TECHNOLOGY

Grade 7

CAPS

Teacher Guide

Revised edition

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Photocopiable grid paper

Minimum materials and tools needed for technology activities

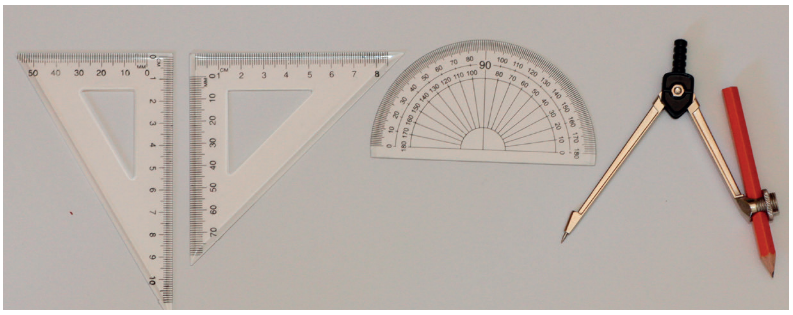
Learners need to bring their own basic writing and drawing tools to class, as well as some waste materials that will be reused. But the school should provide all the other materials and tools listed below.

Not all the materials and tools will be used in every chapter. At the start of each chapter there is a list of the specific tools and materials required for that chapter.

Important: The teacher should read about the required materials and tools for a chapter at least one week before that chapter starts. This will ensure that there is enough time for the teacher to put the necessary materials and tools together, and time for the learners to gather the materials they have to bring to school.

Tools to be bought by learners (necessary for all Technology classes)

Pen, pencil, sharpener, eraser, ruler (30 cm)



Geometry instruments: compass, protractor, set squares (30° and 45°)

Calculators

Materials to be sourced by learners (reuse packaging materials, etc.)

Left: New 180 gsm cardboard in different colours (optional, only if learners can afford it). Middle: Reused Cardboard (thick cardboard like that used for cereal boxes). Right: Corrugated cardboard (single layer)

Cardboard tubes from rolls of toilet paper, foil, etc.

Materials to be bought by schools

Big, strong scissors/ kitchen snips (buy in bulk at about R15 each). DO NOT USE SMALL CHEAP SCISSORS!

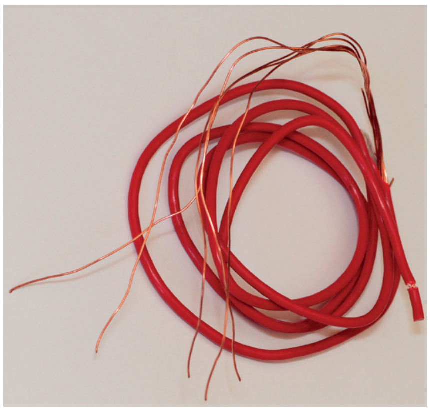
New 180 gsm cardboard in different colours (much thinner than cereal box cardboard, and easier the cut and fold)

Masking tape

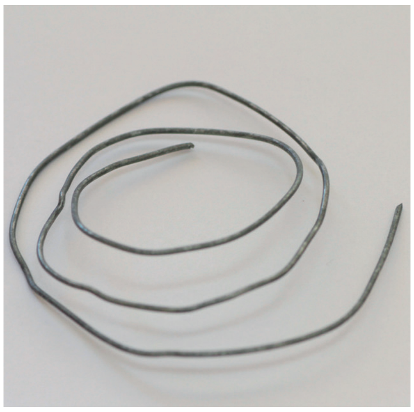
Wood glue (glue stick like 'Pritt' is optional)

Prestik (masking tape can be used instead if this is not available)

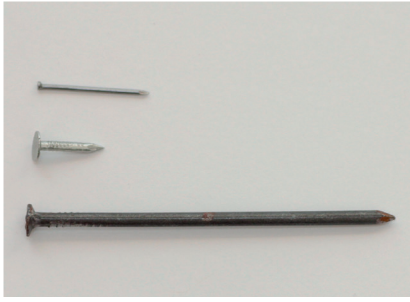
String (cotton, 2-3 mm)



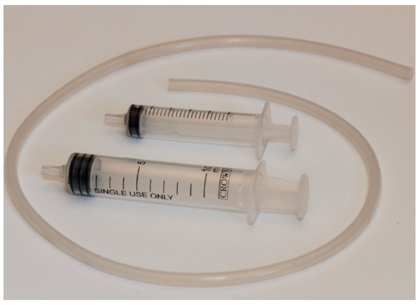
Copper wire, 1 mm (this bends easily by hand and can be cut with scissors; buy from hardware store)



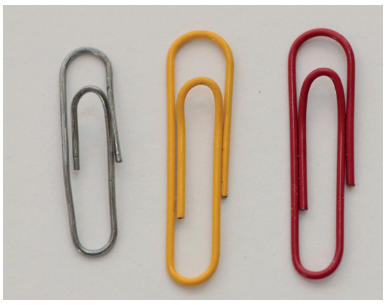
Galvanised steel, wire 1 mm (optional: if pliers or other tools for cutting and bending wire are available)



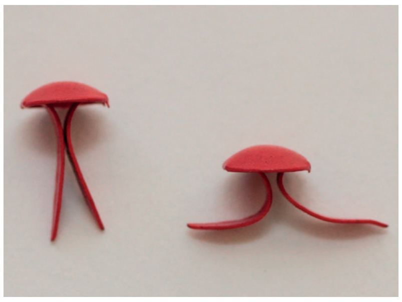
Nails (1 mm, 2 mm, 4 mm, and 6 mm diameters; minimum lengths between 3 cm and 8 cm)



Syringes (buy from a pharmacy, different diameters)
Pipe to use with syringes (buy from a pet shop, for fish tanks)



Paper clips



Paper fasteners (split pins, optional, may need to go to specialist stationery or art shop to buy)

Tooth picks (buy in bulk)

Drinking straws (buy in bulk)

How to use this Teacher Guide

Notes to the teacher at the start of each chapter

All the Learner Book (LB) pages are included in this Teacher Guide (TG). In addition, notes to the teacher are given before the LB pages, at the start of each chapter.

The teacher notes pages have a coloured background.

The teacher notes provide the teacher with:

- a summary of the chapter's work,
- some deeper explanations that are not in the LB, and
- a guide for how to prepare for the week's lessons.

Teachers should therefore read the teacher notes as part of their lesson planning, in addition to reading the LB pages.

Page numbers

The TG has different page numbers than the LB.

The TG page numbers are indicated in the usual position at the bottom of pages.

The LB page numbers are indicated at each place where a new LB page starts.

Answers to questions in the Learner Book

Answers to questions (shown in red) have been added to the LB pages in the TG.

When in the term to teach each chapter

The table of contents in the TG shows for each chapter the week(s) of the term in which that chapter should be done.

Teachers should also refer to CAPS as well as their subject advisors for guidance

The TG should be used in conjunction with the CAPS document.

For assessment of PATs, the TG does not provide analytical rubrics for assessment; the TG only indicates mark allocation and gives example answers. Teachers should make their own analytical rubrics, or use rubrics provided by their subject advisors, and refer to the example of an analytical rubric that is provided on p. 44 of CAPS.

Grid paper for drawing

Square and isometric grid paper are provided on the last three pages of this TG. Teachers may photocopy this for learners if required. When photocopying, please make sure that the copies are made on 100% scale.

Where to find electronic versions of the books

The DBE's Thutong website: http://www.thutong.doe.gov.za/

The Thutong website also contains additional learning resources.

Ukuqonda Institute: http://ukuqonda.org.za/learning-materials/technology-grd-7-9

Term 1: Mechanical systems and control

Chapter 1
What is Technology?

LB page 1

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.

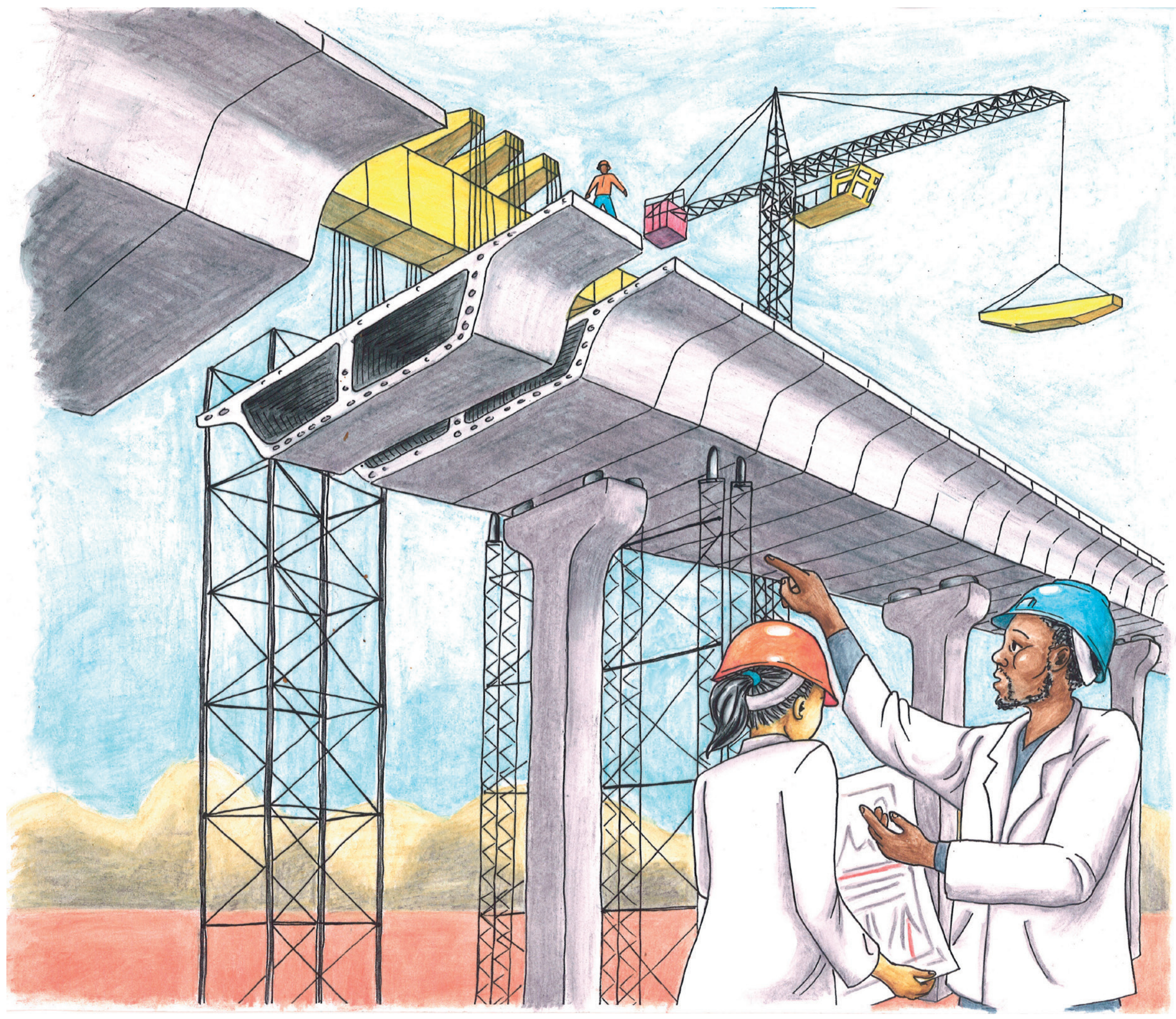


Figure 1

1.1 Materials, tools and plans

Learners are already aware of many technological objects in their lives, but they may not yet think about what those objects are made of, or how they are made. The purpose of this section is for learners to become aware of what things are made of, and how they are made. That means they need to *identify* different materials and the tools needed to build things using those materials. The activities also lead them to *make a distinction* between materials that can be found in nature, and materials that are man-made.

At the end of the section, learners will *read a story about a problem* (getting water out of a deep well) where the solution is not immediately obvious. This makes it clear that you first need to make a plan before you can solve the problem. Learners will read that people who solve problems follow many different steps in order to finally solve those problems. They will read about different important steps that people often follow to solve problems; this is called the design process. The Learner Books will frequently refer back to the different steps of the design process.

1.2 Design a wheelbarrow

In this section, learners are given a taste of the development of a Technology project and of the *design* process. They learn that a product that is good for one purpose may not be good for another purpose. A product should be designed so that it is fit for the specific purpose for which it will be used. Learners have a bit of experience in designing something that has a special purpose.

LB pages 2–3

Technology advances!

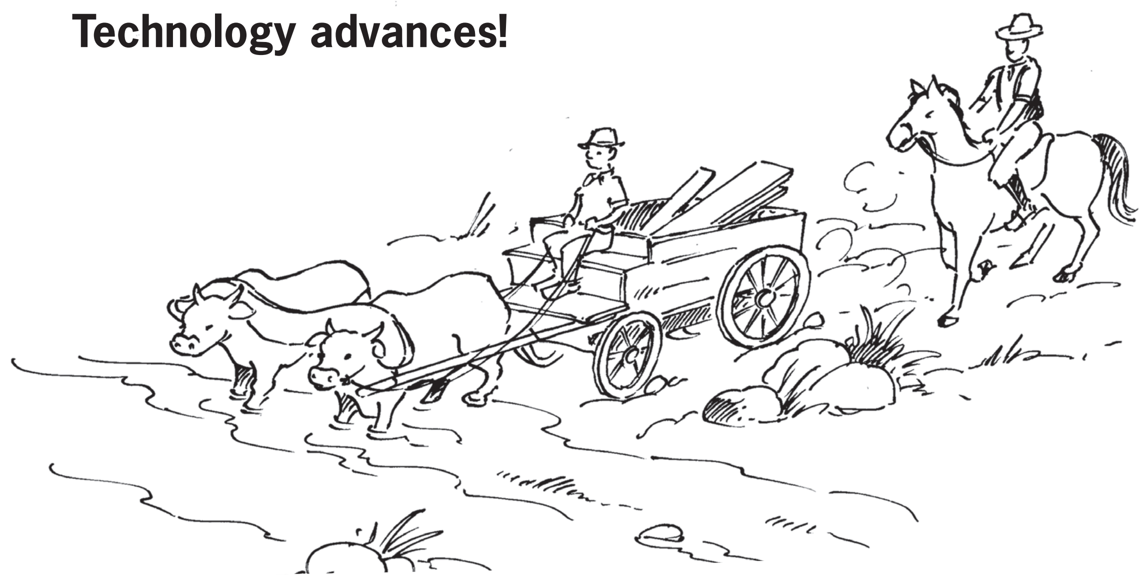


Figure 2: Transport technology 150 years ago

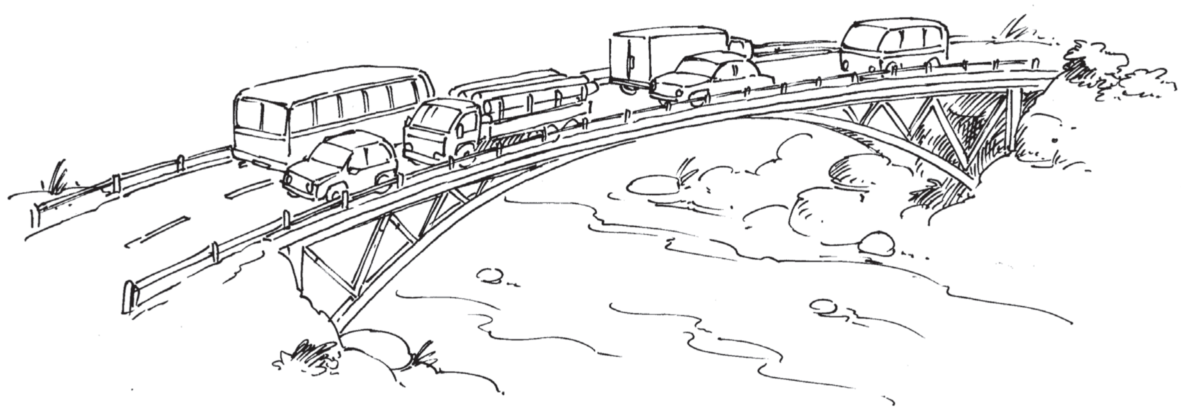


Figure 3: Modern transport technology

1.1 Materials, tools and plans

LB page 4

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.

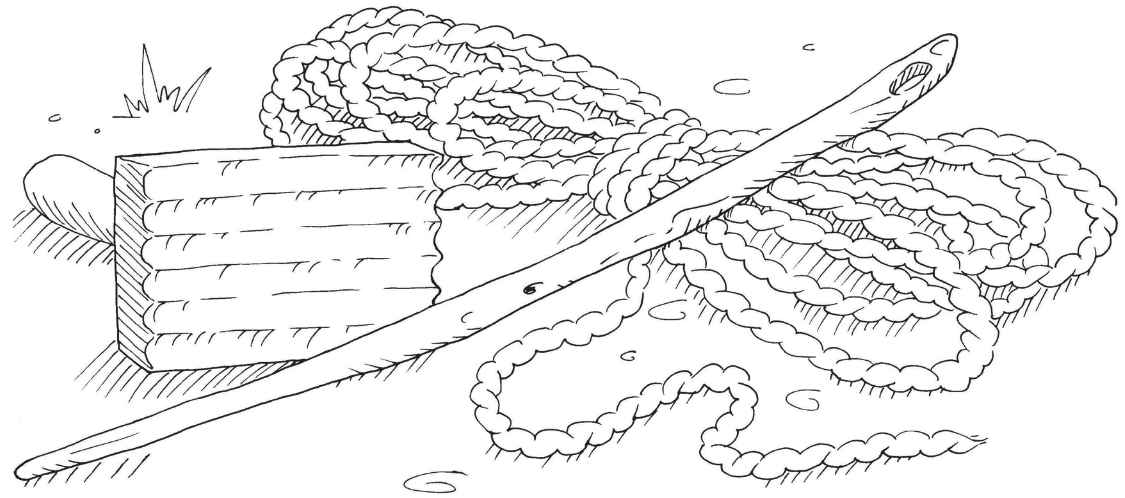


Figure 5: Some of the tools people use to make thatch roofs.

LB page 5

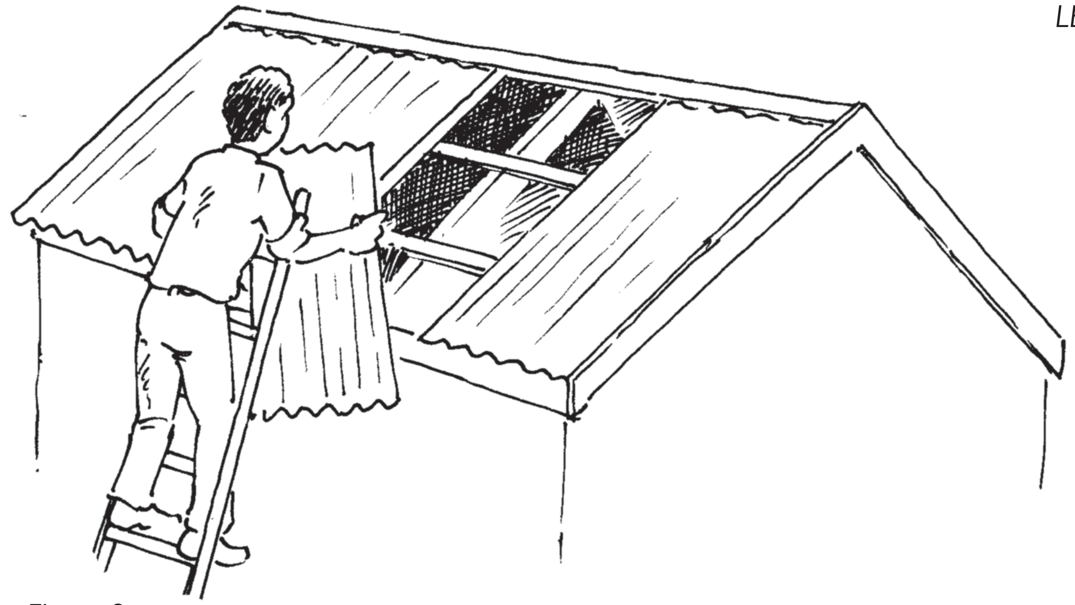


Figure 6

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**.

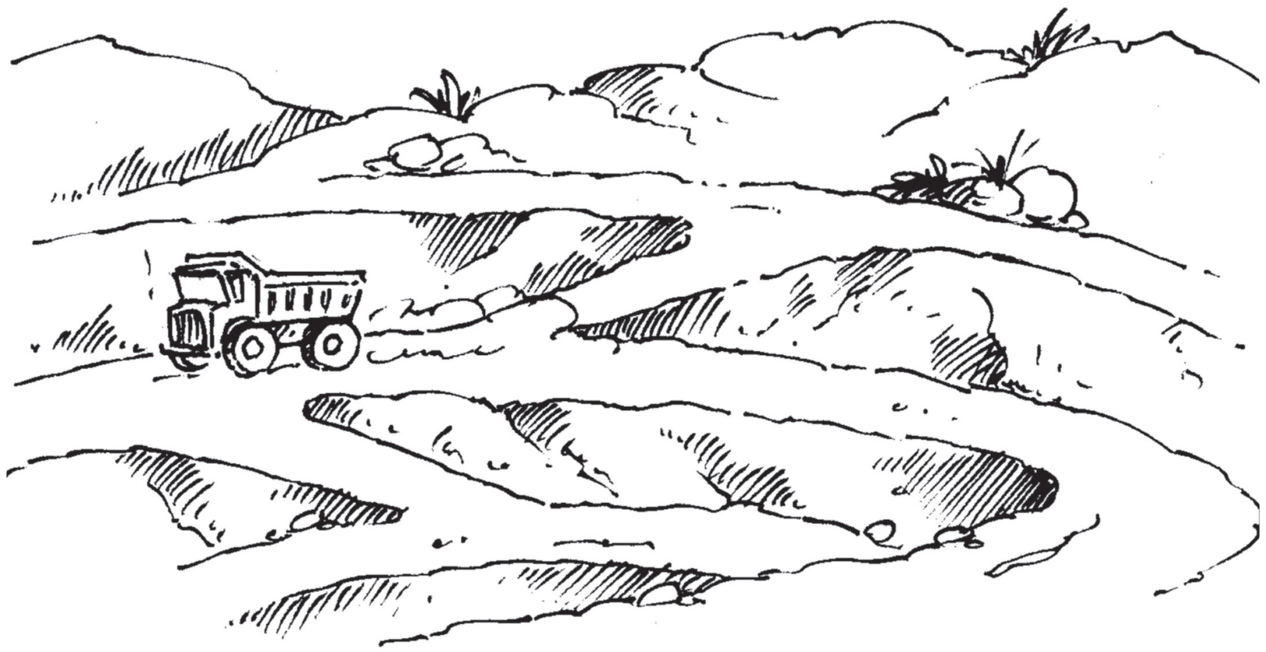


Figure 7: An open mine where rock that contains iron is collected, like at Sishen.

LB page 6

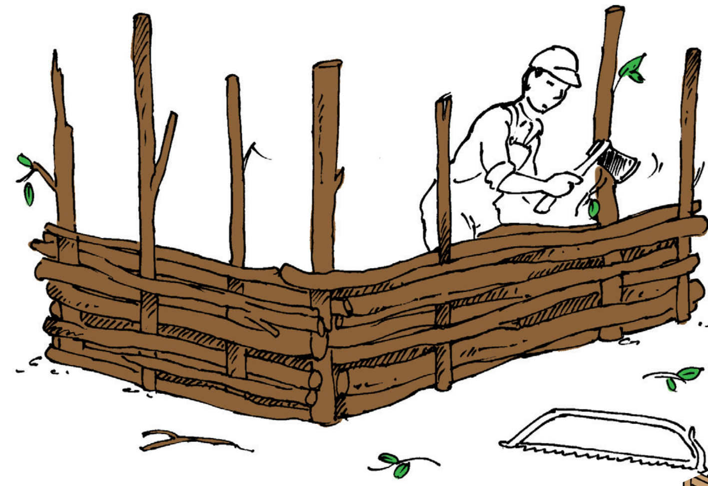


Figure 8: House A

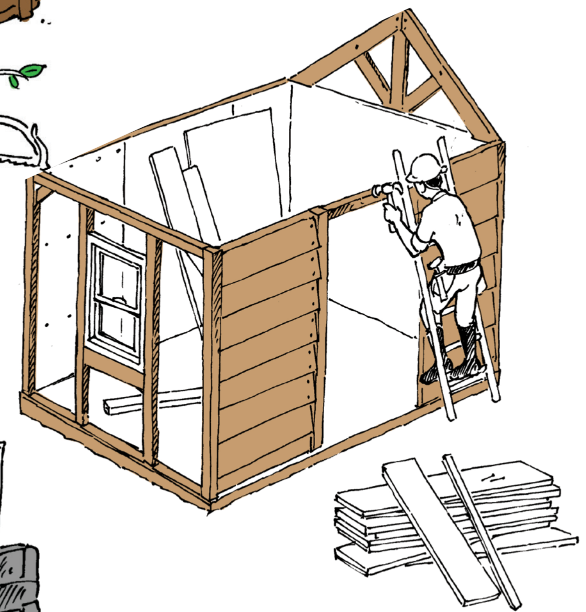


Figure 9: House B

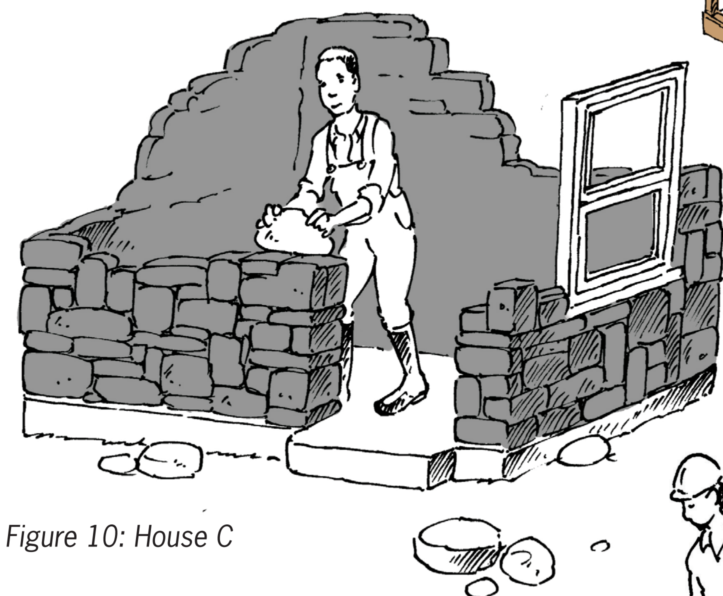


Figure 10: House C

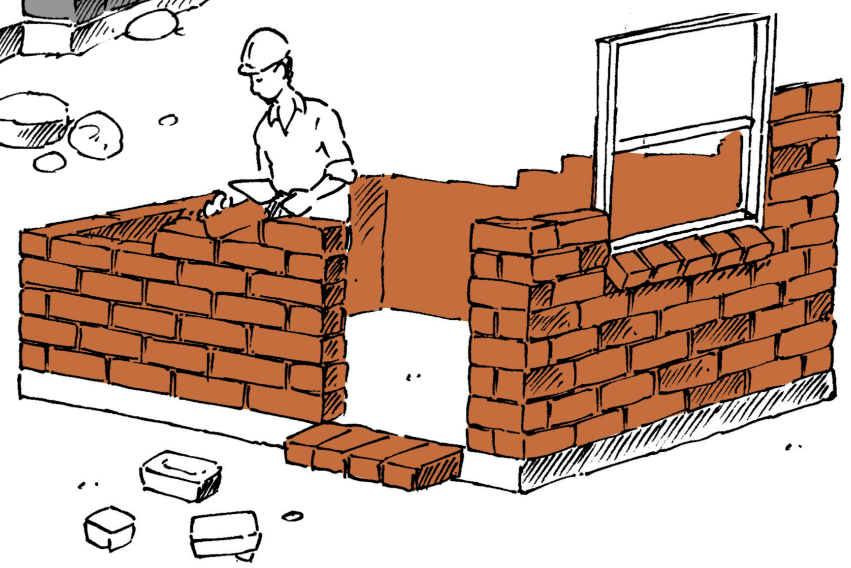


Figure 11: House D

Homework questions about tools and materials LB p. 7

1. (a) What material is being used to build the house in Figure 8?
   Wooden sticks, wooden poles, tree trunks, or tree branches.
   (b) Is this a man-made material or a natural material?
   Natural.
   (c) What tools are used by the people building the house in Figure 8?
   Axe and saw.
2. (a) What material is being used to build the house in Figure 9?
   Wood cut into rectangular planks, and wooden sheets, and glass for windows.
   (b) Is this material man-made or natural?
   It is a natural material that has been changed by humans into a different shape.
   (c) What tools are being used by the people building the house in Figure 9?
   Ladder, hammer and nails.
3. (a) What material is being used to build the house in Figure 10?
   Rocks or stones for walls, wood and glass for window.
   (b) Is this a man-made material or a natural material?
   Natural, except for glass, which is man-made.
   (c) What tools are being used by the people building the house in Figure 10?
   There are no tools visible on the picture, but a hammer, saw and nails would have been used for the window frame, and a trowel would have been used for shaping the cement between the stones.
4. (a) What material is being used to build the house in Figure 11?
   Bricks and cement, wood or aluminium and glass for windows.
   (b) Is this a man-made material or a natural material?
   Bricks: man-made, aluminium: man-made, glass: man-made, wood: natural.
   (c) What tools are being used by the people building the house in Figure 11?
   A trowel for shaping the cement between the bricks, and a hammer, saw and nails for the window frame if it is made from wood.

Read the story and think about Technology LB p. 7

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, 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 that are far away from us. 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.

LB page 8

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.

People who are trained to work with special tools are called technologists. Technologists find jobs much 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.

LB page 9

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.

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.

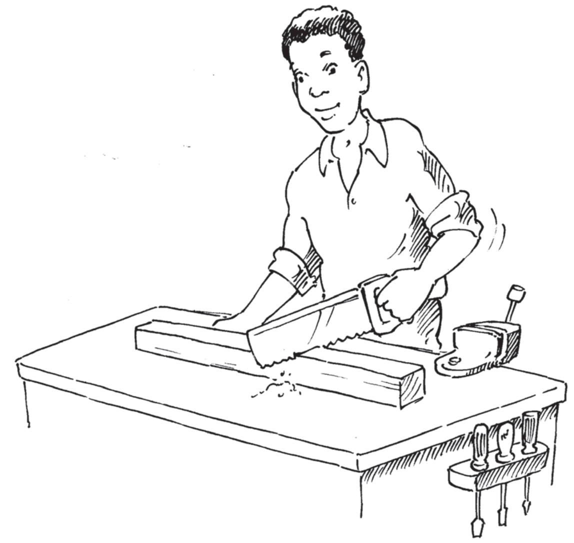


Figure 12: A carpenter is a kind of technologist who makes things out of wood.

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

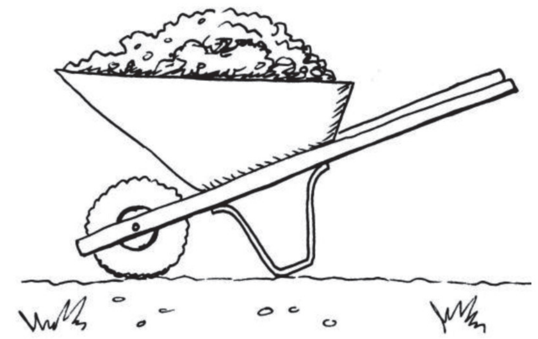


Figure 13

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 the gathering of 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 LB p. 10

1. Write down some questions that you can ask Mrs April.

There are many good questions. Below are only a few examples:

- What types of vegetables does she plan to transport?
- How many vegetables does she want to transport in one load?
- Can the vegetables be packed on top of one another? Or are they soft and easily damaged?
- On what type of path will she transport the vegetables? Is it steep uphill or downhill or is it flat? Is it a smooth path or a rough path?

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.

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**.

The answers depend on the questions they wrote for Q1. Below are a few example answers based on the examples given in Q1:

- She will transport hard vegetables like potatoes and soft vegetables like spinach.
- She wants to transport as many vegetables as possible in one load.
- She wants the client to be able to see all the different types of vegetables in her wheelbarrow.
- She does not want the soft vegetables to be damaged.

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?

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

It should be flatter, but wider so that the vegetables can be placed next to each other.

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

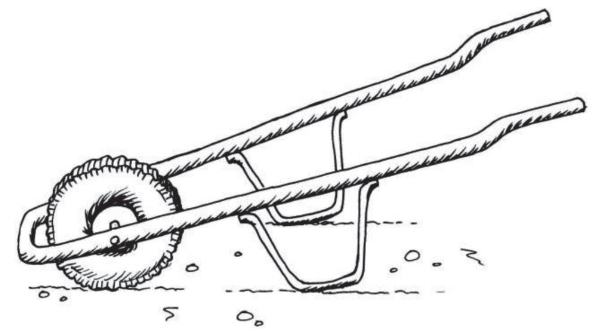


Figure 14

4. Make a sketch to show what you think the new top should look like.

The sketch should show a flat but wide top so that the vegetables can be placed next to one another.

5. Which materials can 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.

A few possible answers: wood, metal sheets, plastic or, fibreglass.

It can be made from wood or metal sheets, since Mr Sethole knows how to work with those materials.

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

LB page 11

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.

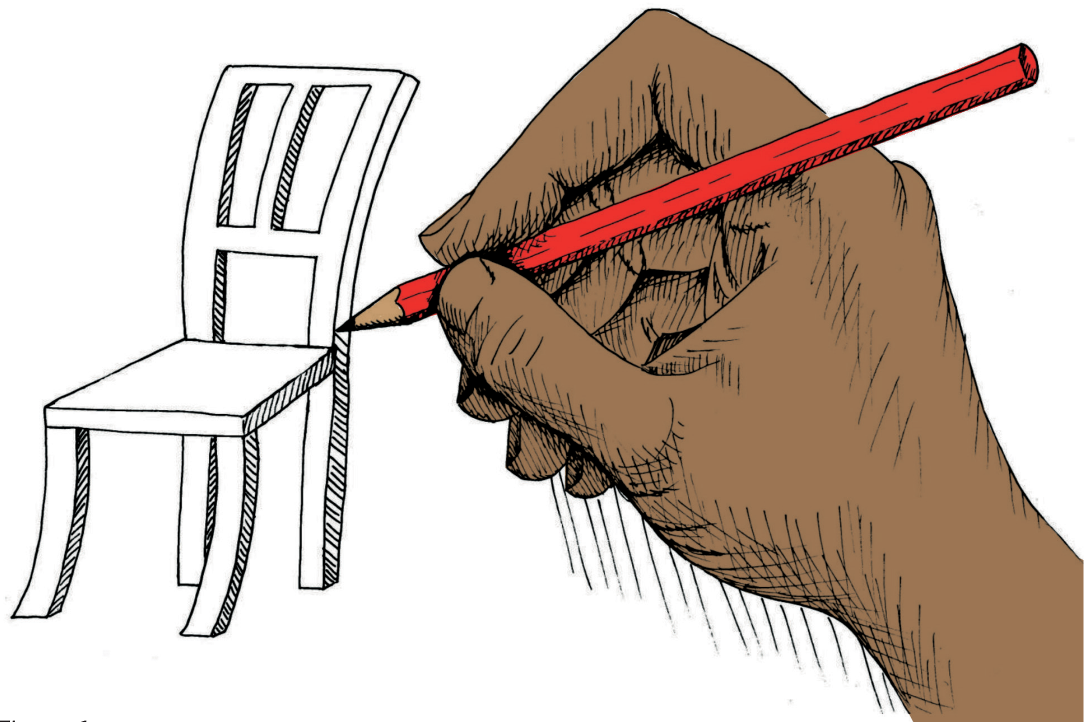


Figure 1

Sketching and drawing are integral parts of the *design* process in Technology. Without them, you would not be able to *communicate* designs to solve problems. Often, while someone is designing something by sketching or drawing it, they will make changes to the design to improve it. For example, you might only see a flaw in the design when you start to draw it.

The first two pages of introduction show a few different ways that designers might use sketches to both generate and communicate ideas. Encourage learners to practise making drawings such as these in their own time.

2.1 A new cupboard for the classroom

Different learners will *design* different solutions for a cupboard to store books in the classroom. You can make the problem more specific by indicating what type of books and what number of books the cupboard should be able to store.

Learners are free to *make* either 2D or 3D sketches of their cupboard design. However, if learners are struggling, you should encourage them to make only a 2D drawing.

Later, learners will make a bigger sketch of their cupboard. This time they should *show different measurements* (dimensions) on their sketches. You can help learners to develop a sense for sizes by asking them to show with their hands what 10 mm, 100 mm and 1 000 mm (1 m) looks like.

2.2 Different types of lines in drawings

This section deals with three important types of lines. Learners *investigate* examples of drawings to discover what the different types of lines mean. They then *make* drawings using these different line types.

A study of a bicycle pump summarises the line types. It would help if you could bring a real pump to the classroom. If you unscrew the retaining nut holding the push rod and plunger in place, you can show learners what the inside of a pump really looks like. This will make communicating its features through drawing more sensible.

Lastly, learners *investigate* and *answer questions* about a drawing on which some of the dimensions and the scale is shown. The reason for scaling a drawing is to make it fit on the page. Learners might be familiar with zooming on a computer, camera or cell phone. Scale is used for a similar purpose.

2.3 Free-hand sketching

In these activities, learners *read* about and *look* at pictures of strategies to sketch. The key principle is to draw easier things before making the final lines on the drawing. Making boundary boxes and drawing feint guidelines are some of the easier things to do that will help to make a good drawing in the end.

Below are some additional tips to help learners sketch successfully. They are not meant to be step-by-step instructions.

- When sketching an object, first *look carefully at the object*, or other similar objects. Do not look only at your hand, pencil or paper. You can only sketch objects well after you have spent time looking carefully at different kinds of objects. If you have never looked carefully at an object, you cannot even begin to sketch it properly.
- Sketches and drawings are essentially combinations of simple flat shapes (squares, rectangles, triangles, circles, ovals, etc.) and lines (straight and curved). When you observe the shapes and lines visible in an object, you can build your sketch from individual simple shapes and lines.
- *Use your whole arm*, from your shoulder to your hand, to move the pencil on the page. It is much easier to draw if you move your whole arm.
- Use *light construction lines* before you draw your final dark lines.
- *Turn the paper* to find the most comfortable position to draw a particular line or shape.

LB pages 12–13

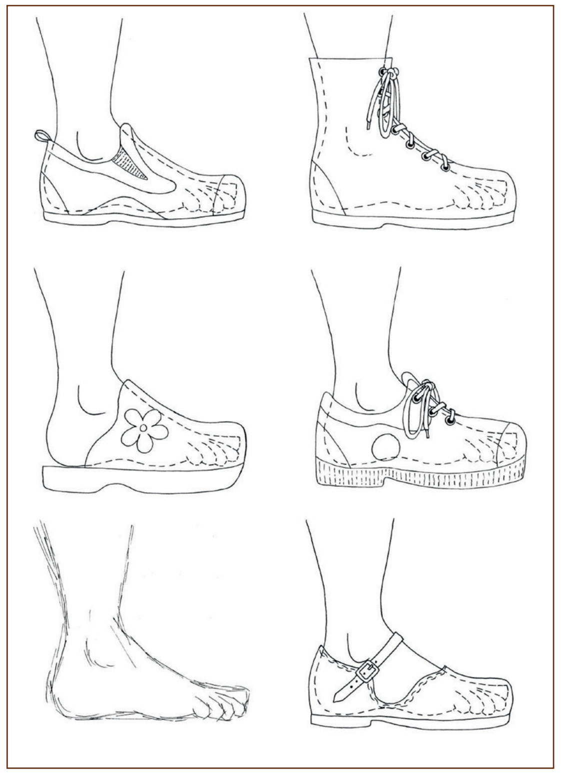


Figure 2: Drawings in a shoe design studio

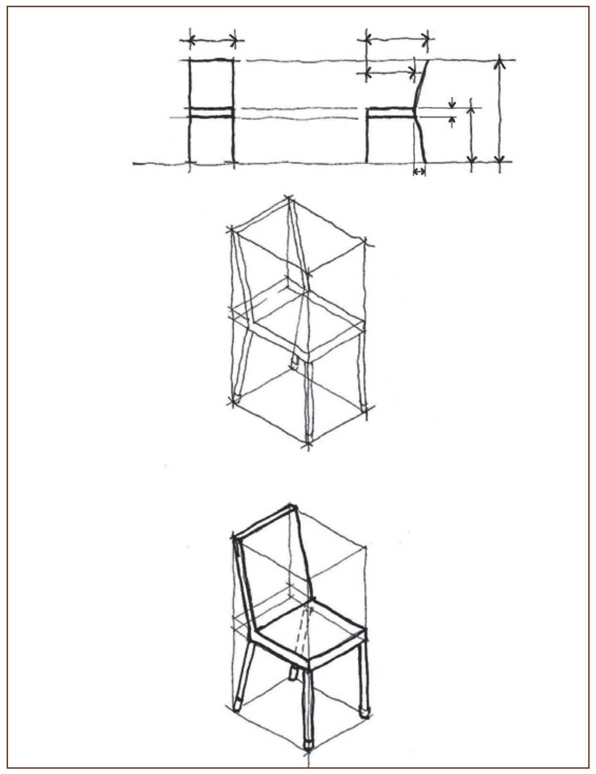


Figure 3: Drawings to design a chair

LB page 14

2.1 A new cupboard for the classroom

Your classroom needs a cupboard to store books.

Answer questions to write design specifications **LB p. 14**

1. How many doors should it have?

   Learner's choice.

2. How many shelves should it have?

   Learner's choice (for example, one shelf for each type of book).

3. What should it be made of?

   Metal, solid wood, chipboard, plywood, or hardboard.

4. How high and how wide should it be?

   Any sensible cupboard sizes: e.g. 1,5 m tall and 2 m wide.

5. How deep should it be?

   Depth should be between 25 cm and 35 cm (An A4 book is 21 cm wide and 30 cm tall, almost no books are bigger than this).

6. Make a rough sketch to show what you think the cupboard will look like.

   Learner's own design, but it should correspond to the answers given for questions 1 to 5.

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).

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.

Learner's own design, but it should correspond to the answers given for questions 1 to 5.

Checklist:

Three or more shelves are shown.

Notes show where the shelves (and possibly also the door or doors) are.

Notes specify the sizes of different parts of the cupboard, giving three measurements for each object (e.g. width, height and depth).

8. Should the real cupboard be three times bigger than your drawing?

   Three times bigger than the drawing will be too small, so no.

9. How many times bigger should the real cupboard be than your drawing?

   A line 100 mm (10 cm) long would need to be scaled up 10 times to give 1 m.

   So a 10 or 15 times scale may be more appropriate.

- 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".

LB page 15

2.2 Different types of lines in drawings

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

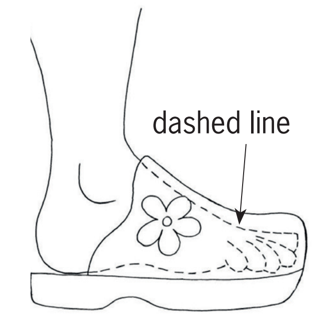


Figure 4

Draw with dashed lines LB p. 15

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

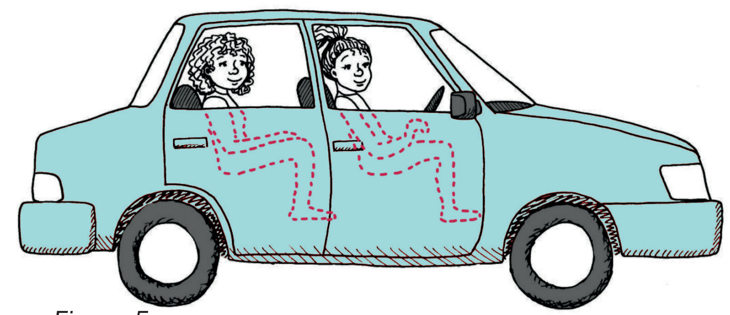


Figure 5

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.

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

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.

