electronic products are made up from many parts, or components, that are connected together to make a circuit, like the electric circuits you learnt about in Chapter 8. Understanding how some of these components work will help to understand how circuits work.

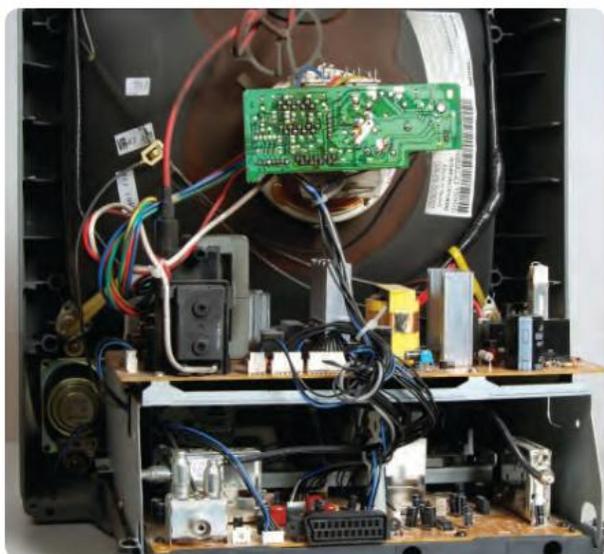
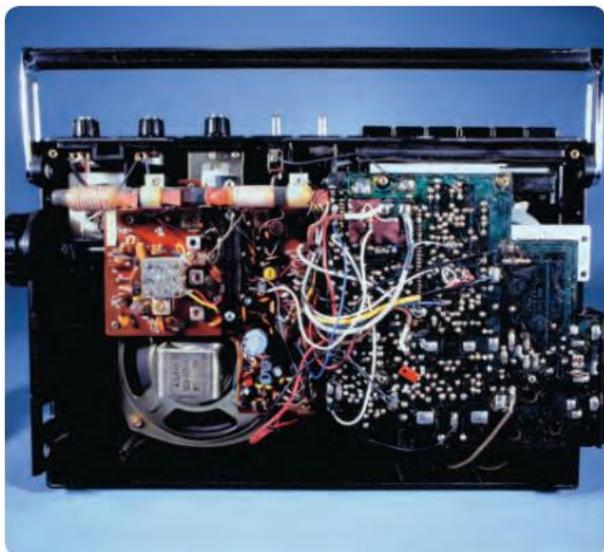


Figure 14.1 Electronic products

Design problem 1: Visit indicator

Visiting family members and friends is a common practice in Solomon Islands. However, this practice also spills into workplaces. Visitors walk into workplaces freely, without invitation, and disturb people who are working. One way to solve this problem is to install lights in each office that are controlled by the **receptionist** at the front desk. Whenever visitors come, the receptionist presses the light switch for the office of the worker to indicate to that person that he or she has a visitor. The worker can then decide whether to see the visitor or not. If the worker decides to see the visitor, he or she can go to the front desk, rather than the visitor walking through the workplace and disturbing everyone.

Design problem 2: Packing case light

Growing old is an experience that cannot be avoided. As people grow old they often experience difficulties with their sight, and many ordinary tasks, such as finding things in drawers or packing cases, can be quite difficult for them. You are going to work out how to put a light in a packing case, to help an old person locate things. When the packing case opens, the light should come on, and when the lid of the packing case closes, the light should turn off.

Tools and equipment used in this chapter	Materials used in this chapter
Hand drill bits	Battery
Long-nose pliers	Bolts and nuts
Phillips screw driver	Bulbs
Slot screw driver	Foils
Soldering iron	LED torch
Tenon saw	Paper clips
Wire cutter	Peg switch
	Resistors (15 Ω , 22 Ω , 39 Ω , 100 Ω)
	Screws
	Wires

At the end of this chapter, you will select one of the design problems above and solve it. In order to help you solve any of these design problems, you must learn some of the basic skills and knowledge about electric currents.

Components of a circuit board

By the end of this topic, you should be able to:

- 7.14.1.1** describe the proper method of cutting and joining wires and components in a circuit
- 7.14.2.1** describe the safety requirements when cutting wires and joining electronic components
- 7.14.2.2** identify the basic components, such as battery, bulbs, switches and resistors (and their symbols), that can be used in a simple circuit
- 7.14.2.3** explain the uses of battery, switches and resistors in a circuit
- 7.14.3.1** identify the different types of tools used in electronic work.

A circuit is made up of many different components. Most of these components are used to control the electric current. Each of them has a different job and controls the electric current in different way. When you switch on your LED torch, the current comes on. You will soon get the opportunity to experiment with some of these components and see how they work.

The components are connected in a special way to one another. A circuit diagram is used to show this. Symbols are used to represent the different components.

Connecting components on a circuit board

There are different ways to connect components in a circuit. In a radio, components are connected using a soldering iron and solder.

Always try out the circuit first to make sure all the components are working and to see whether you understand the circuit diagram correctly. For this you will need to join the components so that they



Figure 14.2 Circuit board with components soldered on

can be **disconnected** easily, without damage to the components. There are different ways to do this. The easiest and the cheapest way is to make your own circuit board. Building the circuit on a **temporary** circuit board will help you to make sure everything is correct. After that you can go ahead and pin the components to each other on a permanent circuit board.



Figure 14.3 Soldering iron



Figure 14.4 Solder

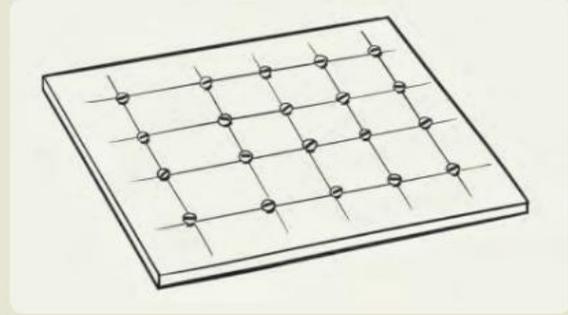


Figure 14.5 Using screws

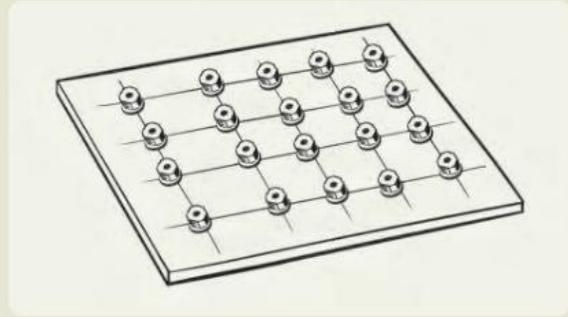


Figure 14.6 Using bolts and nuts

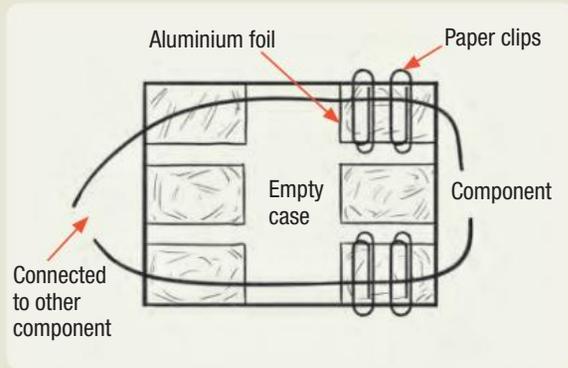


Figure 14.7 Using foils and paper clips

Activity 1: Making a temporary circuit board

You will need:

- wire
- screws
- bolts and nuts
- paper clips.

1 Look at the temporary circuit boards shown in Figures 14.5 to 14.7.

- 2** Choose one of them and make it.
- 3** Keep your temporary circuit board safely somewhere. You will use it later.

A circuit diagram tells you how to connect the components in the right way. If you don't connect them correctly, your circuit will not work and you may even damage some of the components.

A circuit diagram also helps you to figure out how the circuit works. You will need it whenever you want to fix problems or to explain the circuit to someone else.

Activity 2: Making and using different switches

You will need:

- battery
- peg switch
- bulb
- wire.

- 1 Build the circuit below using your circuit board. Make sure your circuit is working.

