TECHNOLOGY

Grade 7

CAPS

Learner Book

Revised Edition

Developed and funded as an ongoing project by the Sasol Inzalo Foundation in partnership with the Ukuqonda Institute.

Published by The Ukuqonda Institute (http://www.ukuqonda.org.za)
Registered as a Title 21 company, Reg. No. 2006/026363/08
Public Benefit Organisation, PBO No. 930035134

ISBN: 978-1-4315-2897-4

This book was developed with the participation of the Department of Basic Education (DBE) of South Africa with funding from the Sasol Inzalo Foundation.

Authors:

Graham Barlow, Louis Botha, John de Klerk, Andrew Hofmeyr, Chris Human, Piet Human, Morne Labuschagne, John Laurie, Ezekiel Makwana, Rallai Maleka, Mafahle Mashegoana, Themba Mavuso, Peter Middleton, Lebogang Modisakwena, Peter Moodie, Neil Murtough, Sarah Niss, Humphrey Nkgogo, Phillip Radingoane, Jan Randewijk, Margot Roebert, Rod Sherwood, Marcus Taba, Cecile Turley, Louis van Aswegen

Editing and language:

Louise Carmichael, Jacqui Greenop, Riekie Human, Xenia Kyriacou, Marlene Rousseau, Yvonne Thiebaut, Karen van Niekerk, Elene van Sandwyk

Illustrations and graphics:

Astrid Blumer (Happy Artworks Studio), Ian Greenop, Chris Human, Piet Human, Peter Middleton, Peter Moodie, Melany Pietersen (Happy Artworks Studio), Theo Sandrock, Lisa Steyn Illustration, Heine van As (Happy Artworks Studio), Leonora van Staden, Geoff Walton

Cover illustration: Leonora van Staden

Photographs:

Lenni de Koker, Ian Greenop, Chris Human, Tessa Olivier, Elsa Retief (GalleryProductions)

Text design: Mike Schramm

Layout and typesetting: Lebone Publishing Services

Subject advisors from the DBE who contributed by means of review:

The publisher thanks those subject advisors of the DBE who reviewed this book series on four occasions in 2013-2014, as well as in October 2017. The authors changed the text so as to align with the reviewers' requests/suggestions for improvements, as far as possible, and believe that the books improved as a result of that. The reviewers were:

[Names to be supplied.]

Thank you for free sharing of ideas, and free access to photographs, to:
Cape Peninsula Fire Protection Association, National Sea Rescue Institute, Beate Hölscher (South African Environmental Observation Network), The Transitions Collective (www.ishackliving.co.za).

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Printed by [printer name and address]

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Term 1: Mechanical systems and control

Chapter 1
What is Technology?

In this chapter, you will learn what Technology is about. You will learn about natural and man-made materials, about tools, and about the design process.

Figure 1

Technology advances!

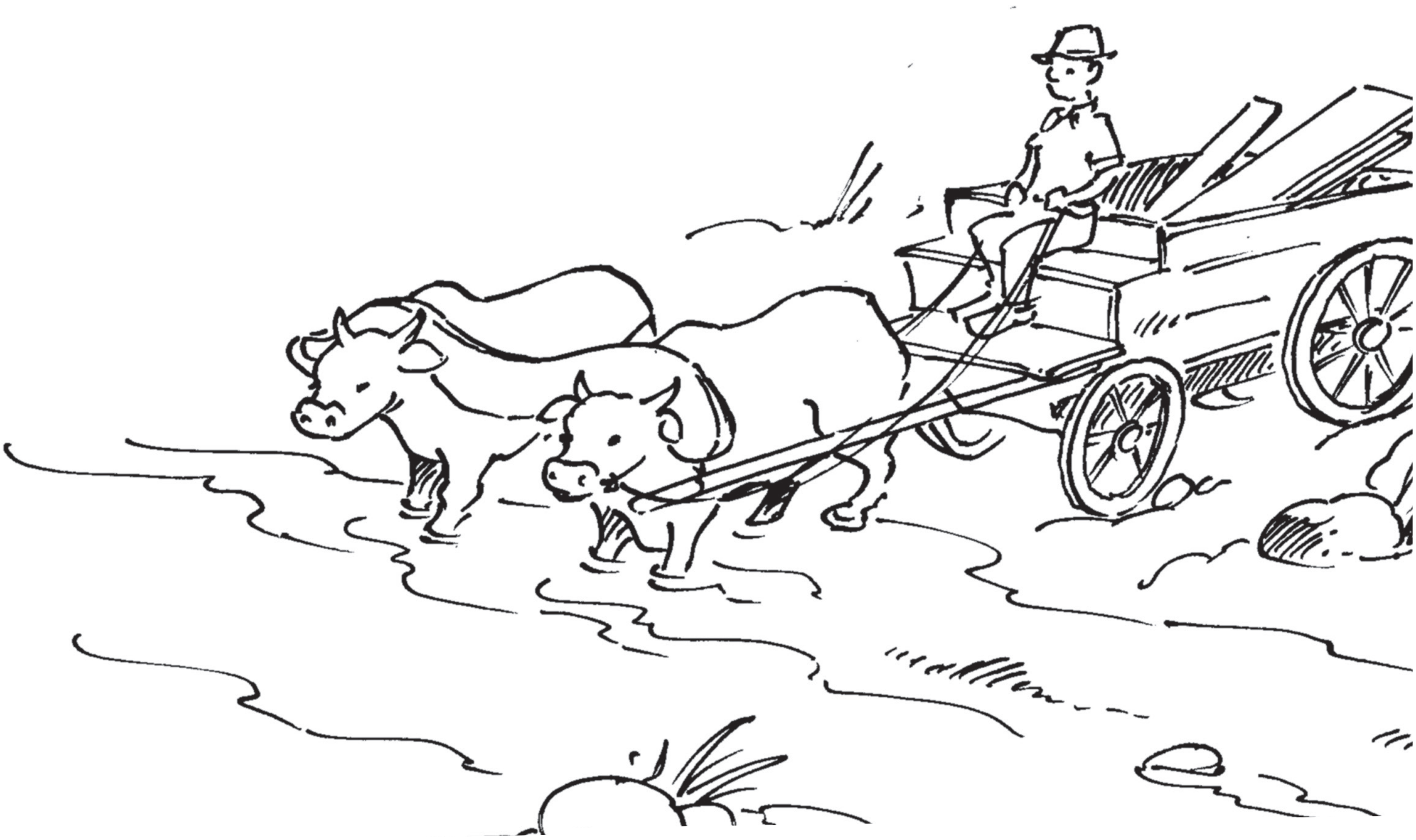


Figure 2: Transport technology 150 years ago

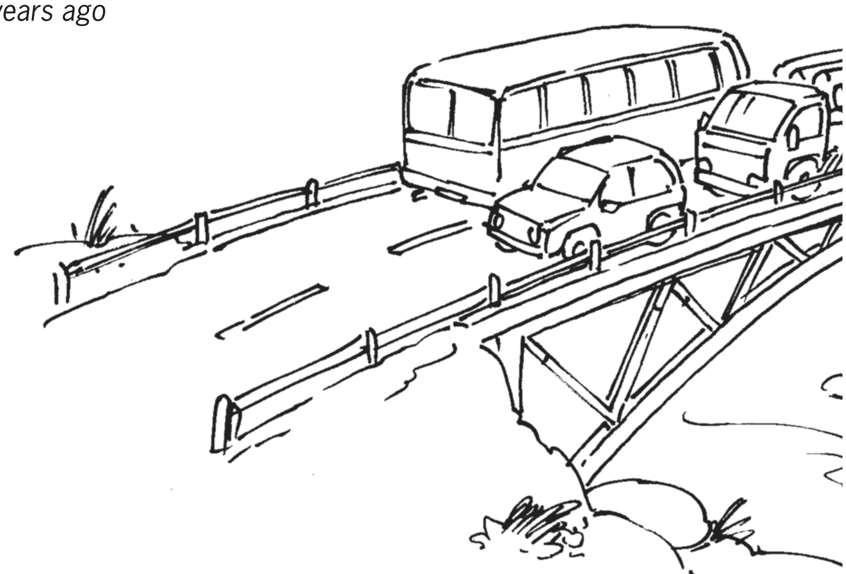
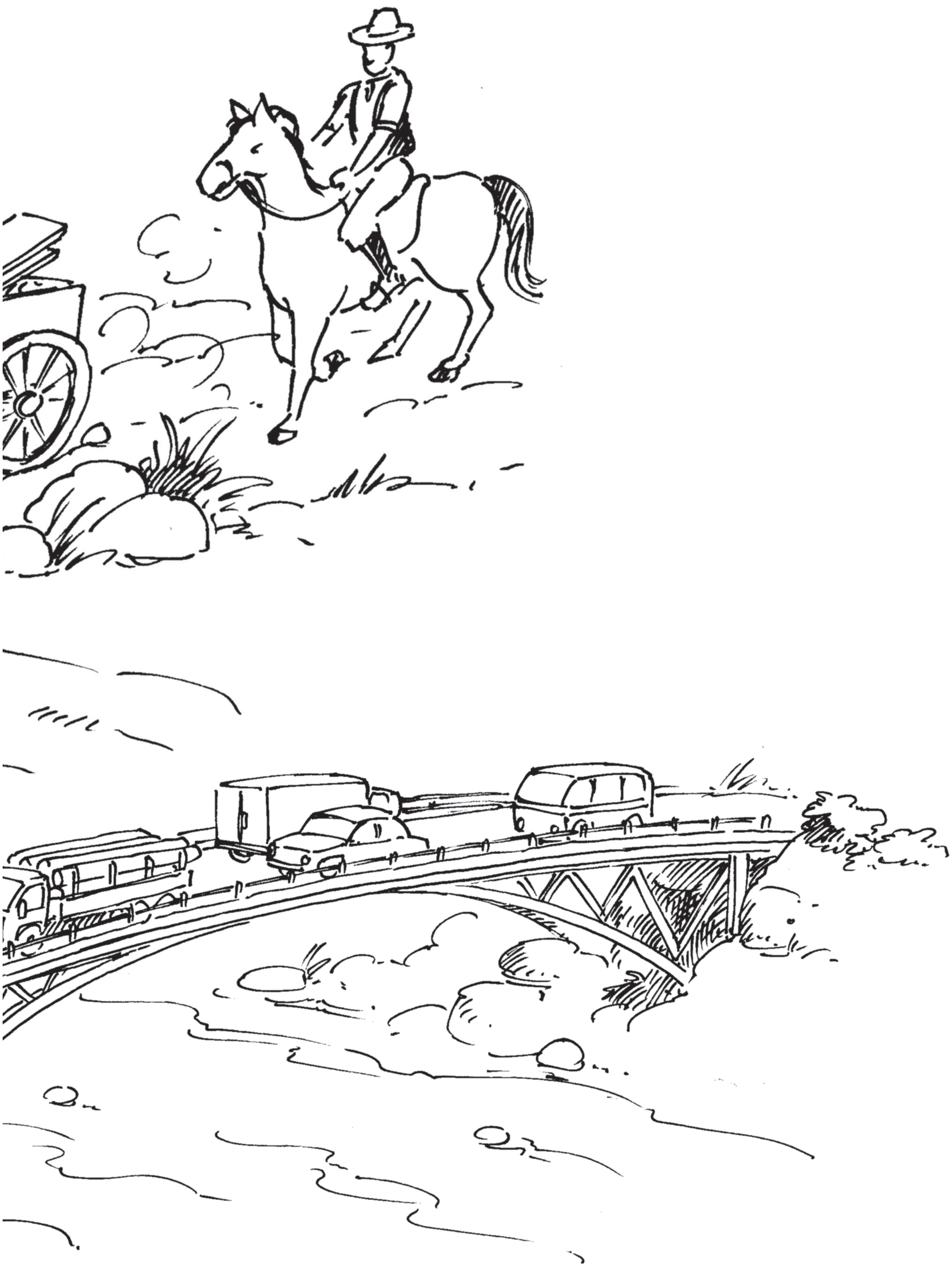


Figure 3: Modern transport technology



1.1 Materials, tools and plans

Figures 4 to 6 show different techniques for building houses, the tools we use to build them and other kinds of activities that fall under the term Technology. Look at the pictures carefully and try to understand what happens in each picture. When you answer the questions on page 7, you should already have some idea what technology is about.

Figure 4

The person shown above is using grass to cover his roof. Grass is a **natural material**. It grows in the veld. Some types of grass are much better for roofs than other types. It is not easy to make a thatched roof. Only a few people have the skills to do it properly.

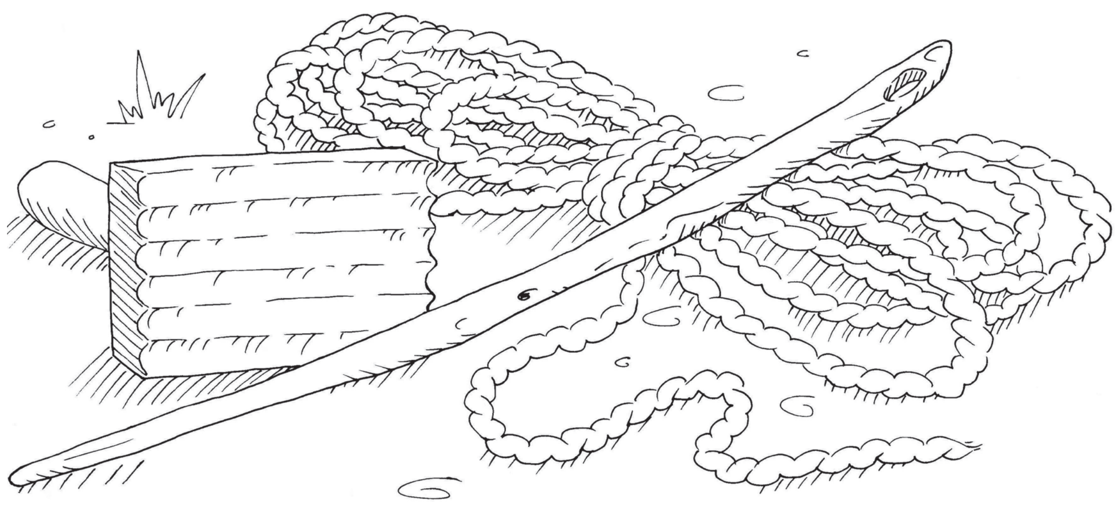


Figure 5: Some of the tools people use to make thatch roofs.

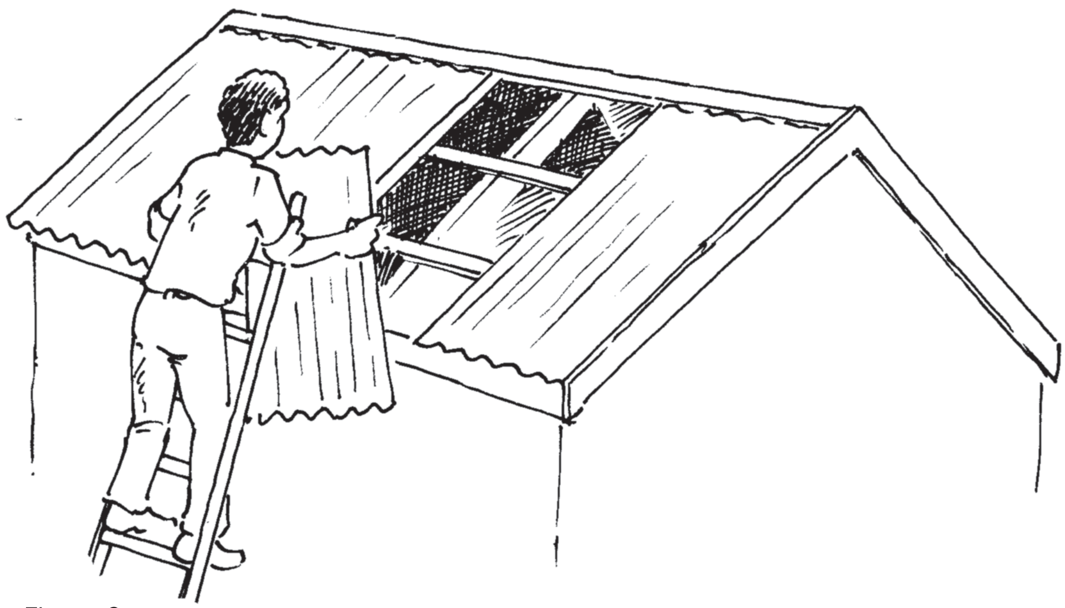


Figure 6

The person in the picture above is using corrugated roof sheets to cover the roof. Metal roof sheets don't occur in nature like grass. People make roof sheets from two metals named iron and zinc. The iron and zinc are obtained by heating crushed rock to separate the metal from other substances. Roof sheeting is a **man-made material**.

Natural materials are changed in different ways to make **man-made materials**.

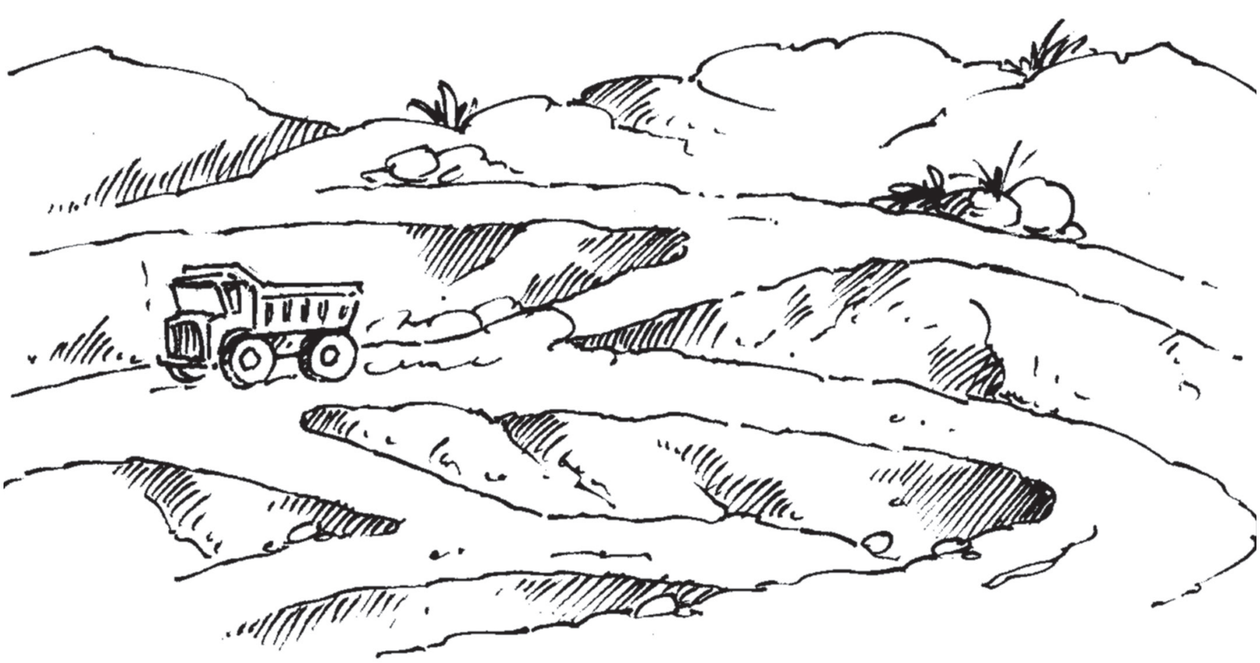


Figure 7: An open mine where rock that contains iron is collected, like at Sishen.

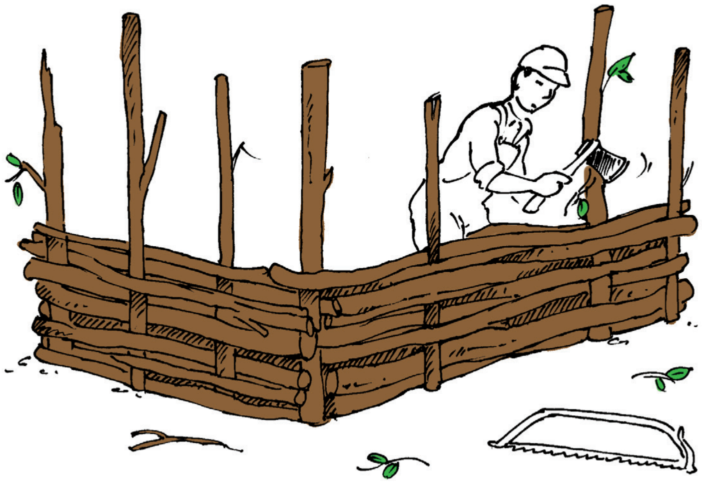


Figure 8: House A

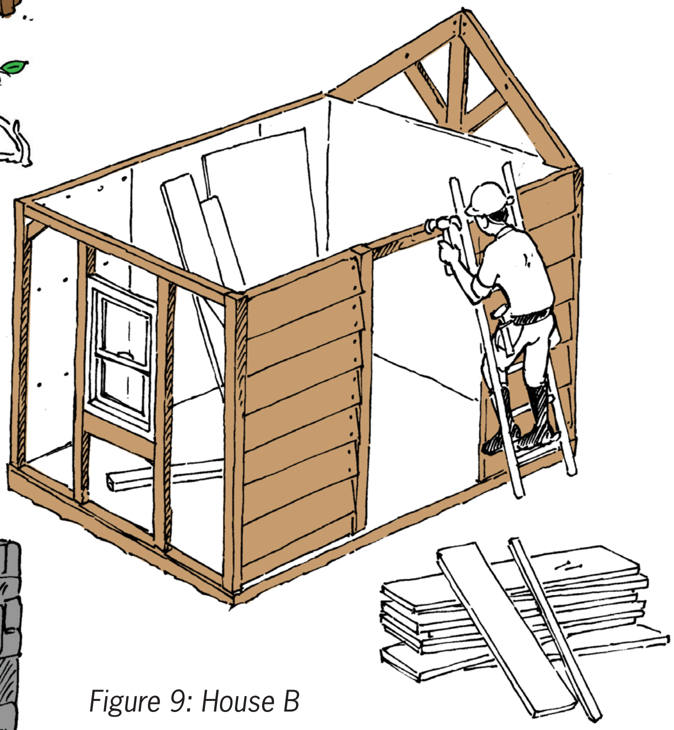


Figure 9: House B

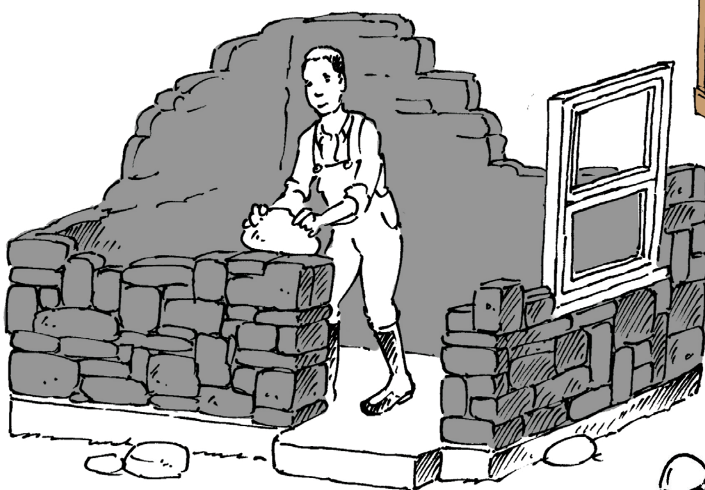


Figure 10: House C

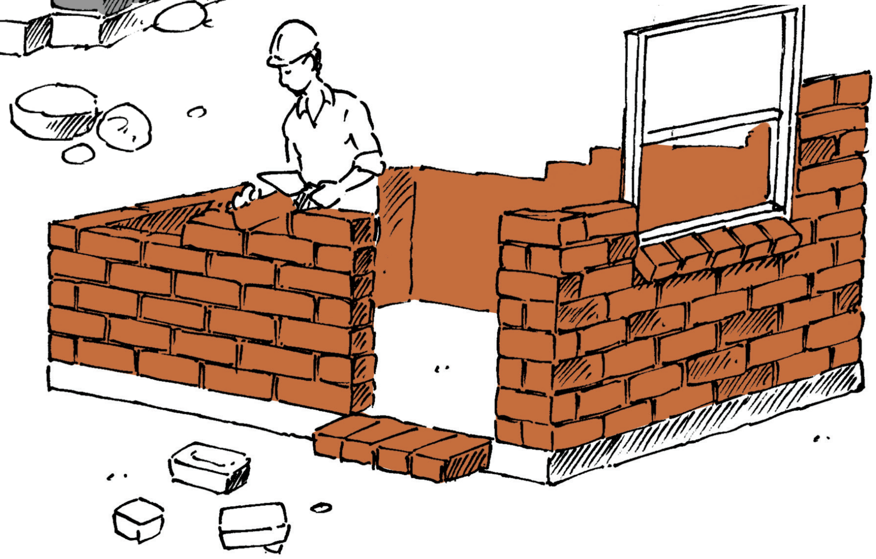


Figure 11: House D

Homework questions about tools and materials

1. (a) What material is being used to build the house in Figure 8?
   (b) Is this a man-made material or a natural material?
   (c) What tools are used by the people building the house in Figure 8?
2. (a) What material is being used to build the house in Figure 9?
   (b) Is this material man-made or natural?
   (c) What tools are being used by the people building the house in Figure 9?
3. (a) What material is being used to build the house in Figure 10?
   (b) Is this a man-made material or a natural material?
   (c) What tools are being used by the people building the house in Figure 10?
4. (a) What material is being used to build the house in Figure 11?
   (b) Is this a man-made material or a natural material?
   (c) What tools are being used by the people building the house in Figure 11?

Read the story and think about Technology

Read the story below:

> *Two girls, Sarah and Tebogo, walk in the veld and climb up a small hill. Suddenly, a rock comes loose and starts rolling down the hill. It lands on Sarah's foot, which gets caught underneath the rock. Tebogo tries to lift the rock, but it is too heavy for her. She looks around and finds an iron pole. She tries to lift the rock with the iron pole and it works! Sarah now manages to pull her foot out from underneath the rock.*

Tebogo was not strong enough to lift the rock, so she used a **tool**. Tools help us to do things that we cannot do with our bodies alone.

Here are some more examples of tools:

- Spoons, knives and forks are used to eat with.
- We use scissors to cut cloth or paper. This works much better than tearing cloth or paper with our hands.
- We use cell phones to talk to people who are far away. Cell phones are tools for communication. Two hundred years ago, there were no cell phones or landline phones. At that time, people could only talk to each other when they were close enough to hear each other without using any tools.
- Doctors and nurses use a variety of tools to treat people who are sick.

Some **tools**, such as knives, forks and spoons, are easy to use.

Other tools, like scissors and screwdrivers, are a bit more difficult to use.

Some tools, like a powerdrill, are even more difficult to use. To use tools like these, you have to be trained.

About 50 years ago, nobody had cell phones. There were no television sets in South Africa. Also, most roads in South Africa were gravel roads. Tarred roads were only found in and around big cities. Most schools didn't have electricity either.

Two hundred years ago, the world was even more different. Electricity had not yet been invented. People travelled on foot, on animals or in carts and wagons drawn by animals. Ships were powered by people who rowed, or by sails which harnessed wind energy.

Many people develop practical solutions to problems so that people can have the things they want and need. To do this, they use their knowledge and skills. They also use tools and materials. When developing solutions to problems, people should try not to damage the environment, and they should keep the needs and safety of individuals, families and communities in mind.

All of this together is called Technology.

Something to think about

A small town has a dam about 3 km away, which supplies the town with all its water requirements. But something very unfortunate happens. There is a big flood, and the dam wall breaks. It will take at least two years to build a new dam wall.
The town is in a rural area that has no electricity.

Luckily, there is an old well near the town, with enough water for everyone. But the well is very deep, and there is no way to get water to the surface. What do you think can be done to get the water out of the well? Are you sure your plan will work? Can you make a drawing to explain your plan to other people?

Everyone uses tools, man-made materials and machines of some kind. Nowadays, people do much less with their bare hands and make much less use of natural materials than in the past.

Technologists are people who are trained to work with special tools. Technologists find jobs more easily than people with no training in Technology.

When people are faced with challenges or problems, they often:

- **investigate**,
- **design** or, in other words, make plans,
- **evaluate** their designs, and often change them,
- **make** the things they have designed,
- **evaluate** the things they have made, and
- **communicate** their designs to other people.

This is sometimes called the **design process**. You will work like this often throughout the year.

1.2 Design a wheelbarrow

In this lesson, you will play an important part in a story. The story is about three people:

- Mrs April, who grows vegetables and then sells them at a street market,
- Mr Sethole, a carpenter, who works mainly with wood, but can also work with metal sheets, and
- yourself.

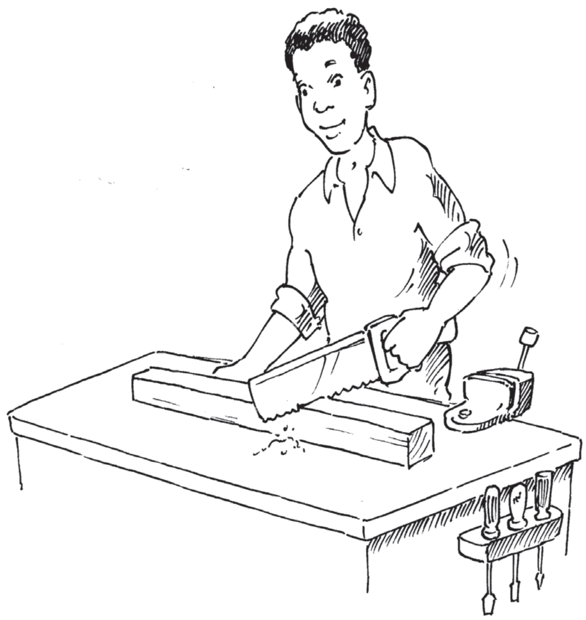


Figure 12: A carpenter is a kind of technologist who makes things out of wood.

Mrs April needs a wheelbarrow to take her vegetables to the street market. She doesn't like the wheelbarrows in the shops. She asks you to go to Mr Sethole and ask him to make a wheelbarrow for her. You take the message to Mr Sethole.

Mrs April could buy a wheelbarrow like the one on the right. But she says this wheelbarrow will not work well for her vegetables.

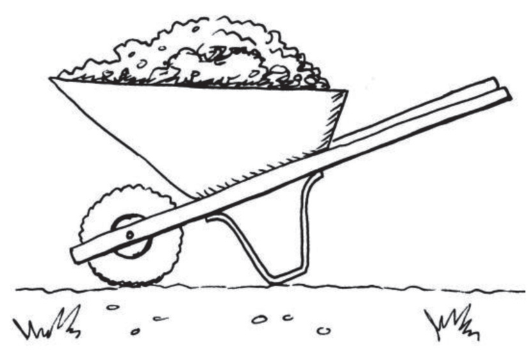


Figure 13

Mr Sethole says to you:

> *"You will have to give me more information so that I can know how to make the wheelbarrow. Wheelbarrows are used for different purposes and they can be of different sizes and shapes. Please ask Mrs April some questions and then come back to me with more information."*

Almost any technology project starts with gathering information. Without good information, it is not clear what has to be done. This part of the design process is called **investigation**.

Write specifications and a design brief

1. Write down some questions that you can ask Mrs April.
2. Try to think what answers Mrs April would give to your questions. Then write two to three lines explaining what she wants to do with the wheelbarrow, and what the wheelbarrow should look like.
3. Mrs April wants to put vegetables next to each other, rather than on top of each other. How should her wheelbarrow differ from the wheelbarrow you can buy in a shop?

   Mrs April has an old wheelbarrow without a top (Figure 14). Mr Sethole says he can make a new top and attach it to the old wheelbarrow.

The description of what the wheelbarrow should look like is part of the **specifications** for the wheelbarrow.

The notes that you are writing in question 2 are sometimes called a **design brief**.

Remember that you are **designing** a wheelbarrow for Mrs April, not for somebody else. So you should consider what *she* will use it for.

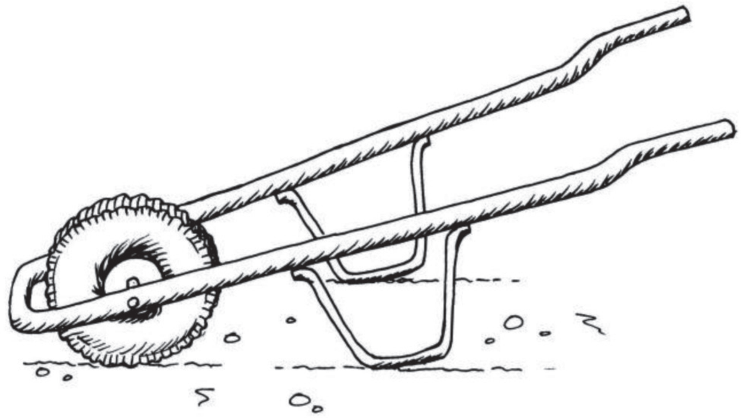


Figure 14

4. Make a sketch to show what you think the new top should look like.
5. Which materials could be used to make the wheelbarrow's top? Describe the options and say which one you prefer. Also explain why you prefer this material.

During the design stage, you should think about possible materials so that you can **select suitable materials** for making the wheelbarrow.

Next week

During the next two weeks, you will learn to make different types of drawings. Drawings will help you to think about things you may make, and to share your ideas with other people.

Chapter 2
How to say things with drawings

Sketching and drawing are very important skills in Technology. They allow us to share our ideas, designs, and technical solutions with other people. In this chapter, you will learn what the main purpose of graphics are. You will also learn about the different meanings of thick and dark lines, thin and feint lines, and dashed lines. And you will learn a little bit about scale and how to show sizes on drawings. But the most important thing about sketching and drawing is that you need to practise. So in this chapter you will learn how to do some simple sketches and how to do a flat drawing showing sizes.

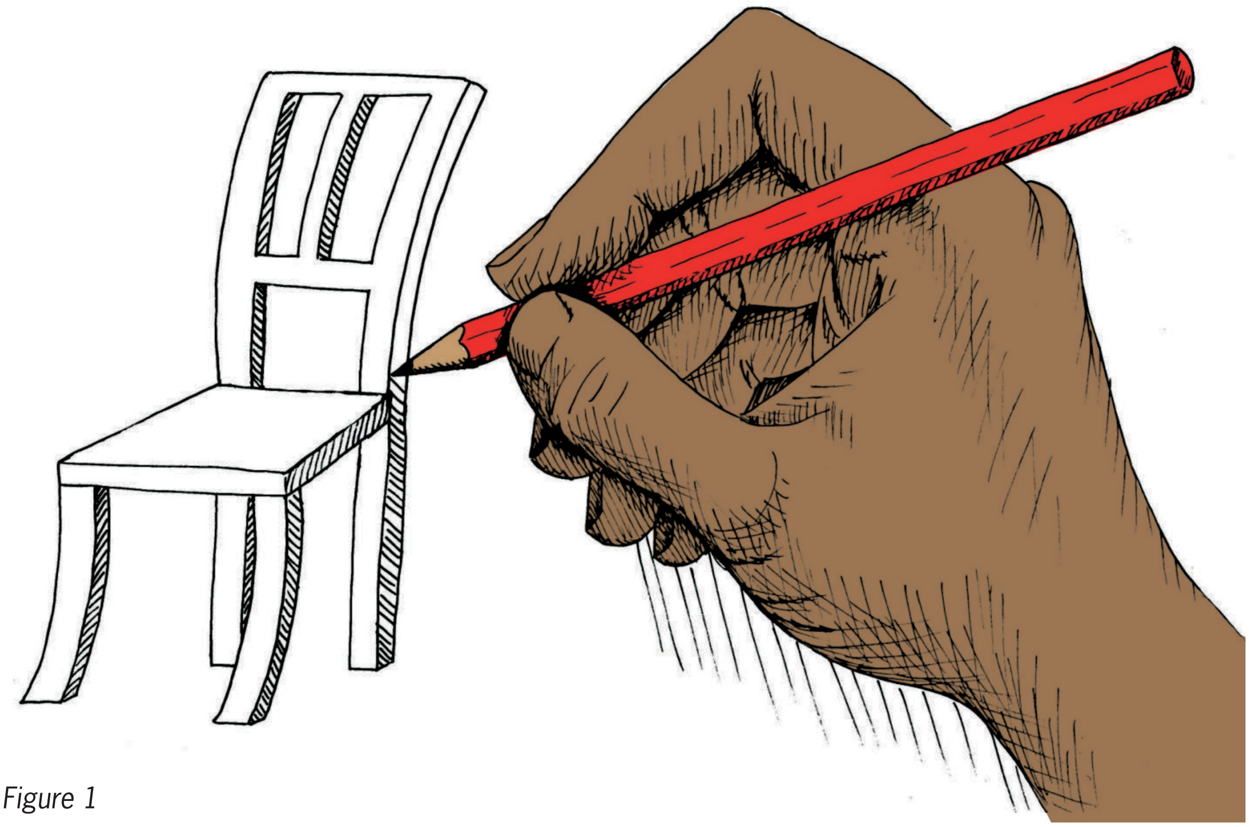


Figure 1

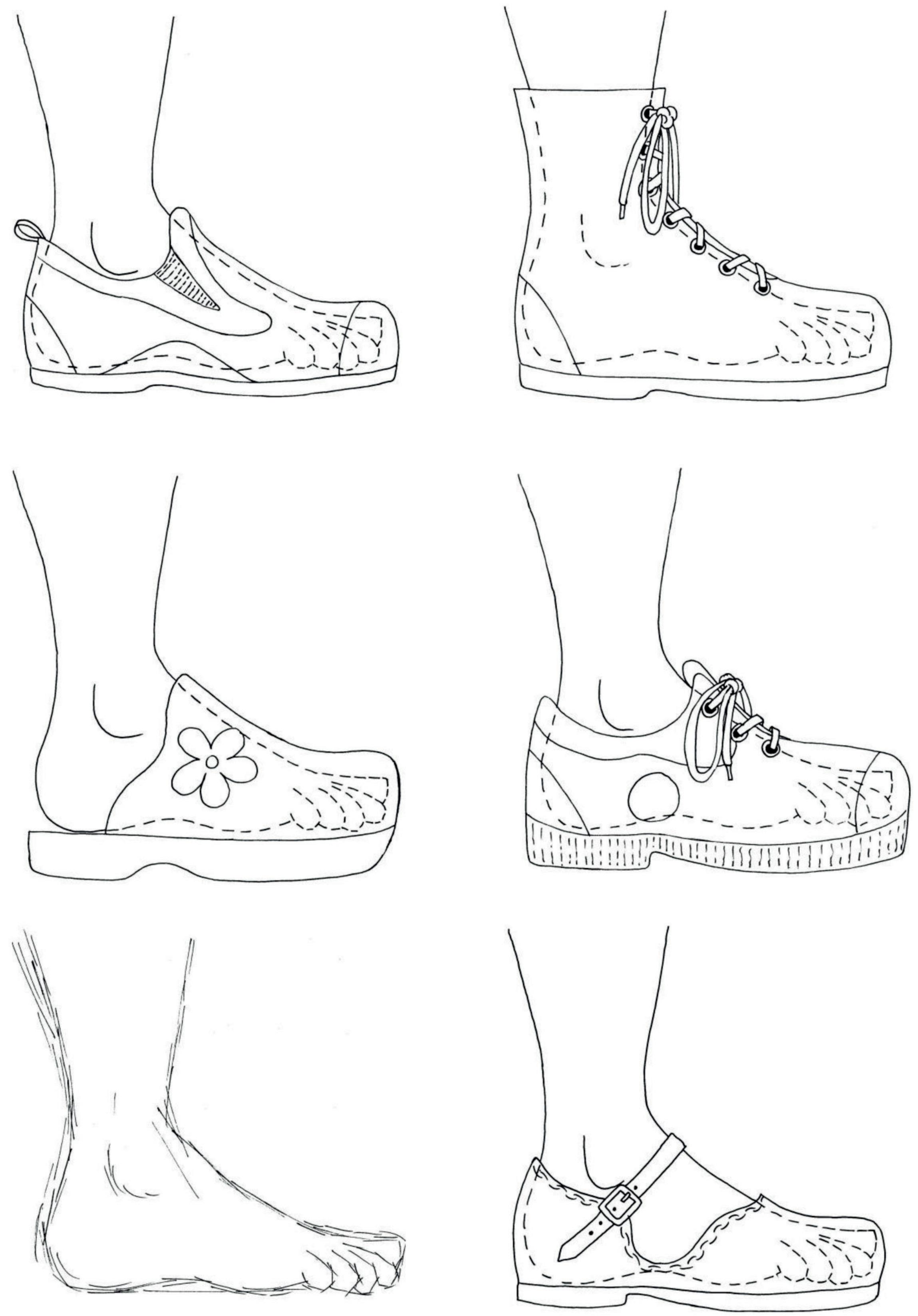


Figure 2: Drawings in a shoe design studio

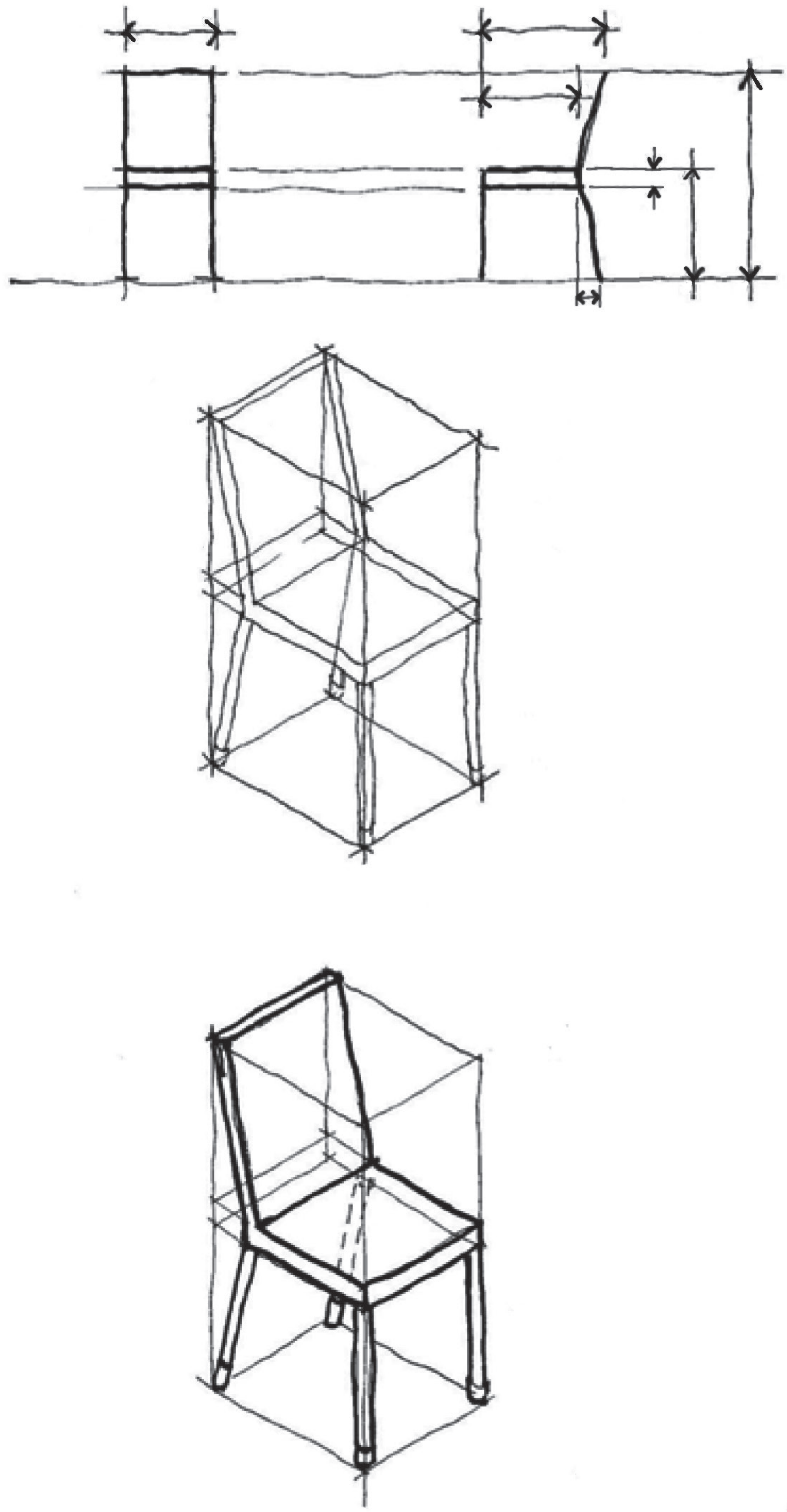


Figure 3: Drawings to design a chair

2.1 A new cupboard for the classroom

Your classroom needs a cupboard to store books.

Answer questions to write design specifications

1. How many doors should it have?
2. How many shelves should it have?
3. What should it be made of?
4. How high and how wide should it be?
5. How deep should it be?
6. Make a rough sketch to show what you think the cupboard will look like.
7. Make a bigger and better sketch of the cupboard. Write notes next to your drawing to show where the doors and shelves are. Also write notes to say how big different parts of the cupboard should be, in millimetres (mm).
8. Should the real cupboard be three times bigger than your drawing?
9. How many times bigger should the real cupboard be than your drawing?

When you answer these questions, you are writing **design specifications** for the cupboard. Whenever you plan to make something, it is useful to first think about what you want to make, and to write your ideas down. You can then give your design specifications to someone else to read. That person will maybe make some useful suggestions that will improve your design. Without written design specifications, it is very difficult to get good suggestions from other people.

- The lengths of different parts of an object are called the **dimensions**. Things like the height, width and depth of the cupboard, as well as the distance between the shelves, are called the dimensions.
- A real object is often several times bigger than a drawing of it. If the object is five times as big as the drawing, we say the **scale** of the drawing is "1 to 5". This is written as "1:5".

2.2 Different types of lines in drawings

In this drawing, a **dashed line** is used to show the foot inside the shoe.

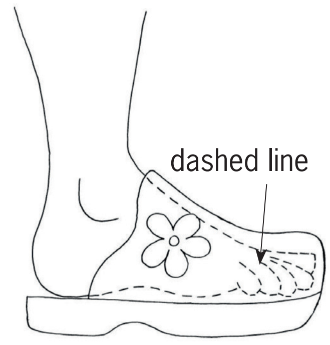


Figure 4

Draw with dashed lines

1. Copy Figure 5 and use dashed lines to show the bodies of the two people inside the car.

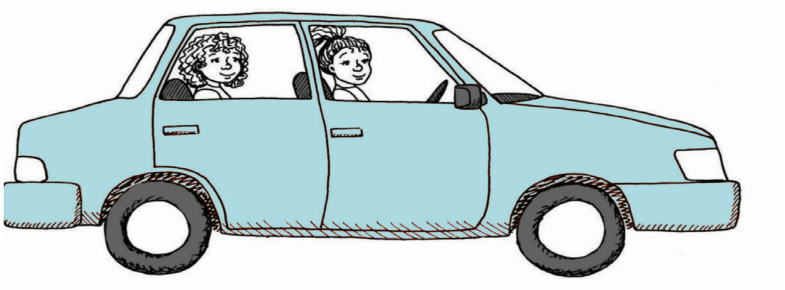


Figure 5

2. Copy the drawing of the cupboard in Figure 6 on the next page. Draw dashed lines on the drawing to show four shelves inside.

The drawing in Figure 6 is called a **working drawing**. A working drawing is an accurate drawing that shows the real sizes.

Solid lines are used to show the visible edges of objects on drawings.

When you want to show something that is behind something else, you should use a **dashed line**. Dashed lines are used to show hidden objects.

Sizes, which can also be called **dimensions**, are shown with a thin **dimension line** with arrows at both ends. Dimension lines are drawn a little bit away from objects.

Short **extension lines**, which do not touch objects, show you what is being measured.

Dimensions are normally given in mm. So you don't need to write "mm" after the number indicating a dimension on a drawing.

Just like you use a language such as English to communicate with others, sketches and drawings are a "language". ust like English, there are rules for drawings to help us understand them better. These rules are known as **drawing conventions**.

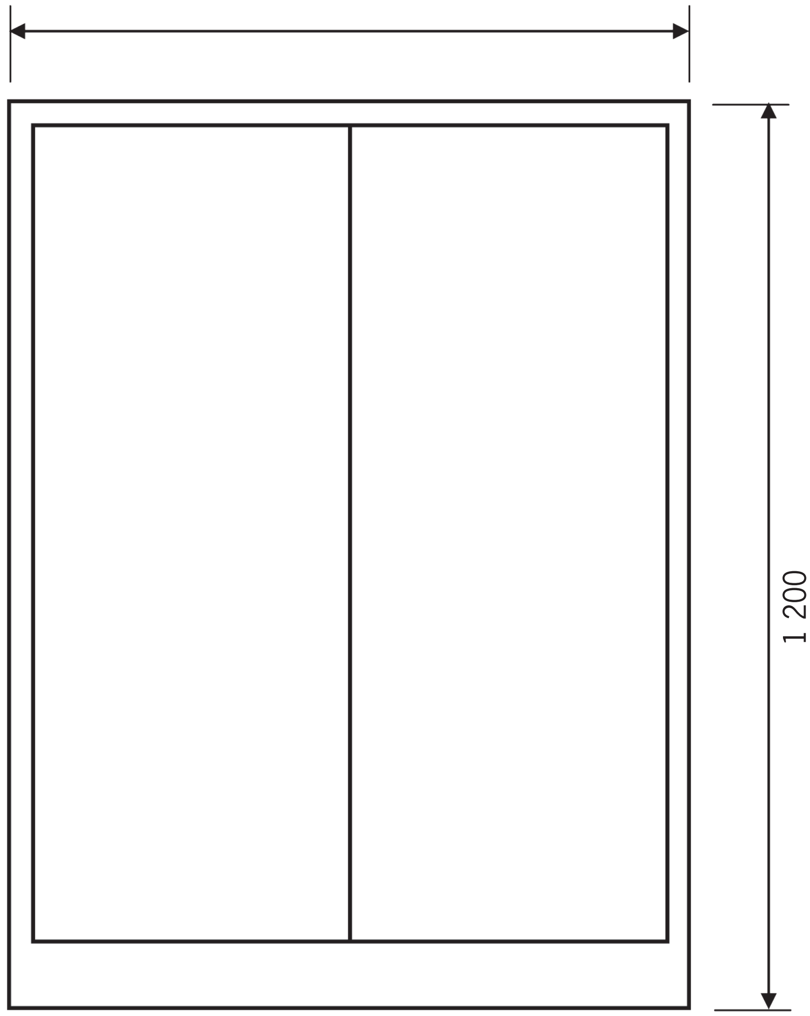


Figure 6

Figure 7

Working drawings are used to design things according to exact sizes. Designers communicate the exact sizes of each part of an object in working drawings, so that each part fits to make the final product work properly. For example, a bicycle pump can't have a push rod that won't fit inside its outer tube. See Figure 8 below.

By looking at some drawings and practising sketching, you have learnt to:

- Use thin feint lines for guidelines, such as the lines for a guide box.
- Use thick lines to show the outside edges of an object, such as the edges you can see from the front.
- Use a solid line to show these edges.

You have also learnt that dimensions are shown by writing the length of an object above a dimension line.

A dimension line has small arrows at each end. These arrows touch small extension lines that show where the length starts and where it ends.

Dashed lines show hidden details of drawings.

Homework: Study drawings of a bicycle pump

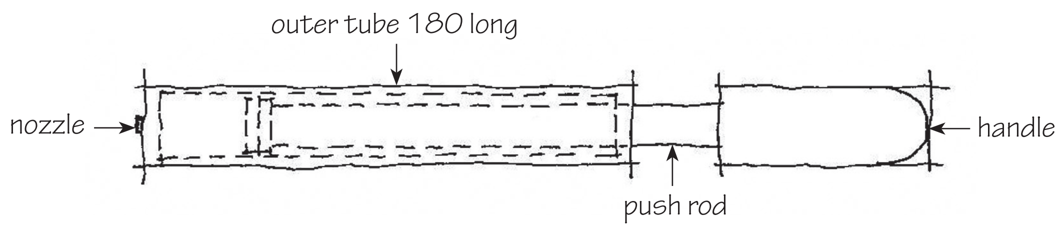


Figure 8

1. Name the parts of the pump shown in this sketch.
2. How long is the outer tube of this bicycle pump?
3. How long is the push rod of the bicycle pump? How do you know this?

Sketching and drawing are important ways of recording and communicating ideas.

For designers and technologists, sketching is like taking notes. It reminds them of their ideas and helps them to share these ideas with others. Sketching is usually done without any instruments. All you need is a pencil and some paper.

Look at the drawing of a different bicycle pump below. This drawing is accurate, so we call it a **scale drawing**. It is four times smaller than a real pump. We say it is drawn to a scale of 1:4. That means that if you measure the length of the outer tube of this drawing, it will be four times smaller than the outer tube of the real pump.

Copy this drawing and answer the questions below.

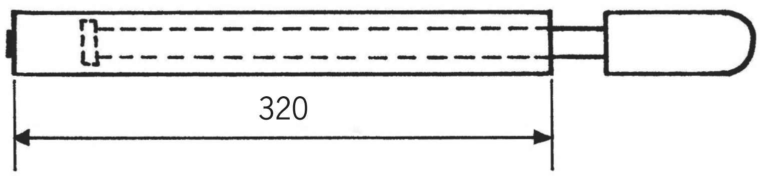


Figure 9: Bicycle pump. Scale 1:4

4. Why is the outer tube of this pump drawn with solid lines?
5. What other part of this pump is drawn with solid lines?
6. Why is part of the push rod drawn with dashed lines and other parts with solid lines?
7. What type of line shows how long the outer tube is?
8. How long will the outer tube of the real pump be?
9. Use the scale on the drawing to find out how long the handle will be on the real pump.
10. Now, draw a dimension line on your pump drawing to show how long the handle will be.
11. Name three different types of lines that you can see on the drawing.
12. What is the scale of the working drawing of the cupboard in Figure 6? You will have to take measurements to find out what the scale is.

2.3 Free-hand sketching

Look at the drawing in Figure 10.

Figure 10

The artist who drew the foot in Figure 10 started by drawing only light, thin lines, like the ones shown in Figure 11 on the right.

Then she used these feint lines as guidelines to draw the foot.

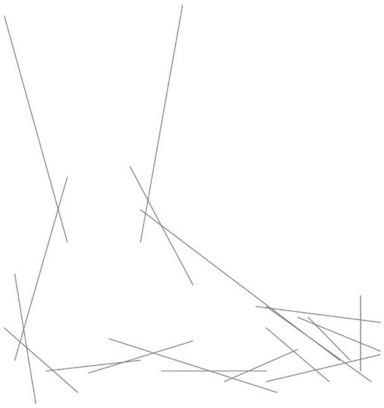


Figure 11

Sketching lines

Use thin, feint lines for the guidelines, which are called construction lines.

Use thicker, dark lines for the outlines of sketches.

Practise sketching

1. Sketch a rectangle with rounded corners.

- Your drawing should be about twice the size of the drawing on the right. It is drawn to a scale of 2:1.
- Sketch a guide box. Do not use a ruler. Use light guidelines.
- Mark the corners with feint lines.
- Make the corners round.
- Now make the outline thicker.

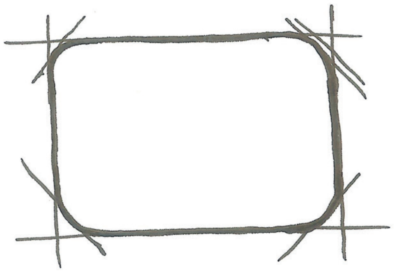


Figure 12

Homework

1. Sketch a triangle with rounded corners.

- Your drawing should be about three times as big as the drawing on the right.
- Sketch a rectangular guide box without a ruler.
- Mark the centre of one side at B, and sketch lines to the opposite corners.
- Round the corners as you did for the rectangle.
- Make the outline of the triangle with rounded corners thicker.

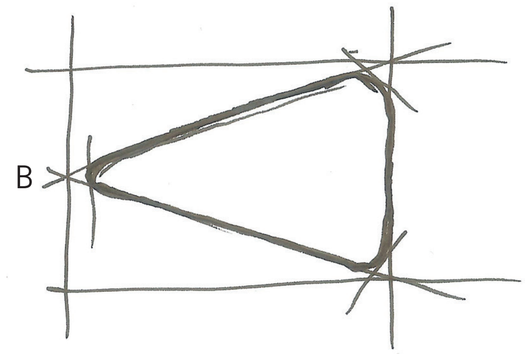


Figure 13

2. Sketch a circle.

- Your drawing should be about four times as big as the drawing on the right.
- Sketch a square guide box. Do not use a ruler.
- Sketch lines from one diagonal corner to the other.
- Mark off the positions C of the centre of each side.
- Mark points D on the diagonals, halfway between the centre and each corner.
- Mark points E halfway between the D's and the corners.
- Sketch a curved line to join up the C's and the E's;:C-E-C-E-C-E-C-E.
- You have sketched a circle. Now make the circle's outline thicker.

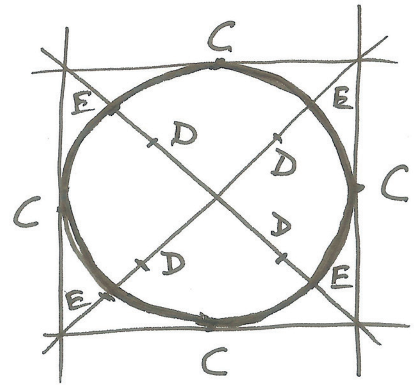


Figure 14

3. Make an accurate 1:4 scale drawing of a bicycle pump on grid paper.

- A drawing of a bicycle pump is shown on the opposite page (Figure 15). Make a scale drawing of this drawing by scaling it down.
- If possible, use square grid paper with 5 mm spacing between lines.
- Use a ruler and make sure you remember the different line types.

Remember:

To **scale down** means to make a drawing smaller than the actual object.

To **scale up** means to make a drawing bigger than the actual object.

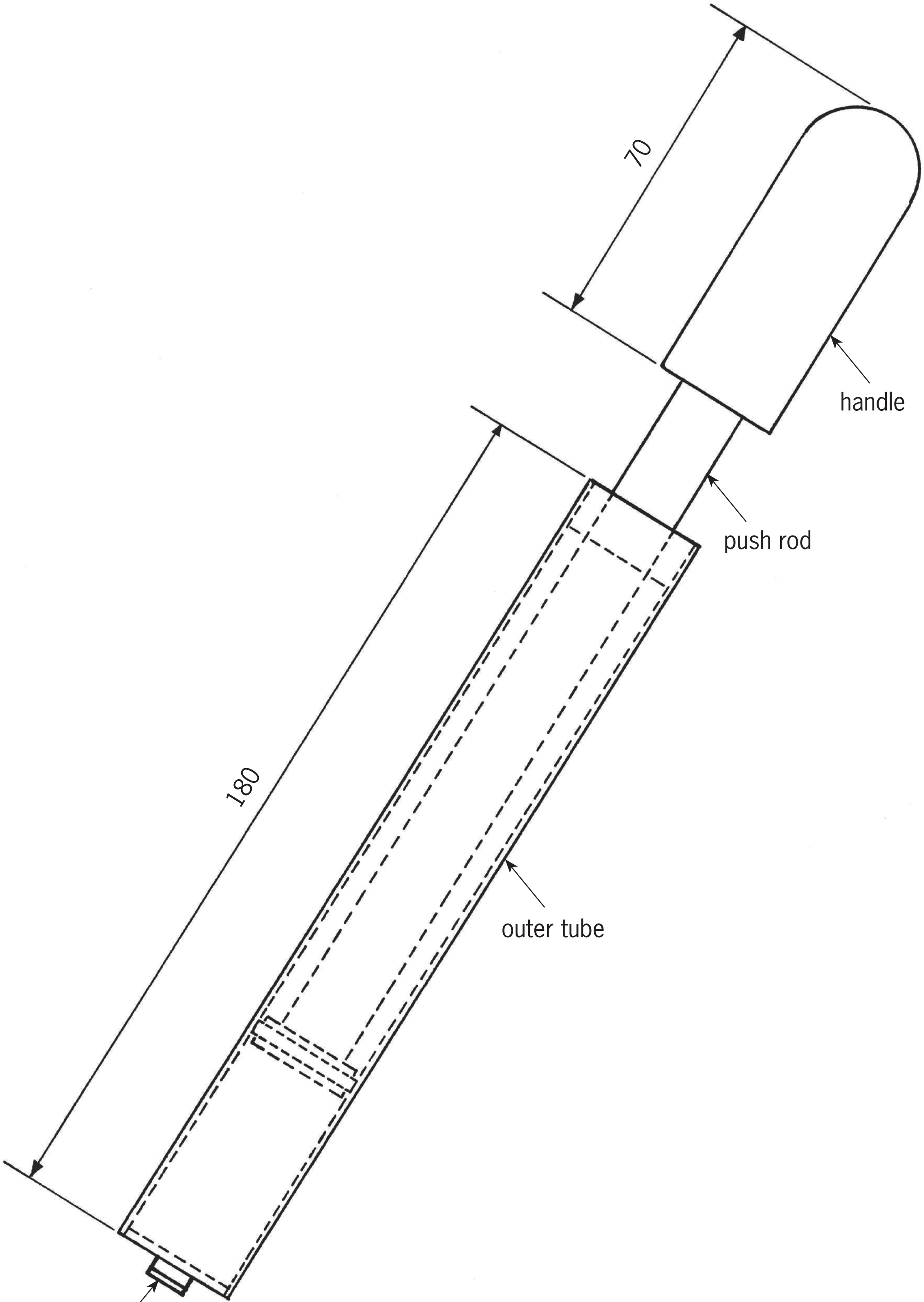


Figure 15: A bicycle pump

4. **The drawing below shows the front view of a house. Make a bigger drawing of the front view of this house.**

   Note the following:

   - The 6 m length of the real house should be 60 mm on your drawing.
   - Show the height of the side wall using a dimension line on your drawing.
   - Show the height to the top of the chimney.

Front view of house

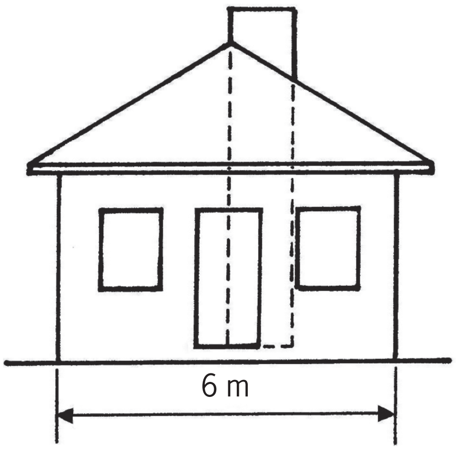


Figure 16

Next week

Next week, you will learn how to make drawings that show more than one side of an object.

Chapter 3
Draw what you see

In this chapter, you will learn how to make two types of drawings. Drawings help us to show others what our ideas look like. Drawings also help us to evaluate our ideas, to become aware of problems and to develop solutions.