LB page 16

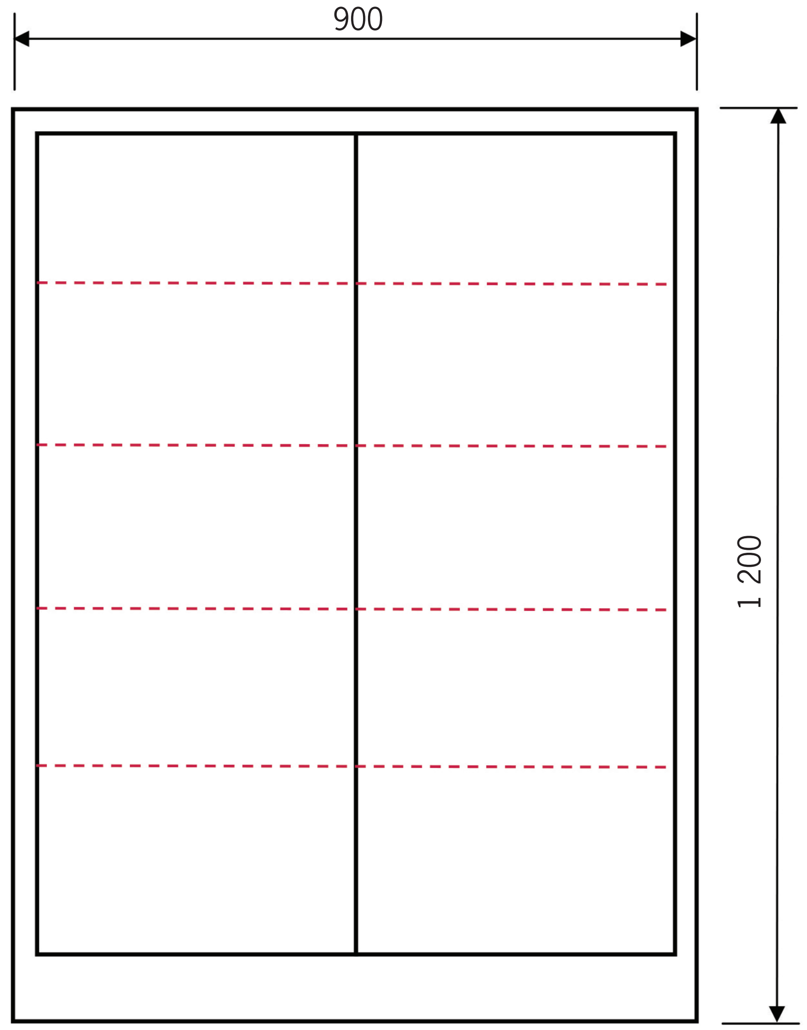


Figure 6

Figure 7

LB page 17

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 to sketch, 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 LB p. 17

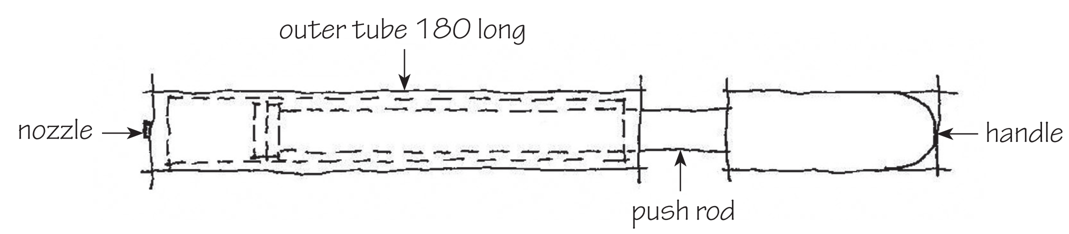


Figure 8

1. Name the parts of the pump shown in this sketch.

   Nozzle; outer tube; handle; push rod.

2. How long is the outer tube of this bicycle pump?

   180 mm

3. How long is the push rod? How do you know this?

   It will be at least the same size as the outer tube plus part of the length of the handle.

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.

LB page 18

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.

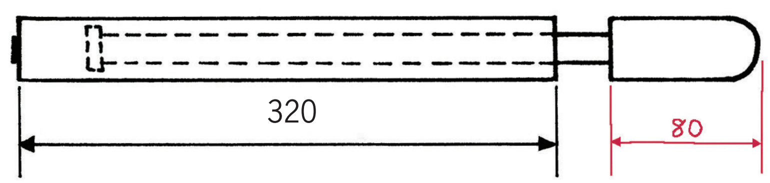


Figure 9: Bicycle pump. Scale 1:4

4. Why is the outer tube of this pump drawn with solid lines?

   It shows the edges of the pump that can be seen.

5. What other part of this pump is drawn with solid lines?

   The handle and the short part of the push rod that is visible between the tube and handle.

6. Why is part of the push rod drawn with dashed lines and other parts with solid lines?

   The hidden part is drawn with dashed lines and the visible part is drawn with solid lines.

7. What type of line shows how long the outer tube is?

   A dimension line.

8. How long will the outer tube of the real pump be?

   320 mm

9. Use the scale on the drawing to find out how long the handle will be on the real pump.

   On the drawing, the handle is 20 mm long, so in real life the handle will be 4 × 20 mm = 80 mm long.

10. Now, draw a dimension line on your pump drawing to show how long the handle will be.

    See the dimensions shown in red on Figure 9 on the previous page. Note that the extension lines are drawn close to the measurement point of the object, but should not touch the object itself.

11. Name three different types of lines that you can see on the drawing.

    Outlines, dashed lines and dimension lines.

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.

    The size of the drawing is 90 mm wide and 120 mm tall. The real size of the cupboard is 900 mm wide and 1 200 mm tall. So the scale is 90 ÷ 900 = 1/10, and this can be written as the ratio 1:10.

2.3 Free-hand sketching

LB page 19

Look at the drawing in Figure 10.

Figure 10

The artist who drew the foot in Figure 10 first drew 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.

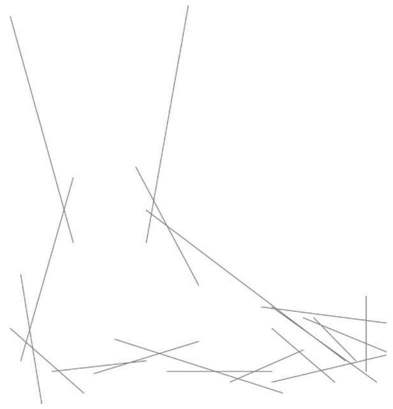


Figure 11

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 LB p. 19

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.

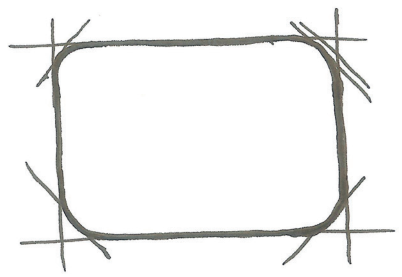


Figure 12

Learner's own drawing, similar to Figure 12, but about twice as big.

Homework LB p. 20

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.

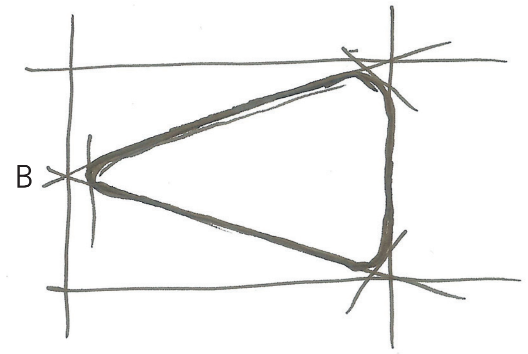


Figure 13

Learner's own drawing, similar to Figure 13, but about three times bigger.

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.

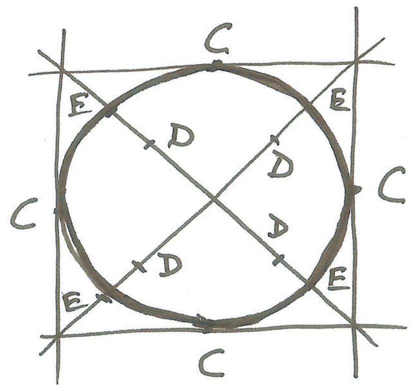
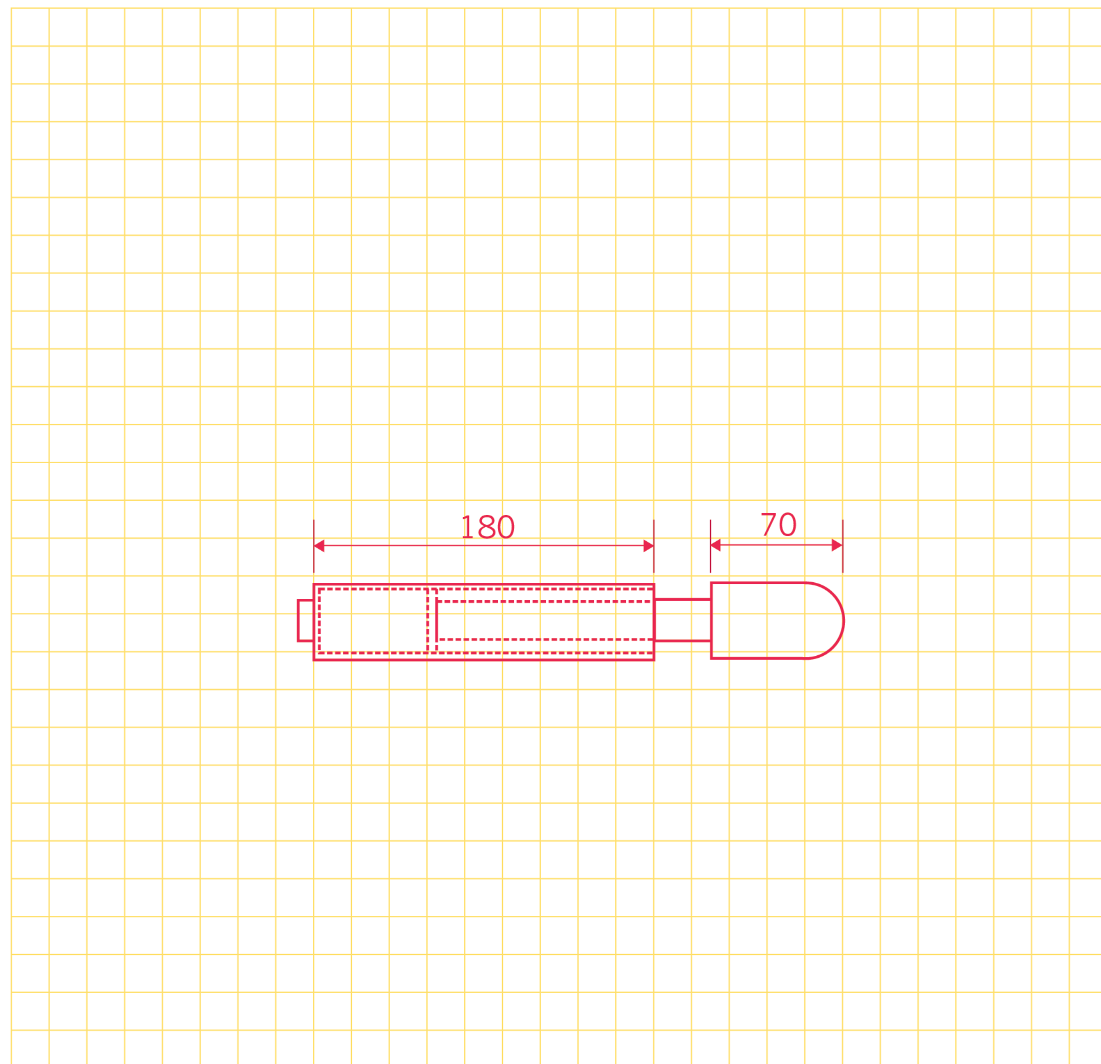


Figure 14

Learner's own drawing, similar to Figure 14, but about four times bigger

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.

LB page 21

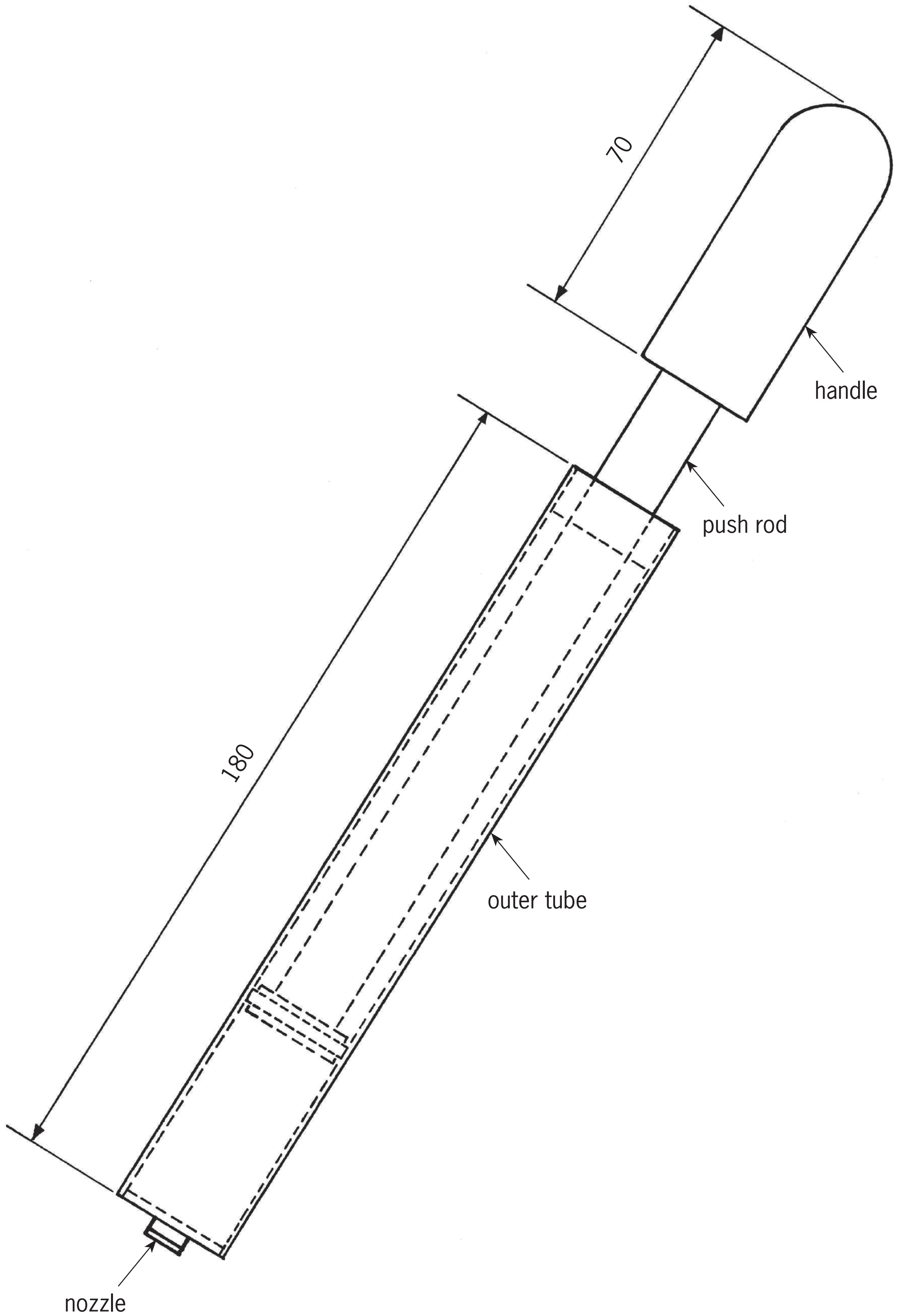


Figure 15: A bicycle pump

LB page 22

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.

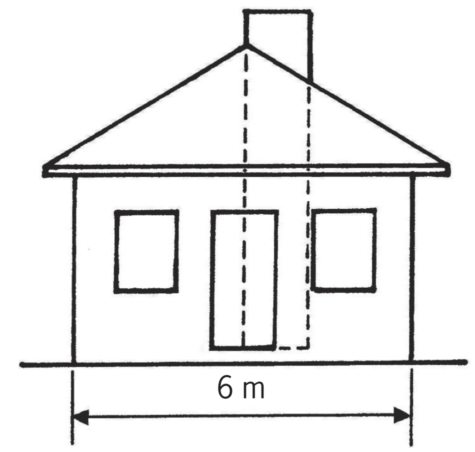
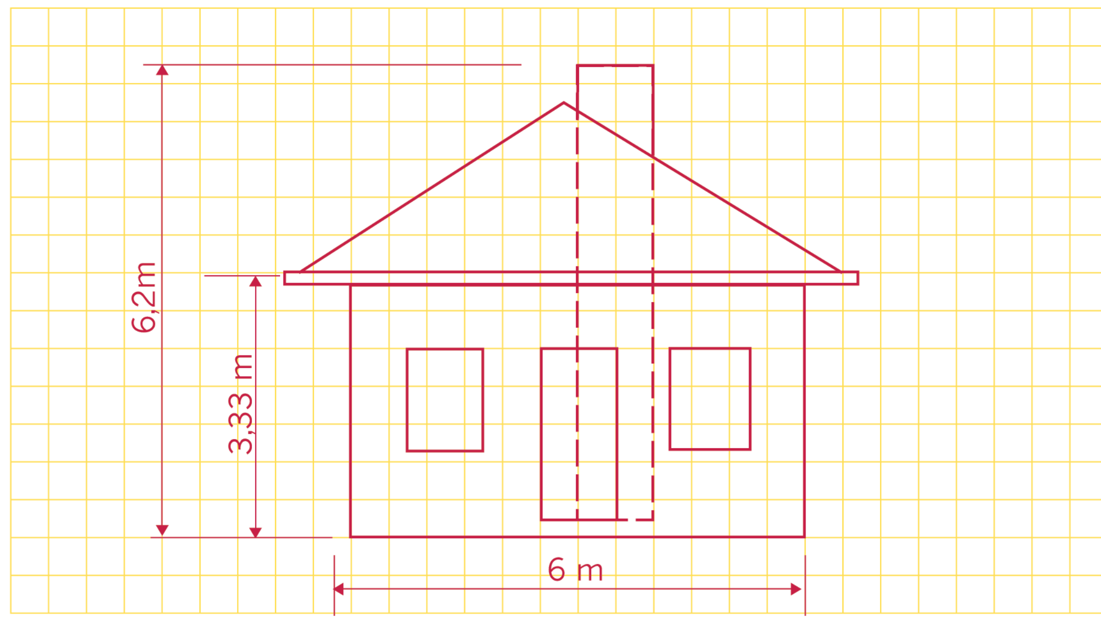


Figure 16



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

LB page 23

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

Since ancient times, people have used various methods to show three-dimensionality (depth of field) of objects in their drawings. In this chapter, learners are introduced to "oblique" drawings and "single vanishing point perspective" drawings.

These two drawing methods were developed more or less between the 1500s and 1600s. They are still used today, as they provide a quick, easy and understandable way to communicate visual information about objects.

Learners might argue that these drawings look a bit odd. You can reply to this by saying that we all see and draw the world in different ways, but that these drawings are like traffic signs: it is a system that everyone agreed to and that everyone can understand.

3.1 Two types of drawings

Firstly, learners *observe* and *compare* examples of an oblique and a perspective drawing of a table. They'll probably say that the one looks more odd than the other, or maybe that the one looks higher than the other. You can assist them by asking which table looks more realistic, and give clues by asking them to look closely at the shapes of the table tops.

Learners *observe* and *compare* the same drawings again, but this time there are construction lines added to the drawings, and the construction lines extend far beyond the drawings. The learners have to *explain* the differences they observe. You can point out that in Figure 4 the construction lines will eventually all come together if they are extended far enough to the top of the page, and in Figure 5 the construction lines are perfectly parallel.

Next, learners will be introduced to the names of the types of drawings that they have been looking at. The drawing with the parallel construction lines is drawn according to a drawing system called "oblique drawing", and the other table is drawn according to the "single vanishing point perspective" system.

3.2 3D oblique drawing

This section deals with the principles of oblique drawing. Learners follow step-by-step instructions to make a *free-hand oblique drawing* of a stove.

Thereafter, they are provided with a grid that will help them to make a very neat oblique drawing based on the free-hand one they just did. You can suggest that they draw their diagonal lines by connecting the bottom left hand corner of a square on the grid to the top right hand corner of the square, and continue in the same direction until the line is long enough.

Finally, learners are introduced to the concept of scale. They *measure* the dimensions of the oblique drawing of the stove and compare it to the real dimensions of the stove. In this way, they discover what a scale of 1:10 means. If they struggle with this, you should explain that the scale 1:10 on page 28 in the Learner Book (page 35 in this Teacher Guide) means that 1 mm on the drawing will represent 10 mm on the real object. Learners also discover that the depth or breadth shown by the diagonal lines on an oblique drawing, are shorter than they should be according to the scale. This is to make the drawing look more realistic, because in real life things look smaller the further away they are from the viewer.

As extra motivation, you should point out that if any learners aspire to be plumbers, mechanics, engineers, architects, carpenters, illustrators or designers later in life, they will always use what they've learnt about scale in this section.

3.3 Perspective drawing

Firstly, learners observe pictures where it is obvious that the further away an object is from the viewer, the smaller it appears. Then they follow step-by-step instructions to *redraw* a picture of a fence using the drawing system of single vanishing point perspective.

Learners are likely to be puzzled by the idea of a vanishing point. You can explain this in the following way:

- When something is far away, it looks so small that we can't see it any more.
- People agreed that in the perspective drawing system the vanishing point will always be on the horizon line. In real life, the horizon line is where the sky and the earth meet. But in the perspective system, it is a horizontal line on the page that represents eye level.
- This means that if you want to draw something as if you're looking down on it, the horizon line (and vanishing point) should be closer to the top of the page. When you want to draw something as if you're looking up at it, the horizon line (and vanishing point) should be closer to the bottom of the page.

Next, learners *follow step-by-step* instructions to draw a box in perspective. You should explain that according to the single vanishing point perspective system, the part of an object that faces you is drawn as if it is seen directly from the front. The parts that go further away from you are drawn with the help of the vanishing point.

Then learners are given an example of an open matchbox perspective drawing. They apply what they've learnt about perspective and draw an open matchbox themselves.

Finally, learners redraw their open matchbox in perspective and add shading to make it look more realistic. You can remind learners that the inside of the matchbox will not get any direct light, so it will be the darkest part of the drawing.

LB page 24

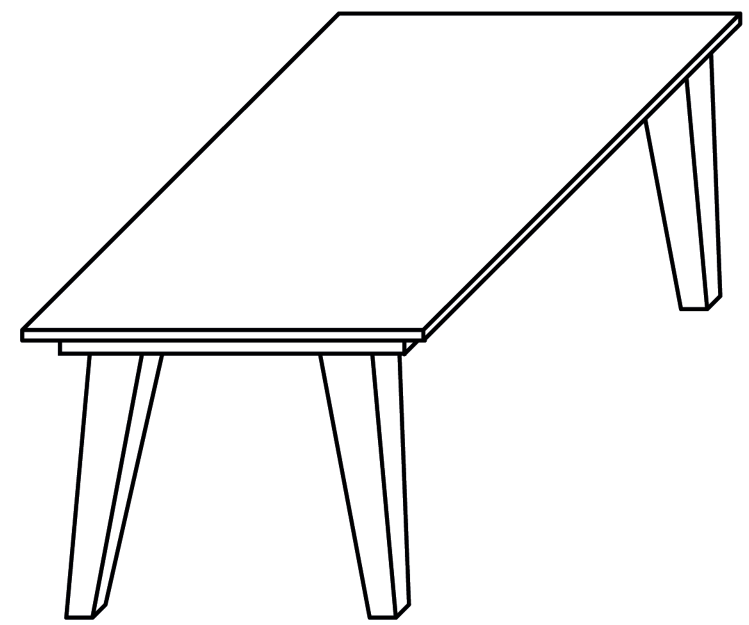


Figure 2 (Drawing A)

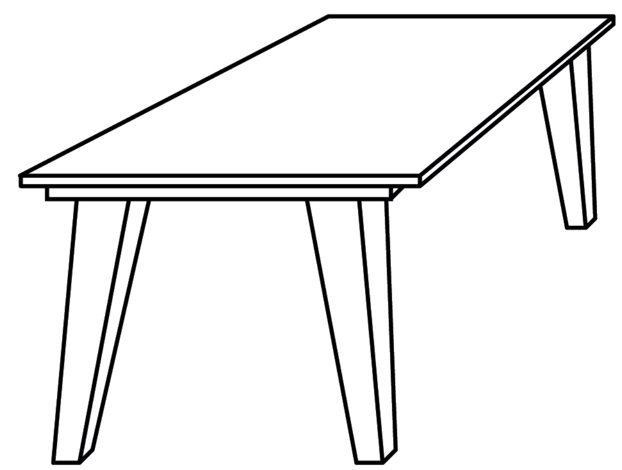


Figure 3 (Drawing B)

3.1 Two types of drawings

LB page 25

Study the diagrams and answer the questions **LB p. 25**

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.

   These are two different drawings of the same table.
   Encourage learners to say this in their own words.

2. Now look at drawing C and drawing D in Figure 4 on the next page. Which one is a smaller version of drawing A? Explain why you say so.

   Drawing D is the same as drawing A.
   If you make the lines of the sides of the table top on drawing A much longer, you see that they are parallel, just as in drawing D.

3. How do drawings A and B differ?

   Drawing B looks more real. It looks like it becomes smaller towards the back, because that is how things look in real life. Drawing A looks like it is wider at the back than at the front. Its back leg also looks too big.

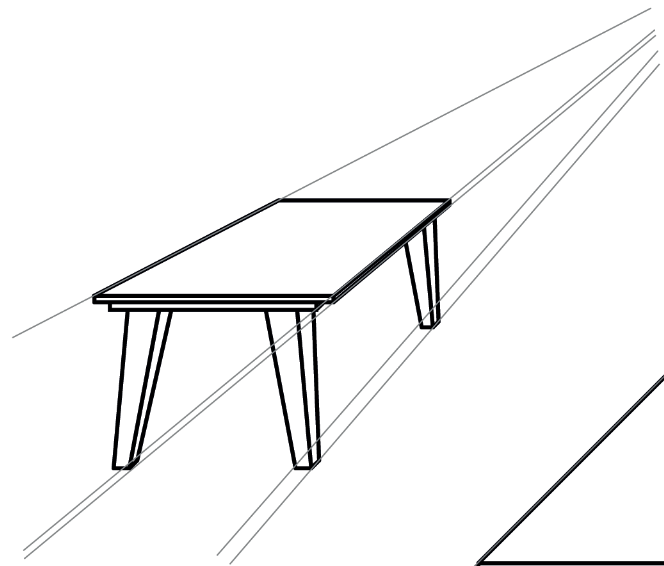


Figure 4: A perspective drawing (Drawing C)

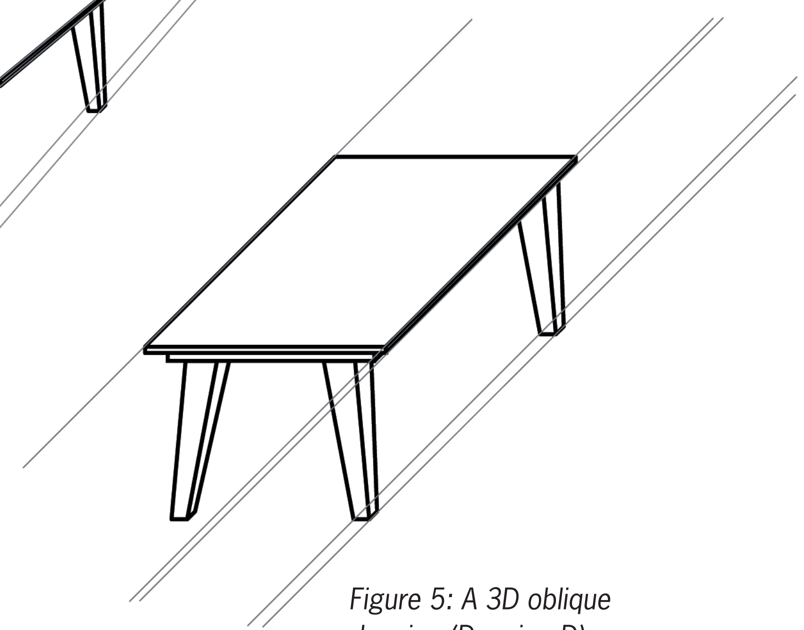


Figure 5: A 3D oblique drawing (Drawing D)

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 look different from 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

LB page 26

Make a 3D oblique sketch

LB p. 26

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.

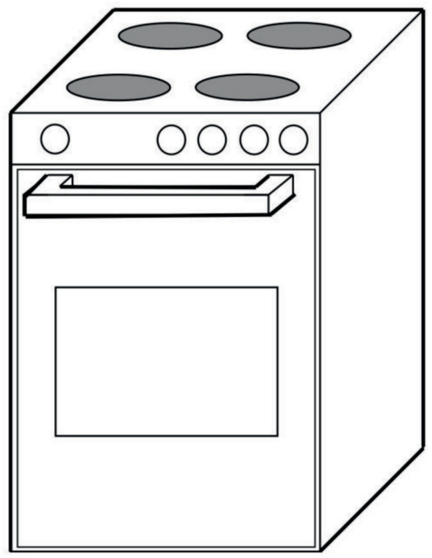


Figure 6

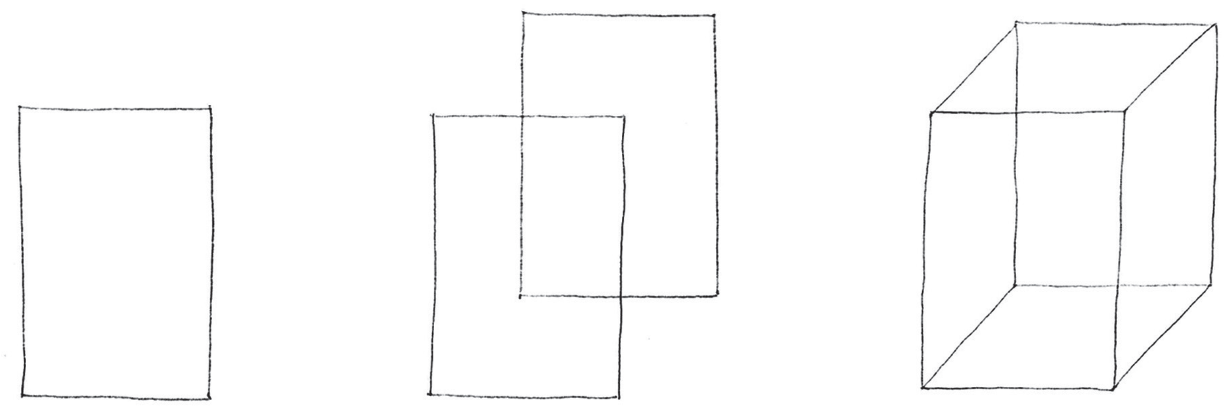


Figure 7

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 can also say **free-hand drawing**.

Learners' drawing should look like Figure 7 step 3 on the previous page, but bigger.

You should check whether learners have used the different types of lines correctly.

Turn your box into a stove

LB p. 27

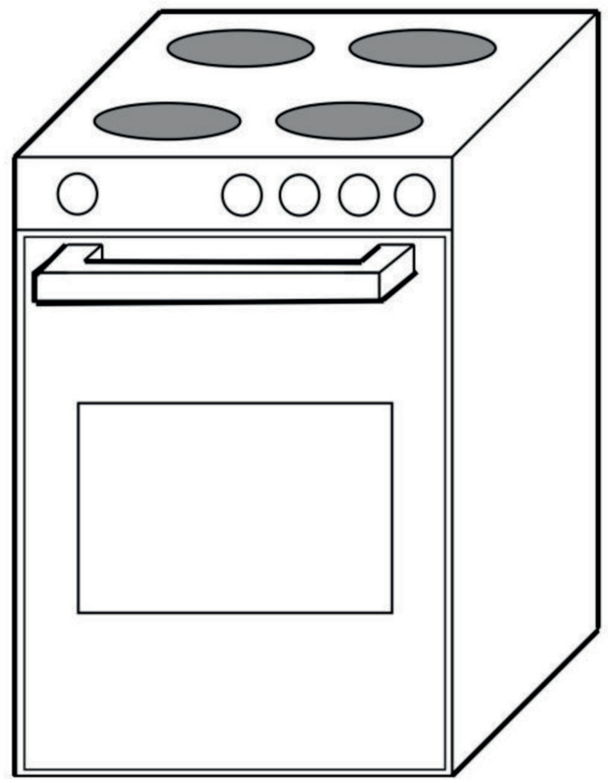


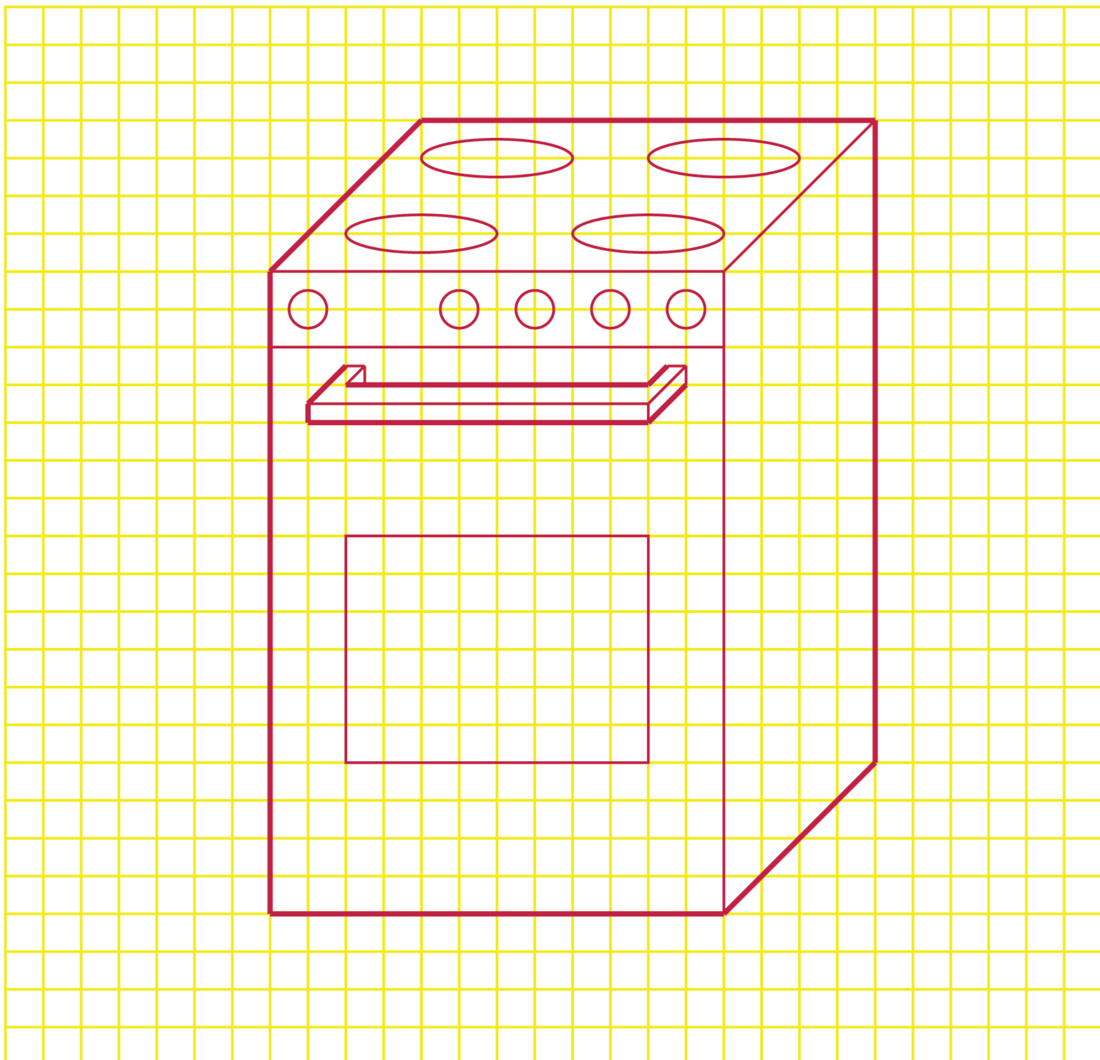
Figure 8

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

- The plates on top of a stove 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 ones below and in Figure 9. Use grid paper to make a better drawing of the stove.



Accurate 3D oblique drawing

LB p. 28

Figure 9 shows an accurate oblique drawing of the stove.

1. Write down the length, height and breadth of this stove.

   length 600 mm; breadth 565 mm; height 850 mm

2. Now measure the length, height and breadth on the drawing with a ruler.

   length 60 mm; breadth 28 mm; height 85 mm

3. What do you notice about the breadth line? Is it drawn to the same scale as the length and height lines?

   The breadth line is shorter. If drawn to the same scale it should have been 56,5 mm.

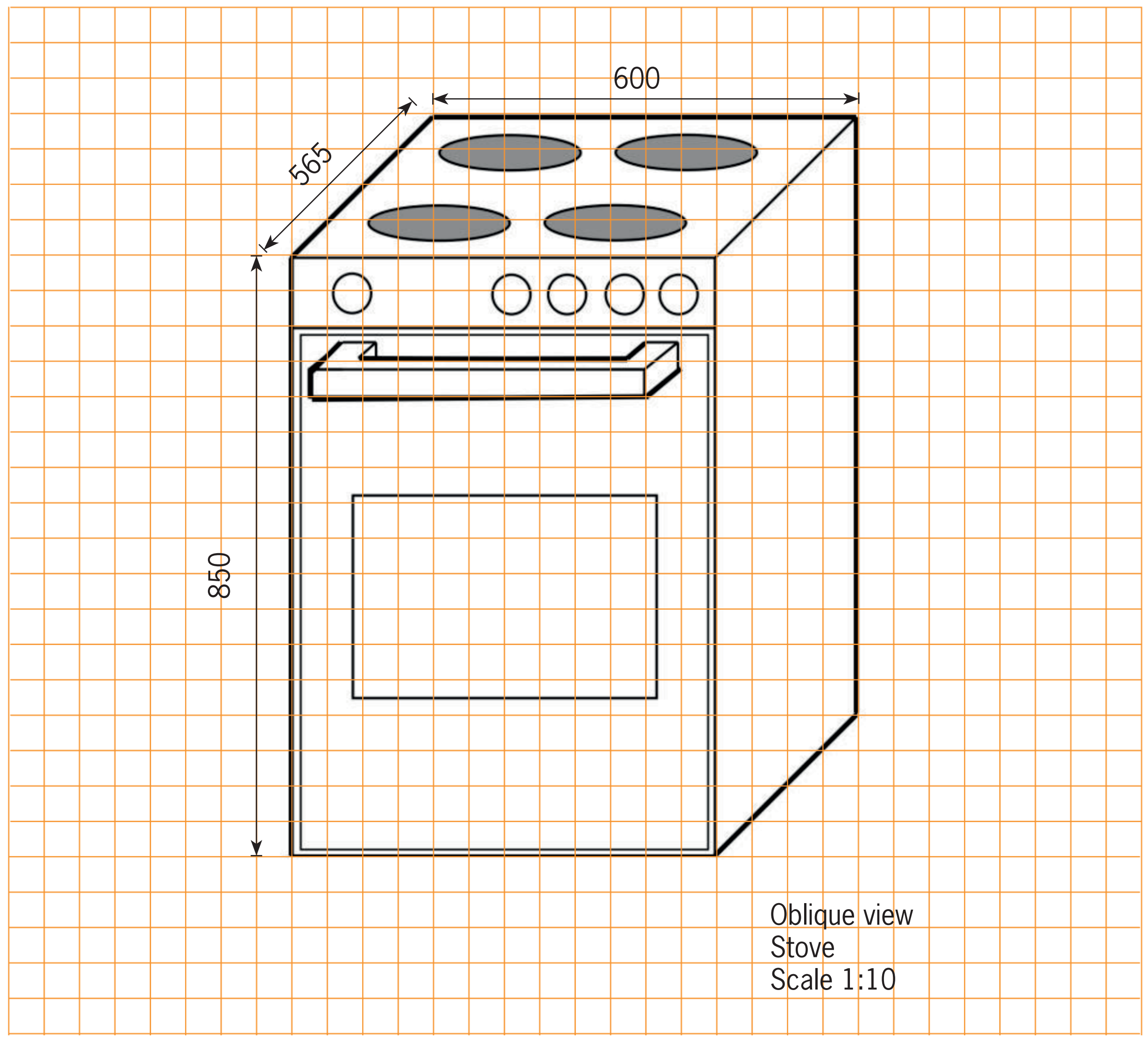


Figure 9

LB page 29

A few important things about obliqu

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.

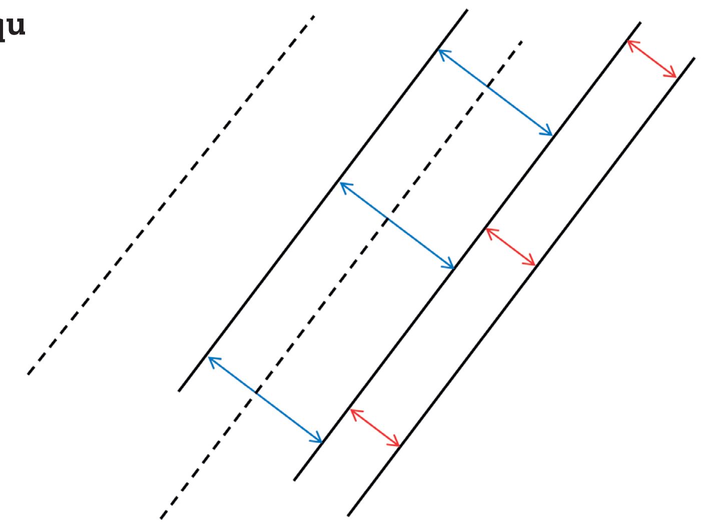


Figure 10

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.

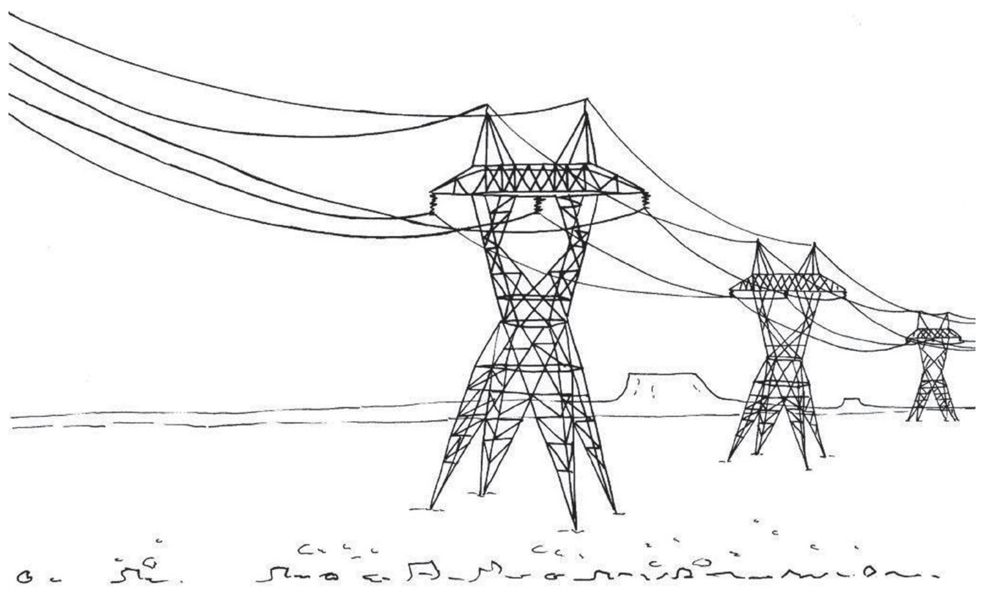


Figure 11

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.