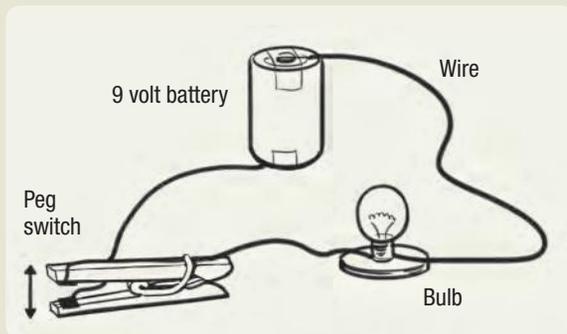


Figure 14.8 Battery, peg switch, bulb and wires connected in a series

- 2 Below are different types of switches. Your teacher will show some to you. Build each of them.

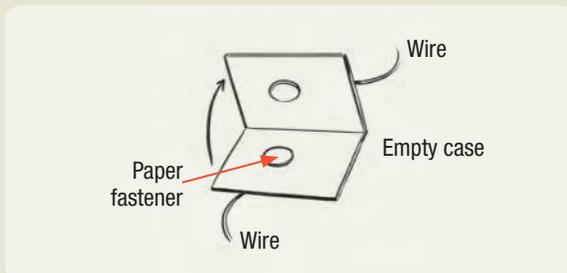


Figure 14.9 Open switch

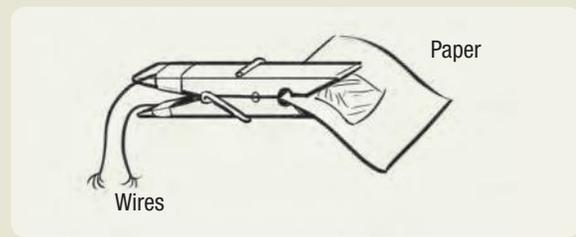


Figure 14.10 Peg paper switch

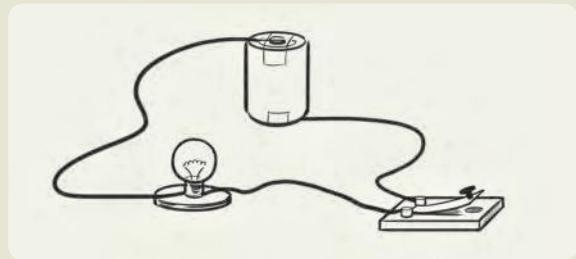
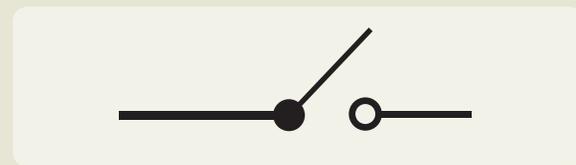


Figure 14.11 Touch switch

- 3 Put the switch into the circuit you built above. Do the same for each of the switches that you have made. Describe what each switch does as you place it into the circuit.
- 4 The symbol for a switch is given below. The solid dot in the symbol is called the pole and the clear dot is called the throw. Copy the following diagram into your exercise book, and label the pole and the throw.
- 5 Write down the purpose of a switch in an electric circuit.



Using switches to control electric current

Switches are used to control electric current in a circuit. For example, when you turn your torch off, the switch breaks the flow of electric current.

There are several types of switches. They all do the same job of breaking the flow of electric current in a circuit, but they do it in different ways.

Using resistors to control electric current

Switches can only control current by switching it on or off, or switching from one component to another. So how do you control the sound coming from your radio? Or the amount of light coming from a bulb? You use a resistor.

A resistor is an electronic component that decreases the flow of the current. Resistors are also used to protect other components from being damaged by too big a current passing through them.



Figure 14.12 Resistor

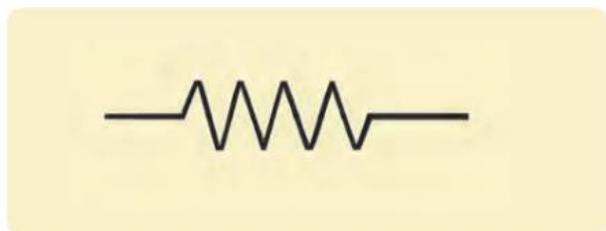


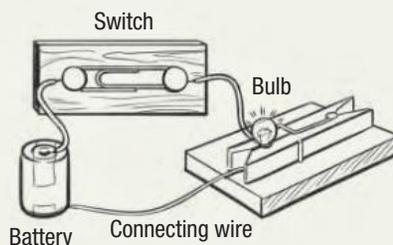
Figure 14.13 Symbol for a resistor

Activity 3: Finding out how resistors work

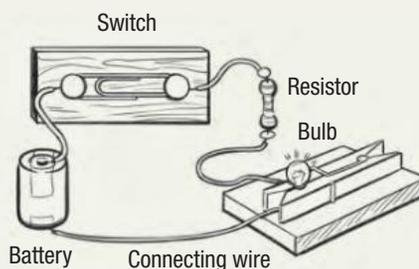
You will need:

- batteries
- resistor
- switch
- bulb
- wire.

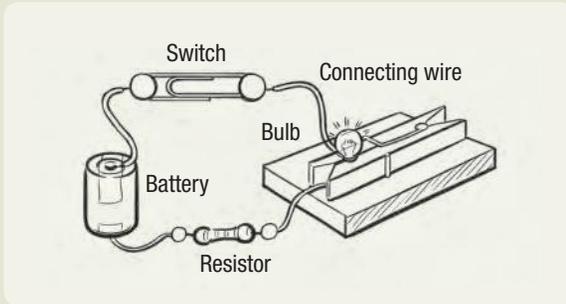
- 1 In groups, look at the side of the battery that your teacher has provided—you will see '9 V' written somewhere on it. You can build a 9 volt battery like this by connecting up six big batteries that you can get from the store. You will also need a 6 volt light bulb. This should be written somewhere on the base of the bulb. You will also need a resistor and a switch.
- 2 Use wires to connect the switch and bulb to the 9 volt battery or batteries. Turn the switch on and notice how bright the bulb is. Turn it off.



- 3 Connect the resistor between the switch and the bulb. Turn the switch on. Describe what you see.



- Was the electric current that passed through the bulb influenced by the resistor? Explain your answer.
- Turn the switch off. Wait for a few minutes, then take the resistor out and connect it as shown below. Does it make a difference to the work of the resistor whether it is connected before or after the bulb?



How much resistance?

When you connect a resistor in series or next to another component, there is a decrease in the amount of electric current supplied to the component. The larger the value of the resistor, the more electric current it takes away and the less current is supplied to the component. The resistor converts the **electrical energy** that it takes away into heat energy, leaving less electrical energy to be supplied to the component. The more electrical energy the resistor converts, the hotter it becomes—so don't touch it when the circuit is still switched on. If you want to remove it from the circuit, leave it for a few minutes after you have switched off the circuit.

If you want to use resistors to control electric current, you need to know how much electrical energy a resistor will convert into heat energy. The amount of resistance that a resistor offers to the current is measured in ohms, represented by the Greek letter *omega* (Ω).

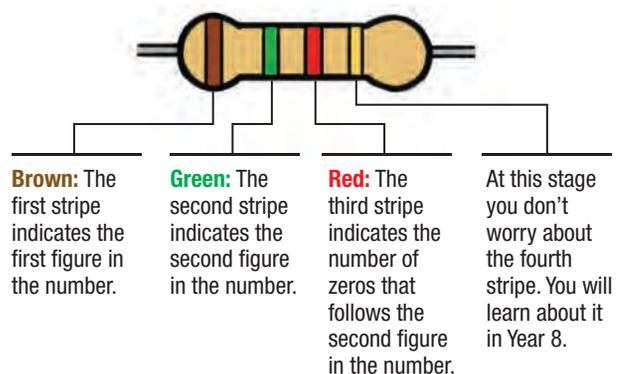
Have you noticed how small a resistor is? It is impossible to print a big value, such as 28 000 Ω on a resistor. Instead, a colour-code is used to indicate the value of a resistor.