Figure 1

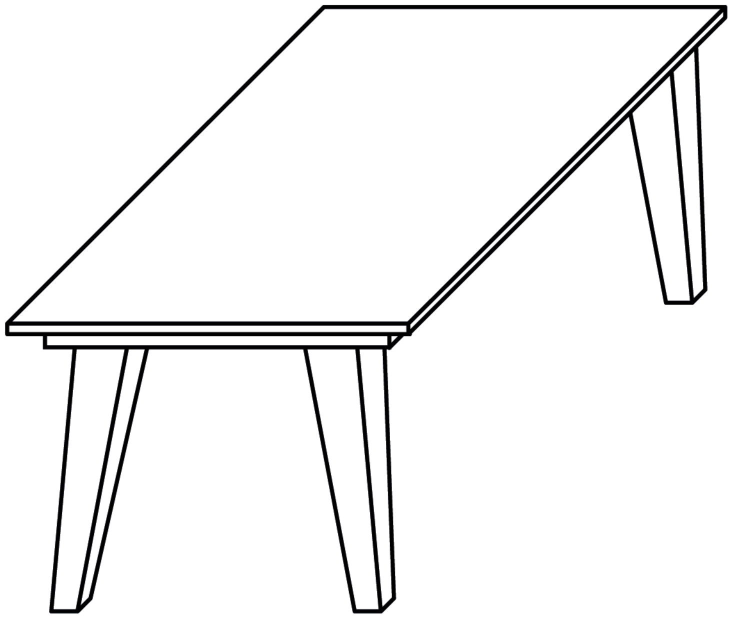


Figure 2 (Drawing A)

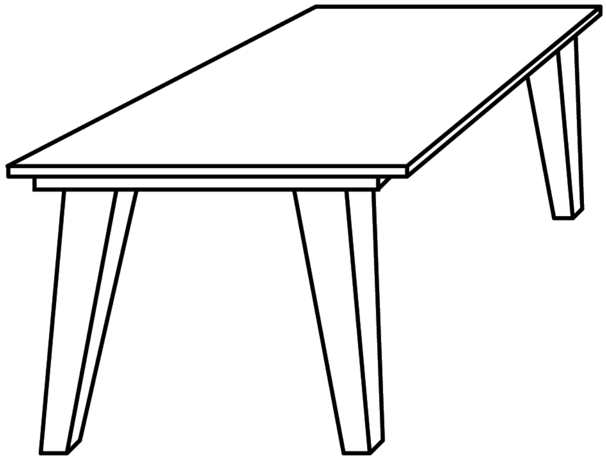


Figure 3 (Drawing B)

3.1 Two types of drawings

Study the diagrams and answer the questions

1. Look at drawings A and B. Do you see drawings of two different tables, or two different drawings of the same table? Take your time and think carefully before you answer.
2. Now look at drawing C and drawing D below. Which one is a smaller version of drawing A? Explain why you say so.
3. How do drawings A and B differ?

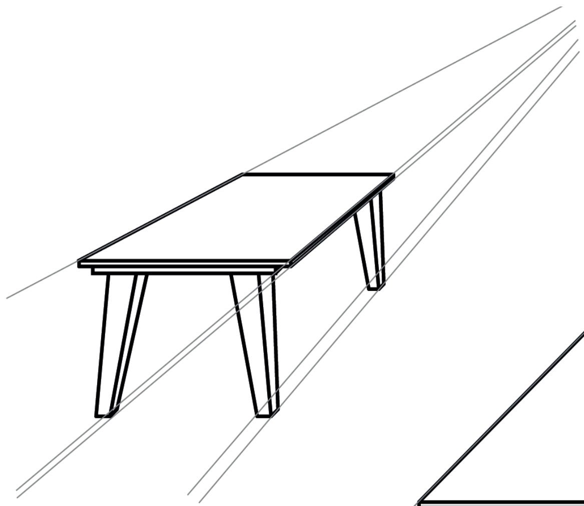


Figure 4: A perspective drawing (Drawing C)

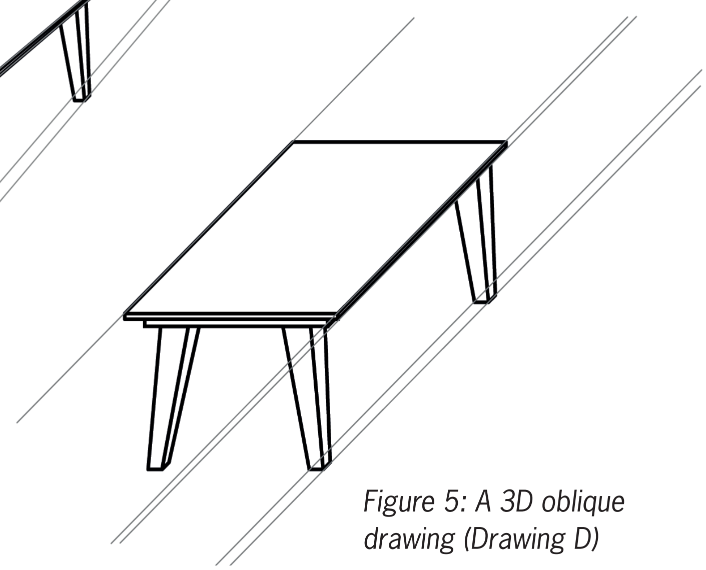


Figure 5: A 3D oblique drawing (Drawing D)

Drawings such as Figure 4 (drawing C) are called **perspective** drawings, or **3D artistic** drawings. In a perspective drawing, the artist tries to show what she actually sees. You cannot take accurate measurements from perspective drawings.

Drawings such as Figure 5 (drawing D) are called **3D oblique** drawings. They do not look the same as what you actually see when you look at the object. We can take measurements from 3D oblique drawings.

In the next lesson, you will make 3D oblique drawings.

3.2 3D oblique drawing

Make a 3D oblique sketch

The steps below guide you to make a good 3D oblique sketch of a stove.

It is easier if you begin by drawing a box in the shape of the stove.

Do not use a ruler.

1. To draw a box, first draw a rectangle to show the front of the box, as shown in step 1 below.
2. Draw another rectangle of the same size as shown in step 2 below.
3. Now draw slanted lines as in step 3 to show the edges of the box that go from the front to the back.

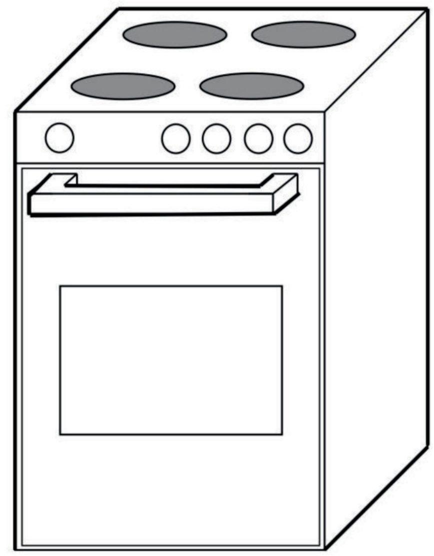
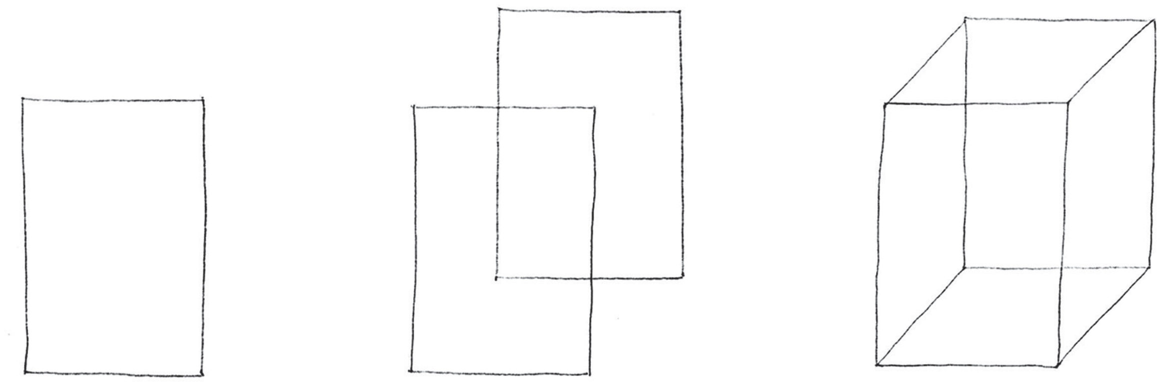


Figure 6



step 1 step 2 step 3

Figure 7

The word **sketch** is often used to indicate a drawing that is made without a ruler or other drawing instruments.
Instead of saying sketch, you could say **free-hand drawing**.

Turn your box into a stove

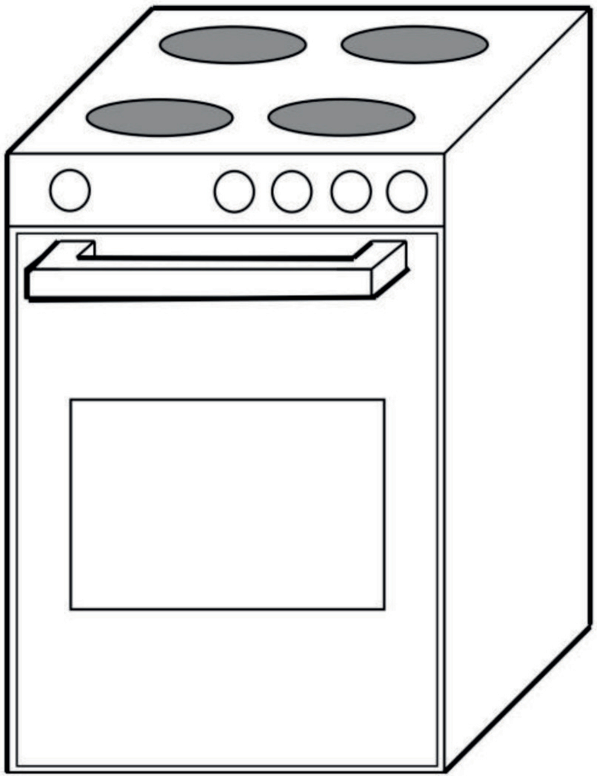


Figure 8

Now see if you can turn your box into a stove. Here are some tips:

- The plates on the stove top are circles. On a drawing like this, they will be squashed circles (ellipses).
- The circles for the knobs are real circles. This is because everything on the front of the drawing is the same as it is in real life.
- Look at how the handle is drawn. It comes out of the front face. To do this, use slanted lines coming forward.
- Make all lines that you can see on the objects thick.

Something to do at home

3D oblique drawings are easier (and more accurate) to make on grid paper, like the one in Figure 9.

Use grid paper to make a better drawing of the stove.

Accurate 3D oblique drawing

Figure 9 shows an accurate oblique drawing of the stove.

1. Write down the length, height and breadth of this stove.
2. Now measure the length, height and breadth on the drawing with a ruler.
3. What do you notice about the breadth line? Is it drawn to the same scale as the length and height lines?

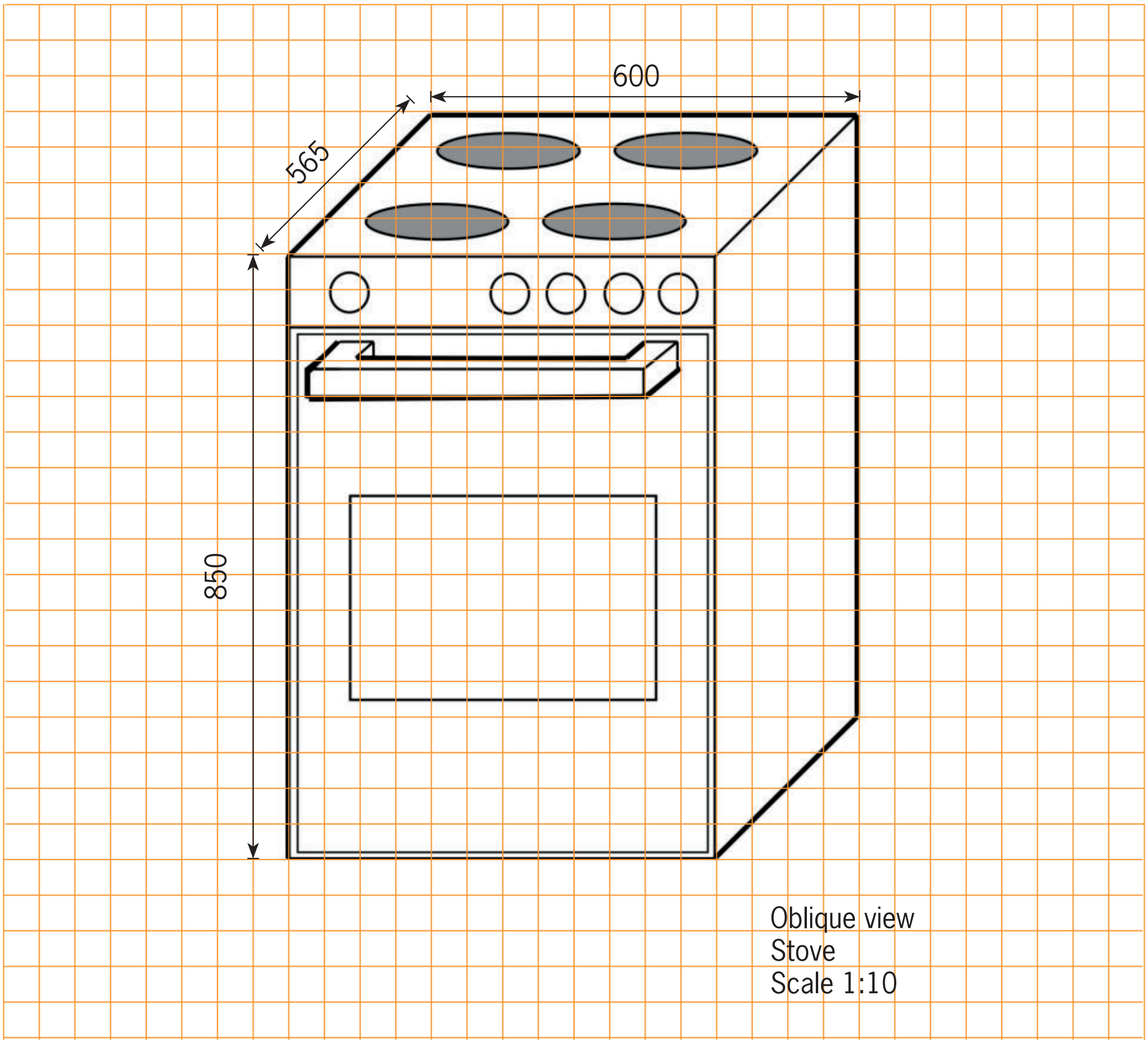


Figure 9

A few important things about oblique drawings

For the front view of an oblique drawing, we use true scale measurements. So, if the length of the object is 600 mm and the scale is 1:10, you will draw the length as 60 cm (600 mm).

But in the sloping breadth direction, you must halve the true scale measurement. So if the breadth is 565 mm and the scale is 1:10, you must draw the breadth line as 282,5 mm or 28,25 cm.

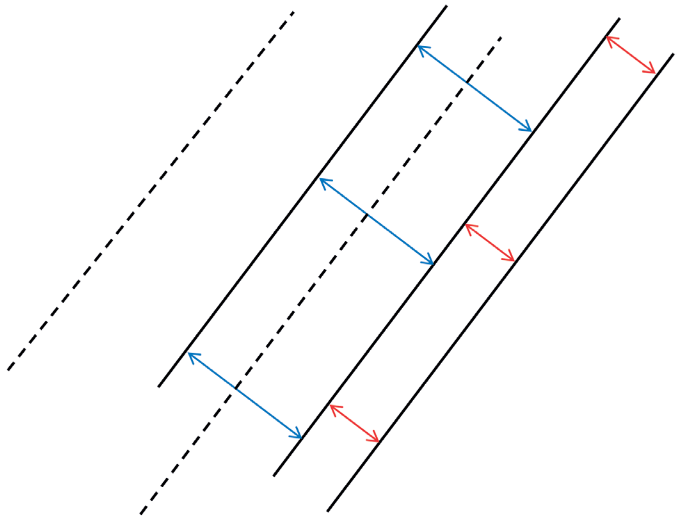


Figure 10

4. Use grid paper. Make an accurate 3D oblique drawing of the stove, with scale 1:5.

In 3D oblique drawings, all lines in the breadth are **parallel**, as shown in Figure 10 above.

3.3 Perspective drawing

When we see something far away, it looks small. When you are close to an object, it looks big.

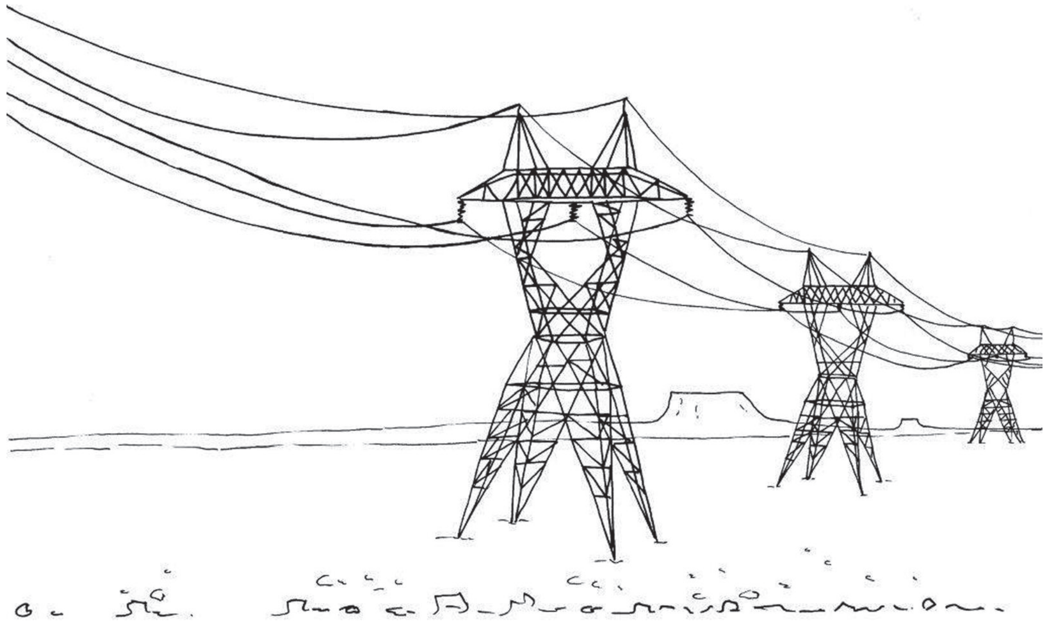


Figure 11

A 3D drawing that shows things getting smaller into the distance is called a **perspective drawing**.

Look at this sketch of a fence and a railway line. They have been drawn going into the distance.

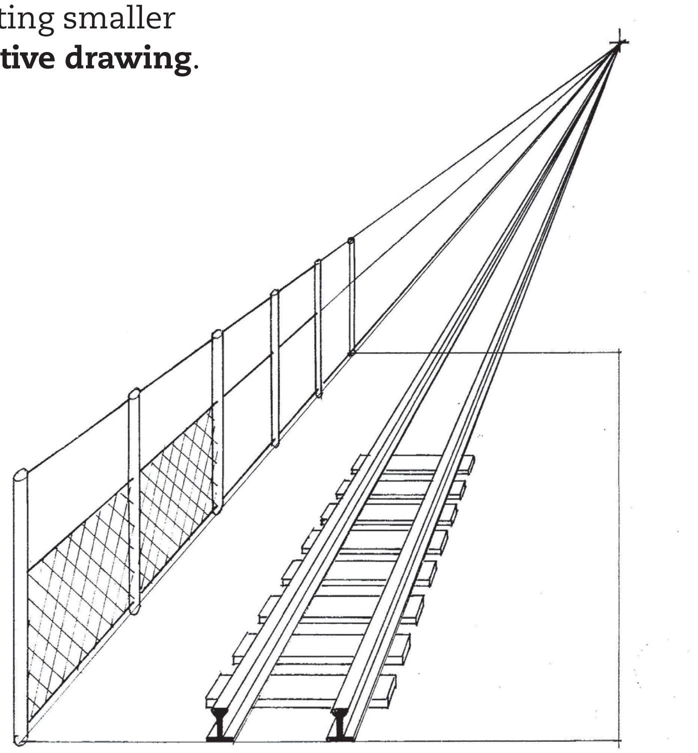


Figure 12

Follow the steps to draw a fence

1. Starting at the bottom left-hand corner of a sheet of paper, draw a fence post. This will be the tallest post because it is the one closest to you.
2. In the top right-hand corner of the page, draw a point. This point is called the **vanishing point (VP**). It represents a distance so far away that you can no longer see the height of the object.
3. From the top of the front post, draw a thin guideline to the vanishing point (VP). You can use a ruler for this.
4. From the bottom of the front post, draw another thin guideline to the vanishing point.
5. Draw a second post behind the first. The bottom of this post must start at the bottom guideline and it must stop at the top guideline.
6. Carry on drawing more posts going backwards into the distance.
7. Keep in mind that the posts will look as if they are getting closer and closer together.
8. Now add some crossing lines to represent the fence wire.

Follow the steps to draw a matchbox in perspective

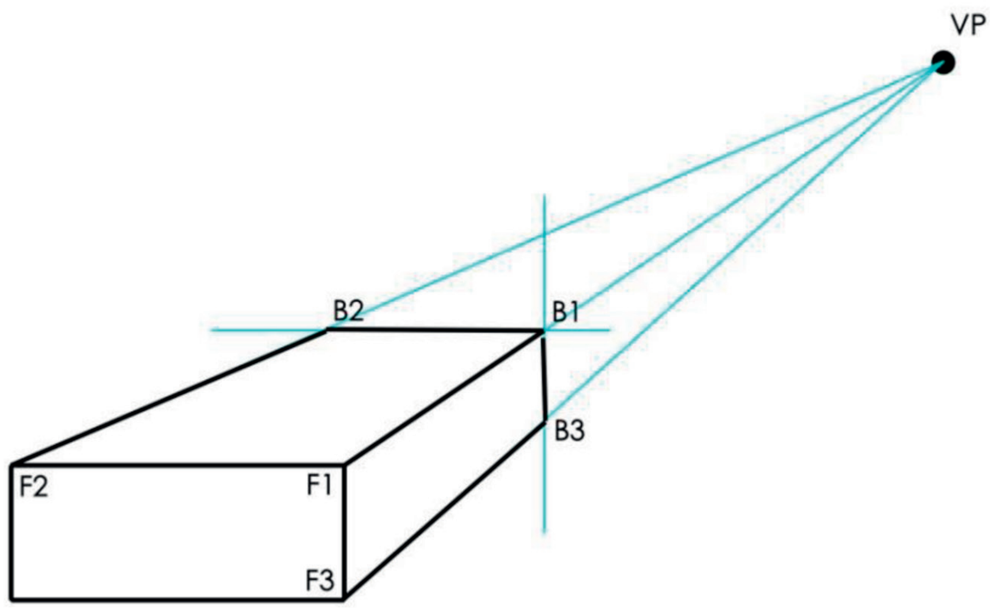


Figure 13

1. In the bottom left-hand corner of a sheet of paper, draw a rectangle to represent the front of the matchbox.
2. Mark the vanishing point.
3. From each corner of the rectangle, draw a thin guideline to the vanishing point. You can use a ruler.
4. Moving back along the guideline from the vanishing point, mark off a point (B1), which makes the breadth of the matchbox look right.
5. From this point (B1), draw a **vertical** line down to the bottom guideline. This is the side edge at the back of the matchbox.
6. From the same point (B1), draw a **horizontal** line towards the left-hand guideline. This will represent the top edge at the back.

Perspective drawing with texture and shading

Look at the open matchbox in Figure 14. Thick and thin lines have been used to make the edges stand out. Try to do this on the matchbox you have already drawn, or on a new drawing.

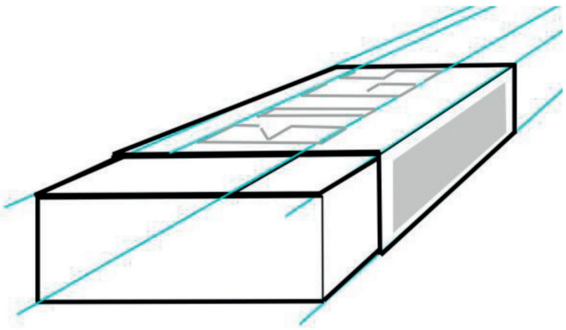


Figure 14

Now draw an open matchbox using single vanishing point perspective.

Add more shading, and even colour

When a surface is flat, the whole surface looks as if it is the same colour. However, some surfaces look darker than others, depending on where the light is coming from.

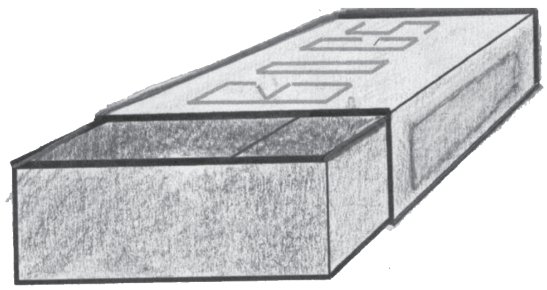


Figure 15

To shade a box so that it looks 3D, draw a new box and do the following:

- Colour the front, top and side surfaces lightly in one colour. You can use a pencil or a coloured pencil.
- Choose the face that will be the second darkest. Colour this surface a second time.
- Choose the face that will be the darkest. If the light is behind the drawing, this will be the front face. Then lightly shade this surface two more times, so the darkest face will have been coloured three times.

Next week

Next week, you will learn about mechanical systems. You will explore how levers work to make it easier to move things.

Chapter 4
Push and lift objects

In this chapter, you will learn about ways in which people manage to do things that they cannot do with their bodies alone.

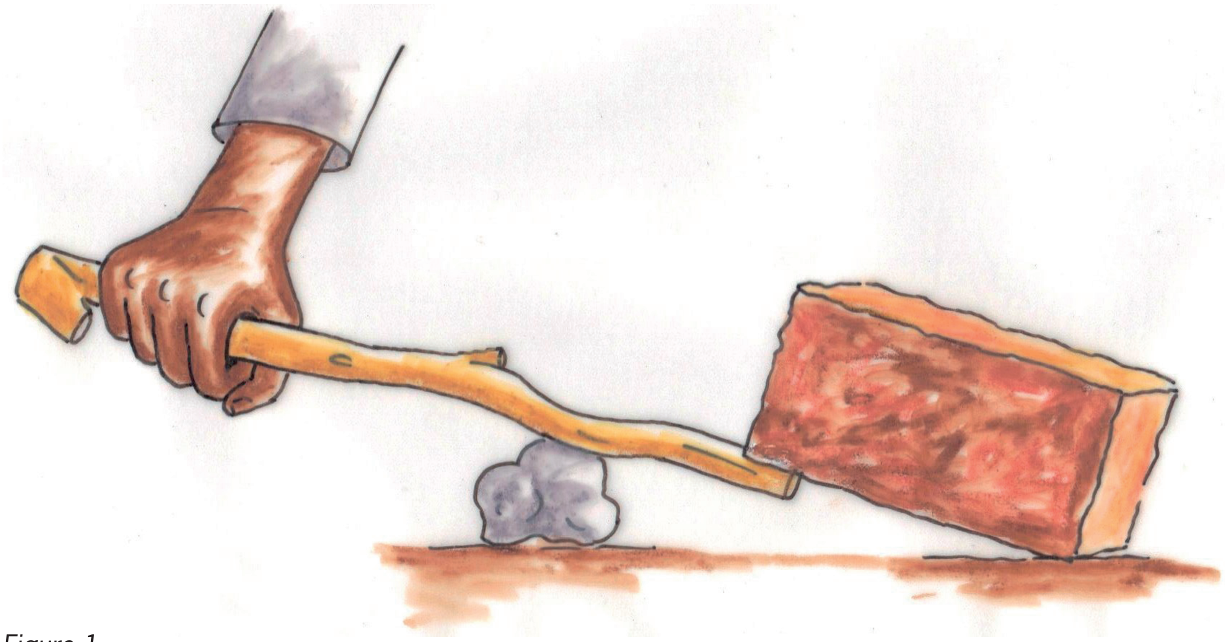


Figure 1

Special projects

If you have time to spare in class or at home, try these activities:

1. Build a working model of the water lever in Figure 2 on the next page. If you can make it in the next two days, you can use it in lesson 4.3.
2. Look carefully at the coloured pictures on the next page. Try to see what properties of levers can be seen in the pictures. In your workbook, write captions for the drawings that explain what they show.

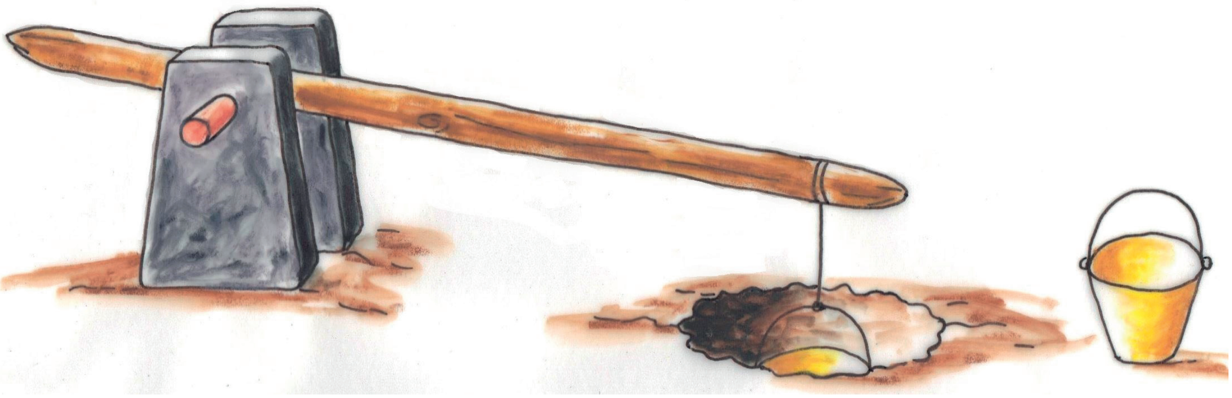


Figure 2

Figure 3

4.1 Lift things with a lever

Explore three different ways to use a lever

In the pictures below, Tom tries to lift one side of a block of concrete with a **lever**. The pictures show three different ways in which he can try to do so.

1. Which way do you think will work best, and why do you think so?

The lever rests on a small stone and will turn on the stone. When Tom pushes the one end of the lever down, the other end pushes the concrete block up.

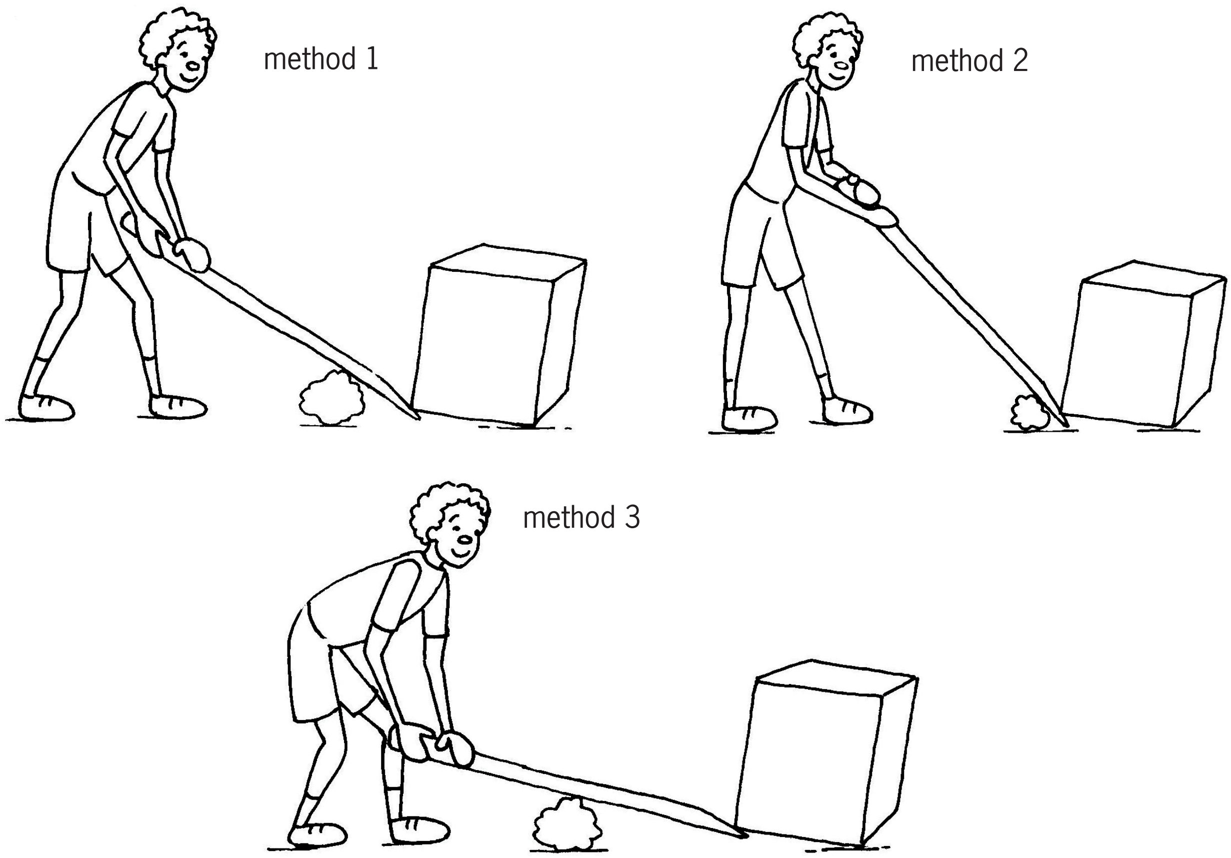


Figure 4

2. Describe what is different about the lever in each of these three cases.

Join two classmates and work with a lever

You need three things for this activity:

- a stick of about 30 cm long, that can be used as a lever,
- a brick or a stone about the size of a brick, and
- something on which the lever can be supported.

Now do the following:

Use the stick as a lever to lift one side of the brick.

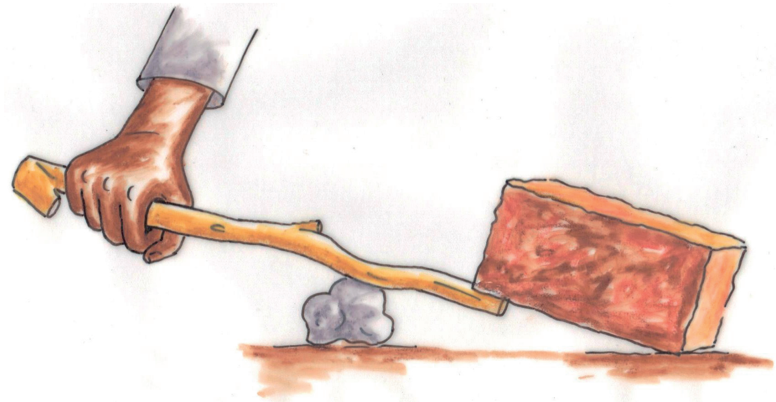


Figure 5

The point where the stick is supported by the brick or stone is called the **fulcrum**. The fulcrum can also be called the **pivot point at which the lever is supported**.

To **pivot** means to rotate freely.

Note that there can be **pivot points that do not support levers**, but merely allow linked/connected parts to move. For example, a door hinge is a pivot point, which allows the door to rotate (to pivot) around the point where it is linked on the door frame. **That pivot point is not a fulcrum, because it does not support a lever.**

Take turns to use the stick as a lever to lift the one end of the brick. Do it with different positions of the fulcrum, so that you can answer the question below.

3. When does the lever help you most? Is it when the fulcrum is close to the brick or when it is far from the brick?

If you did not do the activity above, do this:

Put your pencil against the edge of a book and try to lift the one side of another book up, as shown in the picture below.

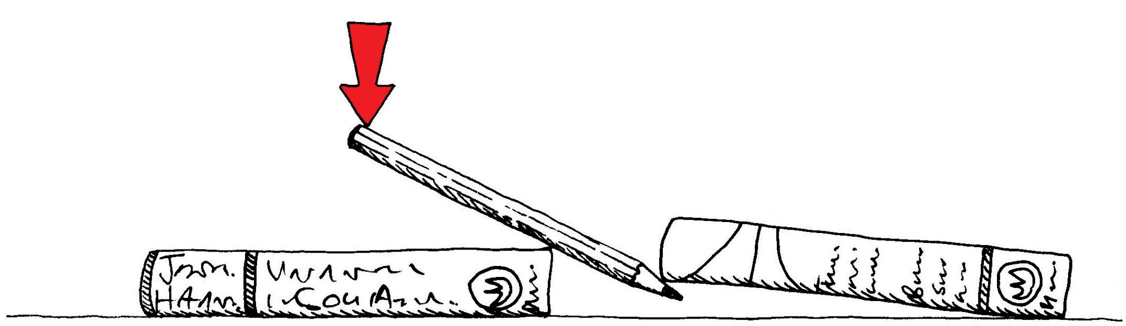


Figure 6

Do this with the edge of the book on the left in different positions below the pencil.

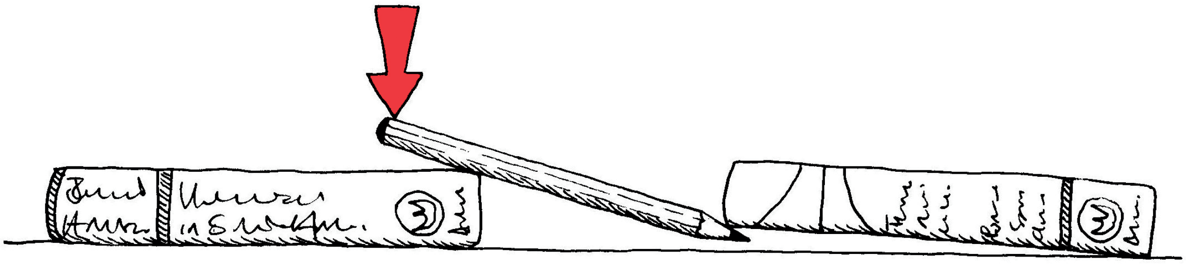


Figure 7

4. In which position of the fulcrum does the pencil give you the greatest "advantage" for lifting the book?

In this case, the word "advantage" means that the lever makes it easier for you to lift the object.

When something is too heavy to lift by hand, you can use a lever to help you lift it. If you want to lift a heavy object, you should use a long lever and the fulcrum should be close to the object that you want to lift. If you give a soft or weak downwards push on the one side of the lever, there will be a strong upwards push on the object on the other side of the lever.

Scientists and technologists use the phrase "mechanical advantage" to describe this. Figures 8 and 9 show that the lever gives you a greater mechanical advantage when the fulcrum is closer to the brick.

Some words that may be new to you, or are used in a new way, are printed in quotation marks, for example "advantage". This is to tell you that you may not immediately understand the word, but you will learn what it means as you continue.

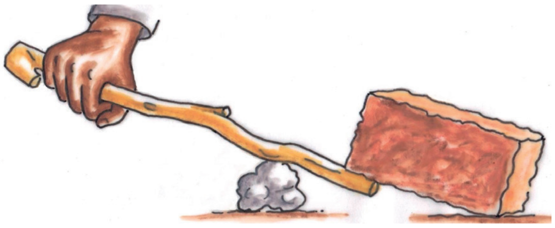


Figure 8: Large mechanical advantage

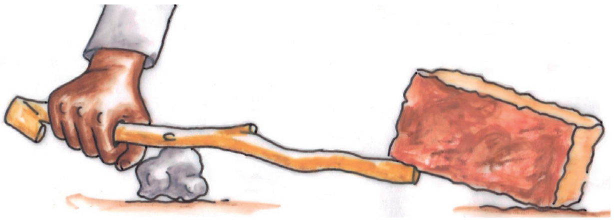


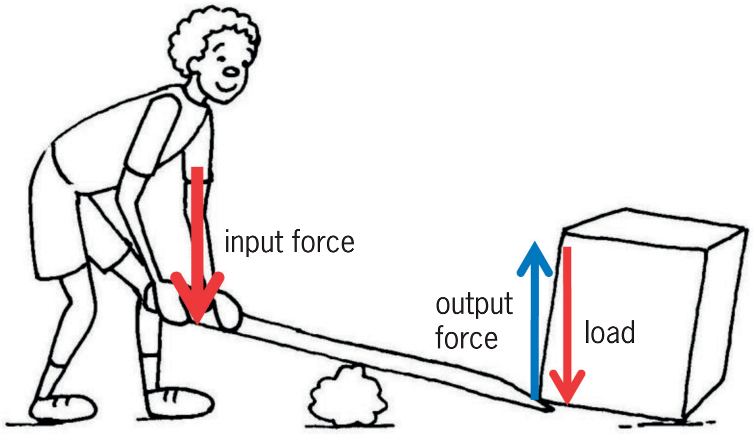
Figure 9: Small mechanical disadvantage

5. Have another look at Figure 4 of this chapter. Which method gives Tom the biggest mechanical advantage when he uses the lever?

The downward push that Tom makes on the lever is called the **input force** or **effort**.

The weight of the concrete block that tries to keep the other end of the lever down is called the **load**.

The upward push on the load is called the **output force** or **effect**.



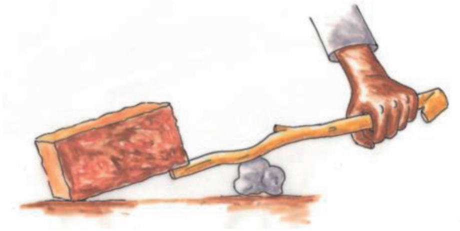
A lever like this where the fulcrum is between the input force and the output force, is called a **first-class lever**.

Figure 10

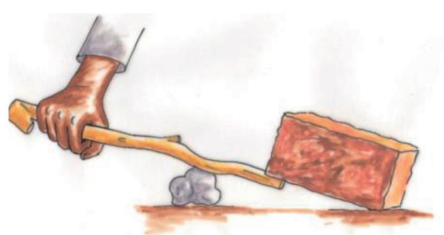
When you use a lever to lift an object, the push on the object may be stronger than, equal to or weaker than your input force.

6. Where is the input force, the load and the fulcrum in each situation below?

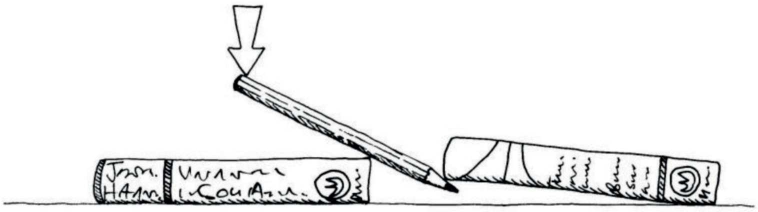
(a)



(b)



(c)



(d)

Figure 11

- The output force may be smaller than the input force. In this case, technologists say the mechanical advantage is smaller than 1. This is actually a mechanical disadvantage.
- The output force may be bigger than the input force. In this case, technologists say the mechanical advantage is greater than 1.
- If the output force is equal to the input force, technologists say the mechanical advantage is 1.

Important: Something you need to do at home

Bring a box or two pieces of cardboard that are at least as big as an A4 sheet of paper to your next Technology class. You will need this to make a cardboard lever and to do a few experiments.

It helps the environment if you pick up boxes or pieces of cardboard and other trash that lie around in the street, so pick them up and help to keep our streets clean!

4.2 Move things without touching them

A lever can turn around the fulcrum. We also say the lever "pivots" around the fulcrum.

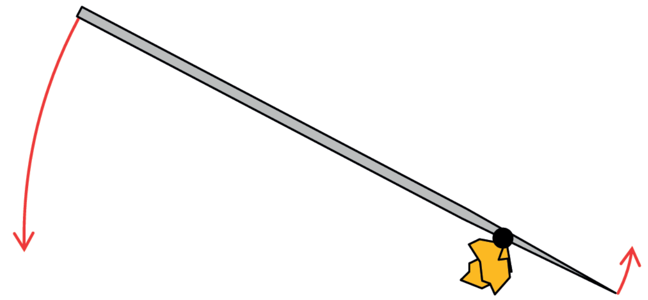


Figure 12

Changing the position of the fulcrum

In the diagrams below, the fulcrum is in different positions.

In each case, state whether the mechanical advantage is bigger than 1, equal to 1 or smaller than 1.

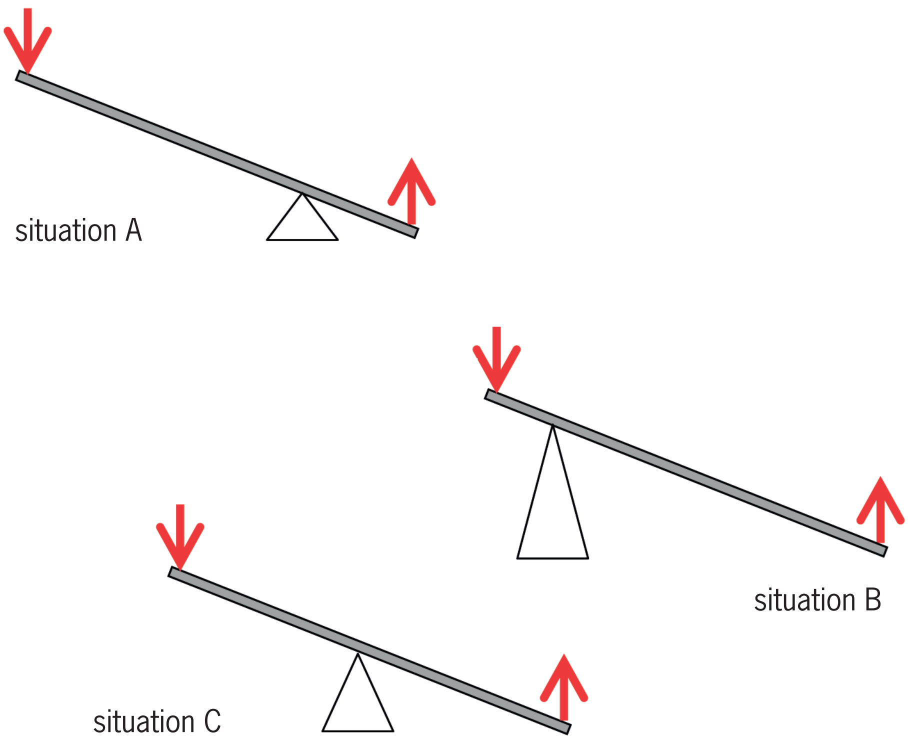


Figure 13

Make a lever with a base

In this activity, you will make a lever that you can use to do a few experiments. Doing the experiments will help you to understand levers better.

Figure 14

1. Find the fulcrum of the lever in the photograph.

If you make your lever from cardboard, you will need the following tools and materials.

Tools:	Materials:
• a pair of scissors, • a sharp pencil or a nail.	• a strip of corrugated cardboard about 30 cm long, • a piece of corrugated cardboard about as big as an A4 sheet of paper, • a sheet of used paper, • a piece of sticky tape, and • a small box or bag with sand or stones inside.

2. Before you start, look carefully at the photo in Figure 14. Make sure you understand how your lever will work.

   Use a strip of corrugated cardboard about 30 cm long and 3 cm wide for the lever. Mark a position for a hole about 4 cm from the one end, in the middle of the width of the cardboard.

You may have construction kits or perforated Masonite available. Use it instead of cardboard for this work. Be careful though and do not limit your opportunities to acquire basic skills by using "easy" materials.

Figure 15

3. Use a sharp pencil to make a hole at the mark.

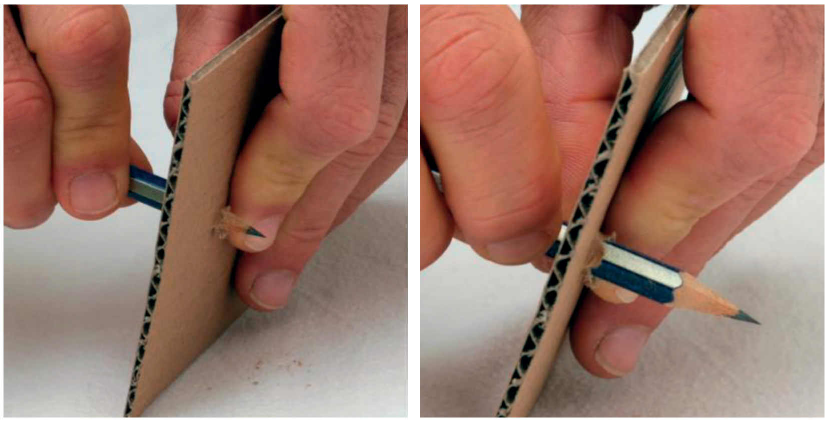


Figure 16

Safety precaution:
Make sure you do not push the pencil into your finger.

4. Make a hole in the sheet of corrugated cardboard, about 8 cm from one end, as shown in the diagram.

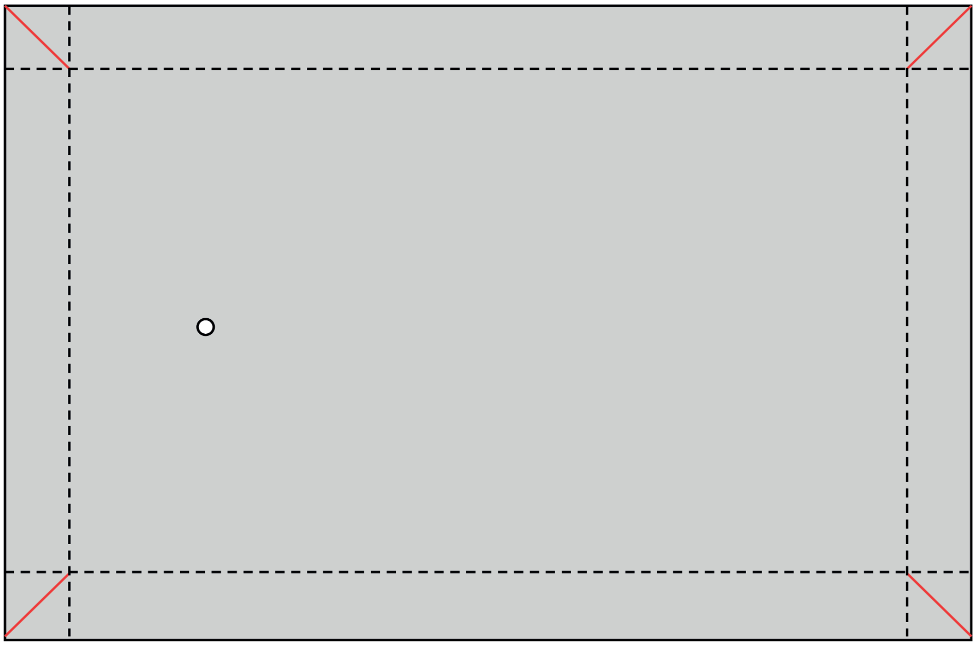


Figure 17

This will be the base to which you will attach your lever.

5. You can use a "paper dowel" to attach the lever to the base. It can act as a pivot around which the lever can swing. To make a paper dowel, tightly roll paper around your pencil as shown below.

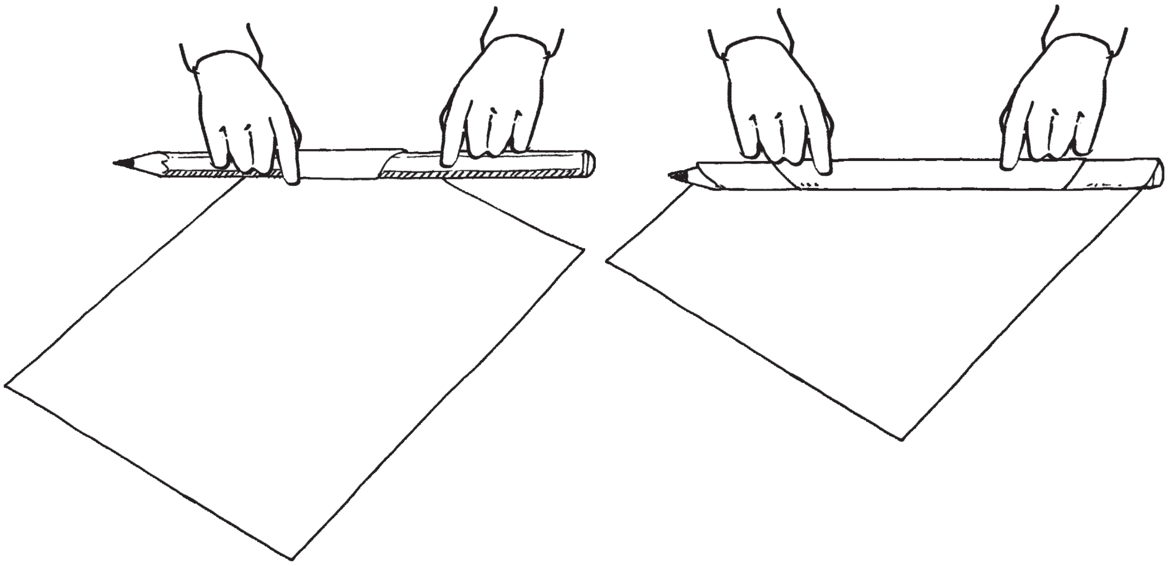


Figure 18

Once you think it is strong enough, cut off the remaining paper.

The holes that you punched into the cardboard strip and sheet will be rough on the one side and smooth on the other.

smooth side of a punched hole

rough side of a punched hole

Figure 19

6. Put the strip on top of the sheet so that the smooth sides of the holes are between the strip and the sheet. Put your paper dowel through the holes so that it connects the strip with the sheet.

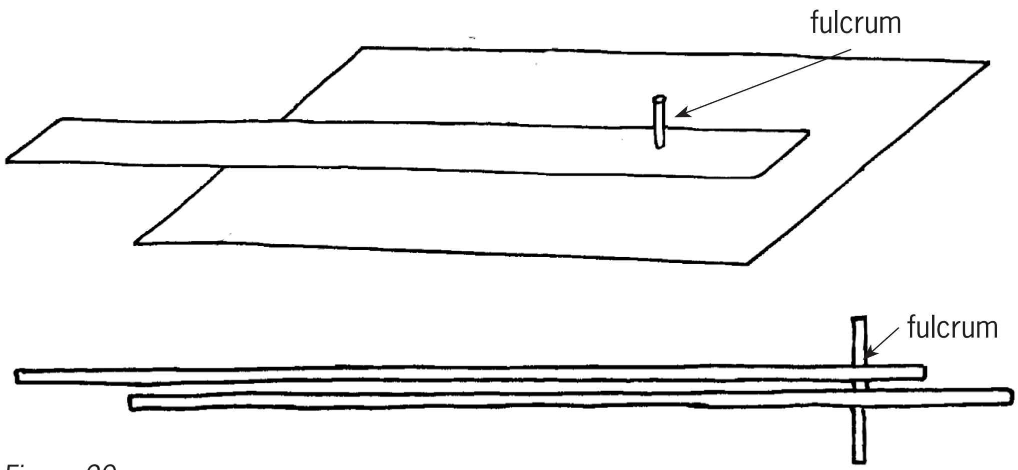


Figure 20

7. Fold the paper dowel over on both sides. Tape it down at the bottom of the support sheet.

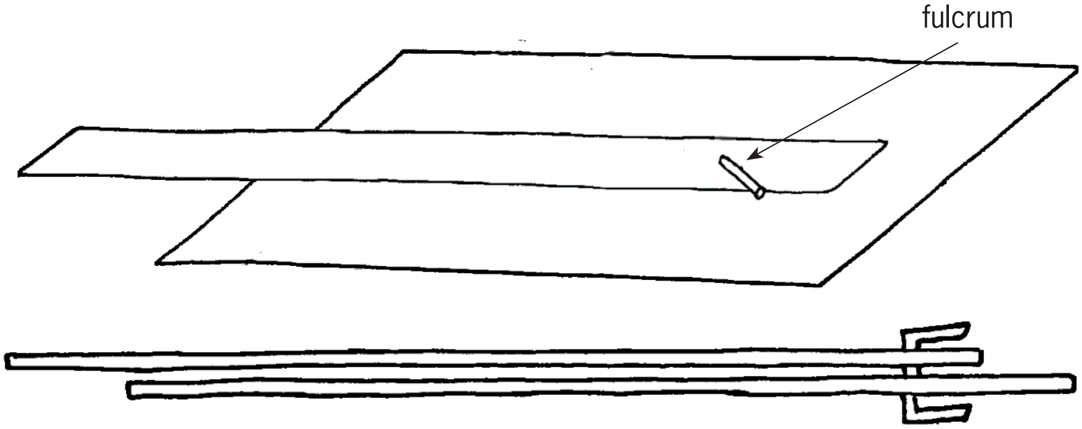


Figure 21

Try to use your lever to move the small bag of sand around on your desk.

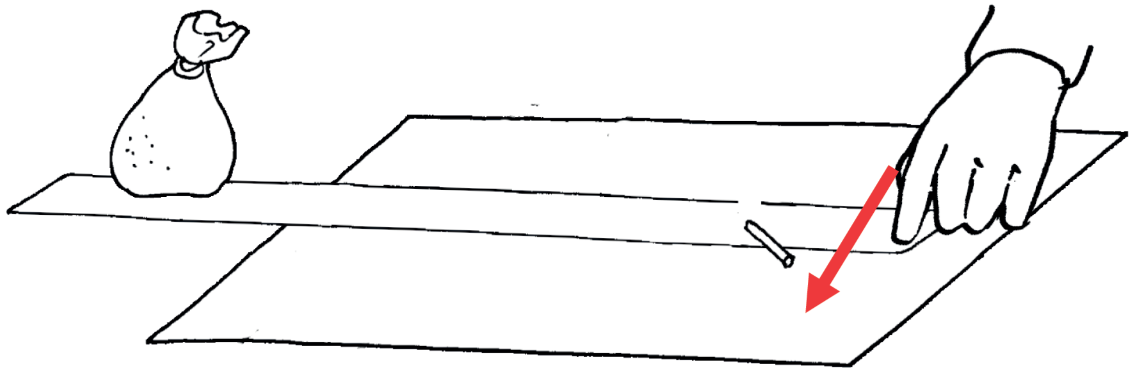
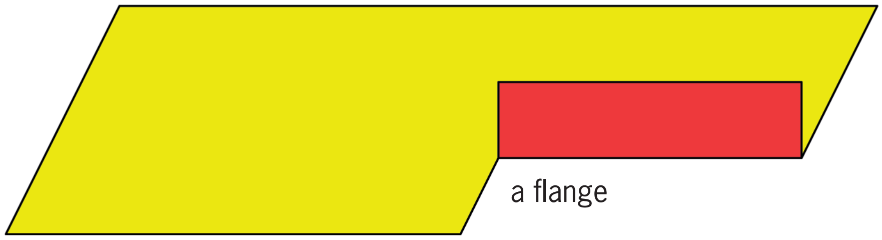


Figure 22

8. It may not work very well. Think a bit, and then describe how you can improve your lever so that it will work better when you want to move the bag around.

Here are two improvements that you could make to your lever:

- You could make cuts and fold the card up to form **flanges** on both sides at each end of the lever. The sketch below shows a piece of paper that is yellow on top and red at the bottom. One cut was made and part of the paper was then folded up to make a flange.



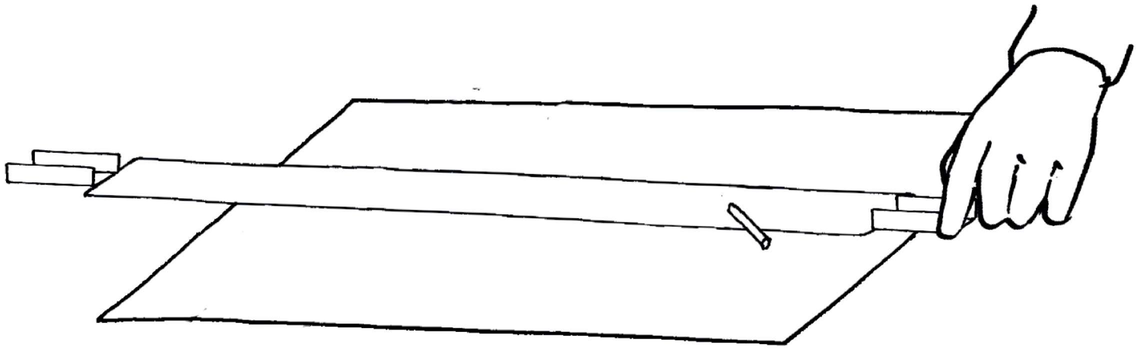


Figure 23

- You could add a paper strip that prevents the lever from lifting up.

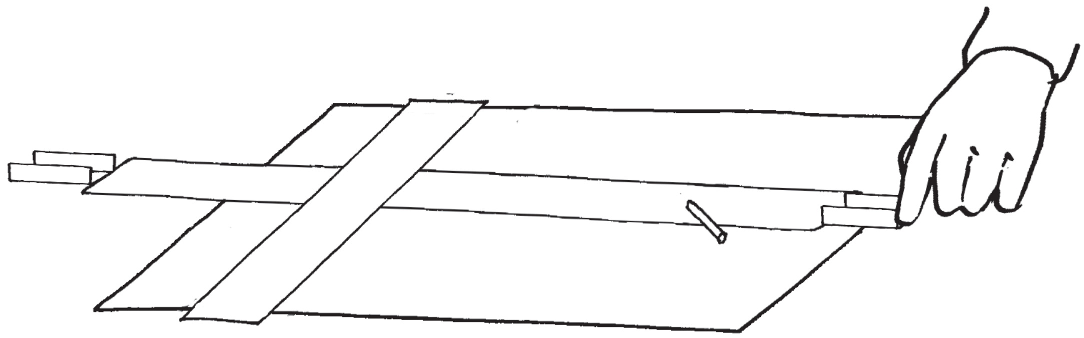


Figure 24

Evaluation and improvement

Technologists evaluate their work all the time. When they see that something will not work well, they change it to make it work better. When you do your PAT later this term, you will design a device that works with two levers. You will make a working model of your design. When you do that, you should also evaluate your design all the time. Look for opportunities to improve your design and your working model.

You can improve your lever on a base by adding “spacers” to keep the lever some distance from the base.

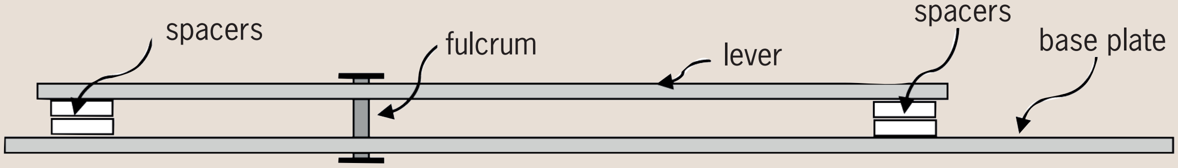


Figure 25

You can cut the spacers from the same cardboard that you used for the lever.

You can glue them to each other and to the lever. It may even be better if you add spacers at the fulcrum too. You will have to cut holes in your spacers, so that the peg or dowel can pass through the holes.