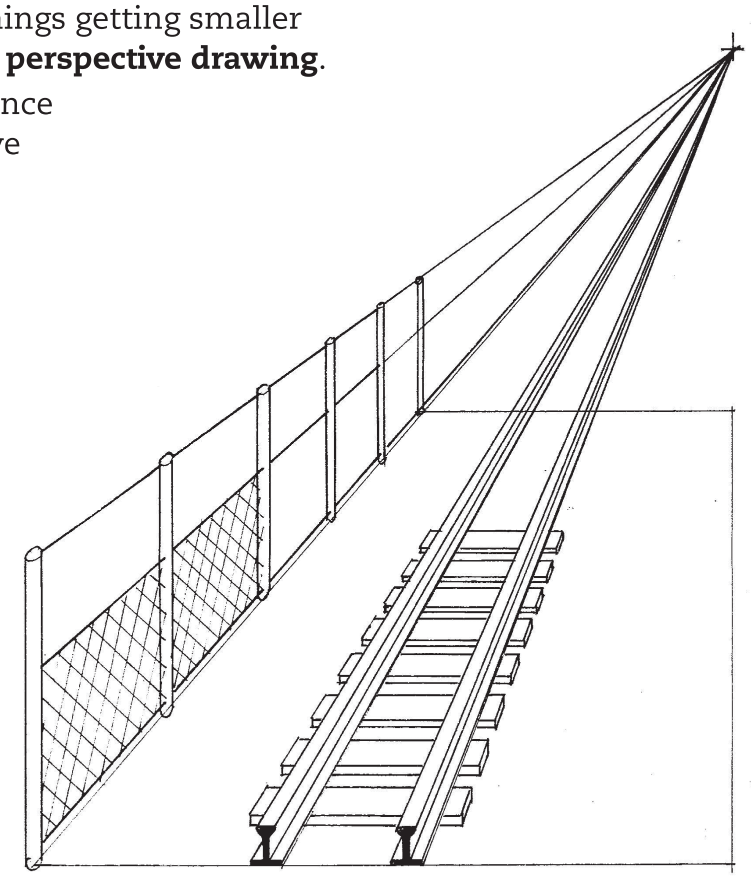
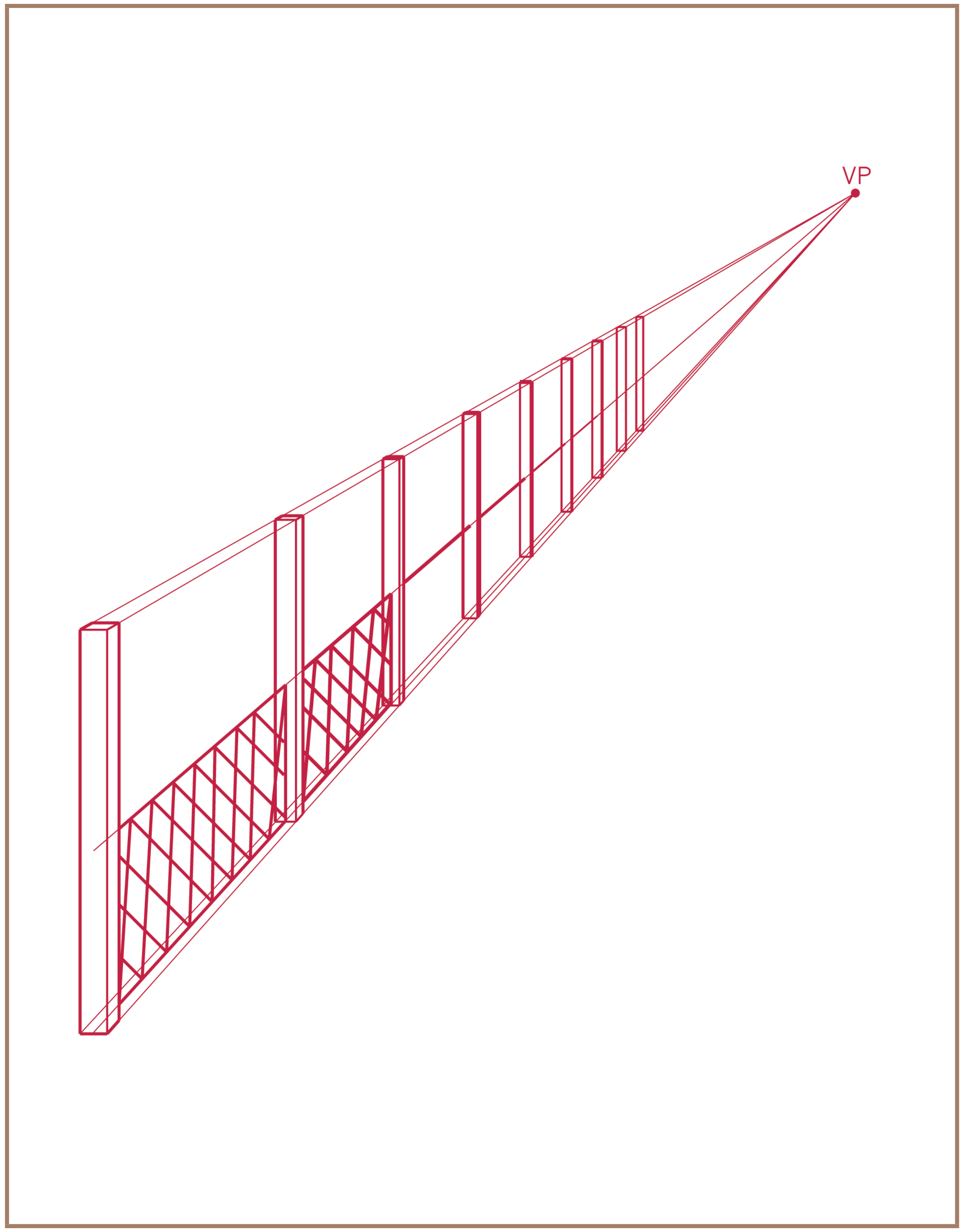


Figure 12

Follow the steps to draw a fence LB p. 30

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 LB p. 31

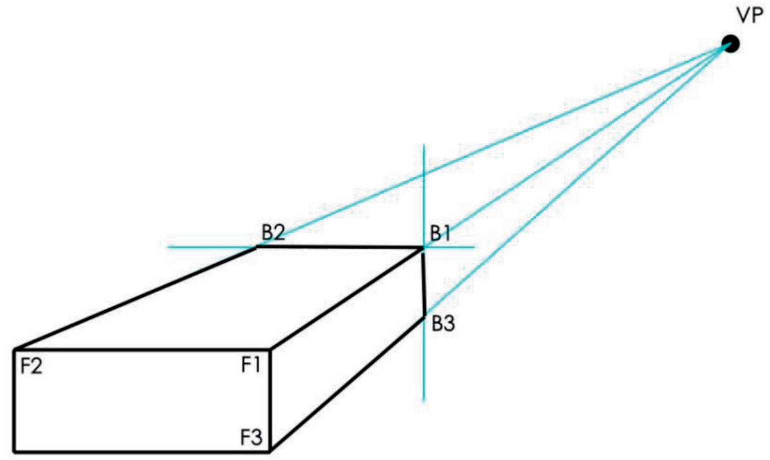


Figure 13

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 LB p. 32

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.

Now draw an open matchbox using single vanishing point perspective.

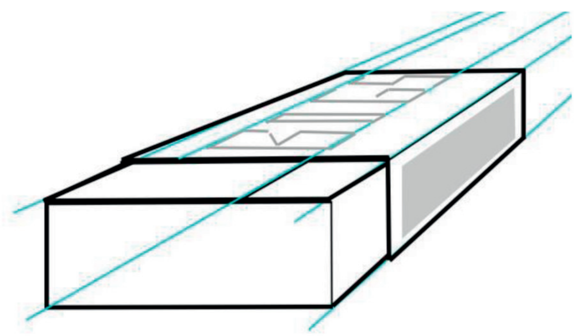
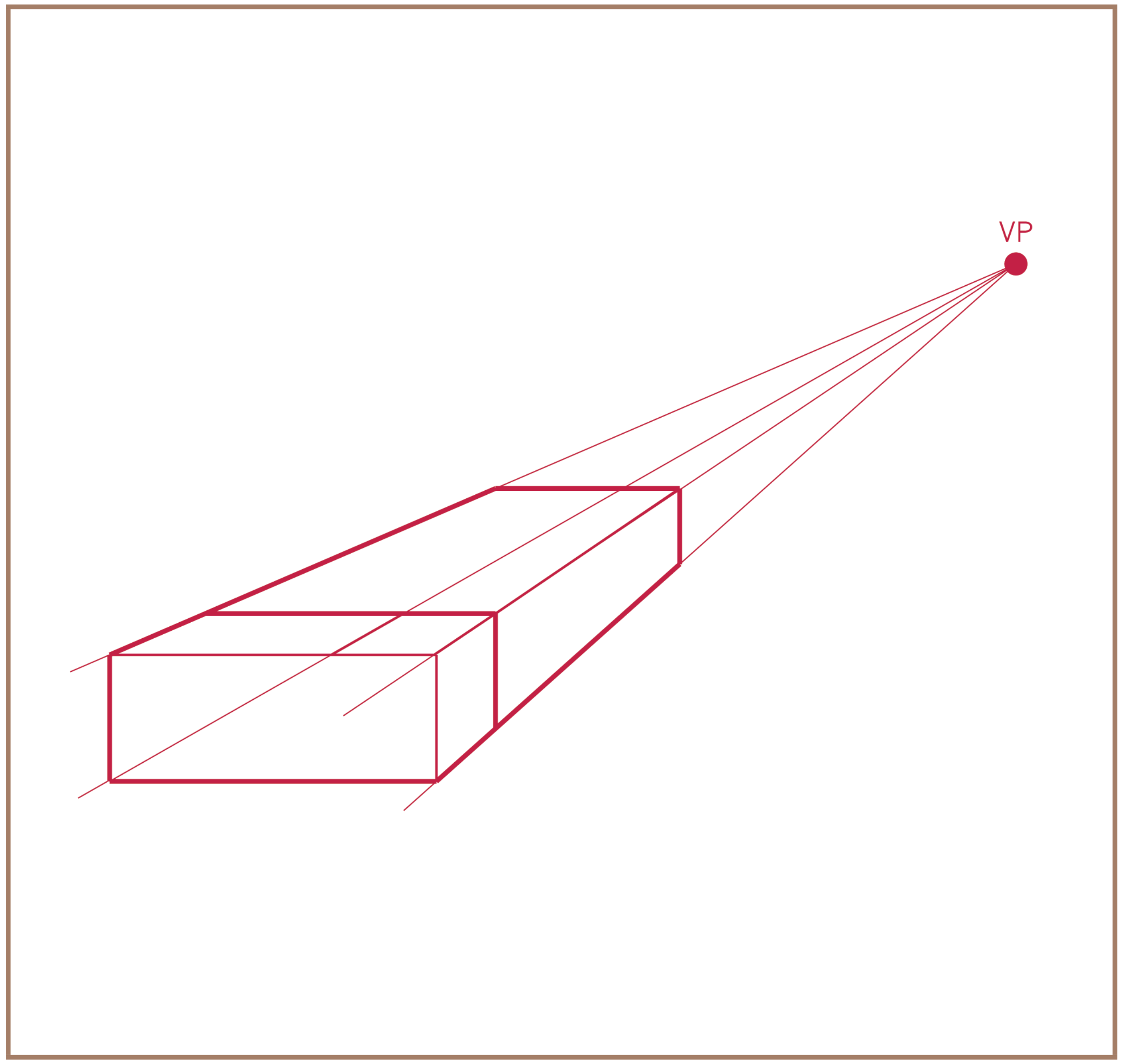


Figure 14



Add more shading, and even colour

LB p. 32

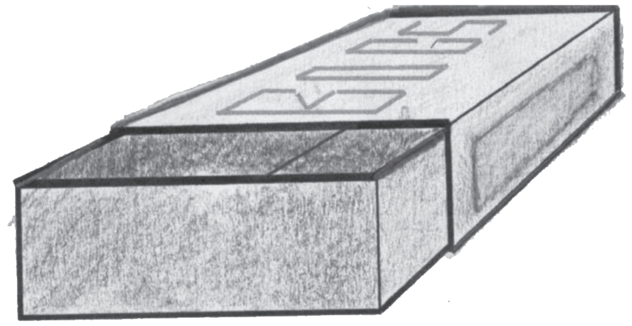
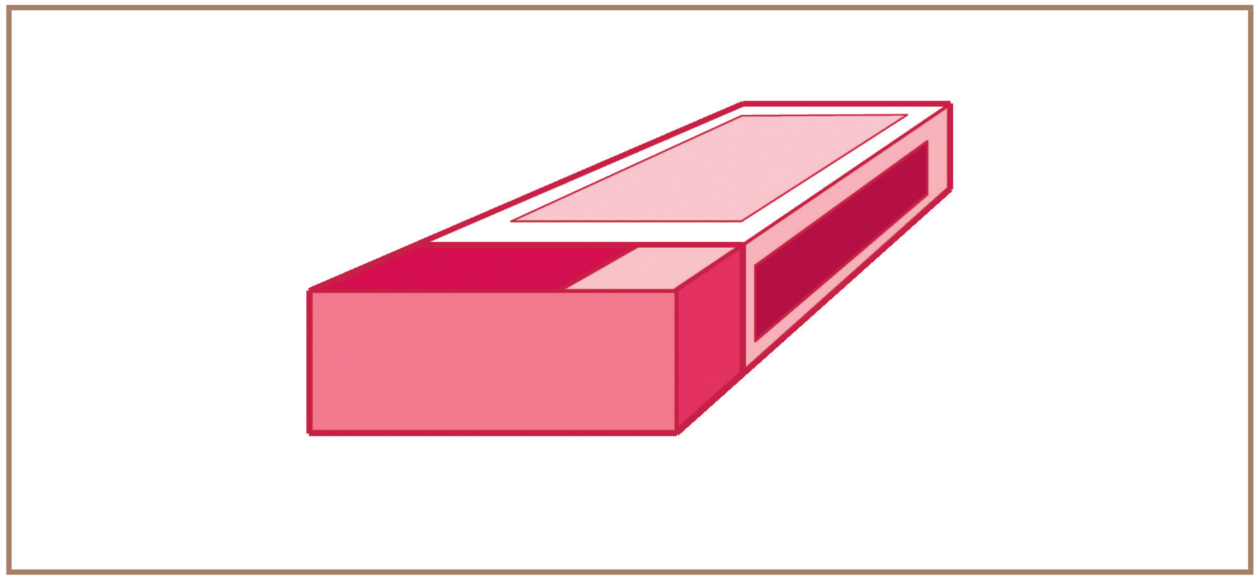


Figure 15

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.

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

LB page 33

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

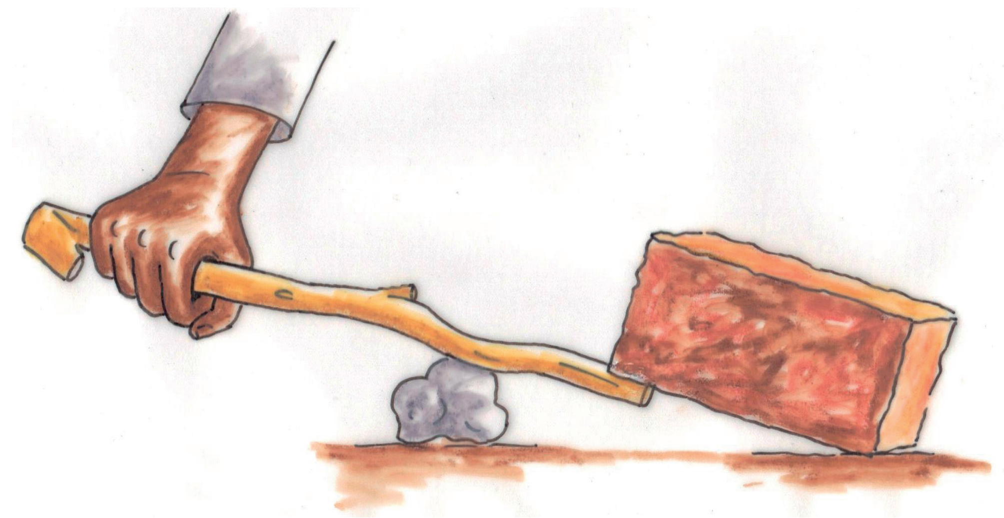


Figure 1

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.

This is the first of three chapters on levers. Learners learn how levers can change the force, the distance and the direction of movement. A lever can change a small input force into a large output force, or a small input distance into a large output distance, depending on where the pivot point, which supports the lever, is (this point is called the fulcrum of the lever). In this chapter, learners learn about only one type of lever, where the fulcrum is between the input force (effort) and the output force (load).

Learners interpret pictures, do simple *experiments*, and *build* lever systems to *investigate* when a lever gives a mechanical advantage (output force is greater than input force) and when they give a distance advantage (output distance is greater than input distance).

Materials and tools required for this chapter:

- masking tape
- scrap A4 paper
- corrugated cardboard
- big, strong scissors
- nails
- wire for pivots
- paper fasteners (split pins, if available)
- washers to use as spacers (optional)
- a small box or bag filled with small stones or sand
- a brick or a big stone
- a strong stick or plank, about 30 cm long

LB page 34

Figure 2

Figure 3

4.1 Lift things with a lever

LB page 35

Explore three different ways to use a lever — LB p. 35

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?

   Method 2 will work the best. The stone around which the stick moves (the fulcrum) is closest to the concrete block that must be moved. And the position where you push down (the effort) is much further away from the stone than the concrete block (the load) from the stone.

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.

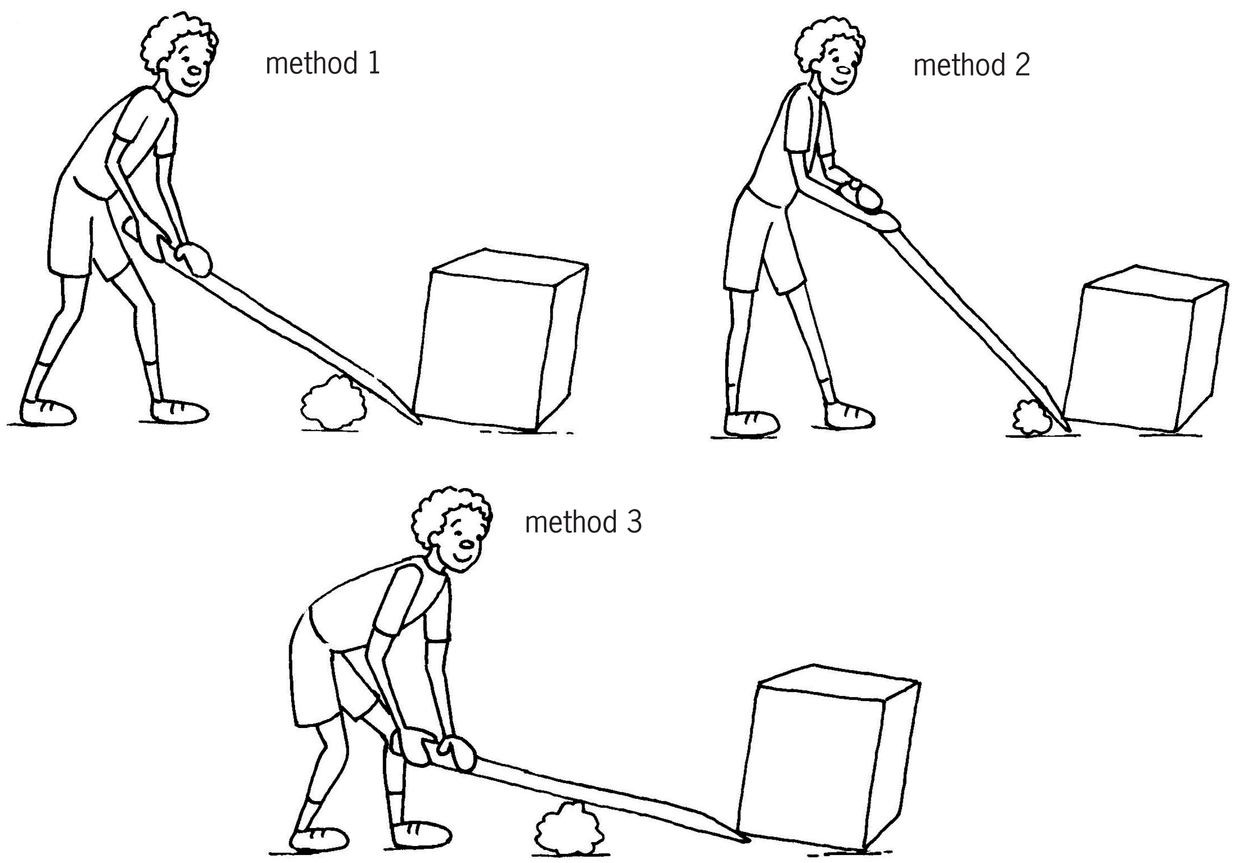


Figure 4

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

   The fulcrums are in different positions along the stick in each of the examples.

Join two classmates and work with a lever — LB p. 35

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:

LB page 36

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

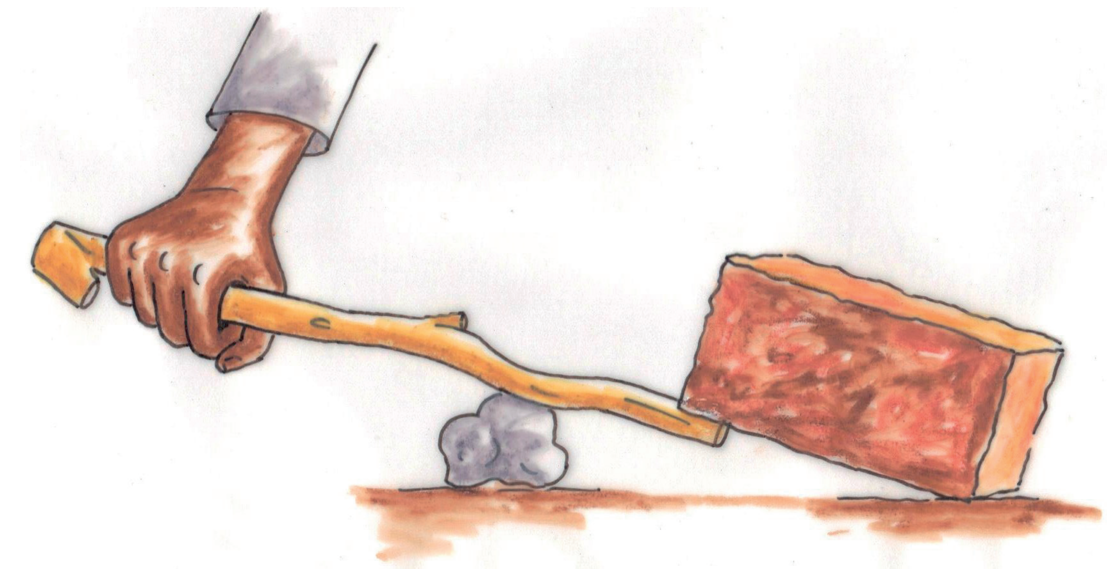


Figure 5

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?

   When the fulcrum is closest to the brick that must be lifted.

If you did not do the activity above, do this: LB p. 36

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.

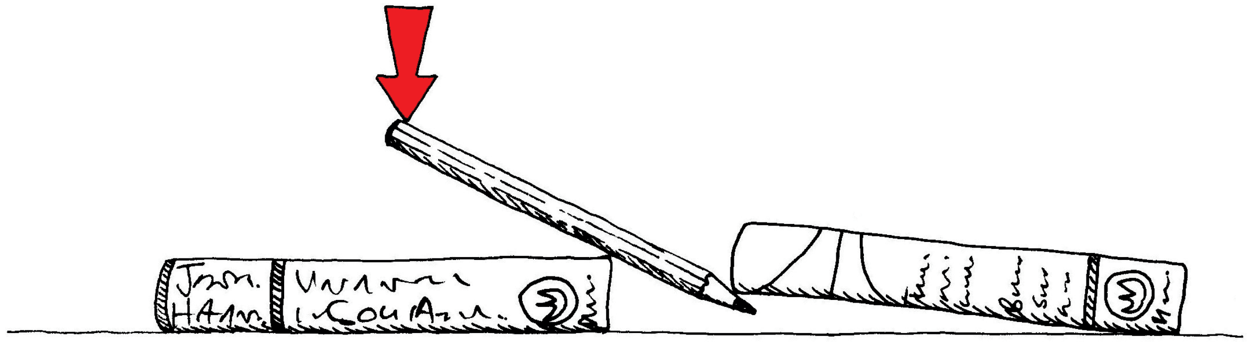


Figure 6

LB page 37

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

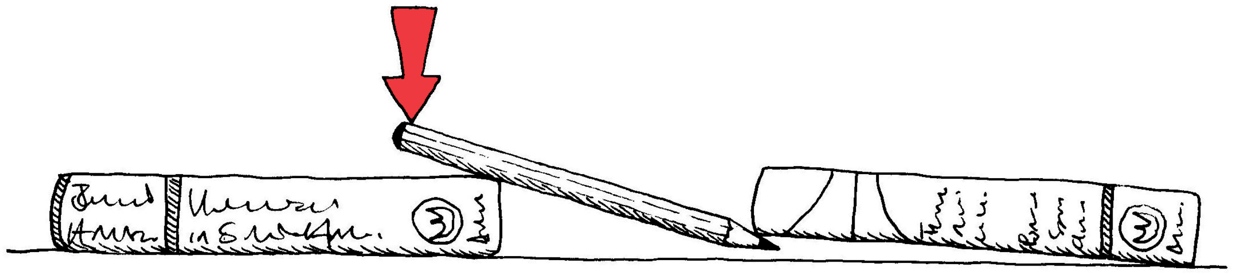


Figure 7

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

   When the fulcrum is close to the book I want to lift and my finger presses on the pencil far away from the fulcrum, as shown in Figure 6.

> 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.

> 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.

Scientists and technologists use the words "mechanical advantage" when referring to this. In the pictures below, the lever gives you a greater mechanical advantage when the fulcrum is closer to the brick.

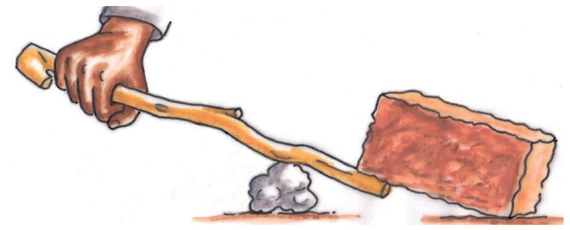


Figure 8: Mechanical advantage

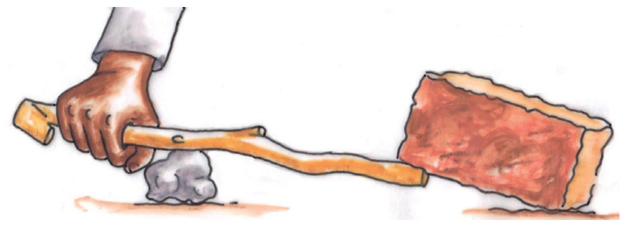


Figure 9: Mechanical disadvantage

LB page 38

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

   Method 2.

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**.

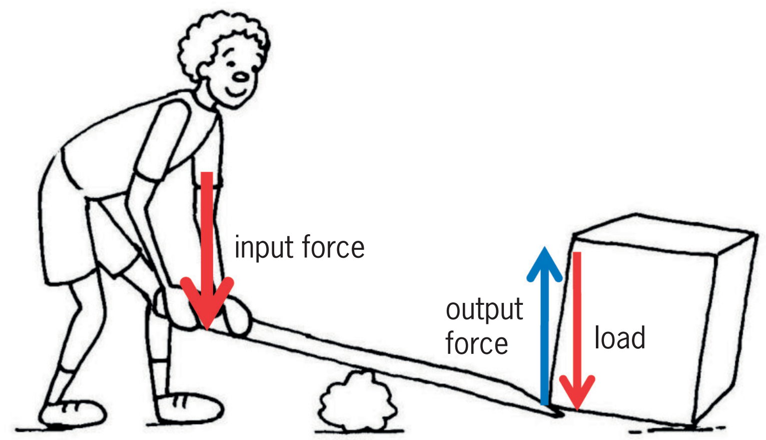
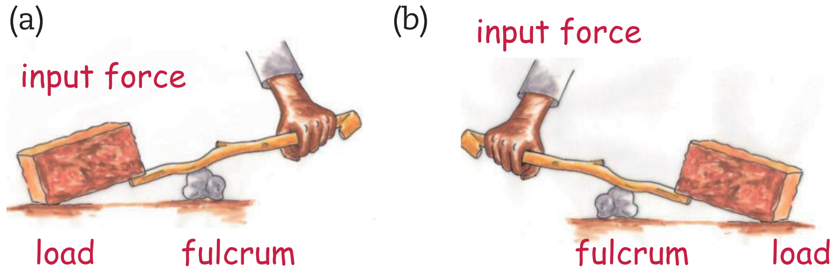


Figure 10

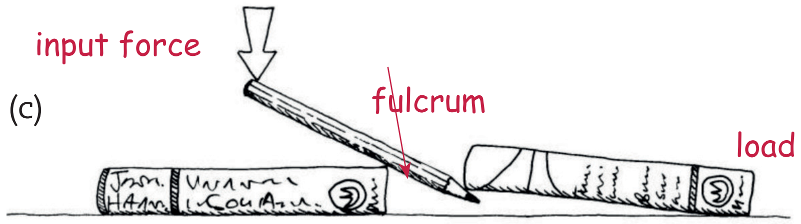
When you use a lever to lift an object, the push on the object may be stronger than, equal to or weaker than your input force.

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

(a) (b)



(c)



LB page 39

(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 — LB p. 39

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 these up and help to keep our streets clean!

LB page 40

4.2 Move things without touching them

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

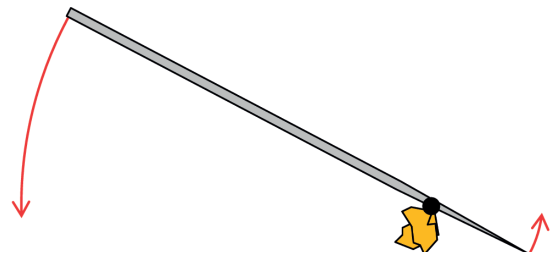


Figure 12

Changing the position of the fulcrum — LB p. 40

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.

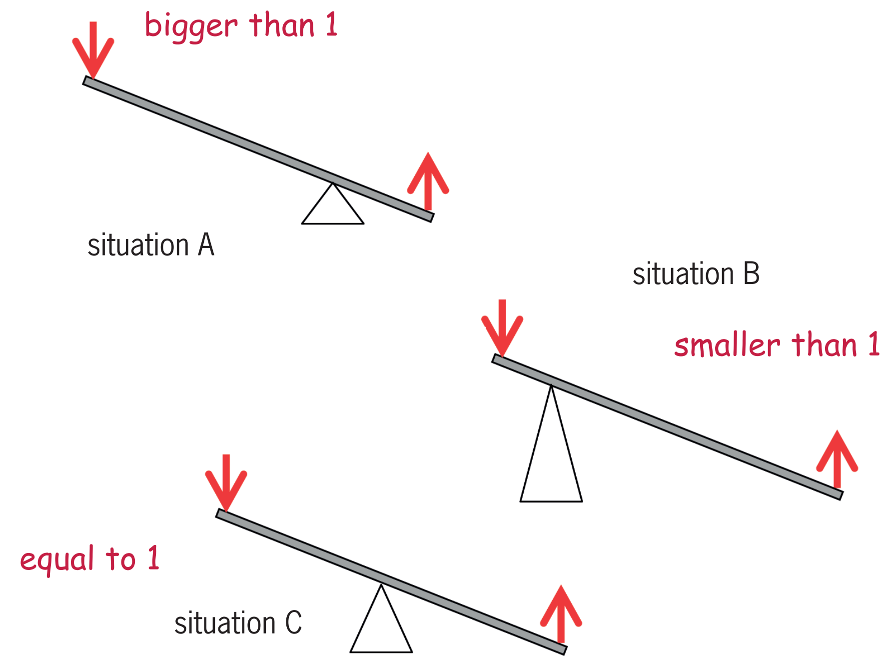


Figure 13

Make a lever with a base LB p. 41

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.

LB page 42

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.

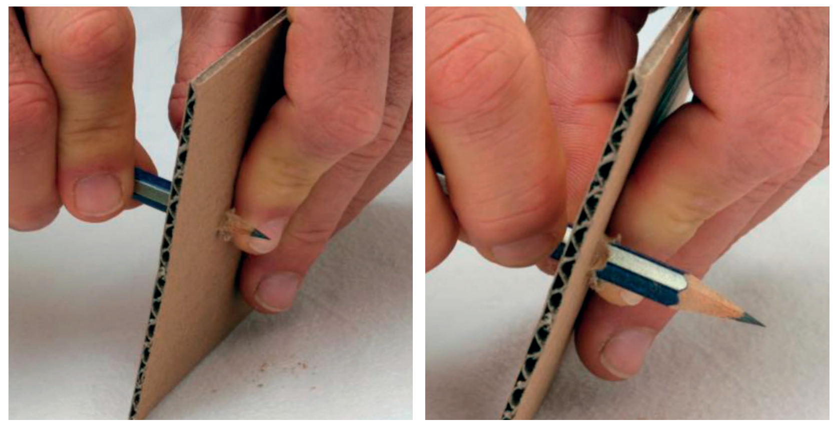


Figure 16

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

LB page 43

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

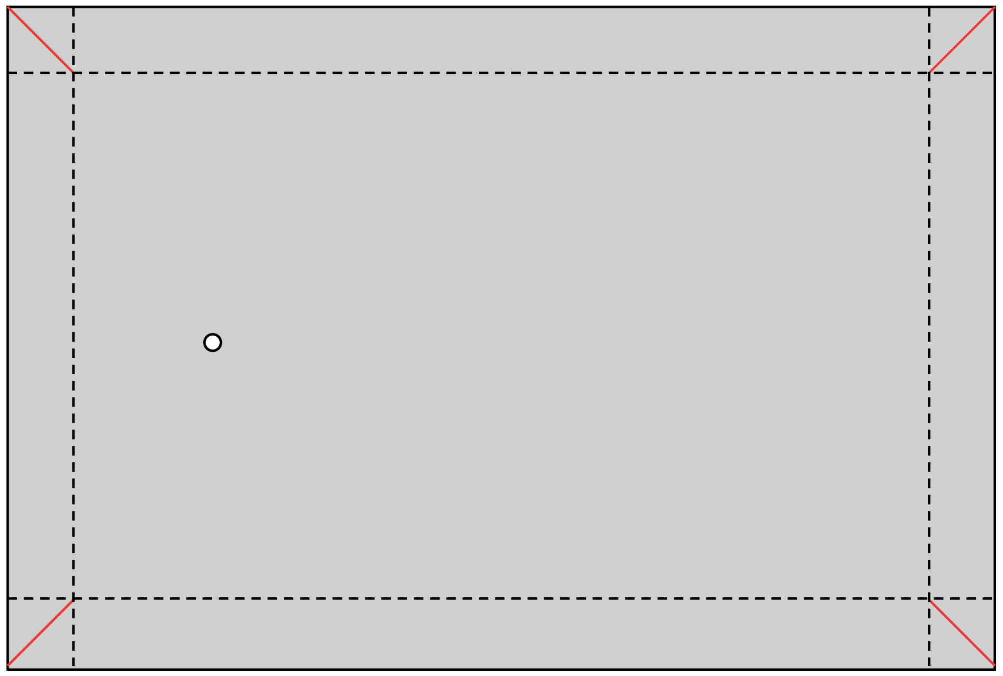


Figure 17

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.

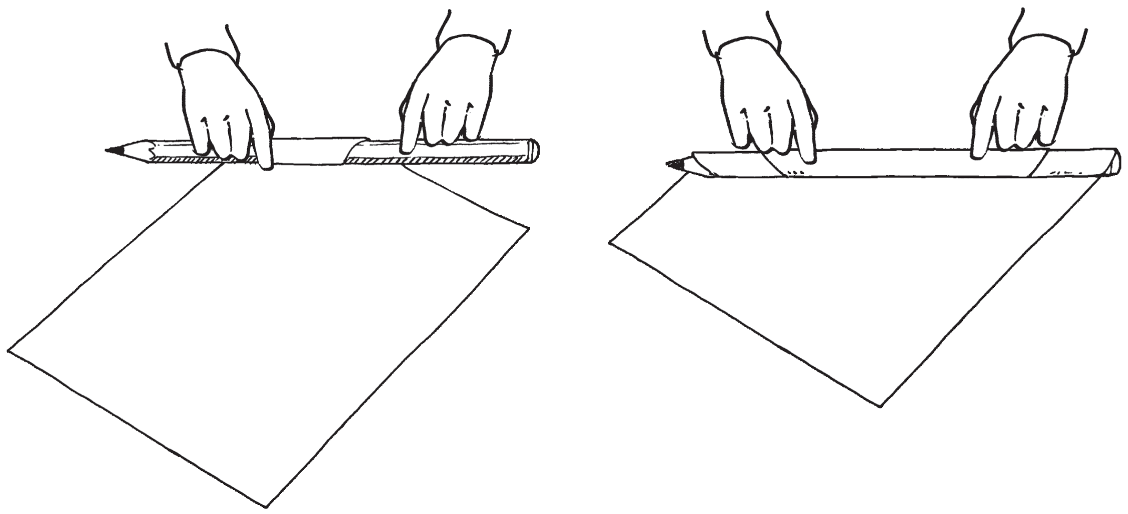


Figure 18

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

LB page 44

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

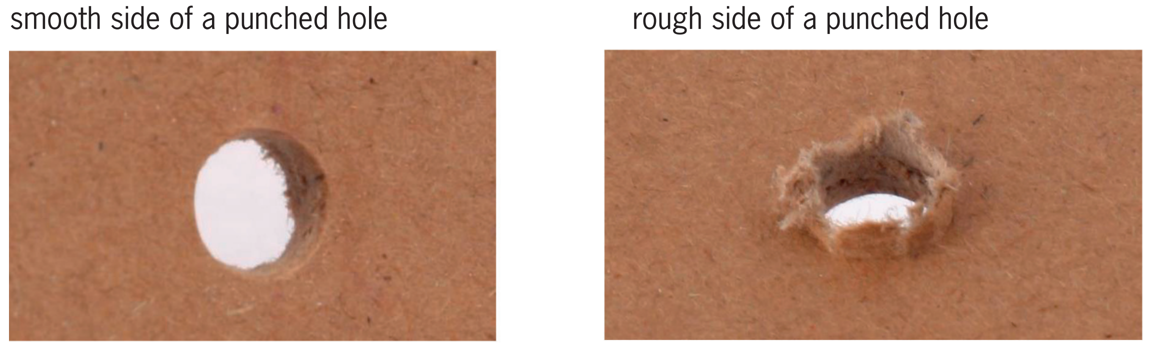


Figure 19

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.

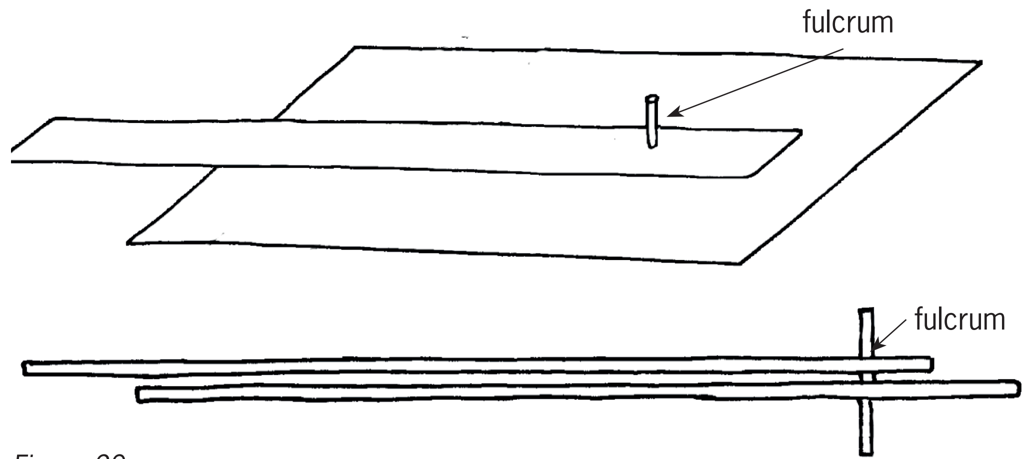


Figure 20

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

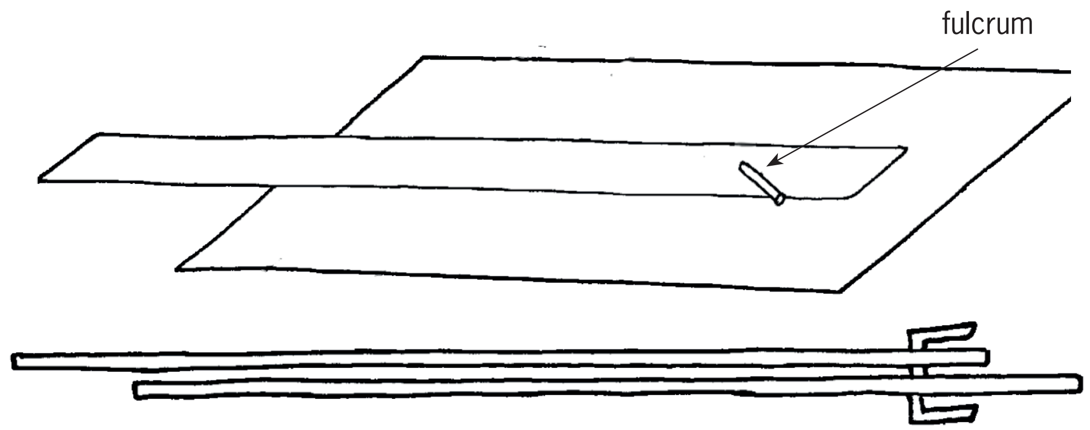


Figure 21

LB page 45

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

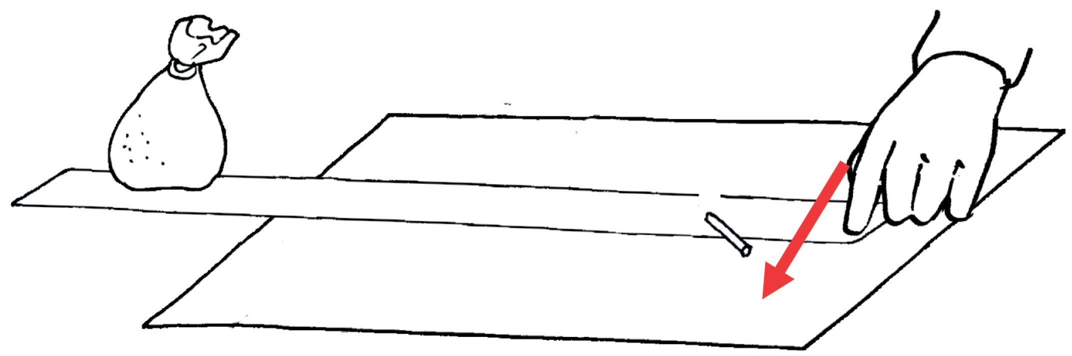


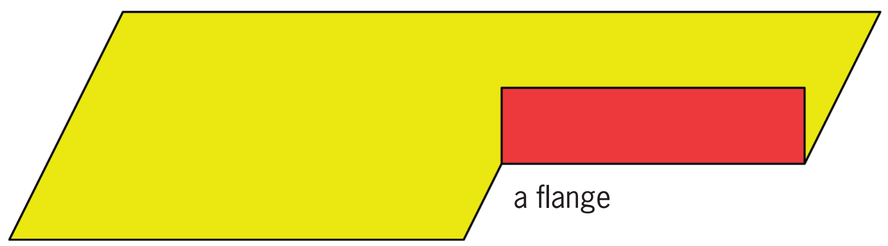
Figure 22

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.

   Move the bag to the other end of the lever. It will then be closer to the fulcrum than the effort is to the fulcrum. It will therefore require less effort to move the bag.

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

- You can 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.



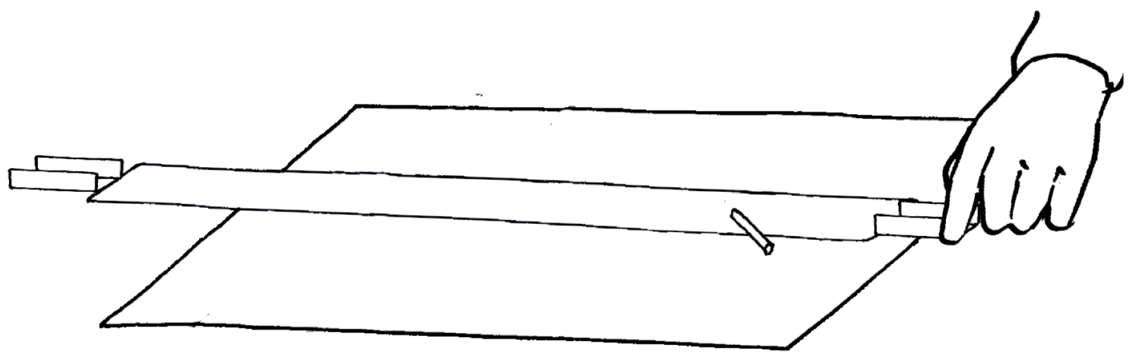


Figure 23

LB page 46

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

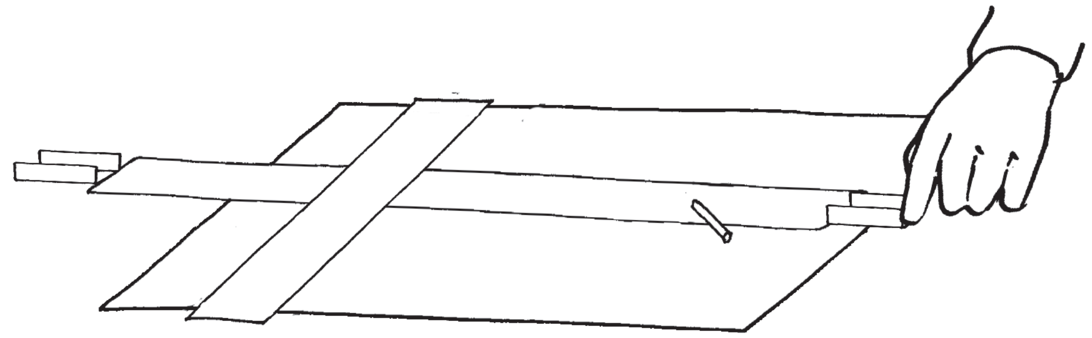


Figure 24

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.