How to determine the value of a resistor using a colour code

- Each colour represents a specific figure value. Study the table of colour codes for the resistors below.

Colour	Figure value
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Purple	7
Grey	8
White	9

- Hold a resistor in your hand, with the gold stripe towards the right. Then read the colour stripes from left to right. An example is given in Figure 14.14.



The value of the resistor is 1500 Ω or 1.5k Ω .

Figure 14.14 Calculating the value of a resistor

Activity 4: Varying the resistance in an electric circuit

- 1 Read the section called 'How to determine the value of a resistor using a colour code' on page 227.
- 2 In groups, work out the value of resistors with the following colour codes. Copy and complete these examples in your exercise book.

a	Brown _____	Black _____	Orange _____	= _____
b	Orange _____	White _____	Brown _____	= _____
c	Blue _____	Grey _____	Black _____	= _____
d	Orange _____	White _____	Yellow _____	= _____
e	Brown _____	Black _____	Brown _____	= _____
f	Grey _____	Red _____	Green _____	= _____
g	Red _____	Red _____	Red _____	= _____

- 3 If you need resistors with the following values, which colour codes would you look for?

a	4 _____	7 _____	0 _____
b	2 _____	8 _____	00 _____



Activity 5: Finding out more about resistors

You will need:

- batteries
- resistors (15 Ω , 22 Ω , 39 Ω and 1000 Ω)
- switch
- bulb
- wire.

- 1 Look back at Activity 3 and repeat step 3.
 - The value of the resistor you used in that activity was 15 Ω . Now take the 15 Ω resistor out and replace it with a 22 Ω resistor. Observe the brightness of the bulb.
 - Take the 22 Ω resistor out and replace it with a 39 Ω resistor. Observe the brightness of the bulb.
 - Take the 39 Ω resistor out and replace it with a 1000 Ω (or 1k Ω) resistor.
 - a Describe the effect that the increased value of the resistor has on the brightness of the bulb.
 - b Describe the effect that the increased value of the resistor has on the electric current.
- 2 Does the bulb light up when you use the 1k Ω resistor? Give one reason for your answer.
- 3 Do you think there can still be an electric current flowing through the circuit, although the bulb is not lighting up? Why or why not? Explain your answer.

Using LEDs

Bulbs are used to light up darkness so that people can see what they are doing. Bulbs are made to light up when electric current passes through them. A lot of electric energy is needed to produce enough light, therefore a large electric current is needed. In fact, bulbs can only light up if the current that passes through them is large enough. This explains why a cell used to light a bulb runs out of power so quickly.

Lights are also sometimes needed to indicate whether an appliance is switched on or not. For example, there is a tiny green light in front of a radio or on the screen of a computer to indicate when it is switched on. Lights such as these might stay on for a very long time. This kind of light is called LED. LED stands for 'light emitting diode'. It is a component that is made to light up when even a small amount of current passes through it. 'Emit' means to 'give off', as a bulb gives off light. An LED is very useful to use as a light indicator because LEDs use only a very small amount of electric current and therefore do not use a lot of power.



Figure 14.15 LED

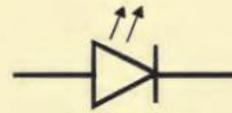


Figure 14.16 Symbol for an LED

How to connect an LED in a circuit

When connecting an LED in a circuit, consider the following.

- An LED will blow if the electric current that flows through it is too large. It can be used with a cell that supplies only 1.5 volts. But if you want to use it with a 9 volt battery, you will have to use a resistor to protect it. The resistor will limit the amount of electric current passing through the LED in a circuit.
- The electric current can pass through an LED in one direction only. The arrow in the circuit diagram symbol shows the direction in which the electric current will pass through the LED: an electric current coming from the positive terminal of the battery will pass through the LED from left to right, leaving through the flat side of the LED. The LED has two terminals: the shorter terminal is the positive (anode) and the longer one the negative (cathode).

- 1 An LED has a flat side to indicate which way it should be connected. The flat side must be facing the negative terminal of the cell or battery.
- 2 The circuit diagram below shows how to connect an LED in a circuit as well as on your temporary circuit board.

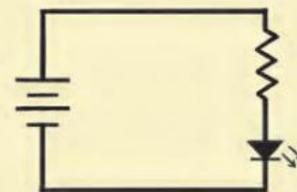


Figure 14.17 Connecting an LED in a circuit

Activity 6: Looking inside an LED torch

You will need:

- small LED torch.

- 1 Open the torch. Look inside it. Can you see a circuit board?
- 2 List two components that you see on the circuit board.

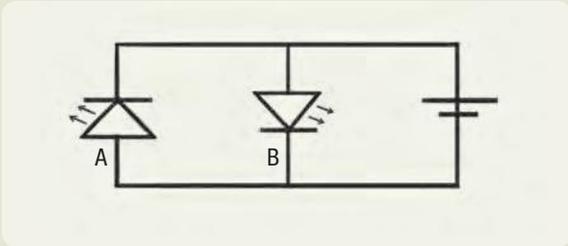
Activity 7: Finding out about LEDs

You will need:

- LED
- batteries
- resistor
- switch
- bulb
- wire.

- 1 Does your radio have a small bulb that indicates whether it is switched on? If so, what is it like?

- 2 Some hi-fi systems have a line of lights that runs up and down as sounds are coming out.
 - a Do these lights look similar to an LED?
 - b Describe how they differ from the LEDs you have.
- 3 List three places where you have seen LEDs used.
- 4 Build the circuit described in the section called 'How to connect an LED in a circuit' on page 229. The LED should light up.
- 5 Take the LED out and connect it the other way around. Does it light up?
- 6 Look at the circuit diagram below. Which of the LEDs will light up? Give two reasons for your answer.



Practical task

By the end of this practical task, you should be able to:

- 7.14.4.1 design and make an electric circuit to address a home need
- 7.14.5.1 use different electronic components to make a simple electric circuit that can be used at school or home
- 7.14.5.2 apply appropriate safety measures when connecting components in a simple electric circuit
- 7.14.6.1 use the correct methods of working with wires
- 7.14.6.2 handle electronic components with care when assembling a circuit
- 7.14.6.3 use tools and equipment safely and appropriately
- 7.14.6.4 use a real-life circuit to draw a circuit diagram
- 7.14.6.5 draw components correctly in a circuit diagram
- 7.14.7.1 share ideas and views about the impact of electronic products on your own life.

Go back and read the design problems at the beginning of this chapter. You are going to solve one of those design problems.

Design problem 1: Visit indicator

Design expectations

The following must be considered in the development of the visit indicator:

- The door switch must be a touch switch.
- An LED must be used as the visit indicator.
- The LED must turn on when the switch is pressed and off when the switch is not pressed.

Investigating

- Select the materials you will use in constructing your model room.
- Look for the type of switch you will use.
- Look for the possible type of circuit you will use.
- Look at different types of batteries that are available in your community.

Designing your visit indicator

- Draw the circuit diagram[s] of the circuit you want to use for the visit indicator.
- Make an open switch using appropriate materials.
- Make a list of the things you will need for the model room and your circuit.

Making your visit indicator

- Build a simple model office room.
- Connect the circuits and fix them in your model office room.

Testing your visit indicator

- Can the LED in a room turn on when the switch is touched?
- Can the LED turn off when the switch is not touched?
- Can two LEDs be turned on at the same time when two separate touch switches are touched?
- Is the LED fixed securely and safely?

Evaluating your work

Answer the following questions in your exercise book.

- 1 What did you do to build your model room?
- 2 Is the structure of the model room strong and neat?

- 3 Make a labelled drawing showing the materials you used to make the door and how you fixed it to the wall or frame.
- 4 How did you decide to position the LED?
- 5 Is the wiring in the model room neat? Did you hide the wires in some way?
- 6 Is the wiring safe?
- 7 How did you place your touch switch?
- 8 Have you learnt anything from other people's designs that will help you to improve your circuits?
- 9 Is there anything you would like to improve on your model?
- 10 What would you change in your work if you were to wire a real room?