Round spacers with holes in the middle are called washers. Washers are often used when things are tied together with bolts and nuts.

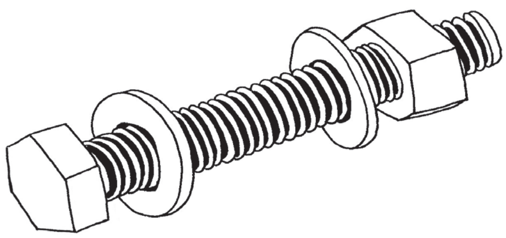


Figure 26

4.3 Do different things with levers

Changing the direction of movement

Levers can be used for reasons other than to gain a mechanical advantage. When you sweep the floor with a broom that has a long handle, you use the broom as a lever. The long handle makes it possible to sweep over a large area while moving your hands only for a short distance. In this case, the lever (the broomstick) gives you a **distance advantage**, although there is no **mechanical disadvantage**.

Levers also change the **direction** of movement. If you push the one end of the blue lever below down, the other end moves up.

Figure 27

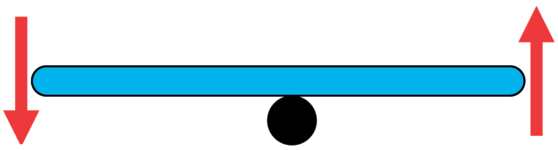


Figure 28

In the above case, the output movement is in the opposite direction than the input movement. Links and guides can be used, as shown in the diagram below, to control the change of direction of movement caused by a lever.

The blue bar on this diagram indicates a lever that pivots around the fixed/ stationary point O. The yellow bar is a rod that can be used to push end A of the lever. The red bar can only move between the two black strips. The black dots at A and B indicate links (for example dowels that fit loosely in holes), around which the yellow, blue and red rods can pivot.

If the yellow rod is pushed in the direction of the blue arrow, in what direction will the red rod move?

If you wish, you may build a system like this from cardboard.

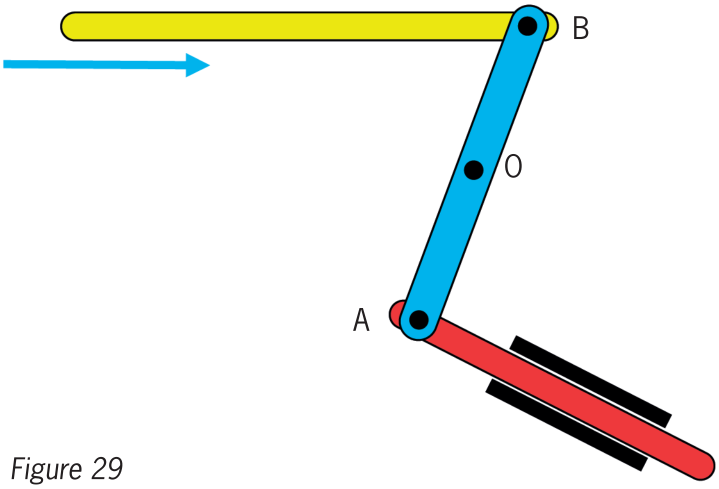


Figure 29

Evaluate a design

Simon wants to build a device that will help him to lift heavy objects. His idea is to drive one lever with another lever, so that he can have a big mechanical advantage. He made this drawing of his design.

Do you think Simon's design will work?

Write down why you think it will work, or why you think it will not work.

Also suggest how he can improve his design.

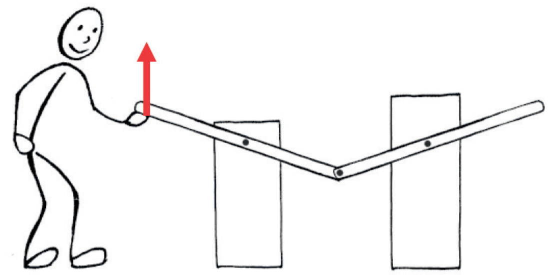


Figure 30

Redesign a water lever

> Have another look at Figure 3. It shows a big lever that lifts buckets of water out of a well.
>
> Strong, young people can easily push the lever down at the short end to lift a bucket of water out of a well, but people who are older or sick are less strong, and find it very difficult to do this.

How can this lever be redesigned so that it becomes easier to lift a bucket of water?

Next week

In the next chapter, you will learn more about effort and load, and how the fulcrum can be changed around to make other types of levers. You will also learn more about other types of levers.

Chapter 5
Other classes of levers

In this chapter, you will learn about two more types of levers, which are also called classes of levers. In first-class levers, the fulcrum is somewhere between the effort and the load. In the other two classes, the fulcrum is at one of the ends.

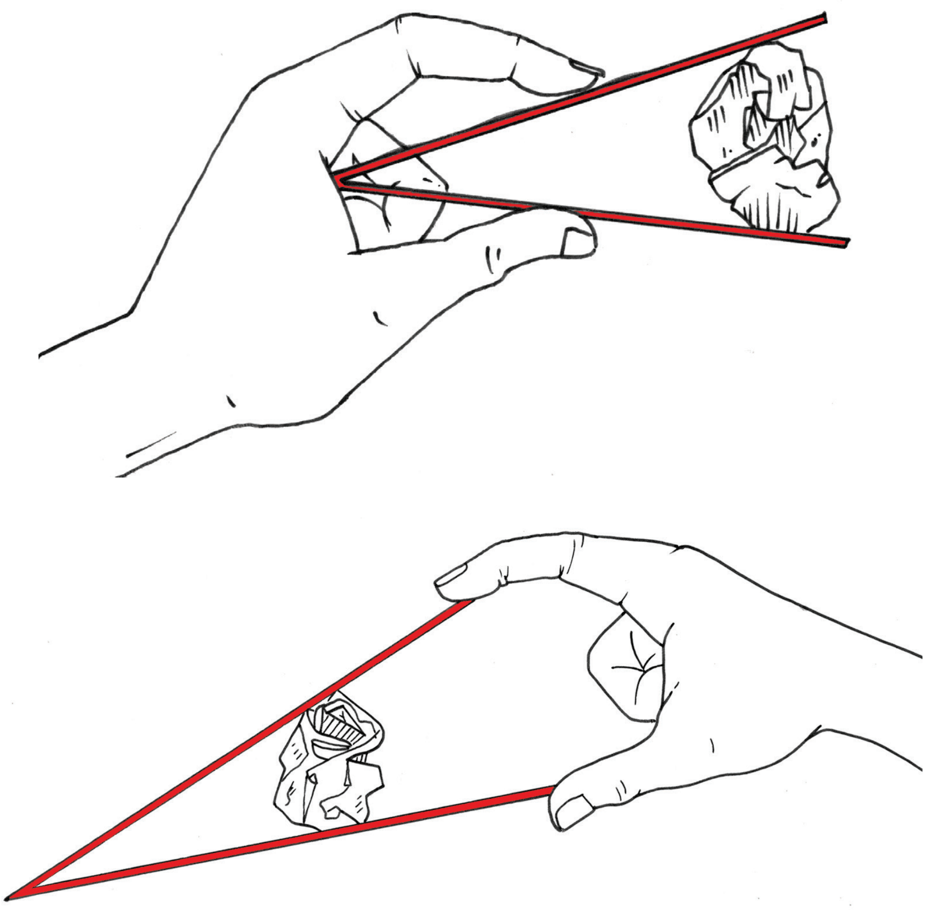


Figure 1

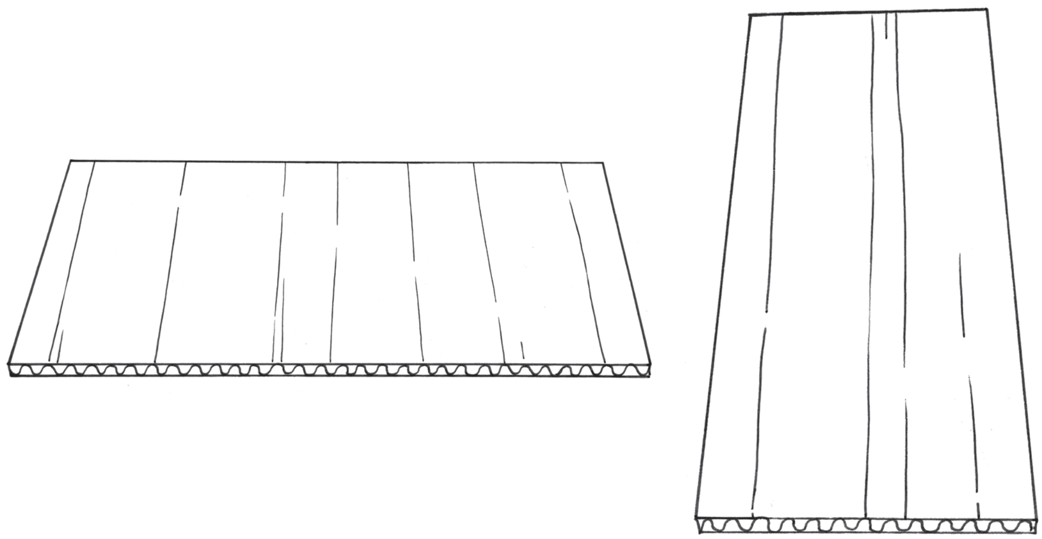


Figure 2: These pictures show two corrugated cardboard sheets of about 20 cm long and 10 cm wide. One of the pieces has the corrugations over the width, and the other piece has the corrugations over the length.

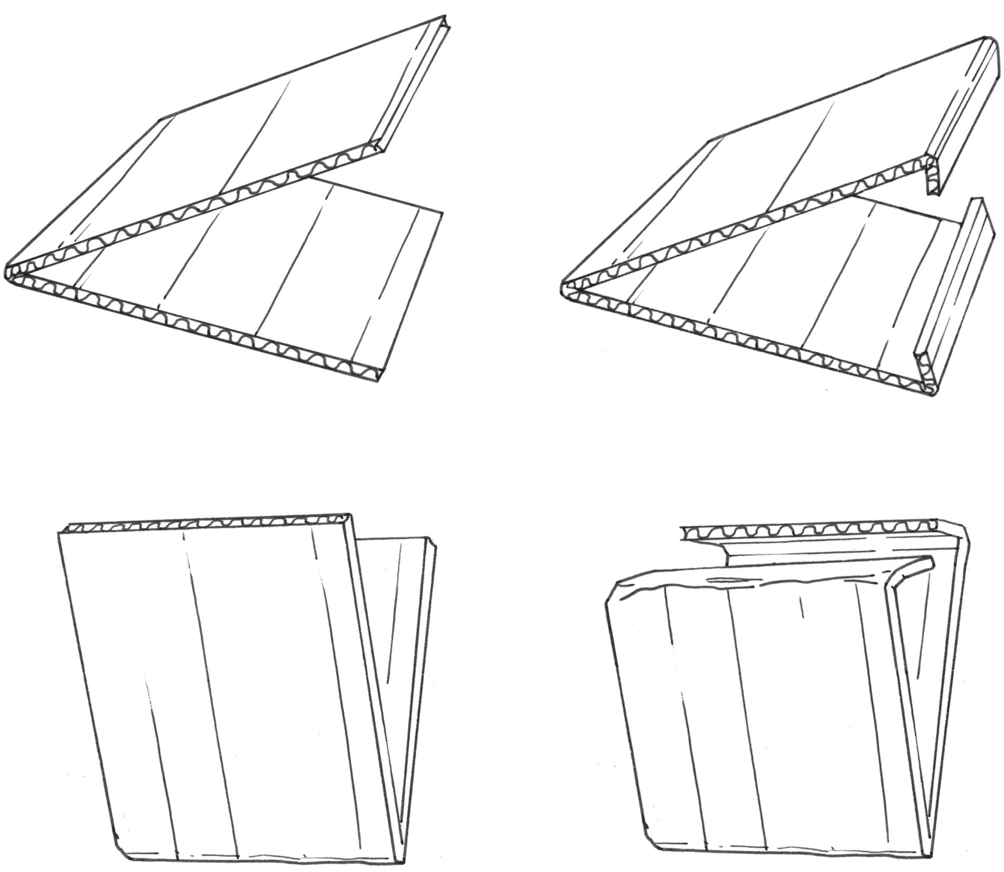


Figure 3: Both pieces are folded in the middle to form springs. The edges are folded to form flanges.

5.1 The three classes of levers

Lift your finger in three different ways

Put your pencil on the desk in front of you.

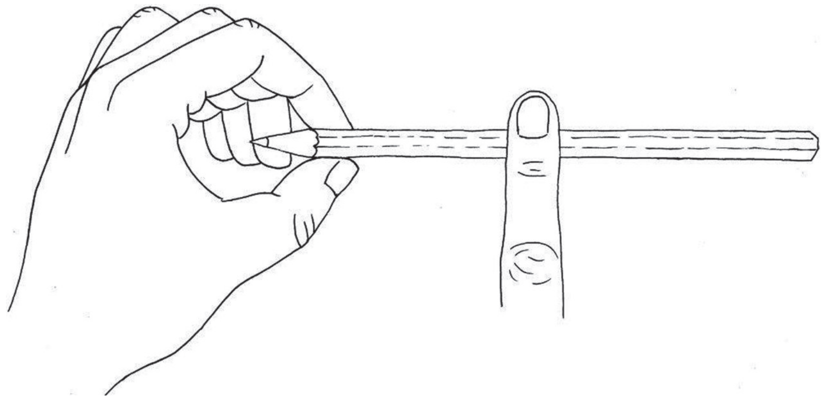


Figure 4

Press the pencil down in the middle with your right index finger. Now try to lift your index finger by lifting the pencil at its point with your left hand, as shown below. When you do this, the pencil acts as a lever.

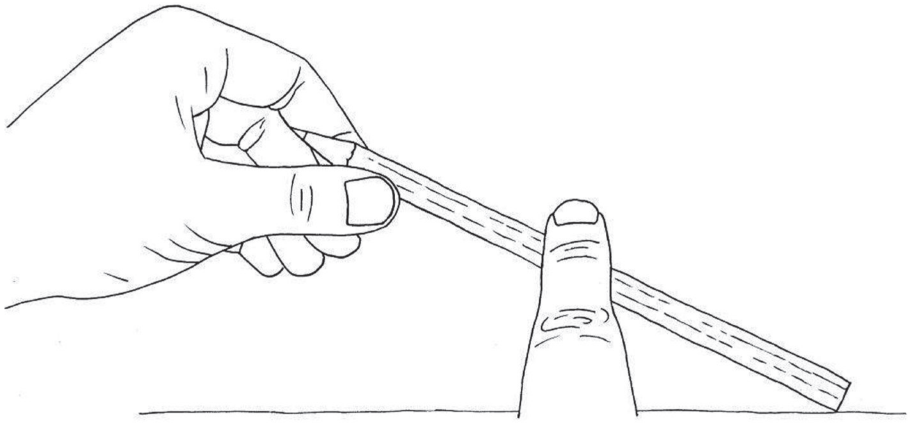


Figure 5

1. The fulcrum of the lever is at the right end of the pencil, where it rests on the desk. Where will the input force on the sketch above be? Where is the load?
2. In Figure 5, the input force is at one end of the lever, and the fulcrum at the other end. How is a first-class lever different from this?

Press the pencil down at the point with your right index finger, and try to lift your finger by lifting the pencil in the middle with your left hand, as shown below.

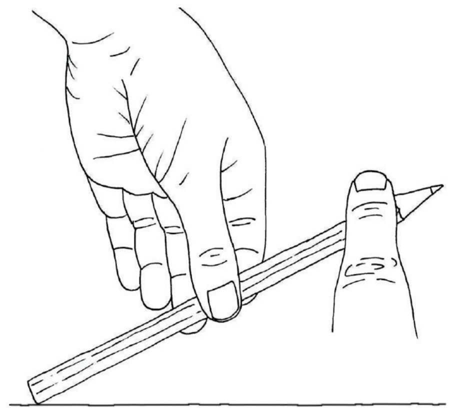


Figure 6

3. The fulcrum of the lever is at the left end of the pencil, where it rests on the desk. Where will the effort be in Figure 6? Where is the load?
4. In the above case, the load is at one end of the lever, and the fulcrum at the other end. How is the situation on the previous page different from this one?

You used the pencil as a **third-class lever** in the above case. On the previous page, you used the pencil as a **second-class lever**.

To use the pencil as a first-class lever, you need to add support somewhere between the two ends to act as a fulcrum.

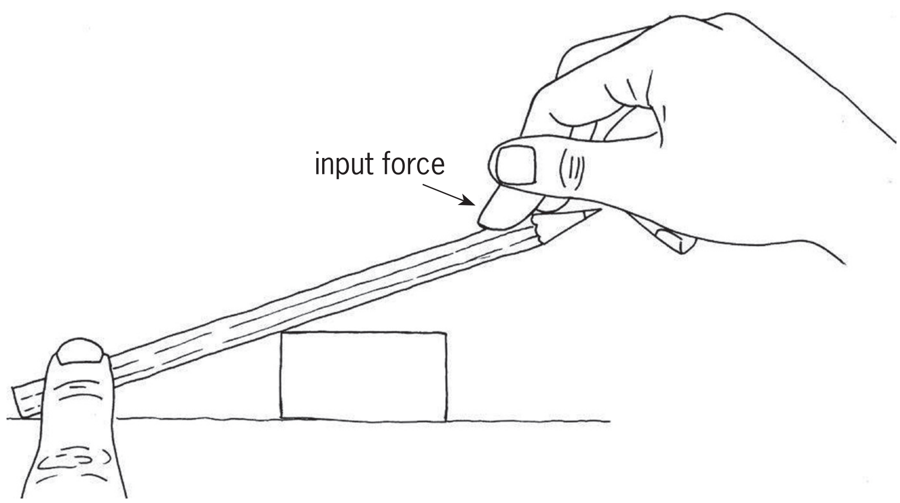


Figure 7

5. Do the experiments from 1 to 4 again. When do you get the biggest mechanical advantage, when you use the pencil as a second-class lever, or when you use it as a third-class lever?

- Levers like this one, where the fulcrum is between the input force and the load, are called **first-class levers**.

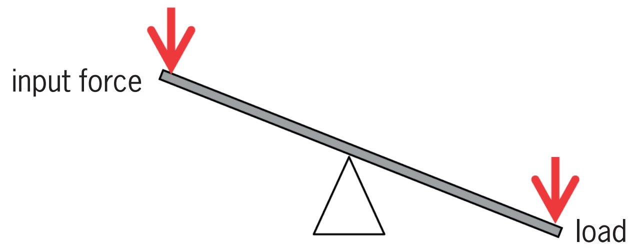


Figure 8

- When the load is between the input force and the fulcrum, it is called a **second-class lever**.

Fulcrum is another word for the pivot point at which a lever is supported.

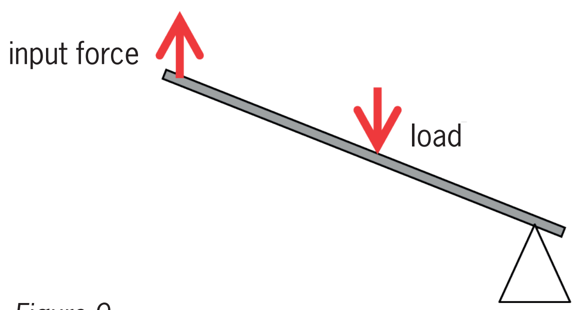


Figure 9

- When the input force is between the load and the fulcrum, it is called a **third-class lever**.

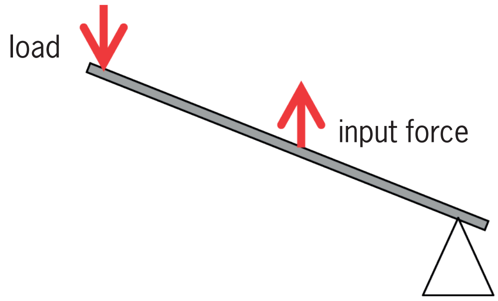


Figure 10

5.2 Practical examples of different classes of levers

Explore some different examples of levers

In Figure 11, the boy is going to swing the hammer to hit the nail into the wall.

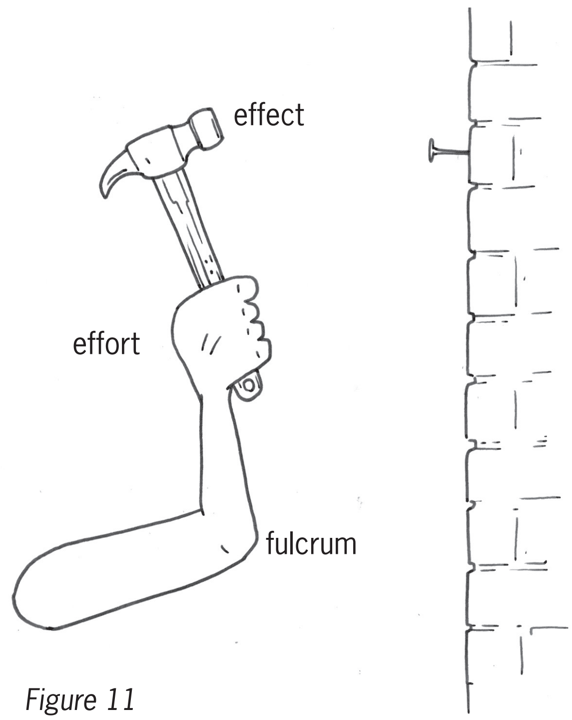


Figure 11

In this situation, his forearm and the hammer together form a lever. The lever swings around the elbow, so the elbow forms the fulcrum.

1. Is his forearm and the hammer a first-class lever, a second-class lever or a third-class lever?
2. Can you think of a sport where a person swings an object to hit something?
3. Rest your right elbow on your desk, then pick up something with your right hand while keeping your elbow on the desk.

   Do it again, but this time hold your left hand lightly on your right arm, just above the elbow, as shown in Figure 12.

   Do you feel the muscle movement inside your arm?

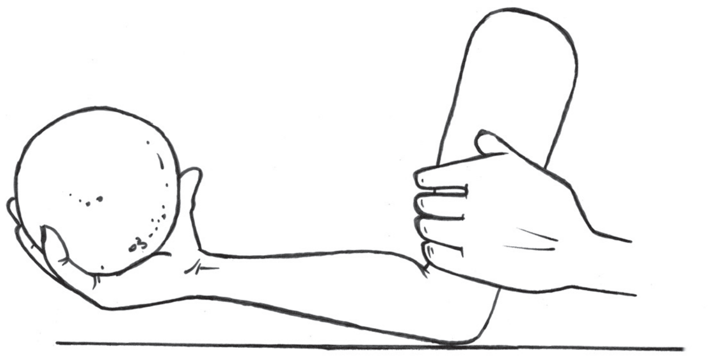


Figure 12

The diagram below explains how your arm works.

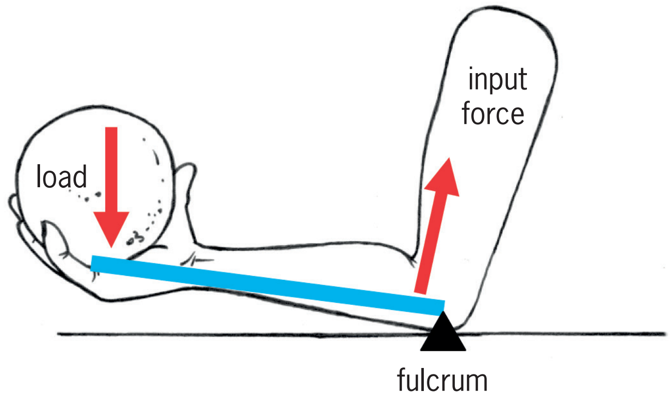
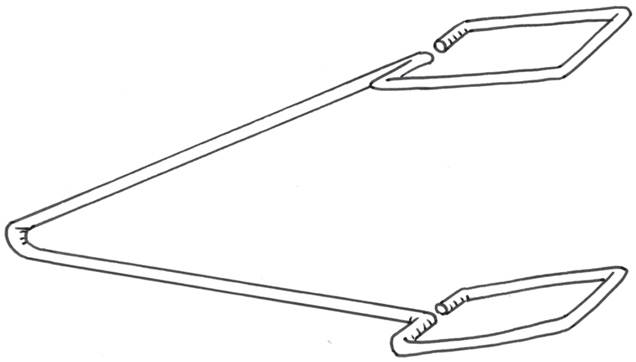


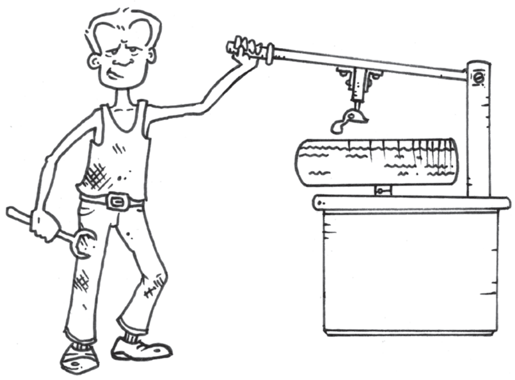
Figure 13

When you pick something up in your hand, your arm works like a **third-class lever** and the input force is between your elbow and your hand. Your elbow acts as the fulcrum and the load is in your hand.

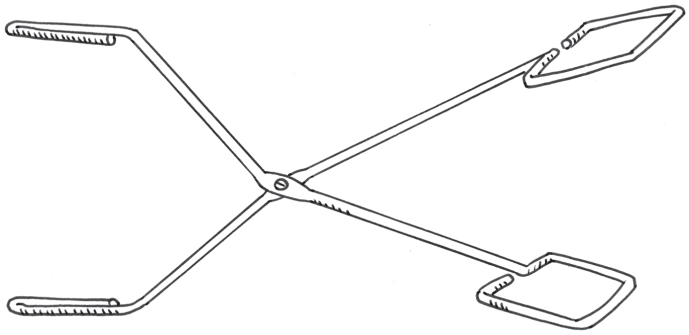
4. Copy the pictures in Figure 14 below. On each picture, draw a small triangle to indicate where the fulcrum is, and an arrow to indicate where the input force is. Make a letter L to show where the load is. Also state in each case what class of lever it is.



(a) kitchen tongs



(b) man pressing down mechanical tyre lever on stand



(c) another kind of kitchen tongs

Figure 14

5.3 More practical examples of different classes of levers

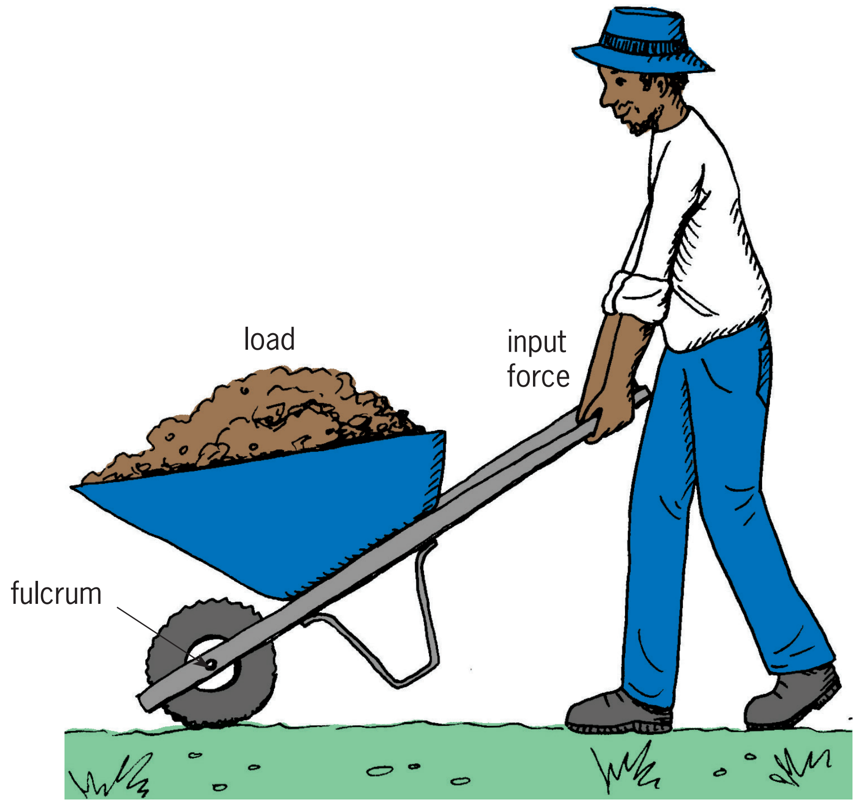


Figure 15

When you use a wheelbarrow, the axle of the wheel is the fulcrum and your arms provide the input force. The load is between the fulcrum and the input force. This is how a **second-class lever** works. The nutcracker below is also a second-class lever.

An easy way to remember how a second-class lever works is to think of a wheelbarrow or a nutcracker.

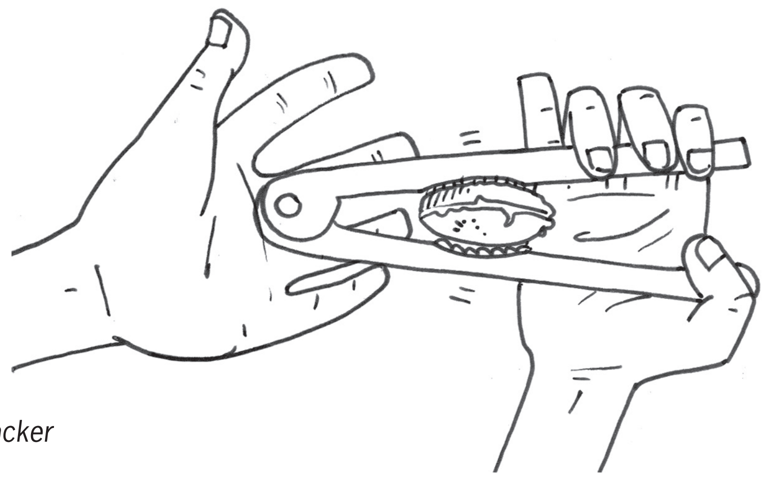


Figure 16: A nutcracker

Make a lever on a base plate

Use corrugated cardboard to make a lever on a base plate, as shown on this scale drawing. The scale of the drawing is 1:3.

Figure 17

For the lever, the corrugations must have the same direction as the length of the lever. Use a strip of cardboard 6 cm wide, and fold up the edges along the length to form flanges as shown on the right.

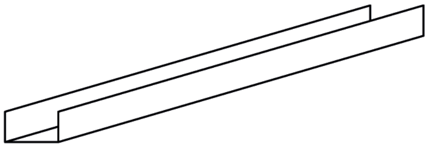


Figure 18

You can use this lever to move a small box filled with sand. You can do this in two ways: by using the lever as a second-class lever or by using the lever as a third-class lever.

1. Make free-hand sketches to illustrate the two ways in which your lever can be used.
2. Use your lever and sandbox to investigate when you get the biggest mechanical advantage, with a second-class lever or with a third-class lever. Write a brief report.

Next week

In the next chapter, you will investigate and learn how levers can be linked, and how they can be used for a variety of purposes.

Chapter 6
Tools with two or more levers

In this chapter, you will learn how levers are combined to make different tools.

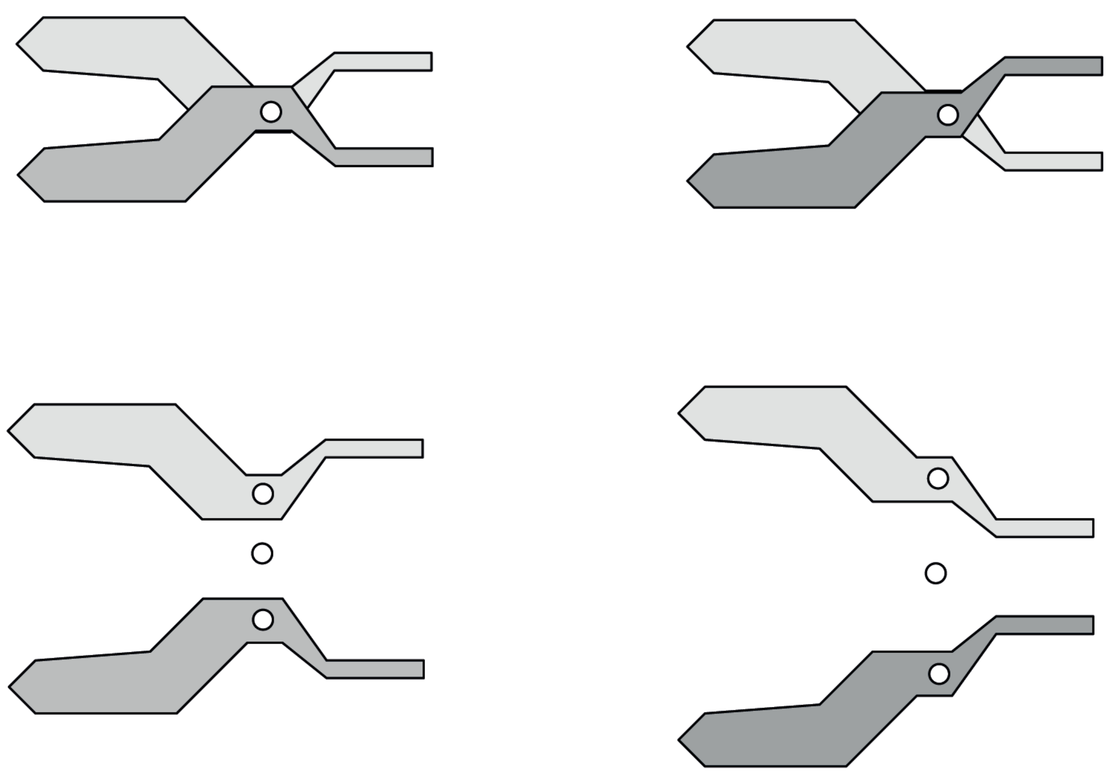


Figure 1: A set of pliers consists of two levers that pivot/rotate around the same fulcrum.

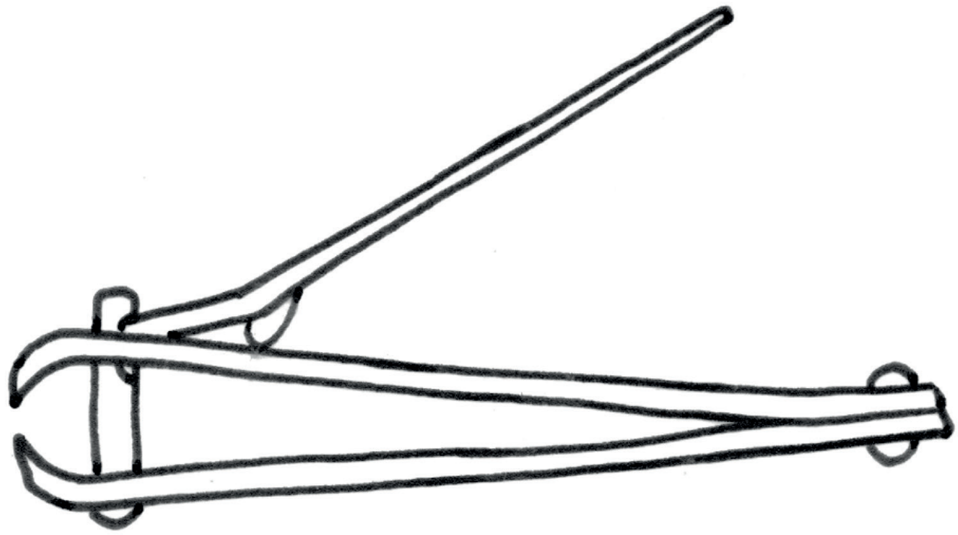


Figure 2

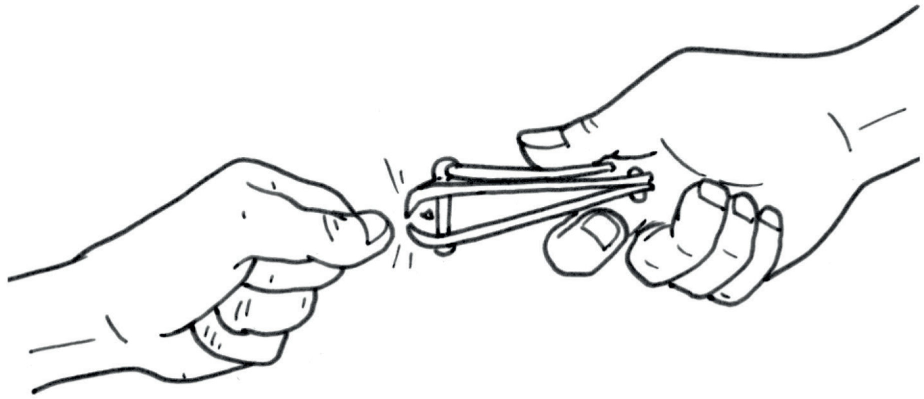


Figure 3

6.1 Pairs of first-class levers

Work with scissors in different ways

Answer the questions below and then do the experiment. Find out which way or method of using scissors works the best. Look at the two methods of using scissors:

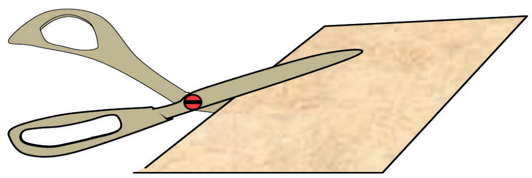


Figure 4

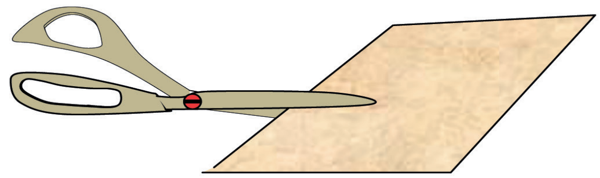


Figure 5

1. What is the difference between these two methods?
2. Which method makes it easier to cut? Explain.
3. Are there any levers in a pair of scissors? If so, how many, and what kind of levers are they?
4. In diagrams A, B and C below, the input force on the blue blade is indicated by a red arrow in each instance. In diagram A, the load on the blue blade is indicated by a black arrow. Show your partner where the load is in diagrams B and C.

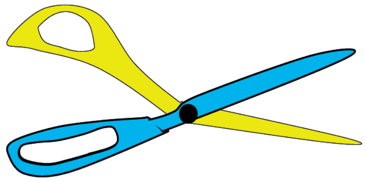


Figure 6: A pair of scissors is actually two blades linked together to work like two levers.

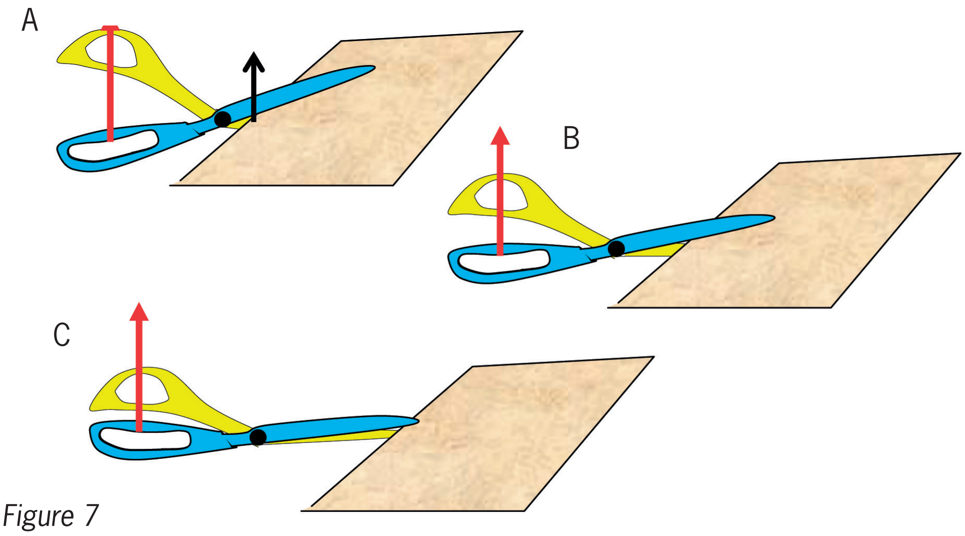


Figure 7

5. In which case is the mechanical advantage of the blue lever the greatest, and in which case is it the smallest?
6. In which case, or cases, is the mechanical advantage of the blue lever bigger than 1?

Can scissors cut thick objects?

1. Why will an ordinary pair of scissors not work well to cut the branches of a tree?

Figure 8

2. Make a free-hand sketch of the type of scissors that can cut the branches of trees. Why will they work?
3. Why will an ordinary pair of scissors not work well to cut a crashed car open to free trapped passengers?

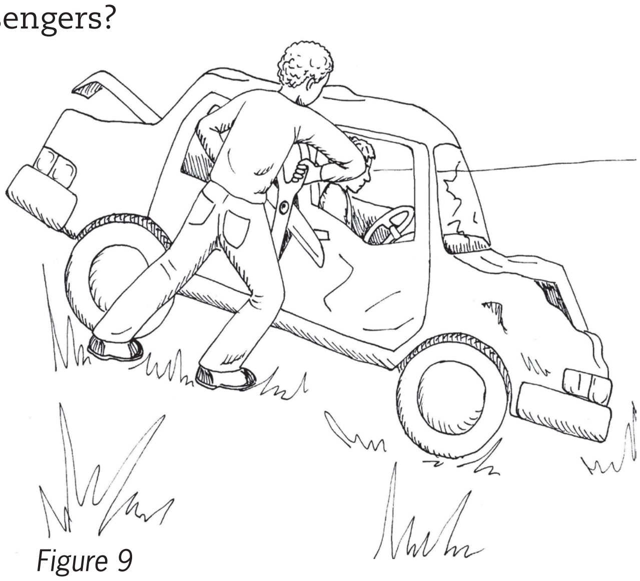


Figure 9

4. Suppose you have to design a cutting tool that can be used to cut through metal. In which ways will this tool be different from an ordinary pair of scissors?

6.2 More tools with levers

What is the best way to crack a nut?

You can use pairs of levers to compress, crush or crack things.

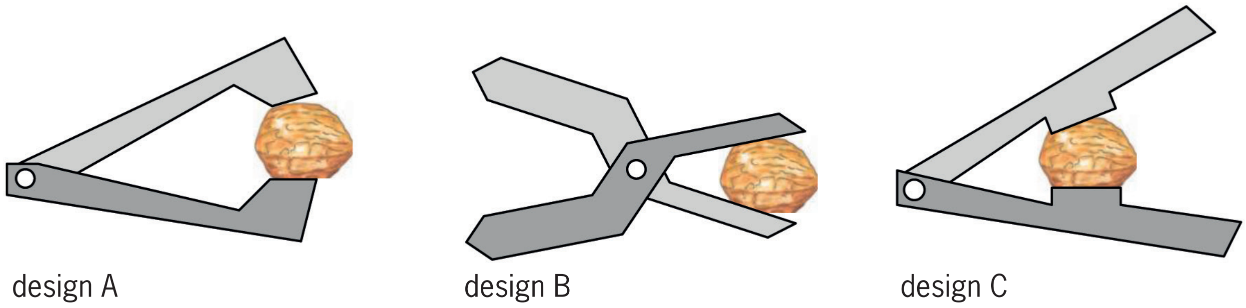


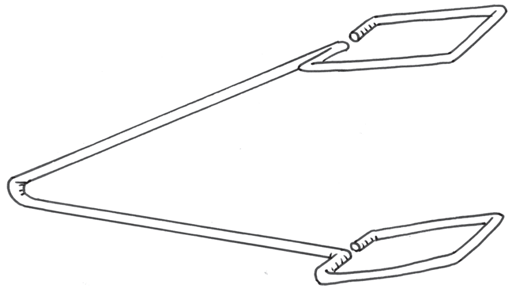
Figure 10

1. Which class of lever is used in each of these nutcrackers?
2. Make a quick sketch of Figure 10. Draw a hand in each case to show how you can press the hardest on the nut.
3. Mark and "label" the input force, load and fulcrum clearly on each of your drawings.
4. Which of the three nutcrackers do you think will work best? Explain why you think so.

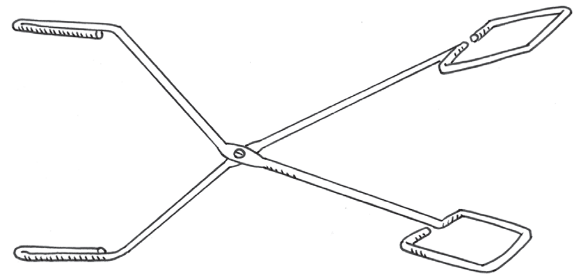
A "label" is a word or sentence that you write next to a drawing to describe or to name a part of the drawing. When you write one, you are labelling a drawing.

Three different kinds of kitchen tongs and two pairs of pliers are shown in Figures 11 and 12 on the next page.

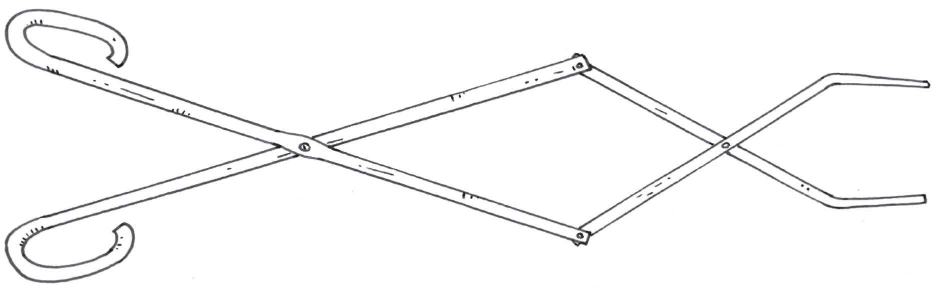
5. Describe the differences between type A and type B kitchen tongs.
6. How does type C kitchen tongs differ from types A and B?
7. Which of the three types of kitchen tongs work in the same way as a pair of pliers? Explain your answer.
8. Describe a situation in which a pair of pliers would be useful.
9. Make a free-hand drawing of a pair of levers that can be used to pull out thorns from your foot. This tool is called a pair of "tweezers".
10. Which class of lever did you choose for your design in question 9?
11. Make a free-hand drawing of tweezers with a different class of lever from the tweezers in your first design.



kitchen tongs type A

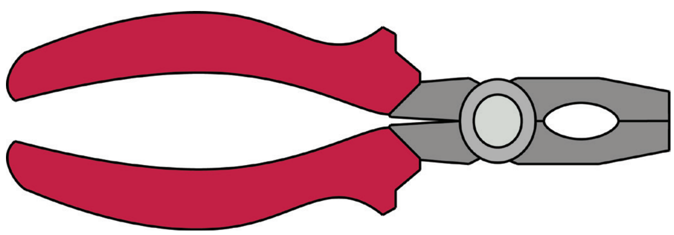


kitchen tongs type B

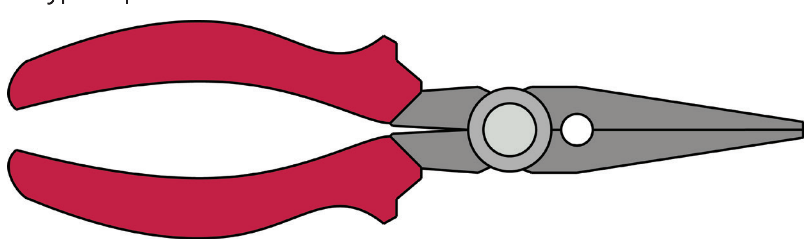


kitchen tongs type C

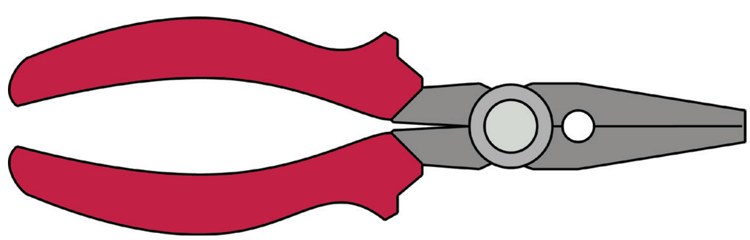
Figure 11



type A pliers



type B pliers



type C pliers

Figure 12

6.3 Many levers in one device

Examine and redesign a pair of nail clippers

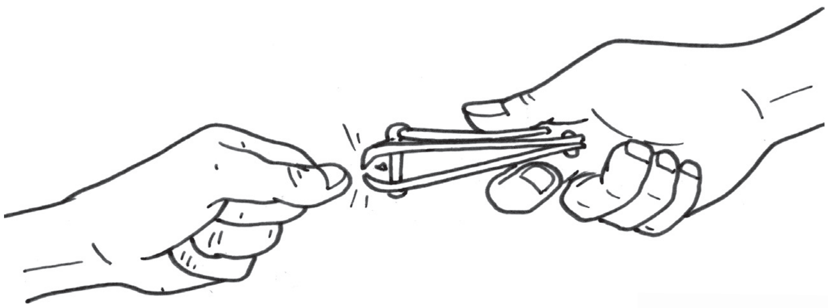


Figure 13

Figure 14 shows the pair of nail clippers on its own. The picture of the nail clippers in Figure 15 is called a **schematic diagram**.

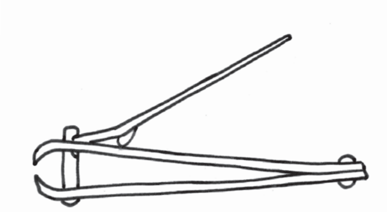


Figure 14

1. Look at the red part of the diagram in Figure 15. It is a lever. What class of lever is it when the nail clippers are used?
2. Copy Figure 15. Show the effort and load on the red lever with arrows and labels. Also show the fulcrum with a small triangle and a label.

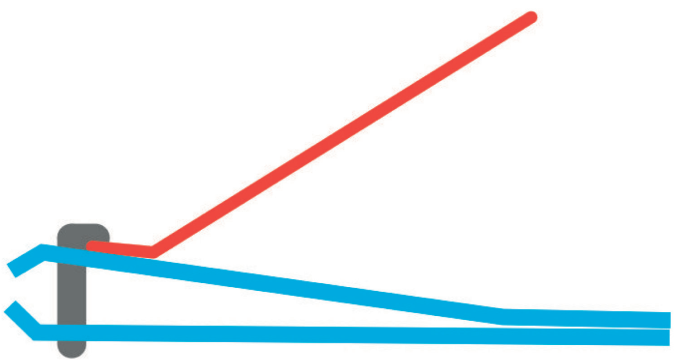


Figure 15

A **schematic diagram** does not show an object as it really looks. It is drawn to show some parts of the object more clearly than if you were looking at the real object.

3. The blue part of the nail clippers is a pair of levers. Are they used as first-class, second-class or third-class levers?
4. Show the effort and load on one of the blue levers with arrows and labels. Also show the fulcrum with a small triangle and a label.
5. Is the effort on the lower blue lever the same as the load on the red lever or not? Explain your answer.
6. Can this design be changed so that the nail clippers could cut harder objects than finger nails, for example, pieces of metal? Make a schematic drawing to show how that could be done and explain why it will have a greater mechanical advantage than the design above.

Investigate another combination of levers

The red and blue **mechanism** consists of two pairs of first-class levers. The pair on the left is used to "drive" the pair on the right.

The four yellow dots show **links**, like the links (pivots) you made with paper dowels when you made levers in the previous two chapters.

Something that is designed to be useful when some of its parts move is called a **mechanism**.

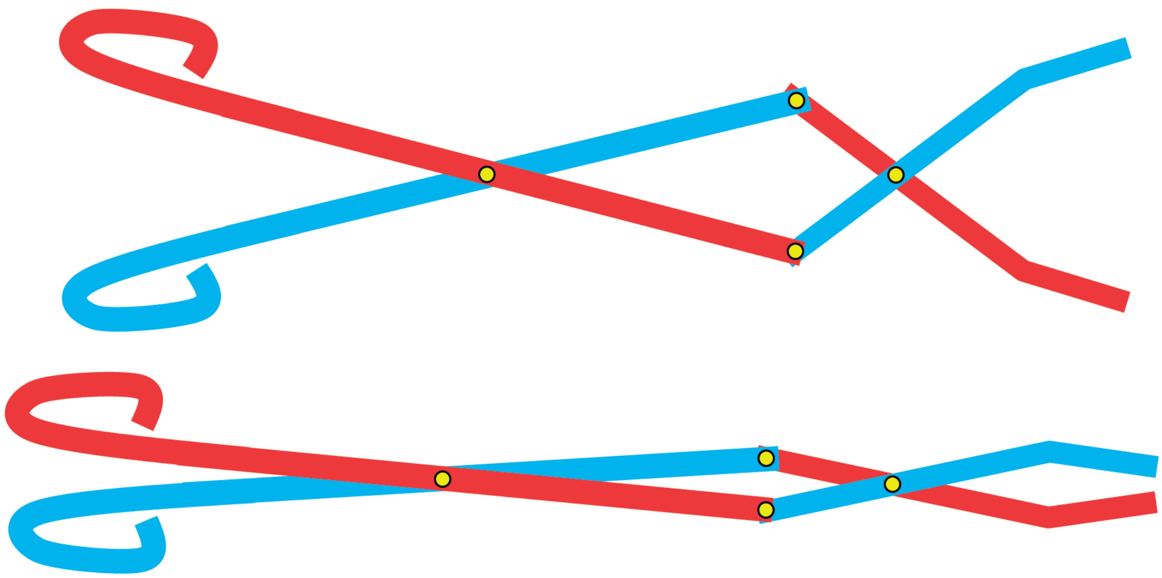


Figure 16

1. What do you think the purpose of this device is?
2. Which of the yellow links/pivots in the drawing are fulcrums supporting levers, and which only connect/join one lever to another?

The above device can also be described as a **system** of two pairs of first-class levers.

The word **system** is used to describe something that consists of several parts that are connected to each other in some way.

Next week

In the next chapter, you will design a tool to cut open car wrecks, in order to save people trapped in crashed cars.

Chapter 7 PAT
Design a life-saving tool

This chapter is a formal assessment task. It will count for 70% of your term mark.

It is a good idea to make a few trial designs before you make the final model. There is a lot to find out, to think about, to plan and to prepare before you can even start with a project. For the next four weeks, you will design and make a mechanical tool. You will design it in such a way that it solves a particular problem.

Work alone, and only at school. Your teacher will assess your work.

Assessment

Design:

Design brief, specifications and constraints .... [12]

Rough sketch of Jaws of Life tool, with labels .... [7]

Oblique drawing of a syringe .... [6]

Make:

Planning to make .... [15]

Completed model .... [20]

2D working drawing .... [10]

[Total: 70]

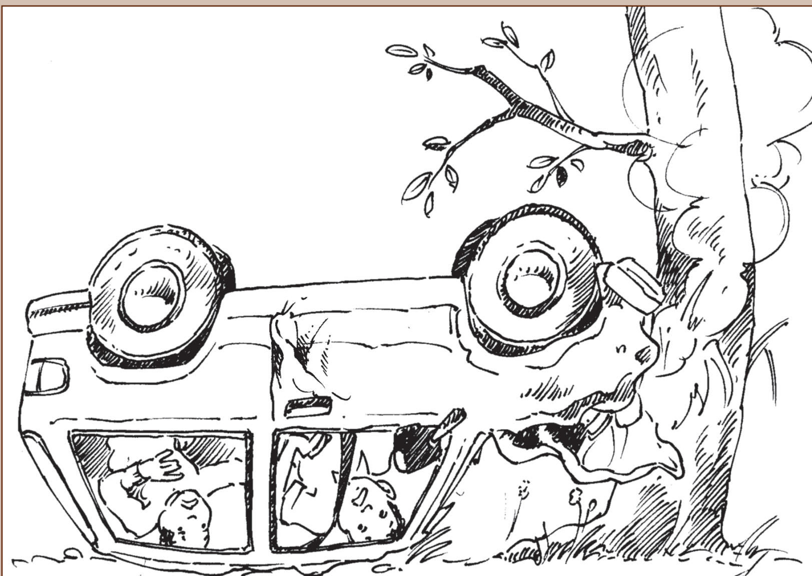


Figure 1

Last weekend, there was an accident just outside town. A car lost control, went off the road and toppled over. Two people were trapped inside the crashed car. They were badly injured, but still alive. Because the metal body of the car was bent, the doors could not open.

Figure 2

An ambulance with "paramedics" arrived to help the trapped people, but the paramedics could not get them out of the crumpled car in time to give them medical treatment or to take them to the hospital. So the two people inside the car died from their injuries.

Incidents like these are very sad. Many peoples' lives could be saved if it was possible to remove them from car wrecks in time to get medical help.

"Paramedics" are people who are trained to do emergency first aid. They can do many things that doctors can do.

Figure 3

If the paramedics had the Jaws of Life tools with them, they could have cut or bent the car doors open with these tools to remove the injured people. Then they could have given medical help to the injured people, and the story would have had a happier ending.

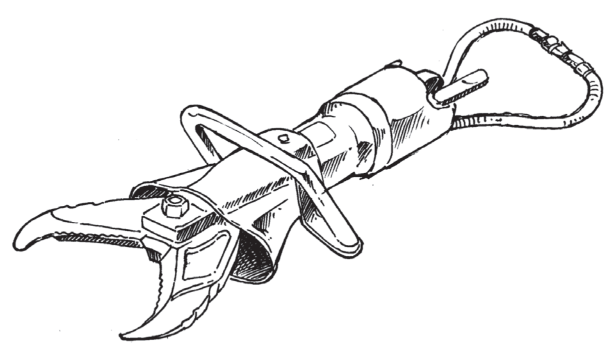


Figure 4

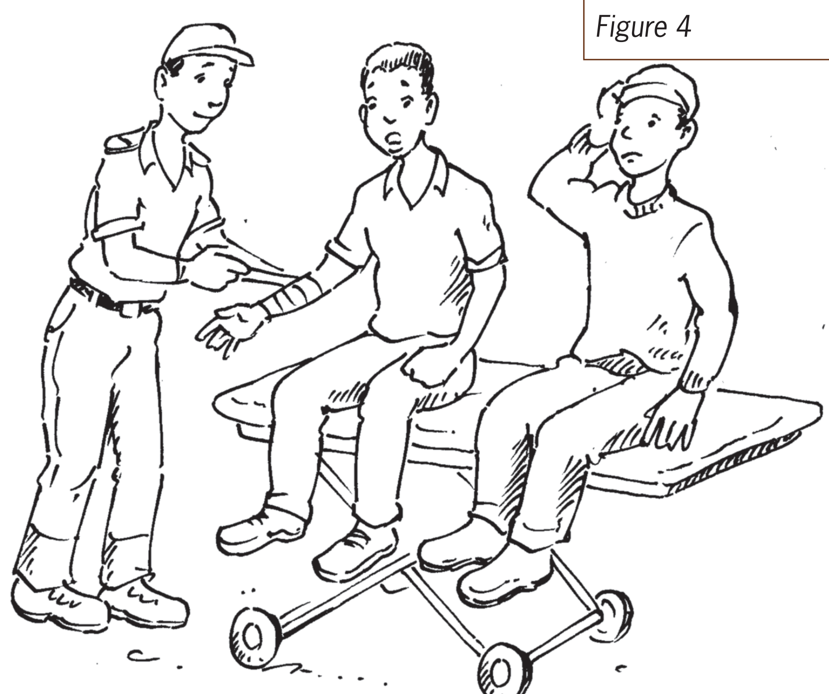


Figure 5

Week 1

Another way to move objects from a distance (30 minutes)

You will now learn how you can use syringes to make things move. This wil help you to design tools that can be used by rescue workers at accident scenes.

When you worked with levers, you learnt the following:

> A push can be made stronger or weaker by using a lever. In other words, a lever can give you a mechanical advantage.
> A movement can be made smaller or bigger by using a lever.
> The direction of movement can be changed by using a lever.

You can also change and control movement by using syringes.

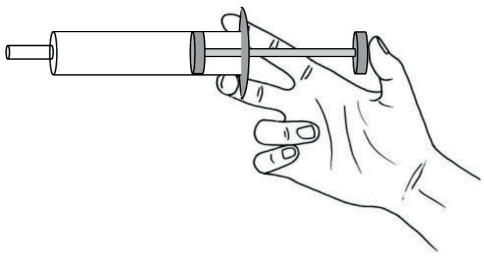


Figure 6: This is how you should grip a syringe so that you can push the plunger in with your thumb.

Now you do it.

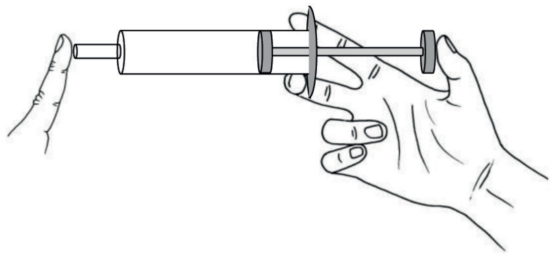


Figure 7: Close the outlet tube tightly with a finger, then try to push the plunger in.

1. What do you feel when you push the plunger now?
2. What do you think prevents the plunger from going all the way in when you push it hard?
3. Do you think there is something in the syringe that you cannot see?

To **compress** means to make something smaller. When you pressed the plunger in while keeping the outlet closed, you compressed the air inside the syringe. That means you forced the air molecules to move closer together.

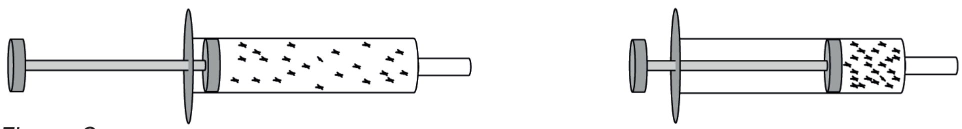


Figure 8

4. Do you think you can use a syringe to push something without touching it? Try to do it.

   Connect two syringes with a plastic tube, as shown below.

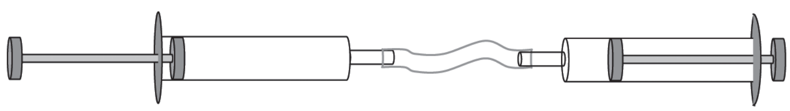


Figure 9

Find out whether your can move small objects by pushing one plunger in.

press here… …to move something here

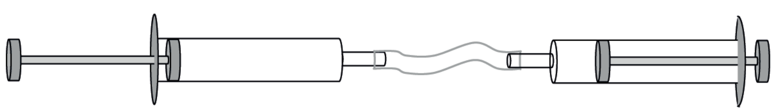


Figure 10

A pushing device made with syringes and a pipe filled with air is called a **pneumatic** mechanism. There are also other types of pneumatic mechanisms.

The word **pneumatic** is used to indicate that *gas* is used to push something.

5. What do you feel when you press the plunger in and try to move the pile of books with your pneumatic mechanism?

When you use a pneumatic pushing device to try move an object, you cannot press very hard, because only a small force is needed to compress the air. You can only press with a big force once the air is already very much compressed, when the plunger is pressed almost fully in. Do you think the same thing will happen if there is water in the cylinders instead of gas?

Fill a syringe with water to investigate this.

Step 1

Some air bubbles may get caught inside.