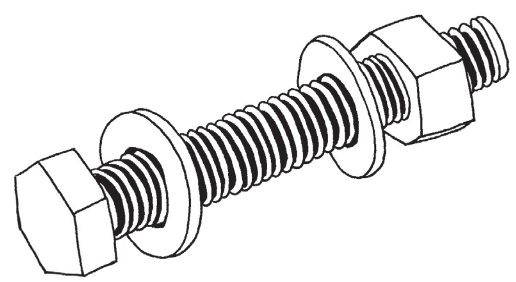


Figure 26

4.3 Do different things with levers

LB page 47

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

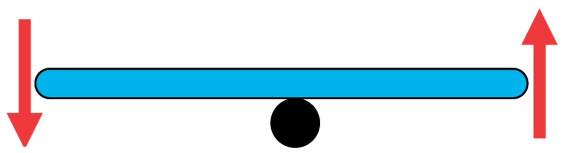


Figure 28

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.

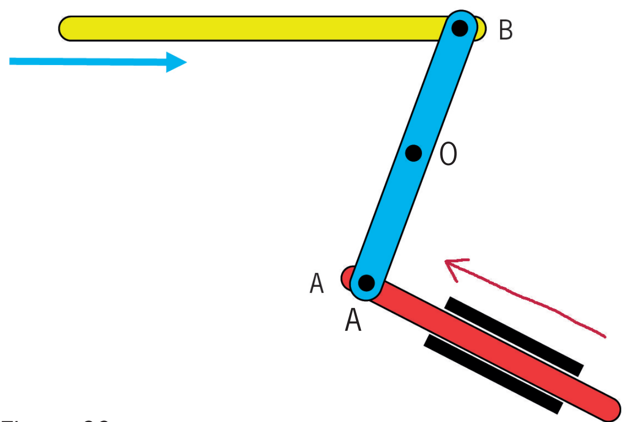


Figure 29

Evaluate a design — LB p. 48

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.

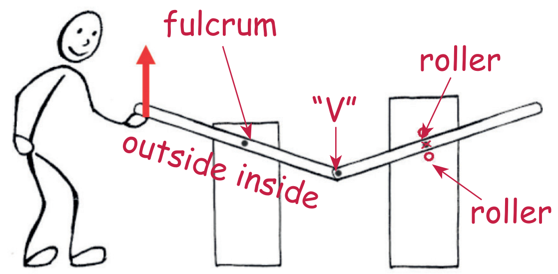


Figure 30

It looks like Simon thinks the heavy object should be in the "V" formed where the two levers connect. The fulcrums of the two levers on the two blocks and the connecting point of the two levers in the middle form a triangle, so it is impossible for the lever to move (a triangle cannot change shape). This problem can be solved by allowing the right-hand lever to slide between two rollers, instead of being fixed with a pin or a shaft. If Simon pulls up as is shown with the red arrow, the object will move down. So Simon should rather push down to lift the object up. The distance between Simon's hand and the fulcrum on the block is the same as the distance from the object to the fulcrum, so the mechanical advantage is 1. That means the same amount of force will act on the object as Simon's force on the other end of the lever, so the device will not make it easier to lift the object. Another problem with the design is that the middle point where the two levers connect can never touch the ground. So Simon still needs to pick up the heavy object to place it in the "V" between the two levers. Simon can improve his design by making the part of the left-hand lever that is between the blocks (on the inside) longer so that the levers can touch the ground. Then he needs to make the part of the left-hand lever, which he is holding, much longer on the outside. This will result in the outside part of the lever being much longer than the inside part of the lever. But then he will have another problem: the outside end of the lever will be very high so he will not be able to reach it. He can solve this problem by attaching a rope to the end of the lever, so that he can pull the rope to lift the heavy object.

Redesign a water lever — LB p. 48

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?

The fulcrum must be close to the load (the bucket) and far from the effort (where you will push).

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

LB page 49

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.

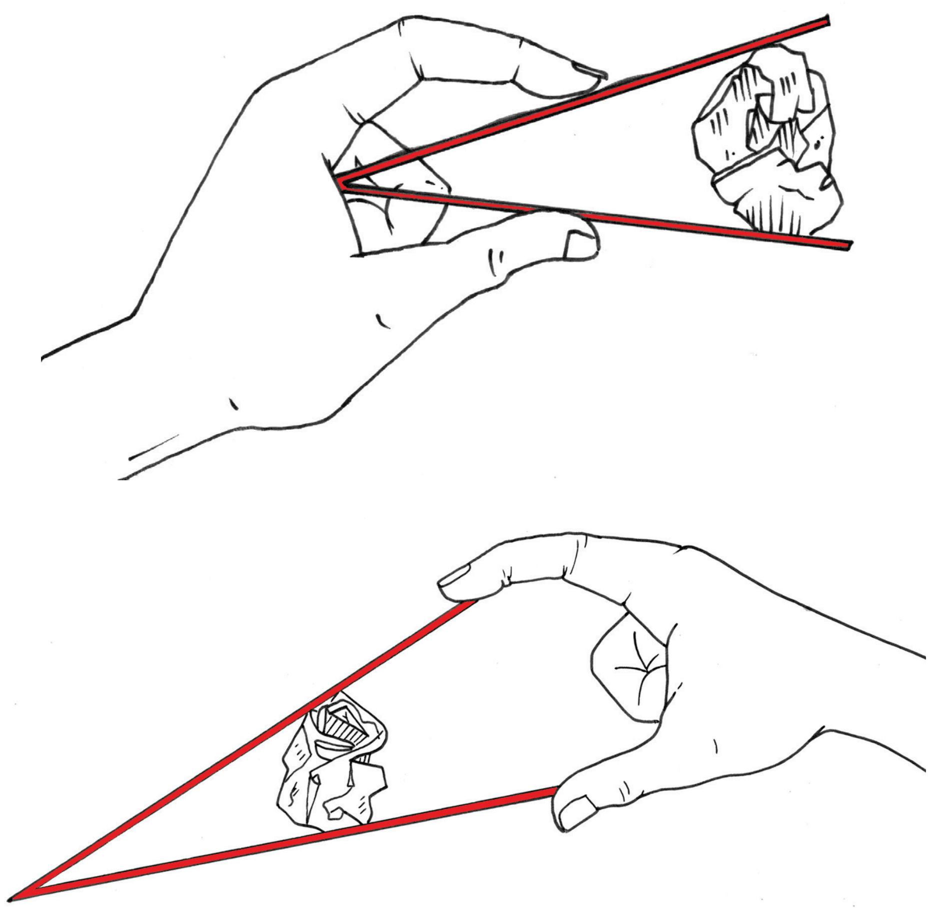


Figure 1

In Chapter 4, learners learnt about first-class levers. In Chapter 5, learners will recap their knowledge of first-class levers, and use this as a background to investigate the two other types of levers: second- and third-class levers.

Materials and tools required for this chapter:

writing materials, e.g. sharp pencils, rulers, erasers and pens

corrugated cardboard

scissors

paper dowels or paper fasteners (split pins) or wire for pivots

a small box filled with small stones or sand (any box that comfortably fits in the palm of a learner's hand will be perfect: a small box from the kitchen, such as a spice box)

Additional resources will help to practically demonstrate levers

spade

two types of kitchen tongs

nail clipper

baseball bat, cricket bat or tennis racket (a stick of about a metre in length would work equally well)

a tennis ball

At the end of Chapter 4, ask learners to make the hinged corrugated card examples, illustrated in Figure 3 of this chapter, as homework. Let them experiment to see which folds the easiest (the top two) and which had the most spring in the hinge (the bottom two). The top two were folded with the corrugations and the bottom two against the corrugations.

5.1 The three classes of levers

Learners discover that there are three classes of levers by doing the simple experimental tasks. They find out that the position of the **fulcrum**, **load and effort** determine the class of lever. The experiments using pencils are easily demonstrated, and are very effective to help the learners remember which lever applies to which position of fulcrum, load and effort. Repetition of the experiments are crucial so that the learners remember quickly.

Allow them to redo the experiments if needed to answer the questions quickly and confidently.

5.2 Practical examples of different classes of levers

This lesson is all about third-class levers to start with (questions 1 – 3). Learners find out that the human body can act as a lever. The illustrations clearly show how the human arm works as a lever. Let the learners act out the actions illustrated. This will help them master the information.

In the latter half of the lesson, learners have to identify the position of the fulcrum in each of the illustrations. If you brought some of the examples to class, allow learners to use them to experience firsthand where the fulcrums are.

5.3 More practical examples of different classes of levers

The two illustrations, the wheelbarrow and the nutcracker, clearly show that the load is in the middle. These are examples of second-class levers, where the load is always in the middle between the effort and the fulcrum.

Learners follow instructions to make a lever on a base plate. They experiment using it as a second- and third-class lever to move a small box filled with sand. They have to determine which of the two levers will give the biggest/most mechanical advantage. That means the one that accomplishes the task with the smallest input force (effort). This is an opportunity for discussion between learners. Encourage this and allow them time to redo the experiment a few times. They should come to the conclusion that the second-class lever gives the biggest mechanical advantage.

LB page 50

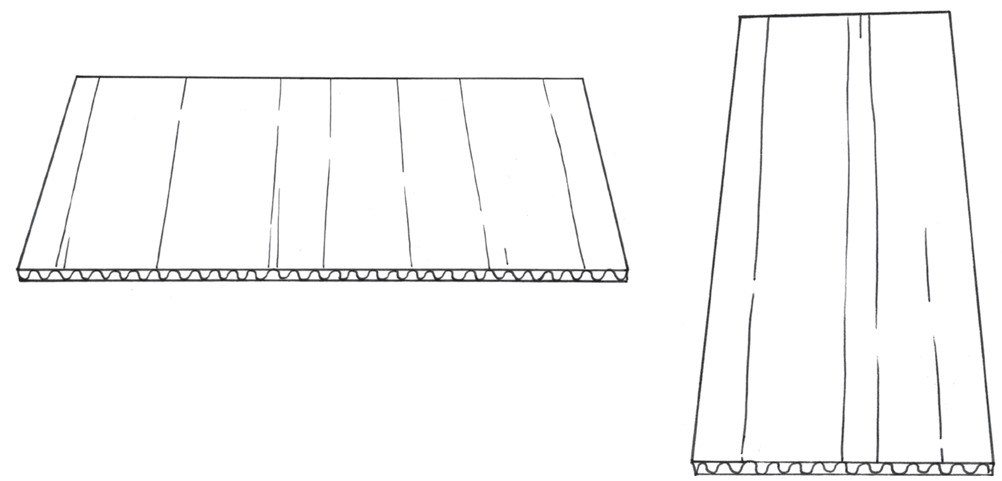


Figure 2: These pictures show two corrugated cardboard sheets of about 20 cm long and 10 cm wide. The one piece has the corrugations over the width, and the other piece has the corrugations over the length.

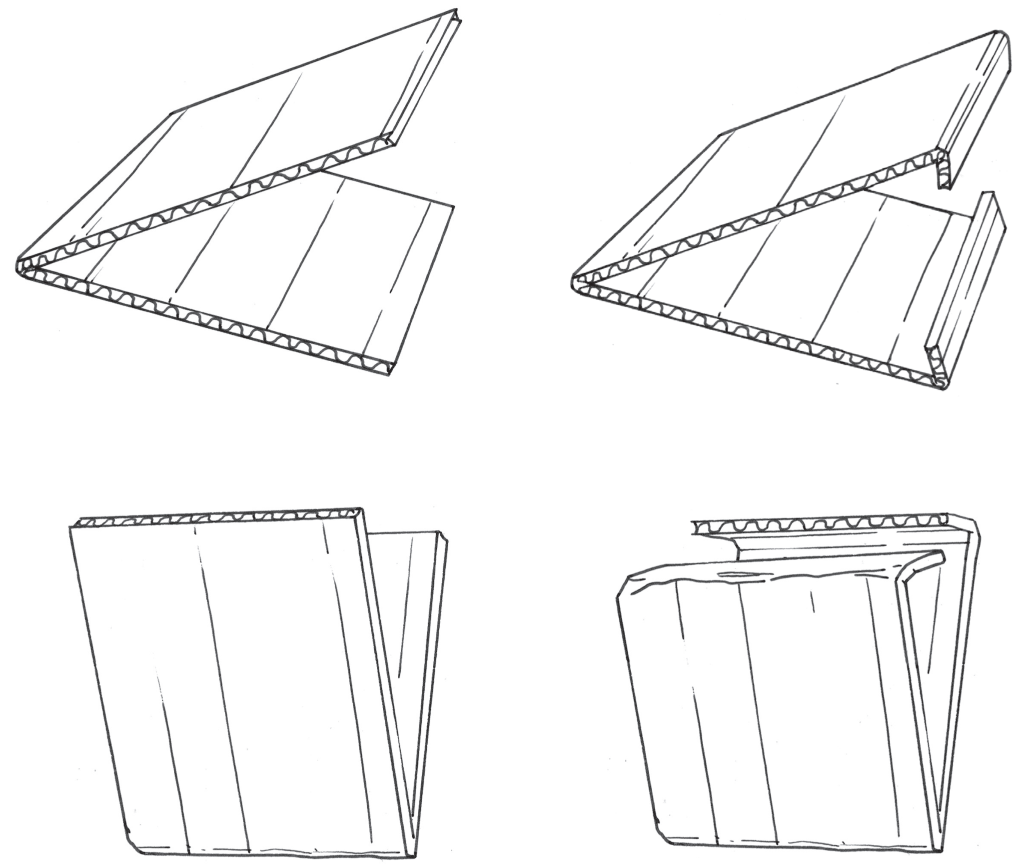


Figure 3: Both pieces are folded in the middle to form springs. The edges are folded to form flanges.

5.1 The three classes of levers

LB page 51

Lift your finger in three different ways

LB p. 51

Put your pencil on the desk in front of you.

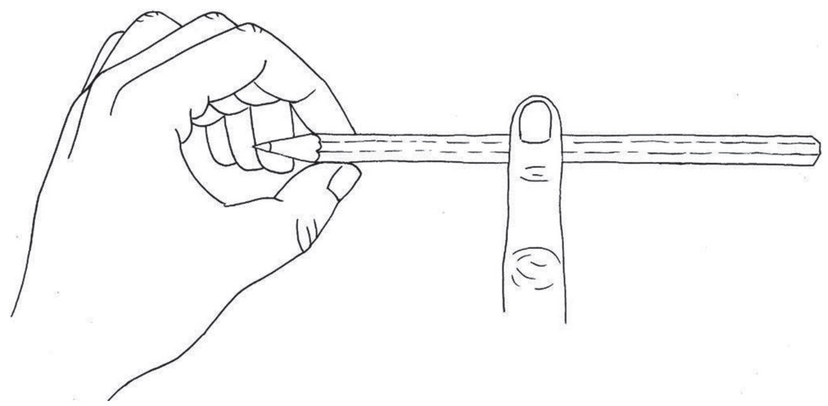


Figure 4

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.

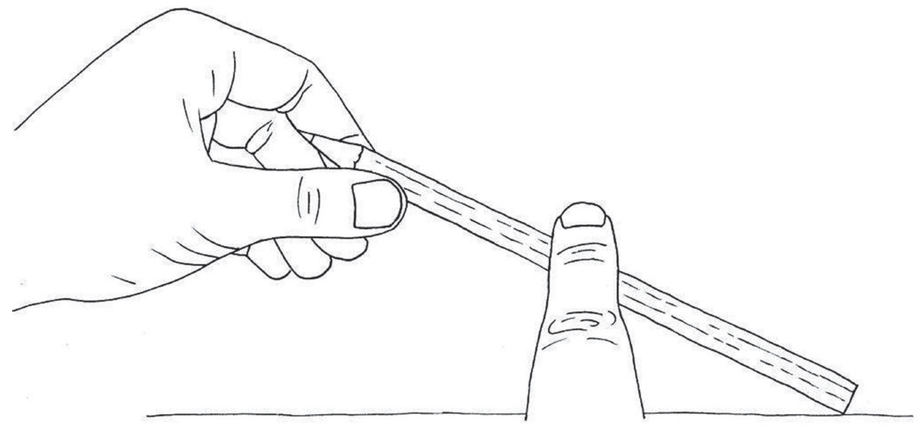


Figure 5

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?

   The input force is on the hand lifting the pencil and the load is in the middle.

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?

   First-class levers have the fulcrum in the middle.

LB page 52

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.

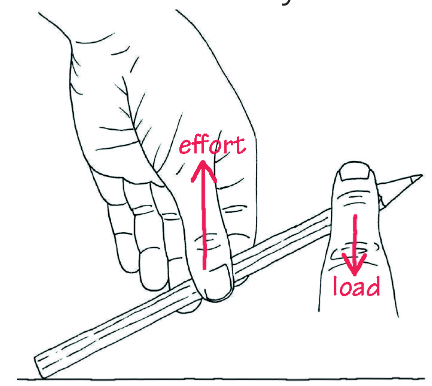


Figure 6

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?

   Effort is in the middle (where the person's hand is pulling).

   Load is on the right at the point of the pencil.

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?

   The load in the example on the previous page, is in the middle.

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.

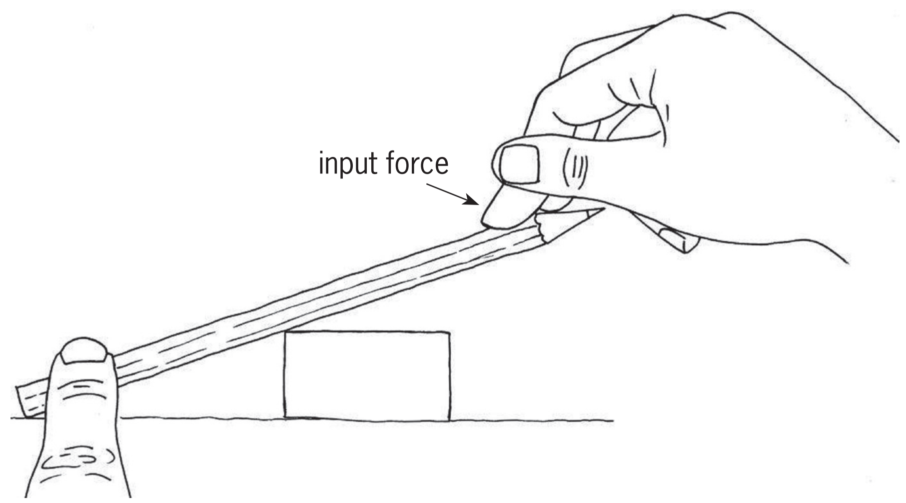


Figure 7

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?

   As a second-class lever.

LB page 53

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

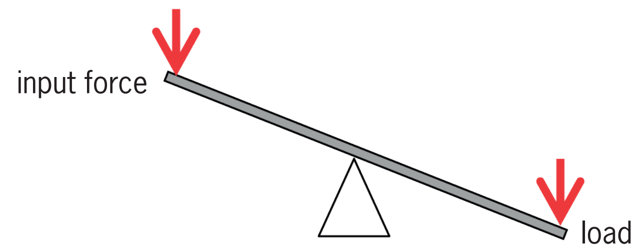


Figure 8

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

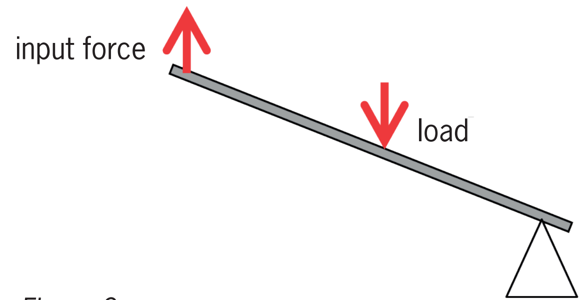


Figure 9

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

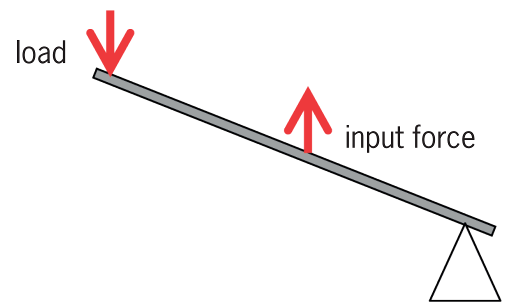


Figure 10

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

LB page 54

5.2 Practical examples of different classes of levers

Explore some different examples of levers LB p. 54

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

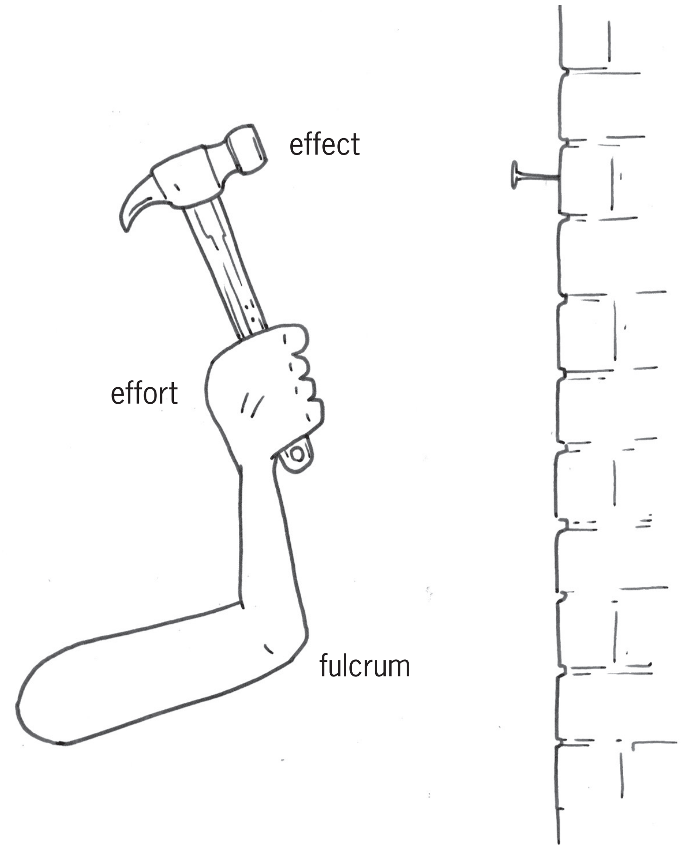


Figure 11

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?

   Third-class lever.

2. Can you think of a sport where a person swings an object to hit something?

   Baseball, cricket, tennis, hockey, golf.

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?

LB page 55

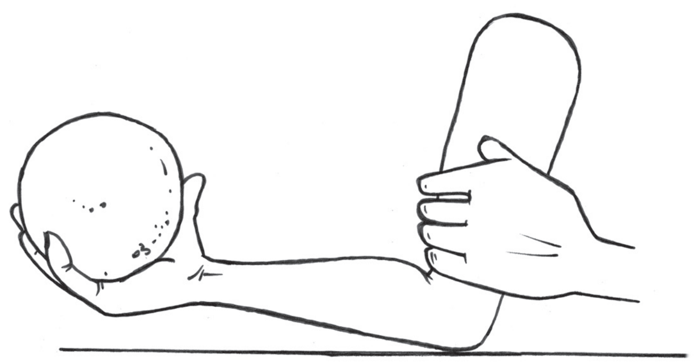


Figure 12

The diagram below explains how your arm works.

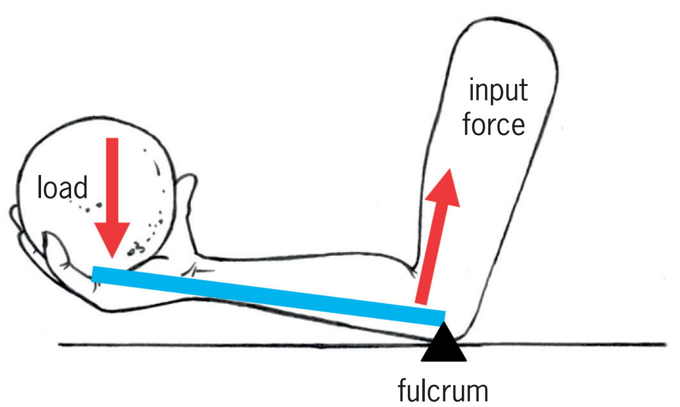
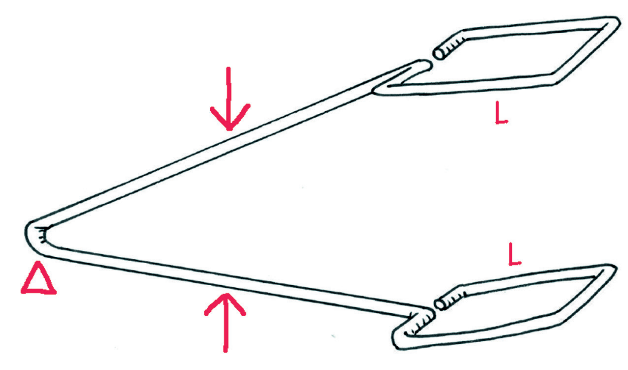


Figure 13

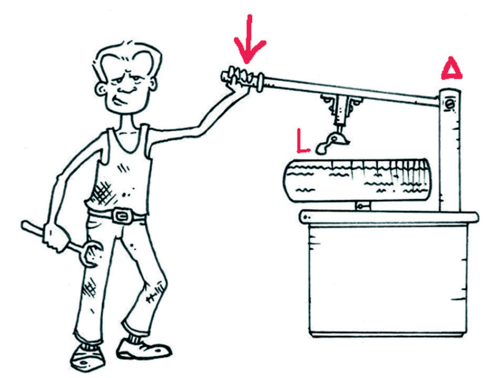
When you pick something up in your hand, your arm works like a **third-class lever** and the input force is between your elbow and your hand. Your elbow acts as the fulcrum and the load is in your hand.

LB page 56

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.

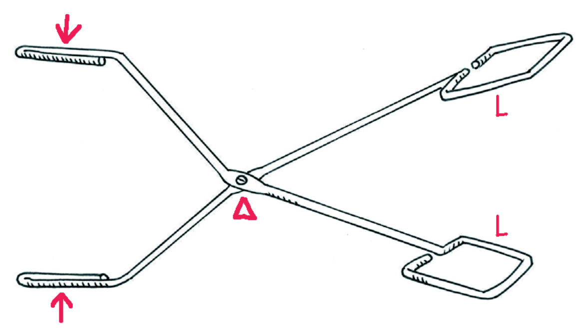


(a) kitchen tongs



(b) man pressing down mechanical tyre lever on stand

Second-class lever



(c) another kind of kitchen tongs

First-class lever

Figure 14

5.3 More practical examples of different classes of levers

LB page 57

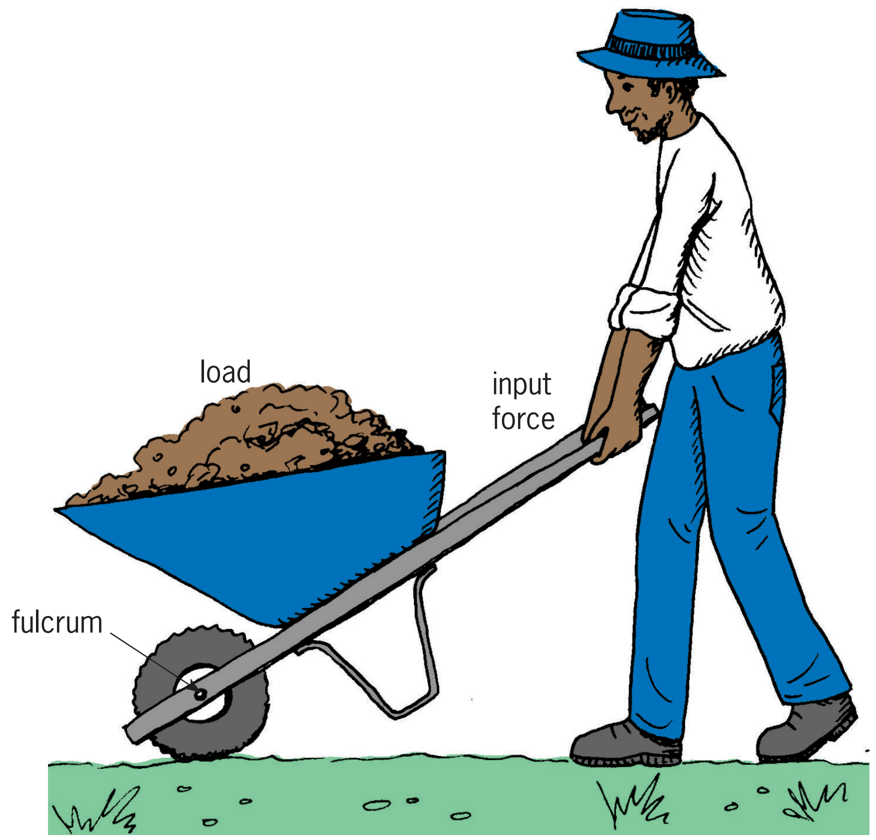


Figure 15

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.

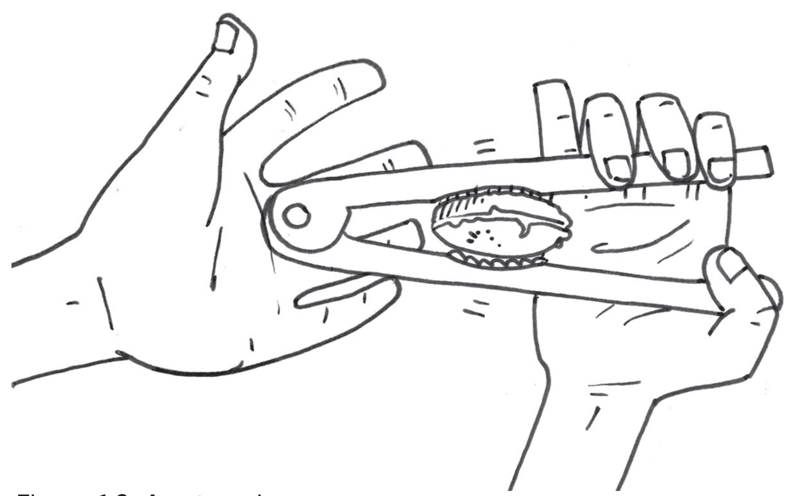


Figure 16: A nutcracker

Make a lever on a base plate

LB p. 58

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.

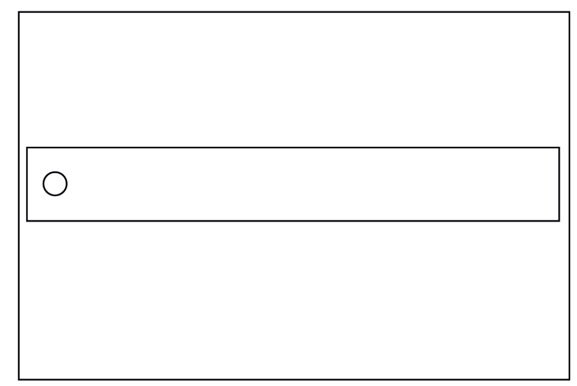


Figure 17

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.

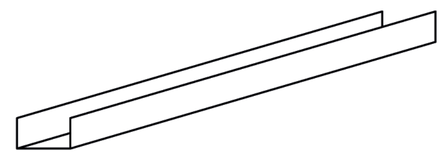


Figure 18

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.

The sketches must show second- and third-class levers. In the first, the small box is in the centre of the lever, and the effort is at the end (see Figure 9). In the next one, the box is at the end and the effort in the middle (see Figure 10).

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.

   It is easier to move the load when the effort is at the one side and the load is in the middle; this gives the biggest mechanical advantage.

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

LB page 59

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

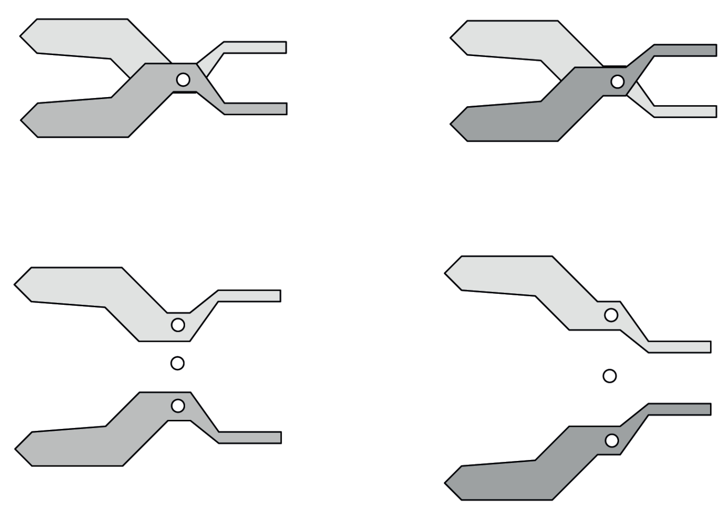


Figure 1: A set of pliers consists of two levers that pivot/rotate around the same fulcrum.

In Chapters 4 and 5 the learners were introduced to levers. They did practical work to understand the concepts of effort, fulcrum and load, and learnt that moving these around created three different types of levers: first-, second- and third-class levers. In this chapter, learners will discover how these classes of *levers are combined to make different tools*. They learn by means of practical investigation and experimentation. Learners try different things with tools to find out which tool gives the greatest mechanical advantage, if any at all.

They also look at some everyday tools to find out how the tools work and why they have been designed as they were, for example nail clippers, pliers and cutters/loppers (a garden tool). The shape of a tool is determined by the job the tool has to do. An efficient tool has a shape that ideally suits the purpose of the tool. Learners investigate how to use tools to get the greatest mechanical advantage (MA).

The illustrations on this page show learners two different designs of pliers, with different purposes. The illustrations on page 60 of the LB show the workings of a nail clipper. A pair of pliers and a pair of nail clippers both consist of more than one lever.

Materials required for this chapter:

corrugated cardboard
scissors
wire or paper fasteners (split pins) for linking levers and pivots
nails or awls

Additional resources that will help to demonstrate (if they can be sourced before 6.2 and 6.3):

different pliers
different nutcrackers
different tongs
nail clippers
tongs with linked levers

6.1 Pairs of first-class levers

Learners are guided through a set of simple tasks using scissors. Encourage them to work carefully with the scissors, as they are sharp tools. Insist they complete each of the small tasks with proper concentration. This should ensure that they will be able to answer the questions for each task. The learners must repeat any task or tasks if they could not answer the questions correctly. Try to avoid giving them the answers, as it is important that they discover the correct answers for themselves. Referring them back to Chapter 5 will help them remember the way levers work and are classified.

The last activity prepares learners for the end of term task (PAT) that they will start next week. They will be designing a rescue tool that will cut through metal to free trapped people in a vehicle after a car accident.

6.2 More tools with levers

The learners' knowledge and understanding of levers is tested and consolidated in this section of work. Make sure that each of the learners have the correct answers in their exercise books as they need this knowledge for the PAT next week.

The learners answer questions about nutcrackers, kitchen tongs and pliers. They have to identify the types of levers the tools represent, identify the best tool for a specific job, and design alternative tools using a different kind of lever from the original.

6.3 Many levers in one device

In the first task, learners discover that a nail clipper is not only one type of lever but different types of levers combined. This is both a revision and an extension task. This could be an opportunity for them to work in partnership; allow two or three learners to work together. Encourage comments and discussion. Make sure that all learners have the correct answers written down in their exercise books.

The second task is about combined levers, which are called linkages or linked lever systems.

LB page 60

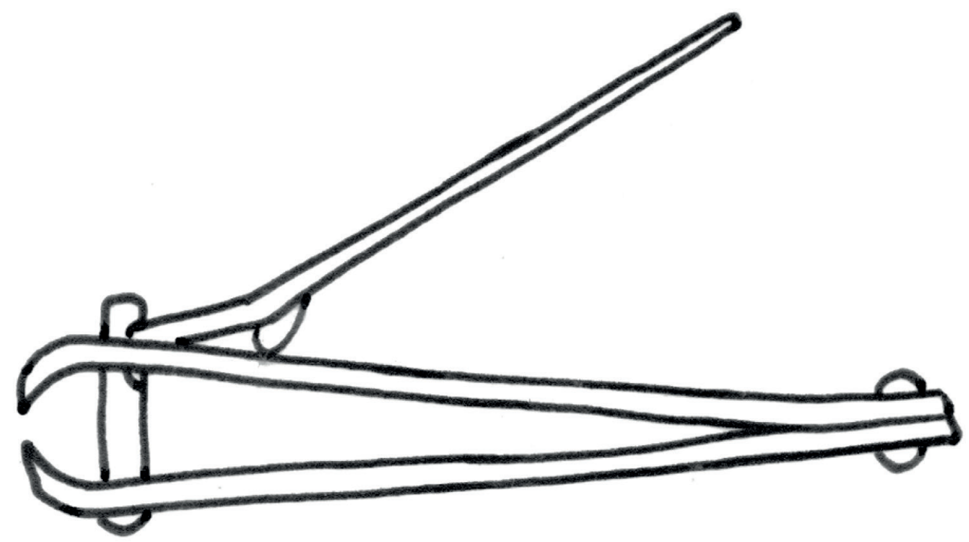


Figure 2

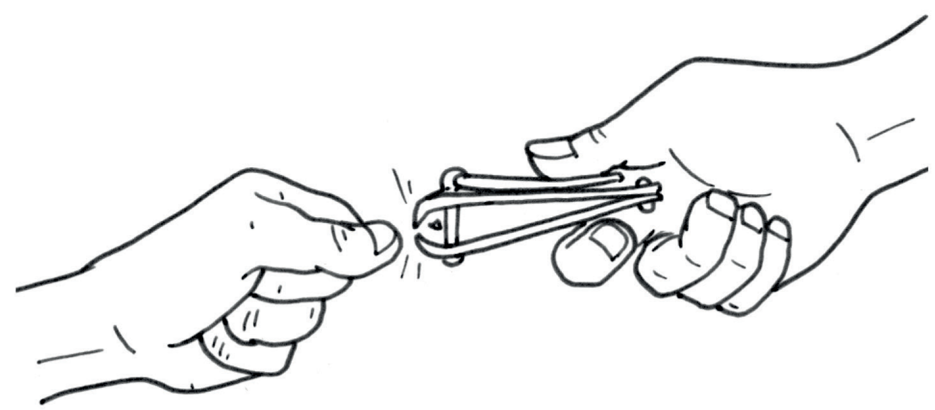


Figure 3

6.1 Pairs of first-class levers

LB page 61

Work with scissors in different ways

LB p. 61

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 in the pictures below.

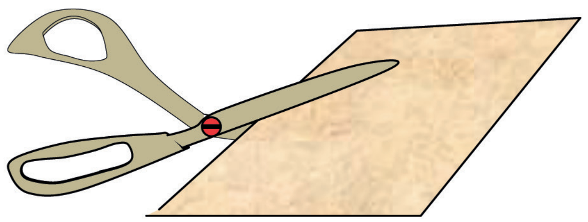


Figure 4

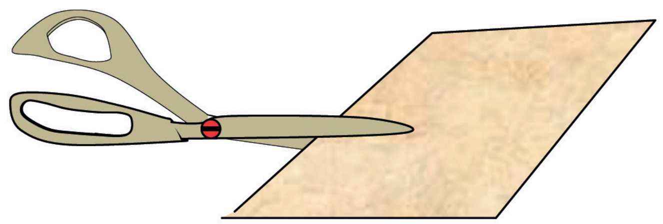


Figure 5

1. What is the difference between these two methods?

   In Figure 4, the scissors start cutting with a part of the blade that is very close to the fulcrum. This gives a great mechanical advantage. In Figure 5, the scissors start cutting with a part of the blade that is far away from the fulcrum. This gives a small mechanical advantage.

2. Which method makes it easier to cut? Explain.

   It is easier to cut with the method in Figure 4, because it gives a greater mechanical advantage. With this method, you also cut a longer piece at a time.

3. Are there any levers in a pair of scissors? If so, how many, and what kind of levers are they?

   Each blade is a first-class lever. Hence, there are two first-class levers.

Note to the teacher: It is OK if learners struggle to give good answers to the questions above. The exercises on the following two pages will guide them to eventually give good answers to these questions.

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.

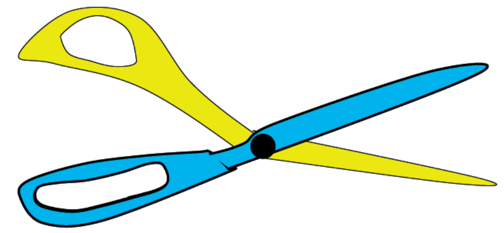


Figure 6: A pair of scissors is actually two blades linked together to work like two levers.

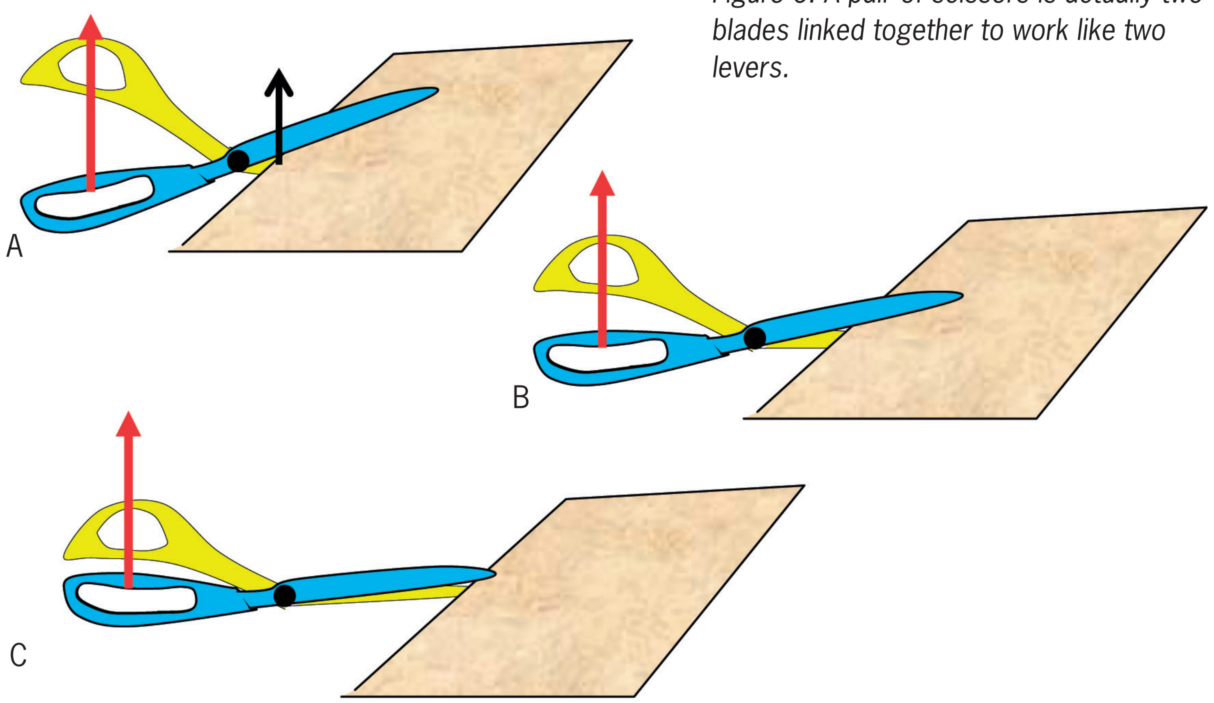


Figure 7

   In each case, the load is at the point where the scissors touch the paper.

5. In which case is the mechanical advantage of the blue lever the greatest, and in which case is it the smallest?

   The mechanical advantage is the greatest in case A, because the blade touches the paper very close to the fulcrum.
   The mechanical advantage is smallest in case C, because the blade touches the paper far from the fulcrum.

6. In which case, or cases, is the mechanical advantage of the blue lever bigger than 1?

   In cases A and B.

Can scissors cut thick objects? LB p. 62

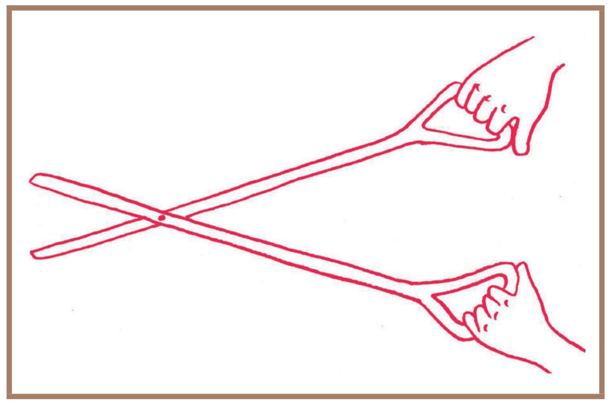
1. Why will an ordinary pair of scissors not work well to cut the branches of a tree?

Figure 8

The handles of ordinary scissors are not long enough to give enough mechanical advantage, and the materials of which the scissors are made are not thick and strong enough to withstand the great force required to cut a branch.

2. Make a free-hand sketch of the type of scissors that can cut the branches of trees. Why will they work?

Long handles that open wide to give great MA. The fulcrum is closer to the blades (load), far away from handles (effort).