Communicating and marketing

- 1 How would you communicate and market this product to the potential users of this product?
- 2 How would you communicate the importance of the skills you have learnt from this chapter to people who have a limited knowledge of electronics?
- 3 What marketing strategy would you use to communicate the importance of a career in electronics to your classmates?

Design problem 2: Packing case light

Design expectations

The following must be considered in the development of the packing case light:

- A peg switch must be used for the packing case light.
- An LED must be used for the light.
- The LED must turn on when the switch is pressed and off when the switch is not pressed.

Investigating

- Select the materials you will use in constructing your model packing case.
- Look for the type of switch you will use.

- Look for the possible type of circuit you will use.
- Look at different types of batteries that are available in your community.

Designing your packing case light

- Draw the circuit diagram[s] of the circuit you want to use for the packing case.
- Make a peg switch using appropriate materials.
- Make a list of the things you will need for the model packing case and your circuit.

Making your packing case light

- Build a simple model of the packing case.
- Connect the circuits and fix them in your model packing case.

Testing your packing case light

- Does the LED turn on when the lid of the packing case opens?
- Does the LED turn off when the lid of the packing case closes?
- Is the LED fixed securely and safely to the wall of the packing case?

Evaluating your work

Answer the following questions in your exercise book.

- 1 What did you do to build your model packing case?
- 2 Is the structure of the model packing case strong and neat?

- 3 How did you connect the circuit in the packing case?
- 4 Make a labelled drawing showing the materials you used to make the lid of the packing case and how you fixed it to the frame.
- 5 How did you decide to position the LED?
- 6 Is the wiring in the model packing case neat? Did you hide the wires in some way?
- 7 Is the wiring safe?
- 8 How did you place your peg switch?
- 9 Have you learnt anything from other people's designs that will help you to improve your circuits?
- 10 Is there any way you would like to improve your model?
- 11 What would you change from your design if you were to wire a real room?

Communicating and marketing

- 1 How would you communicate and market this product to the potential users of this product?
- 2 How would you communicate the importance of the skills you have learnt from this chapter to people who have a limited knowledge of electronics?
- 3 What marketing strategy would you use to communicate the importance of a career in electronics to your classmates?

New words used in this chapter

disconnect	take apart or break the connection
electrical energy	energy used by torch bulbs
receptionist	person who is located in the front of an office as the first point of inquiry
temporary	for a short time
volt	measure of electricity

Chapter 15

Solar power

Learning outcomes

By the end of this chapter, you should be able to:

- 7.15.1.1** describe a solar power system
- 7.15.1.2** describe the components of a solar power system
- 7.15.1.3** describe the safety measures to be taken when working with a solar power system
- 7.15.1.4** investigate a solar power system in your community, then explain how the units are connected
- 7.15.1.5** research how the components of a solar system operate
- 7.15.2.1** identify the tools to be used when working with a solar power system
- 7.15.3.1** design and make a solar power system to address a need at home
- 7.15.4.1** connect the units of a solar power system correctly
- 7.15.4.2** use proper safety procedures when handling or connecting components of a solar power system
- 7.15.5.1** use tools correctly when assembling the units of a solar power system
- 7.15.6.1** investigate the impact of using solar power in your community in relation to environmental issues.

Introduction

The use of electricity has been increasing in recent years in developing countries such as Solomon Islands. People have been using batteries and generators to produce electricity. Recently, people in most of the rural villages have begun to use solar power systems to produce electricity. Solar power has the ability to convert sunlight into electricity. Since good sunlight is common everywhere in Solomon Islands, solar power can be used anywhere.



Figure 15.1 Solar panels on a roof

By understanding how the different parts of a solar power system work, you should be able to connect up a simple system.

Design problem: Solar power system

Solar power is now seen as a **viable** electricity **alternative** for rural communities in Solomon Islands. The government, through the Ministry of Mine and Energy Conservation, has agreed on an action plan to promote solar power for rural communities. However, the problem most people encounter is that they don't have the knowledge and skills to build their own solar power systems. After studying this chapter, you are going to be knowledgeable and skilful enough to help such people build their new solar power systems.



Figure 15.2 These lights use the sun as the source of electricity.

In order to successfully build the solar power system, you must understand how to connect the different parts or components of a system. These can all be bought from various shops in Honiara and in some provincial centres.

Tools and equipment used in this chapter

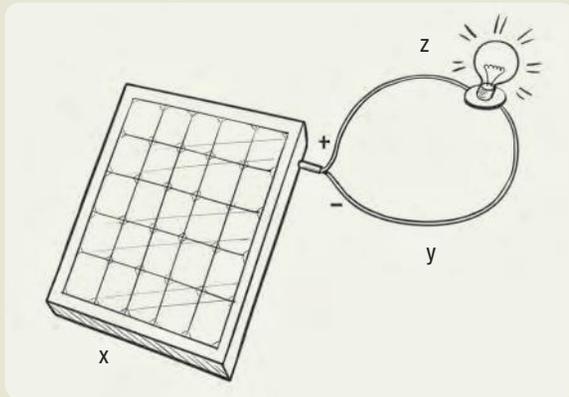
- Brush
- Pliers
- Screw driver
- Shifting spanner
- Soldering iron
- Wire cutter
- Wire stripper

Materials used in this chapter

- Bulb
- Screws
- Solar battery
- Solar controller
- Solar panel
- Solder
- Wire cables

Activity 1: Finding out about solar power

- 1 If your school has a solar power system, look at it or visit one near the school.
 - a List the components that make up a solar power system. Your teacher might help you answer this.
 - b Look at the solar panel or panels. Are they lying flat or tilted? What direction are they facing: north, east, south or west? Find out why solar panels have to be tilted.
 - c Look at the following illustration and write the labels for the parts shown in your exercise book.



- 2 Explain what a solar power system is. Use the photo above to answer this question.
- 3 Ask the owner what are the benefits of using a solar power system, and what problems he or she has experienced.

What is a solar power system?

By the end of this topic, you should be able to:

- 7.15.1.1 describe a solar power system
- 7.15.1.3 describe the safety measures to be taken when working with a solar power system
- 7.15.2.1 identify the tools to be used when working with a solar power system.

Usually when people talk about a solar power system what they are referring to is a solar panel that uses the rays of the sun to make electricity. The sun's rays have energy and we can convert this into electricity. A solar power system is more correctly called a solar **photovoltaic** system.

A solar power system is a system. A system has three important sections:

- an *input section*, which selects what goes into the system to start the process
- a *process section*, which changes the input in various ways
- an *output section*, which tells us what comes out of the system.

This way of representing complicated systems is called a systems approach. We can represent it using three boxes, with arrows that show how information is passed from one section to another. This is called a block diagram. Note that the arrows do not have anything to do with the direction in which electric current flows.

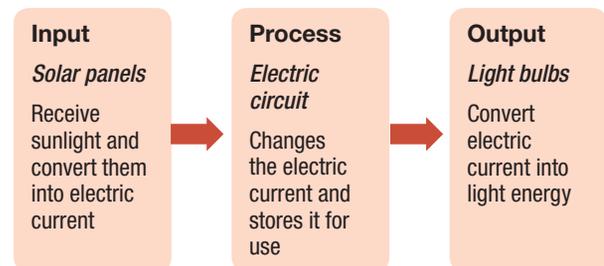


Figure 15.3 Block diagram of a solar power system

How does a solar power system work?

To get an idea of what a solar power system does, look at what a rainwater collection system does.

Imagine the rainwater collection system is replaced with a solar power system.

Activity 2: Describing a rainwater collection system

- 1 Look at the illustration of a tank beside a house.



- 2 Describe everything that happens. What does the roofing iron do? What does the gutter do? What does the tank do? What does the downpipe do? What does the tap do? The illustration above guides you to the answers.
- 3 Describe what happens to the flow of water when the tank is full and what happens when the tank is almost empty.

Activity 3: Comparing a rainwater system and a solar power system

- 1 Look at Figures 15.4 and 15.5.