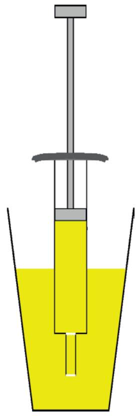
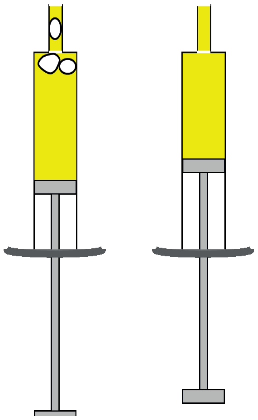


Figure 11

Step 2

Hold the syringe upside down and push the air bubbles out.



6. Do you think you can compress the water just like you compressed the air? Try it. Describe the difference you notice between using air in the syringe, and water in the syringe.

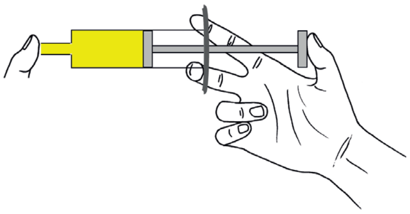


Figure 12

A liquid cannot be compressed.

It is a bit difficult to get the air bubbles out when you fill two connected syringes with water. Figure 11 shows us how to do this.

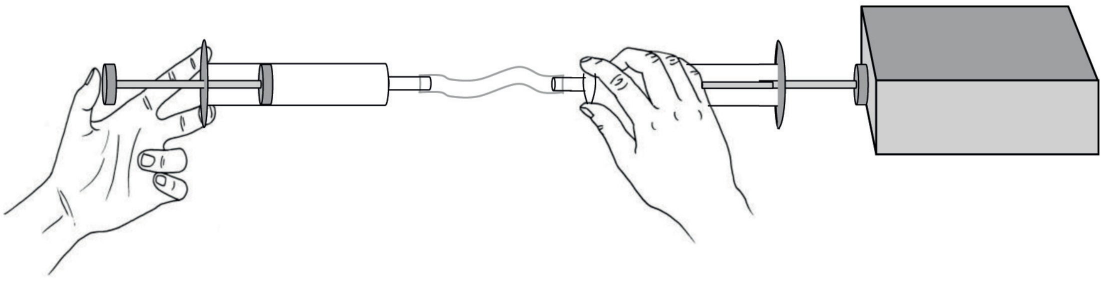


Figure 13

When there is air or other gases in a device like this, it is called a **pneumatic** mechanism.

When there is water or some other liquid like oil in the cylinders and connecting pipe, it is called a **hydraulic** mechanism.

7. What would give the strongest push with the same two syringes, air or water? How can you investigate this?

An important investigation

1. How many books can you put on top of each other and still be able to push them with your pneumatic pushing device?

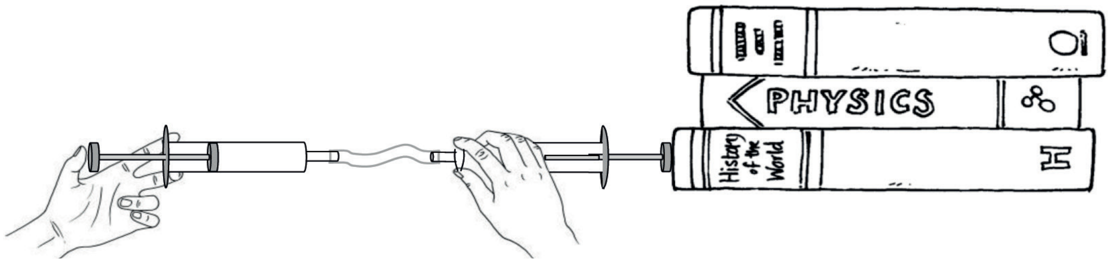


Figure 14

2. How many books can you put on top of each other and still be able to push them with your hydraulic pushing device?
3. Why do you think a hydraulic pushing device provides a stronger push than a pneumatic pushing device?

To experience the difference between pneumatic and hydraulic pushing devices, hold the two plungers of a pushing device in your hands and push the plungers from both sides.

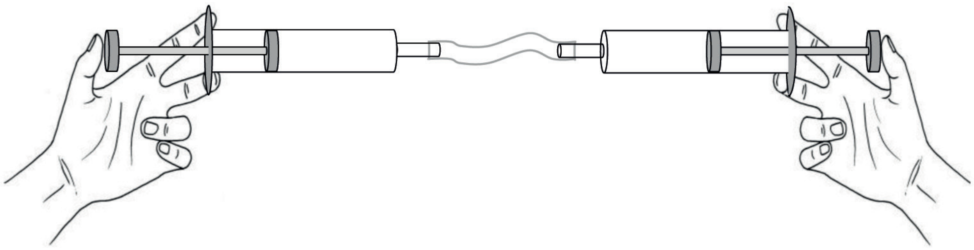


Figure 15

Do this with the syringes filled with air. Then, repeat this with the syringes filled with water.

4. What difference do you feel between the pneumatic pushing device and the hydraulic pushing device?
5. Explain why pneumatic and hydraulic pushing devices act differently.

More investigations

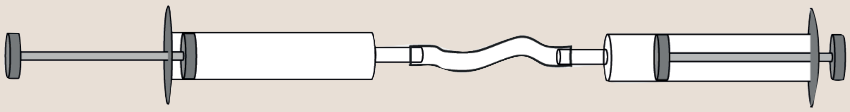


Figure 16

Suppose the two syringes and the tube are filled with water. If the plunger on the left is pushed in 1 cm, will the plunger on the right move out by 1 cm or not? Explain your answer.

If a heavy object, like a stone or a box filled with sand, is placed next to the plunger on the right, will the object also move by the same distance than you pushed the plunger in on the left? Explain your answer.

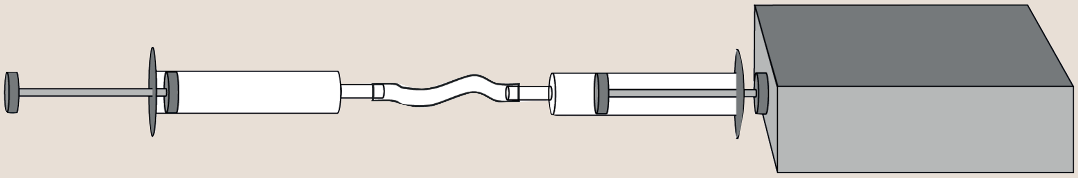


Figure 17

Suppose the two syringes and the tube are filled with air, and a heavy object is placed next to the plunger on the right. If the plunger on the left is pushed in 1 cm, will the plunger on the right move out by 1 cm or not? Explain your answer.

Suppose you use a strong stick or metal rod as a lever to move a brick or other heavy object. If the fulcrum is exactly in the middle of the stick, and you push the one end 5 cm, how far will the other end move?

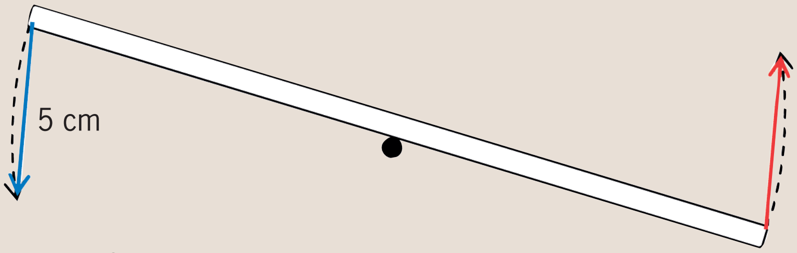


Figure 18

Will the same happen if you use a flexible lever, like your ruler? Explain your answer.

Swap distance for strength: think, predict and investigate

1. The syringe on the left is thicker than the syringe on the right. Suppose the two syringes and the tube are *filled with water*. If the plunger on the left is pushed in 1 cm, will the object on the right move out by 1 cm or not? Explain your answer.

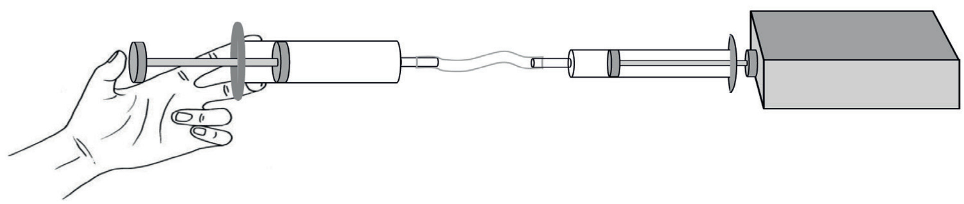


Figure 19

2. What would be different if the syringes and tube were filled with air instead of water? Explain your answer.
3. Now the syringe on the right is thicker than the syringe on the left. Suppose the two syringes and the tube in Figure 20 are *filled with water*. If the plunger on the left is pushed in 1 cm, will the plunger on the right move out by 1 cm or not? Explain your answer.

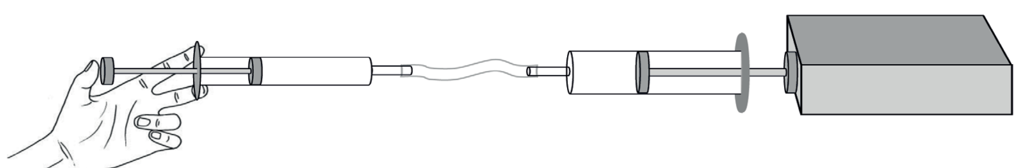
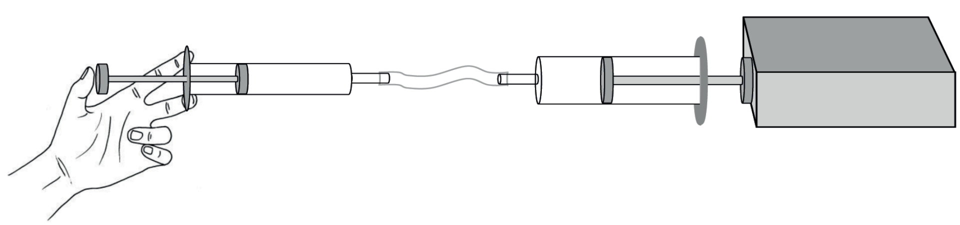


Figure 20

4. (a) In which case below would you need to use a smaller force on the left to move the object on the right?

Case A



Case B

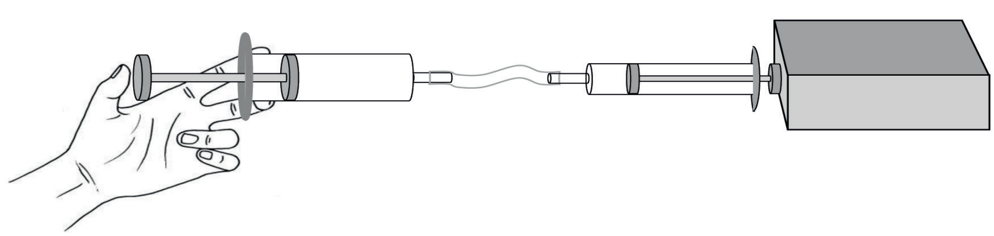


Figure 21

(b) Do a few experiments to check your answer to question (a). Write a short report about what you found out.

5. Lebogang says that when you use a thick syringe to “drive” a thin syringe, you lose strength but gain distance. Jaamiah disagrees. She says that you gain both distance and strength.

   What do you think, and why do you think so?

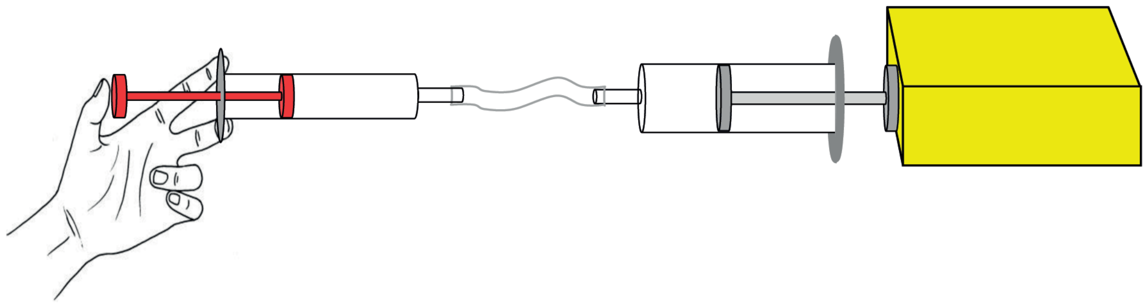


Figure 22

In Figure 22, a thin syringe is used to drive a thick syringe. The distance that the yellow object will move is smaller than the distance moved by the red plunger, but the force on the yellow object is bigger than the force on the red plunger. The mechanical advantage is “bigger than one”. This means that there is indeed a mechanical *advantage*, but a distance *disadvantage*.

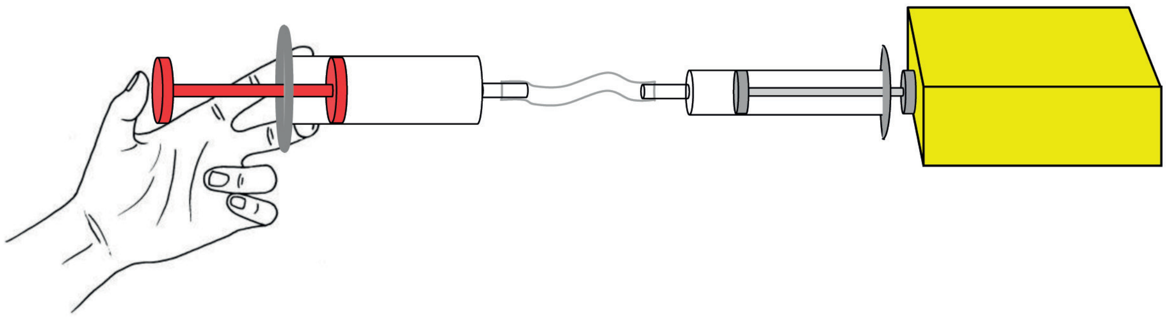


Figure 23

Figure 23 shows how a thick syringe is used to drive a thin syringe. The yellow object will move by a bigger distance than the red plunger, but the force on the yellow object is smaller than the force on the red plunger. The mechanical advantage is “smaller than one”. This means that there is a mechanical *disadvantage*, but a distance *advantage*.

Week 2

Scenario (30 minutes)

Jaws of Life rescue tools can easily cut through the metal of a car body. They can also be used to bend or open the metal body of a car. Rescue workers have to work very carefully to ensure they don't hurt the passengers inside. So the rescue tools should make small movements, compared to the large movements made by the rescue workers operating them.

Figure 24

There are four types of Jaws of Life rescue tools:

- a spreader to pull pieces of metal apart and tear out chunks of metal,
- a cutter to cut metal,
- a combination tool that can cut and spread, and
- a ram, which makes large openings to free people who are trapped.

The situation

The rescue services in your area need a rescue tool. Design and make a **model** of a Jaws of Life rescue tool for them.

A **model** is a small version of a real product. It shows how the real product works, but cannot do the work of the real one. A model does not have to be made from the same materials as the real product.

Your model should:

- operate to cut or prise open crumpled metal,
- work with linked levers,
- be attached to a flat piece of card that will act as a base, and
- be powered by a hydraulic system.

You will use syringes and tubing for the hydraulic system. The syringes should have different thicknesses.

Assessment

Use the information you have been given so far to answer the questions below.

1. What problem did the paramedics encounter at the accident scene?
2. Who will use the rescue tools?
3. Where will the rescue tools be used?
4. In what way will the tools help?
5. Now write the **design brief**. Use your answers to questions 1 to 4 to help you. Start your paragraph with:

   I should design and make a … [4]
6. Identify the **specifications** of the solution.
   (a) What will the tools be used for? [2]
   (b) What will make the tools work? [2]
   (c) To what should your model be attached? [1]
7. Identify the **constraints** on the materials.

   Start your sentences with words like:

   My model cannot or should not … [3]

[Total: 12]

A **design brief** tells us what the problem is, and who will benefit from or use the solution. It does not give us the solution to the problem.

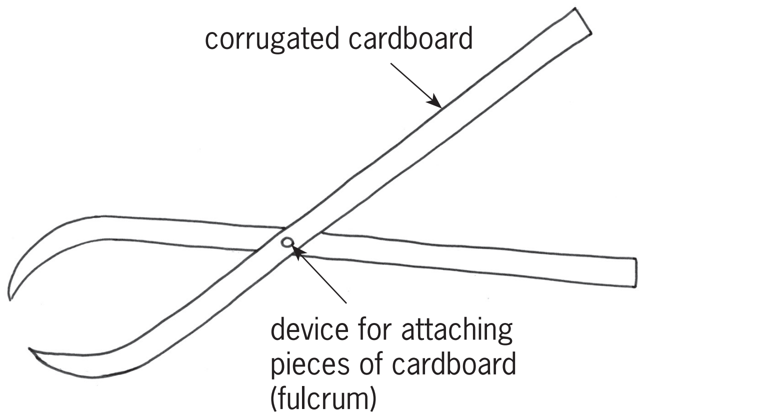
Questions 6 (a) to (c) will help you to understand what the word **specifications** means.

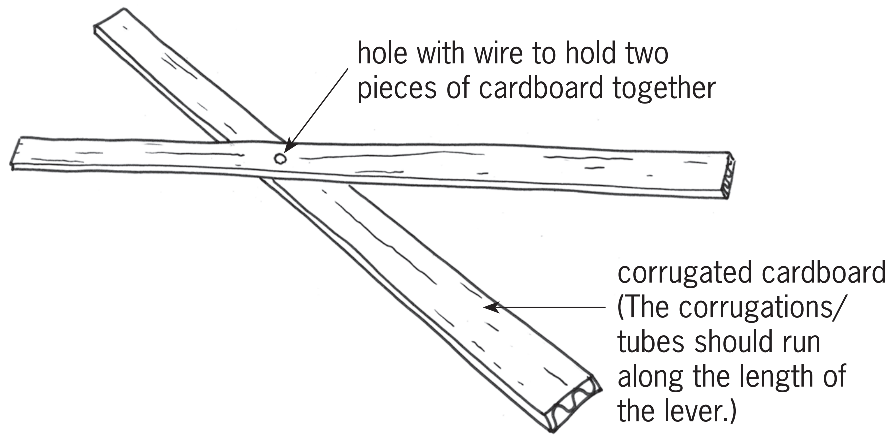
Constraints are limits to what can possibly work. For example, the fact that a shopping bag could break if it is loaded too heavily is a contraint. Also, if you have a limited amount of time to build something, it is called a constraint.

Sketch your idea for a solution (30 minutes)

Before you make your own design, look at these photos of kitchen and fire tongs to get a few ideas. Also look at the sketches on the following page of the designs of other learners. Pay attention to how the sketches use labels and notes to explain the designs.

Figure 25





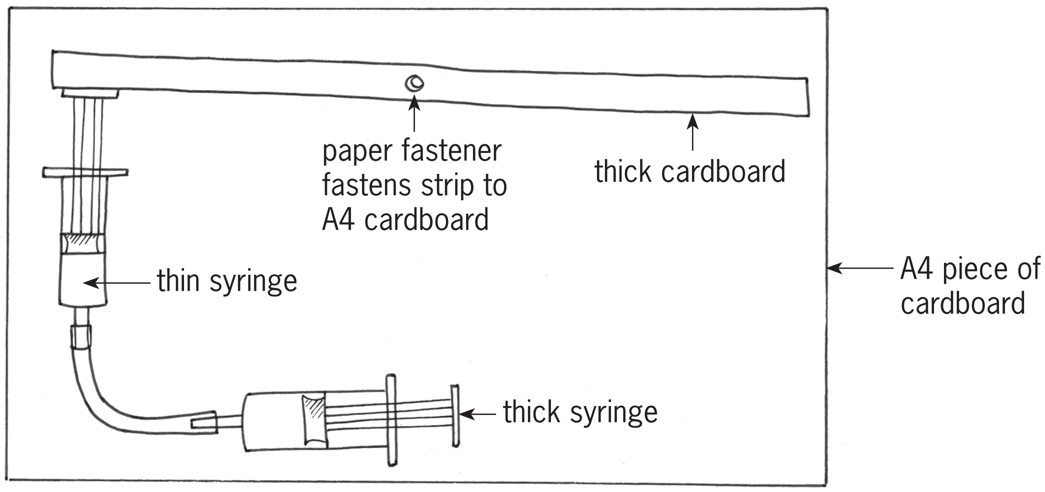


Figure 26: Drawings made by other learners

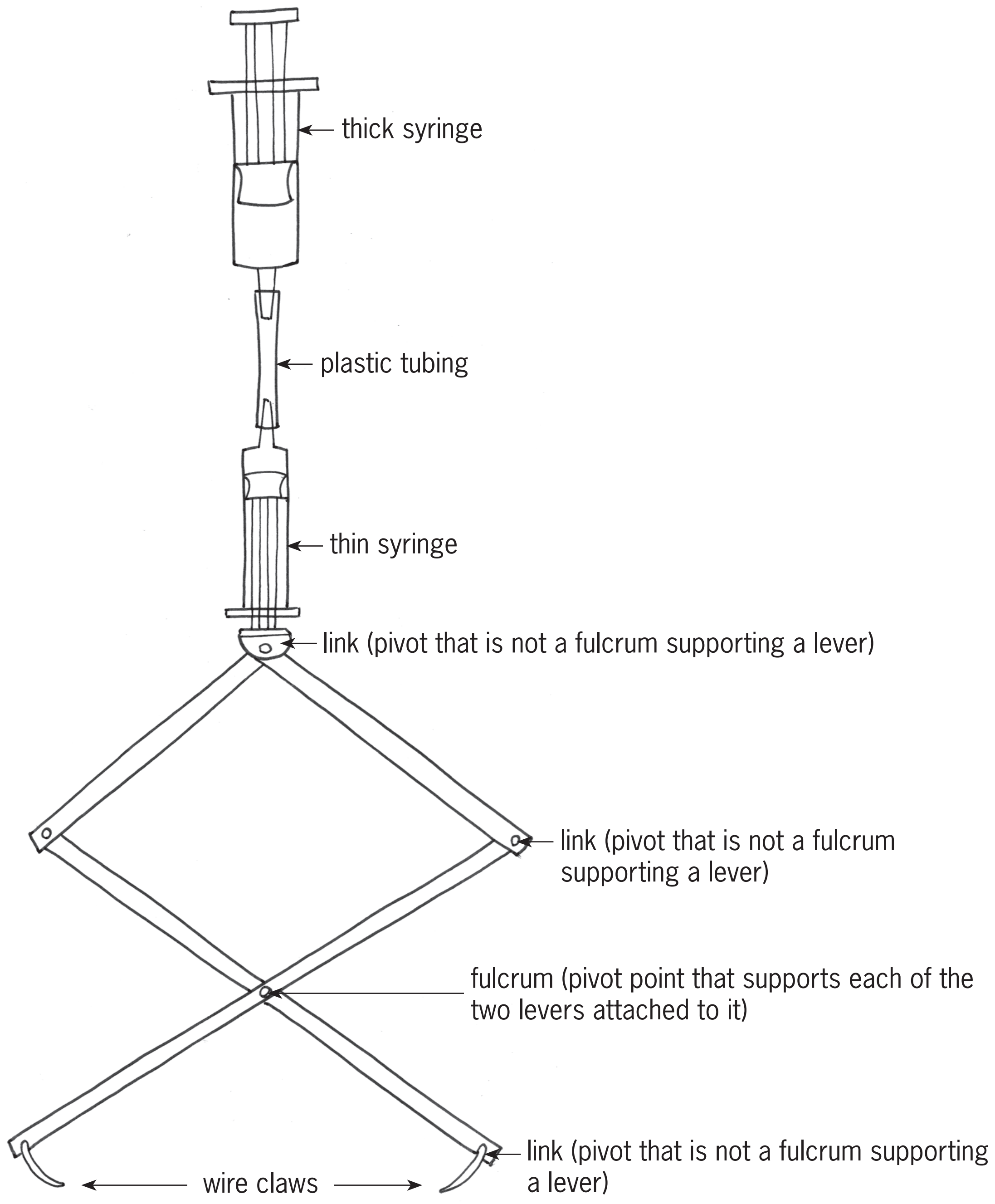


Figure 27: More drawings made by other learners

Now make a rough sketch of your own design

1. Sketch a possible design of the rescue tool. You can make a simple or a difficult model, as long as you do it well. It is fine if your model only demonstrates how the tool will work, even if the model itself does not work.

   Think of the different types of Jaws of Life rescue tools. You have to choose and make *only one type of rescue tool*.

   Label your drawing to show the different parts, and what the parts are made of. Also show where the syringes that form the hydraulic system will go.

[Total: 7]

Planning how you will make your model

1. Make a list of all the **materials** you plan to use to build your model. You have listed some of the materials under "specifications" in the previous lesson. Add any other materials that you will be using.

   What will you use for pivots? What will you use to attach the model to the backing sheet? What will you use to attach the syringe to the backing sheet and the lever? [6]

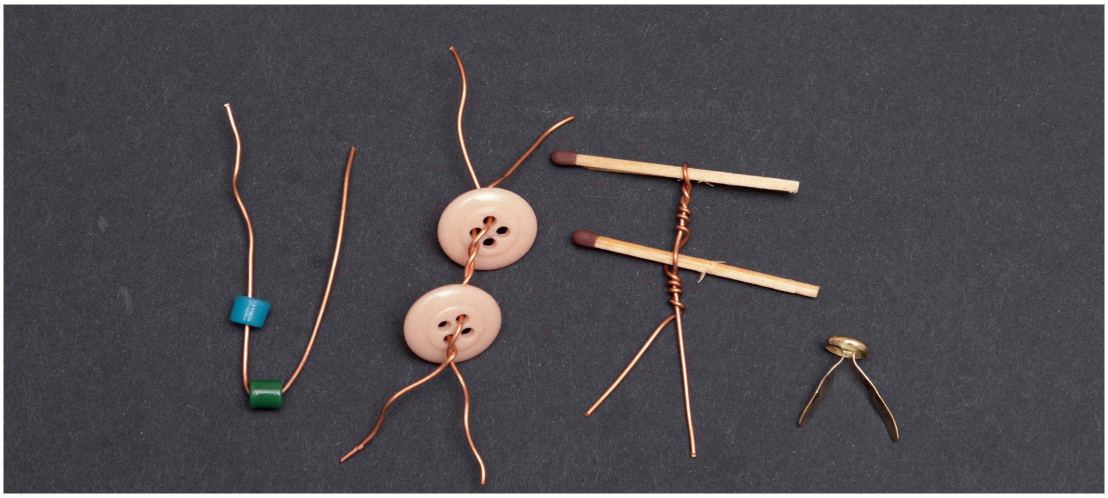


Figure 28: Here are different pivots and ways to attach pieces of cardboard that were used by other learners. Some were bought and some are hand-made.

2. Make a list of the **tools** you will use to build your model. A nail to make holes can also be called a tool. [4]
3. Some tools can be dangerous if they are used incorrectly. Write down a **safety** rule for one of the tools that you will use. An example of a safety rule is shown on the right. [2]

Safety warning

Always carry scissors with the blades facing towards the floor. Hand scissors to someone by keeping the blades closed in your hand.

4. **Order of work**. This is the list of the steps you will follow when you make the model. Below are a few steps to start with. Add more of your own. You can also add steps to this plan while you make your model. [3]

   Step 1: Draw the shape of the levers on the card.

   Step 2: Cut out the card levers.

   Step 3: Make a hole for the pivot point/fulcrum.

   Step 4: Assemble the hydraulic system using two syringes with different sizes and tubing.

[Total: 15]

Week 3

Make a working drawing (30 minutes × 2 = 60 minutes)

Engineers and technologists usually make two or more models before they choose a model for their final solution to a problem. Each time they make a model again, the new model is better than the previous one. Remaking models is an important part of the design process.

Make an accurate **2D working drawing** of your model. This type of drawing shows you what an object looks like when you look at it straight from the front, back, side, top or the bottom. Drawings like these are useful because they show the dimensions (measurements) of the object accurately.

Read through points 1 to 4 before you start to draw.

1. Have another look at Chapter 2 to refresh your memory about how to make a 2D working drawing.
2. Make a 2D working drawing showing one view of your rescue tool. Draw the view that shows the most detail of your model.
3. On your drawing, each part of the tool should be the correct size compared to the other parts.
4. You don't have to draw your model to **scale** and you don't have to add dimensions to your drawing.

Sometimes, working drawings are on a smaller **scale** than the actual objects. For example, if 1 mm on the drawing means 5 mm on the actual object, then we say that the scale is 1:5.

Make a 2D working drawing of your model

- Look at Figure 29 below as an example. Start by drawing an **outline block** to work in.
- To draw the outline block, first take all the measurements of your model in the horizontal and the vertical directions.
- Making a block like this will help you to draw each part of your model the correct size relative to the other parts. This means that the proportions will be correct.
- Use only light, feint lines for the block, because these lines are only guidelines.

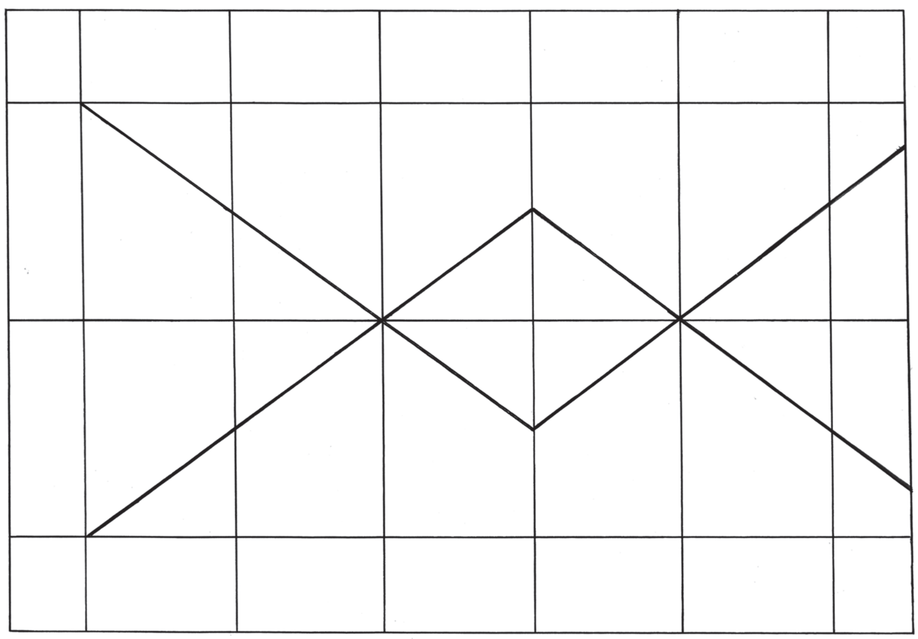


Figure 29: An "outline block" drawing of a lever system

- Once you have drawn your block, complete the 2D drawing of your model.
- Use the checklist on the next page to ensure that you have done everything properly and included everything. Your teacher will use this list to assess your drawing.

Your teacher will look at the following things:	Tick
Does the drawing have a heading?	
Does the heading include the view that the drawing is drawn in, for example the front view?	
Is the block drawn by using the horizontal and the vertical measurements of your model?	
Is the block correctly drawn using feint lines?	
Are the outlines of the device drawn using dark lines?	
Are the different parts of the device in proportion as it would be in the model?	
Is the drawing neat?	

[Total: 10]

Week 4

Complete your model (30 minutes × 2 = 60 minutes)

Remember to work safely and neatly. Pack away your model and its parts at the end of each lesson. Keep the parts together in a plastic or paper bag. Write your name on every part and on the plastic bag so that your parts do not get mixed up with someone else's.

Sometimes, a design does not work out. You can make changes and add things to your model later so that it will work.

- Assemble your materials and tools.
- Draw and cut out your lever.
- Put the lever together.
- You can choose materials other than those that you planned to use for the pivot.

When your model is finished, your teacher will use this rubric to assess it:

Is it made according to your plan? [10]
Does it work smoothly? [5]
Is the model neat and well-made? [5]
[Total: 20]

Make an 3D oblique drawing of a syringe (30 minutes)

Use grid paper. Make a 3D oblique drawing of one of the syringes you used in your model.

Have another look at Chapter 2 to refresh your memory on how to make a 3D oblique drawing.

Look at Figure 30.

1. Start by drawing the front view of the syringe using thick, dark lines. This outlines the shape of the syringe.
2. Measure and draw your 45° diagonal lines from the corners. They must be light, feint lines, because they are construction lines.
3. Measure and mark the depth of the syringe construction lines on the projection. Remember to use half of the real measurement.
4. Draw in the lines at the back. These are called the "rear lines".
5. Draw over all your outlines. They must be dark lines.

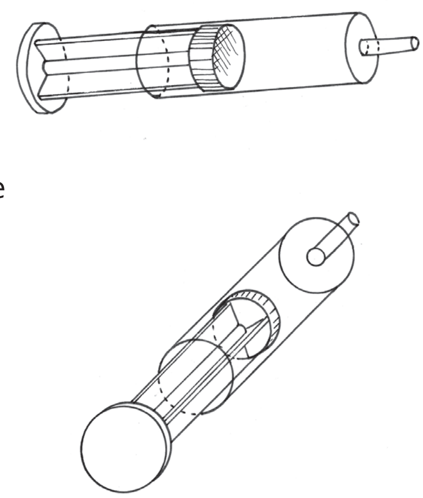


Figure 30

Use the checklist below to make sure that you have done everything properly and included everything.

Things to look at	**Tick**
Does your drawing have a heading?	
Did you start with the construction lines?	
Are these feint lines?	
Did you project your corners at 45°?	
Did you use ½ the depth measurement to find the rear lines?	
Did you draw your outlines as dark lines?	
Is your drawing neat?	

[Total: 6]

Term 2: Structures

Chapter 8
Shells, frames and solids

Right now, you are sitting on a chair at a desk. Soon, you will write things in a book with a pen or a pencil. The book rests on your desk. All these objects are called structures. If you look around the classroom, you will see many other structures. For example, the classroom and the school buildings are structures.

In this chapter, you will learn about natural and man-made structures. You will also learn about shell structures, solid structures and frame structures.

Figure 1: Is a piece of dough or wet clay a structure?

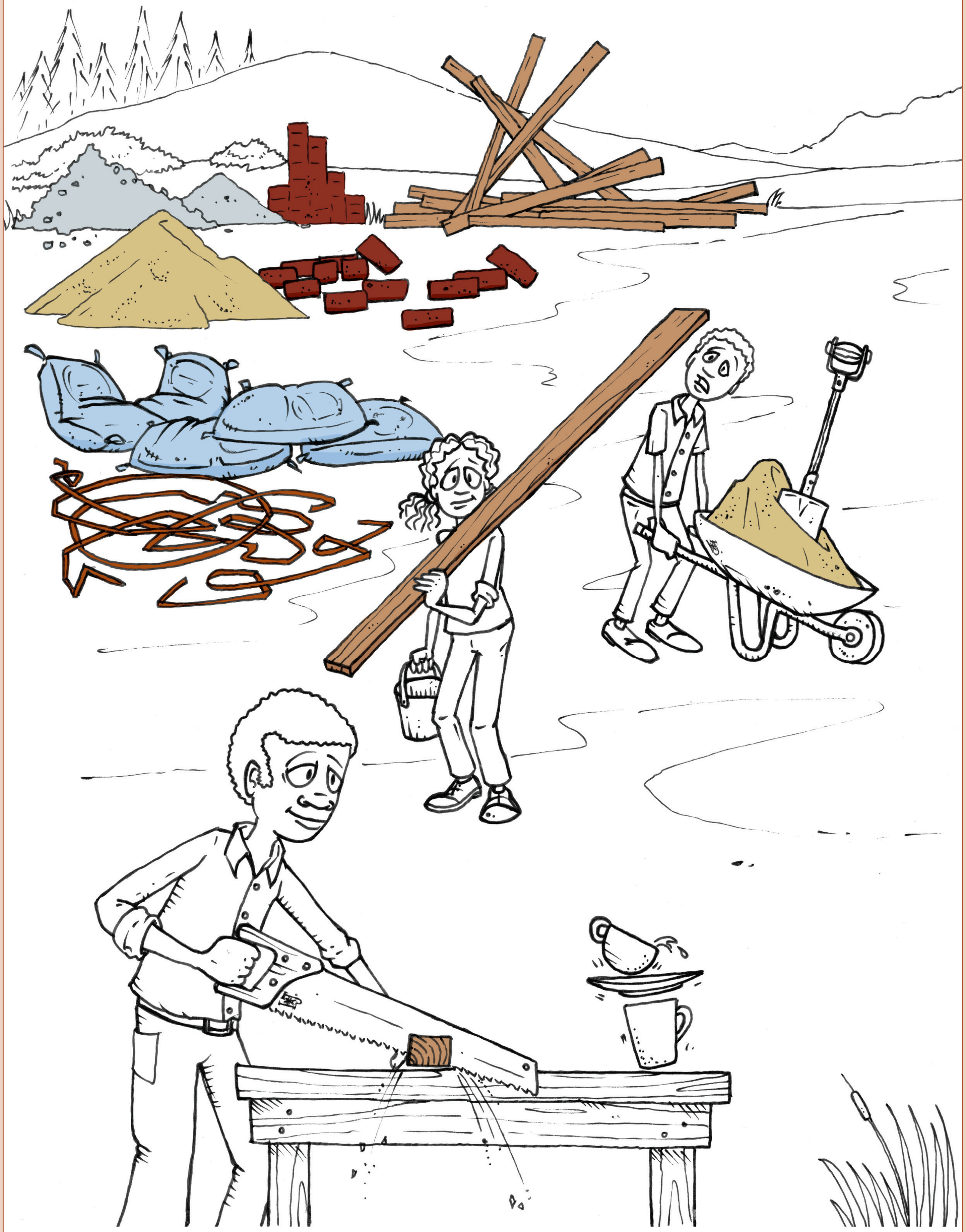


Figure 2: What does it mean to construct something?

Figure 3: What does it mean to construct something?

8.1 Things called structures

Questions about structures around you

Look around you in the classroom. Choose any object, for example a cupboard, a table, a chair, a basket, a bottle, a shoe, a pencil case or a brick. Then answer the following questions about this object.

1. What is this object called?
2. What is it used for?
3. Can it be used to keep certain things in one place, so that they do not lie around all over the classroom?
4. Can it be used to protect something, for example to protect it from sunlight or wind?
5. Is it used to support something?

Figure 4: The chair supports the person sitting on it.

This man is sitting comfortably on the chair. You can say that the chair **supports** the man and keeps him from falling off.

6. Describe two other objects that are different from chairs, but are also used to support something or someone.

Figure 5: The bridge spans the stream.

A bridge that crosses a stream or a river from one end to the other helps people to cross it without getting wet. You can say that the bridge **spans** the stream.

Questions about a small business situation

Suppose you want to set up a stall at a market to sell food such as sugar, flour, maize, rice, eggs, beans and cooking oil. So you buy one large bag each of sugar, flour, maize and rice, and a 20-litre drum of cooking oil.

Figure 6

1. Make a list of the things you can see in this picture.

2. What else do you need to set up your stall before you can sell the goods?
3. What type of container will the eggs you sell come in?

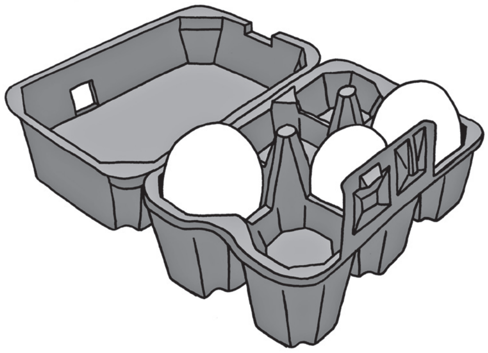


Figure 7

4. Why are eggs packed in special containers like the one in Figure 7?
5. If you wanted to make a table from the two empty crates, what else would you need?
6. Suppose a woman wants to buy 2 kg of flour from you. Would you ask her to hold out her hands so that you can put the flour in her hands, or would you make another plan?
7. What will you use as "containers" when you sell maize, rice, sugar and flour to people?
8. What will you use as a container to sell oil?
9. What did you decide to use to span the two crates to form a table, when you answered question 5 above?
10. How will you protect yourself and the goods you sell when it rains? Draw the **structure** that you will use for protection.

A "container" is something that you use to keep things together in one place, like a paper bag for rice.

The table you will make, the crates that you use to make the table, the containers in which you get the eggs and the plastic bottles in which you sell the oil are all called **structures**.

There are many other things that are also called structures.

People design and make structures for different reasons. Many structures can help you to do one or more of the following:

- To **contain** or hold something, so that it is not all over the place, and to keep it apart from other things.
- To **protect** something, so that it is not damaged.
- To **support** something and hold it up.
- To **span** the space between two objects so that they are connected.

11. Can you think of a structure that can do more than one of these things?

8.2 Man-made and natural structures

Figure 8: A termite mound

Have you ever looked closely at a termite mound? It really is wonderful how it contains and protects termites and their food against the weather and against their enemies. There is a whole city in there!

The termintes rework the material (soil) to make it harder so that it can withstand shocks, while its shape allows rain to flow off it easily. It is an example of a natural structure and it is not man-made.

Man-made shelters have the same functions – to protect people and their belongings. Before man-made shelters such as houses and tents existed, people used caves or trees for protection.

There are many different structures around us. Some are built by us and some are already there in nature. The termite mound is a structure, but it is not built by people. We call structures like these **natural structures**.

A cup that you use to drink tea or coffee is also a structure. It is a **man-made structure** because it was made by people.

Look at the structures on the next two pages, and then answer the questions that follow.

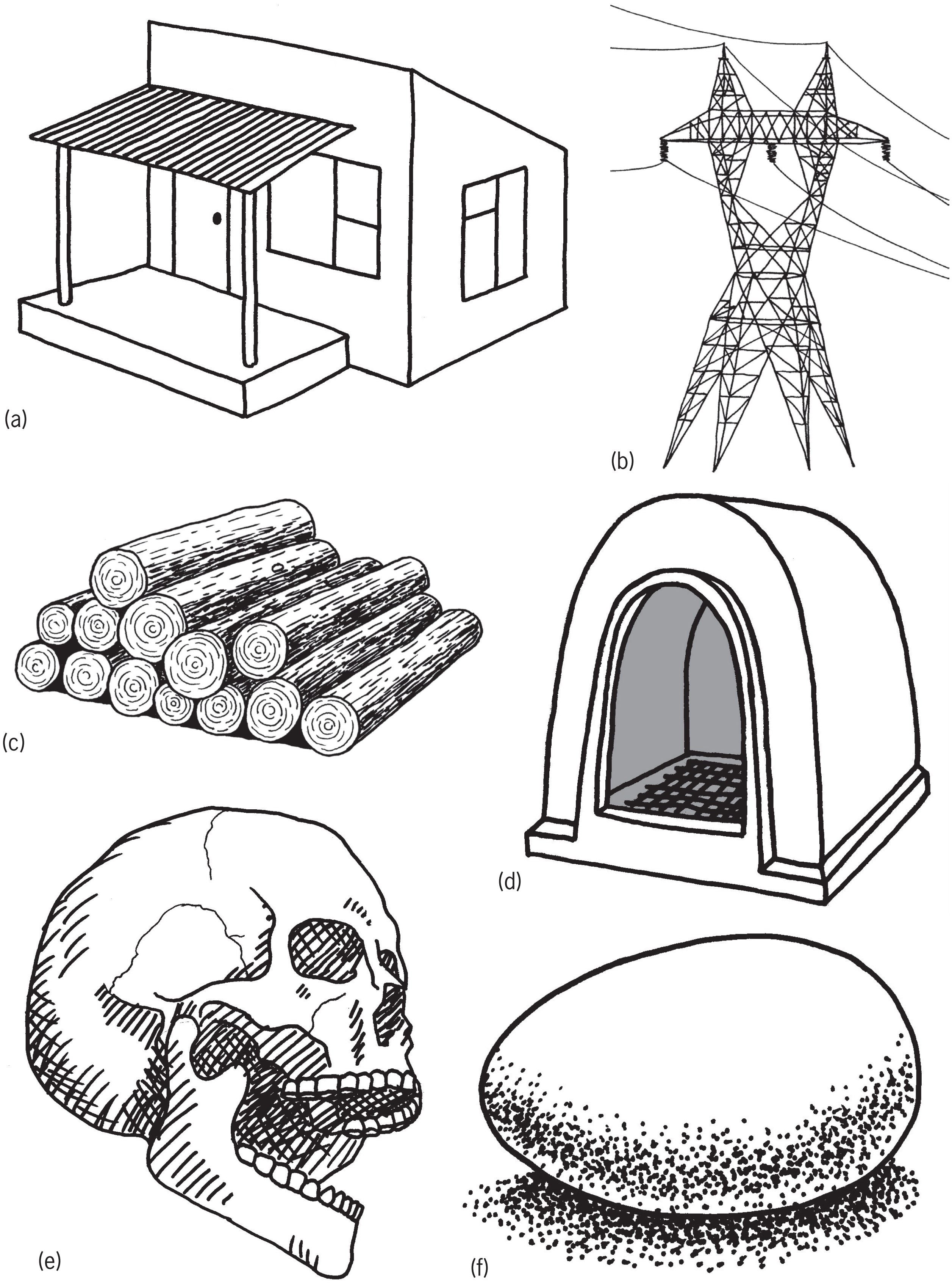


Figure 9

Figure 10

Classify structures

1. Draw up a table like the one below and classify the 12 structures on the previous two pages as either man-made or natural structures.

Man-made structures	**Natural structures**

2. What other natural structures can you think of?
3. Name any three man-made structures that provide protection.
4. Name any three man-made structures that provide support.
5. Name any three man-made structures that contain things.

8.3 Types of structures

There are three basic types of structures: **shell** structures, **frame** structures and **solid** structures. But some structures are a combination.

Shell structures

Most containers used to hold liquids or small solids are shell structures. Examples are coffee mugs, bowls for peanuts and bags for rice or sugar.

The strength of a shell structure is on its outside – in the shell.

Chicken eggs and empty ostrich eggs are examples of **natural shell structures**. Soccer balls or balloons are **man-made shell structures**.

Figure 11: Ostrich eggs were used as water containers by the San people.

Figure 12: Bees store their honey in honeycombs.

Figure 13: A rubber tyre is a shell structure.

Figure 14: A coffee mug is a shell structure.

Frame structures

A frame structure consists of different parts. These parts are combined in such a way to make the structure strong. A ladder and a bicycle are good examples of man-made frame structures. Spiderwebs are natural frame structures.

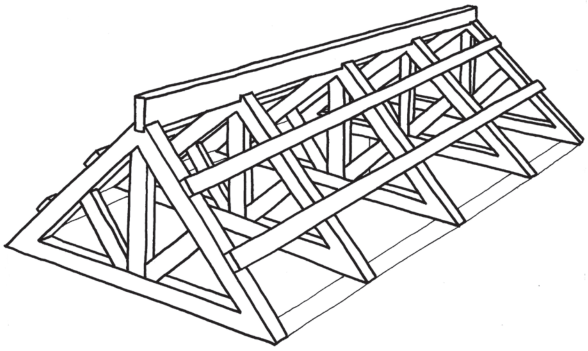


Figure 15: This roof frame is a frame structure made from wooden planks, a natural material. The planks support the roof.

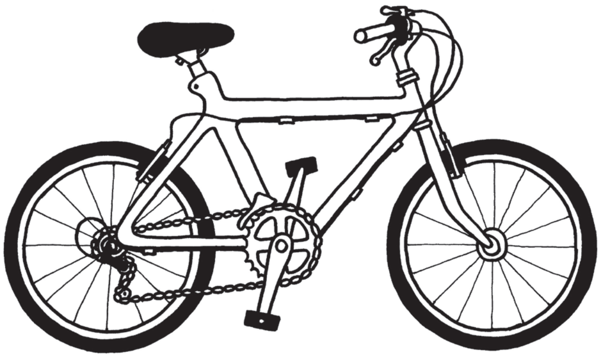


Figure 16: A bicycle frame consists of different metal pipes.

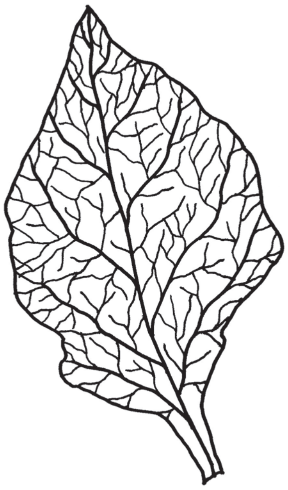


Figure 17: A plant leaf. Look at its veins. They form the frame of the leaf.

Solid structures

Structures like rocks, bricks and cement poles are solid. They do not consist of different parts with open spaces between them. A stone is a natural solid structure and is one piece of material. A brick is a man-made solid structure.

Figure 18: Stones

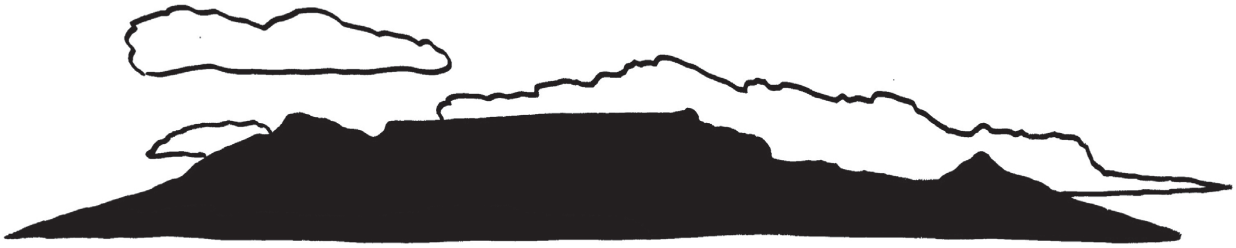


Figure 19: Table Mountain

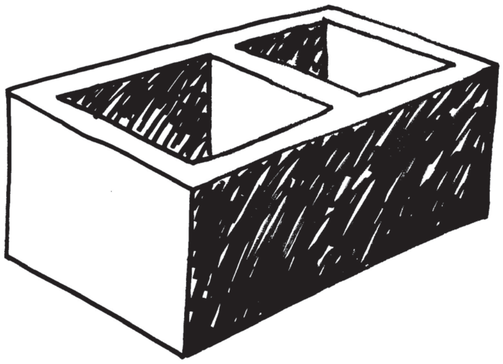


Figure 20: A cement brick

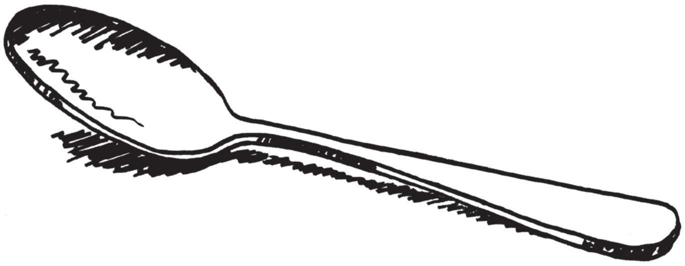


Figure 21: A teaspoon

Combined structures

A house is a good example of a structure that is a combination of shell, frame and solid structures.

- The bricks, roof tiles or roof sheets are all solid structures.
- The different rooms of the house is a shell structure.
- The framework on which the roof tiles or sheets rest are called roof trusses, and are frame structures.

Identify types of structures

1. Create a table with three columns, with the following headings:
   Shell structures, frame structures and **solid structures**.
   Classify the following structures as shell, frame or solid structures:
   a house; electricity pylon; tortoise shell; cell phone tower; human skull; brick; garden chair; spiderweb; dog kennel; wooden logs; chicken eggs and rocks.
2. Write more examples of each of the different kinds of structures in the table.

Support for water tanks

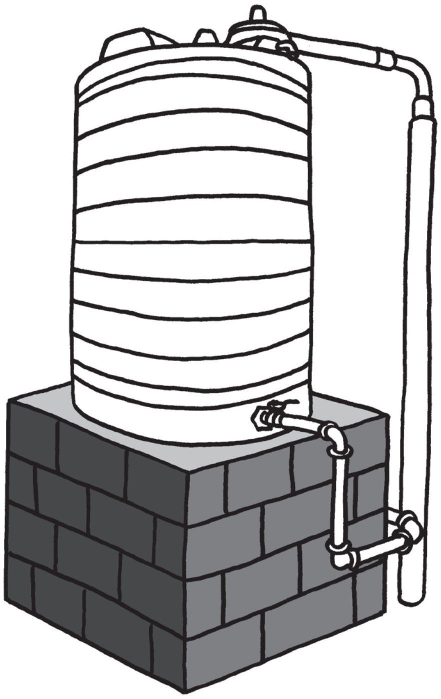


Figure 22: A water tank on a solid brick stand

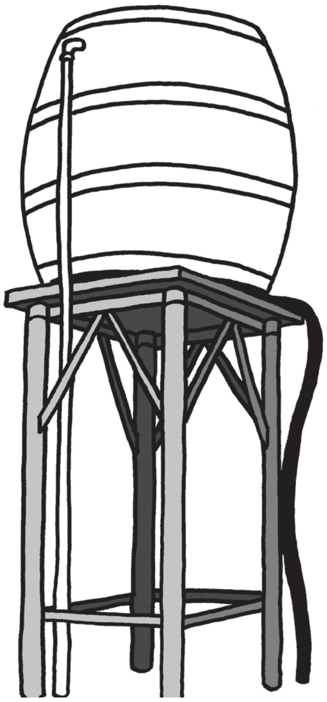


Figure 23: A water tank on a metal-frame stand

1. Name all the structures that you can see in the pictures above. In each case, say what kind of structure it is, and what its purpose is.
2. Compare the support structures for the two water tanks.
   (a) Which stand is a solid structure and which stand is a frame structure?
   (b) Which stand do you think is the stronger of the two? Explain why you think so.
3. Make a free-hand sketch of the metal frame stand and the tank.

Next week

In the next chapter, you will learn about different ways to make frame structures stronger.

Chapter 9
Frame structures

In this chapter, you will look at frame structures such as cell phone towers, windmills, pylons and mine headgear. You will learn how these structures are designed and built so that they are strong enough, and you will find out how the materials used in building these structures can be made stronger. You will also investigate the advantages and disadvantages of landline phones and mobile phones, or cell phones.

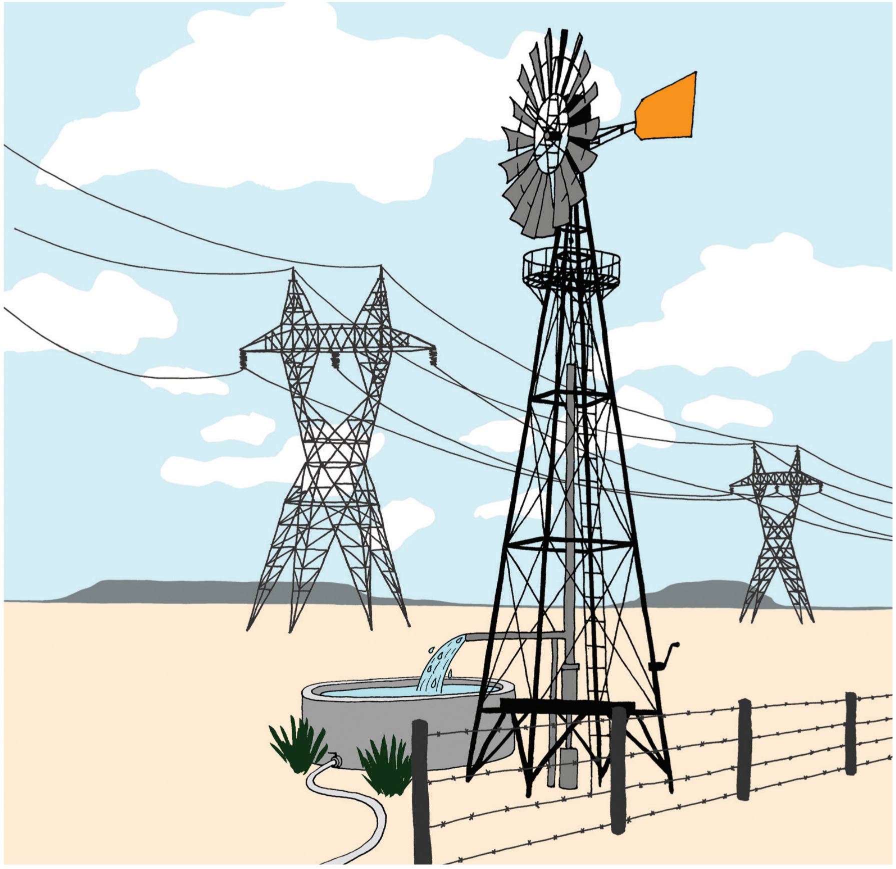


Figure 1

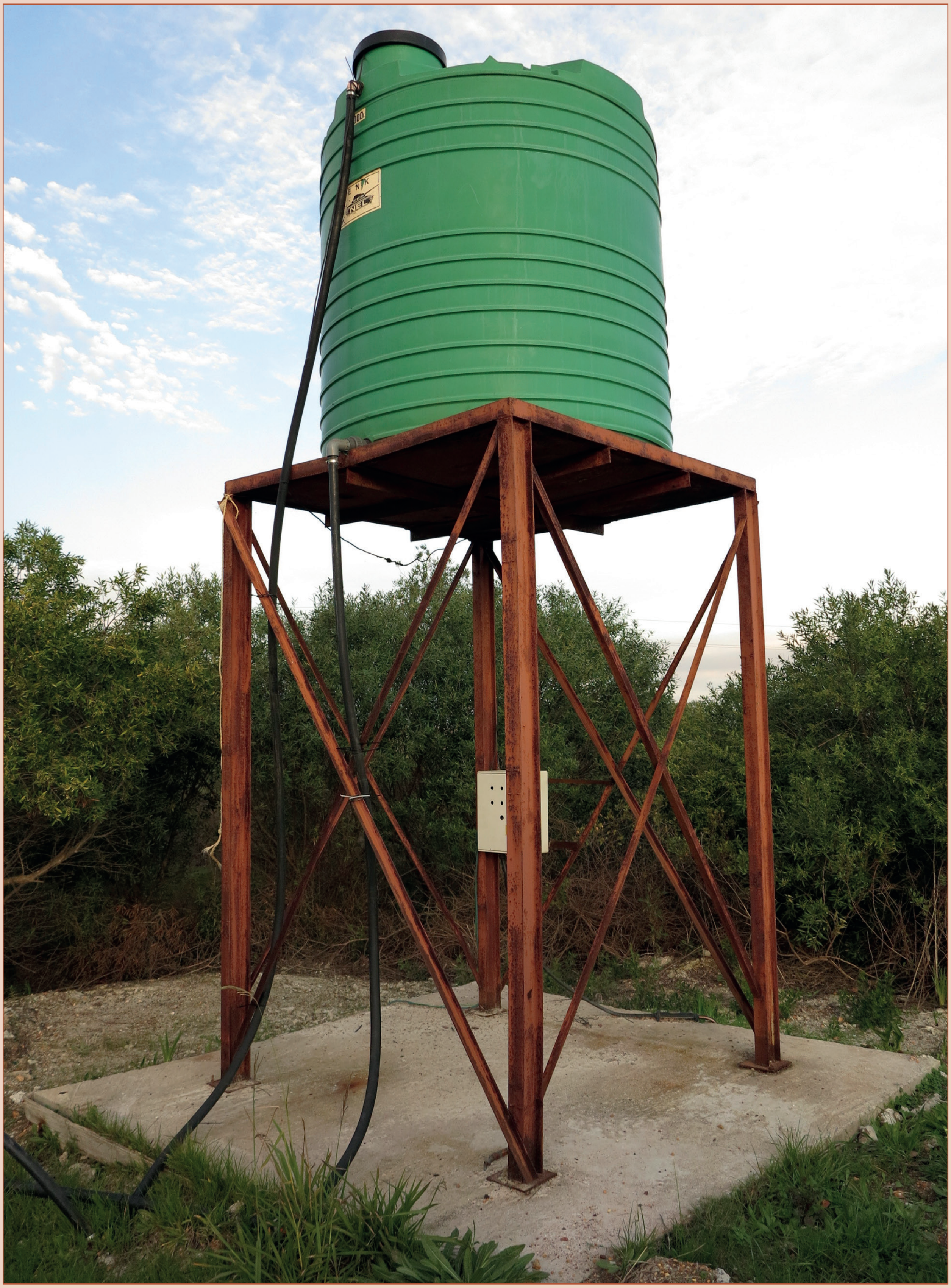


Figure 2

Figure 3

9.1 Strong frame structures

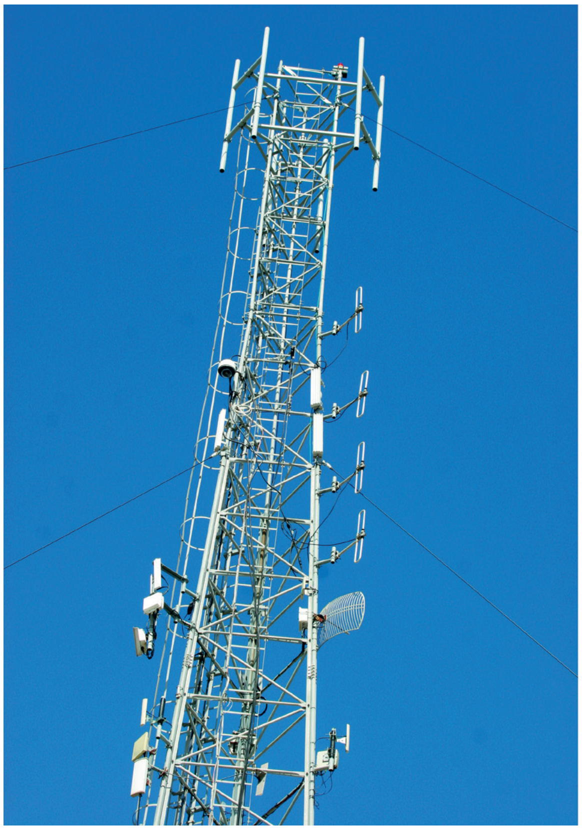


Figure 4: Cell phone tower


Figure 5: A windmill

When the wind blows so that the wheel of a windmill turns, water is pumped from a borehole in the ground. In this way, wind is used as a source of energy. In the same way, wind can also be used to generate electricity. Many years ago, before electricity was discovered, windmills were used to grind grain to make flour.

A cell phone tower is a tall frame structure with devices called wave receivers and transmitters at the top. When two people talk to each other using cell phones, the receivers and transmitters in a cell phone tower lets the waves from one cell phone reach the other cell phone.

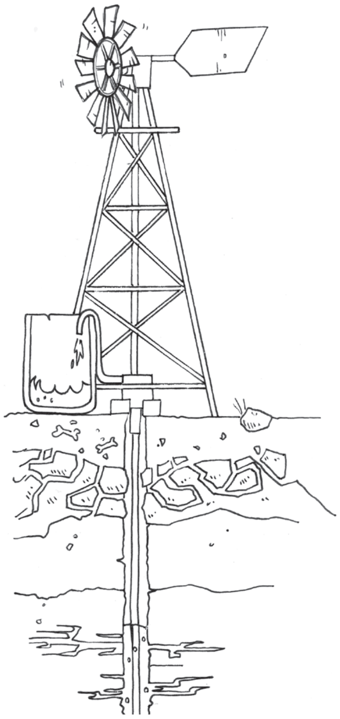


Figure 6

Examine towers

1. Copy the diagrams below. Draw some lines on them to make them look more like the tower of a windmill and a cell phone tower. Do not use a ruler. Just make a quick free-hand sketch.