3. Why will an ordinary pair of scissors not work well to cut a crashed car open to free trapped passengers?

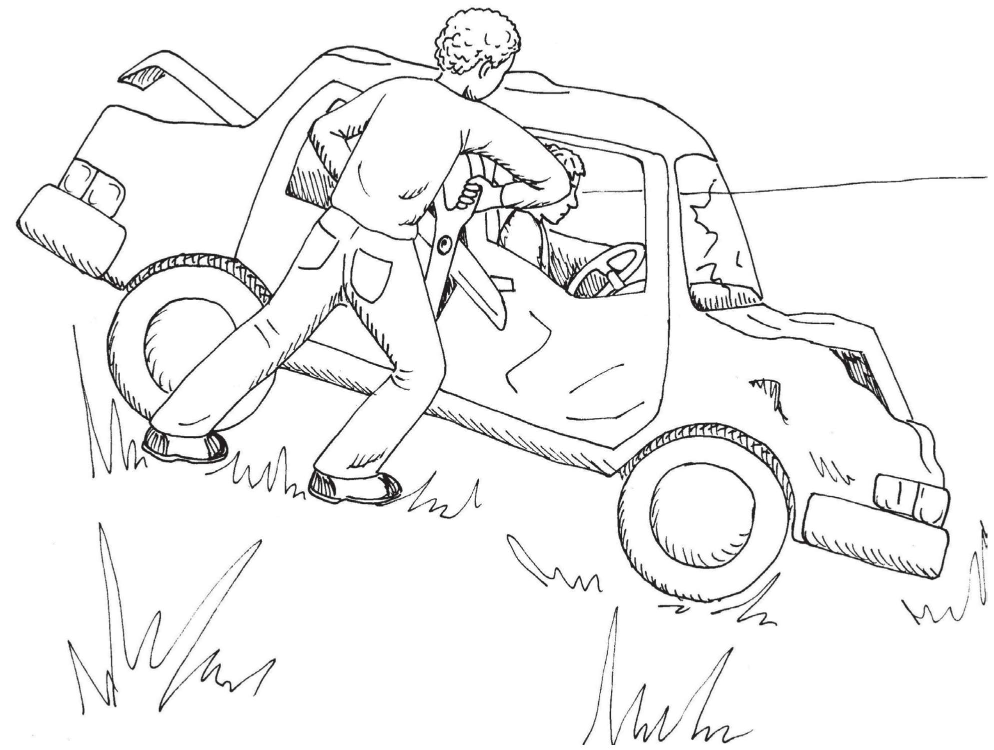


Figure 9

Very long handles and short blades will be needed to provide enough mechanical advantage to cut hard metal.

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?

See the answer to question 3 above.
The blades will also have to be made of a very hard type of metal, so that they do not get damaged by the steel they are cutting.

6.2 More tools with levers

LB page 63

What is the best way to crack a nut? LB p. 63

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

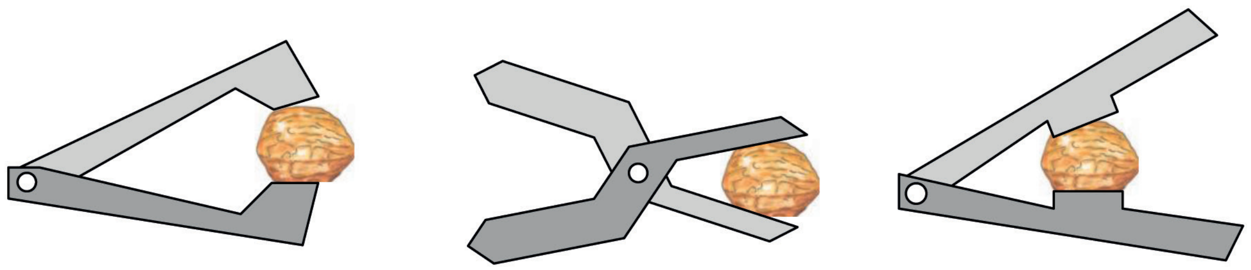


Figure 10

1. Which class of lever is used in each of these nutcrackers?

   A: third-class. B: first-class. C: second-class.

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.

   A: In the middle. B: Left side. C: Right side.

3. Mark and "label" the input force, load and fulcrum clearly on each of your drawings.

   A: Fulcrum on the left; effort in the middle; load on the nut.

   B: Fulcrum on the middle; effort on the left; load on the nut.

   C: Fulcrum on the left; effort on the right; load on the nut.

> 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.

4. Which of the three nutcrackers do you think will work best? Explain why you think so.

   C: The distance between the effort and the fulcrum is greater than the distance between the load and the fulcrum in B

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.

   A is a pair of third-class levers. The fulcrum is at the left end, the effort is in the middle, and the load is at the right end.

   B is a pair of firsr-class levers. The effort is at the left end, the fulcrum is in the middle, and the load is at the right end.

6. How does type C kitchen tongs differ from types A and B?

   It is made with two pairs of first-class levers that are linked together.

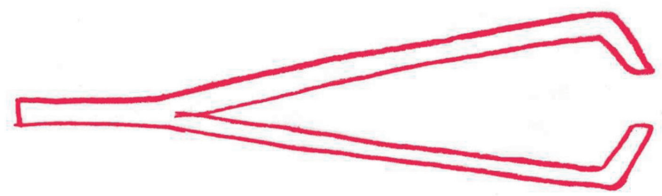
7. Which of the three types of kitchen tongs work in the same way as a pair of pliers? Explain your answer.

   B: It is a pair of first-class levers.

8. Describe a situation in which a pair of pliers would be useful.

   To grip something tightly, e.g. grip a bottle top and turn it to loosen it.

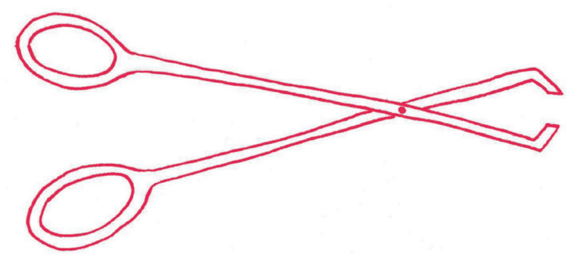
9. Make a free-hand drawing of a pair of levers that can be used to pull out thorns from your foot. This tool is called a pair of "tweezers".



10. Which class of lever did you choose for your design in question 9?

    third-class lever.

11. Make a free-hand drawing of tweezers with a different class of lever from the tweezers in your first design.



LB page 64

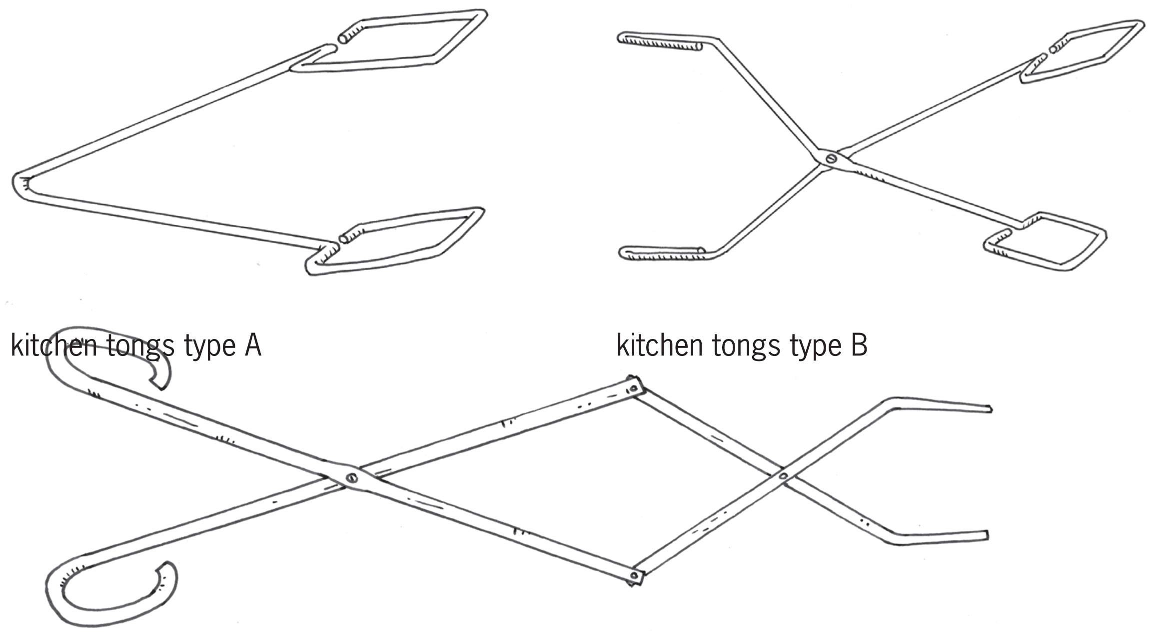


Figure 11

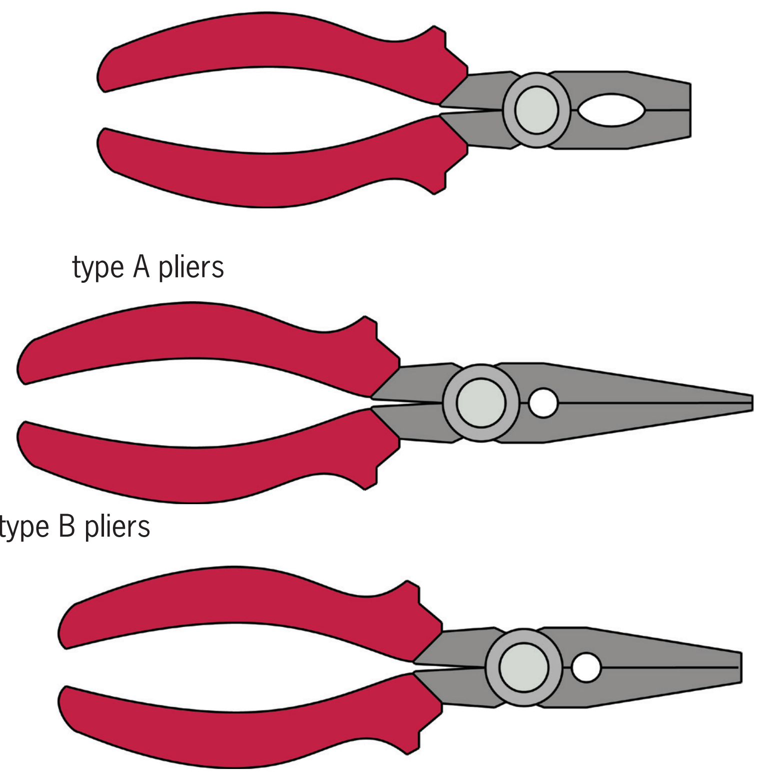


Figure 12

LB page 65

6.3 Many levers in one device

Examine and redesign a pair of nail clippers LB p. 65

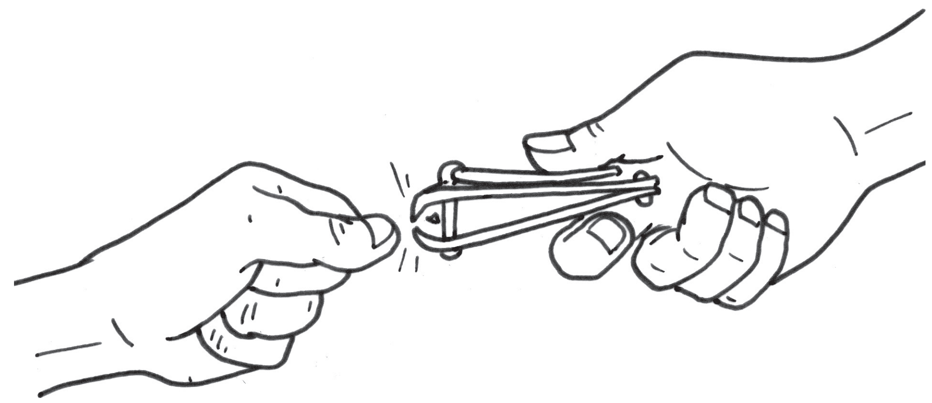


Figure 13

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

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.

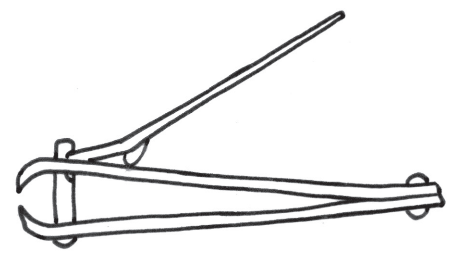


Figure 14

1. Look at the red part on the diagram in Figure 15. It is a lever. What class of lever is it when the nail clippers are used?

   first-class lever. ....

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.

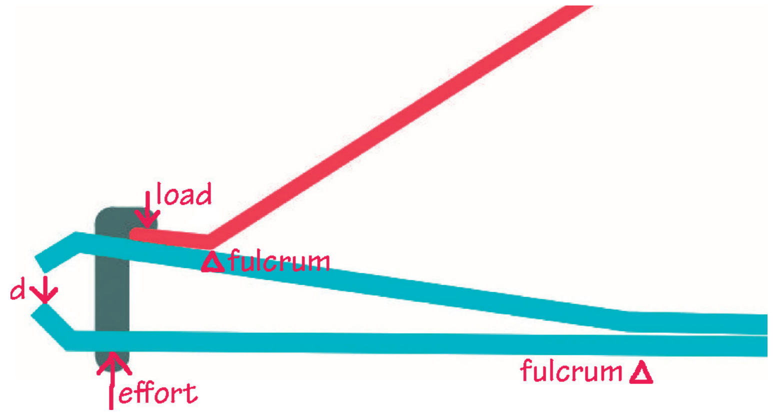


Figure 15

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?

   Third-class levers.

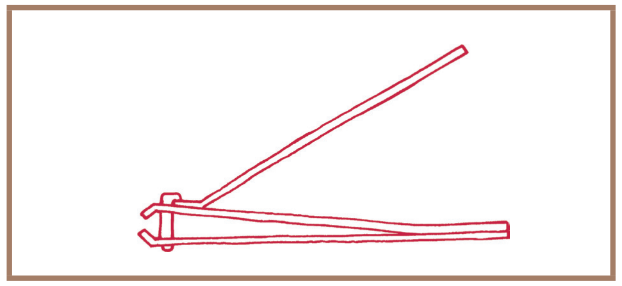
4. Show the effort and load on one of the blue levers with arrows and labels. Also show the fulcrum with a small triangle and a label.

5. Is the effort on the lower blue lever the same as the load on the red lever or not? Explain your answer.

   They are the same, because the left side of the red lever (where the load is) pulls up on the grey vertical pin, and the grey vertical pin pulls up on the lower blue lever to provide the effort on the blue lever.

6. Can the above 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.

   Make the handle of the red first-class lever longer to give a greater MA.
   Move the fulcrum of the blue third-class lever further away from the effort so that the ratio between the fulcrum-effort distance and the fulcrum-load distance is closer to 1. This will decrease the mechanical disadvantage of the third-class lever.



Investigate another combination of levers LB page 66

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**.

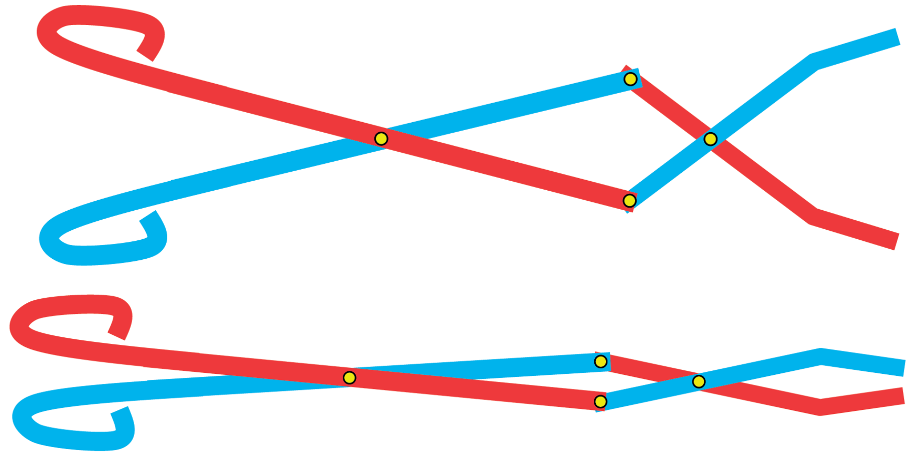


Figure 16

1. What do you think the purpose of this device is?

   To grab and pick up objects that are too far to reach, or in a dangerous place, for example in a fire.

2. Which of the yellow links/pivots in the drawing are fulcrums supporting levers, and which only connect/join one lever to another?

   The two outside links (the yellow dots) are fulcrums.
   The middle two links (yellow dots) only join the two sets of levers.

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

LB page 67

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]

This is the first end-of-term assessment project for the learners. The activities for assessment are prescribed in the CAPS document. Only work done at school may be assessed. The PAT counts for 70% of the term mark, the remaining 30% being the end of term test mark. Most work for assessment has to be individual. In future, the PATs will include team work, but not for this chapter.

Learners will work through the **design process** to design and make a mechanical model of the Jaws of Life tool. The work is divided into four weeks and each week is divided into four 30-minute sessions. It is important that learners are made aware of keeping to the time allocation so that they will be able to complete their models in time.

Materials and tools required for this PAT:

two syringes of different thickness
plastic tubing to connect the syringes
corrugated cardboard
used paper, e.g. A4 or old telephone directories
thin wire, paper clips, paper fasteners, string (for pivots); encourage learners to use waste materials
glue
scissors or craft knives
nails or awls
pliers

Safety

In practical exercises such as this PAT, learners work with sharp tools (scissors, nails or awls). They must have a safety briefing beforehand. Accidents can happen, so have a basic First Aid kit in the classroom (disinfectant, plasters and bandages).

All tasks/questions are essential for the design process, even if no marks are allocated.

All tasks/questions in the PAT should be completed/answered, even the tasks/questions for which *no* marks are allocated for evaluation. This is because all the tasks/questions are essential parts of the design process. So, if certain tasks/questions are not done, then learners will not be able to do the subsequent tasks/questions successfully.

Week 1: Another way to move objects from a distance

Learners learn about pneumatics and hydraulics by means of practical investigation, using syringes and a pipe. The scenario in next week's lesson requires learners to have a good understanding of hydraulics and the advantage of using a hydraulic system over a pneumatic system.

Week 2: Scenario

The learners concentrate on *design* in this section. It is a good idea for the learners to look at the images and text on the double page spread at the start of the chapter. The description of different types of rescue devices and the scenario provides learners with the necessary information to come up with a plan and a design brief with specifications and constraints. It will assist the learners if you take time to explain the terms "specifications" and "constraints" and how they differ. These are terms they will be using throughout the Technology curriculum.

Remind learners that these tasks will be assessed. Learners look at images of a Jaws of Life device, a few kitchen appliances and sketches of devices made by other learners, before they draw two of their own designs. This provides learners with an opportunity to critically evaluate their own work. In later terms, they will be evaluating each other's drawings. Impress on learners that the safety of the trapped victims is a priority. Therefore, their device must accurately make small movements.

Learners are guided through the *planning* process that always precedes the *making* process. Remind learners that this process will be assessed. Emphasise to learners the importance of sticking to the allocated time set out for making. It is easy for learners to underestimate the time it takes to make an object, especially when it is a new process they are learning. With your guidance, they must not waste the first lessons before they start making their models. There will be no time to spare at the end of the lesson.

Move around the classroom and ask questions that will help struggling learners to overcome construction difficulties. Give them direction not solutions; remember, their models are for assessment.

Make sure that they attach their hydraulic systems so that it can operate effectively. The syringe has to move the cutting tool. To do this, the model and the syringe have to be attached to a backing board. If not, the plunger of the syringe will move in a reverse direction and there will be no pushing force on the cutting tool.

Week 3: Make a working drawing

Learners *make* a 2D drawing of their planned tool. Remind them to work neatly and that this drawing is for assessment.

Week 4: Complete your model

During this week, the learners will complete their models, using their design brief and their drawings as guidelines. Impress on learners the importance of sticking to the allocated time set.

The last activity is a formal *drawing task*. The learners have to do an oblique 3D drawing of a syringe. They can base these on the syringes they have used for their model, and use the guidelines and Figure 30 to help them.

Formal drawing usually precedes the *making* stage, but not for this, the first PAT. In this case, the drawing serves as a skills development task. For a first formal drawing exercise, it is easier for learners to draw a product that they can see rather than a model that is in their mind. Make sure that their pencils are sharp and their erasers are clean. This contributes to a neat drawing. Remind learners that the oblique drawing will be assessed.

LB page 68

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.

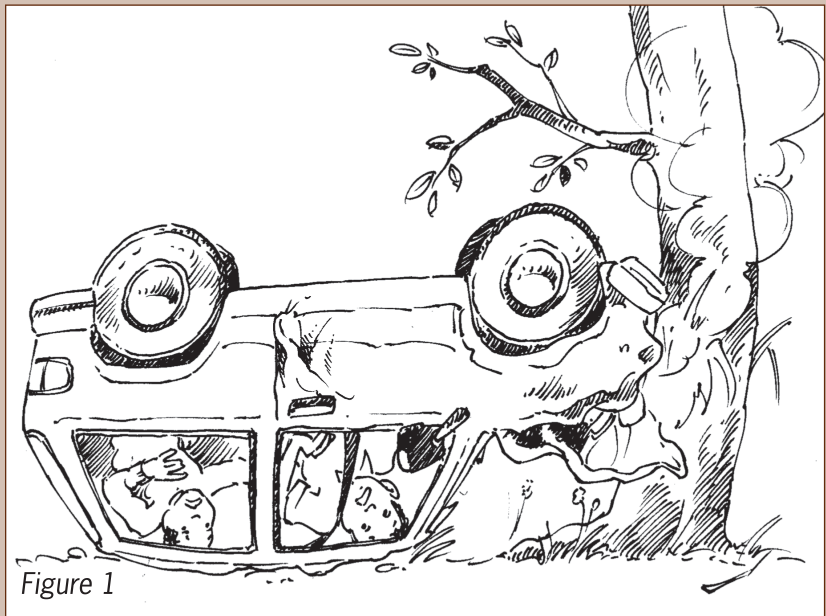


Figure 1

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.

LB page 69

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.

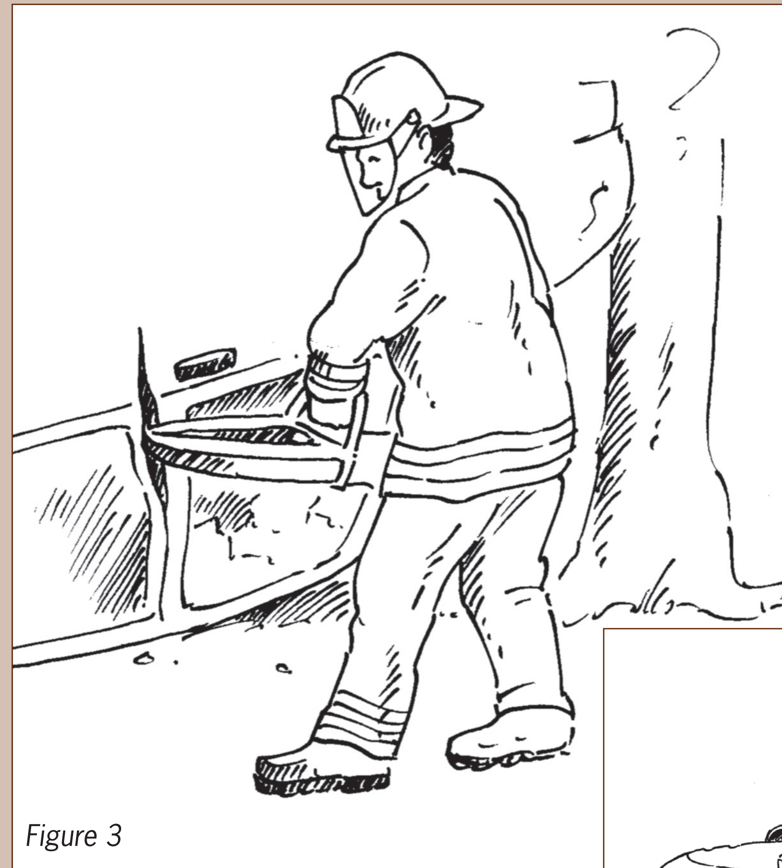


Figure 3

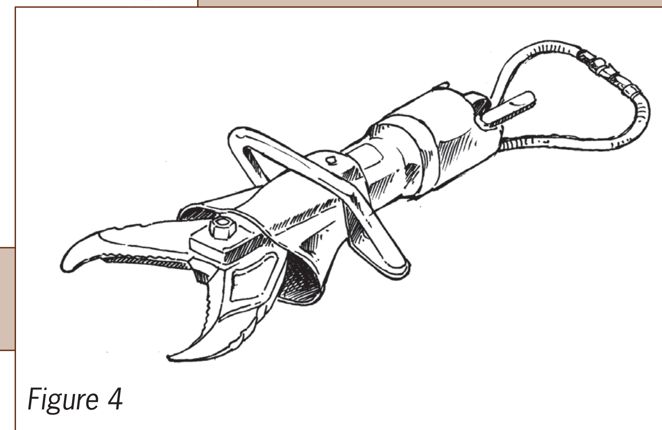


Figure 4

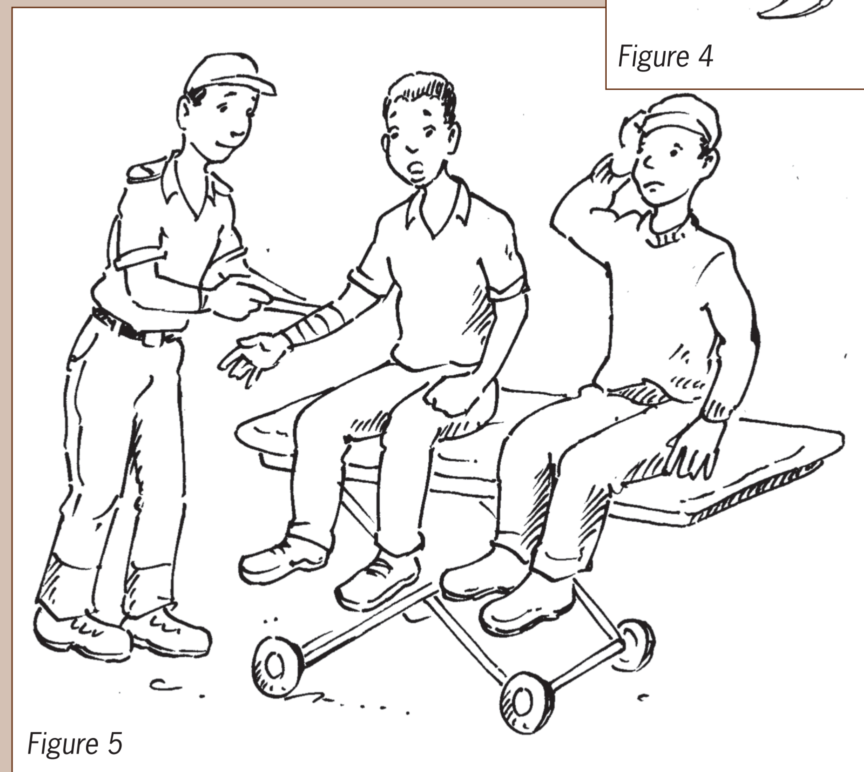


Figure 5

Week 1

LB page 70

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.

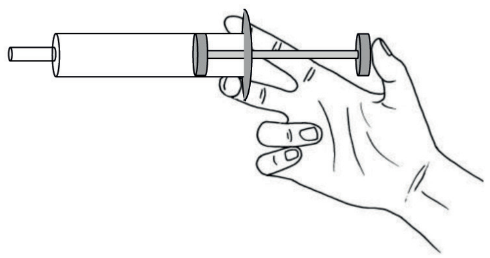


Figure 6: This is how you should grip a syringe so that you can push the plunger in with your thumb.

Now you do it.

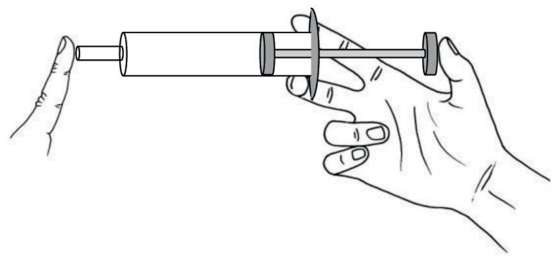


Figure 7: Close the outlet tube tightly with a finger, then try to push the plunger in.

1. What do you feel when you push the plunger now?

   The plunger moves a little and then there is resistance on the outlet against my left finger.

2. What do you think prevents the plunger from going all the way in when you push it hard?

   The air in the syringe.

3. Do you think there is something in the syringe that you cannot see?

   Yes, air.

LB page 71

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.

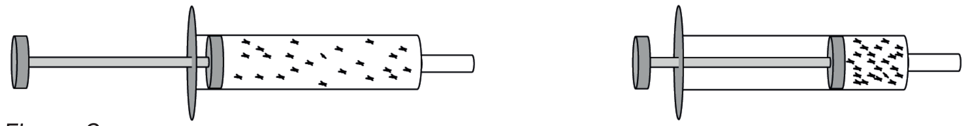


Figure 8

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.

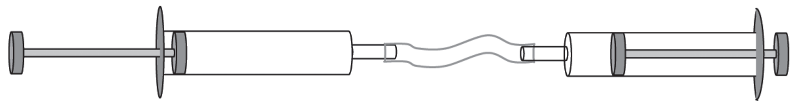


Figure 9

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

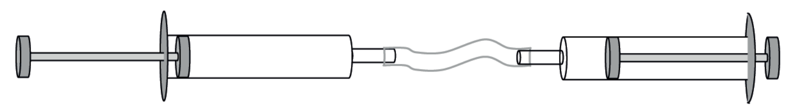


Figure 10

Yes, you can use it to push an object.

A pushing device made with syringes and a pipe that is 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?

   At first it is easy to press in the plunger, but it becomes harder and harder, the further in you push the plunger. The books only start to move when it becomes very hard to push the plunger further in.

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.

LB page 72

Step 1

Some air bubbles may get caught inside.

Step 2

Hold it upside down and press the air bubbles out.

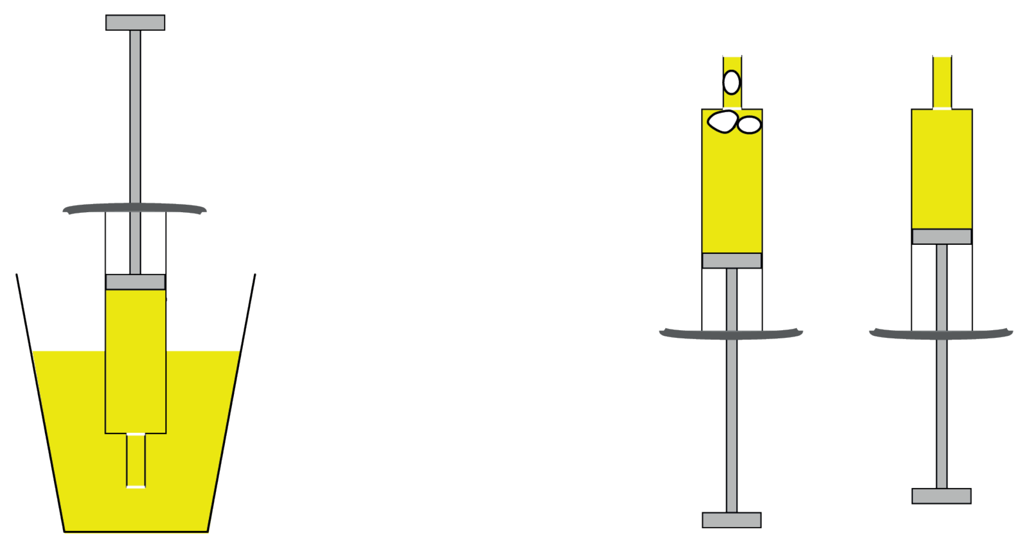


Figure 11

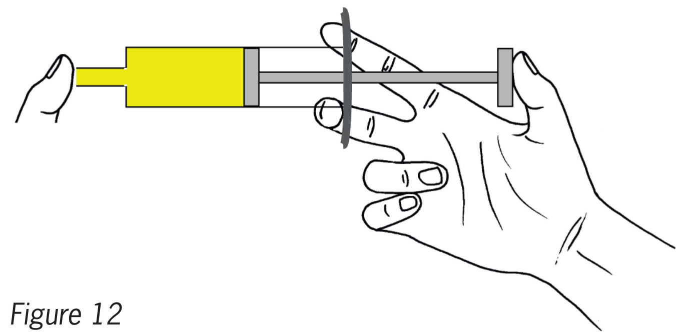


Figure 12

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.

   With air in the syringe, you first press softly and the syringe moves, but you have to press harder and harder the further you press in the syringe.
   With water in the syringe, you immediately have to press the plunger very hard, but it does not move.

A liquid cannot be compressed.

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

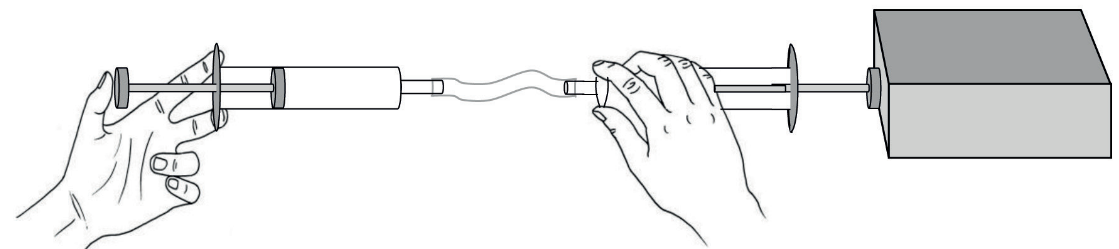


Figure 13

LB page 73

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?

   Water. You can test this by trying to move the books first with a syringe filled with air, and then with the same size syringe filled with water.

An important investigation

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

   Answer will depend on the size, shape and mass of the books. Let the learners experiment.

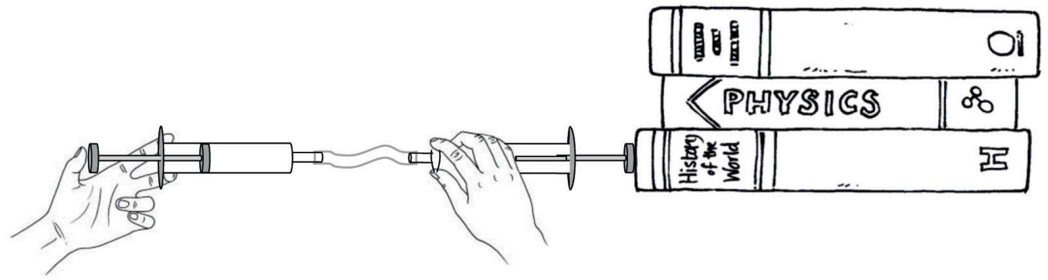


Figure 14

2. How many books can you put on top of each other and still be able to push it with your hydraulic pushing device?

   Answer will depend on the size, shape and mass of the books but will be more than with the syringe filled with air.

3. Why do you think a hydraulic pushing device provides a stronger push than a pneumatic pushing device?

   Because water cannot be compressed like air. With the hydraulic device, you immediately press very hard to move the plunger on the left, and you immediately get the same movement on the right.
   With the pneumatic device, you cannot press that hard, because it is easier to compress the air than to move the books. So you never press hard enough to be able to move many books.

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

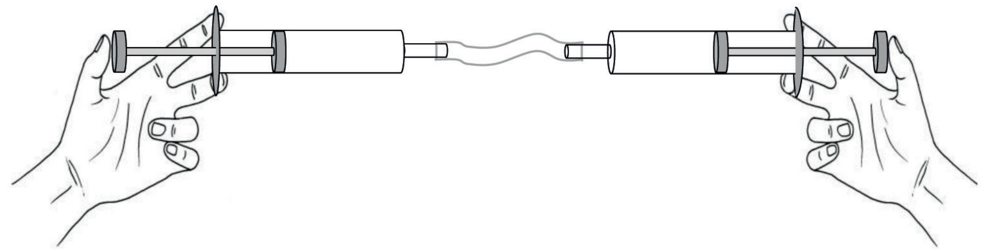


Figure 15

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?

   With the air-filled pushing device, the plungers move closer together. It feels like you are pressing a spring or sponge from two sides.
   With the water-filled pushing device, the plungers do not move at all if you press equally hard from both sides. It feels like you are trying to compress a strong metal or wooden rod, which is impossible.

5. Explain why pneumatic and hydraulic pushing devices act differently.

   Air can be compressed; liquid cannot be compressed.

LB page 74

More investigations

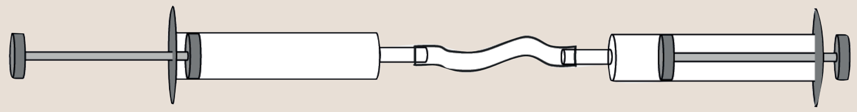


Figure 16

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 on the left? Explain your answer.

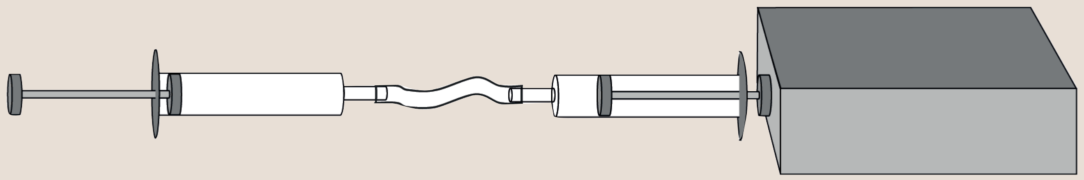


Figure 17

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?

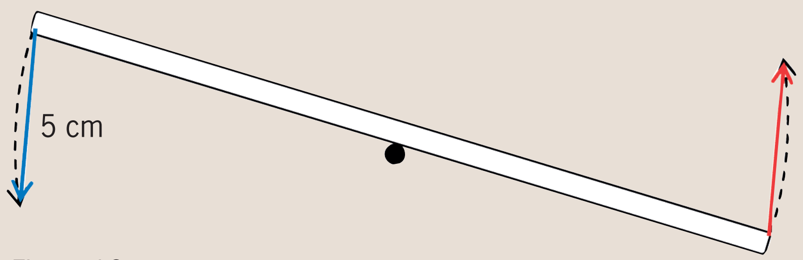


Figure 18

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

LB page 75

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.

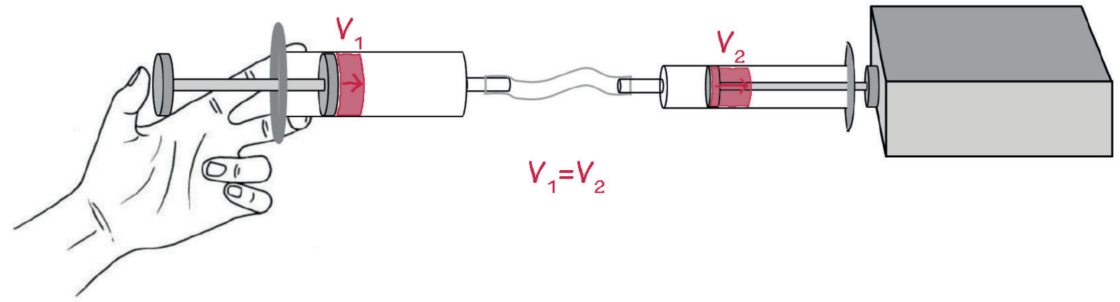


Figure 19

It will move further than 1 cm because the syringe on the right is thinner. The volume of water that leaves the syringe on the left is the same as the volume of water that enters the syringe on the right. See the red volumes drawn on figure 19. Because the syringe on the right is thinner, the plunger will move further to allow the same volume of water to enter it.

2. What would be different if the syringes and tube were filled with air instead of water? Explain your answer.

The plunger on the right will move a shorter distance than when the device was filled with water, because the air will compress.

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.

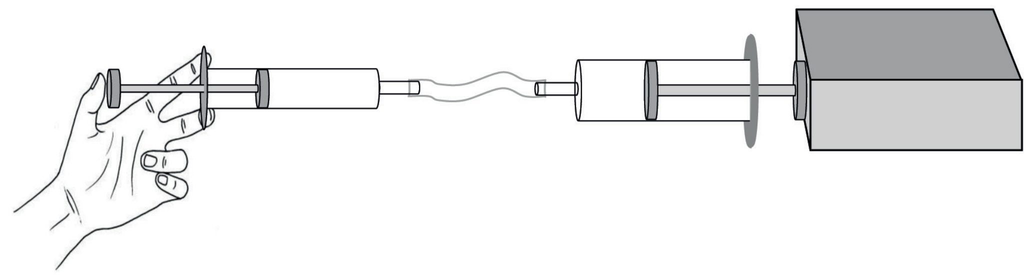


Figure 20

The plunger on the right will move a shorter distance than the plunger on the left. This is the opposite situation from Question 1.

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

In case A.

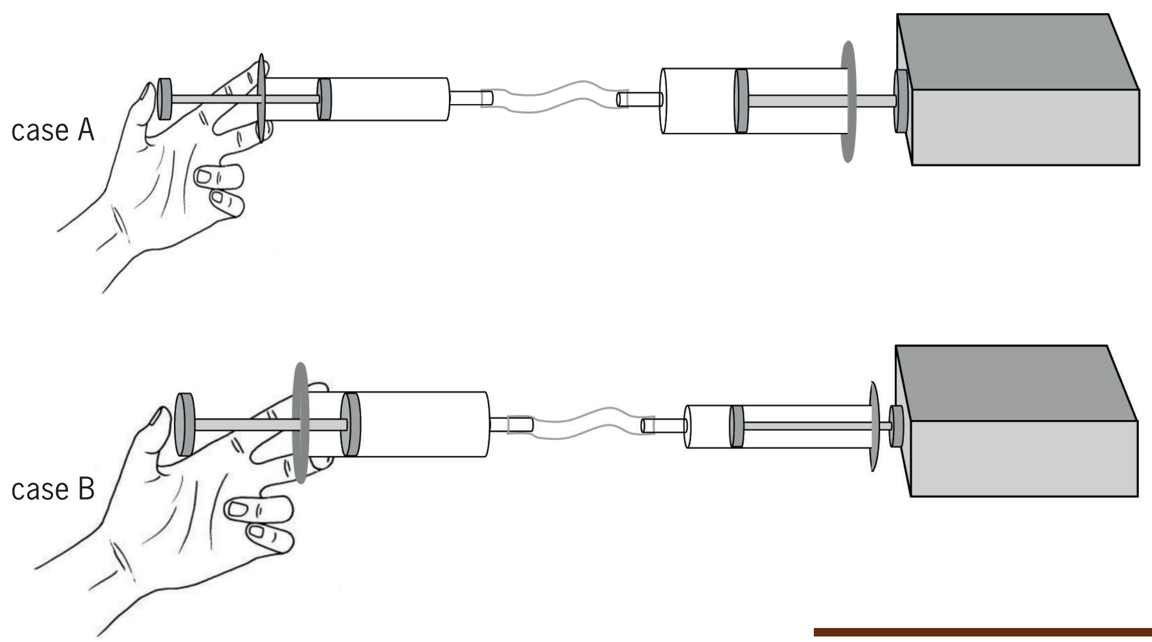


Figure 21

LB page 76

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

Case A: The thin syringe is the input syringe. It requires little force to press in the thin plunger on the left, but the thick plunger on the right moves a smaller distance than the plunger on the left. This device gives a mechanical advantage but a distance disadvantage.

Case B: The thick syringe is the input syringe. It requires much force to press in the thick plunger on the left, but the thin plunger on the right moves a greater distance than the plunger on the left. This device gives a mechanical disadvantage but a distance advantage.

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?

Lebogang is right. The amount of work done at the input syringe should be the same as the amount of work done at the output syringe. A small force pushing over a large distance does the same amount of work as a large force pushing over a small distance.

Should both the force and the distance on the output side be bigger than on the input side, it would mean that more work is done on the output side than on the input side, and that is not possible.

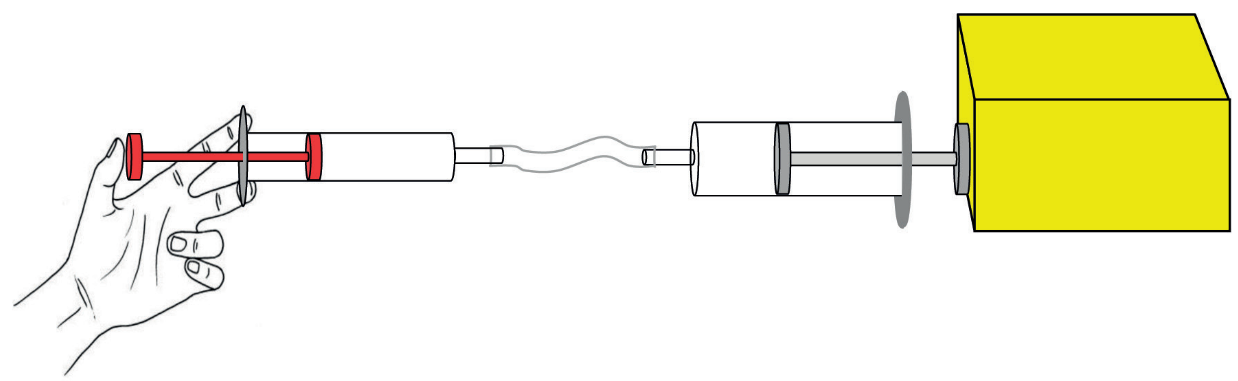


Figure 22

In Figure 22, a thin syringe is used to drive a thick syringe. The yellow object will move by a smaller distance than 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*.