Figure 15.4 Rainwater collection system

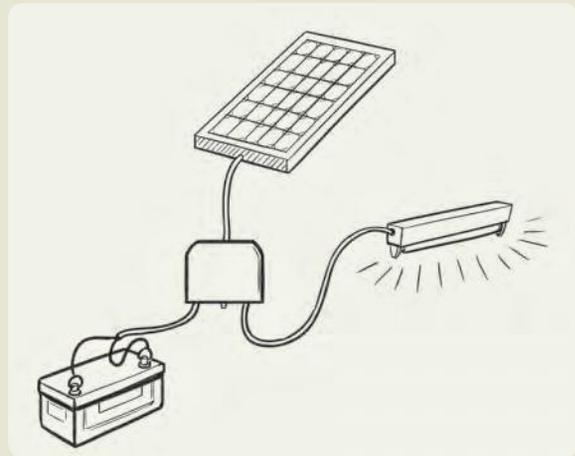


Figure 15.5 Solar power system

- 2 Copy the following table into your exercise book, matching the parts of a rainwater system to the equivalent components of the solar power system.

Rainwater system	Solar power system
Iron roofing	Battery
Tank	Wire
Sprinkler	Controller
Tap	Light bulb
Pipes and gutter	Solar panel

Connecting a solar power system

To make a solar power system, the various components must be connected. There are at least three things that you need to do.

- 1 Find the best place for the components and put them there safely and securely.
- 2 Run electric cables between them and prepare the ends for making the connections.
- 3 Connect the cables tightly at the correct connection terminals.

Where to put the components

The locations chosen for placing the components should be as close as possible. This means that the wires can be as short as possible.

Equipment	Where and how to place it
Solar panel	On a roof or a pole beside the house; tilt it by about 10 degrees and face it north
Controller	On the wall close to the battery, where it can be seen
Battery	Where air flows freely, not too far from the solar panel and lamp
Switch	On the wall, where it is easy to reach as you enter or leave a room or a living area
Lamp	In the centre of a room or where it will give maximum light to a place

Preparing the cables for connection

Watch your teacher as he or she shows you:

- a the correct way to handle and use pliers, a screw driver and a spanner
- b the correct and safe way to handle a solar power component
- c the correct and best way to fix a component into position
- d how to prepare the ends of the cables
- e how to connect the cables to the terminals on a component.

Connecting the components

Only two wires are used to connect each component to another component. A block diagram showing how the components are connected is shown on page 238. The lines represent cables. The cables are colour-coded: red for positive (+) and black for negative (-).

Make sure to connect only the positive (+) side of each component to the correct positive (+) side of the controller. In the same way, connect the negative (-) side of each component to the correct negative (-) side of the controller. Use the correct colour cable.

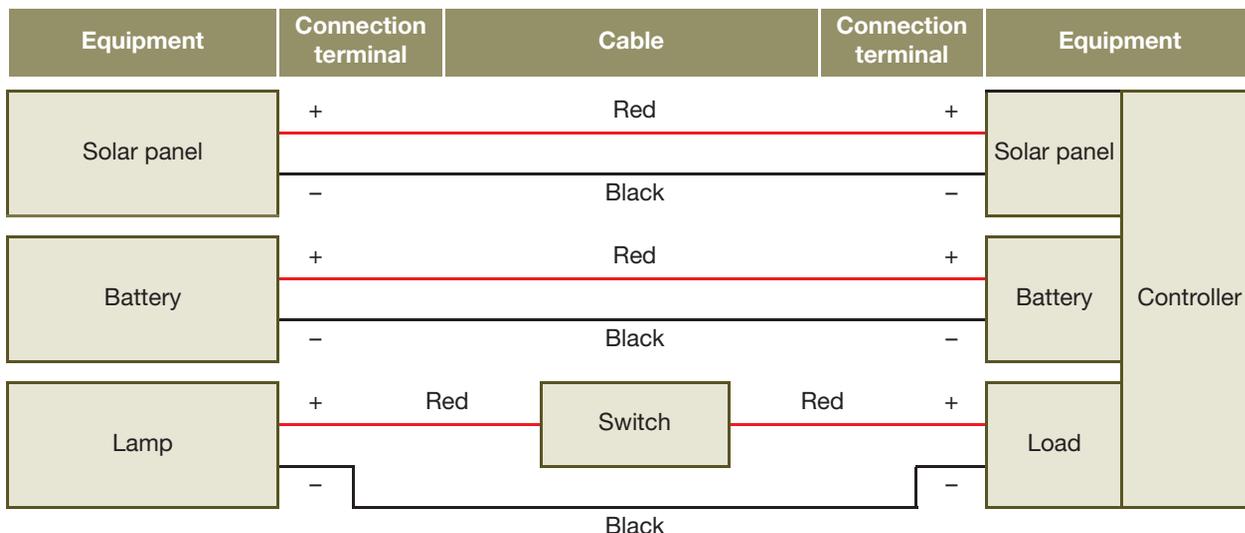


Figure 15.6 How to connect the solar lighting components

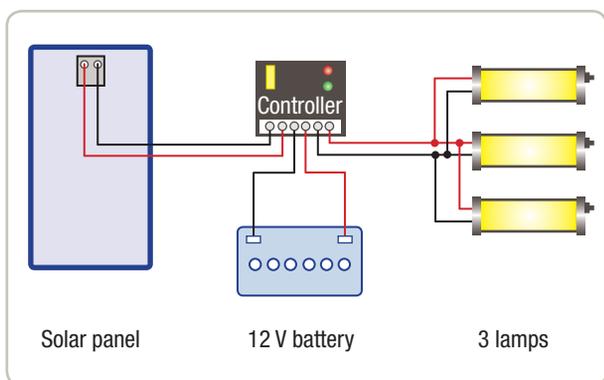


Figure 15.7 How to connect the components of a solar power system

- 1 Read the section called ‘Connecting a solar power system’ on page 237.
- 2 Listen and watch carefully as your teacher demonstrates how to connect the components.
- 3 In groups, follow the steps below to connect the components.
 - a Draw a sketch to show how you will lay out the components. Use lines to show how you are going to connect them. Give your sketch to the teacher to check .

Activity 4: Connecting a solar system

You will need:

- solar panel
- solar battery
- solar controller
- switch
- long pieces of cable
- light bulbs.

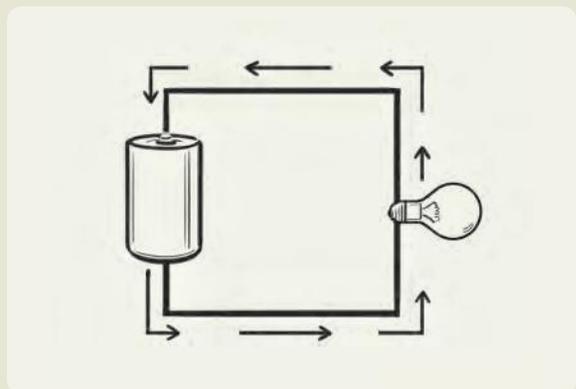


Figure 15.8 Electron flow

- b** Find the most suitable place to put each component. Make sure they cannot move about or fall over easily. (A place is suitable if it is safe for the equipment, does not present any danger to people, and helps the system to work better. Keeping the components as close together as possible is also good practice.)

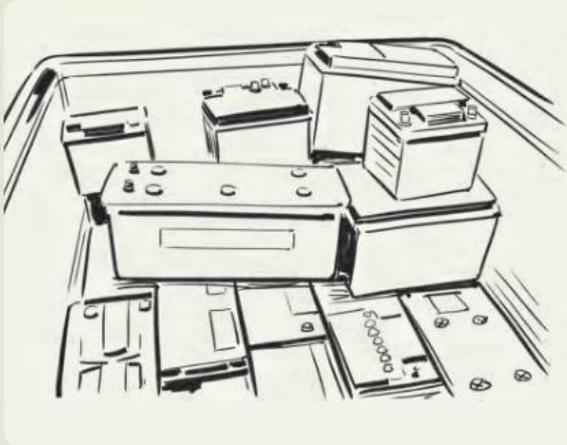


Figure 15.9 Always place batteries somewhere safe.

- c** Run a red cable and a black cable between the components; take the most direct route—that is, run them in a straight line. Always try to keep the cables as short as possible.