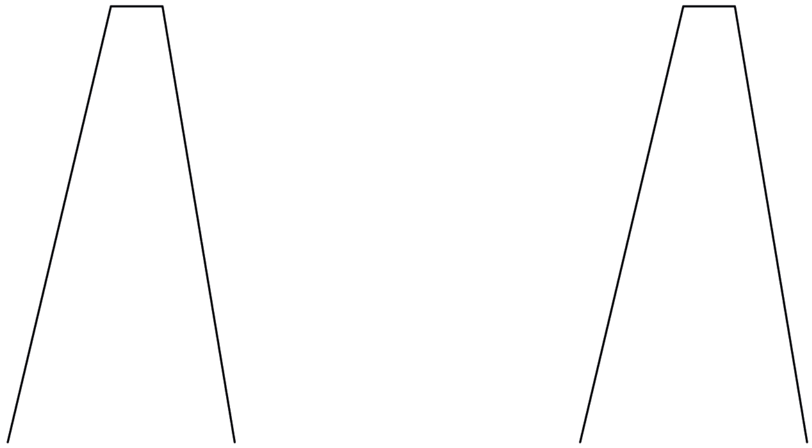


Figure 7

2. Why do you think windmill and cell phone towers are designed as in your drawing?

More questions about the structures in towers

Figure 8: Electricity pylons

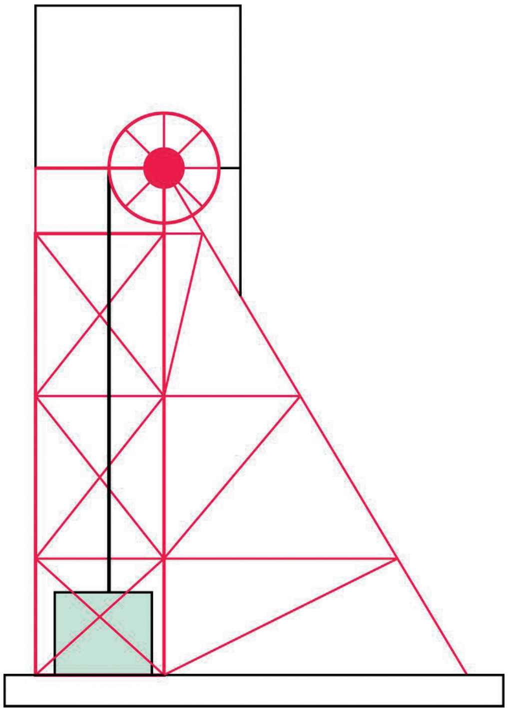


Figure 9: Mine headgear

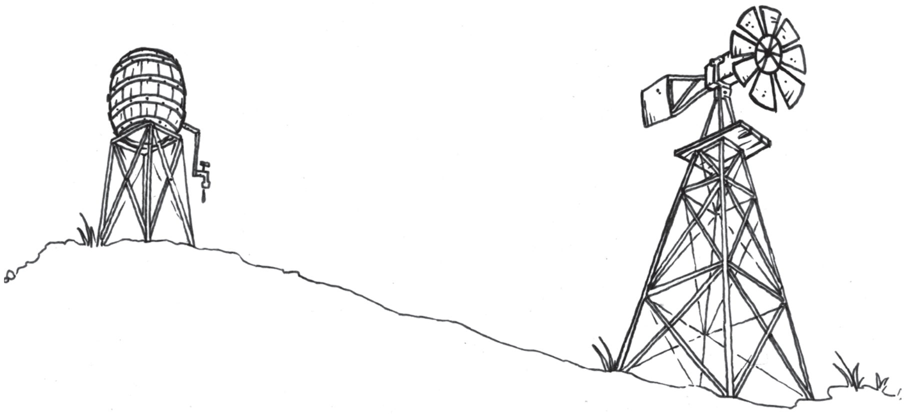
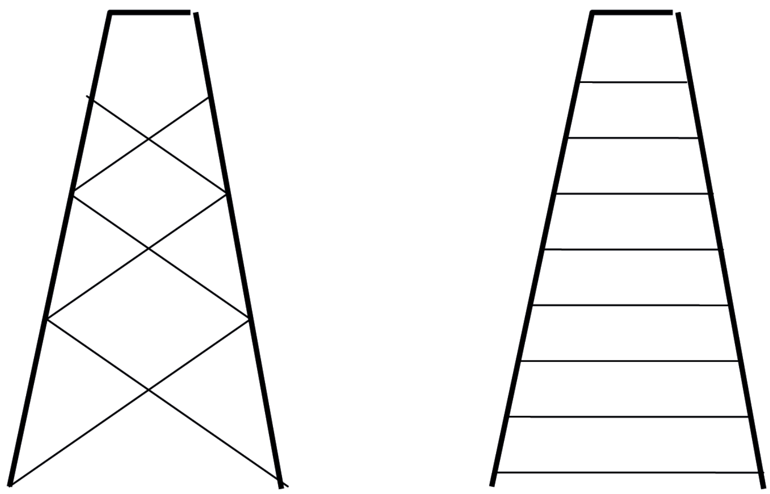


Figure 10

1. Look at the pictures and photographs that have been shown in this chapter so far. They all show frame towers. Do these towers look more like design A or more like design B below?



design A   design B

Figure 11

2. Copy the tower in design A. Draw dark lines on the sides of a triangle in the design. How many triangles are there in design A? Are there any triangles in design B?
3. Why do you think there are triangles in the towers?

9.2 Communication systems

Landlines or cell phones: Which is better?

Some people say it is better to use **mobile phones** than landlines. Others prefer landlines to cell phones.

A mobile phone is another name for a cell phone.

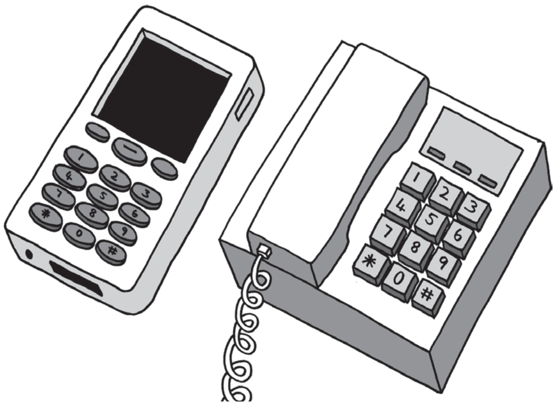


Figure 12

Read the conversation on the following two pages.

1. Why can't Mavis hear what Thomas is saying?
2. Phillip and Lebogang enjoy their conversation. Why are they not experiencing the same communication problem as Mavis and Thomas?
3. Draw up a table like the one below. Use it to describe four advantages and four disadvantages of using landline phones, and of using cell phones.

Device	Advantages	Disadvantages
Landline phones		
Cell phones		


Mavis struggles with homework. She decides to call Thomas on his cell phone, because she has free airtime.
Hello, Thomas!
Philip also struggles with homework. He doesn't have a cell phone, so he calls Lebogang using the landline phone.

Figure 13


Thomas picks up his cell phone…
KGG…BEEEEP!!!…GGG… ZKKRRT…HE…THO…FFFGG
Hello! Hello! Mavis is that you? I can't hear you!
Lebogang picks up the landline.
Hello Lebo! It's Philip. I'm really struggling with the homework and I hoped that you would be able to help me.
Of course, Philip!

9.3 Action research: Strengthening structures

Some materials are not suitable as building materials, but their properties can be changed and improved to make them suitable. You will now **stiffen** a flat sheet of paper to make it suitable as building material for models.

Stiffen: To make something rigid and strong.

Activity 1: Stiffen paper by tubing

Work in pairs.

You need:

- two sheets of A4 paper (preferably waste paper intended for recycling),
- masking tape or cellotape,
- glue, and
- a pair of scissors.

Look at the pictures below before you start.

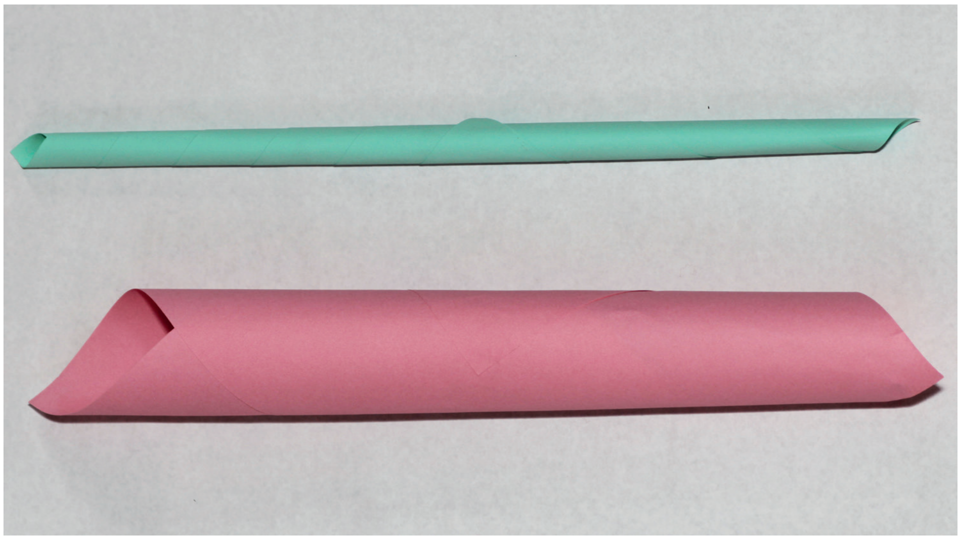


Figure 14

Partner 1: Roll a sheet of paper to form a tube with a centre hole that is not bigger than the centre hole of a toilet paper roll. Fasten the tube with tape to keep its shape.

Partner 2: Roll a sheet of paper into a tight tube with a centre hole, so that a pencil can almost not fit in. Fasten the tube with tape to keep its shape.

Hold the tubes at their ends. Try to bend each one. Which one bends more easily?

Tubing is also used to make strong paper straws. Look at the illustration below to see how to roll paper straws.

Glue down the last piece of the sheet of paper to prevent the straw from unrolling.

Cut off the thin ends of the rolled straw. Now you have a strong paper straw.

Home-made glue

Ingredients

1 cup flour

½ cup sugar

1½ cups water

1 tablespoon vinegar

Method

Mix the flour with sugar in a pot.

Add half of the water. Stir.

Add the rest of the water and stir.

Add the vinegar.

Heat until the mixture gets thick and shiny.

Leave to cool.

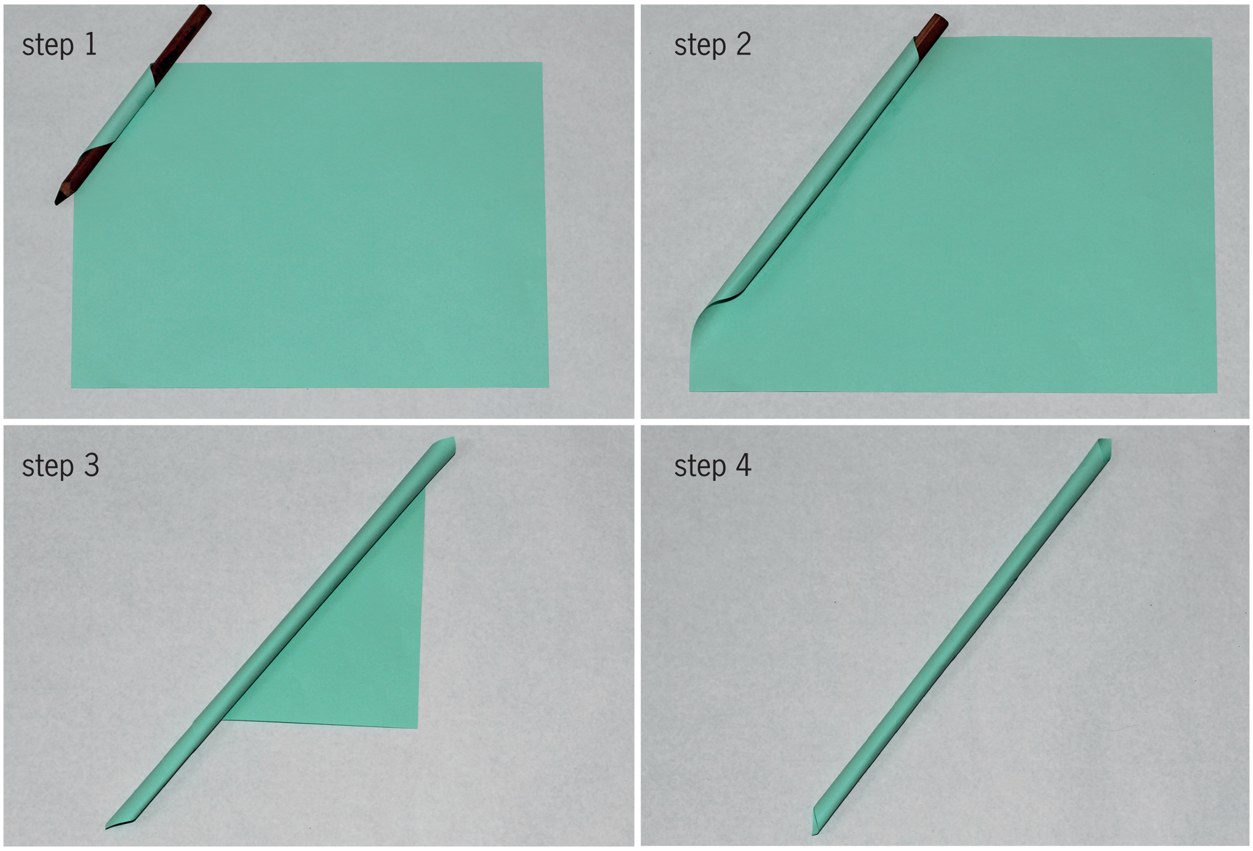


Figure 15

Activity 2: Stiffen cardboard by folding

Work in pairs.

You need some cardboard, sticky tape and a pair of scissors.

You also need two books. Cut two strips of cardboard, each about 30 cm long and 8 cm wide. Fold one strip along its length, in the middle, so that it looks like this:

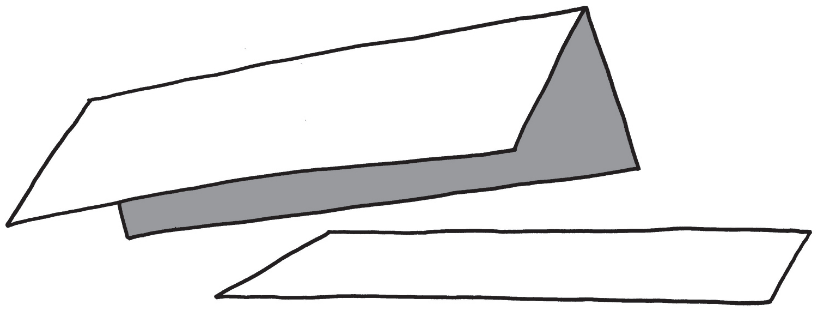


Figure 16

1. Which of the two pieces of cardboard will bend more easily?
   Investigate to check your answer.
   One person holds the flat strip of cardboard across two books as shown below. The other person presses down in the middle of the sheet of paper.

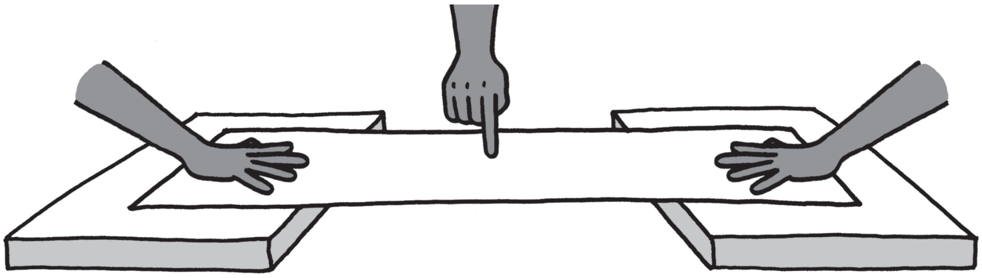


Figure 17

   Do the same with the folded strip.

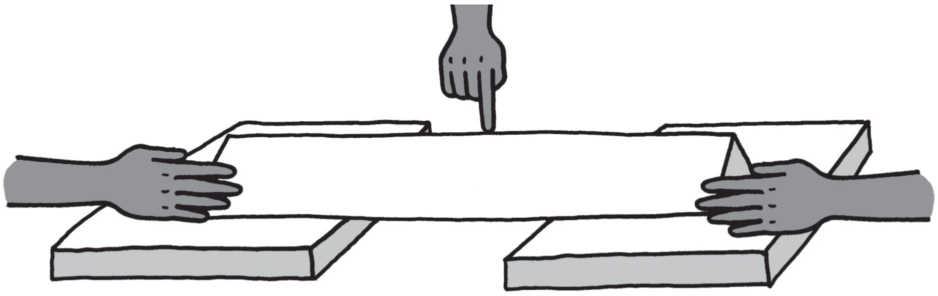


Figure 18

2. Which strip is the easiest to bend, the flat strip or the folded strip?

Activity 3: How to make shapes stable and strong

Work in groups of four.

Materials:

- a few sheets of A4 scrap paper,
- glue,
- thin wire or string, and
- a nail or awl to make holes with.

1. Each group should roll at least five paper straws.
2. Join four paper straws to make a four-sided shape. Look what happens when you push the sides of the square or pull the sides of the square. Does the shape change?

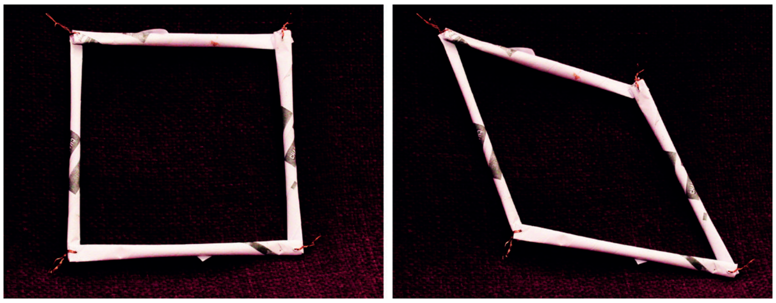


Figure 19

3. Insert another paper straw from the top left corner to the bottom right corner. Repeat the pushing and pulling actions. Does the shape change easily again?

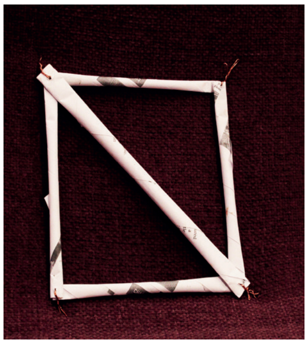


Figure 20

By turning the square into two triangles, you made the structure stable.

Making triangles in a structure is called **triangulation**.

4. Look at the shapes on the right. Decide as a group how you could make them stable.
   (a) Build the two shapes and test your ideas. One pair makes shape A and the other pair makes shape B.
   (b) Push and pull the sides of the shapes before you add extra paper tubes.
   (c) Add the extra tubes and then test your shapes. Are they both stable?

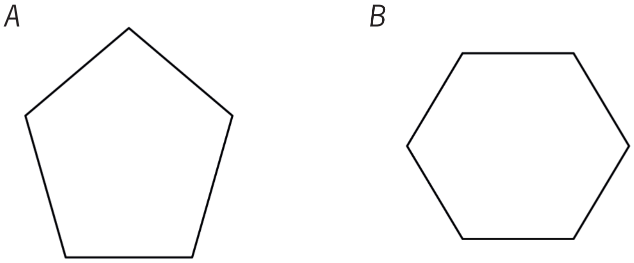


Figure 21

5. Copy the two shapes. Draw where you would add extra straws to create triangles.
6. How many paper struts did you use to turn shape A into triangles?
7. How many paper struts did you use to turn shape B into triangles?
8. Share your drawings with three other learners. Take a good look at where they placed the diagonal members to make their shapes stable.

Use triangulation to make paper strong

1. The drawing on the right is of one side of a bridge.

   It is not finished yet. Copy and complete the drawing to show how triangulation will be used.

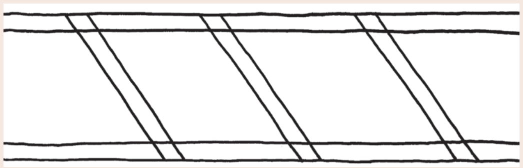
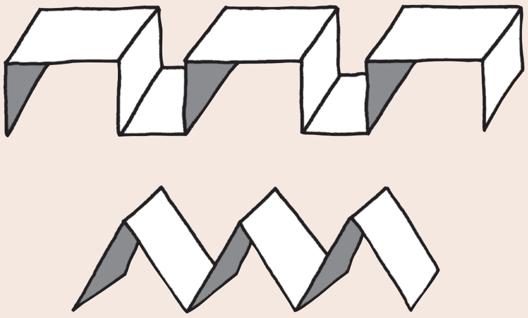


Figure 22

2. Below are drawings of two different frames.
   (a) Make them both, using paper or thin card. Use the same materials for both frames.
   (b) When they are finished, press lightly on each of them with one hand. You will feel that they can withstand a little pressure from above.

   The square frame is strong when you press straight down on it. It is weak when you press down on it from the side.

   The triangular frame can take pressure from the side as well.
   (c) Use the same material you used for the frames. Glue a piece on the bottom and the top of each frame. This will make the frame firmer.
   (d) Now test the strength of each of the frames. Place the same book first on the one and then on the other frame. Start with a fairly light book. If the frame does not break, add another book.
   (e) How many books could each of the frames take before it collapsed?
   (f) Which frame collapsed first?
   (g) Explain why the other frame was firmer.



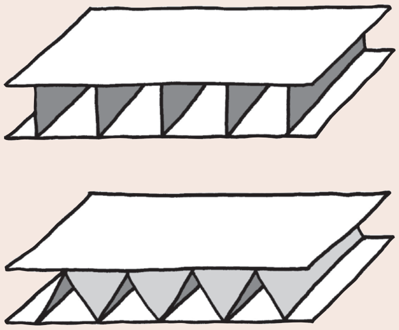


Figure 23

Next week

In the next chapter, you will learn about different things to keep in mind when you plan to build something.

Chapter 10
Things to consider

In this chapter, you will learn about **design issues**. Design issues are things to think of when something like a cell phone tower, bridge, building or power station is designed. They include the purposes of the object or structure, the cost, and how people and the environment will be affected.

Figure 1

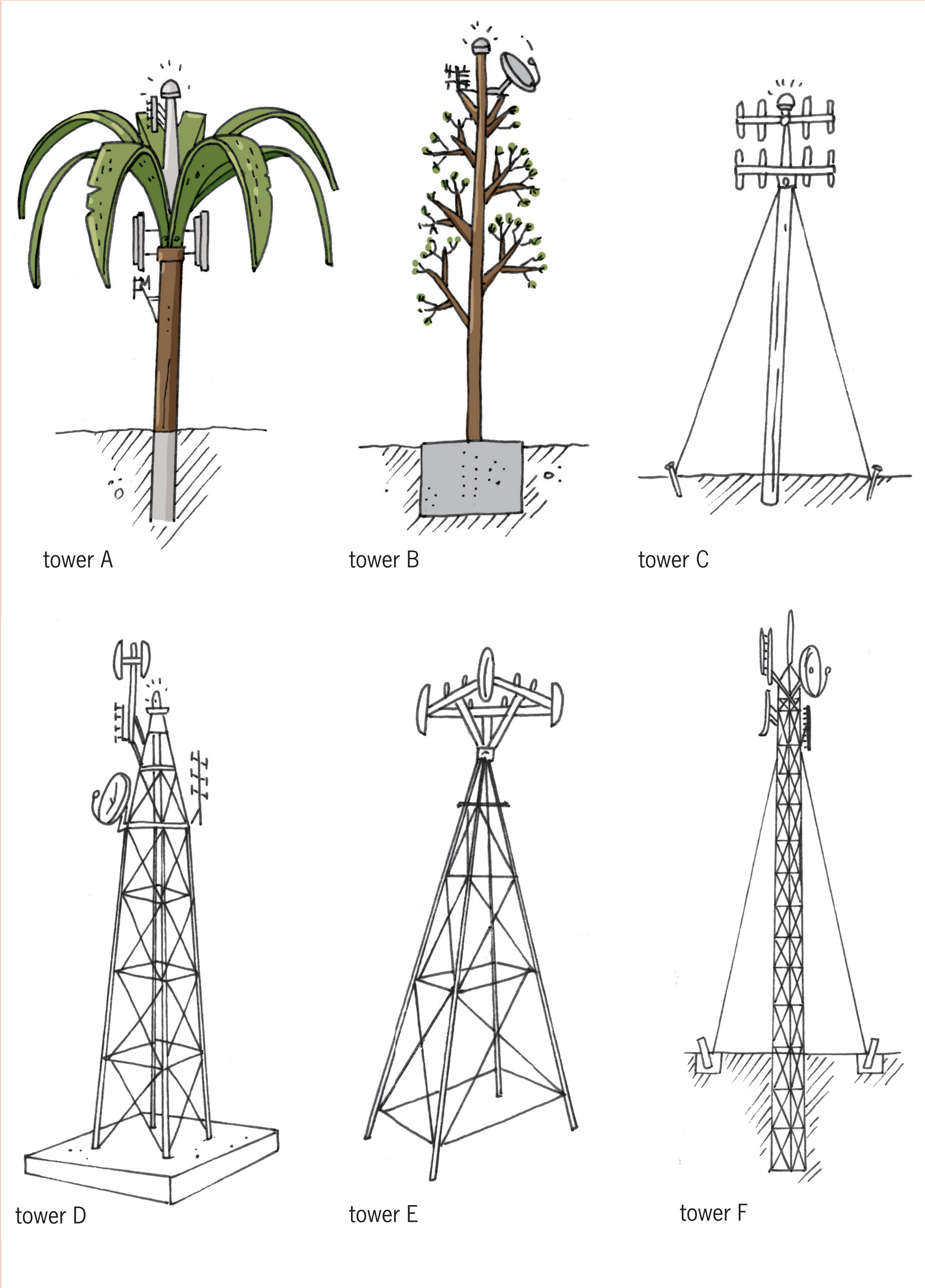


Figure 2

10.1 Why do cell phone towers look as they do?

Examine a few cell phone towers

On the previous page you can see pictures of different kinds of cell phone towers.

1. Why do you think tower A was designed to look like a tree?
2. Why does tower C have cables, while tower D has no cables?
3. Why will tower A not topple over and fall, even when the wind is strong?
4. Why does tower D have a large concrete block at the bottom, while tower E has no foundation?

When an ugly object stands in a beautiful environment, people say the object causes **visual pollution**.

When an object falls over easily, people say it is **unstable**.

The lower part of an object like a tower, on which it stands, is called the **base**.

5. Which of the towers on the previous page has the widest base? Why was it designed to have such a wide base?
6. Which of the towers do you think is most unstable? Why do you think so?

Investigate the centre of gravity

Fasten your pencil with sticky tape to a sheet of paper, as shown below. The end of your pencil must be at the edge of the paper as shown.

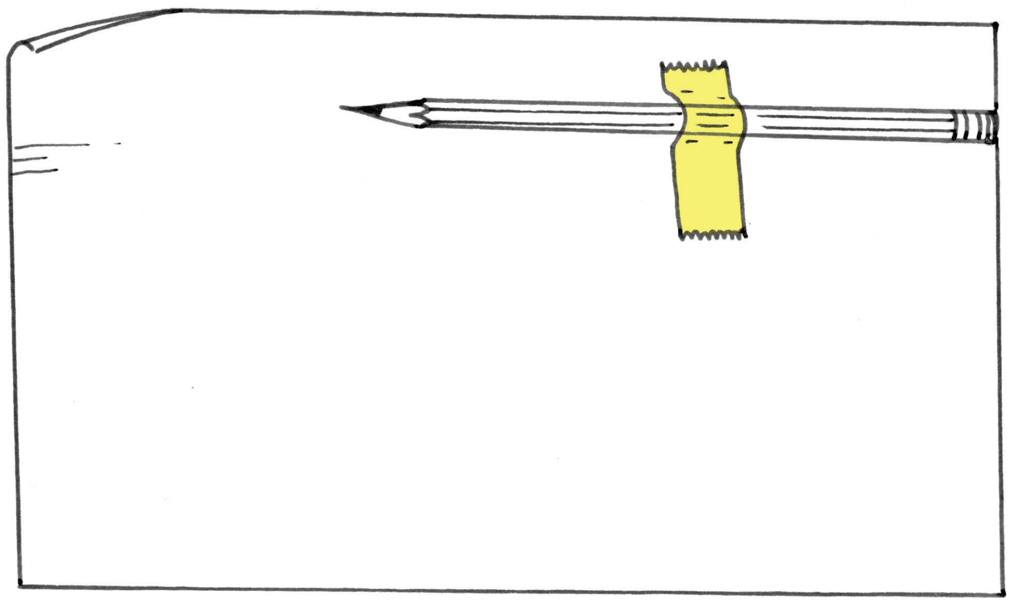


Figure 3

Now roll the paper around the pencil to form a long tube with the pencil inside. Tape the tube on the outside, where the end of the pencil is, so that it can't open up.

1. Try to make the tube stand upright on one end, as in Figure 4. Try this at both ends. What do you notice?

When most of the weight of an object is in its lower part, engineers say it has a **low centre of gravity**.
When most of the weight of an object is in its upper part, engineers say it has a **high centre of gravity**.

2. What is more stable, an object with a low centre of gravity or an object with a high centre of gravity?
3. Which tower on page 116 has the highest centre of gravity?

Figure 4

The following are different ways to prevent towers from falling over easily:

- Make the centre of gravity low. One way of doing this is to connect the tower to a heavy object at its bottom.
- Fasten the tower to the ground with cables.
- Plant the tower deep in the ground.
- Give the tower a wide base.

4. Look at the sketches of the six towers again. For each tower, say which method or combination of methods was used to make it stable.
5. Strong foundations help to keep towers from falling over. Which towers have foundations under ground level to keep them stable?
6. How do the underground foundations differ from each other?
7. Some of the towers are built from solid concrete or fibre glass. Other towers are metal structures. Why do you think the metal towers have triangles in them?

10.2 Things tower designers think about

What questions will you ask?

Suppose a new cell phone tower is going to be built in an area with no cell phone coverage. The mayor of the local municipality in that area invites you to visit him, and says:

> *"I want someone to write a document about the new cell phone tower. The document will be given to the engineers who will design and build the cell phone tower. When they read it, it must be clear what we want. Can you write that document?"*

He then says:

> *"You will need more information before you can write the document. To find that information, you have to ask questions. Which questions will you ask me and other people in the community?"*

Write down questions that you think will help you to find the information you need.

10.3 Give clear instructions

Suppose you are given the responsibility of ordering 100 new classroom desks for the school. The desks will be made at a furniture factory. This is the first time that school desks will be made at this factory. The people at the factory have no experience of making school desks, so you have to give them very clear instructions.

You will soon write a document for the factory manager, so that he can know what the school desks should look like, how big and strong they should be, and what materials they should be made of. Before you do that, examine your own desk in class to help you make decisions about the new school desks. The new desks do not have to be exactly the same as your desk. You can suggest desks that are different from yours.

Write a design brief and specifications for school desks

1. Now examine your desk and think about how you want the new desks to be made. Write notes, and make a few free-hand sketches too.

A document such as the one you will now write is called a **design brief** and the answers to your questions are called **specifications**.

2. Write the document that will be sent to the factory manager. Your document should include one or more drawings. State the dimensions of the school desk.
3. Make a 3D oblique drawing of the desk you want to be made.

Evaluate and improve your document

Read your design brief and specifications for school desks again, and then answer the following questions:

1. Does your document state whether the legs of the desk should be made of wood, metal or plastic?
2. Does your document say how wide the desk top should be?
3. Does your document say how high above the ground the desk top should be?
4. Does your document say how smooth or rough the surface of the desk top should be?

Instead of evaluating your own document, you can evaluate someone else's document. Your teacher could arrange this.

Try to think of other specifications that the factory manager might need, which are not given in your document.

5. Rewrite your design brief with specifications. Include a single vanishing point perspective drawing.

Write one more design brief and specification

Write a design brief and a specification for an FM radio or a cell phone. Use the drawings below to help you.

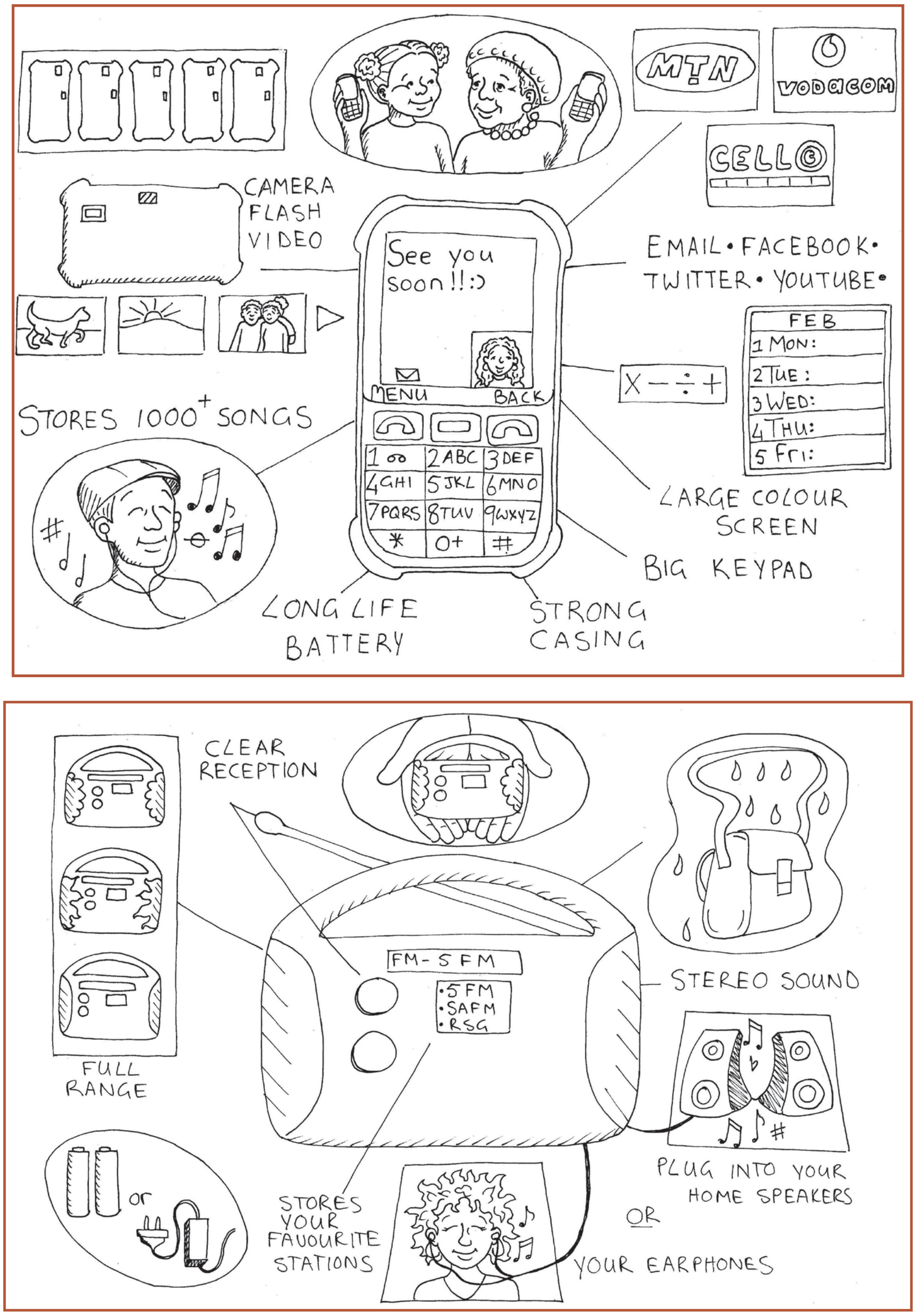


Figure 5

Next week

In the following weeks, you will design and build a model cell phone tower.

Chapter 11 PAT
A model cell phone tower

This chapter is a formal assessment task. It will count for 70% of your term work.

Over the next six weeks, you will design and build a model of a cell phone tower. You will work through the different stages of the design process to do this. Some of the work will be done in a group, and you will do some work on your own. Only the work done on your own will be assessed by your teacher.

Assessment

Investigate:

Design brief, specifications and constraints .... [15]

Design:

Improve your design .... [7]

Plan to make .... [10]

Make:

Building your model .... [22]

2D working drawing .... [16]

[Total: 70]

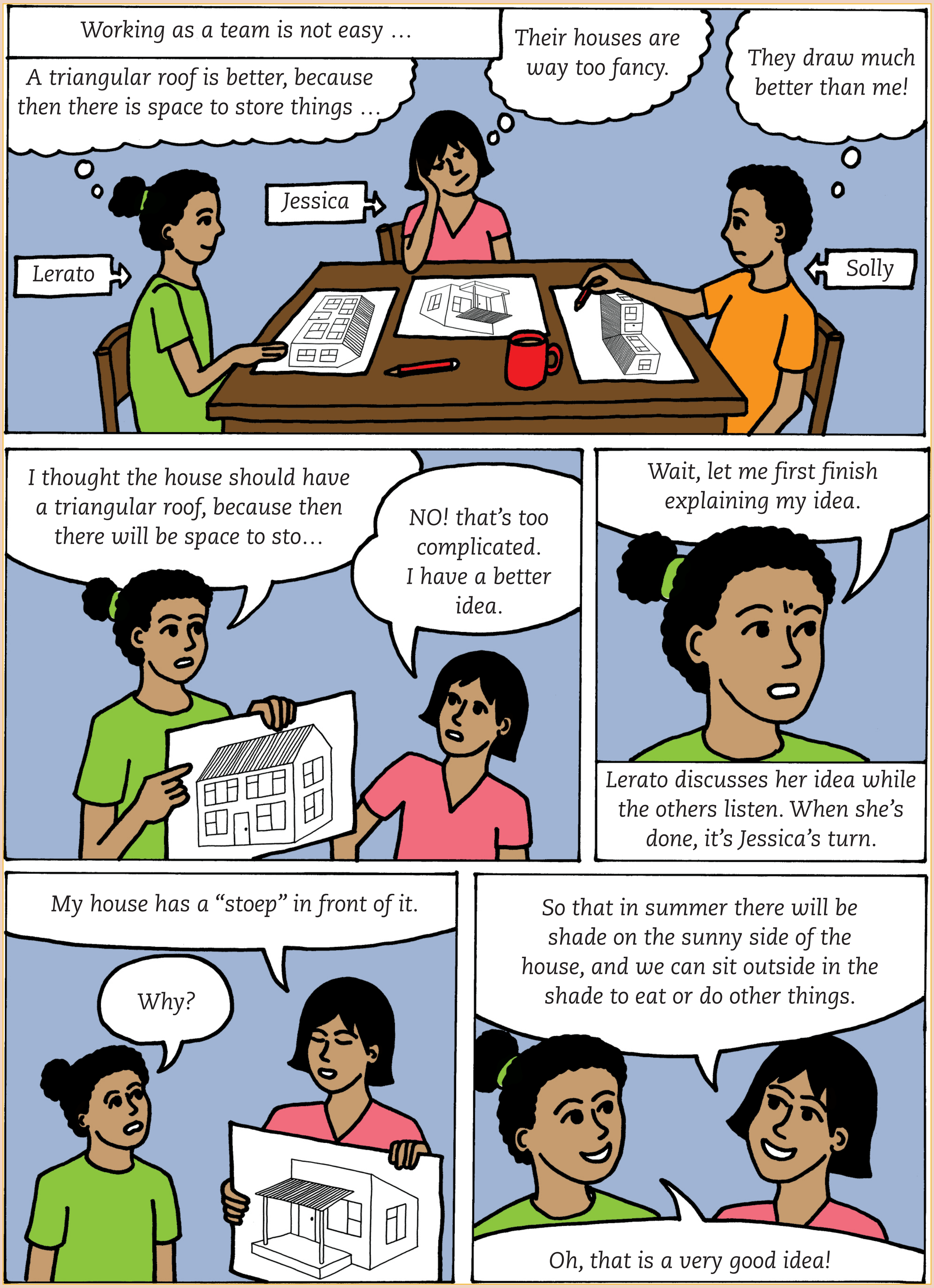

Working as a team is not easy …
A triangular roof is better, because then there is space to store things …
Their houses are way too fancy.
They draw much better than me!
Jessica
Lerato
Solly
I thought the house should have a triangular roof, because then there will be space to sto…
NO! that's too complicated. I have a better idea.
Wait, let me first finish explaining my idea.
Lerato discusses her idea while the others listen. When she's done, it's Jessica's turn.
My house has a "stoep" in front of it.
Why?
So that in summer there will be shade on the sunny side of the house, and we can sit outside in the shade to eat or do other things.
Oh, that is a very good idea!

Figure 1

Solly, you haven't said anything yet. Why did you design an "L" shaped house?
At my family's house, the wind often blows into the house when you open the front door.
So I designed a house where the front door will be sheltered from the wind by the "L" shape.
WIND
I like that idea a lot!
Where I live, the wind never blows much, but now I understand Solly's reason for designing his house in an "L" shape. Let's do it like that!
WIND
Soon, they're designing a lovely house together.
Wow! working in a team can be fun and very rewarding!

Figure 2

Week 1

Make a few decisions (30 minutes)

Your village is about to get cell phone coverage. A cell phone company is planning to build a tower on a hill next to your school. Once the tower is built, the people in your village will be able to use cell phones. For example, they will be able to phone the doctor, clinic or chemist when they get sick. Everyone is very excited and they can't wait to phone their family members who live far away!

Some people are worried that the tower will look ugly. They think that it will not look nice next to the school, that it won't fit in with the surroundings. They would prefer a tower that does not look like a tower.

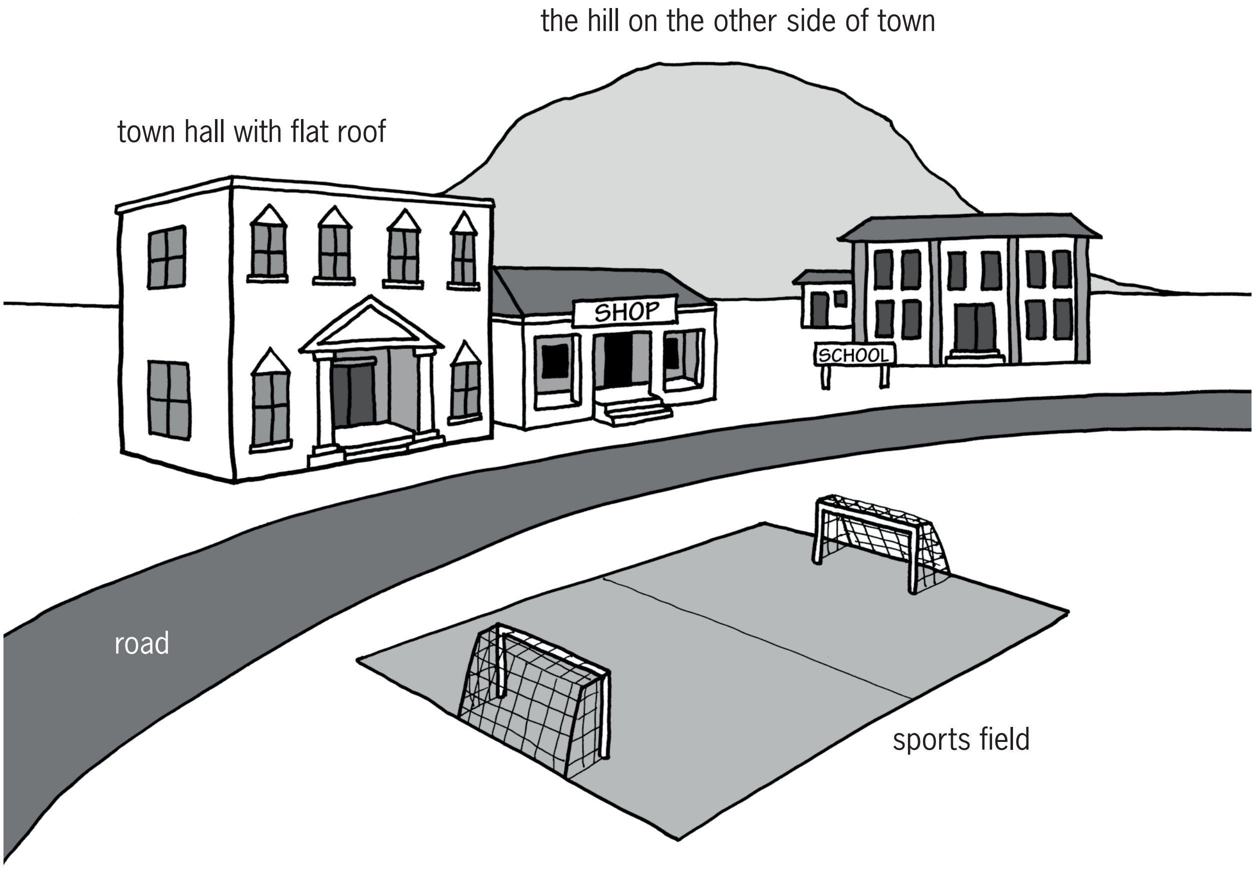


Figure 3

1. Read the story above the picture at the top of the page again, then look at the pictures of six different cell phone towers in Chapter 10. Which of those towers will make the people in your village happy?
2. The cell phone company sends one of their employees to the village. He talks to the people in the village to find out what the designer should keep in mind when she makes plans for the tower.

So he asks you:

"What are the three most important things I have to keep in mind when I design the cell phone tower for your village?"

You can start to answer by saying: *"The tower must be . . ."*

You can also start parts of your answer by saying: *"The tower must not . . ."*

You can mention more than three things if you want.

By writing your answers to the question, you have started to write a design brief and specifications for a cell phone tower.

3. Copy the picture of the village in Figure 3. Where do you think the cell phone tower should be placed? Also decide what type of tower it should be and make a rough drawing of the tower on the right place in the picture.

The cell phone company is looking for ideas for towers they can build. They have asked for your help. Your task is to design and build a model of a cell phone tower.

- Your model should be more than 30 cm tall.
- It should have a flat platform near the top of the tower. In a real tower, technicians will stand on this platform when they install or fix the transmitters and receivers at the top of the tower. The platform on your model should not be larger than a 10 cm by 10 cm square.
- The model should fit in with the surroundings. It must be camouflaged in some way.
- The model should be made from strong materials so that it will be stable.
- It should also be rigid and hold its shape.
- Your model should be reinforced using triangulation.
- You can use any suitable building materials for your structure, such as materials that can be found around your home. Examples are stiff reeds, thin, straight sticks, or hand-rolled paper dowels.

Think about your task, and make a rough sketch of what you think the tower should look like. Also make notes so that you will be able to remember later what you were thinking today.

Design brief, specifications and constraints (30 minutes)

Read through the situation and the information on the previous three pages before answering the three sets of questions below.

Have another look at Chapter 7 to refresh your memory about what the terms **design brief**, **specifications** and **constraints** mean.

1. **Write the design brief.**
   (a) What is the problem? [1]
   (b) Who will be happy about the new tower? [1]
   (c) How will it help them? [1]
   (d) Now write the design brief. Use the answers to the questions you have just answered. Start your paragraph with:
   I must design and make … [2]
2. **Identify the specifications.**
   (a) How should the tower be designed so that it will not look ugly? [1]
   (b) What should be at the top of the tower? [1]
   (c) Write down another specification, in your own words. [1]
   (d) Write down another specification, in your own words. [1]
   (e) Write down one more specification, in your own words. [1]
3. **Identify the constraints.**
   (a) At least how tall should your model be? [1]
   (b) How much weight should your model be able to carry? [1]
   (c) You can only use materials that you can find around where you live. What are these materials? [3]

[Total: 15]

Plan for camouflage and strength (60 minutes)

There are towers almost everywhere. Some support electricity or telephone cables, and keep water tanks off the ground, while others, like church towers, show us what the building is used for.

Many people think towers are ugly. So some towers are covered with plants or things that look like plants. This is called "camouflage".

"Camouflage" means to cover or colour something to make it look similar to, and fit in with, the things around it.

Figure 4: Some insects camouflage themselves very well

Figure 5: This animal camouflages itself well

Start thinking about the model tower that you will build. Answer the questions below and also make a rough sketch with notes, so that people can understand your answers.

1. How will you camouflage your tower?

Towers are designed so that they are **stable**, **strong** and **rigid**.

- Something is **stable** if it does not fall over or collapse easily. The opposite of stable is **unstable**.
- Something is **strong** if it does not break easily. The opposite of strong is **weak**.
- Something is **rigid** if it does not bend easily. The opposite of rigid is **flexible**.

2. How will you make sure that your model cell phone tower is stable?
3. How will you make sure that your model cell phone tower is strong?
4. How will you make sure that your model cell phone tower is rigid?

Some of the people in the village may not like your design. It would be a good idea to give them a choice. Think about possibilities for a different design and make a new drawing with notes to show your new design. It should be completely different from your first design.

Week 2

Compare and evaluate designs (30 minutes)

Join two or three other learners (not more than two or three). Show both of your designs to each other.

Look at the designs of other learners and ask questions about any part of their drawing that you do not understand.

Make suggestions to other learners about how they could improve their designs.

Make notes of what other learners say about your designs so that you can remember it when you try to improve your design later.

Improve your design (30 minutes)

Decide which of your two designs is the best.

Look at your notes to remember what your classmates said about it. Now think about ways to improve your design.

Ask yourself the following questions to help you see how you can improve your design:

> Will the materials bend too easily?
> Will the tower fall over easily?
> Will the tower be strong enough to support the platform at the top?
> Will you have all the materials you need to build your model?

Can you think of other questions that would help you to improve your design?

Also think back to what you have learnt in Chapters 8, 9 and 10 about:

- how frame structures are reinforced to make them stronger and stop them from bending,
- how frame structures are prevented from toppling,
- the important features you identified when you investigated towers, and
- the need to avoid visual pollution.

Make a list of your planned improvements. You can also make a sketch.

Learn to make strong joints (60 minutes)

When a structure breaks, it is called **structural failure.** There are three main reasons why structures fail:

- **When the design is poor.** If you make a bucket with a hole in the bottom, it will not hold water. The water will run out through the hole. The structure cannot work as it should, and it cannot do the work it was designed for.
- **When the wrong materials were used.** The materials used for a structure must be strong enough for the load the structure has to carry. A child's chair will break when an adult sits on it, because the materials were not made to carry such a heavy load.
- **When the workmanship is poor.** When the handle for the pan you fry your food in is not firmly fixed, it will break off. Poor quality workmanship can lead to your hand getting burnt.

You will now practise making strong joints to help you build the model cell phone tower.

Work in a group of three.

You will need:

- handmade paper straws,
- glue (you can make your own – use the recipe on the right),
- wire,
- a thin card,
- sticky tape or masking tape, and
- a nail or an awl.

Home-made glue

Ingredients

1 cup flour

½ cup sugar

1½ cups water

1 tablespoon vinegar

Method

Mix the flour with sugar in a pot.

Add half of the water. Stir.

Add the rest of the water and stir.

Add the vinegar.

Heat until the mixture gets thick and shiny.

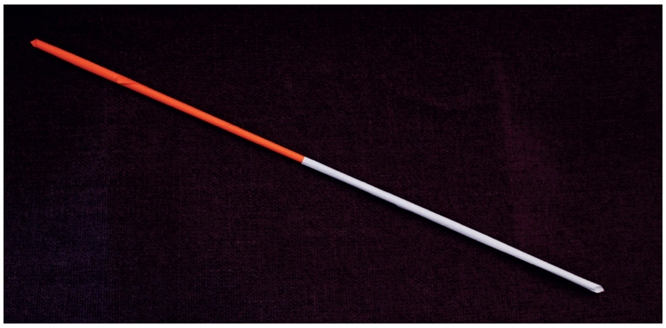
Leave to cool.

Look at the photographs on the next page.

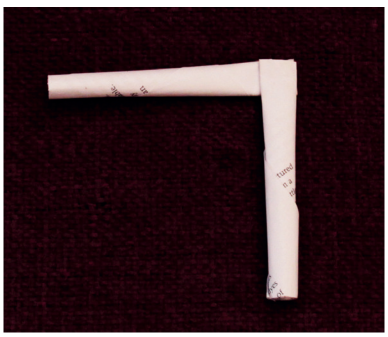
- Partner 1 makes joints A, B and E.
- Partner 2 joins straws, as shown in C and D.
- Partner 3 joins three straws with a paper "gusset", as shown in F.

Leave the joints overnight or longer, until they are completely dry.

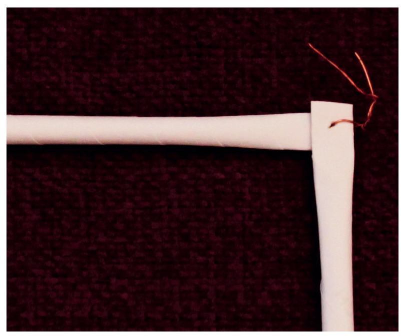
You will come back to these joints later.



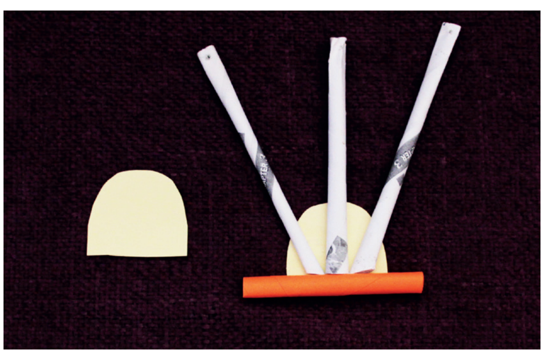
A. Joining two straws by pushing one straw into the other one



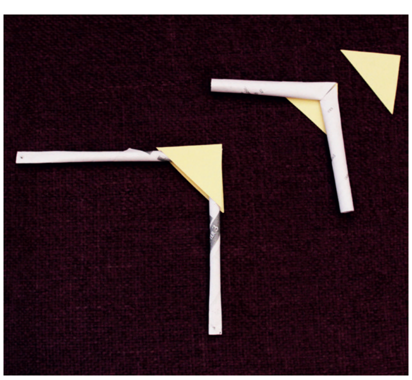
B. Joining two straws by pasting with glue



C. Using wire to make a joint



D. Using a card gusset to strengthen a joint



E. Making and using triangular card gussets to strengthen a joint

F. Making, cutting and pasting three-dimensional card joints

Figure 6

Work carefully with hot things, a stove or open flames.

Use a thick cloth or a pot holder to prevent burning yourself or others.

If you get burnt, hold the burnt area in cold water for 20 minutes.

Do not rub anything on the burn.

Use tools safely

Use tools for the purpose they are made for. Scissors are made for cutting – not for anything else.

It is also important to use tools correctly. If you have not used a tool before, ask someone who knows how to work with it for advice. Keep tools in good working order and pack them away after you have used them.

Week 3

List resources and make a working drawing (30 minutes)

Work on your own.

1. You have already made a design for a cell phone tower. Look at it again. Make a list of everything you will need to build the model.
2. Make a working drawing of your model. Your drawing should show what the model will look like from one side (a single 2D view). Use a ruler and show dimensions. The drawing should be half as big as the model will be. Label your drawing to show the different parts. Show what the parts and the joints are made of. The drawing should be half as big as the model will be.

The tools and materials that are needed to build something are called **resources**.

Form a team and choose a design (30 minutes)

Work in a team of three. Decide what role each team member should play.

Discuss each of your designs. Decide which design you think is best.

- You should choose a design that the team can make. Choose the best design or make up a new design that uses ideas from every team member.
- It is important to draw the design well.
- Everyone should understand exactly what the team will make before you move on to the next step.
- Remember that your design must include a platform on which workers can stand when they work at the top of the tower.
- Someone in the team has to sketch the new idea on a clean sheet of paper. It can be a rough sketch. It should show the materials that will be used and how the joints will be strengthened.
- Make your own drawings of some joints. Also make a copy of the drawing of the whole tower.

Plan to make (30 minutes)

Before any practical task is started, a lot of thinking, planning and preparation happens. We call this process of thinking and gathering tools and materials before we start, **planning to make**.

By now you have decided what your model tower will look like. It is time to start planning how you will build it.

Work on your own now. This work will be assessed by your teacher.

1. Make a list of all the materials you plan to use to build your model. [2]
2. Make a list of the tools you will use to build the model. Even a nail to make holes with can be called a tool. [2]
3. Think of your safety when using tools. Some tools can be dangerous if they are used incorrectly. Write down one safety rule for one of the tools you will be using. [2]
4. Think about the order of work. This is a list of all the steps you follow when you make the model. Below is the first step. Add a few more steps. [4]

   Step 1. Roll straws from scrap paper.

[Total: 10]

Week 4

Build the model

It is important that you finish building the model in the given time. Make sure you understand exactly how much time you have for each step.

If you don't finish in time, you will have to stop when the time is up and start with the next tasks, even if your model is not finished yet.

Remember to work safely and neatly.

Also remember to give each person a task or a part of the model to make. You can help each other, or two people can work together. Each person must work equally hard at building the model.

Pack away your model and its parts at the end of each lesson.

Keep the pieces together in a plastic bag or paper bag. Write your names on the bag. This will prevent your pieces from getting mixed up with someone else's.

Sometimes, a design does not work out. You can make changes and add things to your model while you are building it.

Do not waste time. It often takes longer to make a project than you might expect.

First build the tower without the platform.

You have this period and the next two periods to do this.

Have another look at the joints you made earlier. Ask yourself:

- Which joints will I make?
- Which joints worked the best?
- Which one is best for our model?
- Which materials will we use for the joints?

Decide how your tower will be anchored.

- Are you going to make a frame structure for a base?
- Are you going to use a foundation? What will you use, a piece of cardboard or polystyrene?
- Ask yourself if the tower will topple over, and if it will be able to carry the weight of two A5 textbooks.

Week 5

Finish building (30 minutes)

You have this period and the next one to finish your tower.

- Make sure that the tower stands upright and does not fall over.
- Build the platform and anchor it to the top of the model tower.
- Test if your tower can carry the weight of two A5 text books.
- Camouflage your model. Don't forget that your tower must fit in with the surroundings.

When you have finished, take a good look at your model.

Your teacher will evaluate your model. [Total: 40]

Are you unhappy with some parts of the tower? Make a list of the things that could make it better.

Make a 2D working drawing (60 minutes)

Work on your own. Each learner has to make their own drawing.

Make a 2D working drawing of the front view of your model tower.

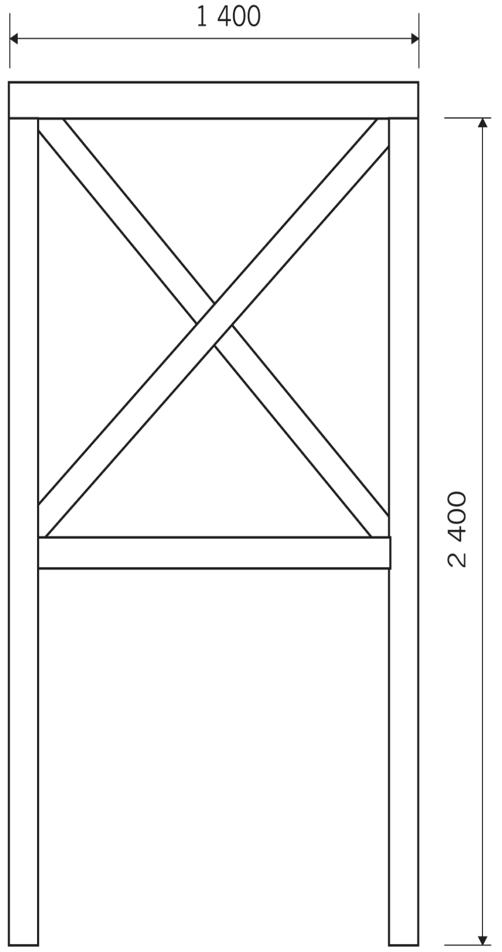
Your teacher will assess your drawing.

If you have forgotten how to do working drawings, go back to the work you did in Chapter 2 to remind yourself. You can also look at the working drawing of a water tank stand on the next page.

Your teacher will assess the following aspects of your drawing, so look at the list below to make sure that you have included everything.

Criteria for working drawings	**Tick**
The drawing has a heading.	
The heading includes the view that the drawing is drawn in, which is the front view.	
The outline of the drawing is darker than the dimension lines.	
The dimensions have only been written down once.	
The dimensions (measurements) are written in millimetres. You don't need to write mm, because this is the unit always used.	
All measurements are placed in the centre of the dimension line.	
Arrowheads are neatly drawn on either end of your dimension lines.	
The drawing is neat.	

[Total: 20]



Front view of a water tank tower. Scale 1:20

Figure 7

Prepare to evaluate (30 minutes)

Next week, you have to evaluate the designs of the other teams, and the towers they have built. To do this, you will develop an evaluation sheet. You will use the evaluation sheet to judge your own tower and the towers made by two other teams.

In week 1 of the PAT, you were given the information that you used for your specifications. Now use this information as your evaluation "criteria".

"Criteria" are ideas you use to judge something.

1. Work as a team. Change each of the criteria into a question you will ask. Draw up an evaluation sheet like the one below.
   - Your model should be no less than 300 mm (30 cm) tall.
   - It should have a flat platform on the top. In a real tower, such a platform is used by engineers when they need to work on the top part of the tower. You will use two A5 textbooks to test if your tower is strong enough to hold the radio transmitters and receivers.
   - The model should fit in with the surroundings. It should be camouflaged in some way.
   - The model should be made from strong materials to keep it stable.
   - It should also be rigid and hold its shape.
   - Your model should show reinforcement through triangulation.

Criteria	Good 3	Medium 2	Poor 1

2. Work on your own. Use the evaluation sheet from question 1 to evaluate the tower you and your teammates have built.
3. Join your teammates and compare your evaluations. Discuss it and try to agree on a final evaluation.
4. Draw up evaluation sheets like the one below for each team. You will use these sheets to evaluate towers built by other teams.

Criteria Team ___'s model	Good 3	Medium 2	Poor 1

Week 6

Plan your presentation (60 minutes)

Each team should prepare a presentation of their plans and model to the rest of the class. The presentation should be at least three minutes long, but not longer than five minutes.

1. Plan your presentation.
   - All the team members have to talk about the work they did when they built the tower.
   - One learner has to show and explain the design sketch. Tell the group how you planned to make the tower fit in with the surroundings.
   - One learner should talk about the problems the group experienced.
   - One learner should talk about how the group tested the tower.
   - Decide who will start and who will talk next.
2. Write notes about what you will do.
3. Practise your presentation. Then give your presentation during the last period of the week.

Hints for presenting

Stand up straight and look at the class when you speak.