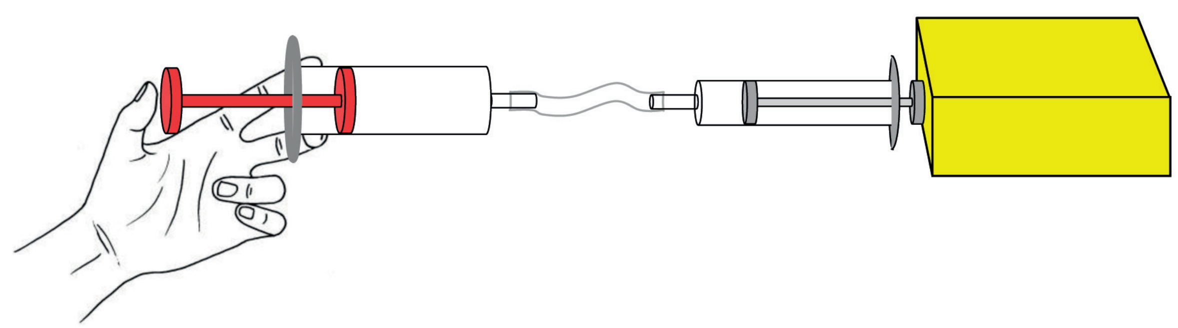


Figure 23

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

LB page 77

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.

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.

Figure 24

LB page 78

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?

   People were trapped in a car that had veered off the road, overturned and was crushed.

2. Who will use the rescue tools?

   trained rescue workers

3. Where will the rescue tools be used?

   at the scene of the accident

4. In what way will the tools help?

   People can be extracted quickly so that they can be given first aid by the paramedics and rushed to the hospital if necessary.

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]

   I should design and make a model rescue/Jaws of Life device that will cut metal to free people trapped in a crashed car.

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.

6. Identify the **specifications** of the solution.

(a) What will the tools be used for? [2]

to force open or cut through crushed metal

(b) What will make the tools work? [2]

a lever system powered by a hydraulic system

(c) To what should your model be attached? [1]

a flat piece of cardboard

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

7. Identify the **constraints** on the materials.

Start your sentences with words like:

My model cannot or should not … [3]

The cutting blades of my model of a rescue tool should not move much when the handles are moved, because big, sudden movements could injure passengers.

It should not require to great a force to move the handles of the rescue tool.

No part of my model should break when the kind of forces for which it is intended are applied to it.

I cannot spend more than 120 minutes to design my model (week 3).

I cannot spend more than 120 minutes to make my model (week 4).

My model cannot be built from materials that are expensive and/or that I cannot find easily.

[Total: 12]

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.

LB page 79

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

LB page 80

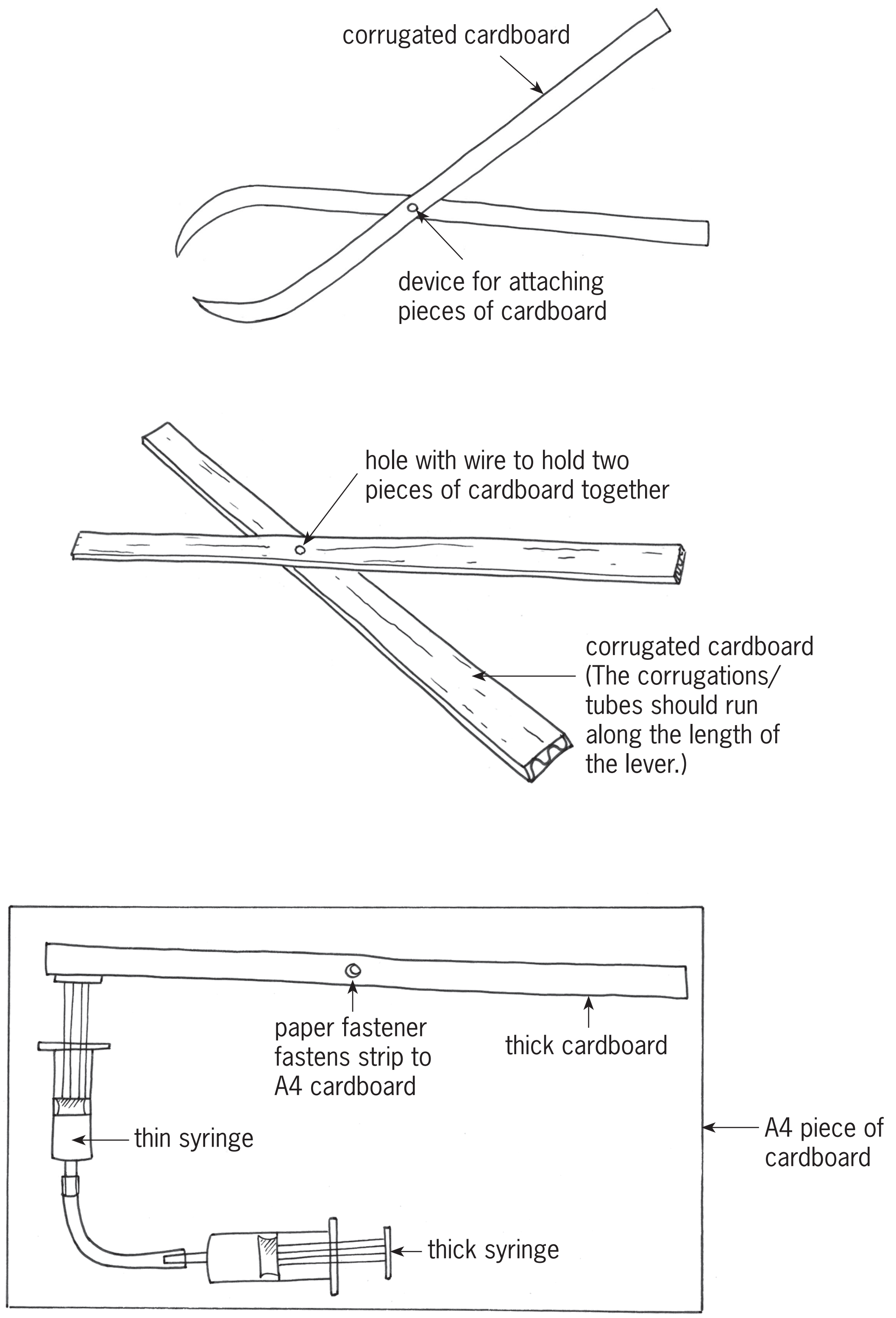


Figure 26: Drawings made by other learners

LB page 81

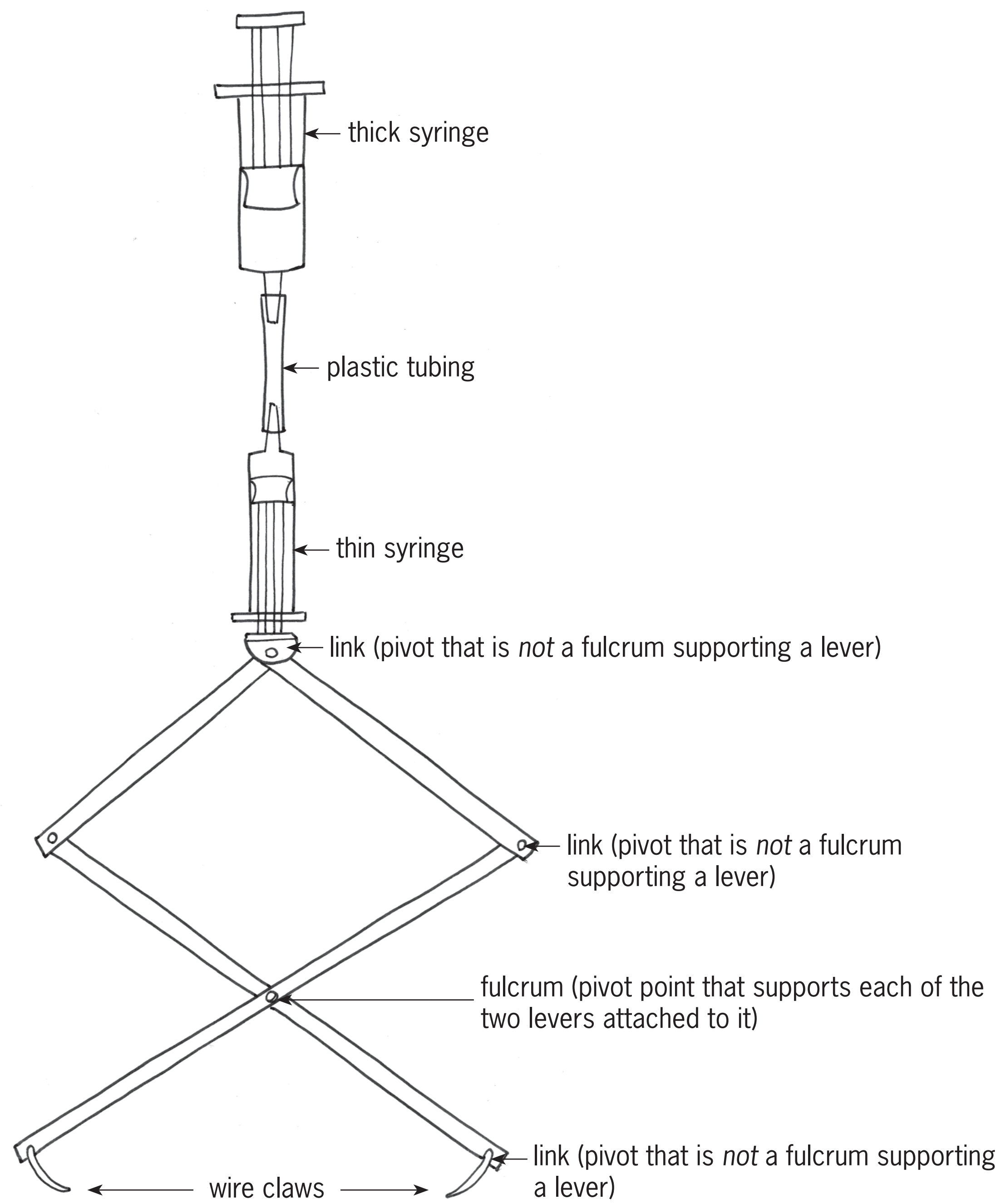


Figure 27: More drawings made by other learners

LB page 82

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]

The learners can use Figures 26 and 27 to get ideas, but encourage them to come up with their own ideas too.

The drawing must include:

- The cutting tool. It must be practical.
- All parts have to be labelled.
- All materials have to be indicated.
- The positioning of the syringes have to be workable and in the correct order (thin syringe for the input force, and thick syringe for the output force).

Guidelines for assessment:

Labeling of parts	[2]
Description of materials	[1]
Syringes positioned to give a mechanical advantage	[2]
Levers designed to give a mechanical advantage	[2]

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]

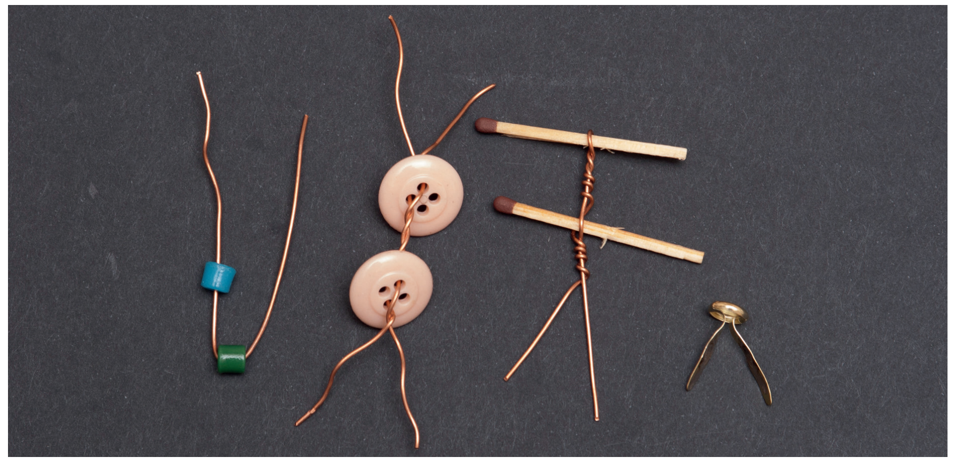


Figure 28: Here are different pivots and ways to attach pieces of cardboard that were used by other learners. Some were bought and some are hand-made.

For the pivots: any suitable materials, for example, but not limited to, wire and beads, string tied to small sticks.
To attach model to backing: any suitable material, e.g. thin wire, paper fasteners, paperclips.
To attach syringes to backing: any suitable material, e.g. thin wire or string.

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]

For example, but not limited to:
scissors or a cutting knife
a nail or awl for making holes
a ruler
pliers
a punch for making holes

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]

   Learners should give an example of a safety rule that is important for one of the tasks that they will perform.

Safety warning

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

LB page 83

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.

Steps 5, 6, 7 and 8.

Three or four practical tasks in logical order.

Suggestions:

Step 5:
Attach lever system to backing sheet.

Step 6:
Attach hydraulic system to lever system.

Step 7:
Test that the hydraulic system works.

Step 8:

[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 you say that the scale is 1:5.

LB page 84

Make a 2D working drawing of your model

- Look at Figure 29 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.

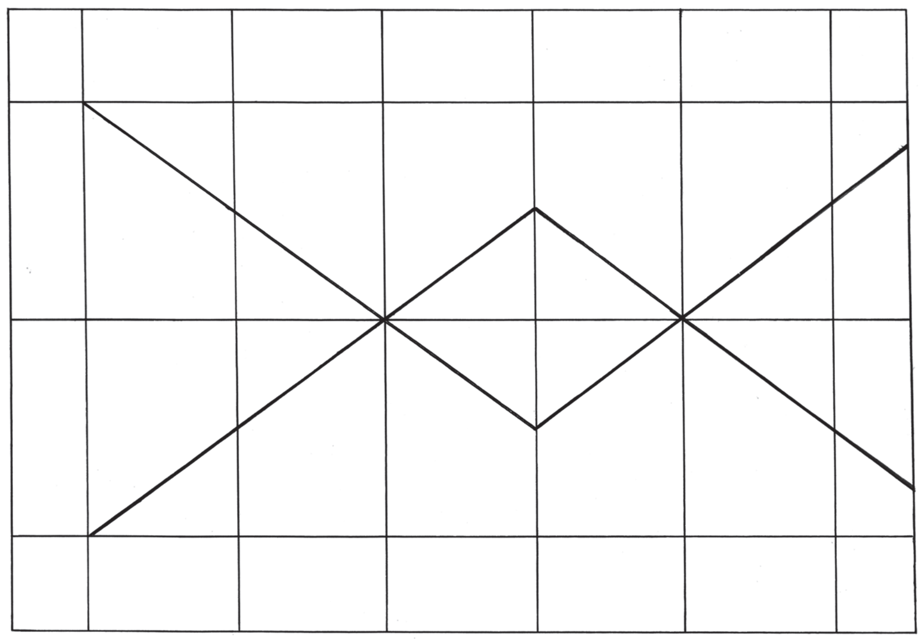


Figure 29: An "outline block" drawing of a lever system

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

LB page 85

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 will 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.
- For the pivot, you can choose materials other than those you planned to use.

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]

LB page 86

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.

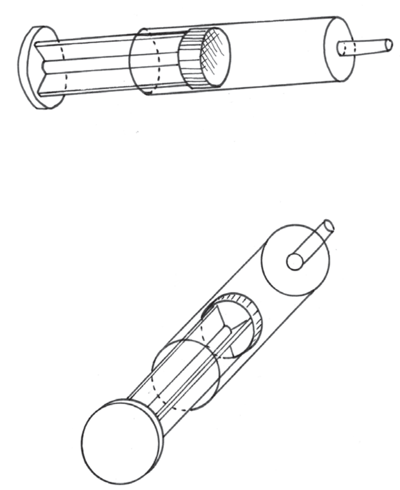


Figure 30

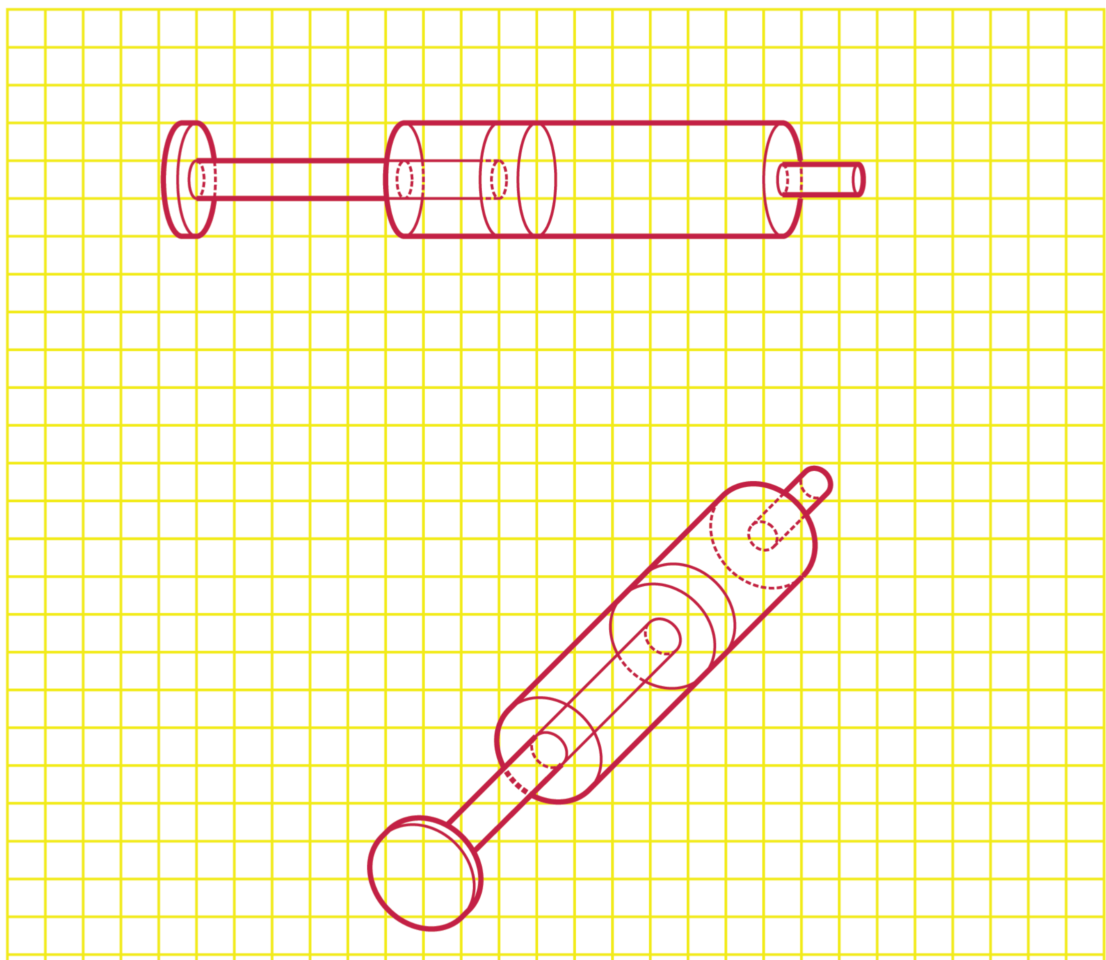
1. Start by drawing the front view of the syringe using thick, dark lines. This outlines the shape of the syringe.
2. Measure and draw your 45° diagonal lines from the corners. They must be light, feint lines, because they are construction lines.
3. Measure and mark the depth of the syringe construction 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 have to be dark lines.

[6]

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

LB page 87

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?

This term's work is about structures. Some of the work will not be altogether new to the learners. They learned about structures in Natural Sciences and Technology in the Intermediate Phase when they built an animal shelter.

Many people may think "structures" refer only to buildings. It is important that learners develop a broader understanding of the term "structures". The same ideas used for designing buildings are also used for designing other things, including simple everyday objects. Also, ideas from nature often inspire how man-made things are designed.

Learners may observe everyday objects very superficially, without giving them much thought. This chapter tries to open learners' minds to things about everyday objects that they have not noticed or thought about before. To do this, they first need to observe everyday objects with an enquiring mind. After observing, they need to describe structures in three ways, namely its purpose, whether it is man-made or natural, and the type of structure. To give such descriptions, they need to learn words to describe differences between structures.

When learners have to *design* their own structures in later chapters, their knowledge of differences between structures will empower them to make good choices of what types of structure to use for what purpose, and of what materials to use.

8.1 Things called structures

The lesson should start by learners *discussing the question* below Figure 1. They should do this in pairs, for about five minutes.

In the activity starting on Learner Book page 90 (page 114 here), learners *observe different objects* in the classroom that are structures, and then answer questions about the purposes of those structures.

In the activity starting on page 91 of the Learner Book (116 in this Teacher Guide), they *read a short story* about a person who will sell things at a market. Then they answer questions to describe the food stall. Finally, they answer questions that require them to *follow the design process*, to make a list of what they need, to choose appropriate containers for different products, and to design a simple table and shelter for the food stall.

Throughout the lesson, they are introduced to words to describe the different purposes of structures, namely to contain, to protect, to support and to span.

8.2 Man-made and natural structures

Learners *read* half a page explaining the difference between man-made and natural structures. Then they *observe* different pictures in the book, and *answer questions* about which structures are man-made and which are natural. They also answer questions to identify the different purposes (contain, protect, support, span) of different structures.

8.3 Types of structures

Learners *read* explanations of words used to describe different types of structures, namely "solid structure", "frame structure" and "shell structure". They also *read* about structures that are combinations of different types of structures.

They *observe* pictures of examples of different types of structures. Then, they *classify* different structures according to these types.

Later, they *identify* the different types of structures in given pictures, and *compare* the strengths of the different structures. Lastly, they have to *sketch* one of the structures themselves.

How to define the word "structure"

It is not easy to give a definition to the word "structure". We use two techniques to give meaning to the word "structure". First, we ask "What is *not* a structure?" This is shown in Figure 1, namely a mass of dough or clay with no fixed shape. Secondly, we ask "What does it mean to *construct* something?", as shown in Figures 2 and 3.

When trying to understand the meaning of a noun like "structure", it often helps to first think of the meaning of the verb form of that noun, in this case "to construct".

The main idea is that you start with raw materials like heaps of bricks, sand, cement and wood, which have *no purposeful shape*. Then you construct something from these raw materials to *give it a purposeful shape*.

LB pages 88–89

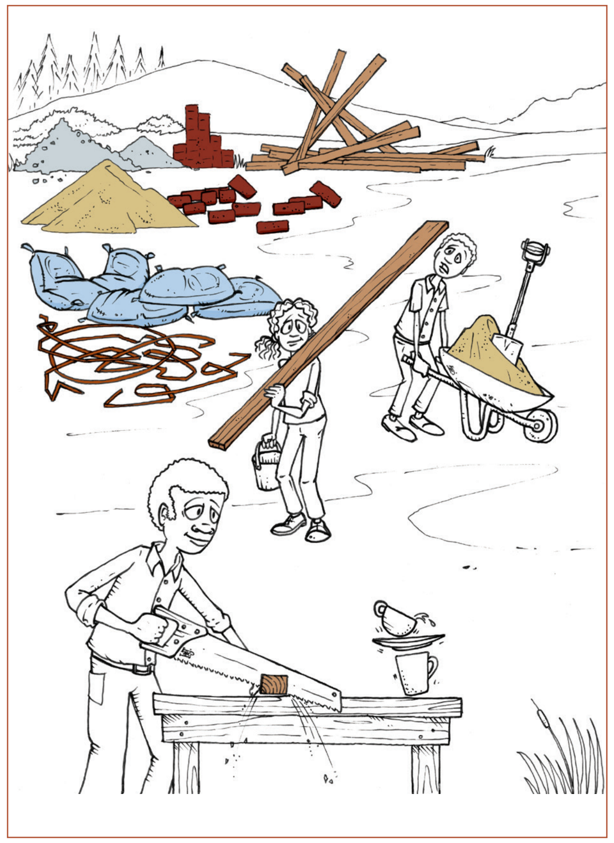


Figure 2: What does it mean to construct something?

Figure 3: What does it mean to construct something?

Although the words solid, frame and shell structure help us to describe many different structures, *there are some structures that cannot be well described with these words*. For example, (a) A termite mound (see Figure 8) is made of solid earth, but it has tunnels and holes inside it. Is it a solid structure or a shell structure? (b) A grass basket (see the bottom right of Figure 3) is made of grass *woven* together. Is this a frame structure? If some learners point out these problems, you should *not* try to correct them by saying that there can only be solid, frame and shell structures. There are not enough words to describe everything in real life. That is why languages need to grow by making new words to describe more things.

LB page 90

8.1 Things called structures

Questions about structures around you LB page 90

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?

   Learner's own choice of an object

2. What is it used for?

   Learners should write a simple description of the object. Remember that one of the important aims of this chapter is for learners to develop their language skills to describe objects.

3. Can it be used to keep certain things in one place, so that they do not lie around all over the classroom?

   This answer will depend on the item.

4. Can it be used to protect something, for example, to protect it from sunlight or wind?

   This question will probably relate to items outside the class.

5. Is it used to support something?

   This answer will depend on the item.

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.

   In this question, the answers may not be limited to structures that support humans. Tables, chairs and shelves are internal examples; bridges, pylons and masts are external examples.

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 LB page 91

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.

   Bags of sugar, maize, rice and flour, eggs, tins, a can of oil.

   Packing cases.

2. What else do you need to set up your stall before you can sell the goods?

   A form of shelter: an umbrella, a marquee or an open fronted tent.

   A table or planks to put on the packing cases to make a table.

   A box for money.

   Bags to put the goods in when they are sold.

   The learners must use their experience to come up with their needs.

3. What type of container will the eggs you sell come in?

   Egg cartons, or egg boxes.

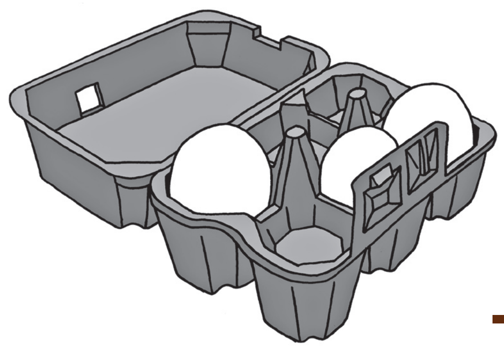


Figure 7

LB page 92

4. Why are eggs packed in special containers such as the one in Figure 7?

   To protect them from breaking when being transported.

5. If you wanted to make a table from the two empty crates, what else would you need?

   Planks of wood to put across the crates.

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 will you make another plan?

   No, for the flour you would give her a paper or plastic bag.

7. What will you use as "containers" when you sell maize, rice, sugar and flour to people?

   a paper or plastic bag

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

8. What will you use as a container to sell oil?

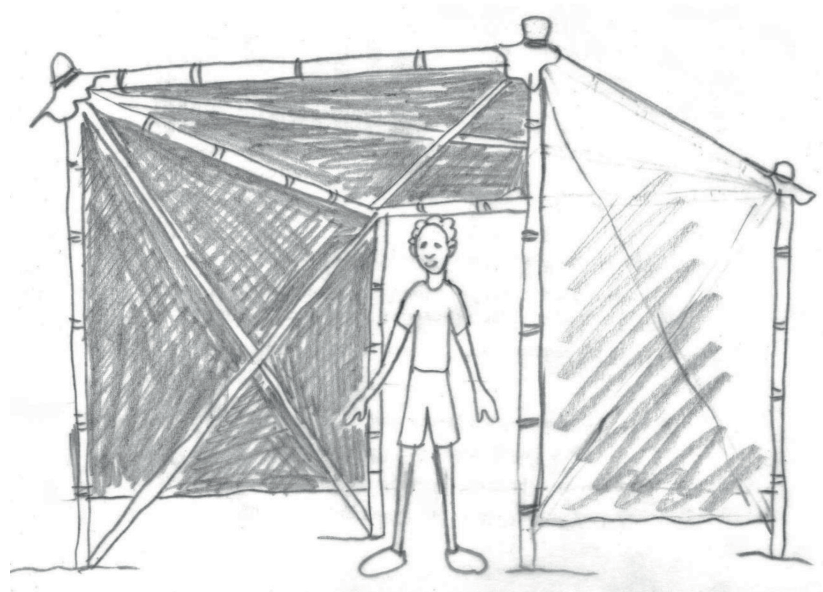
   a plastic or glass bottle

9. What did you decide to use to span the two crates to form a table, when you answered question 5 above?

   The learners must repeat the answer in Q5.

10. How will you protect yourself and the goods you sell when it rains? Draw the **structure** that you will use for protection.

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?

    Examples: A garden shed. A covered bridge. A chest of drawers. A cupboard. Scaffolding. An electricity pylon. Again, the learners can use their imaginations to think of other structures.

LB page 93

8.2 Man-made and natural structures

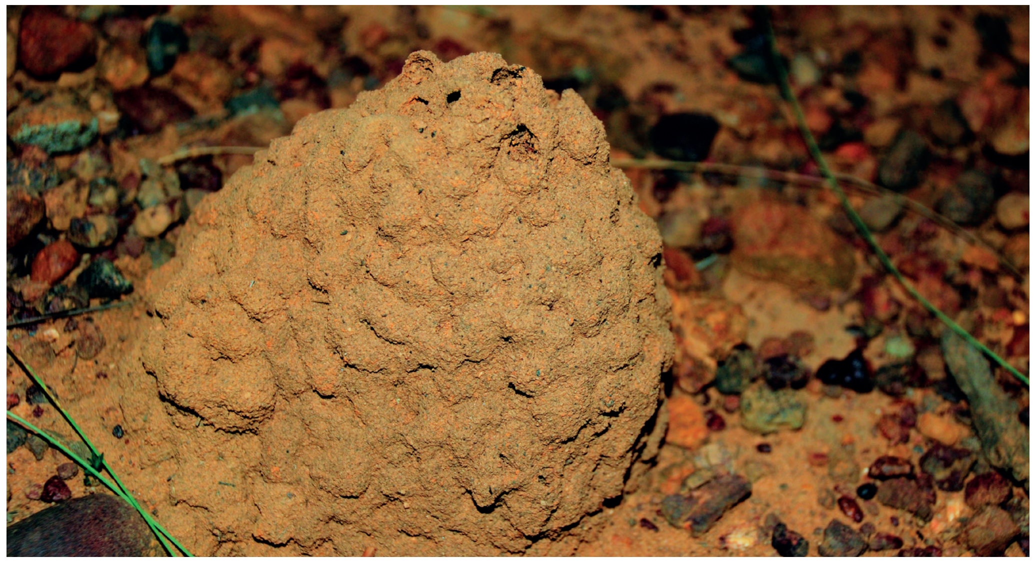


Figure 8: A termite mound

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 termites 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.

LB page 94

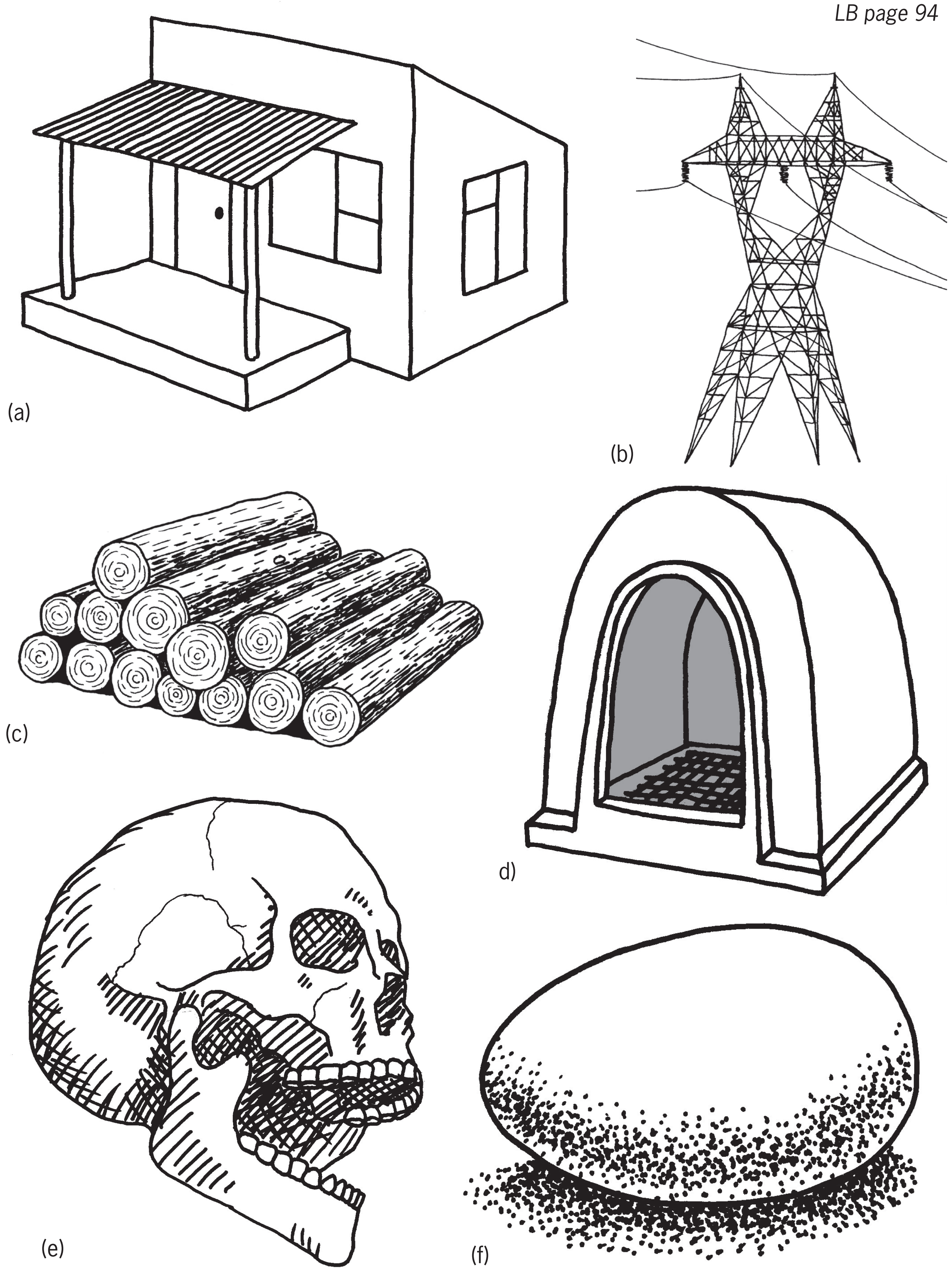


Figure 9

LB page 95

Figure 10

Classify structures LB page 96

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
house	skull
pylon	egg
chair	tortoise shell
cell phone	rocks
cell phone or radio tower	plant
oven	spider web
woodpile	beehive
brick	

2. What other natural structures can you think of?

   Examples: Beehives, cocoons, caves, waterfalls.

3. Name any three man-made structures that provide protection.

   Examples: Houses, tents, bus stop shelters.

4. Name any three man-made structures that provide support.

   Examples: Electricity pylons, bridges, chairs.

5. Name any three man-made structures that contain things.

   Examples: Cupboards, cardboard boxes, bottles.

8.3 Types of structures

LB page 97

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.

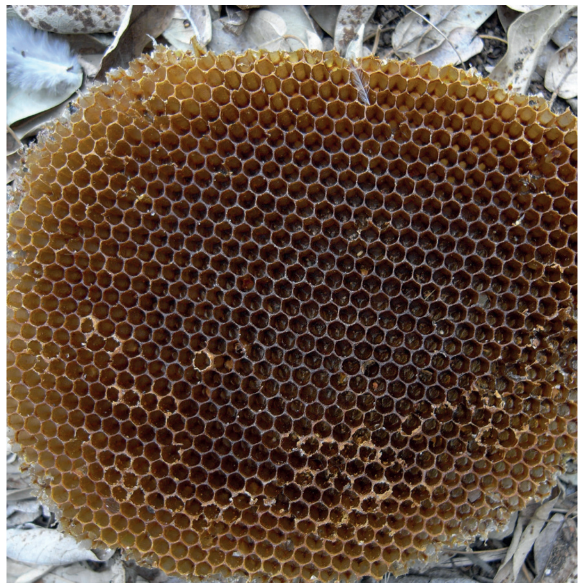


Figure 12: Bees store their honey in honeycombs.

Figure 13: A rubber tyre is a shell structure.

Figure 14: A coffee mug is a shell structure.

LB page 98

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.

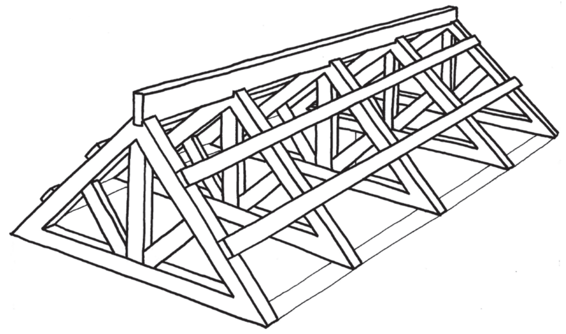


Figure 15: This roof frame is a frame structure made from wooden planks, a natural material. The planks support the roof.

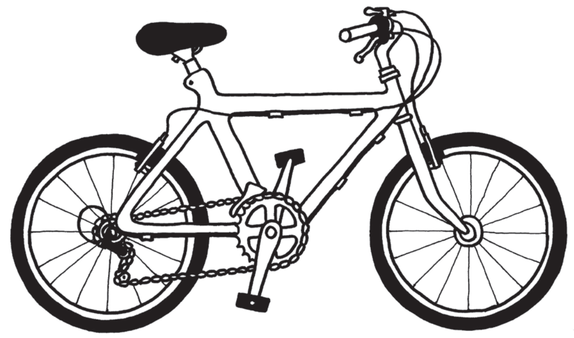


Figure 16: A bicycle frame consists of different metal pipes.

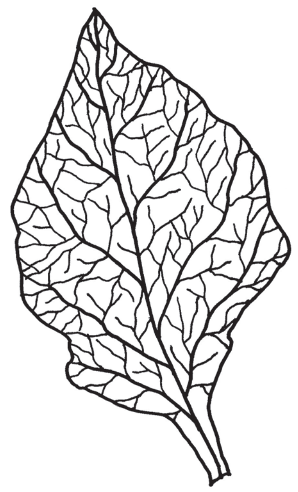


Figure 17: A plant leaf. Look at its veins. They form the frame of the leaf.

LB page 99

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

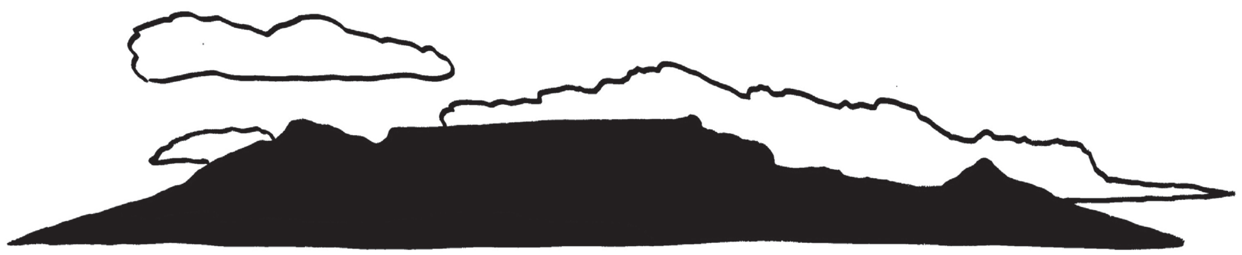


Figure 19: Table Mountain

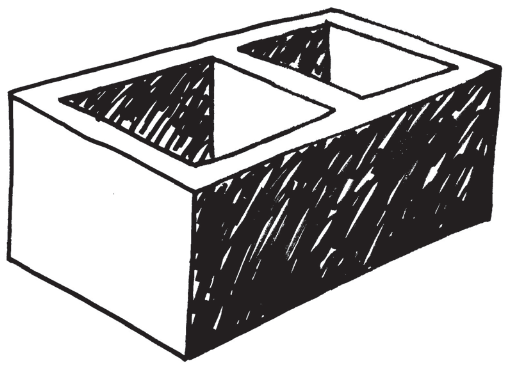


Figure 20: A cement brick

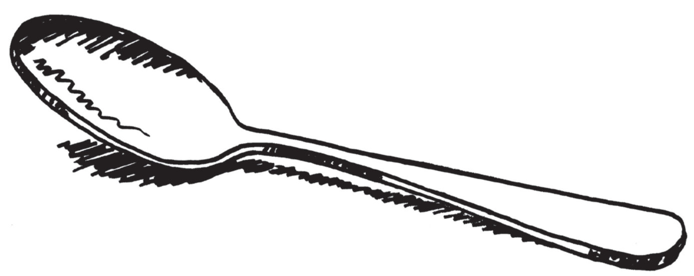


Figure 21: A teaspoon

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

LB page 100

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.

Shell structures	Frame structures	Solid structures
Human skull	House	Brick
Chicken eggs	Electricity pylon	Wooden logs
Bath tubs	Cell phone tower	Rocks
Cups	Garden chair	Concrete pillars
Bowls	Spider web	Iron beams
Vases	Dog kennel	Foundations for buildings
Bike helmets	Chairs	Roof tiles
Basins	Tables	Cutlery
Rubber tyre	Bridges	Gold bars
Coffee mugs	Cranes	Steel railway line

Let learners compare their answers.
Note that it often happens that the same structure contains elements of shell, frame and solid structures.

Support for water tanks — LB page 100

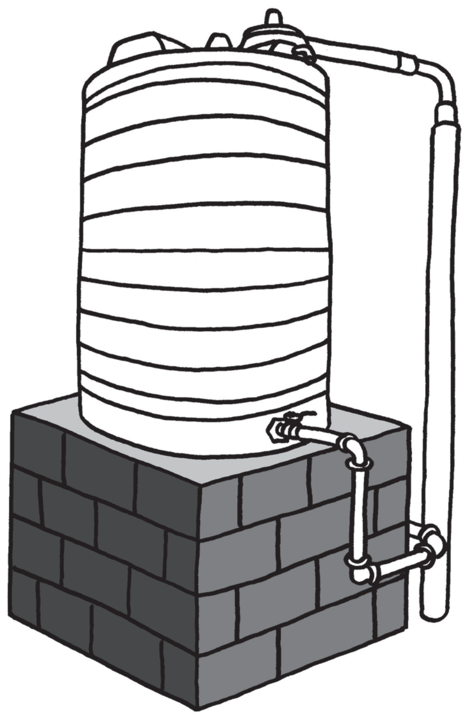


Figure 22: A water tank on a solid brick stand

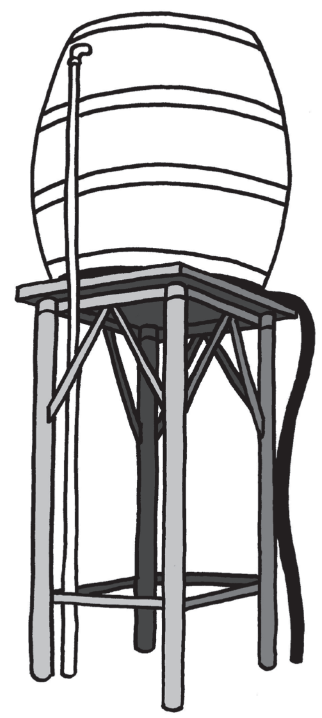


Figure 23: A water tank on a metal-frame stand

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.

   Figure 22: A water tank is a shell structure to contain water. A solid brick stand is a solid structure to support the weight of the water tank. Pipes are shell structures to let water in and out of the tank.

   Figure 23: The same as Figure 22, except that the weight of the water tank is here supported by a metal frame structure.