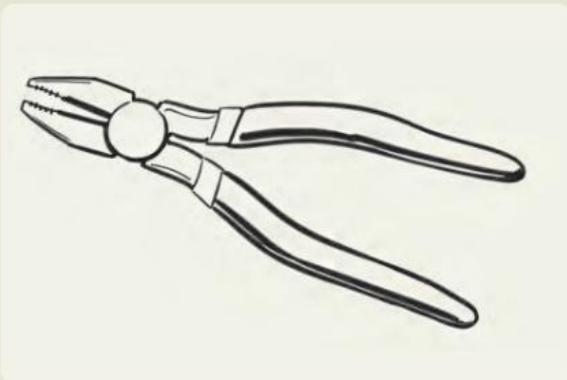


Figure 15.10 Use pliers to cut the cables

- d** Cut the cables to the required lengths using pliers. Strip off the insulation to show the wires. You can use a wire stripper to do this. If the wire is made up of many small wires (strands) twist them together with the pliers. Do this to all the cables.



Figure 15.11 Stripping the insulation from a cable end

- e** Release the screw at each connecting terminal of a component with a screw driver. Take the black cable and push the exposed wire into the negative (–) terminal. Tighten the screw. Refer to your diagram to make sure that you are making the right connections.

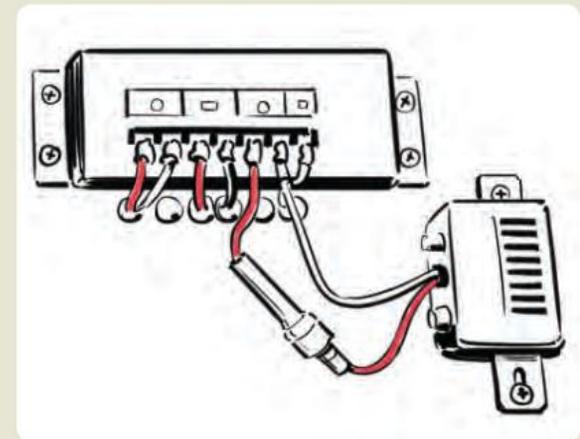


Figure 15.12 Terminal wires connected to a solar controller

- f Repeat Step d for the red cables to connect them to the positive terminal.

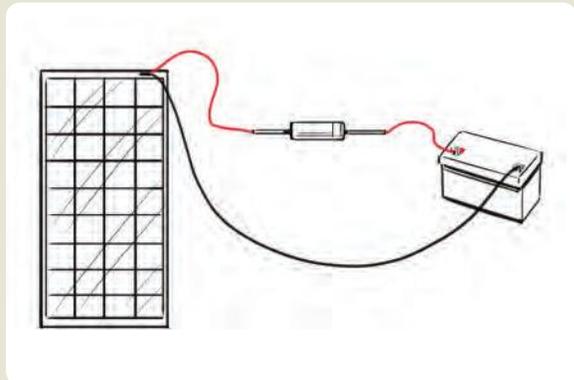


Figure 15.13 Wire cable connected to the positive terminal of a solar battery

- g Ask your teacher to check how you have connected all the components.

Your solar lighting system is now ready to operate.

Safety measures

By the end of this topic, you should be able to:

- 7.15.4.2 apply proper safety procedures when handling or connecting components of a solar power system
- 7.15.5.1 use tools correctly when assembling the units of a solar power system.

Electricity safety

Electricity is very dangerous. Electricity in a house that uses 240 volts can kill you. Even a solar lighting system that operates on 12 volts, direct current source (Vdc) can cause severe problems. For example, if a connection is accidentally made between the wrong connections, terminals or the red and black wires, a high current will flow. The high current can cause overheating. It will melt the insulation (rubber covering) around the wires and possibly start a fire. The high current may damage the components through which it flows and may make a system **unusable**. Although there are only two wires to connect to each component of the system, making the wrong connection may also cause lasting damage to components.

Handling precautions

- 1 Handle all electrical devices and equipment with great care at all times. Do not drop them or leave them where they will get damaged.
- 2 Read the manufacturer's instructions and follow them exactly.
- 3 When you are not sure about something, ask your teacher for help.

Wiring safety precautions

- 1 Draw a diagram of how you intend to connect the components. Ask your teacher to check it for correctness before connecting the equipment.
- 2 Use tools with care and handle them in the right way.

- 3 Check cables for damage; cover exposed wires with insulation tape. Keep cables as short as possible and lay them carefully where they cannot be reached easily.
- 4 Connect the negative (-) wire first. Connect the positive (+) wire last.
- 5 Make connections tight and ensure that connection terminals are properly insulated.
- 6 Get your teacher to check all wiring and connections for correctness and tightness.

Battery safety precautions

- 1 Lead-acid batteries are filled with hydrochloric acid. If this comes into contact with your eyes or skin, wash it off quickly with lots of water.
- 2 Handle batteries with care and always keep them in an upright position.
- 3 Keep batteries where air flows freely. Do not bring fire or light a match near them.

Activity 5: Identifying tools used for connecting solar power components

During the demonstration of 'Connecting a solar power system', you saw how the tools depicted below are used. Copy the following table into your exercise book and complete it by filling in the names of the tools and what they are used for.



Name of the tool	Use of the tool

These tools are electrical tools. Some have a rubber covering around the handles. Write down one reason why.



Solar power system components and their functions

By the end of this topic, you should be able to:

- 7.15.1.2 describe the components of a solar power system
- 7.15.1.4 investigate a solar power system in their community, then explain how the units are connected.

As you can see, a basic solar power system consists of a solar panel, a battery, a controller and an **appliance**. These components are connected with electric cables so that electricity can move through the system. The solar panel is placed in an open space outside the house. The battery, appliance and controller are placed inside the house.

Solar panels

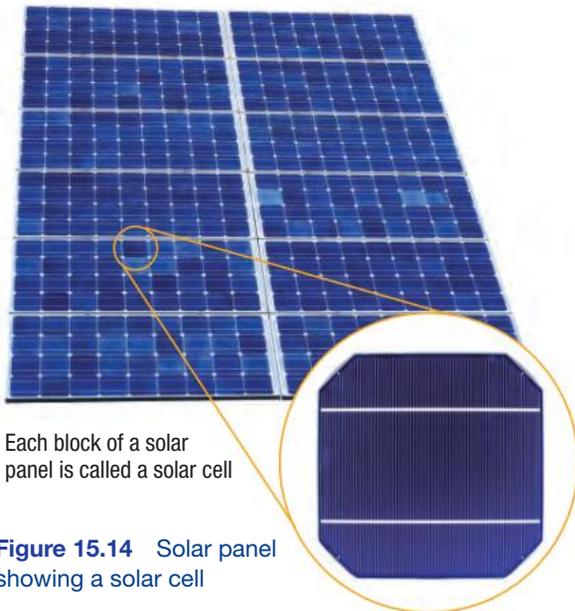


Figure 15.14 Solar panel showing a solar cell

A solar panel is a **photoelectric device**. It is capable of converting sunlight into electricity, and is the most important component of a solar power system. A solar panel consists of solar cells that are connected and then covered with a layer of

glass. A metal frame holds them together. They are placed on special cement, which helps to draw heat away from the solar cells. This stops the cells getting too hot and becoming damaged.