Do not read your presentation.

Speak clearly, so that everyone can hear you.

Know when it is your turn to speak.

Keep to the time limit.

Next term

Enjoy your winter holiday! After the holiday, you will make things that work with electricity and magnets.

Terms 3 and 4

Term 3: Electrical systems and control | structures | mechanisms

Chapter 12
Magnetism

In this chapter, you will learn all about magnetism. You will investigate magnetic fields, and you will experiment to see which kinds of materials are magnetic.

Figure 1: The back of a speaker can be used to pick up certain items!

12.1 What is magnetism?

Some people use fridge magnets to keep notes or lists on the fridge's door. You even get magnets in the shape of words or letters that you can put on a fridge door to play with. The magnets make the letters stick to the metal of the fridge door.

Can you think of other ways in which magnets can help us in our daily lives?

In this chapter, you will learn about different types of magnets and how we use them in everyday life.

Thousands of years ago, humans discovered that a certain type of rock could attract iron. This rock was called lodestone. People believed that it had magical powers! Pieces of lodestone would also push or pull other pieces of lodestone.

Magnetism is a force that can attract (bring closer) or repel (push away) objects that have a magnetic material like iron inside them.

The ability to attract iron is called **magnetism**.

We now know that lodestone contains a material called magnetite, which is a kind of iron oxide. Iron oxides are chemical compounds of iron and oxygen. "Lodestone" is a natural magnet.

All magnets are able to attract other magnets or magnetic objects. Magnetic objects consist of iron or some other metals.

Experiment with a magnet to pick up paperclips. You will notice that if you hold the magnet far away, nothing happens. If you move the magnet closer to the paperclips, the paperclips will suddenly stick to the magnet.

Figure 2: Lodestone attracts pieces of iron.

Thinking about magnetism

Work in pairs and discuss these questions.

- What is it about a magnet that attracts these particular objects?
- Does a magnet have to touch a magnetic object to attract it?

To find out more about magnetism, do the following investigation.

Action research

You need the following for this activity:

- a ruler,
- a paperclip, and
- at least three different kinds of magnets.

Put the ruler flat on your desk. Place a paperclip so that it is in line with the zero mark of the ruler. Put one magnet at the other end of the ruler. Slowly push the magnet towards the paperclip, as shown in the picture. The moment the paperclip moves towards the magnet, stop moving it.

Look at the measurement on the ruler to see how far apart the magnet and paperclip were when they came together.

Repeat this with each of your magnets.

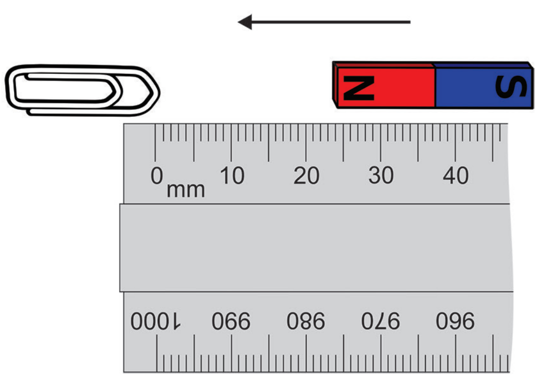


Figure 3

1. Copy and complete the table to show the distance at which each magnet attracted the paperclip.

	Distance from paperclip
Magnet 1	
Magnet 2	
Magnet 3	
Magnet 4	

2. Which magnet is the strongest?
3. Which magnet is the weakest?

A magnet has an invisible magnetic field around it. The field is stronger close to the magnet, and weaker further away. The magnet does not affect the paperclip until the paperclip is close enough, so that the force of the magnetic field on the paperclip is greater than the friction between the desk and the paperclip.

Stronger magnets can attract magnetic materials from further away than weaker magnets can.

A few questions to answer

1. Name three situations in which you have seen or used magnets.
2. How would you find out if an object is magnetic or not?
3. You have two magnets, one is magnet A, which can attract a paperclip from 10 cm away. The other magnet, magnet B, can attract a paperclip from 12 cm away. Which magnet is stronger? Explain your answer.
4. Why can a magnet have an effect on a paperclip from a distance? Explain this in your own words.

12.2 Permanent magnets and magnetic fields

The north pole of a magnet points to the Earth's magnetic north pole if it is allowed to swing freely on a thread.

You have learnt that magnets can pull certain objects towards them because the objects have a magnetic field around them. An object moved by a magnet becomes a "temporary" magnet. A temporary magnet is not a magnet all the time. When you move the paperclip within the magnetic field of the magnet, the paperclip also becomes a magnet. The paperclip loses its magnetic field quickly.

A permanent magnet keeps its magnetic properties for a long time. A temporary magnet acts as a magnet only as long as it is in the magnetic field of a permanent magnet.

A lodestone is a natural permanent magnet. You will investigate permanent magnets that have been made artificially. These magnets have a north end and a south end, but they can come in different shapes. There are two basic shapes of magnets that you will use: bar magnets and horseshoe magnets.

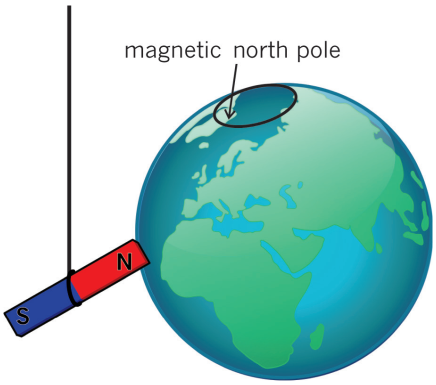


Figure 4: The north pole of a magnet points to the Earth's magnetic north pole.

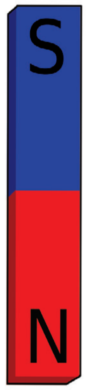


Figure 5: Bar magnet

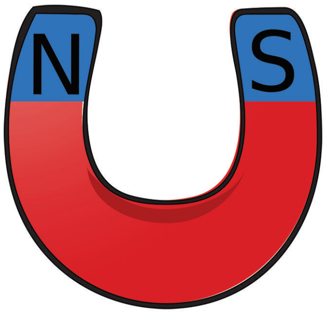


Figure 6: Horseshoe magnet

Bar magnets are rectangular, with a north pole on one end of the bar and a south pole on the opposite end of the bar. This means that the poles are far apart.

Horseshoe magnets also have a north and a south pole, but the bar is bent into a curved shape. This bend brings the north and south poles closer together than they would be in a bar magnet.

Let us investigate what the north and south poles of the magnet mean.

Investigating magnet poles

For this investigation, you will need two bar magnets, with the north and south poles marked. Work in small groups.

1. Hold a bar magnet in one hand and put another bar magnet on your desk. Bring the north pole of the magnet in your hand close to the north pole of the magnet on the desk. Write down what happens when you bring the north poles of the two bar magnets closer together (Figure 7 (a)).
2. Now bring the south pole of one of the bar magnets close to the south pole of the other bar magnet. Write down what happens when you bring the south poles of the two bar magnets closer together (Figure 7 (b)).
3. Now bring the north pole of one bar magnet close to the south pole of the other bar magnet. Write down what happens when you bring the north pole close to the south pole (Figure 7 (c)).

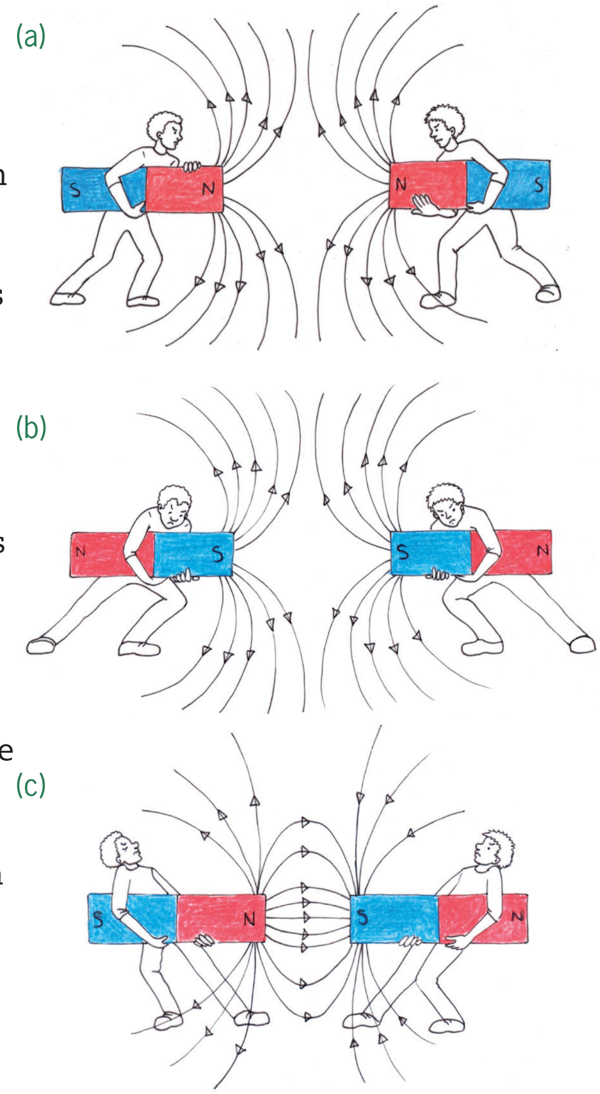


Figure 7

You should have noticed that as the north poles were brought together, there was a "resistance" to getting too close. This is why you found it difficult to get the north or south poles to touch each other. However, when you bring the north pole close to the south pole, they pull towards each other.

When the poles are the same, the force pushes them apart, but when the poles are different, the force pulls them together. So a north pole and a south pole attract each other, while a north and a north pole or a south and a south pole repel each other.

The magnetic field around each magnet has direction.

We say that unlike poles of a magnet attract each other and like poles repel each other.

Visualising magnetic fields (extension)

Although we cannot see magnetic fields, we can detect them using iron filings. Work in small groups to do this investigation.

You will need the following for this activity:

- two bar magnets,
- a piece of firm white paper, just bigger than the magnets, and
- iron filings.

Iron filings are tiny pieces of iron that look like a fine powder. Be careful – the filings will stick to the magnets, so you must make sure that you keep a piece of paper between the magnets and the filings at all times.

1. Put one of the bar magnets on the table in front of you.
2. Put the piece of white paper over the magnet.
3. Lightly draw the outline of the bar magnet on the paper, and mark the positions of the north and south poles.
4. Carefully sprinkle the iron filings onto the paper in the area of the magnet.

   You should see the iron filings making a pattern around the magnet. Gently spread the iron filings around the magnet so that you can see the whole pattern. Notice the places where there are lots of iron filings very close together and the places where the iron filings are more spread out.
5. Draw the pattern that the iron filings make.

The iron filings show you the pattern of the magnetic field. Each tiny piece of iron behaves like a magnet and lines up with the magnetic field around the bar magnet.

If you are not able to see the magnetic field pattern for yourself, here is a photograph of iron filings around one bar magnet.

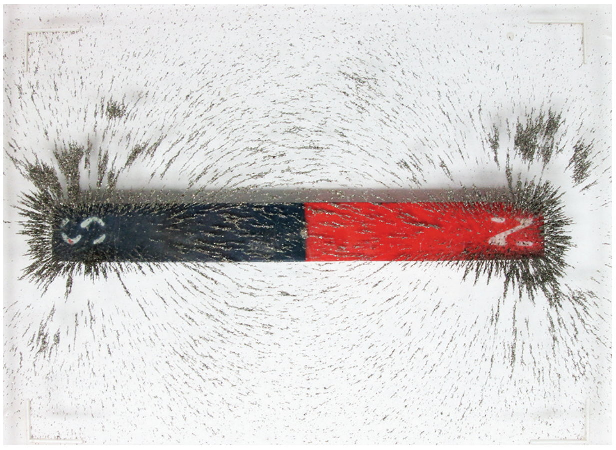


Figure 8

To draw a magnetic field around a magnet, you use lines to represent the path of the iron filings. Figure 9 shows the lines. These are called magnetic field lines. The lines always have arrows that point from the north pole to the south pole.

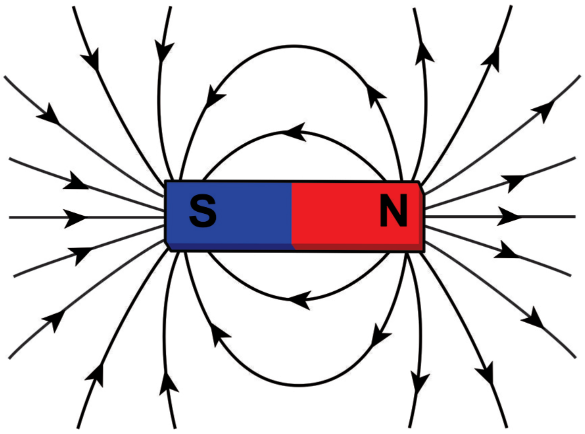


Figure 9

Notice the following about the magnetic field lines in Figure 9:

- The field lines have arrows on them.
- The field lines come from the north pole and go to the south pole.
- The field lines are closer together at the poles.
- The magnetic field is stronger in the places where the lines are closer together.
- Further away from the magnet the lines get further and further apart, showing that the field is much weaker.

Repeat the steps using two bar magnets with the north and south poles labelled. Put the north pole of one magnet close to the south pole of the other magnet. Put the paper over the magnets and sprinkle the iron filings on top of the paper.

6. Use field lines to draw the pattern you see. Draw the lines closer together where there are many iron filings and further apart where there are fewer. Do your field lines look like those in Figure 7 (c), where the magnets attract each other?
7. Now repeat the steps using the north pole of one magnet close to the north pole of the other magnet. Put the paper over the magnets and sprinkle the iron filings on top. Draw the pattern you see. Do your field lines look like those in Figures 7 (a) and (b), where the magnets repel each other?

12.3 Which substances will stick to a magnet?

Practical investigation

For this investigation, you will need the following:

- a bar magnet or a horseshoe magnet,
- pins,
- ceramic, such as a mug,
- iron nails,
- wood,
- plastic,
- copper,
- paper, and
- coins.

1. Group work. Hold a magnet close to each of the objects in turn. The material will either be attracted to the magnet, or not. Draw up a table like the one below, with a row for each material. Put a tick in the column that matches what you see.

Material	Attracted to magnet	Not attracted to magnet
pins		

2. List the items that stuck to the magnet.
3. What do you notice about all of the items that did stick to the magnet?
4. Are all metals attracted to magnets?

Did you see that the materials that do not contain metal did not stick to the magnets? That means that non-metals are not highly magnetic substances. We say that they are not magnetic.

Did you see that the only things that were attracted to the magnet were metals? Does that mean that all metals are magnetic? You will investigate this further in the next chapter.

All substances are magnetic in some way. However, many substances have very weak forms of magnetism, so that there is not enough attraction to make them move towards a magnet. Strongly magnetic substances will stick to a magnet.

Next week

In the next chapter, you will learn how people use the property of magnetism in the recycling industry.

CHAPTER 13
Investigation: Metals and magnetism

In Chapter 12 you learnt about magnets and magnetism. Now you will investigate which metals are attracted to magnets and which are not. You will also learn why it is good to recycle scrap metal and how this important work is done.

We can also recycle materials other than metal. Plastic, paper, cardboard and other materials that are often thrown away could be recycled instead. Since we are running out of basic resources, we need to reuse or recycle as much as we can instead of simply throwing things away.

You will start work on a recycling plan for your school by recording the waste produced by your school and how much of it could have been recycled. Many factories use waste materials, so you can develop a plan to raise funds for your school by recycling waste.

Figure 1: Metals used in the home

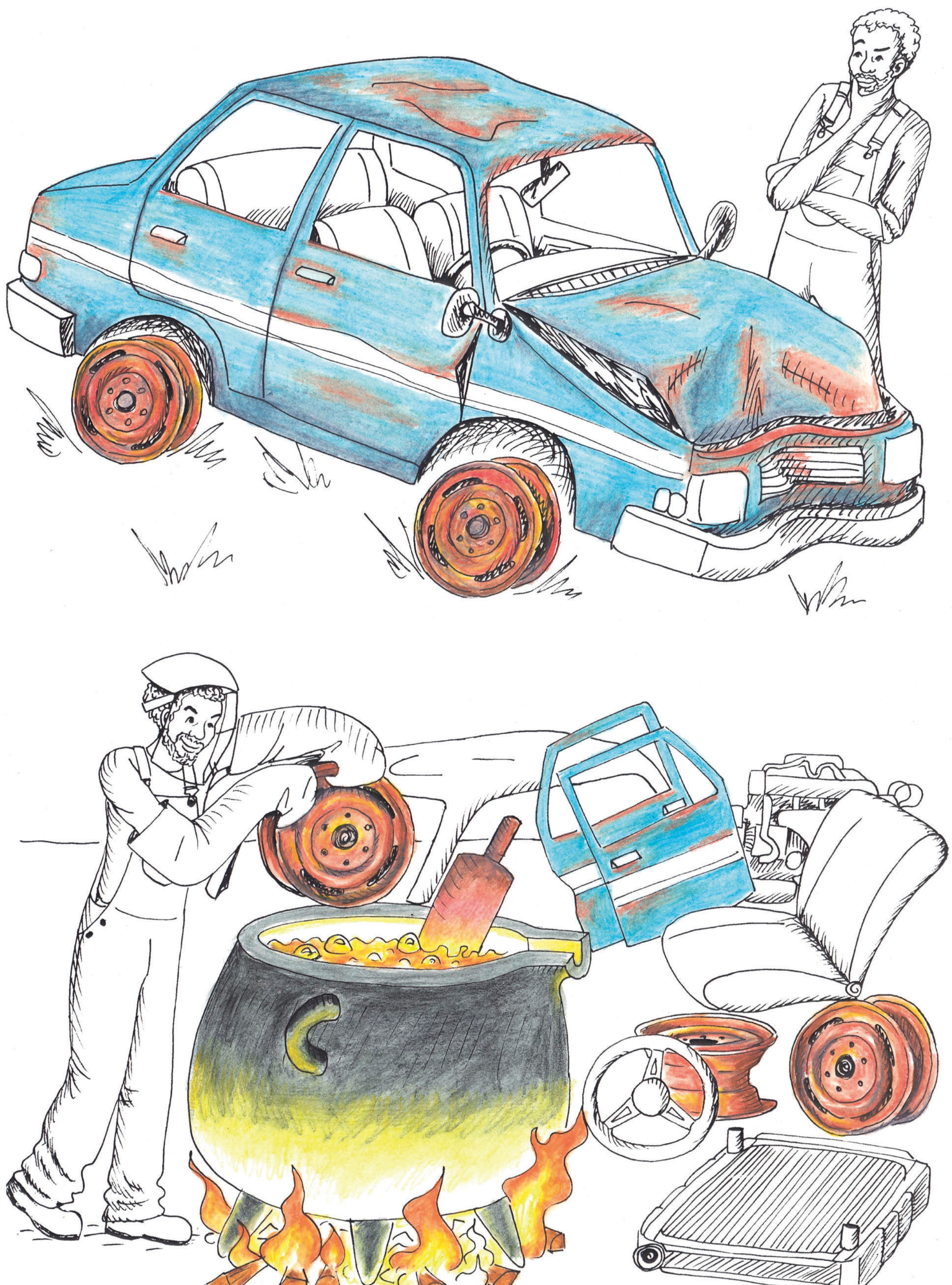


Figure 2

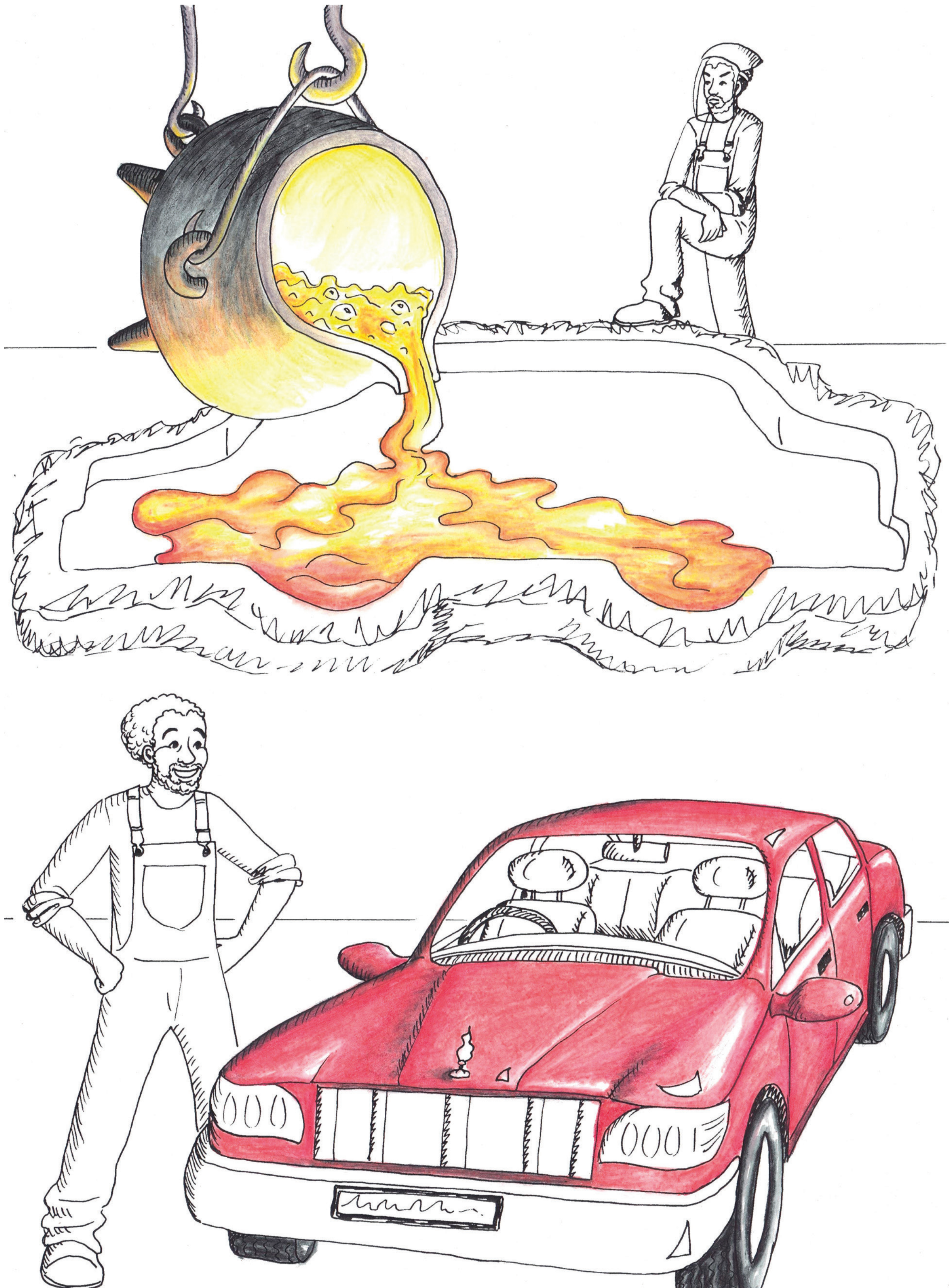


Figure 3

13.1 Magnetic and non-magnetic materials

You learnt about magnetism and magnets in Chapter 12. You learnt that non-metals do not stick to magnets, while other metals do stick to magnets. We say that these metals are magnetic.

Look at the objects made of different metals in Figure 4:

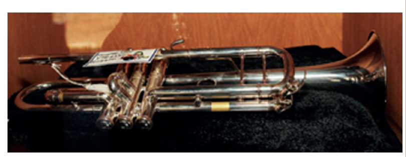
Steel electricity pylons

Cast-iron stove

Lead solder

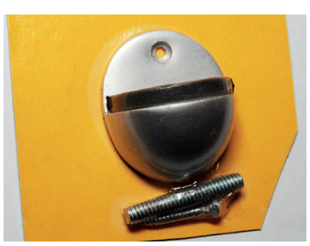
Copper beading

Brass horn. Brass is a mixture of copper and zinc.

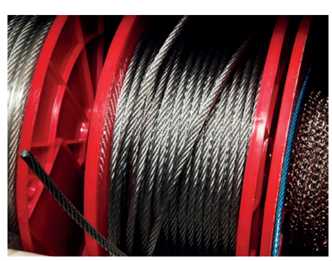


Silver trumpet (brass coated with silver)

Gold earrings



Nickel cupboard fittings (steel coated with nickel)

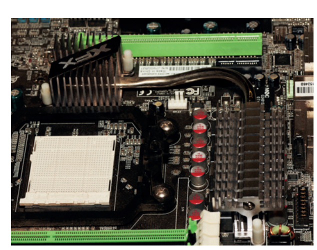


Steel cable

Bronze pot. Bronze is copper mixed with tin.

Steel keys

Tin can (steel coated with tin)



Aluminium computer parts

Figure 4: Some different types of metal

1. Do this task individually. Which of the objects are made of magnetic metals? Copy and complete the table below:

Material	**Is the material magnetic?**	
	Yes	**No**
Steel pylon		
Cast-iron pot		
Silver trumpet (brass coated with silver)		
Copper beading		
Brass horn		
Lead solder		
Gold earrings		
Nickel fittings (steel coated with nickel)		
Steel cable		
Aluminium computer parts		
Bronze pot		
Tin can (steel coated with tin)		
Steel keys		

How many pure metals are magnetic? If you said only three, then you are correct. They are iron, nickel and cobalt. Steel is also magnetic because it contains iron.

Many people think that tin is magnetic, but it is not. The tins that you buy food and other household goods in are actually made of very thin steel and are covered with another thin layer of tin to stop them from corroding. When you place a magnet next to a tin can, it is attracted to the iron in the steel, not the tin.

Often, you will see iron that has rusted. This is called corrosion. Rusty iron is still magnetic.

When a metal is in contact with oxygen, it forms rust over time.

Iron rust is also magnetic.

Tin and zinc don't rust easily, so we use them to protect iron and steel.

Figure 5: The coating of zinc has worn off this corrugated steel roof.

Investigation: Test which metals are magnetic

Common metal objects

In your daily life you see many useful metal objects around you. Some are very big, such as cars and buses. Some are very small, such as paperclips.

Draw up a table like the one below, with enough rows for 15 objects.

1. In the first column, list 15 metal items that you use or often see around you.
2. In the second column, write down what metal each object is made of. If an object consists of more than one metal, write down which metal makes up the biggest part. For example, cars are mainly made of steel.
3. Test the items to see whether they are magnetic or not. Write down your results in the last column.

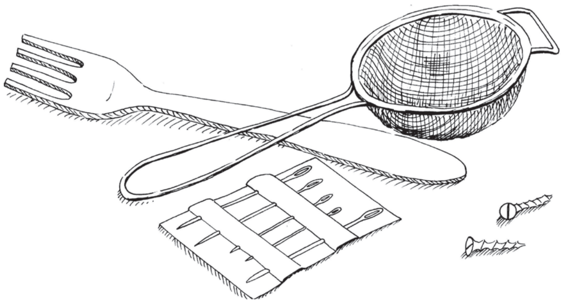


Figure 6: Things you find around the house: a fork, a strainer, needles and screws.

Object	Metal	Magnetic: Yes/No

13.2 Case study: Recycling scrap metals

Are you surprised that so many things we use every day are made of metal? We use different metals to help us with almost everything we do. This means that factories need a constant supply of metal so that they can keep manufacturing all these items. We use millions of tons of steel, aluminium and other metals every year. But the Earth's supply of metal will eventually run out. Can you think of the problems this will lead to?

Recycling means to use something over and over again. It may be in a different form, but we use the basic materials again and again.

The answer is to **recycle** the scrap metal. Everything that is made of metal can be broken up and sorted into its basic parts and used again. This will help to save the country millions of rand each year and will also stop us from using up all the planet's resources.

Metal is ideal for recycling as it can be melted down and reused without losing its strength.

Figure 7: Steel recycling bales

Collecting scrap metal

The process of collecting scrap metal for recycling starts when people learn to not throw metal objects away. Everything made of metal can be recycled and everyone has to make sure that nothing that can be reused is thrown away.

At home, make sure that all small metal objects, such as empty tins, are collected separately and sent to recycling centres. Bigger objects such as old household appliances will be collected by scrap metal dealers. Scrap metal dealers sort the different types of metals they collect into piles and send these to the factories. The factories then melt down the metal objects so that the metal can be used again.

Figure 8: The international recycling symbol. When you see this sign, it means that the materials used to make the product can be recycled.

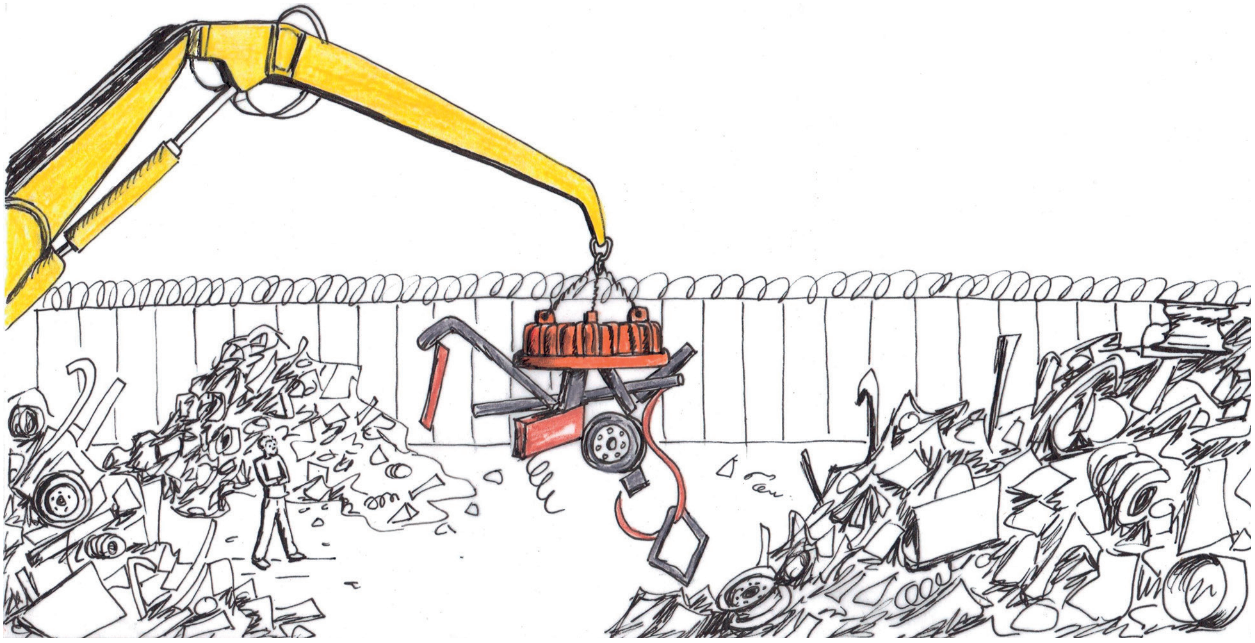


Figure 9: Scrap metal yards use magnets to sort piles of scrap metal.

Can you see how a magnet can be used to help sort piles of metal? Scrap dealers use large magnets to pull out the magnetic metals from the piles. This speeds up the process.

Making money from recycling

To encourage people not to waste valuable materials that can be recycled, scrap metal dealers will pay for scrap metal. They usually pay by mass, so it doesn't really matter what shape or form the metal comes in, it is the mass that counts.

But this can create problems too. Some people steal metal objects such as steel manhole covers and copper wire from telephone and electricity cables, to try and make money. Stealing these articles is not only dishonest, but it also puts other people in danger. If manhole covers are stolen, then there are holes in the roads that people can drive or fall into. Stolen electricity cables can cause loss of power.

Collecting scrap metal honestly: Your ideas

1. Do you think there are metal items that scrap metal dealers should not accept from people trying to sell them? Discuss your ideas with another learner. Write down the items you think scrap metal dealers should not buy.
2. List a few scrap metal objects that people can collect to sell to scrap metal dealers.
3. If you were collecting scrap metal to sell to a scrap metal dealer, how would you show that you had gathered the items legally? Here is an example: "I would get the owner of the house to give me a letter saying that he or she gave me the items."

   Write down any other steps you could take.

Identifying recyclable materials

Scrap metal is not the only recyclable material. Most waste can be recycled. There are companies that specialise in collecting all forms of recyclable waste, and this serves the community in many ways.

In the last section of this chapter, you are going to investigate what a recycling scheme for your school will achieve.

Class activity: Investigate recycling at your school

Before you start collecting materials, discuss in class which of the waste materials produced by your school could be recycled. Remember that it is not only your classroom, but the whole school.

Get one learner to write these items on the board, with a few examples of the materials you are likely to find at school.

For example:

Plastic: milk bottles, cold drink bottles.

Cardboard: food cartons, boxes.

How much recyclable waste is produced by the school?

- For the next week, keep a record of the amount of waste that the school produces.
- It would be helpful if the rest of the school knows that you are collecting recyclable waste. Ask your principal if you can have a special waste bin or small area where learners can bring their recyclable waste. If your school has extra waste bins, you could place them next to the normal bins and stick recycling labels on them.

Safety

When you are collecting waste materials, always wear gloves. Wash your hands thoroughly after you have finished sorting the material.

- Collect the recyclable material and sort it into piles. Put this recyclable material into clear plastic bags. Tie each bag when it is full and mark them clearly. Get advice from your teacher on where to store the material while you are collecting it.
- Find out if there are scrap dealers near you or your school who will collect the waste, and ask them how much they will pay for the various types of material.

13.3 Recycling plan for your school

Making money from recycling

You have been collecting and storing recyclable waste for one week. Now do the following exercises as a class:

- Gather all the waste you have collected and make sure it is correctly sorted: one pile for paper, one pile for cardboard, one pile for plastic.
- Place the piles into bags and mark them carefully according to what is in the bag.
- Weigh the various types of material. Work out the total amount of each material that you have.
- Multiply the weight of the material by the value the scrap dealer said they would pay for that material.
  For example:
  3 kg aluminium tins at R3,50 per kg: R3,50 × 3 = R10,50
- Total all the amounts for all of the materials.
- Discuss ways you could improve the collecting system.
- Discuss ways to make sure the whole school is involved and interested in this project.

Write an individual report on the value of recycling for your school

You have worked as a class to see how much recyclable material can be collected over a week from the school, and how much money could be made for school projects. Each of you must now write a report on the process.

You need to include the following topics:

1. Which materials could the school recycle?
2. What amounts of each material could be collected each week on average?
3. Who will collect the waste each day?
4. Where will you store the waste material safely and hygienically?
5. What scrap dealer or recycling company will collect the material, and how much will they pay for it?
6. Should you bring extra material from home or other collection points to add to the piles each week to make more money?
7. Should you involve the whole school in the project?
8. Write down new ideas about how to make the process of recycling more efficient while raising extra money.

Next week

In the next lesson, you will learn about simple electrical circuits, how to draw circuit diagrams, and how to make an electromagnet.

Chapter 14
Simple electric circuits

In this chapter, you will learn what an electric circuit is and how to connect all the parts of an electric circuit. You will learn how to draw circuit diagrams. You will also learn how electromagnets work and how to make a simple electromagnet.

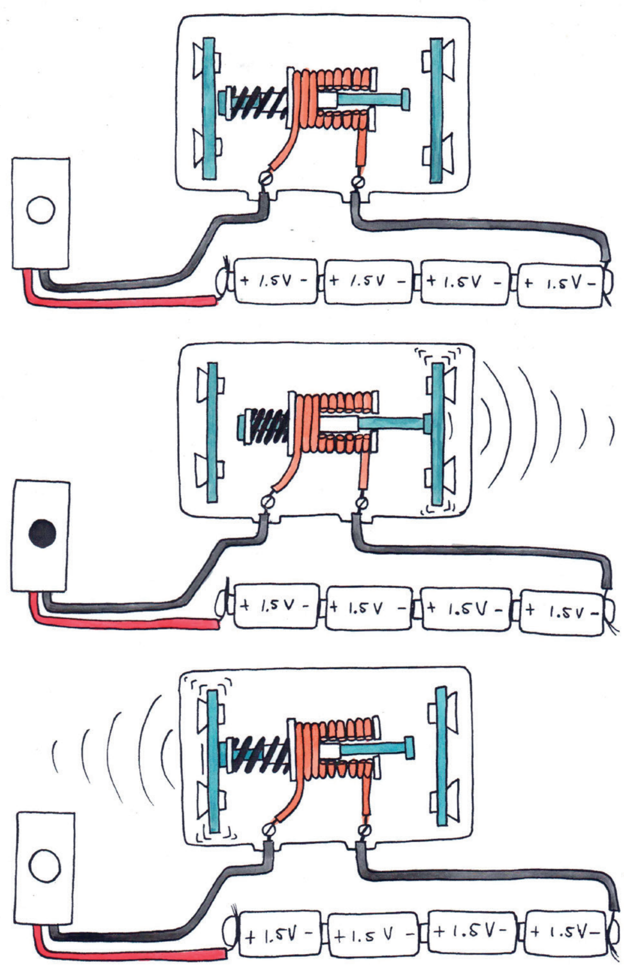


Figure 1: How does an electric door bell work? The coiled copper wire of an electromagnet forms part of the electric circuit.

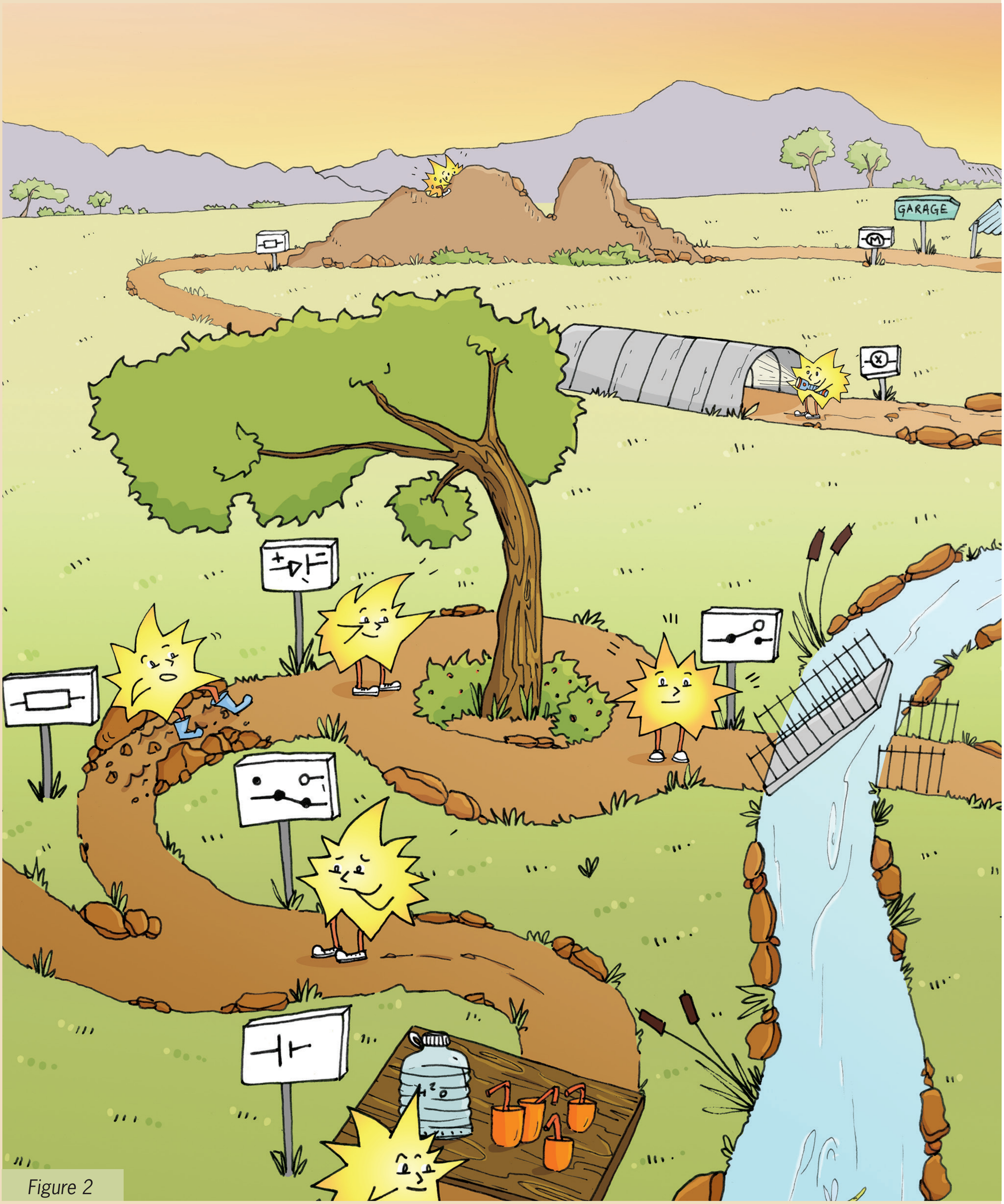
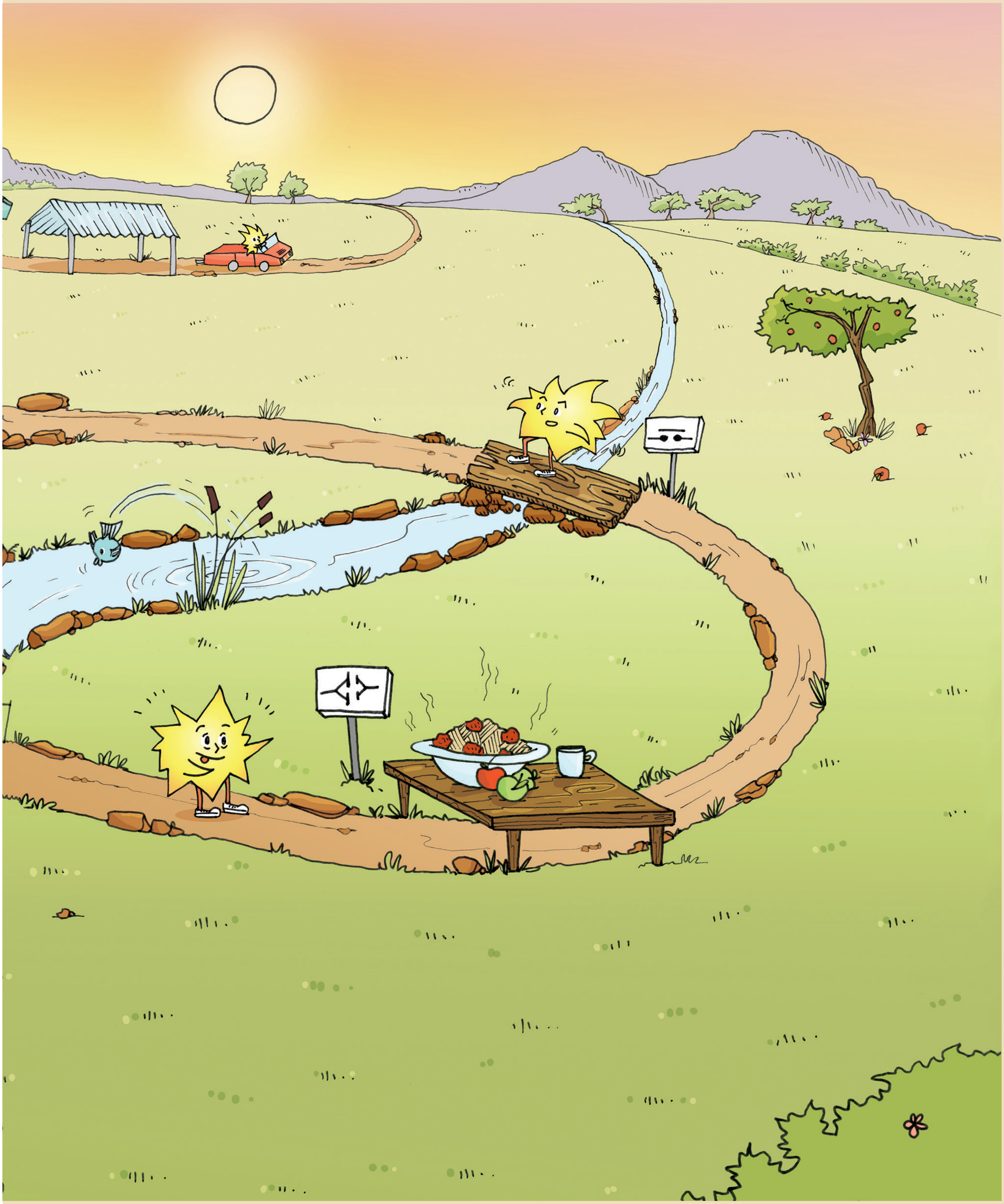


Figure 2



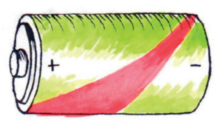
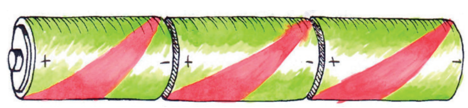
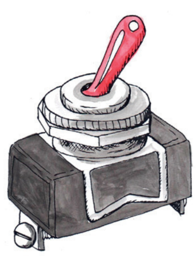
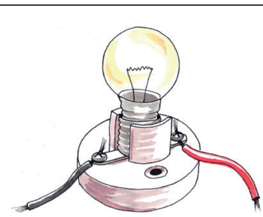
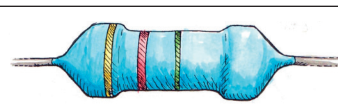
14.1 Circuits and components

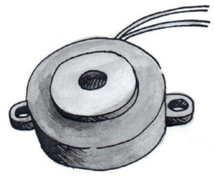
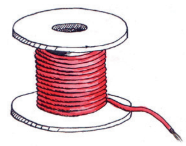
An electric circuit needs three basic things to work:

1. An energy source. This can be a cell or a stronger power source.
2. A complete circuit. There has to be an unbroken pathway of conducting materials through which the electrical current can flow.
3. A load. There has to be some form of resistance in the circuit. This could be in the form of a light bulb, a resistor, a motor or other electrical components.

To show how an electric circuit should be connected, we draw circuit diagrams with symbols that show each **component**. This is a simple way to represent the electric circuit. This table shows the symbol we use for each component:

A **component** is one part of a whole system.

Name	Picture	Symbol
electrochemical cell or cell		
batteries in series, which means they are next to each other		
switch		
light bulb		
resistor		

Name	Picture	Symbol
buzzer		
conducting wires		

The following is an example of a simple electric circuit. This circuit consists of a cell, a switch, and a light bulb that have been connected by insulated copper conducting wires.

Circuit diagrams are shown as rectangular boxes, even though the real circuit looks quite different.

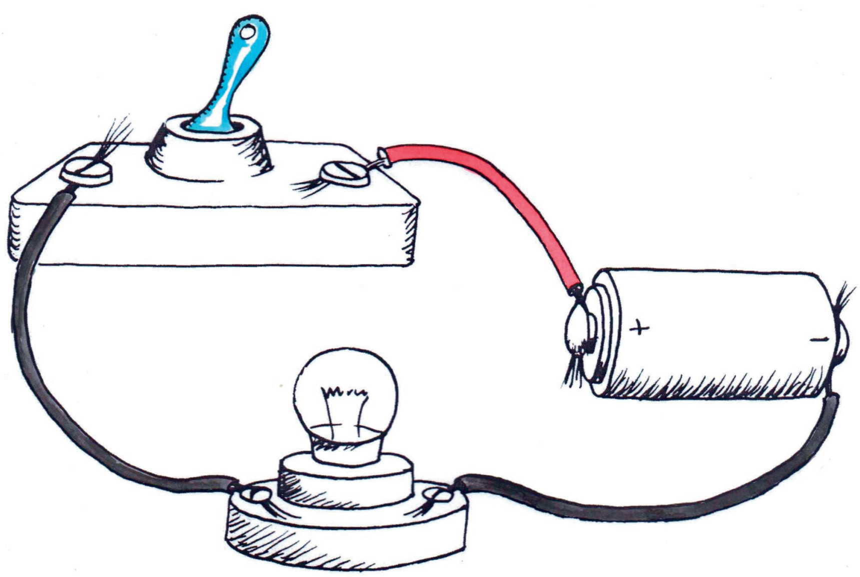


Figure 3

Questions to answer

1. What are the three things that you need to make an electric circuit?
2. How do you think you can see if the circuit in Figure 3 is working?
3. If you made a mistake while putting the circuit together and the connections were not complete, what do you think would happen?

14.2 Building your own electrical circuit

Build simple circuits

For this practical exercise, you will need the following objects:

- several 1,5 V cells or one 9 V cell,
- insulated copper wires,
- a switch, and
- a light bulb.

1. Divide into groups of three or four.
2. Connect the components as shown in the diagram in Figure 4.
   (a) Does the light bulb light up?
   (b) Why does the light bulb not light up?
3. Now try the circuit in Figure 5.
   (a) Does the light bulb light up?
   (b) Why does the light bulb light up?
4. Draw a circuit diagram to show how you connected the components in your circuit. Remember to use a ruler.
5. Which of the components in your circuit is the energy source?
6. Which of the components in your circuit is the load?

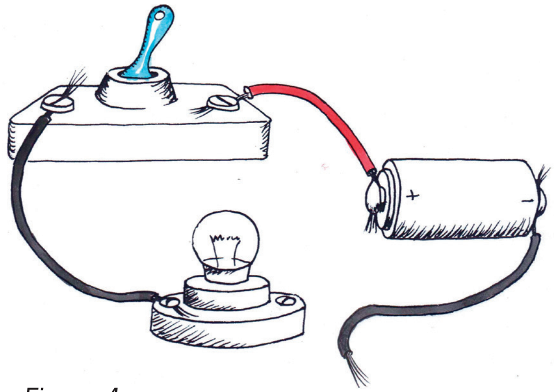


Figure 4

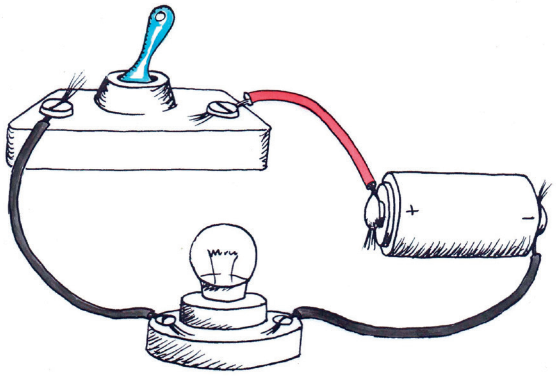


Figure 5

14.3 Electromagnets

Now we are going to look at a very interesting phenomenon, which is the relationship between electricity and magnetism.

Electromagnets are magnets that are created using electricity. They are not permanent magnets. They are only magnets when electricity flows through conducting wire that is coiled around them. When the electricity is switched off, they lose their magnetism.

Electromagnets are very useful for separating scrap material. Scrap material in waste dumps is usually a mixture of metals and non-metals. The ferrous metals, which are those that contain iron, are still valuable. It takes a lot of time to sort waste material by hand.

As you learnt last week, ferrous metals are attracted to magnets. An electromagnet is passed through the waste material and all the ferrous metals stick to it. The electromagnet is then moved over a collection bin. When the electromagnet is switched off, the ferrous metals are no longer attracted to it and they fall into the bin.

Apart from being useful to sort scrap metal, electromagnets are often used as components in other electrical devices. Some examples include:

- in motors: to rotate the motor,
- in loudspeakers: an electromagnet responds to the sound signals and amplifies them,
- in computer hard drives: electromagnetism is used to write and store data,
- in electric bells: electromagnets attract and release the hammer of the bell, and
- in a magnetic door switch: electromagnets can close and open doors.

Figure 6: An electromagnet is used to sort metal in a scrap metal yard.

In all of these applications, the fact that the magnetic force can be controlled by switching the electric circuit on and off is the property that makes the electromagnet so useful.

Now, let us look at a simple electromagnet in the classroom. Your teacher can do this experiment as a demonstration.

Make a simple electromagnet

For this activity, you will need the following objects:

- a long iron nail, about 15 cm long. If you don't have a long nail, you can make a bundle of several pieces of iron wire,
- 3 m of insulated copper wire,
- a size-D cell, or two size-AA cells connected in parallel,
- a wire stripper, and
- metal paperclips.

1. Use the wire stripper to strip a small piece of the insulation from both ends of the insulated copper wire.
2. Wrap the insulated wire neatly around the iron nail. Make sure that you keep the wire turning in the same direction. Keep the coils close together.

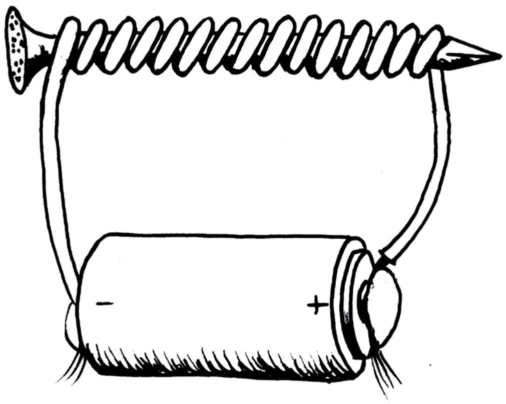


Figure 7: A simple electromagnet

Safety note:
The iron nail can become quite hot, so be careful not to burn your hands!

3. Now connect one of the stripped ends of the wire to the positive terminal of the cell.
4. Connect the other stripped end to the negative terminal of your cell.
5. To test if your electromagnet is working, see whether it can pick up paperclips. If the paperclips are attracted to the iron rod, then your electromagnet is working!
6. Once you have tested your electromagnet, disconnect the wire from one terminal of the cell. Now try to pick up the paperclips. Are the paperclips attracted to the iron rod?
7. How can you use the electromagnet to pick up paperclips from one place and then put them in a different place?

How does an electromagnet work?

There is a strong relationship between electricity and magnetism. The electricity in the wire coils creates a magnetic field. The iron nail is right in the middle of this magnetic field. Because the iron nail is a magnetic material, it becomes magnetised by the field. The magnetic field from the electric current is made much stronger, or amplified, by the magnetic field in the iron nail. Without the iron core, the magnetic field would be very weak. When the electric current is switched off, the iron nail loses its magnetism.

Next week

Next week you will revise mechanical systems and frame structures in preparation for this term's PAT.

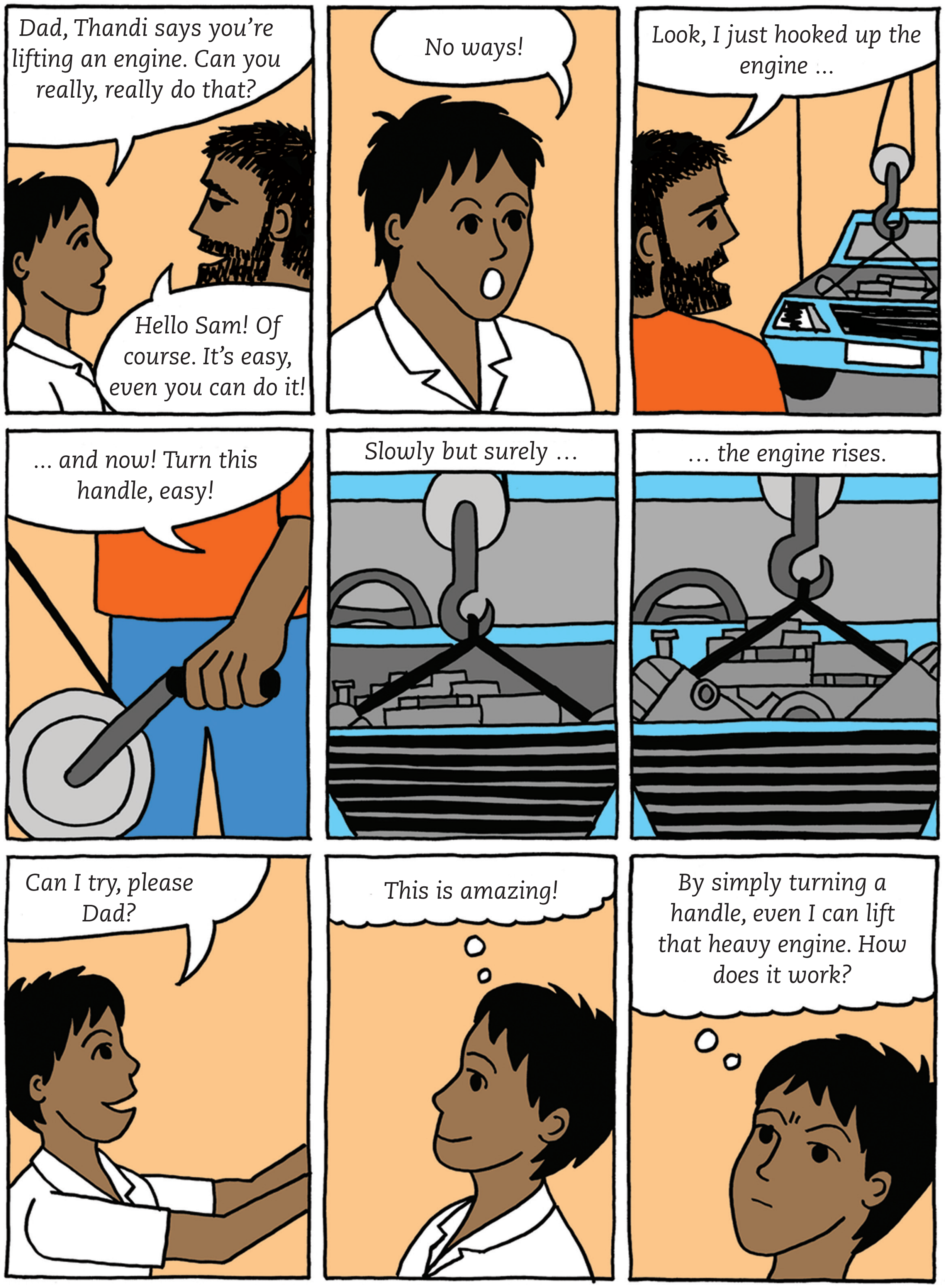
Chapter 15
Simple mechanisms combined

In this chapter, you will learn how simple mechanisms can be combined to make complex machines that are useful. You will learn about a mechanism called a pulley, which is often part of a crane. Then you will learn how a crank handle can be used to make a winder. A crank and winder mechanism allows a rope to wind up easily.

Figure 1: Cranes use pulleys and levers.


Sam goes past his Dad's workshop on his way home from school.
RECEPTION
WORKSHOP
Hello Thandi. What's Dad doing?
Hi Sam! He's lifting an engine out of a car.
What!?! Seriously? He can't be that strong!
Why don't you go help him?
That's impossible!

Figure 2


Dad, Thandi says you're lifting an engine. Can you really, really do that?
Hello Sam! Of course. It's easy, even you can do it!
No ways!
Look, I just hooked up the engine ...
... and now! Turn this handle, easy!
Slowly but surely ...
... the engine rises.
Can I try, please Dad?
This is amazing!
By simply turning a handle, even I can lift that heavy engine. How does it work?

15.1 Machines combine simple mechanisms

Do you remember what a mechanism is? Mechanisms are the parts that make up a machine. Machines are usually made of many simple mechanisms connected together.

Why are mechanisms useful? They help us to move things further, faster or more easily. They can also change the direction of movement.

Remember:

- Mechanical advantage reduces the input or effort force so that loads are easier to move.
- First-class levers have the fulcrum positioned between the effort and the load.
- Second-class levers have the fulcrum positioned at one end of the lever and the effort at the other end. The load is always between the effort and the fulcrum.
- Third-class levers have the fulcrum and the load positioned on opposite ends of the lever. The effort is in the middle.

Figure 3 shows a "tower crane". These cranes are used to help us build high buildings.

Tower cranes are tall, straight cranes that use ropes, pulleys and winches to help people lift very heavy things, such as bricks and cement. They are made of simple mechanisms all working together.

Questions about a tower crane

Use the picture of the tower crane in Figure 3 to answer the questions.

1. What do you think the main purpose of the crane is?
2. What do the pulleys do?
3. The crane needs to lift heavy things from different places on the ground. How does the trolley help people to lift things from different places on the ground?
4. Why does the crane need to **rotate**?

Rotate means to turn around an axis or centre point.

5. The jib has a fulcrum on top of the vertical column. It has an input force or effort from the diagonal cables right at the top of the crane pulling the jib up, and a load pulling the jib down. How do you know that the jib is actually a lever?
6. Is the jib a first-class, second-class or third-class lever? How do you know?

7. What stops the crane from falling over when it lifts something?
8. Make a list of all of the mechanisms on this crane that help it to lift loads.
9. Now make a list of all the parts that hold the crane up, and keep it balanced, so that it can lift things safely.

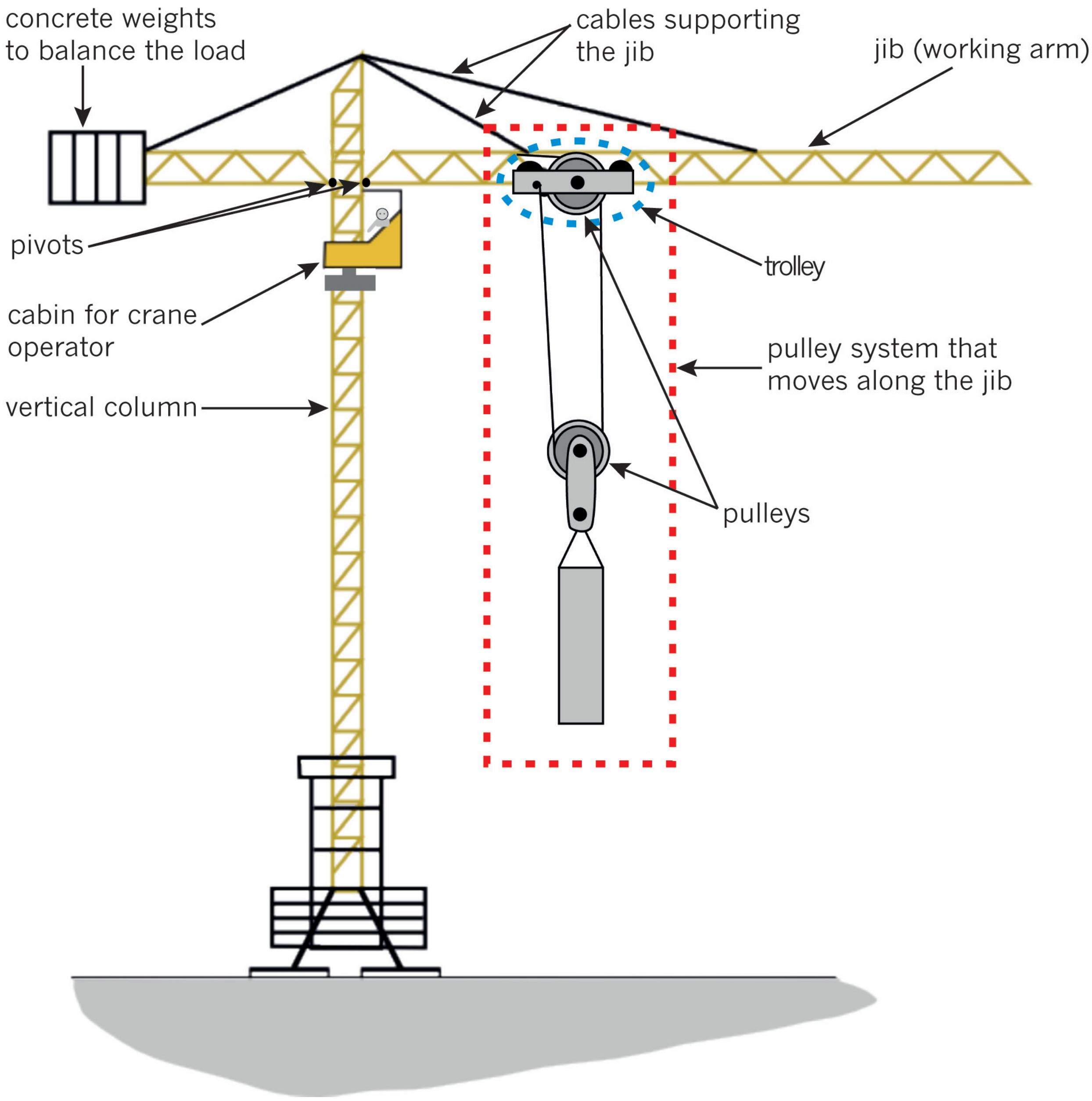


Figure 3: A tower crane uses many different mechanisms.