2 Compare the support structures for the two water tanks.

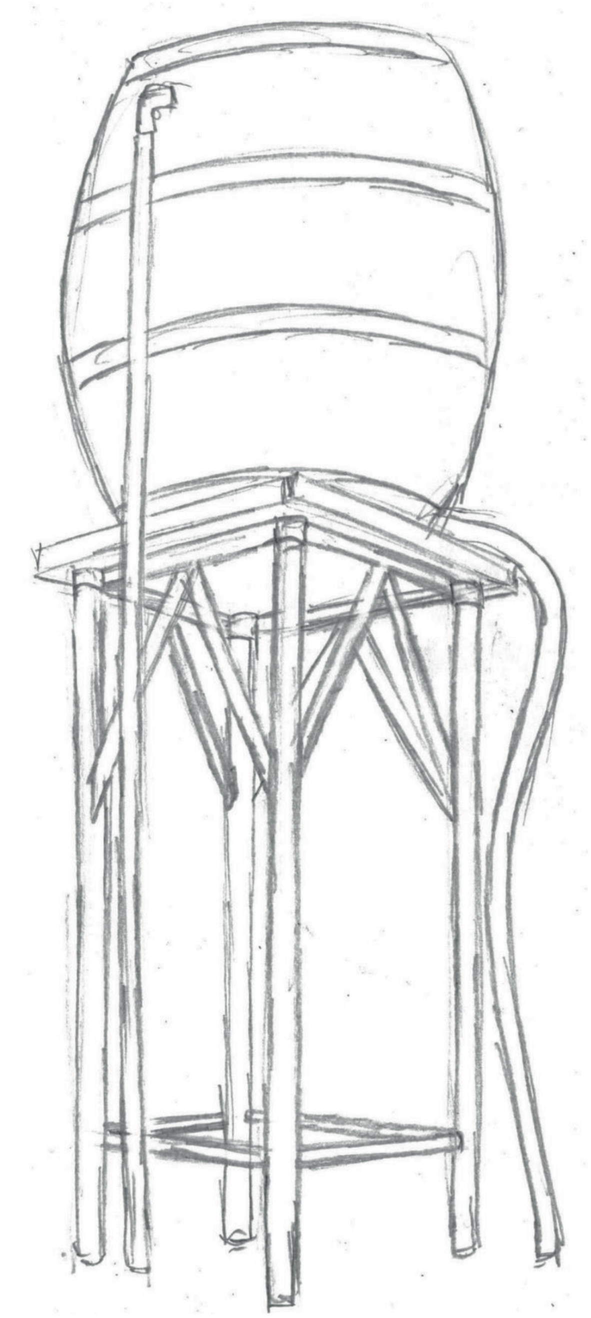
(a) Which stand is a solid structure and which stand is a frame structure?

Figure 22 – Solid; Figure 23 – Frame

(b) Which stand do you think is the stronger of the two? Explain why you think so.

Figure 22: The solid structure gives more support, because of how it is built, it is wider and lower. Another advantage of the solid stand is that it won't rust.

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

LB page 101

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.

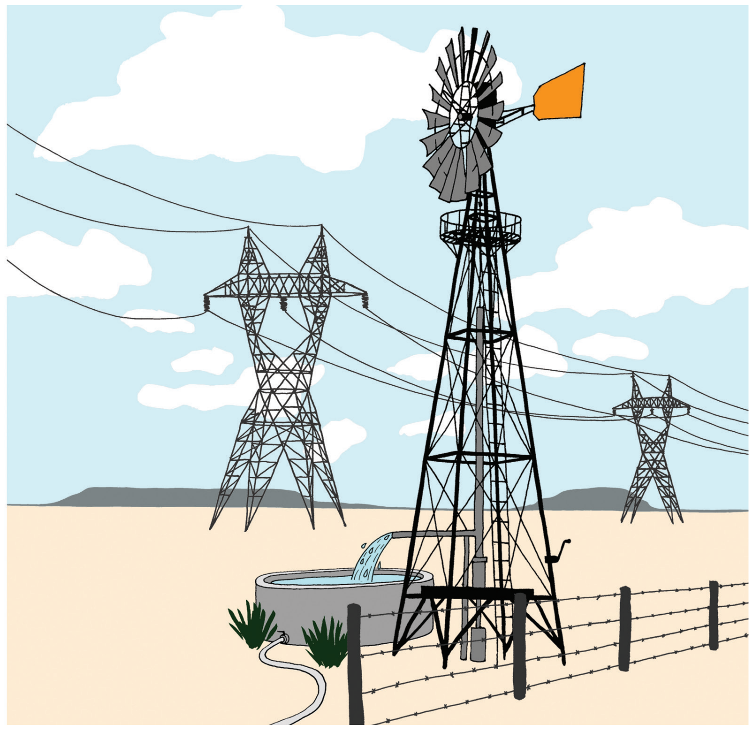


Figure 1

This chapter builds on knowledge gained in the previous chapter. Learners find out more about frame structures such as cell phone towers, windmills, pylons and mine headgear. They learn how these structures are designed and built so that they are strong enough, and find out how the materials used in building these structures can be made stronger. They also *investigate* the advantages and disadvantages of landline phones and mobile phones, or cell phones.

Materials and tools required for this chapter:

- sheets of A4 paper (preferably waste paper intended for recycling),
- masking tape or sticky tape
- cardboard (e.g. used cereal boxes)
- glue
- scissors
- thin wire or string
- a nail (to punch holes in cardboard)

9.1 Strong frame structures

The first few illustrations show different frame structures. Man-made structures shown are electricity pylons, a cell phone tower, a frame underneath a water tank and a windmill. A spider web is shown as an example of a natural structure, as learnt in Chapter 8. To review what they already know, the learners can identify everyday examples of frame structures. These can include tables, chairs and desks that are found in homes, offices and classrooms. They will learn that fences, gates and bridges are frame structures, as well as scaffolding that is used when new structures are built or when existing buildings are maintained.

The man-made structures have all been strengthened using diagonal members that create triangles: this is called **triangulation**. Learners find out that frame structures are made strong and stiff or rigid through triangulation. The activities are designed for learners to *analyse* and *compare* as they work through them. The learners should work in groups to talk about and discuss their observations. They will work out the answers by completing the activities.

9.2 Communication systems

The illustrated case study serves as an introduction to this lesson. Learners have to identify the advantages and disadvantages of landline communication to mobile (cell phone) communication. They have to compare the two systems. Allow for discussion and critical thinking. There is no definite better or worse, or no definite right or wrong answer.

9.3 Action research: Strengthening structures

This lesson has been designed to develop the learner's practical skills, critical thinking and problem solving. Learners will discover that the properties of materials can be changed and improved. They will make materials stiffer and stronger. Flat sheets of paper will be changed to make them suitable building material for models.

Activity 1. This should take the learners about 10 minutes. It focuses on stiffening paper through tubing. It guides learners through the process of making strong, firm paper tubes. Paper tubes can be used to build most of the models from Grade 7 to Grade 9.

Activity 2. Learners work in pairs to stiffen cardboard by folding. The activity should take between 5 and 10 minutes. During this investigation, learners will find out that a folded piece of card cardboard is stronger than a flat piece, i.e. a piece that has not been folded. Impress on them to follow the instructions carefully.

Activity 3. Make shapes stable and strong. Allocate at least 15 minutes for this group activity. Groups construct a square shape using paper tubes. They manipulate the square and discover that it does not hold its shape. Once they add another diagonal tube to form two triangles, the square stays stable. By doing so, they discover the purpose of triangulation, which is to stabilise frame structures. They continue to build the five-sided (pentagon) and six-sided (hexagon) shapes, push and pull them and add additional tubes to ensure that the shapes become stable and hold their respective forms. They continue to complete the written exercise.

LB pages 102–103

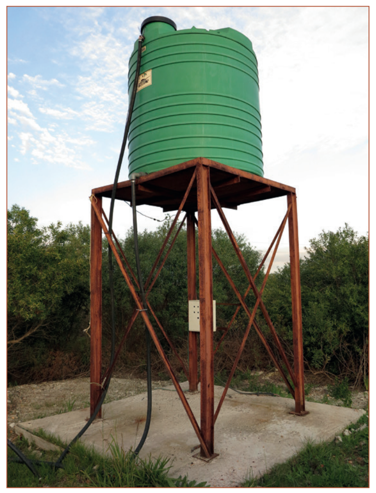


Figure 2

Figure 3

LB page 104

9.1 Strong frame structures

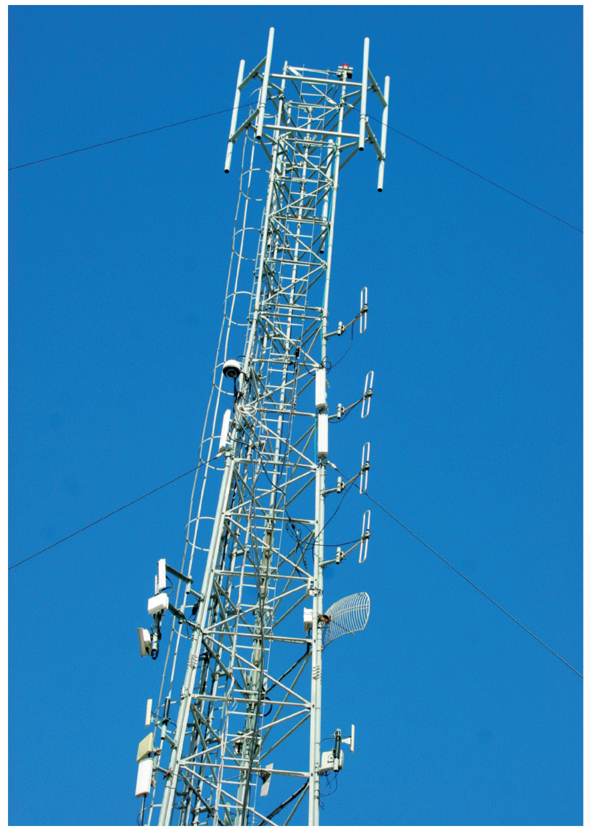


Figure 4: Cell phone tower

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.

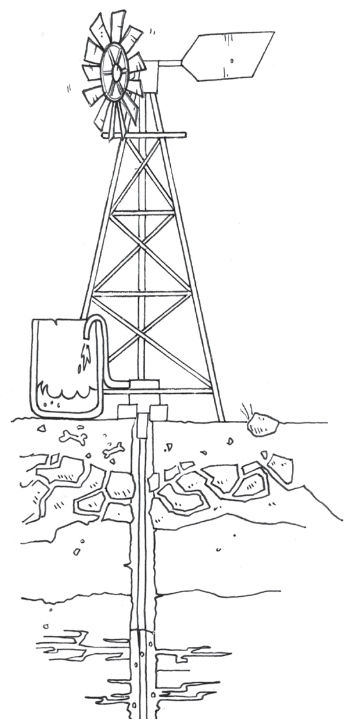


Figure 6

Examine towers LB page 105

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-har

   The learners should draw triangular struts as illustrated here.

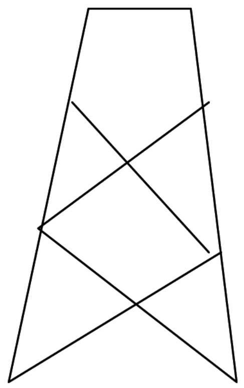


Figure 7

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

   So that the tower will be firm, remain standing and not fall over.

More questions about the structures in towers LB page 105

Figure 8: Electricity pylons

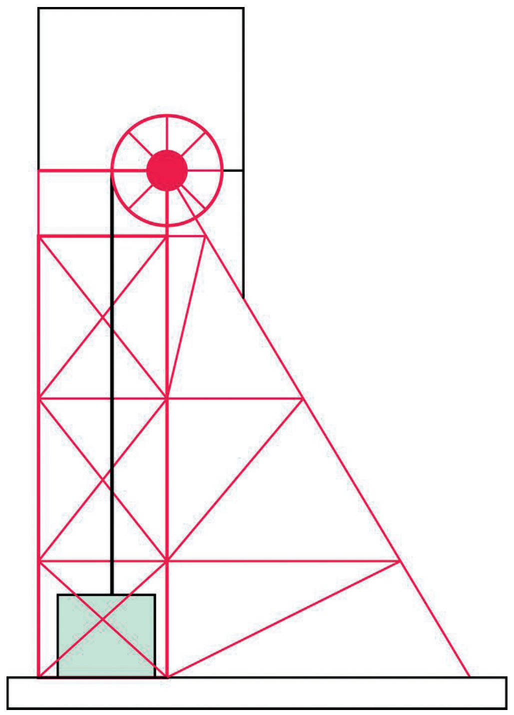


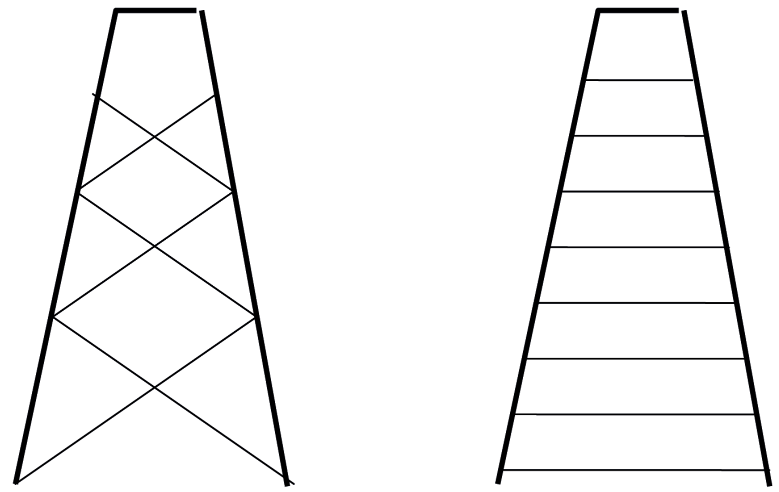
Figure 9: Mine headgear

LB page 106

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 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?

   10 triangles on design A. No triangles on design B.

   Bottom centre of A is not a triangle unless you take the ground level into account as a side.

   Top centre of A is a pentagon, 5-sided shape.

3. Why do you think there are triangles in the towers?

   Triangles makes the tower stiff and strong (rigid) to hold its shape.

LB page 107

9.2 Communication systems

Landlines or cell phones: Which is better? LB page 107

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.

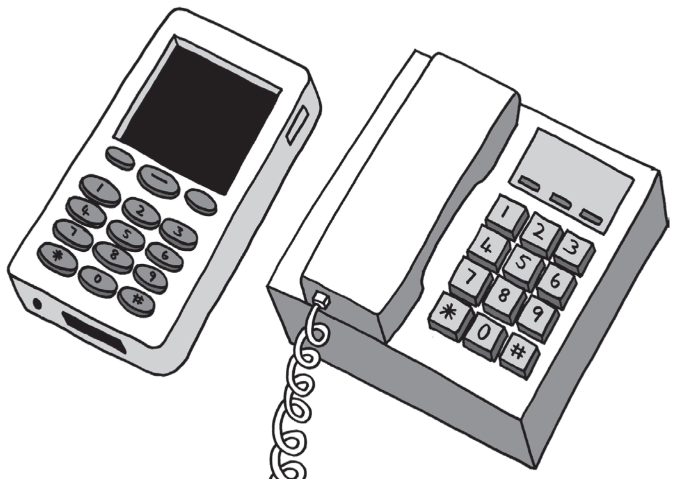


Figure 13

Read the conversation on the following two pages.

1. Why can Mavis not hear what Thomas is saying?

   Because her phone cannot pick up the signal from the cell phone tower. The mountain is blocking the signal from Mavis' cell phone to Thomas' cell phone.

2. Phillip and Lebogang enjoy their conversation. Why are they not experiencing the same communication problem as Mavis and Thomas?

   The landline carries the signal across all the barriers without being blocked.

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	Cheaper for local calls Can call directory services on 1023 for free or use the directory to find numbers Most businesses have landline phones Good connection even in bad weather or where there are overhead electricity cables	Can check time update on 1026 but it costs Cannot be used away from home No text messages No internet connection No radio or camera Expensive for long distance calls Can only be used on home/business premises
Cell phones	Cheaper than landline over long distances, pay for length of call (duration) not distance Can be used anywhere where there is a signal not necessarily from home Can send text messages Built in clock Has radio connection Most have cameras Many can connect to the internet	Expensive for local calls depending on length of call; pay for duration No directory service Poor connection in bad weather or close to overhead electricity cables No cell tower receiver/transmitter, no connection

LB page 108

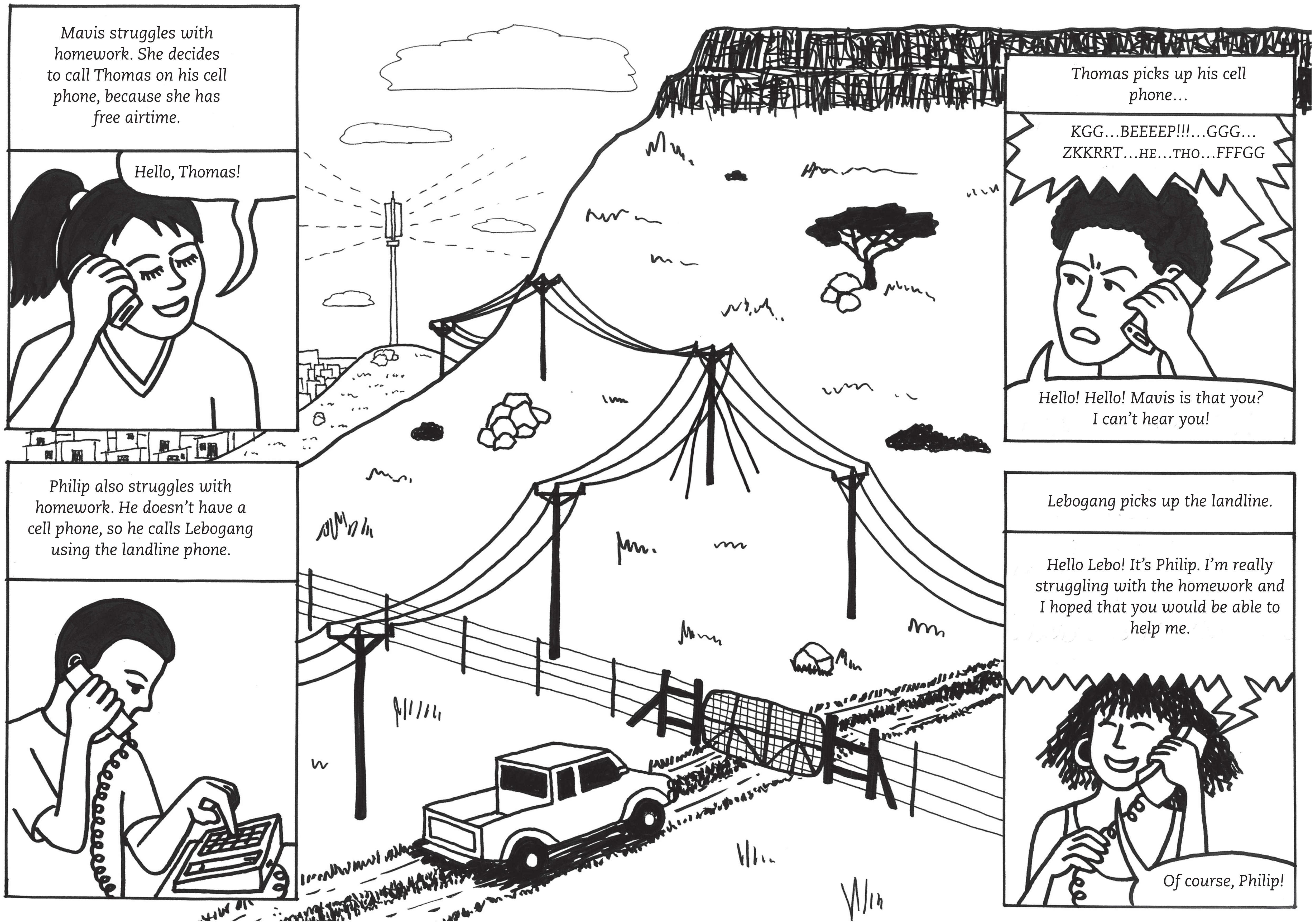


Figure 10

LB page 110

9.3 Action research: Strengthening structures

Some materials are not suitable as building materials, but their properties can be changed and improved to make it 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 LB page 110

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.

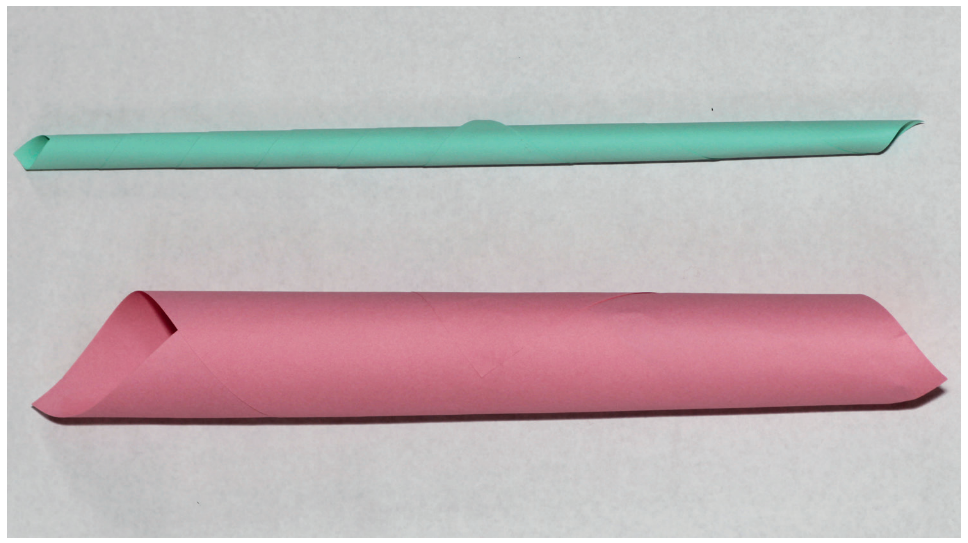


Figure 14

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?

the tube with the bigger centre ....

LB page 111

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
1 ½ 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.

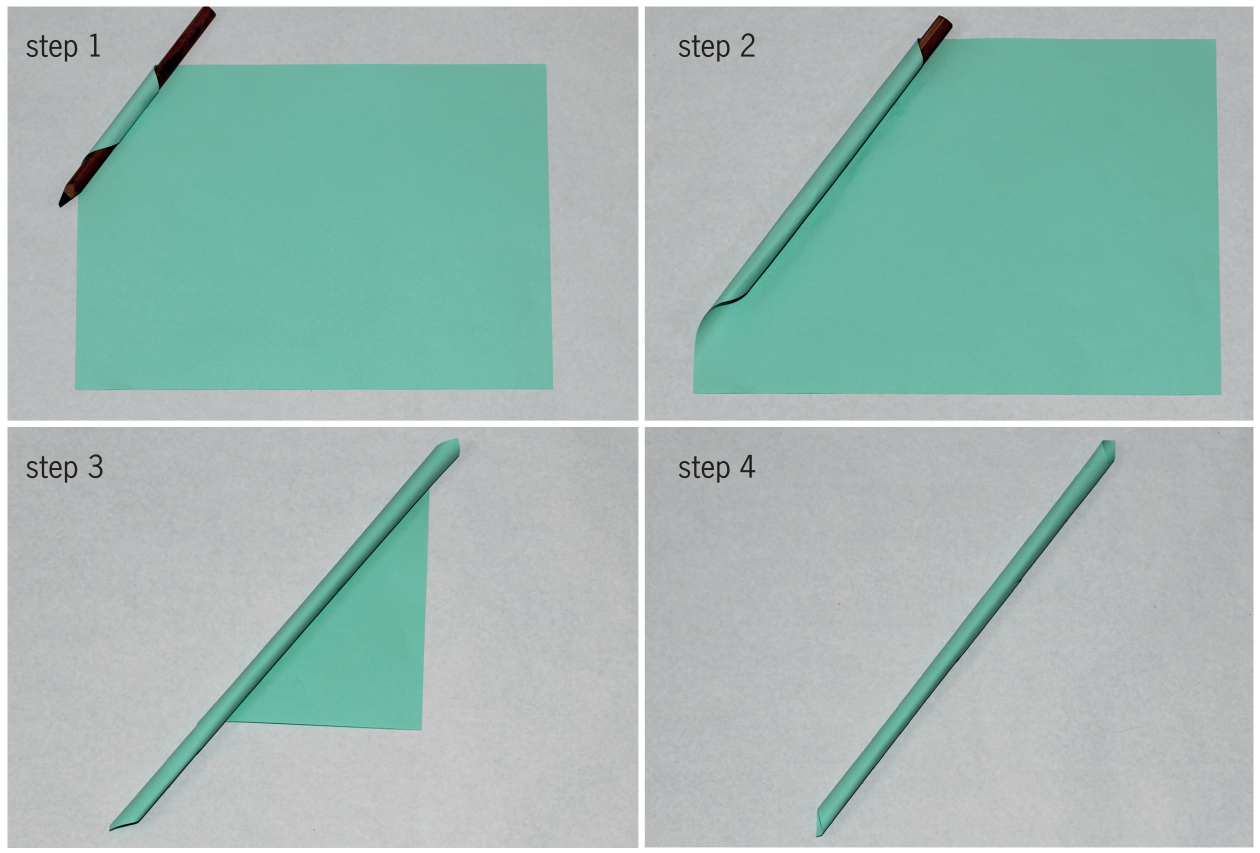


Figure 15

Activity 2: Stiffen cardboard by folding — LB page 112

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:

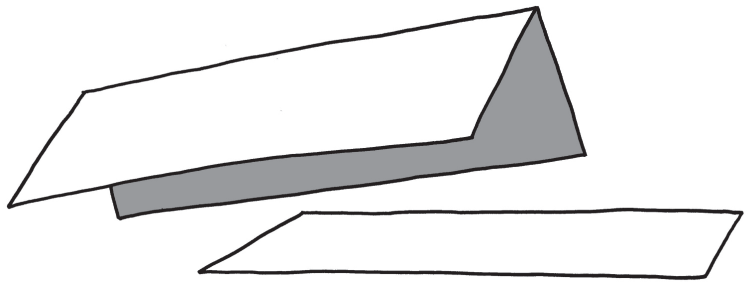


Figure 16

1. Which of the two pieces of cardboard will bend more easily?

   the flat unfolded piece

   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.

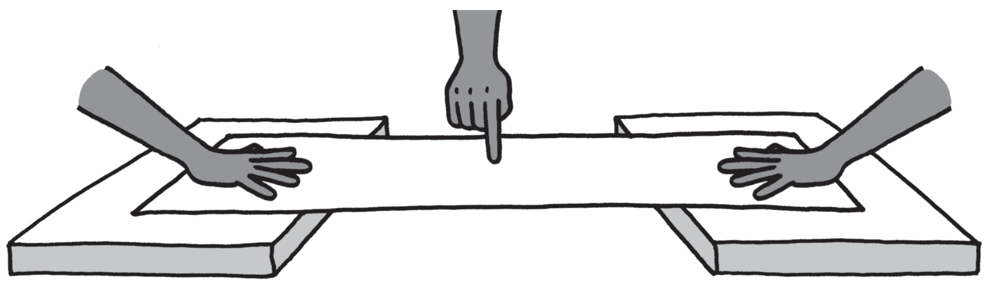


Figure 17

Do the same with the folded strip.

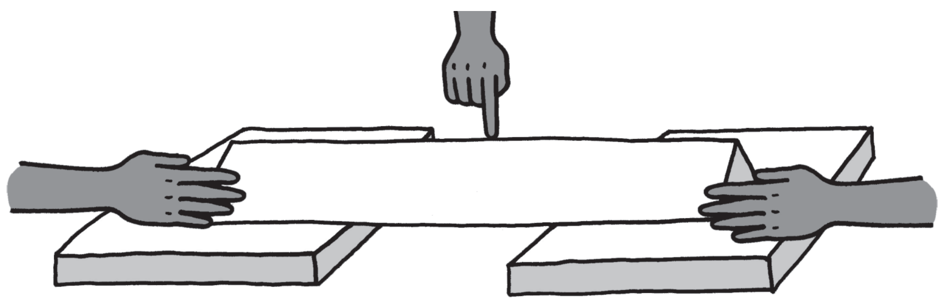


Figure 18

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

   the flat strip

Activity 3: How to make shapes stable and strong — LB page 113

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.

3

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?

   Yes, it can be pushed to form different sloping shapes. The shape is flexible and unsupported. It becomes distorted. Distort means it has been changed from how it was originally.

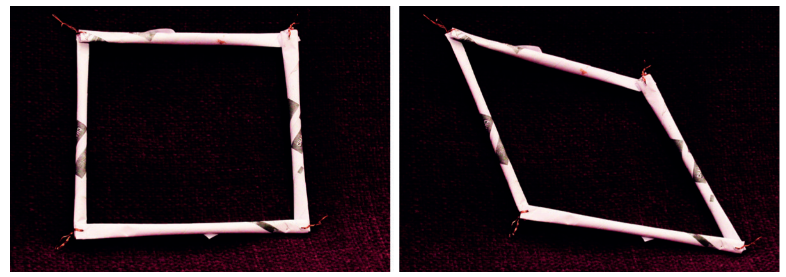


Figure 19

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?

   No, the square retains its square shape. It is sturdy, rigid and strong.

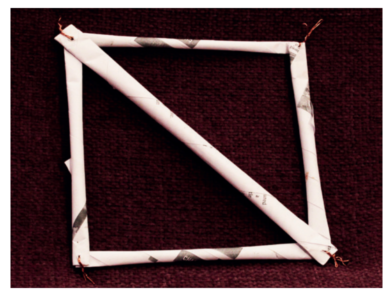


Figure 20

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 below. 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) Test your shapes once you have added the extra paper tubes. Are they both stable?

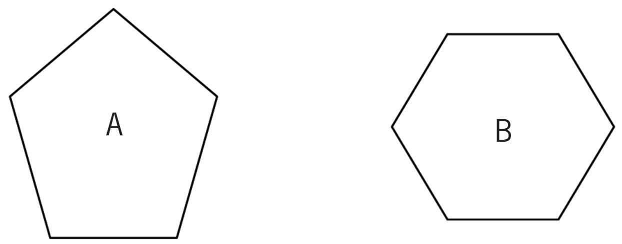


Figure 21

LB page 114

5. Copy the two shapes. Draw where you would add extra paper straws to create triangle shapes.

6. How many paper struts did you use to turn shape A into triangles?

two ....

7. How many paper struts did you use to turn shape B into triangles?

three ....

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 below is of one side of a bridge. It is not finished yet. Copy and complete the drawing to show how triangulation will be used.

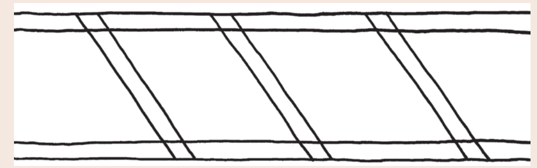


Figure 22

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? See what happens.
(f) Which frame collapsed first? straight sided frame
(g) Explain why the other frame was firmer.

Triangles were formed – triangles withstand forces well.

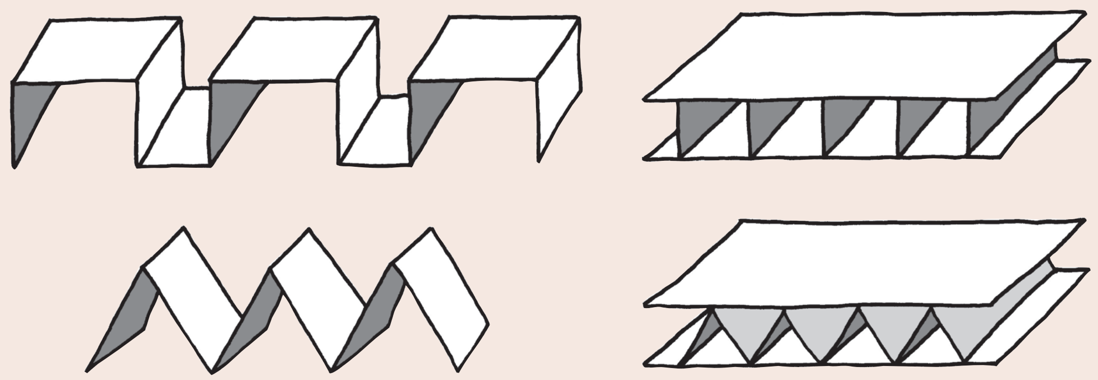


Figure 23

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

LB page 115

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

In this chapter, learners will learn about **design issues**.

Design issues arise when any **structure** is being planned. The learners will explore the issues that must be considered when designing structures like cell phone towers, bridges, buildings or power stations. These issues include the *purpose* of the object or structure, the *cost,* and how individual people, communities, society as a whole and the environment will be affected, in other words, the *impact* of designs on society.

During this chapter, the learners will *study* cell phone towers and *identify design issues* including visual pollution, the base size, stability of the tower and the centre of gravity of the structure.

They will write a *design brief* with specifications for a school desk and *make* an oblique drawing, *evaluate* their own design brief, and formulate more design briefs.

Materials and tools required for this chapter:

writing materials, e.g. pen, ruler, eraser, pencil (HB), pencil sharpener

sheets of A4 paper (preferably waste paper intended for recycling)

masking tape or sticky tape

10.1 Why do cell phone towers look like as do?

The learners *study* illustrations of different cell phone towers. Each tower has been designed to focus on a different **design issue**. Learners *investigate* issues such as visual pollution, stability and base size.

In addition, the learners examine the centre of gravity using practical examples. They learn about low and high centre of gravity and which of these produces a more stable object. They identify ways of preventing a structure from falling over and learn more about foundations.

The questions will enable the learners to understand the issues clearly, and give you the opportunity to ensure they understand how important it is to take centre of gravity into consideration when designing any structure.

10.2 Things tower designers think about

Learners *formulate questions* to ask the mayor, the municipality, and the community to gain the information needed before a cell phone tower can be erected in that community. Any **'fit-for-purpose'** questions will help to ensure that they do not start off with an unsuitable solution.

10.3 Give clear instructions

In order to give the learners practical experience, they will examine their own desks and formulate a *design brief* with *specifications* for a school desk. They should ask questions such as:

- Who is it for?
- What is the use/purpose?
- Will it do the job? Is it value for money/cost-effective?
- Is it safe to use?
- Is it easy to use? (Ergonomics)
- Does it fit the person it is meant for? (Ergonomics)
- Does it look good? (Aesthetics)
- Will it affect society?
- Will it affect the environment?

The learners must understand that these questions are crucial to the design of the desk. They will write a *design brief* based on the answers to these questions. The design brief, plus an oblique drawing of the designed desk, will be sent to the 'factory manager' that will make the desks. Consolidate the learners' understanding of a design brief, the specifications and oblique drawings. A *design brief* tells us what the problem is, who will use the solution or who will benefit from it, but not what the solution will be (the drawing, however, will show the solution). The *specifications* are a list of what must be included and what the solution must do.

Learners *evaluate* the design brief and specifications and continue to answer a set of questions. The questions aim to identify any information they may have missed. They also make an oblique drawing of their proposed desk design.

They follow on this with another *design brief* and *specifications* for a cell phone tower or an FM radio. This activity is aimed to consolidate their knowledge and further develop the learners' skill in formulating design briefs and writing specifications.

LB page 116

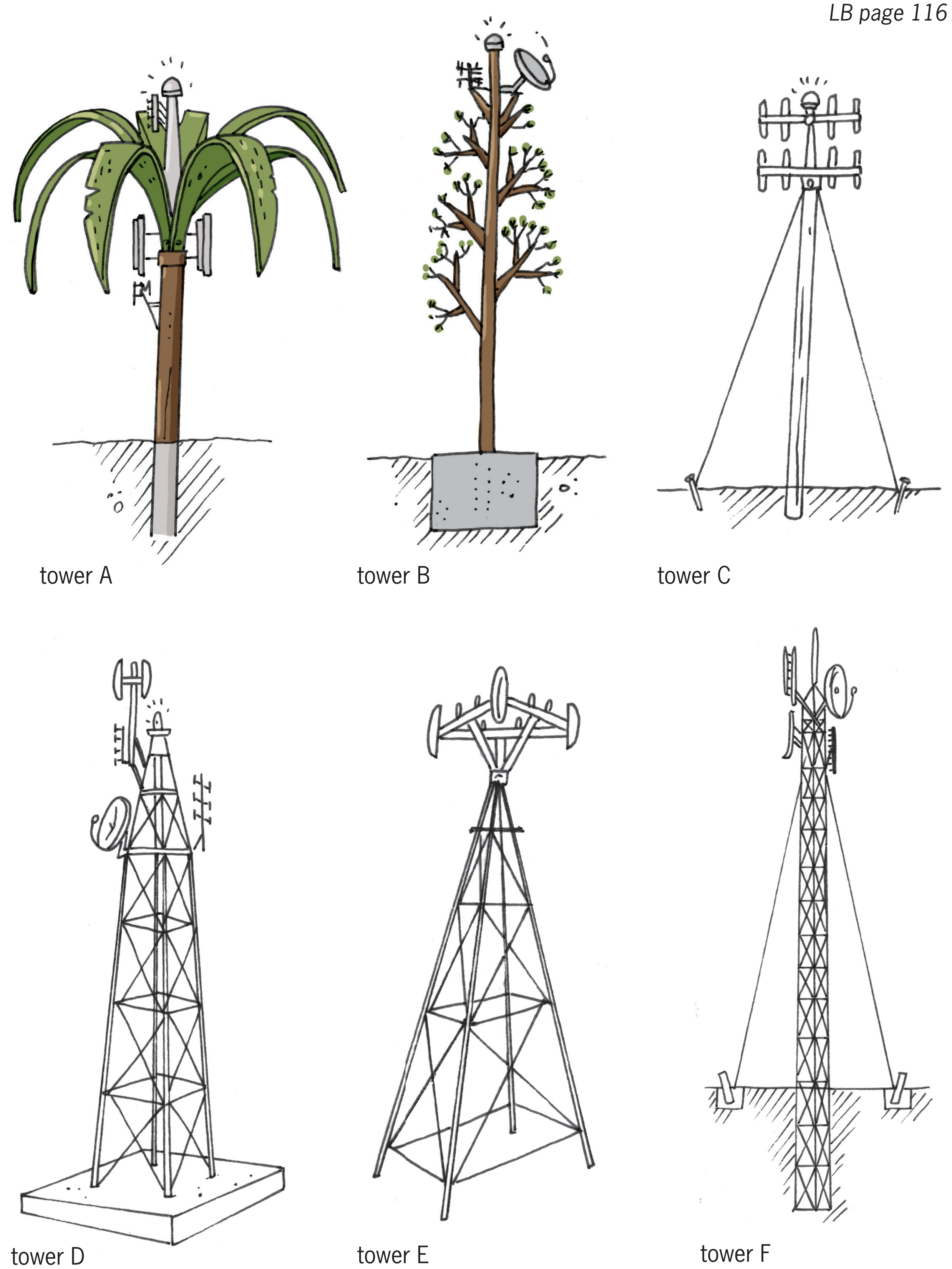


Figure 2

LB page 117

10.1 Why do cell phone towers look as they do?

Examine a few cell phone towers — LB page 117

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

1. Why do you think tower A was designed to look like a tree?

   to fit in with the surroundings/the environment

2. Why does tower C have cables, while tower D has no cables?

   C has cables to keep it upright and stable, so that it does not fall over. D has a foundation and the base is broader than the top, this keeps it stable

3. Why will tower A not topple over and fall, even when the wind is strong?

   its foundation underground is deep

4. Why does tower D have a large concrete block at the bottom, while tower E has no foundation?

   D has a concrete foundation to anchor the tower. E has a much broader base than D. The broad base makes it stable.

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?

   E. The broad base lowers the centre of gravity and keeps it stable enough to not fall over.

6. Which of the towers do you think is most unstable? Why do you think so?

   C. Cables are not as effective as foundations.

Investigate the centre of gravity — LB page 118

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

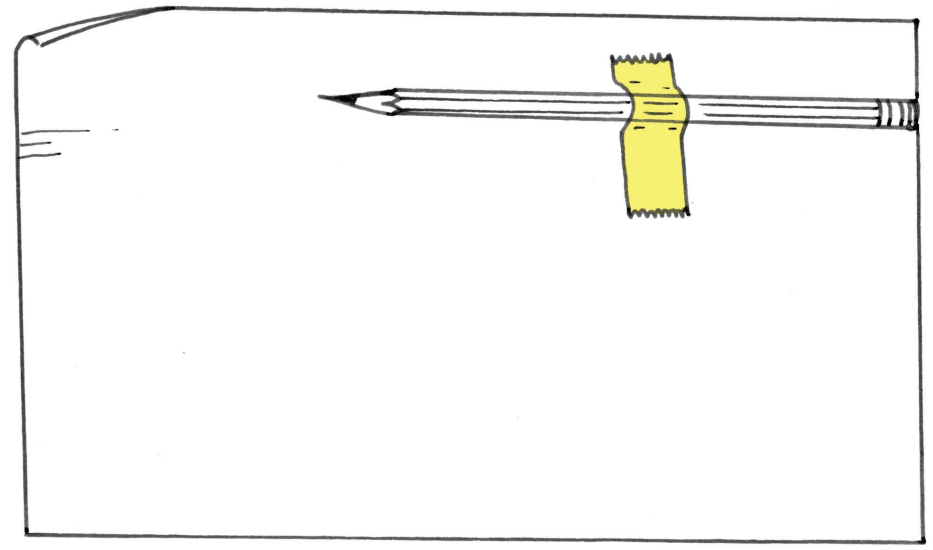


Figure 3

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.

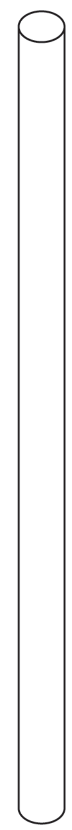


Figure 4

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

   The end where the pencil is, is more stable, it is heavier, i.e. has a lower centre of gravity.

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?

   low

3. Which tower on page 155 (Learner Book page 116) has the highest centre of gravity?

   C

LB page 119

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.

   A: deep foundation

   D: heavy object at the bottom

   C: cables

   D: wider base, heavy object at the bottom

   E: wide base

   F: cables, deep foundation

5. Strong foundations help to keep towers from falling over. Which towers have foundations under ground level to keep them stable?

   A, B and F

6. How do the underground foundations differ from each other?

   A: narrow, deep concrete foundation

   B: wider, heavy concrete foundation

   F: narrow metal foundation

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?

   The metal towers are frame structures, and not solid structures like the other towers. Frame structures need triangulation to make them stable. Solid structure do not need that (but solid structures are heavier).

LB page 120

10.2 Things tower designers think about

What questions will you ask? LB page 120

Suppose a new cell phone tower will 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.

For example:

Where is the best place to put the tower, where all residents will receive the signal?

How can it fit in with the environment?

How can it look good and not cause visual pollution?

What can be done to make it cost-effective?

What materials will be used?

How will it be stabilised/anchored?

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

LB page 121

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.

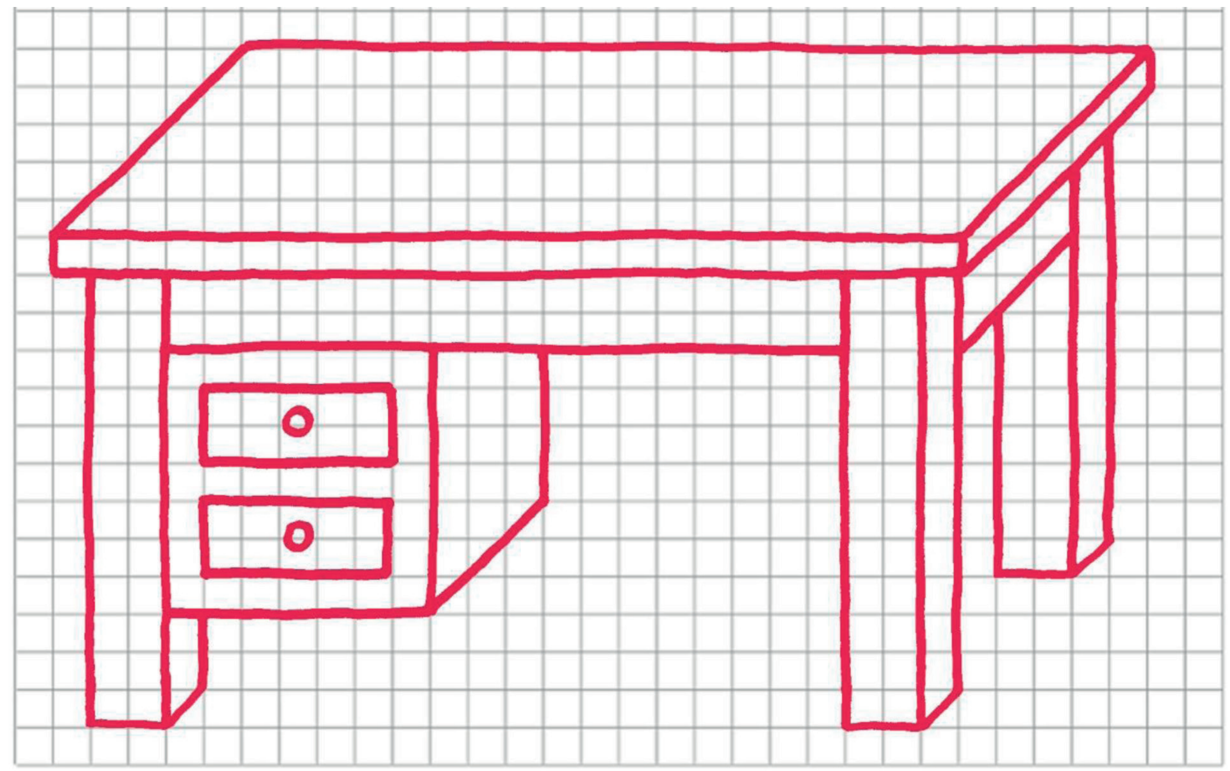
Check that the sketches are workable. Make sure learners' notes include :

- What the school desk should look like,
- How big and strong it should be (for younger or older learners),
- What materials it should be made of, and
- What features it must have.