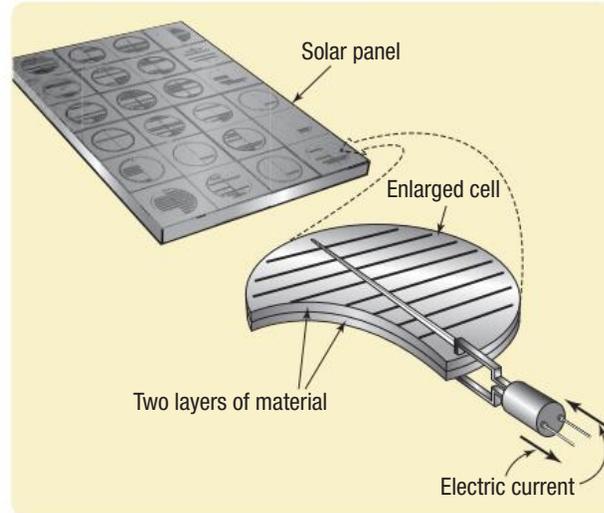


Figure 15.15 Parts of a solar cell

When sunlight falls on the solar cells of the panel, electricity is produced. The amount of electricity produced depends on the number of solar panels, the size of solar cells on the panel and the brightness of the sun. The bigger the solar panel, the greater the collection of sunlight and therefore the production of electricity. This is similar to the roof of a house collecting rainwater for a tank – the bigger the size of the roof, the greater the

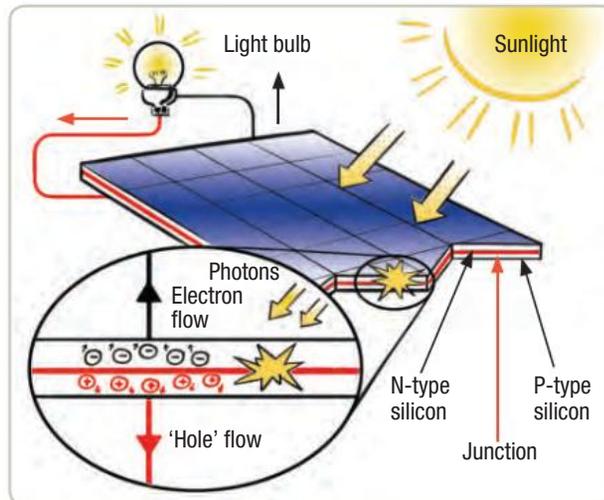


Figure 15.16 How a solar panel produces electricity

collection of water. The solar panel will collect more sunlight and produce more electricity when it faces the sun directly.

A 12 volt solar panel has 30 to 36 solar cells. The solar panel produces the highest power on clear, sunny days and when the solar panel faces the sun.

That means a solar panel in Solomon Islands must not be laid flat. One side must be raised and it must face towards the north. It is best to tilt the solar panel in the direction that the sun will be going when it sets.

Activity 6: Finding out about solar panels

- 1 In groups, look at a solar panel. Write down the number of solar cells on the solar panel.
- 2 You may notice that the sizes of the solar panels can be different. Explain how this affects the amount of electricity each will produce.
- 3 Look behind the solar panel for the words 'current', 'voltage' and 'volt-ampere'. Write down the numbers that appear next to these words and explain what they mean.
- 4 Each solar cell on a solar panel is able to generate 0.5 volts of electricity. Explain what this number means.
- 5 If a solar cell can produce 0.5 volts, what will be the total number of volts the solar panel you saw will produce?

The current is the amount of electricity produced.

The voltage is the amount of force that drives the current to move from one point to another.

An electric circuit is the path in which the current flows. An electric circuit is found in solar cells.

Battery

The second most important component in a solar power system is the battery.

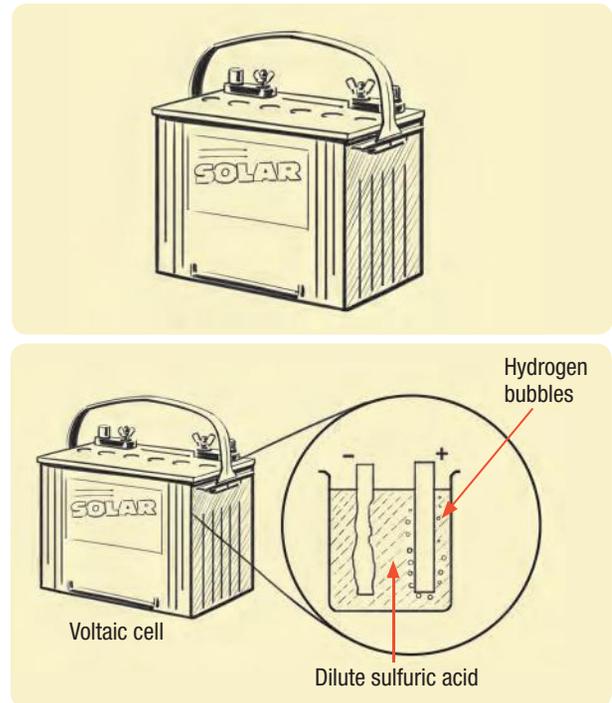


Figure 15.17 Solar battery. The battery contains voltaic cells, which are small boxes filled with acid. Zinc and iron metals are placed inside this acid, as is illustrated in the diagram.

A battery consists of several **voltaic cells** that are connected together. They are placed in a container that is filled with an acid solution. The acid solution can be dry or wet. Two connection points, called terminals, from the voltaic cells stick out at the top of the container. The container may be completely sealed (closed up) or it may have openings at the top.

Activity 7: Finding out more about the battery

You will need:

- used truck battery.

- 1 Open the battery. Draw what you see. On your drawing, label the different parts of the battery using these words: voltaic cell, terminals, acid solution.
- 2 Describe how the voltaic cells are connected together in the battery.
- 3 Write a short paragraph about the effects the battery might have on the environment.

The main function of the battery is to store the electricity produced by the solar panel. Electricity cannot be stored in its original form. Fortunately, a battery has the ability to change the electricity into **chemical energy**, which is stored in the battery. Wires between the solar panel and the battery enable the electricity to flow to the battery.

A battery does two things. It:

- receives the electricity produced by the solar panel and changes it into chemical energy
- changes the chemical energy back into electricity. This happens when an appliance is connected to its terminals.

The device that does this in a battery is a voltaic cell. Each cell has a voltage of 2. Therefore, a 12 V battery has six cells connected in a way that produces a total of 12 volts between its two terminals.

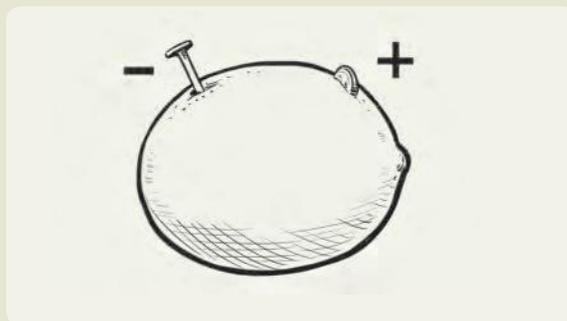
A battery is made to store only a certain amount of electricity. The amount it can store is shown by its **ampere-hours** (Ah). If it is forced to take in more electricity than it can hold, it will become damaged; and if all the electricity is drawn out of a battery, it will also become damaged.

Activity 8: Making a voltaic cell

You will need:

- 2 fresh lemons
- 3 pieces of wire
- 2 nails
- 2 coins
- small light bulb from a two-battery torch.

- 1 Insert a nail and a coin inside each lemon as shown below.



- 2 Connect the coin in one lemon to the nail in the other lemon with a piece of wire.
- 3 Connect a piece of wire to the free nail and the body of the bulb.
- 4 Touch the bottom of the bulb to the free coin in the other lemon. What happens? If nothing happens you might need to connect more lemons or check the connections and the bulb.

Controller

The battery, solar panel and appliance all connect to the controller. The controller is the device that controls the operation of the whole solar power system. It has two sections: a charge controller section and a discharge controller section. The charge controller section controls electricity flowing into the battery. The discharge controller controls electricity flowing out of the battery. There are three connections that all the other components are connected to.



Figure 15.18 Solar controller. The two wires on the left come from the solar panel; the two in the middle connect to the battery; the two on the right connect to the appliance.

The main function of the controller is to protect the battery from damage. It does this in three ways. It:

- keeps the amount of electricity in the battery at around 12 volts
- stops electricity flowing into the battery when the battery has reached the amount it is made to store.

These first two actions are done by the charge controller section.

- stops electricity flowing out of the battery when the electricity stored in it is almost used up. This action is done by the discharge controller section.

Another function of the controller is to stop electricity flowing back into the solar panel from the battery. This can happen on a cloudy or rainy day and at night. At such times the solar panel will act like an appliance and draw electricity from the battery.

To carry out its functions, the connection from the solar panel to the battery must pass through the charge controller section of the controller. The connection from the battery to the appliance must pass through the discharge controller section of the controller.