15.2 Pulleys – mechanical advantage from ropes and cables

Look at Figure 4. A man is lifting a heavy bag. He is using a rope wrapped around a pulley, so that he can pull down to lift the bag, instead of lifting the bag up. The pulley makes it possible for the rope to change the direction in which the rope pulls. When he pulls down on the rope, he can lean with his weight on the rope to make it easier to pull the bag up. But there is no mechanical advantage in this situation.

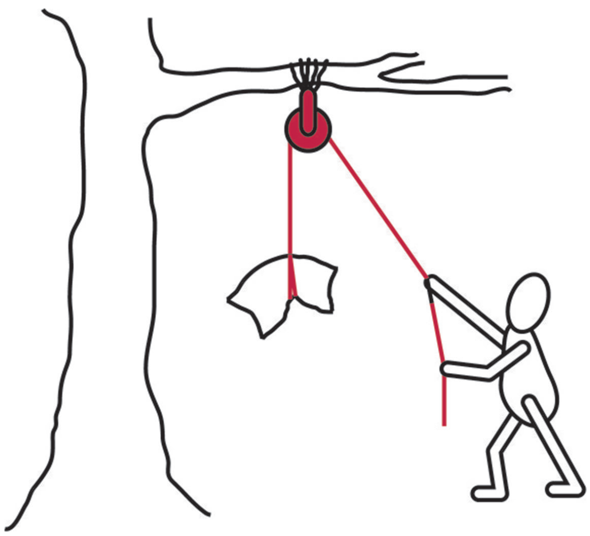


Figure 4: A man is using a rope and a pulley wheel to lift a heavy bag.

Look at Figure 5. A person uses two pulleys to lift a weight. One pulley wheel is connected to the ceiling. The second pulley wheel hangs on a loop of rope. The two pulleys and the way the rope is wrapped around both pulleys, forms a **pulley system**. The pulley system makes it easier to lift a load.

Here is how the pulley system works:

- At the effort end, you pull on one piece of rope.
- Two pieces of rope lift the load.
- Two pulleys connected to a single piece of rope, as shown in Figure 5, give a mechanical advantage.

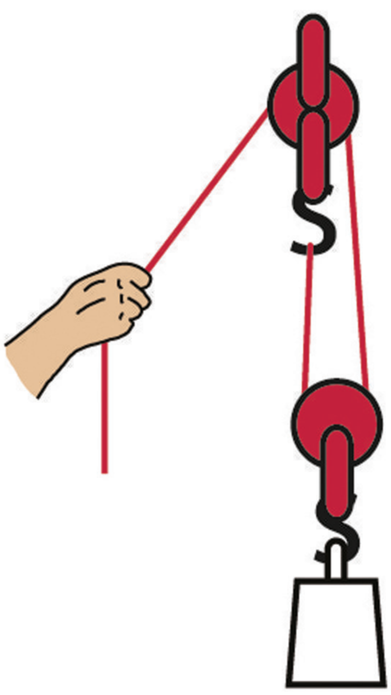


Figure 5: If you connect two pulleys to a piece of rope like this, you get a mechanical advantage.

Make your own pulley system

You need the following things for this activity:

- two plastic curtain sliders to act as pulleys,
- 500 mm of string or cotton,
- a few weights, like steel nuts or washers,
- a flat piece of corrugated cardboard, about A4 sized,
- paper clips, and
- three pins.

Study the picture in Figure 6 to help you make your own pulley system. The instructions are below.

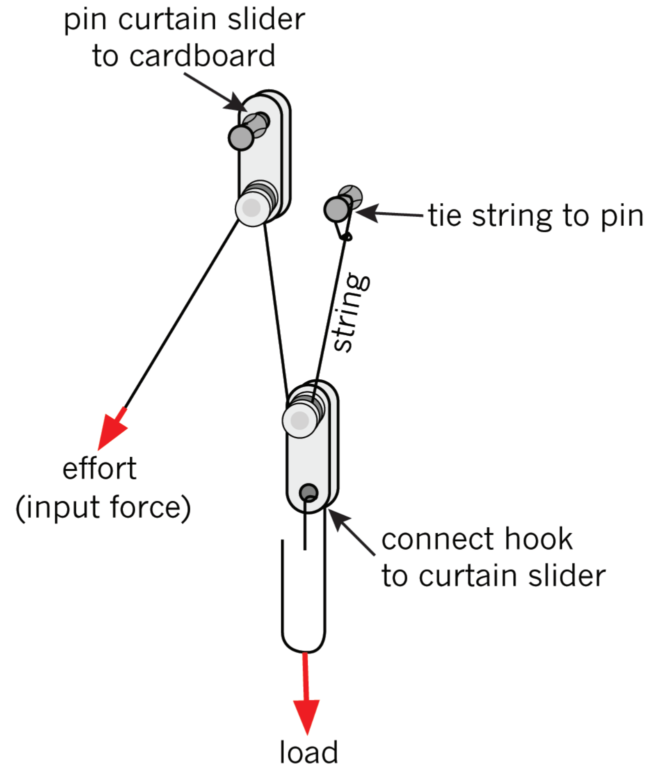


Figure 6: You can make a pulley system out of curtain sliders.

Making your own pulley system

- Use a pin to attach a curtain slider close to the top of the corrugated cardboard. This will be the fixed pulley.
- Make a hook from a third paper clip and attach it to the bottom hole of the other curtain slider. This will be the moving pulley.
- Use a pin to fix one end of the string to the cardboard somewhere close to the fixed pulley.
- Thread the string around the moving pulley, and then back up and over the fixed pulley.
- Attach your load to the hook at the bottom.
- Hang the pulley board onto a wall, or lean it against a wall.

1. Pull the string downwards. What happens to the load?
2. How many parts of the string pull up the load on the output or load side of the system?
3. How many parts of string are pulled down on the input or effort side of the system?
4. Pull the end of the string at the input or effort side down by exactly 100 mm. Then measure how far the load lifts up.
5. Try to lift the load without the pulley system. How does it compare to lifting the load with the pulley system? Does the pulley system make it easier?

An even easier pulley system

Do this activity for homework to add to your understanding of pulley systems. Add two more curtain sliders to your pulley system. Look at Figure 7 to help you. Test the system by lifting the same load as before.

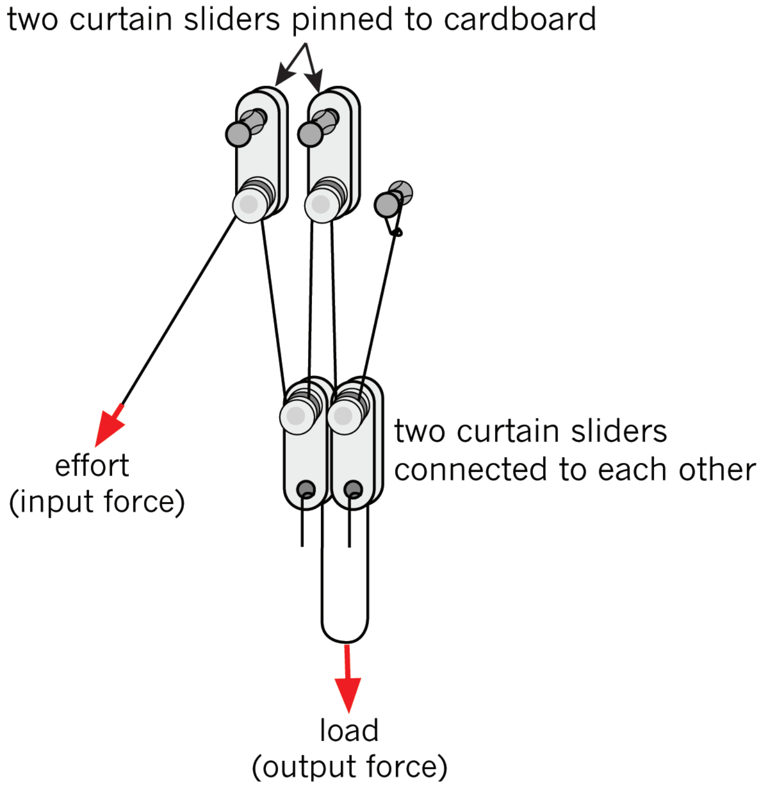


Figure 7: You will increase the mechanical advantage if you use more pulleys. There will be more lengths of string to lift the load.

1. What distance does the load lift when you pull the string down by 100 cm?
2. Describe what a pulley mechanism does.
3. What do you think pulley systems are mostly used for?
4. Real pulley systems use wheels instead of curtain sliders. Why do you think this is? Hint: Think how you can make it easy to slide an object over a rough surface.

15.3 Combining mechanisms

Make a lifting system

In this activity, you will combine mechanisms to make a machine that can lift things. Remember that machines make it easier for us to move, lift, push or pull things.

Look at the model of the lifting system shown in Figure 8. You will have a chance to make a lifting system similar to this one in the activities that follow. But first, answer the questions below.

1. How does the pulley system in Figure 8 help to lift things?
2. What does the working arm in this system do?
3. Explain how you could use this system to lift a load.

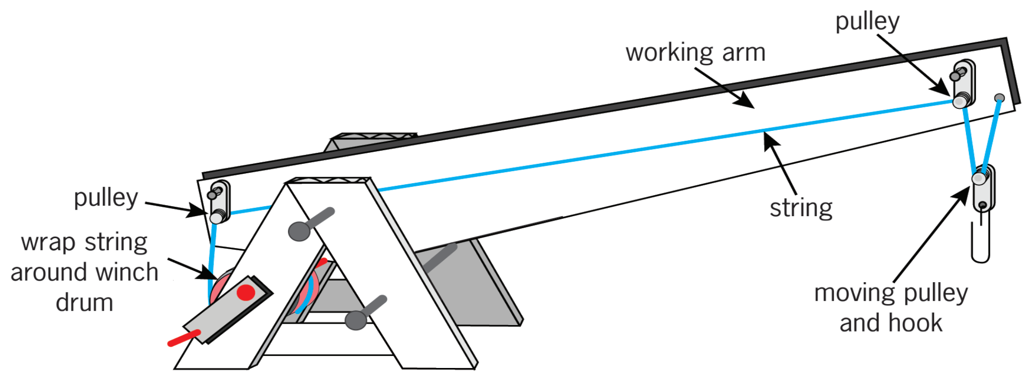


Figure 8: A lifting system that you can make

Make an A-frame for a fulcrum

Trace the shapes in Figure 9 below onto a piece of corrugated cardboard. Cut out the cardboard shapes.

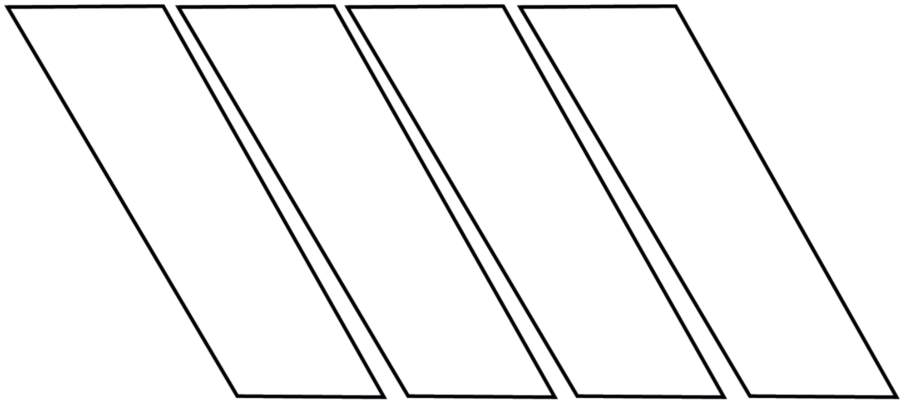


Figure 9: Use these four shapes to make an A-frame.

- Use these shapes to make two A-frames.
- Glue two shapes together at the top.
- Add parcel tape to the bottom to make the A shape.

Look at Figure 10 to see how to do this.

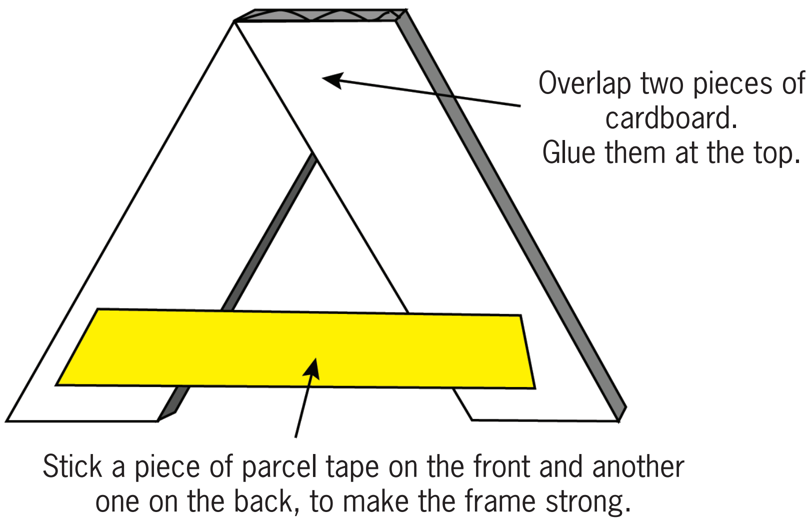


Figure 10: How to make an A-frame

Make a hand-driven winch

A winch is a mechanism that is the combination of:

- a **winch drum** that is a cylinder around which rope or cable is rolled up,
- an **axle** that allows the drum to rotate, and
- a **crank** that is a lever or "arm" with which the drum is turned.

The **drum** of a winch can also be called the **spool** of a winch. The drum of a winch is like a pulley, except that it does not turn freely like a pulley does. The drum of a winch turns together with the crank and axle when the crank is turned.

You need the following things for this activity:

- two milk-bottle tops,
- sticky tape,
- a long nail,
- stiff cardboard 15 mm wide and 40 mm long, and
- a small nail.

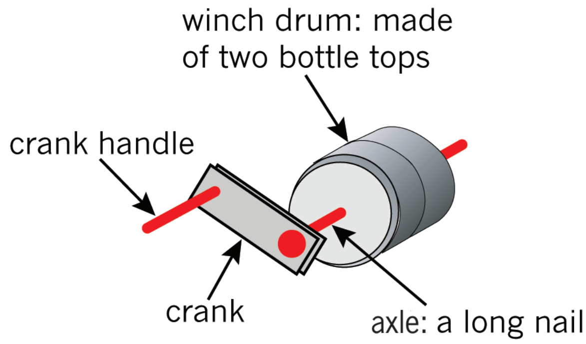


Figure 11: You can make a hand-driven winch drum by joining two milk-bottle tops together.

To do:

- Tape the two milk-bottle tops together.
- Make two small holes in the centres of the bottle tops. The **axle** of your winch will go through these holes.
- Cut a piece of stiff cardboard for your crank. It should be about 15 mm wide and 40 mm long.
- Push the long nail through one side of the crank. Then push the nail through the centre of the drum, and out through the other side of the drum.

An **axle** is the straight bar around which something like a wheel or a winch drum rotates. In other words, it is the fulcrum around which something turns.

Note: The crank lever and the drum must fit tightly onto the nail. When the crank turns, the drum should also turn.

- Make a crank handle by pushing a smaller nail through the other side of the crank lever.

Attach the winch to the A-frame

- Make a hole through each of the two A-frames, in the one "leg" of the A-frame, about 45 mm from the base.

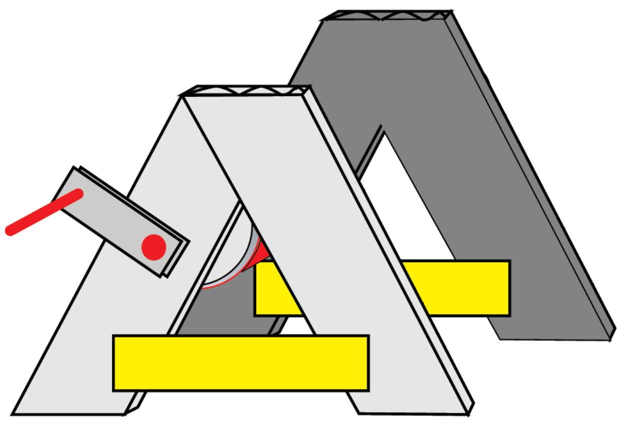


Figure 12: Put your crank and winder into your A-frame.

- Carefully take the winch apart and set the drum aside. Then push the axle with the crank attached to it through the hole on the A-frame at the front.
- Put the drum between the A-frames at the front and the back, and then push the axle through the drum again.
- Keep pushing the axle until it goes through the hole in the A-frame at the back.

A hand-driven winch acts as a lever

The crank and the drum of the winch are both fixed to the axle. So the crank, the drum and the axle move together as if it is one object. They all rotate around the point where the axle is supported by the structure.

There is an input force (effort) at the position of the crank handle. There is an output force (load) at the position on the circumference of the winch drum where the rope is attached. So the input force and the output force act at different positions of the same object. That object rotates around the axle. This means that the axle acts as the fulcrum of a lever.

The big rotational movement of the crank handle is changed into the smaller rotational movement of the circumference of the drum, because the drum has a smaller radius than the distance from the center of the axle to the crank handle. See Figure 13.

So the rotational force on the crank handle will be smaller than the rotational force on the drum.

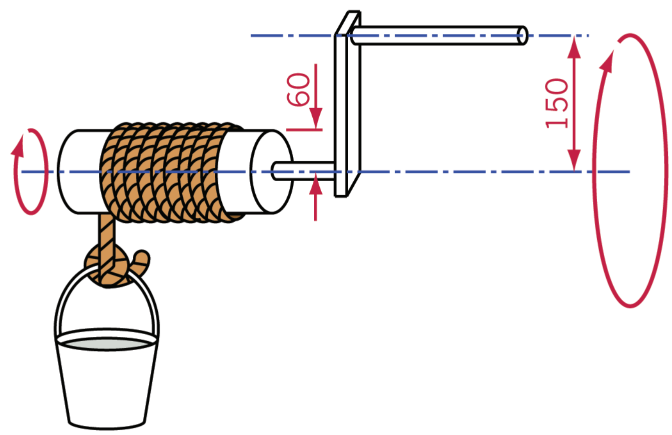


Figure 13: A hand-driven winch lifting a bucket of water

Make a working arm

Now trace this shape and use it to make a corrugated cardboard working arm, exactly the same size as the one below in Figure 14.

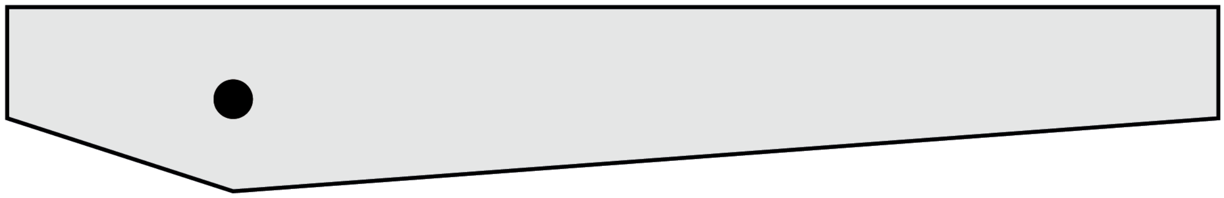


Figure 14: You can use this shape to make a working arm.

Follow these steps:

- Make a hole in both A-frames, about 10 mm down from the top.
- Make a hole in the working arm, 10 mm up from the bottom of the V-shape.
- Use a nail to join the working arm to the two A-frames.
- Push another nail through the right legs of the A-frames to hold the working arm up. Look at Figure 15 to help you.

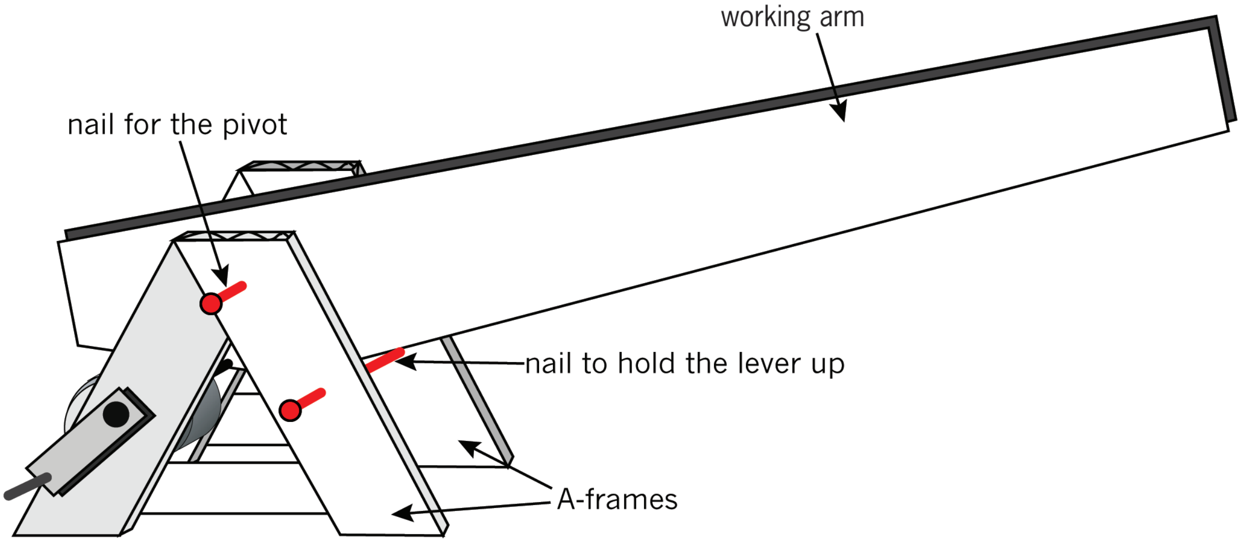


Figure 15: How to connect your working arm to your A-frames

Add a pulley system

Follow this method:

- Pin two curtain sliders onto your working arm, one on the right and another one on the left. These sliders will guide your lifting rope.
- Add a pin, or make a hole on the right-hand side of the working arm. Tie a piece of cotton thread or thin string to the pin, or make a knot through the hole.
- Make a hook from a paper clip and hook it onto another curtain slider.
- Thread the string around the pulley with the hook on, over the pulley on the right side of the working arm, and then over the pulley on the left side of the working arm.
- Pull the loose end of the string down to the winch, and wrap it around the drum a few times. Then stick it onto the drum.
- Turn the crank until the hook hangs in the air.

Look again at Figure 8 to help you, and answer these questions.

1. How do you use this system to lift things?
2. What shape do you think makes the A-frames on this system strong?
3. a) As it is at the moment, the working arm of your model crane does not move. Could you change or add something so that you can make the working arm move up and down? Explain how you could do this.

   Hint: You can have two winches on a crane.

   b) If the working arm is used as a lever in the way you answered question 3.a), then what kind of advantage does that lever give? And what class of lever is it?
4. Name the simple mechanisms that are combined to make the lifting system you described in question 3.
5. a) Does the winch give you a mechanical advantage? Explain your answer.

   b) How can the mechanical advantage of the winch be increased?
6. Does the pulley system give you a distance advantage? Explain your answer.

Remember: A mechanical advantage makes the output force (on the load) bigger than the input force (effort).

A distance advantage makes the load move further than the effort moves.

What have you learnt?

1. Give an example of a machine that uses a crank.
2. Give an example of a machine that uses pulleys.
3. How can some designs of pulley systems give a mechanical advantage?

Next week

Next week, you will start your PAT for Term 3. You will design and make a machine to help a scrap-metal dealer sort the magnetic from the non-magnetic metals in the scrap yard.

Chapter 16 PAT
Build a model crane

For this term's PAT, you will work on your own and as part of a group to build a crane that can be used to pick up pieces of metal. You will work through all the stages of the design process while you build a model crane with an electromagnet. Your teacher will assess you on all the stages of the design process.

Assessment

Design:	Write a design brief with specifications and constraints	[15]
Investigate:	Identify cranks and pulleys	[10]
	Sketching and perspective drawing	[10]
Make:	Draw a flow chart	[5]
	Draw a circuit diagram	[8]
	Model crane with electromagnet	[12]
Evaluate:	Develop an evaluation sheet	[5]
Communicate:	Oral presentation	[5]
		[Total: 70]

Figure 1

Figure 2

Week 1

Design Part 1 (30 minutes)

A scrap metal dealer sorts magnetic and non-magnetic metals into separate piles for recycling. They use a crane with a magnet, but find it difficult to remove the metal pieces from the magnet. They need a magnet that can be switched on and off to help with this.

The company wants you to design and build a model crane that:

- should be a simple frame structure,
- should be made strong, stiff and reinforced through triangulation,
- has an arm that rotates around a pivot at the bottom, so that the top end of the arm can be raised and lowered,
- uses a winch, a cable, and pulleys to lift and lower the arm, and
- is made from any materials. Some can be bought, while others can be simple materials, such as paper dowels or elephant grass.

The crane should have an electromagnet attached to its arm. The electromagnet:

- should have a soft iron core made from a bundle of short lengths of iron wire,
- must have a switch so that it can be switched on and off, and
- must be strong enough to pick up several steel paperclips, nails or coins.

Design brief with specifications and constraints

Work on your own. This task will be assessed. Read through the information given under "Design Part 1" before completing the three sets of questions.

Ask yourself:

- What is the problem?
- Who is the solution for? Or, in other words, who will benefit from it?
- What should the solution do?
- Will it benefit or harm the community?

1. Now write the design brief. Use the answers to the questions you have just answered to help you. [3]
2. Identify the specifications.
   (a) List the specifications for the model crane. [7]
   (b) List the specifications for the electromagnet [4]
3. Identify constraints, if there are any. [1]

[Total: 15]

Investigate cranes (30 minutes)

Identify cranks and pulleys

Work on your own. This task will be assessed.

1. Look at the four pictures of cranes below and on the following pages. Each crane has a winch and one or more pulleys. Copy all four crane pictures. Draw quick sketches.
2. Look at where the winches are placed. Mark each winch with the letter W.
3. Look at where the pulleys are placed. Mark each pulley with the letter P.
4. Which of the cranes have pulley systems with two or more pulleys?

[10]

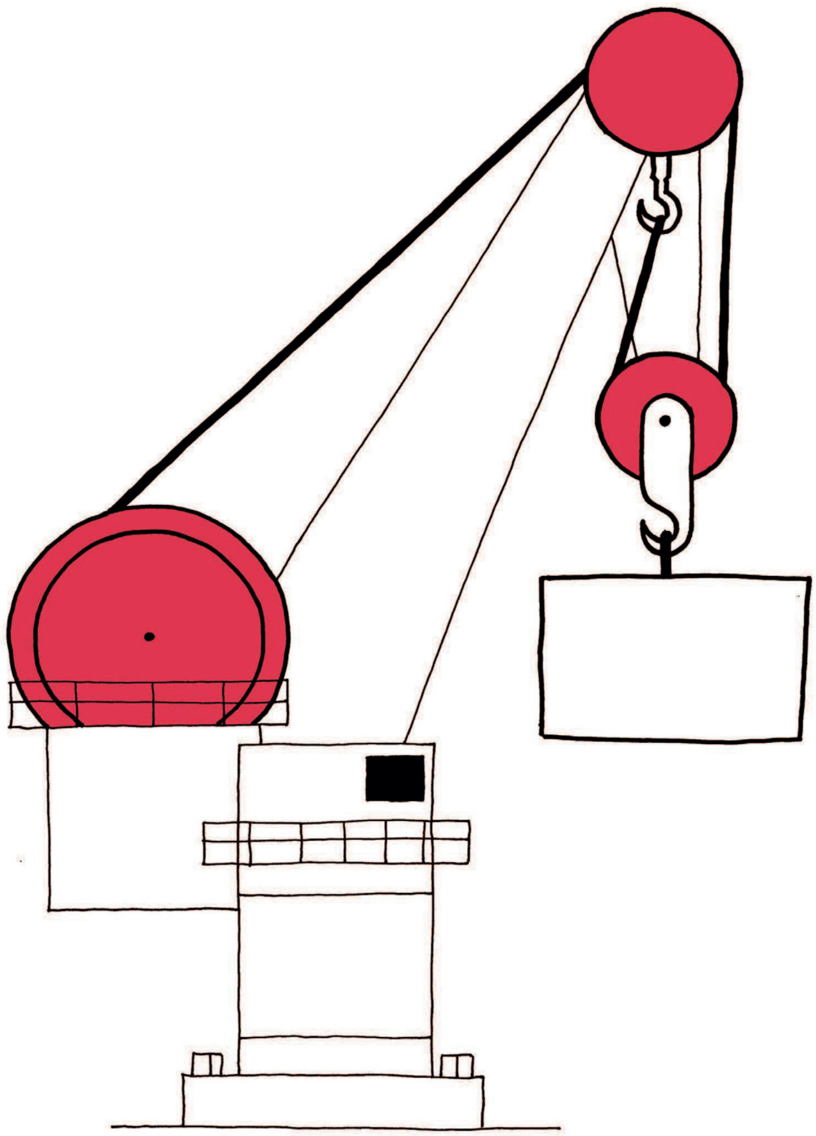


Figure 3: Crane in a harbour

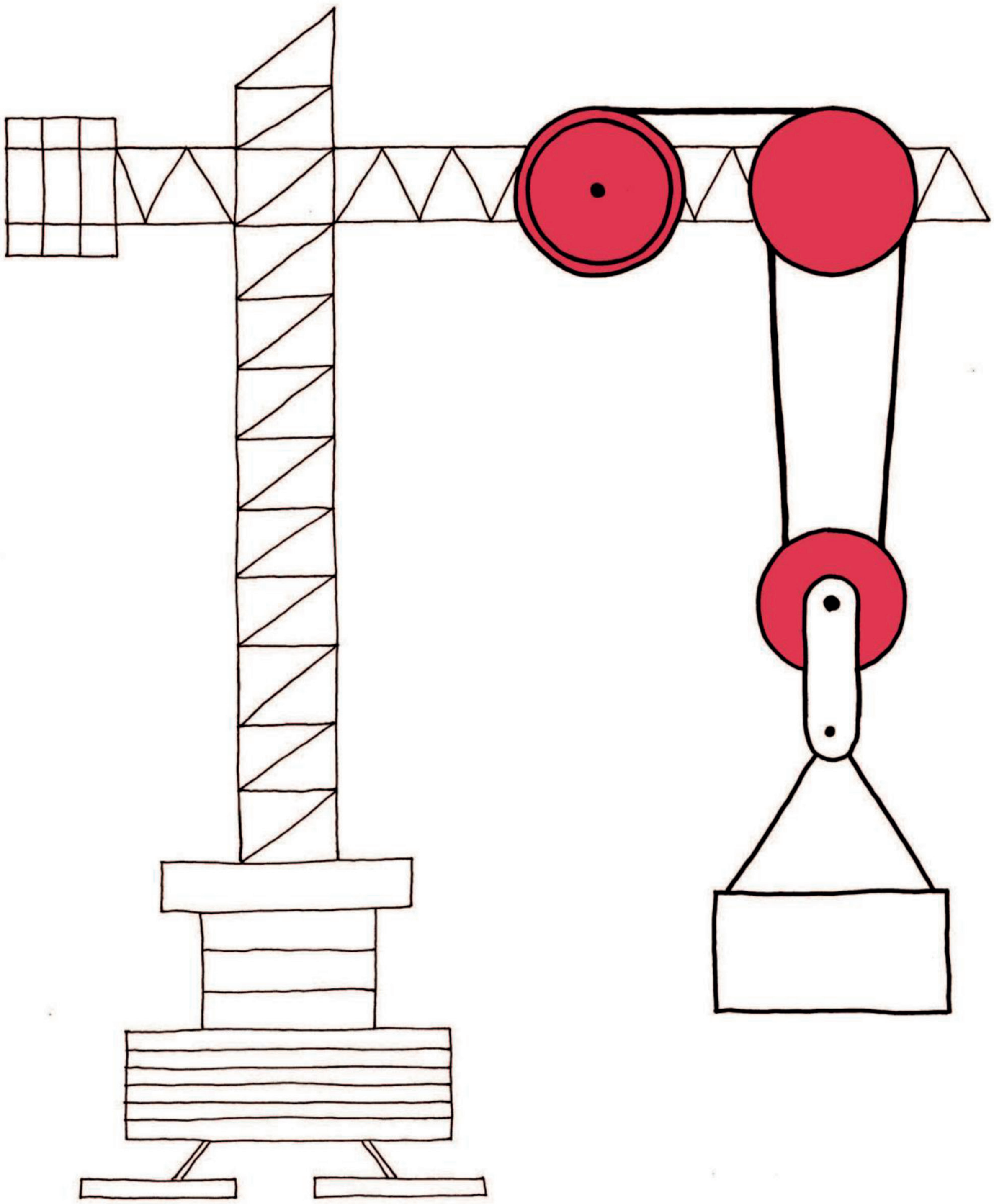


Figure 4: Tall builder's crane

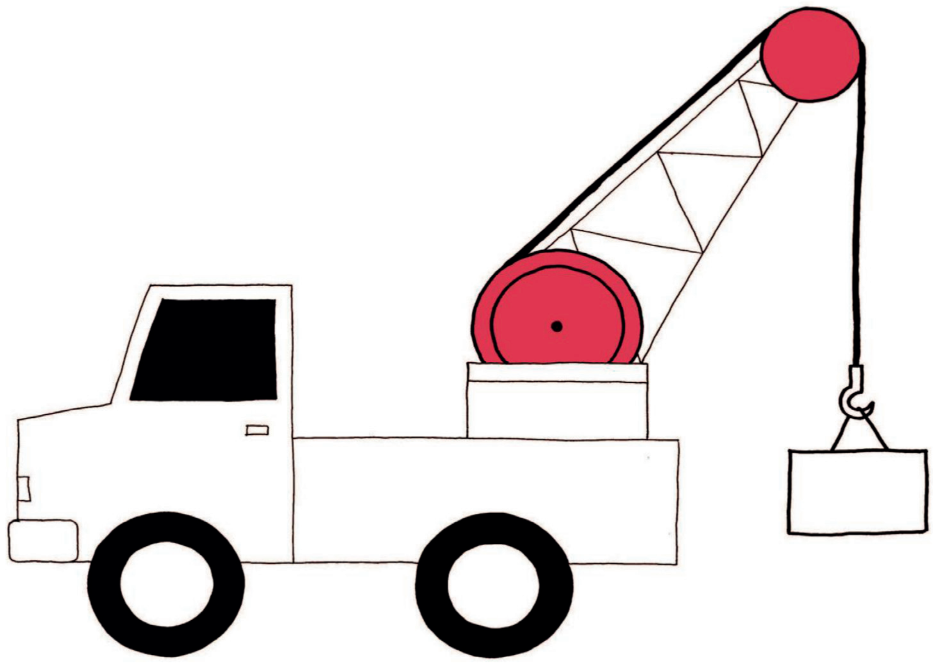


Figure 5: Crane on a truck

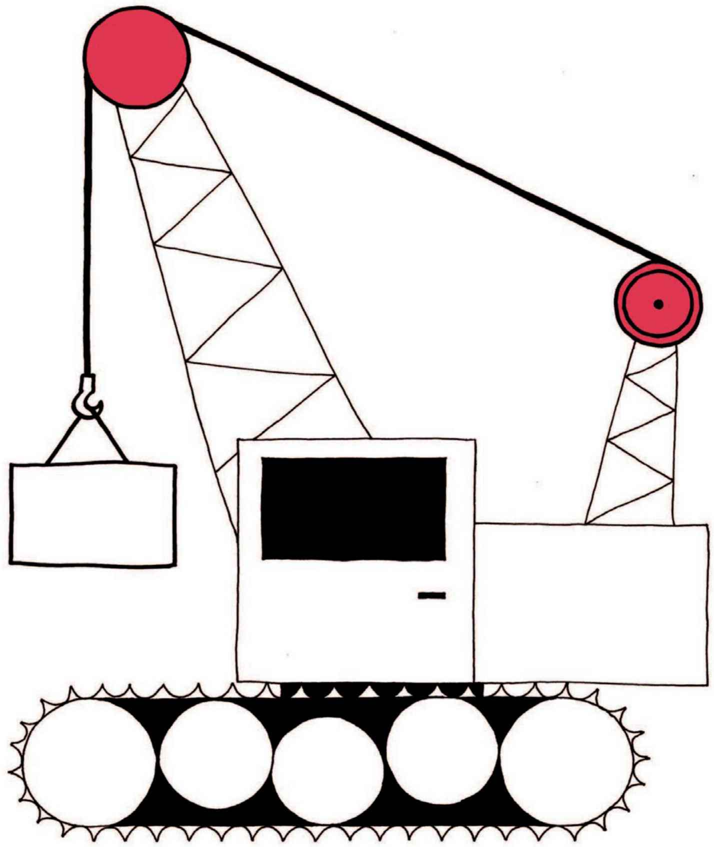


Figure 6: Crane on caterpillar tractor

Look at this model crane

Work in pairs. Look at the photographs on the next few pages, showing different views of a model crane. Answer the questions after the series of photographs.

Figure 7

Figure 8

Figure 9

Figure 10

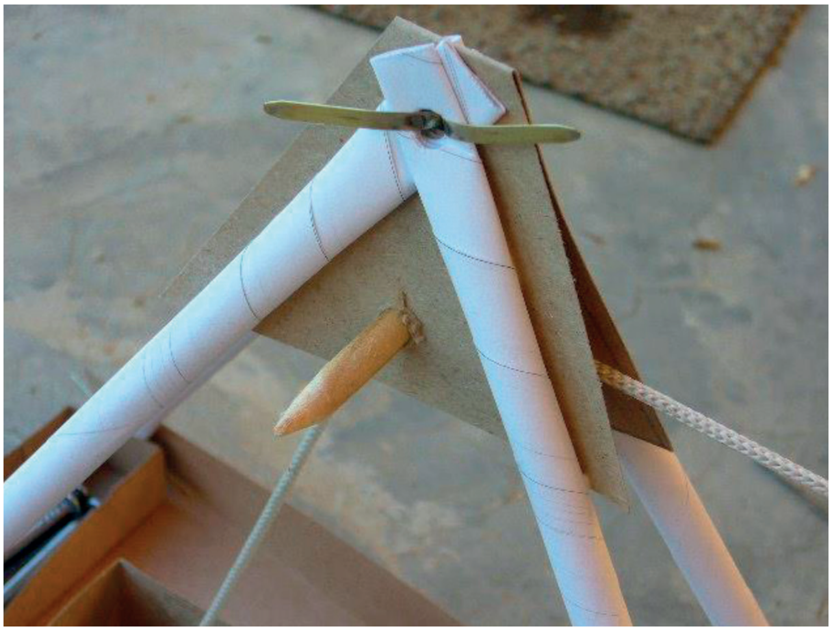


Figure 11

Figure 12

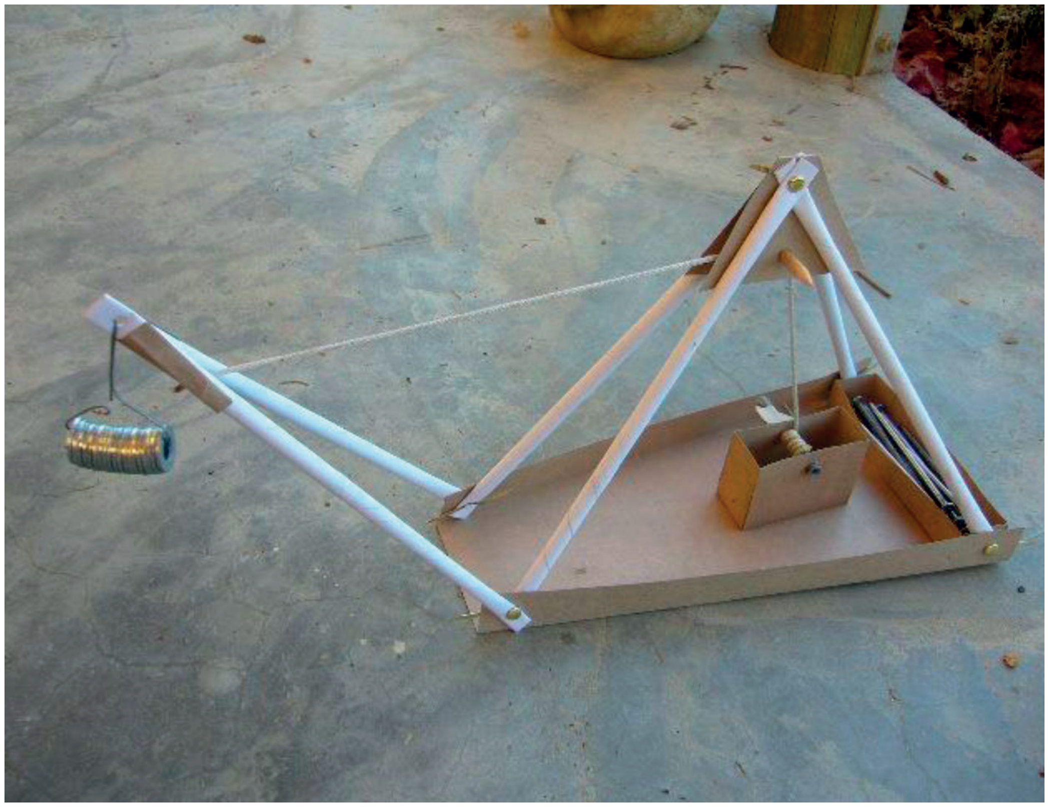


Figure 13

Figure 14

Figure 15

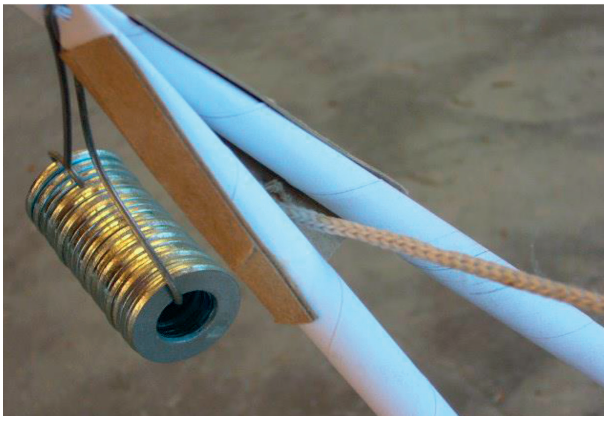


Figure 16

1. The frame of the model crane in the photographs is built from paper tubes made into triangles (see Figure 13). How many triangles were used?
2. Show your partner the triangles in Figure 13. How many are there?
3. List the materials used to build this model.
4. Identify the materials used for the joints on this model.
5. Look at Figures 11, 12 and 13. Look at how the pulley is made. What material is the pulley made of?
6. Look at Figure 14. List the materials used to make the winch.
7. Note where and how the weight has been attached to the end of the pulley. Explain what you see.
8. What is the purpose of the box of nails at the back of the crane?

Sketching and perspective drawing (60 minutes)

Sketch your ideas

1. Read the specifications for your model crane again. Remember that you have to use materials suitable to build a frame structure.
2. Think of two different designs.
3. Sketch one of your designs. Add labels to show the parts of the crane and the materials you will be using. This sketch will be assessed. Use this checklist to make sure that you have included everything.

Things to look at	
Does your drawing have a heading?	
Did you label the different parts?	
Did you indicate the materials you will use?	

Your teacher will assess your sketch using a scale from 3 to 1:

3: Good work, **2:** Satisfactory work, **1:** Poor work

[10]

4. Draw your other design in single vanishing point perspective. Your drawing doesn't have to be drawn to scale. Use this checklist to see if you have included everything. This drawing will not be assessed.

Things to look at	
Does your drawing have a heading?	
Did you mark the vanishing point?	
Did you draw the face of the crane that shows the most detail?	
Did you draw feint guidelines from the corners of the shape of the crane to the vanishing point?	
Did you draw horizontal and vertical lines to show the back of the crane?	
Did you darken the feint lines that show the outline of the crane?	

Week 2

Planning to make the crane (30 minutes)

Now it is time to prepare for the actual building of the model crane. Work in a group of three or four. You will build the model together as a team.

Decide what you will do and how

Work as a team for the first task. Work on your own for tasks 2, 3 and 4.

1. Look at all the designs. Each member will have two designs to offer. Discuss all the designs. Decide which design the team will build. Your group can also develop a completely new design. Remember what you learnt about reaching an agreement last term when deciding this. If you develop a new design, one person has to make a design sketch of the new design.
2. Make a list of all the materials you plan to use to build your model.
3. Make a list of the tools you will use to build the model, for example, the tools that you will use to measure and cut.
4. Think about your own safety when you use tools. Some tools can be dangerous if used incorrectly. Write down one safety rule for one of the tools you will use.

Order of work

You are going to present the steps you will follow to build the model as a "flowchart". Flowcharts are sometimes called flow diagrams.

- Flowcharts are designed to make information easier to understand.
- They are fun to use, because you can use colours and pictures instead of just words.
- You will make a process flowchart. A process flowchart shows the method or process of making something from start to finish. There are other types of flowcharts too.

How to make a flowchart

- The first shape identifies the topic or the first step of the process.
- Arrows show the direction of the process from the first step to the end. Follow the steps to read the process in the correct order. They can run horizontally or vertically.
- The last shape is used for the last step in the process.

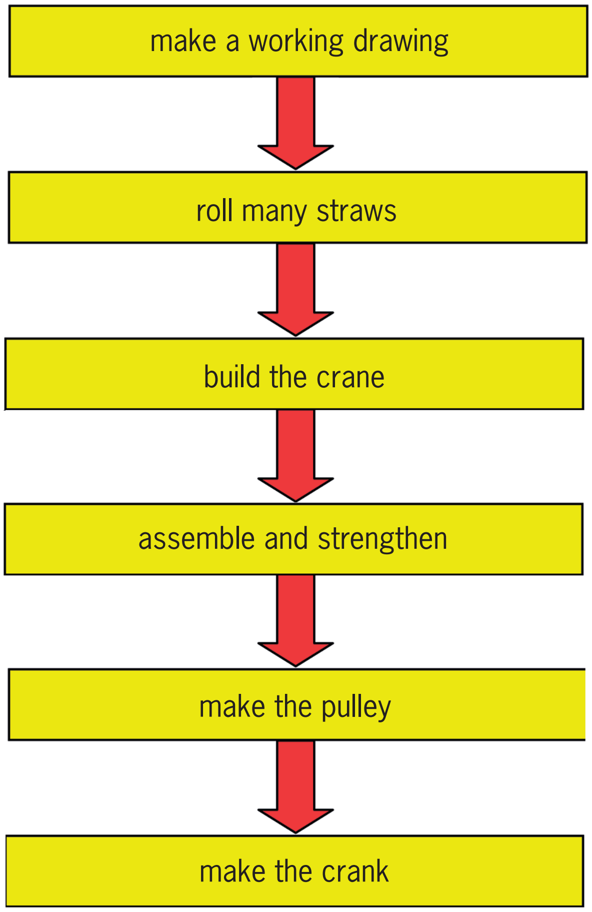


Figure 17: A flow diagram for building a model of a crane

Plan to make an electromagnet (30 minutes)

You made an electromagnet in Chapter 14. An electromagnet is made up of:

- a core that can be an iron bolt for a hard core, or a bundle of short pieces of iron wire for a soft core,
- a long length of insulated wire to wrap around the core, and
- insulation tape to hold the components together.

The circuit for the electromagnet is made up of:

- a battery. You can use four 1,5 V D-cells. We use D-cells instead of 1,5 V AA-cells (penlight batteries), because the D-cells contain more material and therefore last longer.
- a battery holder. The cells must be connected in series, one behind the other for them to provide 6 V of power. You can use insulation tape to tape them together.
- a switch. Use a switch that will stay on until you want to switch it off. You can make your own or buy a switch.
- wire to connect the different components.

1. List the materials you will use for the electromagnet.
2. List the equipment you will use to build the electromagnet and its circuit. Make sure you use the correct tools. Don't cut wire with scissors.
3. Write at least one safety rule to follow while making the electromagnet.
4. Draw a flowchart of the method you will follow to build the electromagnet and its circuit. This task will be assessed.

You can use thin telephone wire instead of insulated copper wire. Because this wire is thin, you get more turns when you wrap it around the nail. More turns will make the magnet stronger.

[5]

Draw a circuit diagram (30 minutes)

Your teacher will assess this task. We draw working drawings before we start making a model. When you plan to make a circuit, you first draw a circuit diagram.

Draw a circuit diagram for the electromagnet

Indicate on your circuit diagram:

1. The heading. That will be what the diagram is for.
2. The positive and negative poles on the battery.
3. The direction of the flow of current. Use an arrow to show the direction the current will flow in.
4. The correct symbols for the different components. Use the symbol for an electromagnet shown below. [8]

Figure 18: Circuit symbol for an electromagnet

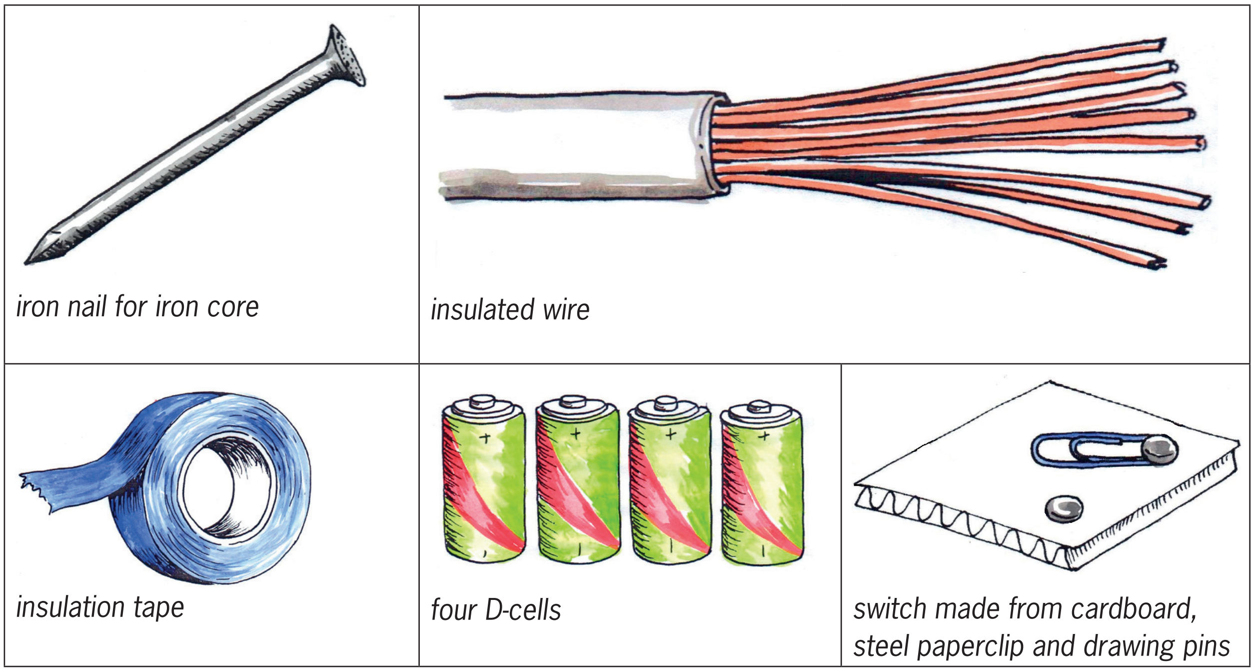


Figure 19: Materials used to make an electromagnet

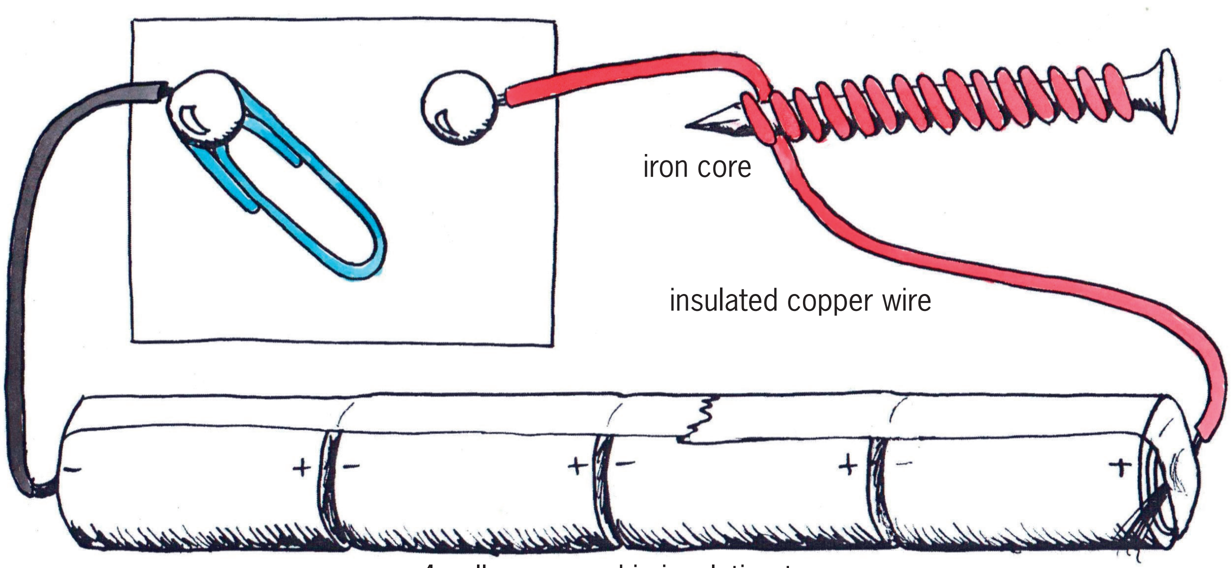


Figure 20: Electromagnet

Start building the crane and electromagnet (30 minutes)

Make sure that you finish building the model crane and the electromagnet in the time given. Pay special attention to the time allocated for each of the tasks. You may not have more time.

Remember to work safely and neatly. Remember to give each person a task or a part of the model to make. Each person has to work equally hard to build the model. Pack away your model and its parts at the end of each lesson in a box with your names on it.

Sometimes a design does not work out. You may make changes and add things to your model so that it will work.

- You have 180 minutes (6 × 30 minute lessons) to put the crane together and to build the electromagnet.
- The time indicated on the next page is a guide for you to follow.
- Remember to evaluate as you go along.
- Your group's model with its electromagnet will be assessed.

Prepare to build

1. Gather all your materials and tools.
2. Roll as many straws as you think you will need, as well as a few extra ones.
3. Start making the crane and the box it will be mounted on.
4. Start wrapping the iron pieces with the insulated wire.

Week 3

Build the crane (30 × 4 = 120 minutes)

Build the frame of the crane (30 minutes)

- Make sure that the joints are well made and strong.

Join the frame to the base (30 minutes)

- Measure the structural members accurately. This will contribute to a stable crane that balances properly.

Build the winch (30 minutes)

- Make the winch and insert it in its housing.

Attach the winch and thepulley to the frame (30 minutes)

- Make sure that the frame is strong and firm enough where the winch and the pulley will be attached to the frame. .

Practise measuring

Use a good-quality, firm ruler. Make sure the ruler is marked in millimetres.

Start measuring from the zero (0), not the edge of the ruler.

Use the correct tools

Use a sharp pair of scissors or a craft knife to cut string, paper or card.

Use a sharp nail or an awl to make a hole.

Week 4

Build the electromagnet (30 × 2 = 60 minutes)

Make the electromagnet (30 minutes)

Make as many coils of insulated wire around the iron core as possible. This will make the electromagnet stronger.

Build and assemble the electrical circuit (30 minutes)

- Assemble the electrical circuit for the electromagnet.
- Attach the circuit to the crane model.
- Add the counterweight materials to the crane so that it will balance and not fall over.
- Evaluate and make any changes you think are necessary.

[12]

Revise and draw: Oblique drawing (30 minutes)

Oblique drawing:

- Draw the lines for length and height straight up and straight across, exactly like the front view of the box in Figure 21.
- Oblique drawings should be scale drawings. For the front view of an oblique drawing, use true scale measurements. So if the length of the object is 600 mm and the scale is 1:10, you draw the length as 60 mm. Indicate the scale below your drawing.
- Corners are projected at a 45° angle and the depth measurement must be half the true scale measurement. So if the depth is 300 mm and the scale is 1:10, you must draw the breadth line to 15 mm.
- Make sure that you have given your drawing a heading.

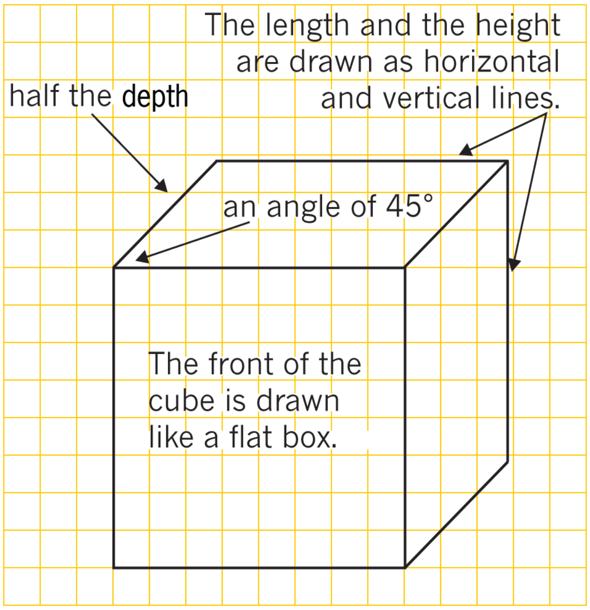


Figure 21: How to draw an oblique drawing

Scale:

- We often draw objects smaller than they really are.
- A scale drawing of 1:4 is four times smaller than the real object. If the object is 400 mm wide, we draw its width as 100 mm.

Make an oblique drawing

Work on your own.

1. Choose one part of your model to draw in oblique view.
2. Draw a rough sketch first.
3. Then use grid paper. Draw the part to scale. You can draw it larger than it is on the model. If you draw it twice the real size, show the scale as 2:1.

Develop an evaluation sheet (30 minutes)

Your crane with its electromagnet is finished. Now you have to develop a checklist to judge your crane and how well it meets the specifications.

- Does it meet the criteria you identified as specifications?
- Does the electromagnet work well?

To judge the cranes, you will develop an evaluation sheet. Remember: you developed an evaluation sheet to evaluate your tower last term.

Develop an evaluation sheet

1. Work on your own. This task is for assessment. Make a list of the features the crane model must have. Use your list of specifications to help you. [5]

Here is an example:

The crane needs to work properly.		
The crane must be able to lift and lower small metal objects.		

2. Work as a team.
   (a) Combine your individual sheets into one joint evaluation sheet.
   (b) Include a three-point scale. 3: Good, 2: Just all right, 1: Poor.

This evaluation sheet will be used to evaluate your own model and the models that the other groups have built.

3. Use the evaluation sheet to evaluate your own model.

Week 5

Evaluate the other models (30 minutes)

When you evaluate work, you have to do your best to be "objective" and fair. This means that you must not give high marks to your friends unless they really deserve it. You have to give them the marks they deserve for the work they have done, and you should be able to explain and support the mark you gave. This means that your comments have to be valid.

To be "objective" means to judge something for what it is without being emotional or personal. It also means you should try not to think about the person who made the model, but rather to think only about the model.

Evaluate the models of other groups

1. Work as a team.
2. Copy your evaluation sheet three or four times.
3. Evaluate the models of three or four teams. Remember to write down the names of the teams you are evaluating.

Prepare your presentation (30 minutes)

Each team should prepare an oral presentation of their plans and functioning model to the class.

The team's presentation should be longer than five minutes but shorter than seven minutes.

1. Plan your presentation.

- All the members of your group should be part of the presentation.
- Decide what each person will do.
- Each person should talk about the work they did and the role they played.
- One learner should show and explain the design sketch.
- Another learner should explain the circuit diagram and draw it on the board.
- One learner should show how the crane with the electromagnet works.
- Another learner should talk about the problems the group experienced.
- Include the following information in your presentation:
  - how an electromagnet works,
  - how to make an electromagnet stronger, and
  - why it is important to sort metals.

Hints for presenting your work:

Stand up straight and look at the class while you speak.

Do not read your presentation.

Speak clearly. Do not mumble or whisper. Everyone should be able to hear you.

Know when it is your turn to speak.

Keep to the time limit.

- Make an artistic drawing of your model crane with its electromagnet.
- Decide who will start and who will talk next. Know when it is your turn.

2. Use the rest of this lesson to practise your presentation. You might also need to spend some time at home for this. You have lots of time to practise as you will be doing self-reflection in the next lesson.

Reflection and evaluation (30 minutes)

To **reflect** means to look back. Looking back at what you did and how you completed a task is an important learning activity. It gives you the opportunity to identify the mistakes you made, as well as what you did well. From this, you learn not to make the same mistakes again, and how to improve on what you do well.

Reflect and evaluate your own work and contribution

Work on your own. This task is for assessment.

1. Write down at least five activities that you want to reflect on. Choose at least:
   - one practical activity,
   - one drawing activity,
   - one activity where you had to answer questions, and
   - one group activity.
2. Draw up a table like the one below. Tick a face to show how you felt about each activity. [5]

Description of the activity	☺	😐	☹

Deliver your presentations (30 minutes)

It is important that everyone takes part, as you will all be assessed by your teacher. You will have three lessons (150 minutes) to complete the presentations.

Oral presentation

1. Each person's oral presentation will be assessed separately.
2. Your teacher will use an evaluation sheet like the one below to assess you.

Criteria	Good	Satisfactory	Poor
The learner speaks clearly so that everyone can hear.			
The learner speaks confidently, knows the work and what he or she wants to say.			
The learner makes eye contact with learners sitting in the front and in the back of the class.			
The learner explains his or her own role in the project.			
The learner shows and demonstrates the model/ drawing/diagram.			

Week 6

Presentations continued (30 × 4 = 120 minutes)

All the presentations must be finished by the end of this week.