Appliances

An important component in a solar power system is the appliance. These include light bulbs and fluorescent lights for producing light, electric fans for cooling, pumps for drawing water and pushing it into a water tank, radio receivers for listening to the radio (in Pijin we call them wireless radios), and radio transceivers for talking with someone faraway, and so on.



Figure 15.19 Examples of appliances

The appliance is connected to the two terminals of a battery. As long as it is connected to the battery it will draw electricity out of the battery and use it. It stops using electricity when it is disconnected from the battery.

If more appliances are connected to the battery, more electricity will be used. If the solar panel does not put enough electricity in the battery the appliance could use up all the electricity in the battery.

Accessories

There are other items, devices and components that may be found in a solar power system. These are called accessories. An accessory is something that is additional and which the solar power system can work without, such as cables, connectors, switches, indicator lights, **voltmeters**, **ammeters** and fuses or circuit breakers. Your teacher will show you some of these accessories.

The main function of an accessory is to make the operation of a solar power system easier, better and safer. For instance, electric cables enable the main components to be placed further apart in more suitable locations; connectors help to make better and safe connections; switches allow components to be connected and disconnected easily and safely; indicator lights show the condition of the system; voltmeters and ammeters show the voltage and current at selected points; and fuses and circuit breakers disconnect

components automatically when things go wrong with them. Your teacher should show you how to use the **multimeter**.



Figure 15.21 Multimeter

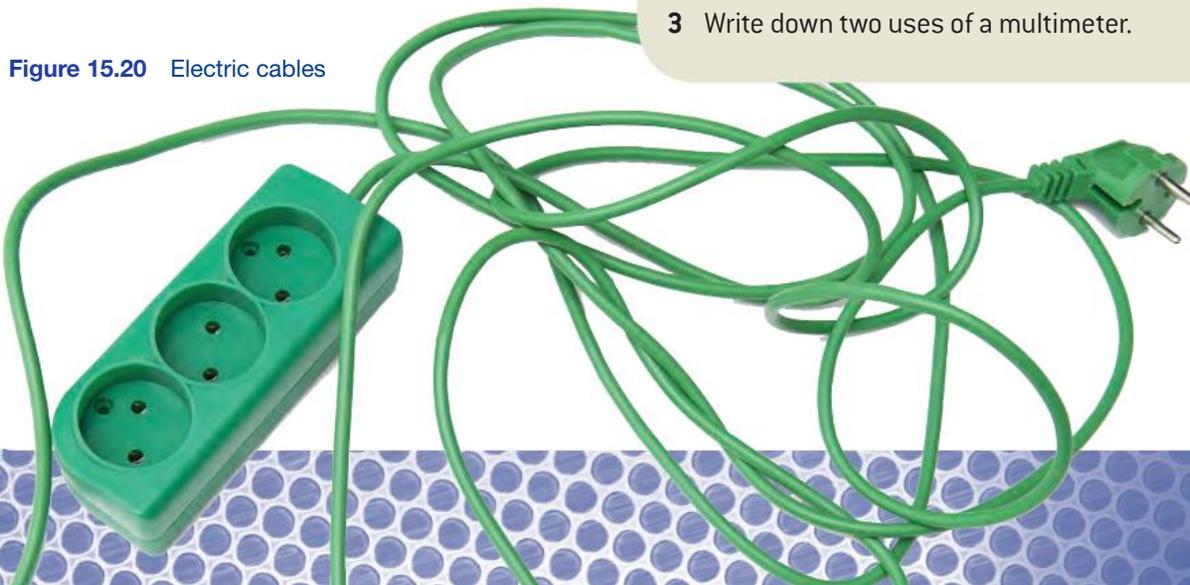
Activity 9: Using a multimeter

You will need:

- multimeter.

- 1 Your teacher will demonstrate how to use a multimeter to read the voltage and current in the solar power system that you built in Activity 4.
- 2 In groups, read the voltage and currents at the following points in the same circuit:
 - a connecting terminals of the solar panel
 - b terminals of the battery.
- 3 Write down two uses of a multimeter.

Figure 15.20 Electric cables



Practical task

By the end of this practical task, you should be able to:

- 7.15.1.5 research how the different components of a solar system operate
- 7.15.3.1 design and make a solar power system to address a need at home
- 7.15.4.1 connect the different units of a solar power system correctly
- 7.15.4.2 use proper safety procedures when handling or connecting components of a solar power system
- 7.15.5.1 use tools correctly when assembling the units of a solar power system
- 7.15.6.1 investigate the impact of using solar power in your community in relation to environmental issues.

Go back and read the design problem at the beginning of this chapter. You are going to solve that design problem.

Design problem: Solar power system

Design expectations

The following must be considered in the development of the solar power system:

- The components must be well connected.
- The solar panel must sit on a well-built structure and be **tilted** in the direction of the sun.
- All connections onto the solar controller must be fitted correctly.

Investigating

- Look around your home or the homes of neighbours who have a solar power system. Then do the following:
 - draw where the different components are placed
 - write down the name of the different components of the solar power system in your drawing
 - write down two strengths and weaknesses of the solar power system
 - look at the way the solar panel is positioned for the sun.
- Look at the correct way of connecting the components of a solar power system.
- Look at the correct way of connecting all the components to the controller.

Designing your solar power system

- Write the design brief for the solar power system.
- Draw a block diagram of the solar power system.
- Make a list of materials that you will need for the solar power system.

Making your solar power system

- Decide where the components will be placed.
- Prepare an appropriate structure for the solar power system.
- Use appropriate tools for cutting and joining wires of the solar power system.
- Use your block diagram to connect the solar power components.

Testing your solar power system

- Is the structure made for the solar panel rigid and strong?
- Is the wire connection terminated properly?
- Is the battery charged during the day?
- Does the light come on when you turn on the switch?

Evaluating your work

Answer the following questions in your exercise book.

- 1 Does the solar power system serve the purpose for which it is designed?
- 2 Do the wires connecting the different components fit neatly into the connection points?
- 3 Does the size of the solar panel matter in a solar power system?
- 4 Did the construction or making of the project take a long time? If yes, why?
- 5 Have you learnt anything from other people's designs that will help you to improve your solar power system?
- 9 Is there anything you would like to improve on your model?
- 7 What would you change in your design if you were building another solar power system?

Communicating and marketing

- 1 How would you communicate and market the importance of a solar power system as a sustainable alternative source of energy to all Solomon Islanders?
- 2 How would you communicate the importance of the skills you have learnt from this chapter to people who have **limited** knowledge of a solar power system?
- 3 What marketing strategy would you use to communicate the importance of a career in solar power to your classmates?

New words used in this chapter

alternative	another
ammeter	device used to measure current in a circuit
ampere-hour	maximum amount of current stored in a battery at one given point in time
appliance	piece of electric equipment that people use in their homes
chemical energy	kind of energy stored in a torch battery
limited	few or very little of
multimeter	device used to measure electricity
photoelectric device	device that can change light into electricity
photovoltaic	able to change light into electricity using solar cells
tilted	slightly at an angle
unusable	not able to be used
viable	potential, reasonable
voltaic cell	part of a solar panel that actually converts light into electricity
voltmeter	device used to measure voltage in a circuit



Solomon Islands Technology

Year 7

Learner's Book

Solomon Islands Technology Year 7 Learner's Book is part of a series for Technology in Years 7–9. This textbook helps learners achieve the learning outcomes for the Technology Syllabus, developed during the Solomon Islands School Curriculum Reform from 2005 to 2012. The Ministry of Education's Key Learning Outcomes are addressed in many of the practical activities in this textbook, enabling learners to demonstrate their learning capability.

Technology is an important subject within the secondary school curriculum. In this subject, learners are exposed to authentic situations that form the basis for building problem-solving skills. Learners are given time to learn by actually doing.

Studying Technology enables learners to confidently and competently produce a technological product, solution or outcome in response to a worthwhile opportunity. This textbook promotes entrepreneurship by encouraging learners to use indigenous, modern materials and systems to make an income. This textbook also enables learners to gain important technology skills, attitudes, and knowledge that remain useful long after a student has left the school system. Studying Technology helps improve a person's quality of life, wherever they choose to live.