Term 4: Processing | Bias in and impact of technology

Chapter 17
Emergency situations

In this chapter, you will learn about emergency situations and the effects they have on people. People are sometimes forced to leave their homes because of emergencies. They then become refugees. You will learn how sheltered, safe areas are created for refugees and how aid workers provide food and water.

Figure 1: This family of refugees were forced to leave their home and now need a safe place to live until they can return.

Figure 2: Devastating fires are just one form of emergency situation that communities might have to face.

Emergency situations can cause large numbers of people to be forced from their homes. Emergencies not only affect people in areas where a disaster took place, but also the people in the area where the **refugees** are moved to. People need shelter, water and food. A refugee camp has to be set up, and the camp needs to be very well planned.

Refugees: People who are forced to leave their homes during a disaster or in an emergency situation. Sometimes, refugees move to a safe area that is close by, and at other times, they have to travel to another country.

In emergencies, plans to help refugees need to be made very quickly to prevent further suffering. Two types of emergency situations that force people to leave their homes are war and natural disasters.

In this lesson, you will learn about emergency situations and investigate ways to help refugees.

War

Since the beginning of time, there have been wars between people all over the world, and while armies fight battles, people are forced to flee from their towns and villages. Over the centuries, many people have ended up as refugees. Even today, there are more than 3,8 million refugees all over Africa. These people have been chased from their homes because of wars.

Figure 3: This refugee camp was set up for Rwandans during the war in their country in 1994.

Natural disasters

Natural disasters are caused by nature and not by people. Floods, wildfires, earthquakes, and volcanic eruptions are all natural disasters. All of them can force people to leave their homes.

Natural disasters usually happen with no warning. They can create emergencies very quickly, which means that people have to move to safer areas immediately.

In 2000, a terrible flood hit Mozambique and destroyed huge areas of farming land. Thousands of people lost their farms and were forced to flee to dry ground. Refugee camps were set up in other parts of Mozambique and also in South Africa.

Compare the pictures on the right. These pictures were taken from a satellite in space. They show the same area in Mozambique before and during the flood, and how much land was flooded.

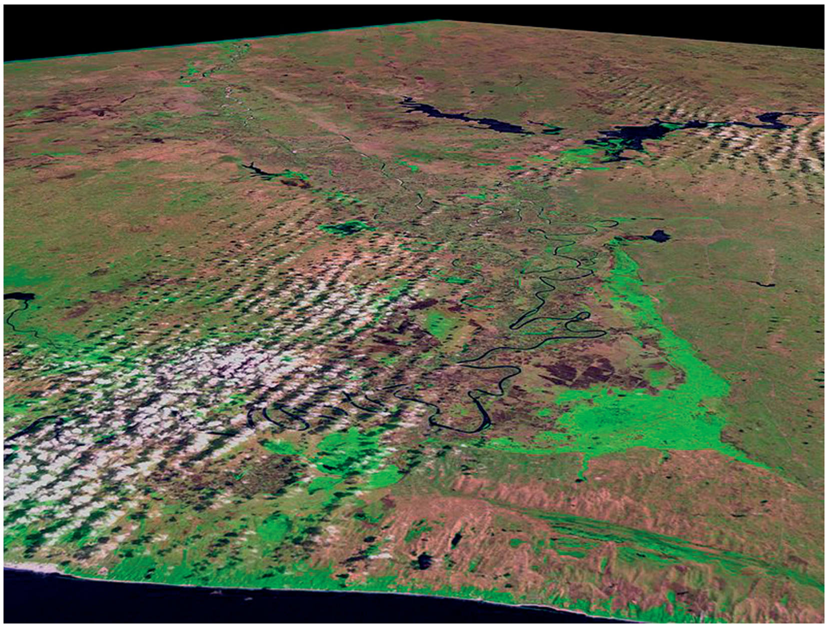


Figure 4: This satellite picture of the disaster area in Mozambique was taken before the flood.

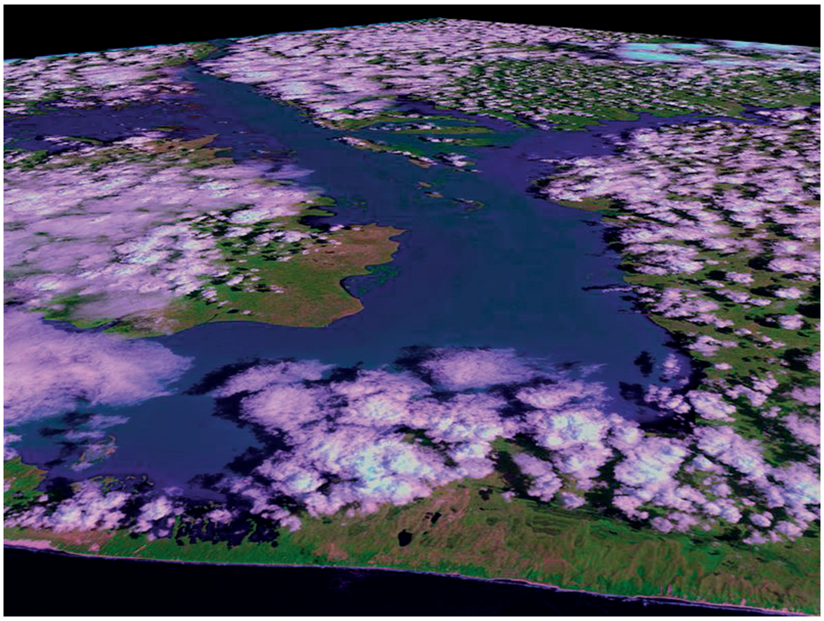


Figure 5: This satellite picture of the disaster area in Mozambique was taken during the flood.

A natural disaster can also happen over a longer period of time. In Africa, we rely on rain to water our crops, but this continent often has droughts. Droughts can create emergencies for farmers. During long droughts, large groups of people can be forced to leave their homes and their farms. These people then look for food, water and shelter, and they become refugees.

Figure 6: Droughts in Africa cause the destruction of habitats and the death of wildlife.

17.2 Initial problems facing refugees

Disasters such as floods and wars happen suddenly, which means that people have to leave their homes quickly. These refugees will not have a lot of food and water with them. They will also not have tools or materials to build shelters.

Emergencies that happen more slowly over longer periods of time include droughts, or long wars. Refugees in situations like these have a bit more time to pack up their possessions and plan their journey.

The type of emergency situation influences the **mix of people** in a refugee camp. Sometimes, there will be more men than women. Other times, there will be many babies who are not able to walk yet and small children. And at other times, there will be many elderly people who need special help and care.

Mix of people: The different types of people in a group, such as the young and the old, male and female and disabled people.

For example, during a war, there are usually fewer men at home, because the men will be fighting. During a drought, babies and elderly people may die since they are more vulnerable.

Different people have different needs for food, water and shelter. Children become dehydrated more quickly than adults do and they also need more high-energy foods. Old people need more warmth and blankets.

Questions for you to answer

1. Which emergencies happen suddenly, without warning?
2. How will these sudden emergencies affect each of the following:
   (a) the mix of people in the group?
   (b) the amount of food and water refugees have with them?
   (c) the ability of refugees to build their own shelters?
3. Which emergencies happen slowly, over a longer period of time?
4. How will these slower emergencies affect:
   (a) the mix of refugees in the group?
   (b) how much food and water will they have with them?
   (c) whether they can build their own shelters or not?
5. Which emergencies are the most difficult to plan for? Explain why you say so.
6. Which emergencies are easier to plan for? Explain why you say so.

17.3 Refugees in a foreign land

When refugees arrive at a refugee camp, they need many things, such as food, clean water and shelter. These basic needs have to be supplied by the rescue workers who are setting up the refugee camp.

In the following exercise, you will look at the experiences of people on either side of a refugee situation: refugees and the rescue and aid workers who are helping them.

Situation: Refugees in a foreign land

Discuss the situation below in groups of three or four before answering the questions yourself. Your answers should be short paragraphs.

> A sudden war has broken out between two small countries in central Africa and a large number of people had to flee to a neighbouring country.
>
> Imagine what it must be like to be one of the refugees, and also what the situation would be like for the **host** nation.

Host: A person who gives food, water and shelter to another person. A host nation is a country that helps refugees from another country.

1. What do you think the mix of people in the group is like? Remember this is a war situation, and people had to flee from their country. Think about the ages of the refugees and write down which groups will need the most care and attention.
2. What are their needs for shelter? Remember that they have not brought many possessions with them. Who will provide the shelters or the materials needed to build them?
3. What food and supplies do the refugees need? Remember that the refugees have been travelling on foot for long periods of time. Think about the ages of the people. Will some of them need more food and water than others, and if so, why? Will some people have special needs, and if so, why?

Next week

One of the biggest problems facing refugee camps is to provide enough nutritious food. Nutritious food provides all the nutrients your body needs to stay healthy.

Think about these questions to prepare for next week's lesson:

- Which foods are the easiest to find in your area?
- Which foods are the cheapest to buy in your area?
- Which foods would you choose to feed a large camp of refugees?

Chapter 18
Processing food for emergency situations

In the previous chapter, you learnt about refugees and why large numbers of people can be forced to leave their homes and their countries. Usually, refugees have little or no possessions. They can also not carry enough food for a long period of time. In this chapter, you will learn how to process food for emergency situations. Processed foods last much longer than fresh foods and are ideal for refugee camps. You will write a design brief and plan an emergency meal that is nutritious and tasty. It should be possible to make this emergency meal in a refugee camp.

Figure 1: A refugee camp in Darfur, Sudan, in North Africa

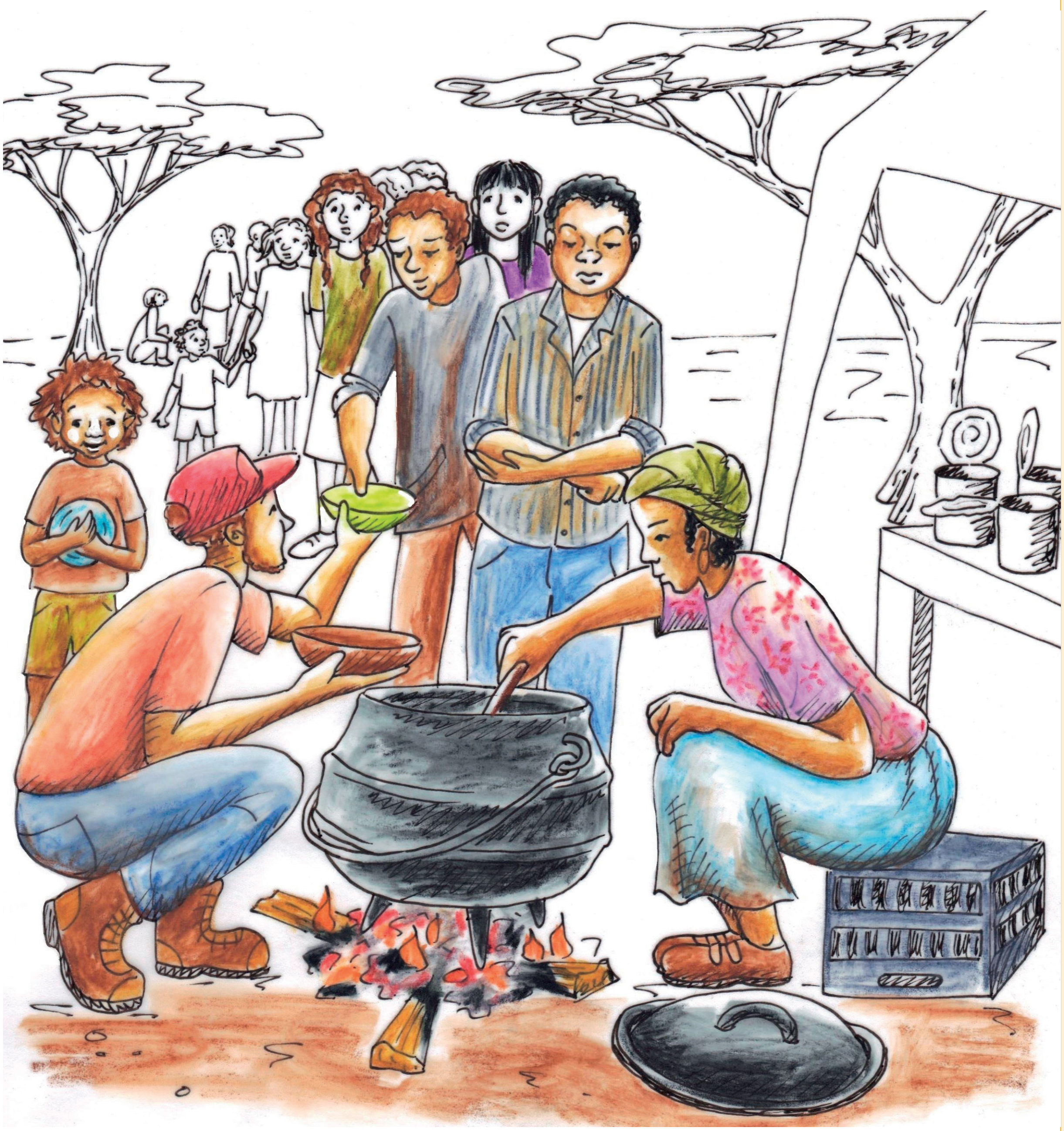


Figure 2

Figure 3

18.1 Investigate types of food

When refugees travel to a host country, the people in the host country usually take care of them.

In the previous chapter, you looked at the mix of people and how this mix would change, depending on whether the emergency was caused by a natural disaster or a war.

The type of food refugees eat depends on the mix of the group. Children need more protein than older people, babies need special milk formulas, and old people need lots of vegetables to protect them from disease.

For homework, you had to think about types of food that are available in South Africa and that can feed a large group of people. The food had to be cheap, easy to find and nutritious.

Refugees do not expect expensive food, just enough healthy food. Poor nutrition can lead to problems like illness and disease. If refugees get weak or sick, they will not be able to look after themselves and the situation in the refugee camp will become worse.

Nutritious food

To remain healthy, the human body needs different types of food, from all the food groups. Diets that contain food from all the food groups are called balanced diets. A balanced meal includes the following food groups:

- Carbohydrates: These provide energy and are found in starchy foods like potatoes, mealie meal, rice and bread.
- Protein: These build muscle and give us strength. Protein-rich foods include meat, fish, chicken, eggs, beans, cheese and milk.
- Fats and oils: These provide energy and help to protect our internal organs. They also help our bodies to fight disease. Foods in this food group include cheese, butter, margarine and oils such as sunflower or canola oil.
- Vitamins and minerals: These are found in all foods, but especially in fresh fruit and vegetables. They are very important for good health, strong bones and teeth, and to keep your brain working well. Vitamins also help to prevent disease. For example, Vitamin C, which is found in oranges and lemons, fights colds and flu.

Food groups and balanced diets

Have a look at the drawing below and see if you can tell which of the foods are high in carbohydrates, protein, fats and oils, and vitamins and minerals. Notice that similar types of foods are grouped together into so-called food groups. We need to eat food from all five food groups to stay healthy.

You can think of nutrition as a wheel where each type of food is an important part.

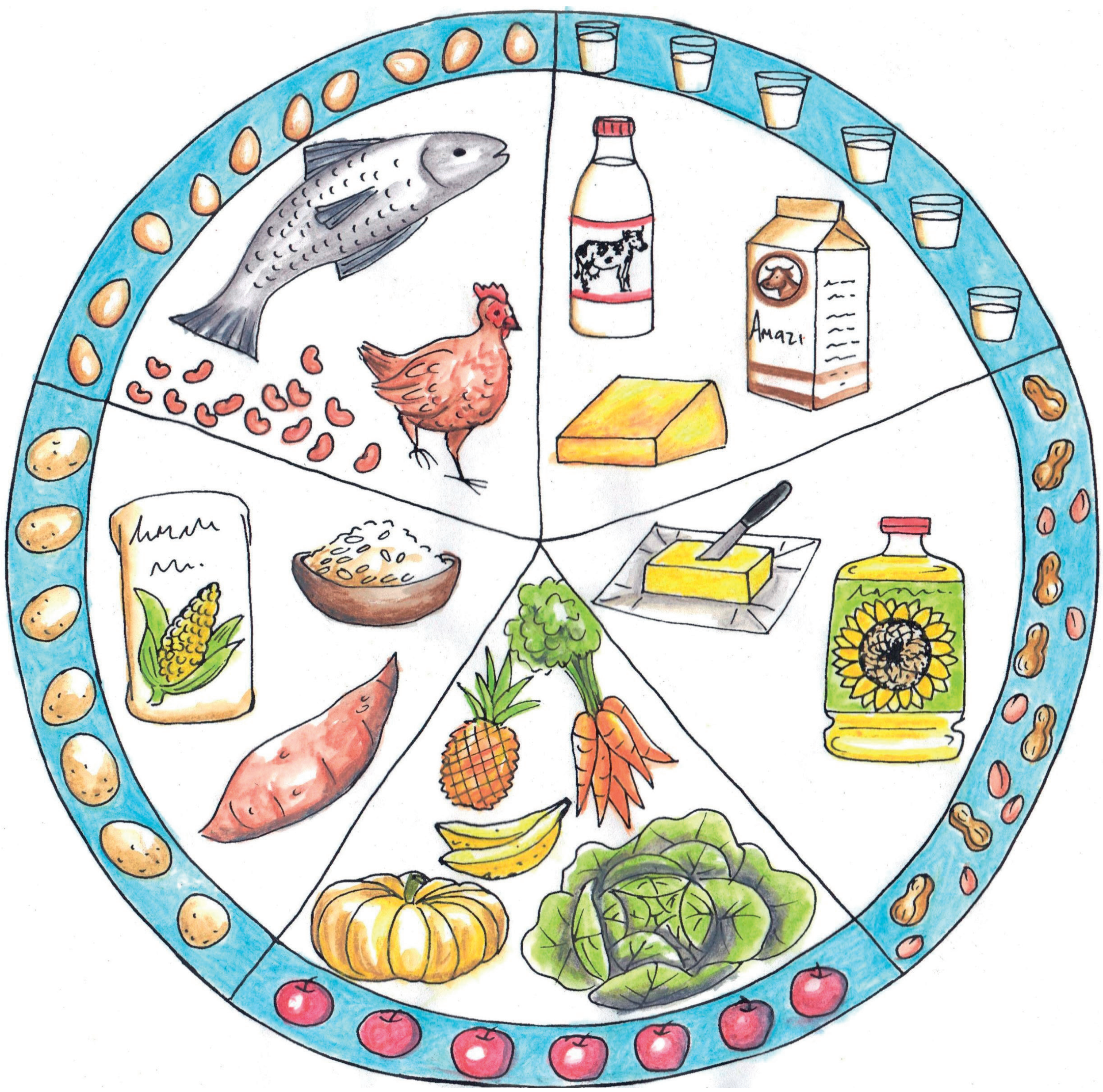


Figure 4: A balanced diet consists of food from all five food groups every day.

Also remember that your body needs fresh, clean water to keep working and to digest and absorb the food you eat.

Figure 5: Drinking fresh, clean water is very important for your health.

Compare notes and make decisions

For your homework in the previous chapter, you were asked to think about foods that are cheap and easy to find, and that are nutritious and easy to prepare.

- Work in pairs and compare your homework notes.
- Explain the reasons for your choices to each other. The main things to consider are the cost of the food, how easy it is to find, and how nutritious it is.
- Make a joint decision on what you would feed the refugees. If both of you have good ideas, you can suggest a combination of your dishes.

Figure 6: Bananas are very nutritious and they are cheap and plentiful in summer.

Figure 7: Oranges have lots of Vitamin C to help prevent colds and flu. They are cheap and widely available in winter.

Figure 8: Wheat is very nutritious. It contains carbohydrates for energy.

Figure 9: Spinach grows quickly and is high in vitamins and minerals.

Questions about your investigation

1. What type of food did you choose? Write down why you chose it.
2. Did you think about the different age groups of the people in the camp? If you have chosen different foods for different age groups, explain why you did that.
3. Is there a lot of this food available to feed a large group? Write down why it should be easy to get enough of it for the camp.
4. Is the food nutritious? Write down why you think the food you have chosen will keep the refugees healthy.
5. Is it easy to prepare? Write down the reasons for your answer.

18.2 Investigate your refugee camp

Whole class work: Make decisions

A group of 100 refugees have settled near your community. You have been asked to feed them. Before you draw up your plans, the whole class has to make decisions about the issues below.

- What is the mix of the group? Divide them into four categories: babies, children, adults and old people. Copy and complete the table below to help you with the next task.

The number of people of different ages in your group of 100 refugees

Age group	Number of people in this age group
Babies (1–5 years old)	
Children (6–15 years old)	
Adults (15–65 years old)	
Old people (older than 65 years)	

- Your group has not brought any food with them. Decide where you will find food to feed the people. How will you transport the food? How will you cook it?
- Is there a supply of clean water nearby? Why is water important for cleaning and cooking food? Discuss your answers with each other.
- Will the food be nutritious? Can you feed the people the same food every day until they can be resettled? Discuss your answers with each other.

Write notes on all your decisions.

18.3 Write a design brief to feed your refugee camp

Listing the ingredients and quantities per meal per person

Before you can work out how much food you need for 100 people, work out how much food you need for one meal. The food needs to be nutritious, tasty and easy to find. It should include as many of the food groups as possible.

For each age group, list the ingredients and amounts you will need for one person. Draw up tables like the ones below. One example has been done for you.

Amount of each ingredient needed to feed one baby

Ingredient	Amount
Samp	One third of a cup (100 grams)

Amount of each ingredient needed to feed one child

Ingredient	Amount
Samp	Two thirds of a cup (200 grams)

Amount of each ingredient needed to feed one adult

Ingredient	Amount
Samp	1 cup (300 grams)

Amount of each ingredient needed to feed one old person

Ingredient	Amount
Samp	Half a cup (150 grams)

Design a meal for 100 refugees

Once you have completed the ingredient tables, each of you have to write a design brief to feed the 100 refugees. Your design brief should list your specifications. Specifications are the ingredients that you will need to make the meal.

You need to work out how much of each ingredient you need to make one nutritious meal for each age group. For example, this is how you would do the calculations.

For each ingredient, add the amount needed for each of the age groups:

- One baby needs 100 grams of samp for one meal. Now multiply 100 grams by the number of babies in your group.
- One child needs 200 grams of samp for one meal. Now multiply 200 grams by the number of children in your group.
- One adult needs 300 grams of samp for one meal. Now multiply 300 grams by the number of adults in your group.
- One old person needs 150 grams of samp for one meal. Now multiply 150 grams by the number of old people in your group.

Example:

- If there are 20 babies in your group, multiply 100 grams by 20. This gives you 2 000 grams, or 2 kilograms, of samp needed for all the babies for one meal.
- If there are 30 children in your group, multiply 200 grams by 30. This gives you 6 000 grams, or 6 kilograms, of samp needed for all the children for one meal.
- If there are 40 adults in your group, multiply 300 grams by 40. This gives you 12 000 grams, or 12 kilograms, of samp needed for all the adults for one meal.
- If there are 10 old people in your group, multiply 150 grams by 10. This gives you 1 500 grams, or 1,5 kilograms, of samp needed for all the elderly people for one meal.

Specifications for your design brief

Now write the specifications for your design brief. Make two lists. In the first list, write all the ingredients that you need to make one nutritious meal for 100 refugees of different ages. In the second list, write the amounts of each ingredient you need.

Next week

Next week, you will prepare a meal according to your design brief. It will have to be tasty, nutritious, easy to find and easy to make in the refugee camp. You will taste and evaluate the meal yourselves, so think carefully about what you are going to prepare!

Chapter 19
Making and evaluating emergency meals

In the previous chapter, you investigated the types and amount of food refugees need to stay healthy while they are in an emergency situation. You learnt about nutrition and about the food groups that should be in every meal. You also wrote a design brief to feed a refugee camp of 100 people. In this chapter, you will investigate how to make your own meal, prepare the meal and then evaluate it.

Figure 1

Figure 2: Ingredients for an easy-to-cook, healthy meal.


Saldanha

19.1 Method for preparing part of a meal

Choose one item of food from your emergency meal. Remember that it should be:

- nutritious,
- easy to find,
- easy to cook, and
- tasty.

Before you prepare the food, write down the steps you have to follow to make it. Write the steps in the correct order, from start to finish. Think carefully about what you need to do first, and then what you need to do after that. To list your steps in this way can be called writing your steps in **sequence**. Write the steps one underneath the other in a table.

A list of ingredients for a meal as well as the sequence of steps to prepare the meal (the method), are together called the **recipe** for the meal.

But first, write down how or why you will do each step. How you will do a step is called an **instruction**. Why you will do a step is called a **reason**. Write the instruction and reason for each step next to the particular step. Look at the drawing below to see what Linda has done.

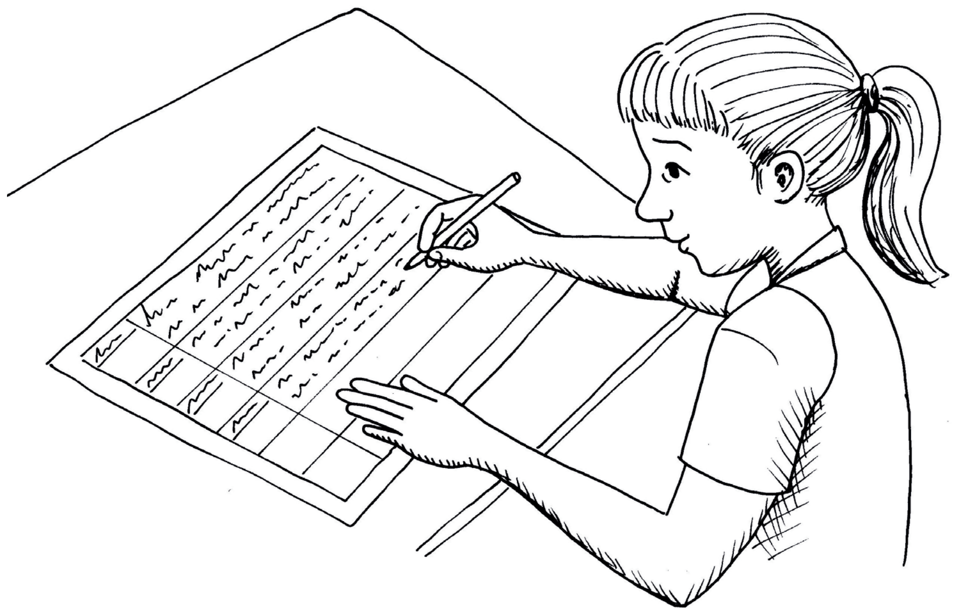


Figure 3: Draw up a table that shows what you need to do to prepare the food from start to finish. Write the instruction and reason for each step in the column next to each step.

You have to plan carefully, and then set out your plan using the following guidelines:

- Say whether the food you will cook is for breakfast, lunch or dinner. Explain why you decided to cook it for that meal. Here is an example of how to write your answer in the table:

Example

Breakfast	It is the most important meal of the day and will give the refugees a lot of the energy they need.

- Which item of food did you choose? Explain why. Does it mainly consist of carbohydrates or protein? Look back at the food groups you learnt about in Chapter 18.

Example

Samp	It is high in carbohydrates for lots of energy.

- Estimate how much of each ingredient you will need to make your item of food for one adult. To do this, look back at your design brief in Chapter 18.

Example

Samp	300 grams

- Write down how you are going to prepare your item of food. Write down each step in the process.

Example

Measure	Measure out 300 grams of samp. Measure out 1 litre of water.

- How are you going to cook the food? For this activity, you have to write down the process that you will follow at home, not what you would do at a refugee camp.

Example

Choose a pot	Select a pot that will be suitable for cooking the food.
Mix the ingredients	Place samp, water and salt in the pot.

- How long do you think the preparation and cooking will take? Divide it into steps. Add up all the steps and put in the total time at the end.

Example

Measure ingredients	5 minutes
Mix ingredients	2 minutes
Cook ingredients	30 minutes
Total time	37 minutes

- Ask an adult at home to help you. Write down in your plan who this person will be.

Figure 4: Get an adult to help you with the ingredients and the cooking.

When you have completed your plan, take it to school. Discuss your plan with another learner. This is an important part of the planning before you cook the meal. If either of you missed an important step, you will have to rewrite your plan. Remember, the steps in your plan are your guide to cooking the food.

19.2 Prepare the food

In this lesson, you will follow your plan and prepare an item of food at home. It will only be enough for one person, not for 100 people! You will then bring your food to school and the class will evaluate it.

You need to do this part of the activity at home.

- Find all the ingredients before you start.
- Read the plan you wrote to help you. Follow the steps closely.
- If you change one of the steps, write down how you changed it. Also write down why you changed it. You will use this information when you evaluate your making sequence.

Very important!

You must get permission from an adult when you use equipment at home to cook, or if you are taking ingredients from the cupboard.

Also ask an adult to help you cook.

After cooking the meal, taste it to check that it tastes good. This is called evaluating the flavour of the meal. If you have cooked the meal for the right length of time, it should be easy to chew and swallow. This is called evaluating the texture of the meal. You will present the meal for evaluation, so it should taste good and be healthy. A healthy meal will have the correct nutritional value. You learnt about nutrition in Chapter 18.

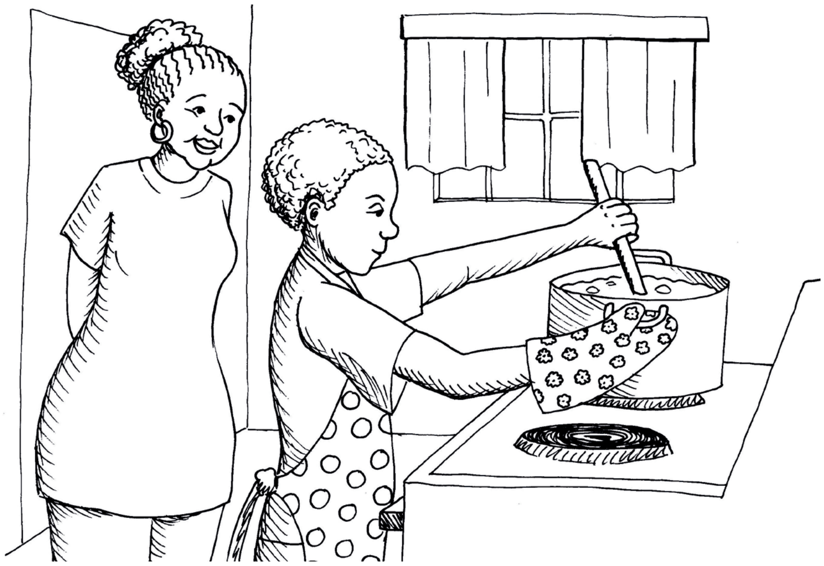


Figure 5: Ask an adult to help you with the ingredients and the cooking.

Store the meal in a plastic container with a seal that will keep the air out. If you don't have a special container, use an empty, clean margarine container.

Keep the container in the fridge overnight. Bring your item of food to school the next day for evaluation.

Safety warning

If you use an open fire to cook on, remember that open fires can be dangerous. Always make sure safety measures are in place.

1. Make sure the fire is completely out when you have finished your cooking.
2. Put something around the fire to ensure it does not spread.
3. Keep small children away from the fire.

19.3 Evaluate the food

Bring your prepared meal to school for evaluation. Work in groups of four. Use plastic spoons and taste each other's meals.

After trying out all the food that the other learners have brought to school, write an evaluation of their food and of your own food.

Hygiene warning

Bring your own spoon to school. If you share a spoon, wash it with soap and water before you use it.

Copy and use the checklist below. Tick "yes" or "no" for each question.

	Yes	No
Flavour: Is the food tasty?		
Texture: Does the food taste as if it is properly cooked?		
Nutritional value: Is the food healthy?		
Comments:		

When you have all tasted each other's meals and listed your comments, give each other feedback. Do not be rude about other learners' food. Make positive suggestions. Say how you think they can improve the taste, texture or nutritional value of their food.

Now write an evaluation of your own meal based on the feedback you received. Write your evaluation in paragraph form.

For example:

I found this to be a very interesting task. At first, it was difficult to work out how to make sure there was enough protein and carbohydrates, so I used the food groups to guide me. I chose samp as it is a very nutritious grain, which is cheap and easy to find. I checked on cooking times for the samp to make sure it was properly cooked and that the texture was right. I added salt and butter to make it tasty.

Now write a second paragraph about everything that you learnt in this chapter. At the end, write down how you would do it differently next time.

For example:

In this chapter, I learnt about planning. I also learnt how to prepare and cook an item of food. If I had to do this lesson again, I would add spinach to my samp, because spinach has vitamins that are not found in samp. Spinach would have made my food more nutritious.

Next week

In the next lesson, you will investigate materials that can be used in rescue operations. Choose two emergency services that support the community, for example the fire department and the National Sea Rescue Institute.

Chapter 20
Protective clothing

In the previous three chapters, you investigated situations that can cause people to become refugees. You also investigated how food is processed. You then wrote a design brief for a meal for 100 refugees, and you designed, made and evaluated food that is nutritious as well as tasty. In this chapter, you will investigate the special clothing worn by people who work in emergency situations. For example, these rescue workers could be from the fire department or the National Sea Rescue Institute (NSRI).

Figure 1: Fire fighters have to wear special clothes to protect them from fires.

Figure 2: Sea rescue workers also wear specifically designed protective clothing.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20.1 Emergency services

Dangerous situations such as fires, floods and accidents usually happen unexpectedly. People need to take immediate action to save the lives of the people involved. This type of situation is called an emergency.

Emergencies don't always mean that many people are forced away from their homes. An emergency may affect only one family, or even just one person.

For example, a house fire or a wildfire can threaten a group of houses. Other examples of emergencies are when swimmers get into difficulty out at sea, or when fishermen are in trouble on a sinking boat.

People who work in emergency services are called emergency workers. They are specially trained to respond to emergencies and they must be ready to respond quickly to a call for help. Emergency services include the fire department, police, ambulances and sea-rescue services.

Emergency workers go into dangerous situations, so they need to wear protective clothing.

> Emergency workers wear clothes that are designed to protect them from danger. These clothes are known as **personal protective equipment**, or **PPE**.
>
> Experts study the dangers caused by emergencies and design and make clothes, shoes, helmets and other items that will protect emergency workers during these situations.
>
> The government's department of labour sets occupational health and safety regulations (OHS), that specifies what kinds of protective equipment must be used in what kinds of jobs.

Emergency services

1. Think about emergency situations that can happen in your community. Draw up a table with two columns, and list the emergency situations in the first column. List as many as you can think of.
2. List the emergency services that can be called to help in each situation. Write them in the second column of your table.
3. Think about other communities. Are there emergencies that could affect them, but not affect your community? Think about the environment where these communities live. Are there rivers or beaches nearby? Are they in cities, the country, forests or grass fields? List all the emergencies that could happen in these places. Then list the emergency services that can be called in to help them.

20.2 Clothing for emergency workers

Emergency personnel wear protective clothing that is specially designed to protect them from the dangers they could face in an emergency. For example, fire fighters need protection from flames and heat, and sea-rescue workers need protection from water, rain, the wind and cold.

The materials we use to make any kind of clothing are called "textiles". Special textiles are used to make protective clothing. These textiles are made from woven or knitted materials, that can have chemicals added to them to give them special qualities, such as waterproofing or fire resistance.

Figure 3: A fire on a mountain. Fire fighters monitor the situation to make sure that the nearby community is safe.

A firefighter's protective clothing

Fire fighters' jackets are made from fire-resistant textiles, and are lined with reflective tape so that fire fighters can be seen in the smoke.

Fire fighters' boots are made of strong leather, with thick soles to protect their feet from flames.

A sea rescuer's protective clothing

Sea rescuers' jackets are designed to keep sea rescuers dry and warm, even in heavy storms. They are made of thick plastic or rubber.

*Waterproof boots, or **wellingtons**, are made of thick rubber. They keep a sea rescuer's legs and feet dry and warm. The rubber sole also prevents slipping on wet decks.*

Figure 4

Clothing for emergency workers

Now that you have learnt about some of the protective clothes used by emergency workers, you can design some protective clothes of your own.

Fire fighters and sea rescuers wear the specific clothes mentioned on the previous few pages. Think about the other emergency services that you listed in the exercise "Emergency services".

Wellington boots were named after a Duke of Wellington in England. He was a famous soldier who wore them into battle.

1. Write down at least three emergency situations that they may be called to deal with.
2. Write a list of special protective clothes you think they should wear in each situation.
3. Write down the textiles their clothes should be made of.
4. Draw a picture of one type of protective clothing that you have written about.

20.3 Investigate protective clothing and emergency equipment

In this section, you will investigate the kinds of protective clothing and emergency equipment used by fire fighters and sea rescuers.

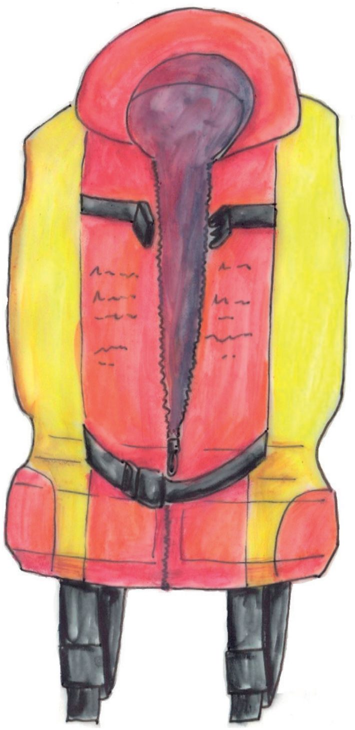
Group investigation

Work together in groups of four.

Choose one of the emergency professions you have learnt about: fire fighting or sea rescue.

Discuss the special clothes that these emergency workers wear to help protect them in their duties. Use the information in this chapter, but also try to find extra information from people you know. For example, maybe you know someone who works at the fire department and can talk to them. The pictures on the opposite page will give you more information.

Protective equipment or emergency equipment used by emergency workers includes life jackets for sea rescuers and oxygen tanks for firefighters.



Sea rescuers always wear life jackets when they are at sea. Life jackets help them to float if they fall into the sea, so that they do not drown. A life jacket is made from thick plastic or rubber and has air or foam inside so that it can float.
Figure 5

Fire fighters carry oxygen with them to help them breathe when there is a lot of smoke from a fire. An oxygen tank is an example of the type of protective equipment used by emergency workers. The tank is made of thick metal to keep the oxygen from exploding. The pipes are made from rubber so that they are airtight (oxygen cannot leak out). The dials have a covering made of glass or see-through plastic.
Figure 6

Protective clothing and emergency equipment

After you have done your investigation and you have all the information, copy and complete a table like the one below.

In the first column, write down an item of clothing or equipment that you have learnt about. Then answer the questions in the other columns. You should say what the item of clothing or equipment is made from, and also say why it is made from that material. Here are two examples to get you started.

	Firefighters		**Sea-rescue workers**	
	Made from	**Why?**	**Made from**	**Why?**
jacket	fire-resistant textile	cannot catch fire	thick plastic	can withstand bad weather and keep the rescue worker dry
boots	leather	strong enough to protect fire fighters' legs and feet from flames	rubber	waterproof

After you have completed the table, answer the following questions on your own:

1. Why is it important that protective textiles are used to make clothes for emergency workers?
2. What clothes should fire fighters wear, and what equipment should they carry when they respond to a call?
3. In what other emergency situations should special clothing or equipment be used? Think about the refugees you learnt about in Chapter 17. What kind of emergencies could happen in their camp?

Next week

Next week, you will begin your PAT for this term. In this PAT, you will investigate a natural disaster and design emergency shelters for victims of the disaster. You will also sketch a design idea and make a model of an emergency shelter.

Chapter 21 PAT
Shelters for refugees

For the next three weeks, you will investigate building techniques (past and present), making fabric waterproof and the burning characteristics of textiles. Then you will design and build a model emergency shelter. You will work on your own and your teacher will assess your work.

Assessment

Design:

Design brief and specifications .... [12]

Design sketch .... [20]

Make:

Waterproof fabric .... [10]

Model emergency shelter .... [28]

[Total: 70]

Figure 1: An informal settlement during a fire

Shack dwellers face many problems. Fires are particularly dangerous. Shack fires kill many people every year. People in shacks use open fires and candles for heat and light. When a candle falls over or an open fire is not dampened down to kill all the flames, a fire starts. These fires spread very quickly because shacks are built too close to each other. There are also no proper roads in between the shacks. This makes it difficult for fire fighters to reach the fires in order to put the fires out.

Figure 2: A town flooded after very heavy rainfall

People sometimes build houses on an open piece of land without thinking if it is a good place to live. Sometimes the land is low lying and there is nowhere for the storm water to go when it rains heavily. The area becomes flooded and the water runs through their homes. This causes a lot of damage to the few possessions they have. Often people don't want to leave their flooded shacks because they are scared that their possessions will be stolen while they are living in temporary housing.

Week 1

Investigate Part 1: Let us look how our ancestors lived (30 minutes)

The Khoi (Khoikhoi or KhoeKhoe), which means "people people", and the San (Bushmen or Sho), which means "men without domestic livestock", were the first people to live in southern Africa. They were the earliest inhabitants of our country and have been living here for thousands of years.

Both groups were nomadic. Nomads do not live in one place for a long time. They move from a place in search of food for themselves and their animals. The Khoi people owned livestock. They moved in search of good grazing for their cattle and goats. The San people were hunter-gatherers. They did not have livestock. The men tracked and hunted wild animals. The women collected mainly eggs, roots and bulbs.

Both groups built dome-shaped huts made from green sticks tied together at the top. These frame structures were covered with reeds and grasses that grew around them. Some of the Khoi wove grass into mats, which they used to cover the frames. The grasses or reeds made the huts windproof and waterproof. When they moved on they left the huts behind, so their huts were not made to last a long time. These were not permanent dwellings.

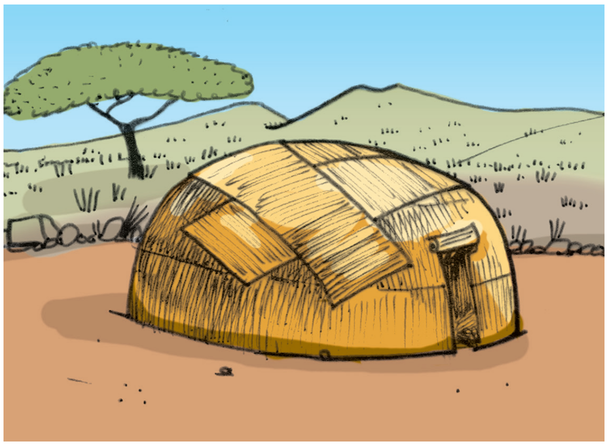


Figure 3: Khoi hut

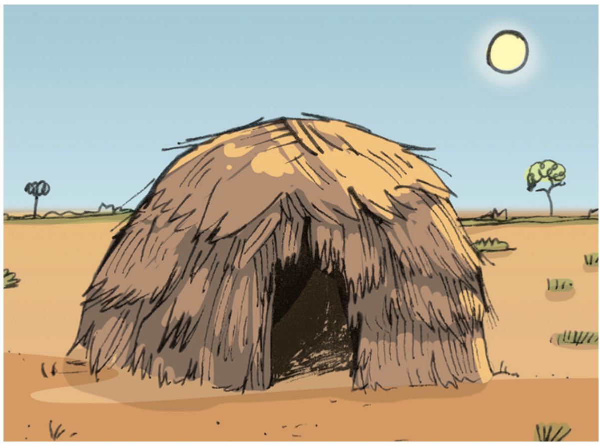


Figure 4: San hut

Look at the homes of the Khoi and the San people

Work in pairs.

1. What materials did the Khoi and the San use to build their homes?
2. Where did they find the materials they used?
3. Were the building materials suitable for the environment where the Khoi and San lived? Explain your answer.
4. What happened to the huts and materials they left behind once they moved on to another place?
5. Do you think that any of the materials would have harmed the surrounding environment where they were used? Give a reason for your answer.
6. Why did the Khoi and the San people need their structures to be temporary?

Investigate Part 2: Permanent homes of our indigenous people (30 minutes)

About 2 000 years ago, people slowly **migrated** from northern Africa to the south. Four main groups ended up in the area that is now South Africa: Nguni, Sotho, Venda and Tsonga.

These are the forefathers of most of our **indigenous** cultures. They grew crops, mainly grains like maize for food. They kept cattle for meat and milk. So they needed to live close to rivers or streams and in areas where the land was fertile.

Migrate: to permanently move from one place in a country to another place or another country.

Indigenous: people originating in a particular country.

Because they lived in one place, they built permanent homes.

Some people built dome-shaped huts. They did this by:

- making a framework with upright branches,
- using thin green saplings to make a fine mesh between the upright branches, which makes a strong framework that lasts for a long time, and
- covering the framework with thatch and then with plaited grass mats. The two layers of covering insulate the huts against extreme temperatures and keep the people warm and dry.

Figure 5: The framework is covered with grass.

Figure 6: Completed dome-shaped hut

Other people built round "rondavel" homes.

- Saplings were used for the straight upright walls.
- Gaps between the saplings were filled with clay.
- The walls were plastered on the inside and outside with clay.
- A cone-shaped roof was made from a framework of wooden sticks covered with grass, reeds or thatch.

Figure 7: Rondavel hut

Ndebele people came into contact with **immigrants** from Europe. They started to build rectangular homes.

- The walls were built with mud bricks and plastered with mud.
- The outside walls were decorated with brightly coloured designs. This makes these homes "distinctive" and attractive.

Immigrant: a person who moves to another country permanently.

Something is "distinctive" if it has a special property or quality that makes it stand out from other similar things.

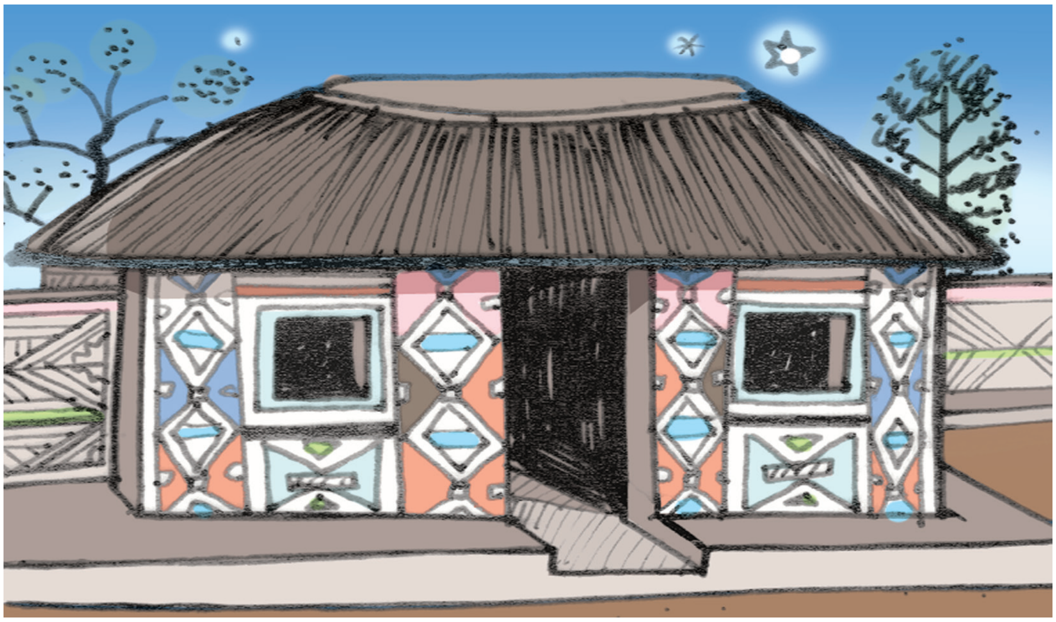


Figure 8: Rectangular Ndebele hut

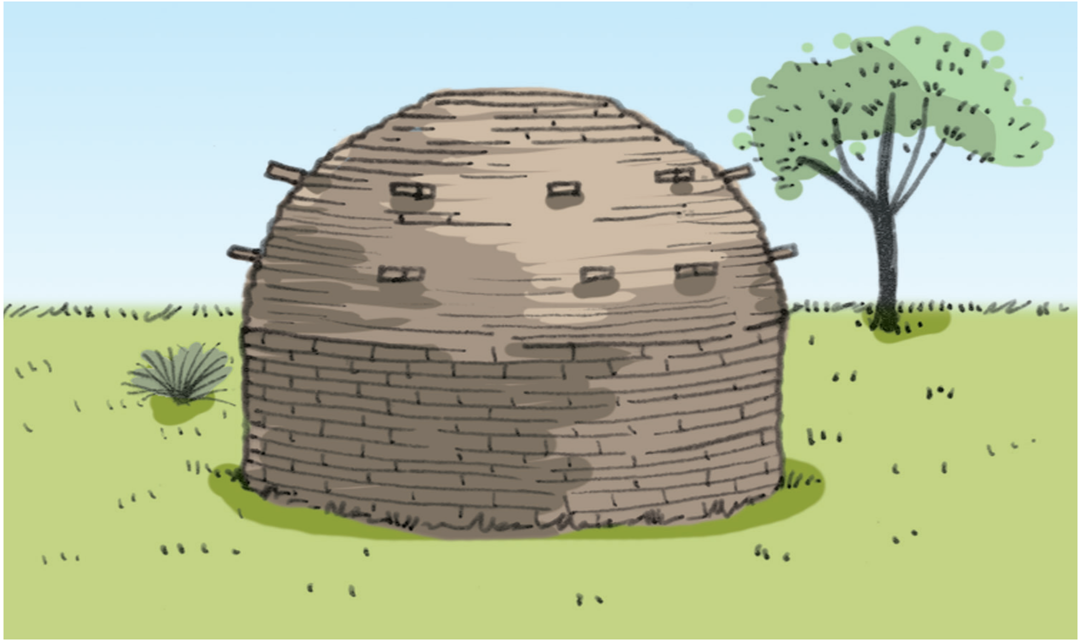


Figure 9: Corbelled hut

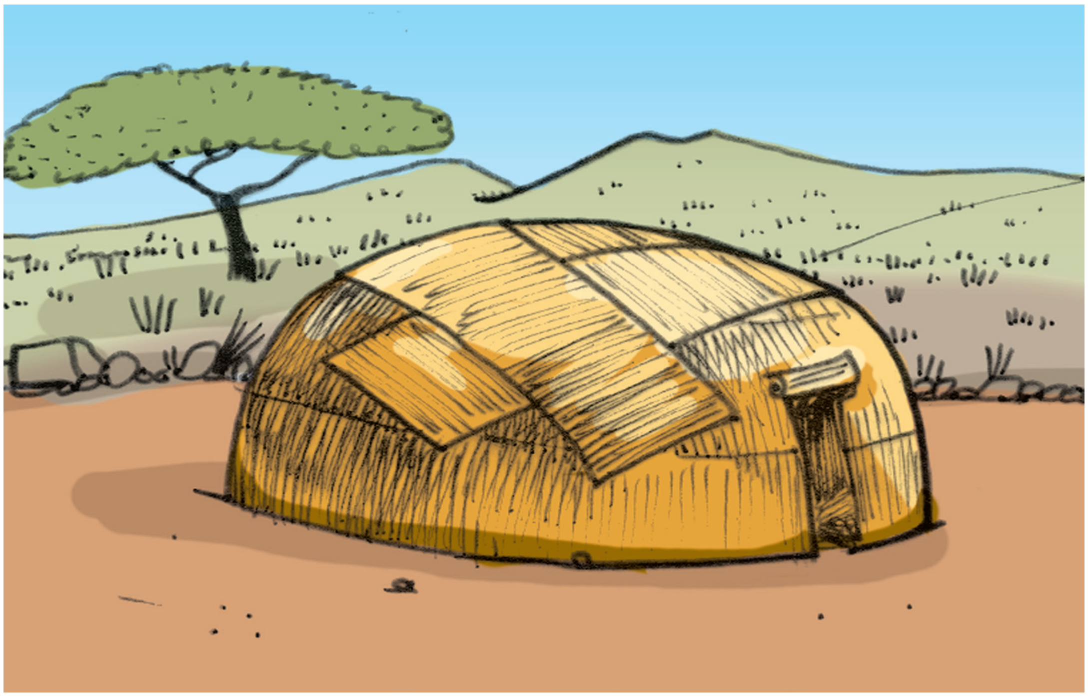


Figure 10: Matjieshut

Matjiehuts were temporary houses built by the Nama people of the Richtersveld. This building style was later adopted by white farming families when they needed temporary houses.

Corbelled huts were built by the first colonial farmers that ventured inland to the Northern Cape. They were nomadic farmers, called trekboers. This is an area where no trees grow so they used rocks for their first simple homes. Flat stones were used to build the dwellings, from the walls right up to the roof, with a minimum of a mud-clay bonding substance. The 'scaffolding' was there so you could easily climb up and make running repairs to the roof. Although this style of building originated in the Mediterranean more than 4 000 years ago, it was only introduced to South Africa once settlers arrived from Europe and Indonesia a mere 300+ years ago.

Look at the huts built by our indigenous people

1. Why did these people build permanent homes?
2. What makes their dome-shaped huts better than those that the Khoi and the San people built?
3. Why do the people that build 'rondavel' huts choose to use mud as a building material?
4. What is the advantage of using thatch as a building material?
5. What is special about the homes of the Ndebele people?
6. Are the materials used to build these homes suitable for building homes? Explain your answer.

7. Would any of the building materials they use harm the environment? Explain your answer.
8. Do you think the early people who moved from North Africa were immigrants like the people from Europe that came much later? Explain your answer.

Investigate Part 3: Dwellings in informal settlements (30 × 2 = 60 minutes)

Many people migrate from rural areas to large towns and cities looking for a better life. They arrive with no money and no place to live. They build temporary places to live on open pieces of land near the towns. As more people arrive, more houses are built until there is a whole group of houses close to each other. We call this group of houses an informal settlement.

These informal settlements have no roads, no water supply, no toilet facilities and no waste removal. These temporary houses are commonly called shacks.

People use materials that they find in scrap yards and what they can afford to buy. Some examples are cardboard, plastic sheeting, wooden planks, old tyres, pieces of polystyrene foam and sheets of corrugated iron.

These materials have many disadvantages:

- Polystyrene foam and cardboard catch fire and burn easily.
- Dry wood burns quickly too.
- When tyres get old and deteriorate, they give off unhealthy fumes.
- Plastic and tyres give off black fumes when they burn. It is very unhealthy to breathe in these fumes.
- Old sheets of material made of asbestos are sometimes taken from demolished buildings and used to make walls and ceilings. Asbestos is very harmful to humans and should be avoided as a building material.

WARNING

Asbestos is very harmful to people. The fine fibres irritate the lungs and can cause lung disease and cancer.

Its only advantage is that it is heat and fire resistant, but this does not make up for its health hazard.

Figure 11

Look at the materials used to build shacks

1. Look at the photographs of shacks and informal settlements on the previous page. Draw up a table like the one below to record information about the different materials. Do not use the example that has been completed for you.

Material	**What is the material used for?**	**Is it suitable for what it is being used?**
Bricks	To hold down a roof	Bricks are not heavy enough to hold down a roof during a strong wind.

2. Do you think the materials used by the Khoi and San people and the indigenous people are better or worse than those used to build shacks? Give reasons for your answer.

Week 2

Let us help the disaster management team (30 minutes)

The scenario

The disaster management team wants to be better prepared for emergency situations. They need emergency shelters that can be moved easily to disaster areas. The shelters will be stored until there is a need for them. They must be set up and packed away quickly and easily.

The health of the disaster victims who will be housed in the shelters is important. The shelters have to be sturdy and windproof and waterproof. They must be safe and large enough for six people to live in for up to a month.

They have asked for help with a design. The specifications are:

- design a shelter,
- build a model of the design,
- the structure must be covered with fabric that you have made waterproof, and
- the shelter should keep people safe and healthy.

The first task is to find out how to make fabric waterproof. The second task will be to find ways of making fabric fireproof. Your teacher did some research and found the following information.

Different ways to make fabric waterproof

- Spray fabric with a commercial silicone spray.
- Rub candle wax or petroleum jelly (Vaseline) on the fabric.
- Paint fabric with any PVA paint.
- Cover fabric with transparent plastic contact sheeting. This plastic sheeting has a smooth front and a sticky back. You can also call it sticky-backed plastic.
- Mix ½ cup cooking oil and ¼ cup turpentine in a spray bottle. Spray the fabric a few times with the mixture.

Different ways to make fabric less likely to catch fire and burn

- Mix 2 tablespoons borax with 1 cup hot water in a spray bottle. Spray fabric a few times until soaked. Leave to dry and spray again.
- Mix 2 tablespoons borax and 1 tablespoon boric acid with 1 cup hot water in a spray bottle. Spray the fabric, leave to dry and spray again. Repeat a few times.
- Paint fabric with PVA paint and cover the fabric with sand on both sides while the paint is still wet.

Something that you add to make fabric or something else difficult to burn is called a "fire retardant".

Get ready to conduct water and fire retardant experiments in your next lesson

1. You will work in groups. Some groups will conduct the waterproof experiments and other groups the fire retardant experiments. Work in groups of six. Each group will split up into three pairs. Get your groups and pairs together.
2. Use identical pieces of cotton fabric for all the experiments. Scrap pieces of canvas or denim will be ideal. Each pair will need a piece of fabric more or less 10 cm × 10 cm.
3. You will need lots of old newspapers or magazines to work on.

To compare the different ways of treating fabric in a fair way, you need to use the same type of materials for each treatment.

Figure 12: Some materials for waterproofing tests

Figure 13: Some materials for fire retardant tests

Waterproofing and fireproofing (30 minutes)

In this lesson, you will prepare the samples for testing later.

Groups that will waterproof fabric:

- Pair A: You will need three pieces of fabric. Apply candle wax to the first piece, petroleum jelly to the second piece, and PVA paint to the third piece.
- Pair B: Apply sticky-backed plastic to a piece of fabric.
- Pair C: Apply cooking oil and turpentine to a piece of fabric.

Leave the samples to dry on newspaper. Write the method you applied on your sample on the newspaper. That way you will know which method was applied to each piece of fabric.

Groups that will make fabric fire retardant:

- Pair D: Apply borax solution to a piece of fabric.
- Pair E: Apply borax and boric acid solution to a piece of fabric.
- Pair F: Apply PVA paint and sand to a piece of fabric.

Leave the samples to dry on newspaper. Write the method you applied on your sample on the newspaper. That way you will know which method was applied to each piece of fabric.

Investigate Part 4

In this lesson, you will test your samples to find out how well the different methods worked. Use one piece of fabric that was *not treated by any method* to help compare the effectiveness of the treatments. We call this the control sample.

Appoint one pair to do the testing. The other group members have to record what they observe.

Testing samples (30 minutes)

Test waterproofed samples

Use a spray bottle filled with water. Spray the samples until they are wet on top. Lift up the sample and observe the newspaper underneath. What do you see?

Draw up an observation table like this one:

Method applied	Paper stays dry	Paper slightly wet	Paper very wet
Control sample (untreated fabric)			
Candle wax			
Petroleum jelly			

Method applied	Paper stays dry	Paper slightly wet	Paper very wet
PVA paint			
Sticky-backed plastic			
Cooking oil and turpentine			

Copy and complete:

1. The most effective method is:
2. The least effective method is:

Test fire retardant samples

You cannot set alight the whole sample. That would be too dangerous. Cut a thin strip from each sample. The strip of fabric must be less than 1 cm wide.

Some of the samples may burn. Wear safety goggles to protect your eyes and oven gloves to protect your hands.

You will need:

- a metal sheet, enamel plate or piece of wood to work on. Do not work on newspaper, since paper burns easily.
- a candle and matches.
- a pair of tongs or a wooden clothes peg to hold the sample over the flame.

Hold the sample over the flame for a few seconds. Observe how it reacts while in the flame and once removed from the flame. Copy and complete the table below.

Method applied	Reaction while in the flame	Reaction once removed from the flame
Control sample (untreated fabric)		
Borax solution		
Borax and boric acid solution		
PVA paint and sand		

Copy and complete:

1. The most effective method is:
2. The least effective method is:

How do different textiles burn?

For this experiment, you need the same equipment that you used to test your fire retardant samples. A few fibres of different textiles, for example woollen cloth or knitting yarn, cotton fabric, and synthetic fabric such as nylon or polyester will be useful.

One person will conduct the experiment while the rest of the class will observe, draw up a table like the one below, and record their observations in their table. Follow the same safety rules as you did when you tested your fire retardant samples.

Sample	Approaching the flame	In the flame	When removed from the flame	Smell	Remains after burning
Sample 1					
Sample 2					
Sample 3					

Compare your observations with the information below. Now you will know what textiles your samples were made of. Fill in the textiles in your observation table.

Sample	Approaching the flame	In the flame	When removed from the flame	Smell	Remains after burning
Animal fibres such as wool	Shrinks away	Burns slowly	Smoulders and then the flame dies	Burning hair	Dark blob that turns to powder when touched
Plant fibres such as cotton	Pulls towards the flame	Burns quickly	Continues to burn	Paper burning	Grey, feathery ash
Synthetic fibres such as nylon and polyester	Tip starts to melt	Burns and melts	Continues to melt	Acid	Hard blob of plastic

1. Which of the textiles is the least flammable?

In the next lesson, you will waterproof a piece of fabric that you will use to cover your model. You will need a piece of fabric of at least 50 cm × 50 cm in size.

Make Part 1: Waterproof the fabric for the model (30 minutes)

You have to make fabric waterproof, so that it is ready to be used to cover your model emergency shelter. Use a piece of cotton fabric of at least 50 cm × 50 cm. The fabric need not be in one piece. You may sew pieces together to create the right-sized square. Take care to make strong joints that you can waterproof well.

[10]

Week 3

Design Part 1: Design and sketch the model shelter (30 minutes)

Write a design brief and specifications

Go back to the situation and read through it carefully. Also make a note what the disaster management teams expect from you. Remember that you are building a model, so you must consider the scale of the model. If you are using your cloth of 50 cm × 50 cm, and you use a scale of 10:1, the actual shelter would be 5 m × 5 m. Would this be big enough for six people?

1. Write a design brief. [3]
2. Identify and list the specifications you have been given. [9]

[Total: 12]

Design Part 2: Design sketch (30 minutes)

Make a sketch of your design

1. Make a rough pencil sketch of a possible solution.
2. Label your drawing to show the different parts of the model shelter.
3. Identify the materials you will use. [Total: 20]

Make Part 2: Construct the model

(30 minutes × 2 = 60 minutes)

Build your model

1. Collect all the materials and equipment you need for your model.
2. Decide how you are going to go about building the model.
3. Think about any safety measures you have to consider.
4. Only now can you start building the model.
5. Once the model is finished, check that you have met all the specifications. The specifications become the features of the model emergency shelter.
6. Make sure that you considered the health and safety of the disaster victims.
7. Make adjustments if needed.

Your teacher will look at the following

- Can the model be transported easily?
- Can it be set up and packed away quickly and easily?
- Can six people live in it comfortably for a month?
- Is it windproof and waterproof?
- Is the waterproofing effective? (Consider the health of the victims.)
- Is it safe? (Consider the dangers of fire.)
- Is it well built and sturdy?

Good luck, and do your best! [Total: 28]