Once you are satisfied that the learners have covered all the design issues, they must use the information from Q1 to write a design brief. This will be neater and more structured than their notes. Make sure that they follow a logical progression, with all the necessary steps. They will use this information for Q3 as well.

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.



The learners draw an oblique plan of the desk. See example.
Drawings must be labeled - include features (parts) and materials

Checklist	Mark
Does the drawing have a heading?	
Did they start with the construction lines? Are these lines feint?	
Did they project the corners at 45°?	
Did they use $\frac{1}{2}$ the depth measurement to find the rear lines?	
Did they draw the outlines as dark lines?	
Is the drawing neat?	
Does it look like a desk?	

Evaluate and improve your document — LB page 121

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

These questions must be answered based on what the learners have actually written in the design brief. They can either evaluate their own briefs, or they can exchange/swap books with one another and evaluate one another's work.

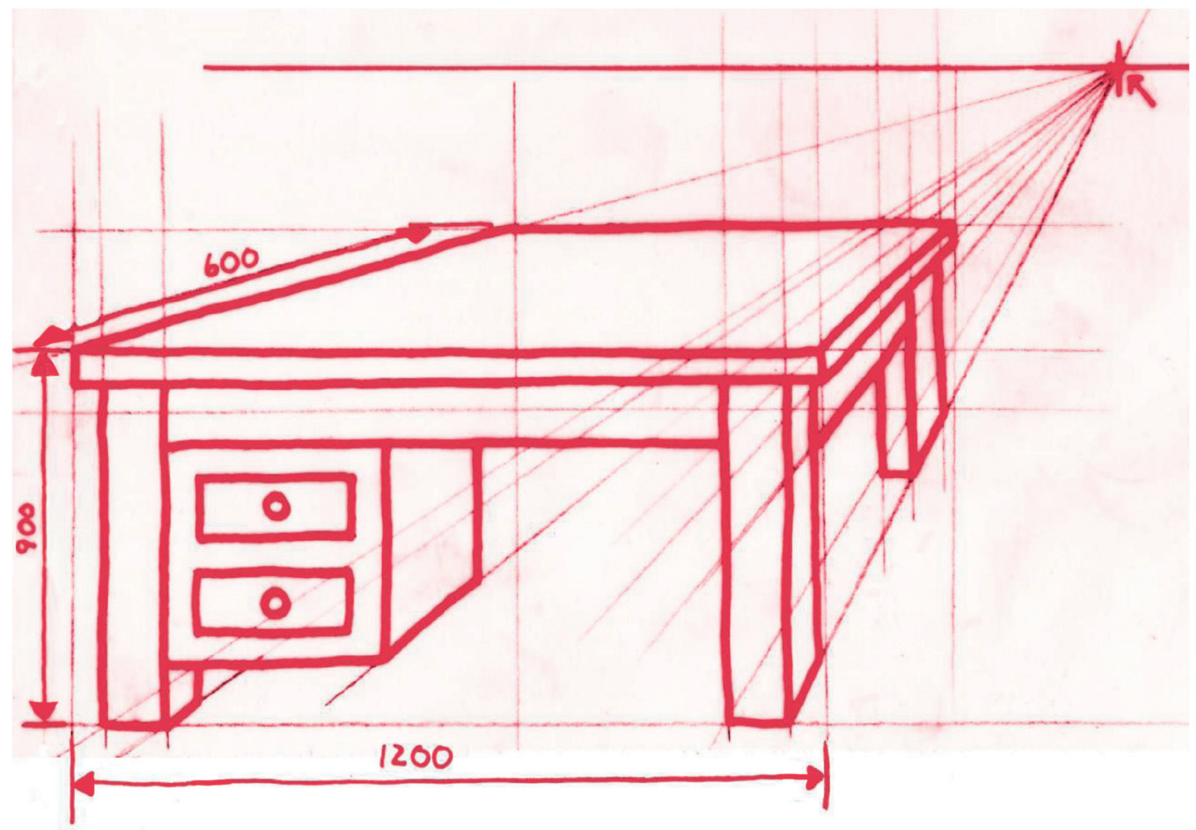
1. Does your document say if the legs of the desk should be made of wood, metal or plastic?
2. Does your document say how wide the desk top should be?
3. Does your document say how high above the ground the desk top should be?
4. Does your document say how smooth or rough the surface of the desk top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

They can now critically review their design briefs for the desk, and rewrite them if they feel they can improve them. They must do the vanishing point perspective drawing. See criteria on the next page.



Single vanishing point perspective drawing
Use plain white paper
Write the heading
Indicate the vanishing point
Draw one view of the desk
Feint lines from front to the vanishing point
Neat
Draw in the horizontal and vertical lines to show the back and outside edges of the desk
Outline of the desk in dark lines
Indicated scale

Write one more design brief and specification LB page 122

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

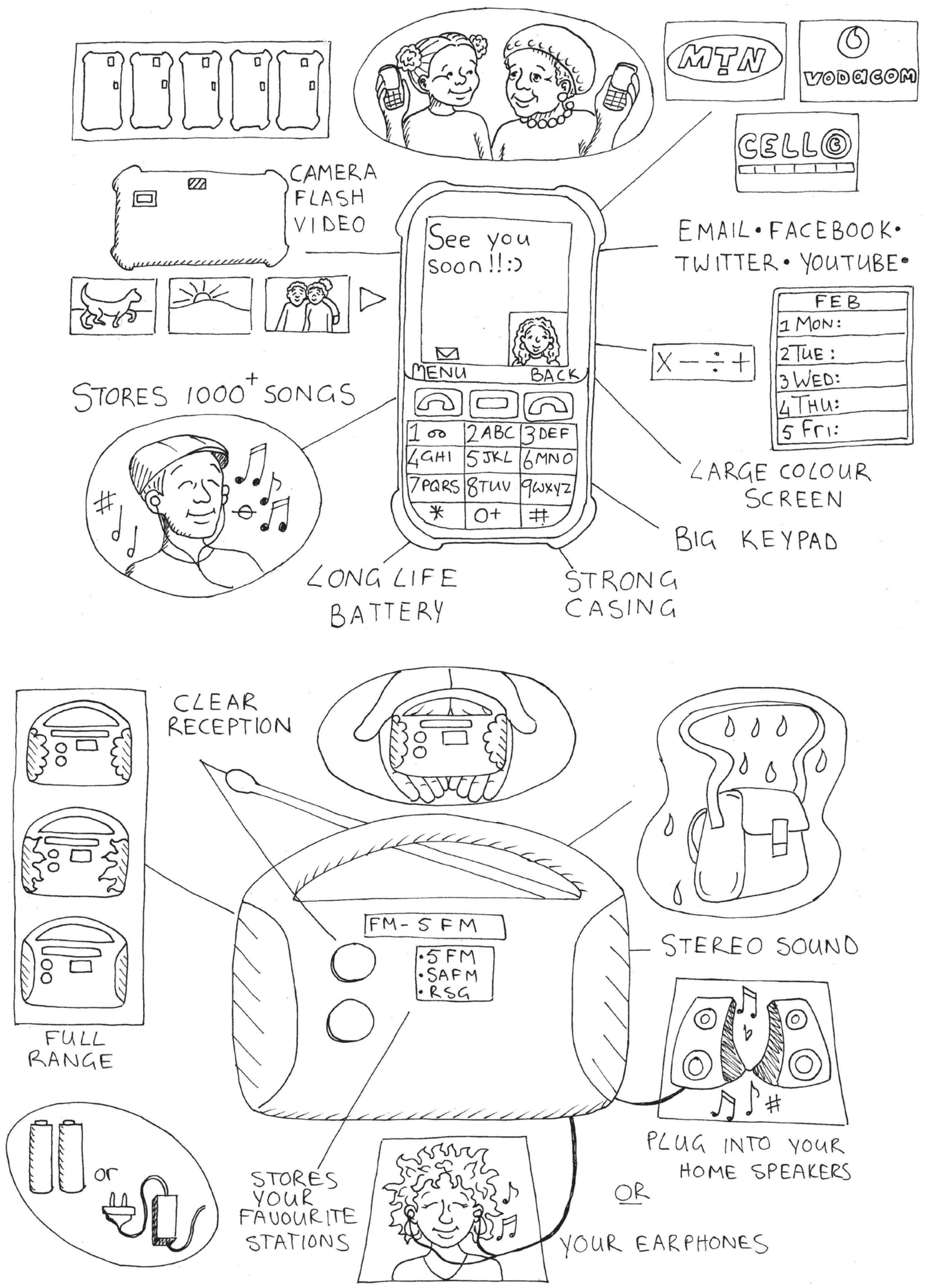


Figure 5

If the learners have time to complete this exercise, you can check their design briefs and sketches and make sure they meet the requirements a manufacturer would need.

Next week

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

Chapter 11 PAT
A model cell phone tower

LB page 123

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]

Over the next six weeks, learners will design and build a model of a cell phone tower. They will work through the different stages of the design process to do this. Learners work individually and in teams designing and building a cell phone tower. Learners become aware of the good and bad aspects of having cell phone reception in their area. It will bring people in the vicinity in contact with the outside world, but the tower could be unsightly, which has a negative impact. Therefore, their tower must blend in with the environment.

Only the individual work will be assessed except when the teams build the model towers. This mark will be shared by all the team members. One of the aspects of this PAT is encouraging the learners to work together as teams, and to appreciate the benefits of cooperative work.

Note: The activities for assessment are prescribed in the CAPS document. Only work done at school may be assessed. Most tasks for assessment are individual. The model, made by the team, must also be assessed. All members of the team will get the same mark for the model.

Materials and tools required for this PAT:

writing materials
card e.g. corrugated cardboard
stiff reeds; thin, straight sticks; or hand-rolled paper dowels
thin wire that can be worked with; paperclips or paper fasteners for joints
glue
rulers
scissors or craft knives
nails or awls
pliers

All tasks/questions are essential for the design process, even if no marks are allocated.

All tasks/questions in the PAT should be completed/answered, even the tasks/questions for which *no* marks are allocated for evaluation. This is because all the tasks/questions are essential parts of the design process. So, if certain tasks/questions are not done, then learners will not be able to do the subsequent tasks/questions successfully.

Week 1: Make a few decisions

The first activity provides learners with the necessary information to successfully formulate a *design brief* with *specifications and constraints*. Remind learners that these are individual activities and for assessment. They must remember to plan for camouflage and strength in order to build a strong, firm model.

Week 2: Compare and evaluate designs

Decide on the formation of the teams beforehand. Learners design their models and make working drawings. They *evaluate* and *improve* their designs. They learn to make strong joints; this is a **skills development activity**. Learners acquire practical expertise and knowledge that they will use when they make their models.

Week 3: List resources and make a working drawing

Learners draw their proposed model and decide in teams what their model will look like. In the first section, they *plan to make* individually, as this activity is to be assessed. This activity is followed up with more team work. It is a good time in the PAT to remind the learners of the benefits of team work, and to use the best ideas that come out of the team's designs.

Week 4: Build the model

This week, teams will build their models. Your task is to ensure productivity and success by monitoring each group and ensuring that all the learners are occupied and involved. Make sure they understand that they only have three hours to build and complete the model so there will be no time to waste. Help individuals that struggle and support groups that become dysfunctional.

Week 5: Finish building

Groups complete tests and make final adjustments to their models. Assess the group's model. Learners make a 2D drawing of one face of their model. Point out to learners that they must take note of the 'criteria for working drawings' before they start their drawings, and again once they completed the drawings. Make sure that their pencils are sharp and their erasers are clean. This is an individual task and for assessment.

Week 6: Plan your presentation

Please note that although the Learner Book doesn't specify it, the learners have to deliver their presentations to the class, and evaluate the other teams' towers and presentations.

Learners develop *evaluation criteria* to evaluate their own models and the models of other groups. Impress on them to be fair when they evaluate the work of others. If they are not fair, their evaluations will not be valid. Instruct learners that every person must take part in the presentations; each one must have a turn to speak. They have to practise the presentations and make improvements beforehand. During this time, make sure that everyone has an opportunity to participate in the presentation.

The learners must deliver their presentations and complete their evaluations of the other groups. Therefore, it is important that **all** groups have the opportunity to deliver their oral presentations, so timekeeping of each presentation must be strictly controlled. This term, they began to develop their presentation skills. Next term, they will do presentations again, a second opportunity to further develop their planning and oral skills.

LB pages 124–125

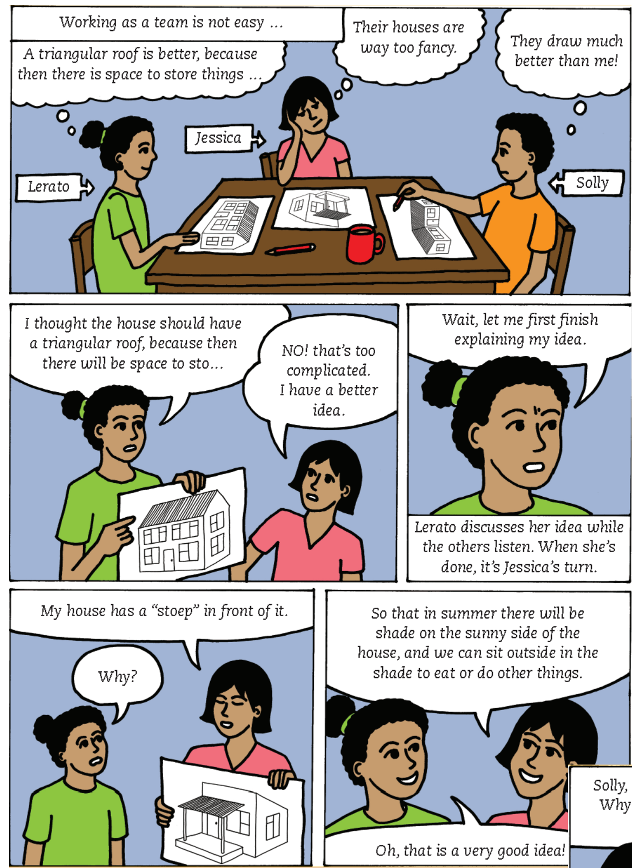


Figure 1

Figure 2

LB page 126

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.

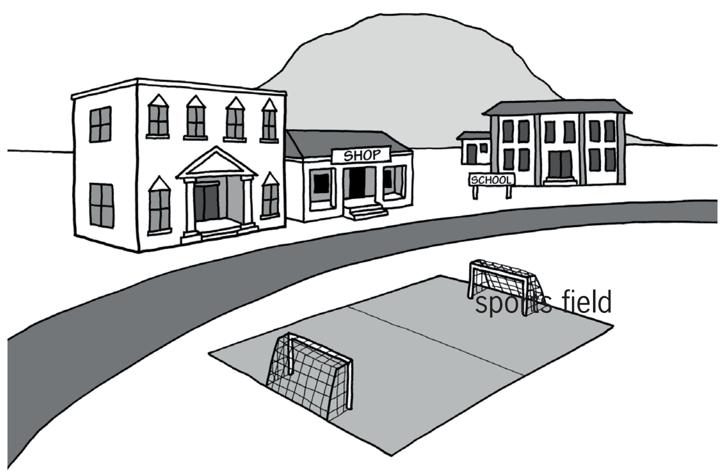


Figure 3

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?

   A or B if placed near the school/ D, E or F if on hill

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.

LB page 127

The tower must be camouflaged/it must fit with the surroundings.

It must look nice next to the school.

It must not look unsightly/ugly.

It must look like a tower.

All the villagers must have reception

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

Note to the teacher: Some people are concerned about possible negative health effects of electromagnetic waves from cell phones, cell phone towers (transmitters), and radio and TV transmitters on humans and other living organisms. Some of your learners may also have such concerns. The concerns have to do with the strength (energy output of 'wattage') of the transmitters. Some of the heat you feel against your ear when you speak on a cell phone for a long time is because of the energy of the electromagnetic waves heating up your phone and your ear slightly.

Cell phones have only been around for about 30 years, but their usage has rapidly increased, which means that a lot more energy is being released by man-made electromagnetic waves. The amount of energy that passes through you depends on how close to a transmitter you are. It increases very quickly when you move further away from the transmitter.

Medical researchers are not yet able to say for sure what the long-term effects are of our modern-day high level of exposure to man-made electromagnetic energy. Many scientists have done studies that could not show that cell phone electromagnetic waves have any negative health effects. Some other scientists say that most of the published studies are paid for by cell phone or communication companies (such studies are very expensive), and they therefore believe the studies were not objective. In short, there is not yet enough scientific information to say for sure that our modern-day exposure to electromagnetic waves can definitely not have negative health effects on the long term.

Many people, and even the laws of some countries, take precautions because of uncertainty about the long-term safety of man-made electromagnetic waves. People will for example talk using hands-free kits or headsets rather than holding a cell phone next to their heads, because the transmitter in the cell phone is then further away from the person. And many countries have laws preventing cell phone, radio and TV towers from being too close to places where people live and work (increasing the height of a tower also moves the source of the electromagnetic energy further away from people).

If some of your learners say a cell phone tower should not be built close to a school or a house because of health concerns, you should point out to them that that is a good precaution, but that scientific research so far has not proven that cell phone radiation is dangerous, although it is possible that future scientific research may prove that it is dangerous.

If some other learners say that cell phone electromagnetic waves poses no risk and that scientific research proves it, you need to point out to them that the scientific studies have so far not proven that cell phone electromagnetic waves is a health risk. But future scientific studies, studying more people over a longer-term period, might give a different conclusion.

All scientists would agree that if you lived in a hut at the top of a radio or cell phone tower, with the powerful transmitters right next to you, would probably not be good for your health! At the least, you will feel quite hot so close next to those powerful transmitters. So the big question really is, how far away is safe enough, or how much time close to it is safe enough?

For this PAT, there is not enough time for a proper discussion about the topic of safety. If learners start such a discussion, allow it for 5 to 10 minutes. But then cut that discussion short, by asking everyone to accept, for the sake of simplicity and precaution, that the cell phone tower will be put on the hill rather than next to any building. Then remind learners to focus on the concerns stated in the problem statement, namely about the appearance of the 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.

Check learners' drawings for the following:
Close to the school/On the hill behind the school
Can choose the type of tower and give reason(s) for that choice.
Neatness of drawing

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.

Rough sketches.
Check the learners' sketches for workability. If they have missed any of the criteria, get them to modify or redo the sketch.

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.

LB page 128

1. **Write the design brief.**
   (a) What is the problem? [1]
   The village has no cell phone reception, it needs to be in contact with the outside world.
   (b) Who will be happy about the new tower? [1]
   most of the people who live in the village
   (c) How will it help them? [1]
   People will be able to phone family members, conduct business over the phone, call the doctor, clinic or chemist when they get sick, etc.
   (d) Now write the design brief. Use the answers of the questions you have just answered. Start your paragraph with:
   I must design and make … [2]
   I must design and make a model cell phone tower to give cell phone reception to all of the people in the village. The visual appearance of the tower should be acceptable to people in the village.
2. **Identify the specifications.**
   (a) How should the tower be designed so that it will not look ugly? [1]
   to fit in with the surroundings
   (b) What should be at the top of the tower? [1]
   a flat platform
   (c) Write down another specification, in your own words. [1]
   platform 10 x 10 cm
   (d) Write down another specification, in your own words. [1]
   made from strong materials

(e) Write down one more specification, in your own words. [1]

model must be stable

Other options: model must be rigid, hold its shape, reinforced with triangulation

3. Identify the constraints.

(a) At least how tall should your model be? [1]

more than 30 cm

(b) How much weight should your model be able to carry? [1]

two A5 textbooks

(c) You can only use materials that you can find around where you live. What are these materials? [3]

stiff reeds, thin, straight sticks or hand-rolled paper dowels

[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

LB page 129

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?

   Any relevant suggestion, e.g. colour paint to fit in, add material that looks like plants or leaves.

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?

   Make a wide base or make sure that it is balanced with anchor ropes or a good deep or wide foundation.

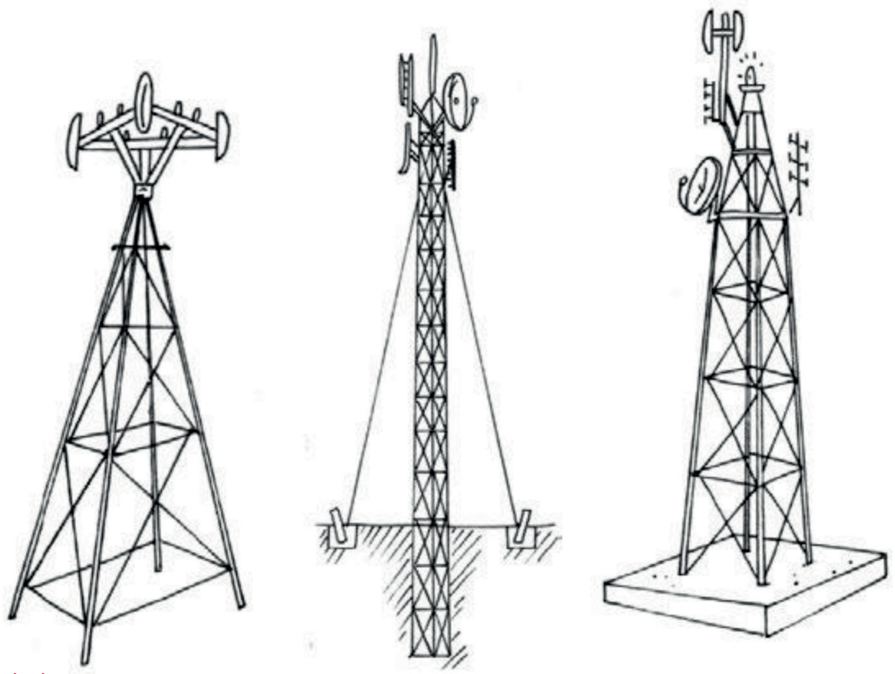
3. How will you make sure that your model cell phone tower is strong?

   Use strong materials to build with; make strong joints; use triangulation.

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

stiff structural elements; good joints

These are three of the sketches from Chapter 10 that the learners can base their ideas of a cell phone tower on. However, they can use their imaginations to come up with other ideas. They must be reminded of the camouflage.



Their sketch has to:
Have a platform on top [1]
Show triangulation [1]
Have a wide base, good deep or wide foundation or cables to keep it stable [1]
Have labelled parts [1]
Identify materials used [1]

[Total: 5 x 4 = 20 marks]

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 drawing with notes below to show your new design. It should be completely different from your first design.

The second sketch the learners do can also be based on the cell phone towers shown on page 116 of the Learner Book.
Their sketch has to:
Have a platform on top [1]
Show triangulation [1]
Have a wide base, good deep or wide foundation or cables to keep it stable [1]
Have labelled parts [1]
Identify the materials used [1]

[Total: 5 x 4 = 20 marks]

LB page 130

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.

Evaluation notes.

The learners must be encouraged to give positive evaluations when evaluating each other's designs. They must consider the design criteria for the cell phone tower and apply these to the designs. The feedback they receive must be noted in their workbooks in this section.

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.

LB page 131

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

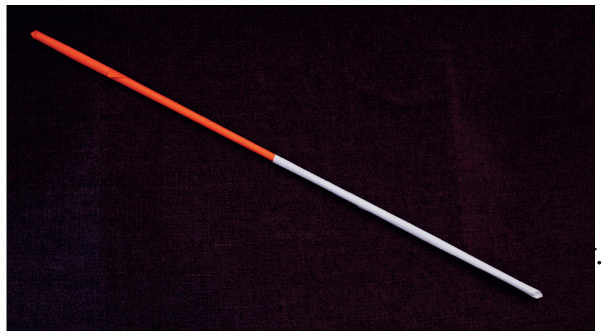
Mix the flour with sugar in a pot.
Add half of the water. Stir.
Add the rest of the water and stir.
Add the vinegar.
Heat until the mixture gets thick and shiny.
Leave to cool.

Look at the photographs on the next page.

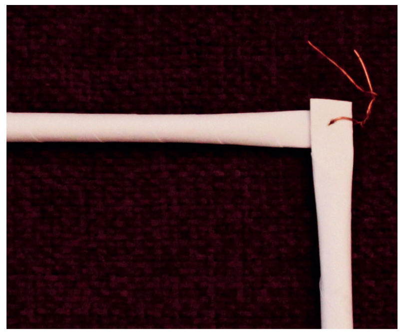
- Partner 1 makes joints A, B and E.
- Partner 2 joins straws, as shown in C and D.
- Partner 3 joins three straws with a paper "gusset", as shown in F.

Leave the joints overnight or longer, until they are completely dry. You will come back to these joints later.

LB page 132

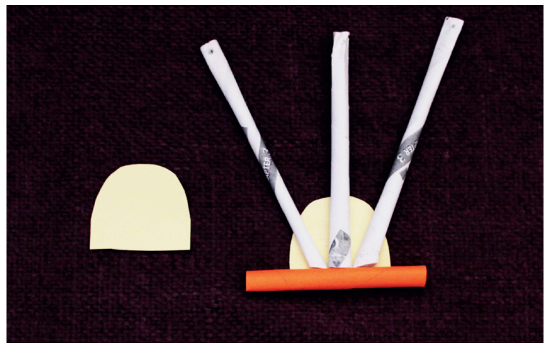


A. Joining two straws by pushing one straw into the other one

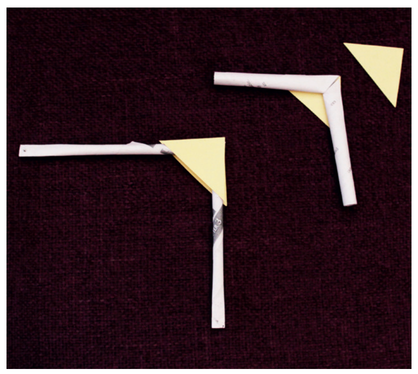


B. Joining two straws by pasting with glue

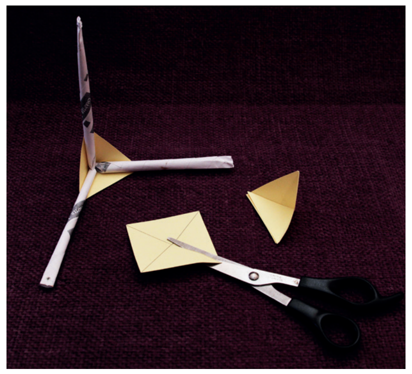
C. Using wire to make a joint



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

Choose and use the right tool for the task you need to do. If you don't have the right tool close by, then rather wait until you have fetched the right tool. If you cannot find the right tool, then change your design so that you can make it safely with only the tools that are available to you.

Scissors are made for cutting sheets with your hand holding both handles whilst closing it. Do not try to use one blade of a pair of scissor as a knife – many people have cut their fingers whilst trying to do that! If you need to cut on a flat surface with a knife, then fetch a craft knife to do that.

If you have not used a certain kind of 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.

LB page 133

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.

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

Any appropriate materials e.g. paper dowels, card, glue, material to join ....

dowels for example sticky/masking tape, pins, paper clips, paper fasteners, ...

thin wire. ....

2. Make a working drawing of your model. Your drawing should show what the model will look like from one side. 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 learners make their working drawings, based on the design they have chosen as a team.

The drawing should show what the model will look like from one side, in 2D.
The drawing must indicate dimensions. The learners must use rulers to make sure that the scale is correct in the drawing: 1:2 scale.

The drawing should be half as big as the model will be.

The different parts must be labeled to make construction easier.

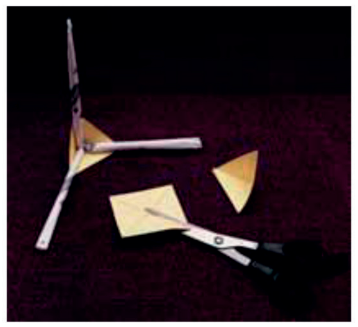
The learners must note what the parts and the joints are made of.

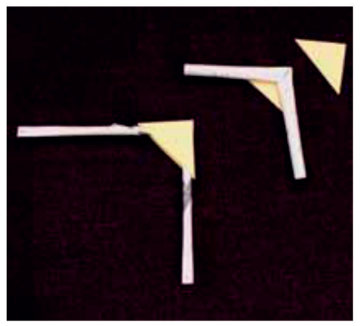
Form a team and choose a design (30 minutes)

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 can 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.

The learners must refer back to Figure 6 on page 132 of the Learner Book to make the drawings of the joints they are going to build. These two pictures give good guidelines.





The learners must make a drawing as accurate as possible to the final model. This drawing must be of the model they are going to build, not of a cell tower. They can practise with rough sketches on spare paper beforehand so that they have a clear picture of what the tower is going to look like, and how it will be made.
They must include all the materials, the dimensions, and label the parts accurately. It must be to scale 1:2. Remind the learners that they must divide the actual measurements by half for this scale.

LB page 134

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]

   Examples of materials they will need:
   glue
   thin card
   sticky tape or masking tape,
   stiff reeds; thin, straight sticks; or hand-rolled paper dowels.
   soft wire, paperclips, or paper fasteners for joints.

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]

   Examples of tools they could use:
   pliers
   scissors
   a nail or an awl to punch holes.

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]

Examples of answers:

Use the tool for the purpose it was designed for.

Carry scissors with blades facing down.

Hand scissors to someone with you holding the blades.

When using a knife, be extra cautious; the blade must always face away from the user.

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.

Step 2.

Step 3.

Any steps in logical order. Here are some suggestions:

Join dowels to make them longer than 30 cm

Join dowels to make the framework.

Make foundations.

Build side pieces of tower.

Add triangulation.

Measure and cut platform.

Attach platform to frame.

Camouflage with …(whatever material or design they have decided on).

Test model's strength with two A5 textbooks

Learners should write down six or more similar suitable steps.

[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.

LB page 135

First build the tower without the platform.

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

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.

You must evaluate the learners' models based on the criteria below.
Ensure that there is fairness in the process of marking between the teams.

Criteria	Beyond expectations 4	Yes, met 3	Not totally met 2	Hardly met 1
More than 30 cm tall				
Platform on top				
Strong, firm, rigid, holds form				
Carries weight of 2 A5 textbooks				
Camouflaged				

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.

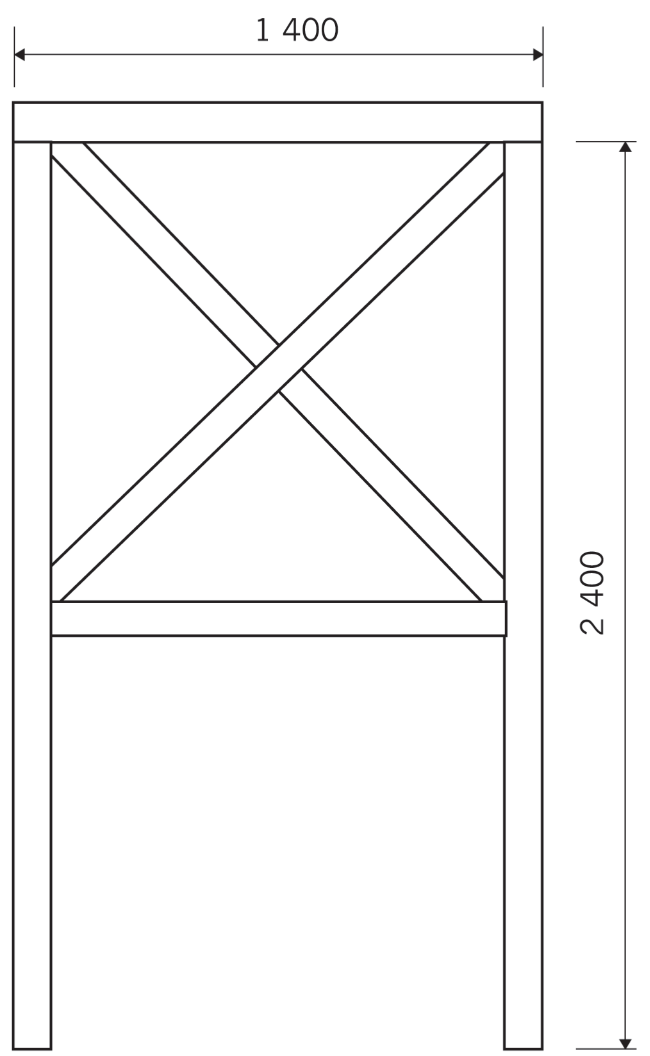
If you have forgotten how to do working drawings, go back to the work you did in Chapter 2 to remind yourself. You can also look at the working drawing of a water tank stand on the next page.

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

LB page 136

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 have to write mm, because designers always use millimetres on working drawings.	
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

Working drawing.
The learners must follow the criteria on page 136 of the Learner Book when making these drawings. Assess them based on this criteria.

LB page 137

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.

The learners must evaluate each other's designs and towers under your guidance.

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 that 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.

The learners must change each of the above criteria into a question they will ask, and write the question in the evaluation sheet. They must work as a team. This task forces learners to state the criteria in their own words – they paraphrase the criteria. This helps them to develop their language skills about technology, and it can also help them to understand the criteria better. Examples of how the questions can be worded are given below.

- Is the model 30 cm tall or taller?
- Does the model have a flat platform on the top? Is this platform a square that is 10 cm by 10 cm in size or smaller?
- Does the model fit in with the surroundings? Is it camouflaged well?
- Does the model use triangulation to reinforce it?
- When you put two A5 books on the platform, does the model keep its shape (is it rigid)?
- When you put two A5 books on the platform, does the model stay upright (is it stable)?
- When you put two A5 books on the platform, are none of the materials of the model damaged (is it strong enough)?

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

LB page 138

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.

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.

2. Write notes about what you will do.

In this answer, the learners must have considered the points in the section above. The items below are examples of what they must note.
- They must plan the process of the presentation carefully; what will be oral (the background and the difficulties) and what will be demonstrated on the model (the outcomes).
- They must have the content of the presentation written out.
- They must know who is going to deliver which part.
- They must note the time they have for each part of the presentation

3. Practise your presentation. Then give your presentation during the last period of the week.

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

LB page 139

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!

Materials and tools required for this chapter:

pen, pencil and eraser
paperclips
ruler
magnets of different shapes and sizes
iron filings

The text in the Learner Book gives only a short and partial explanation of magnetism, so that learners don't have to read too much. However, learners may ask intelligent questions, which cannot be answered by the text in the Learner Book alone. To be able to answer such questions from learners, you should read on to the end of the teacher notes.

12.1 What is magnetism?

Learners practically *investigate* the strength of magnetic forces, using different magnets. They also think about everyday uses of magnets.

12.2 Permanent magnets and magnetic fields

Learners read about the difference between a "permanent" and a "temporary" magnet. They also find out that the Earth itself has a magnetic field. They then do practical *investigations*, which help them to visualise a magnetic field using the idea of magnetic "field lines".

You should explain Figure 4 after learners have looked at it for the first time. The learners see the bar magnet hanging so that its north (N) pole points towards the top of the picture of the Earth globe. There is a point at the top of the globe called the geographic North Pole. On a globe model of the Earth, the whole ball spins around that N pole point, and of course, the other point at the bottom of the ball represents the south (S) pole.

However, you also see a small black circle around the geographic N pole – learners will ask what it means. The answer is that the Earth has a magnetic N pole that is in a slightly different position than the geographic N pole. What's more, the position of the magnetic N pole moves slowly – as much as 52 kilometres every year. For the last 180 years, it has been moving northward. Currently, the position of the magnetic N pole is in the far north of Canada.

Learners might also wonder why we say the north pole of a bar magnet is attracted to the north pole of the Earth – after all, you will do an activity with them in which they find that the N pole of a bar magnet repels the N pole of another bar magnet. You can explain to them that the north pole of a magnet is really the north-seeking pole of the magnet; it moves towards or "seeks" the Earth's North Pole. We have just shortened the name of the magnet's pole to "north pole" and in the pictures of the magnet, we show it as "N".

12.3 Which substances will stick to a magnet?

Divide learners into groups.

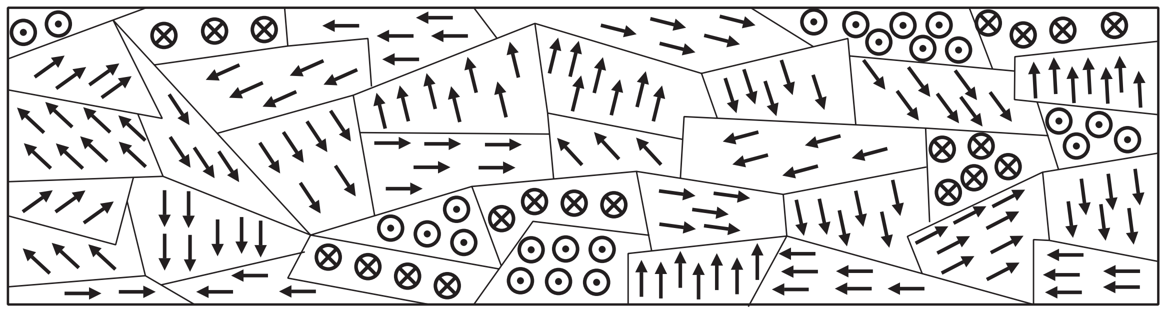
Learners *practically investigate* which materials and substances are magnetic, and which are not. You should make sure that learners do this whole activity with care. They should sort the materials, draw the table, and complete the table. This activity is an example of the *process of classification*. Later in the Technology curriculum, learners will have to classify substances again, but different substances and with a different way of classifying.

The magnetic force is a strange phenomenon that is hard to understand, but it is quite simple to show what is does, and you will show the learners this in the activities of the chapter.

To understand the underlying reasons for the magnetic forces of attraction and repulsion, you would need to know about atomic structure, as well as how the electrons in atoms arrange themselves in different energy levels. That's quite difficult stuff to understand.

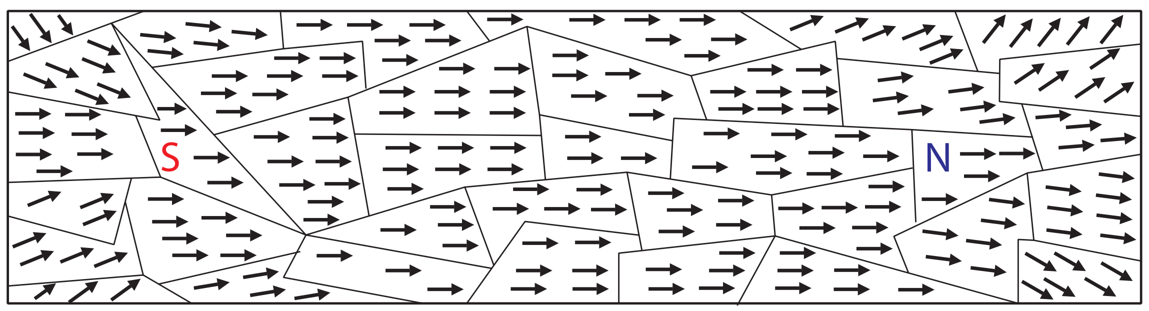
However, there is another, less difficult way to understand what happens in magnetic materials. Let's take iron, for example. We can imagine tiny volumes inside a piece of iron, called domains. In each domain, the iron atoms behave like tiny magnets, each with a north pole and south pole.

In the first diagram, you see domains, and in each domain you see arrows pointing in different directions. The arrows represent little magnets, pointing in the direction of their own fields. If you see an x, it represents the tail of an arrow, pointing away from you. A dot in a circle represents an arrow pointing towards you.



Domains inside a bar of iron. Notice that the domains are magnetised in different directions.

In the second diagram, you see what happens when a strong permanent magnet strokes over the iron bar. The mini-magnets in all the domains respond to the magnetic force of the permanent magnet and the bar of iron as a whole becomes a magnet. You can see that it now has a south pole and a north pole.



Domains line up their magnetisation in the same direction as the field of the permanent magnet.

So what happens when the permanent magnet is taken away? Well, some kinds of steel lose their magnetism quickly, but other kinds of steel keep their magnetism. The first kind of steel gives you a temporary magnet and the second kind gives you another permanent magnet.

Steel is made of iron mixed with small amounts of carbon. The carbon atoms get in between the iron atoms and prevent the iron atoms from sliding over each other. This makes the steel harder than iron.

You can get low-carbon steel and high-carbon steel. In low-carbon steel, there are not so many carbon atoms between the iron atoms and the domains of iron atoms don't stay aligned as they were in the second diagram. The steel loses its magnetisation.

If the steel is high-carbon and hard, there are more carbon atoms among the iron atoms and these carbon atoms lock the domains so that their magnetisation cannot go back into random directions. We say the steel bar has become a permanent magnet. You need to do more work to magnetise high-carbon steel than low-carbon steel but the magnetisation lasts much longer.

However, if you heat the permanent magnet or hammer it, the magnet loses its magnetisation. This happens because the iron atoms get enough energy to move past each other and the magnetisation of the domains becomes random again.

12.1 What is magnetism?

LB page 140

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.

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.

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

Figure 2: Lodestone attracts pieces of iron.

Thinking about magnetism LB p. 140

Work in pairs and discuss these questions.

- What is it about a magnet that attracts these particular objects?

  Learners do not need to know the answer to this question yet. The discussion should get them to think about how the magnet attracts the objects.

- Does a magnet have to touch a magnetic object to attract it?

  No, the magnet doesn't have to touch the object. It just needs to come close enough to it. Discuss with learners why the magnet has no effect when it is far away from the object. There is an area around the magnet in which the magnet can attract magnetic objects.

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

Action research LB p. 140

You need the following for this activity:

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

LB page 141

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.

Do this again with all of your magnets.

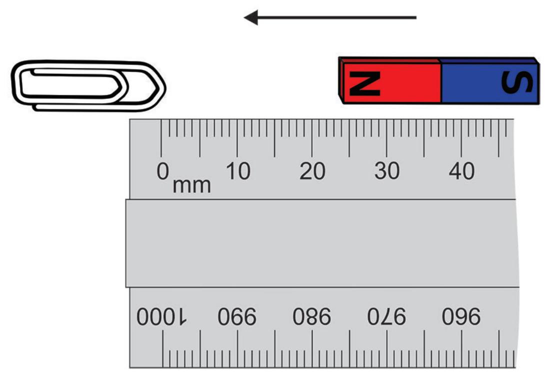


Figure 3

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	

The purpose of this activity is to encourage learners to think more about the how the strength of the magnetic force between two objects depends on how close the objects are together, as well as on how strong the magnet is. We are building towards the concept of a magnetic field. This also prepares learners to see that the magnetic field is stronger closer to the magnet and weaker further away. However, guard against the misconception that the magnetic field ends suddenly and only exists in a contained area.

2. Which magnet is the strongest?

   Discuss with learners that a stronger magnet is able to attract the paperclip from further away. Their answers will depend on the magnets they use.

3. Which magnet is the weakest?

   A weak magnet will only attract a paperclip if it is very close to it.

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 LB p. 141

1. Name three situations in which you have seen or used magnets.

   For doors that need to stay closed without catches. For instance: fridge doors and certain cupboard doors.
   Magnets are used to stick items onto a metal board. They can be used for calendars; work schedules or notes on metal surfaces like fridge doors.
   Magnetic compasses.
   Magnets are inside all electrical motors, and in household appliances such as drills, hairdryers, fans and washing machines.
   Magnets are inside all computers.

2. How would you find out if an object is magnetic or not?

   Hold a piece of magnetic material (such as a paper clip) near the magnet to see if the object is attracted to the magnet.

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.

   Magnet B is stronger. Its magnetic field is stronger, so it can attract objects from a greater distance.

4. Why can a magnet have an effect on a paperclip from a distance? Explain it in your own words.

   There is an invisible magnetic field around the magnet that attracts certain materials.

LB page 142

12.2 Permanent magnets and the 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.

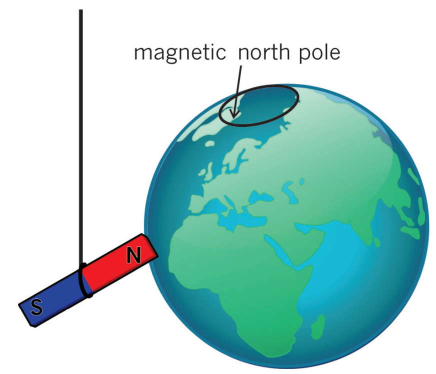


Figure 4: The north pole of a magnet points to the Earth's magnetic north pole.

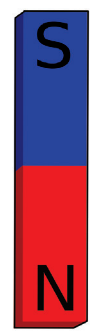


Figure 5: Bar magnet

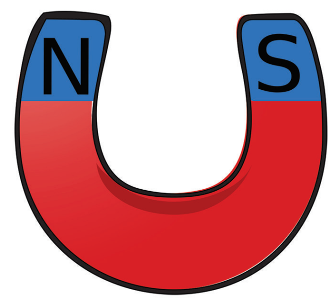


Figure 6: Horseshoe magnet

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 has been 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 LB p. 143

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).

   It is very difficult to hold the magnets close to each other, because they are pushing each other away. The two north poles repel each other.

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).

   It is very difficult to hold the magnets close to each other, because they are pushing each other away. The two south poles repel each other.

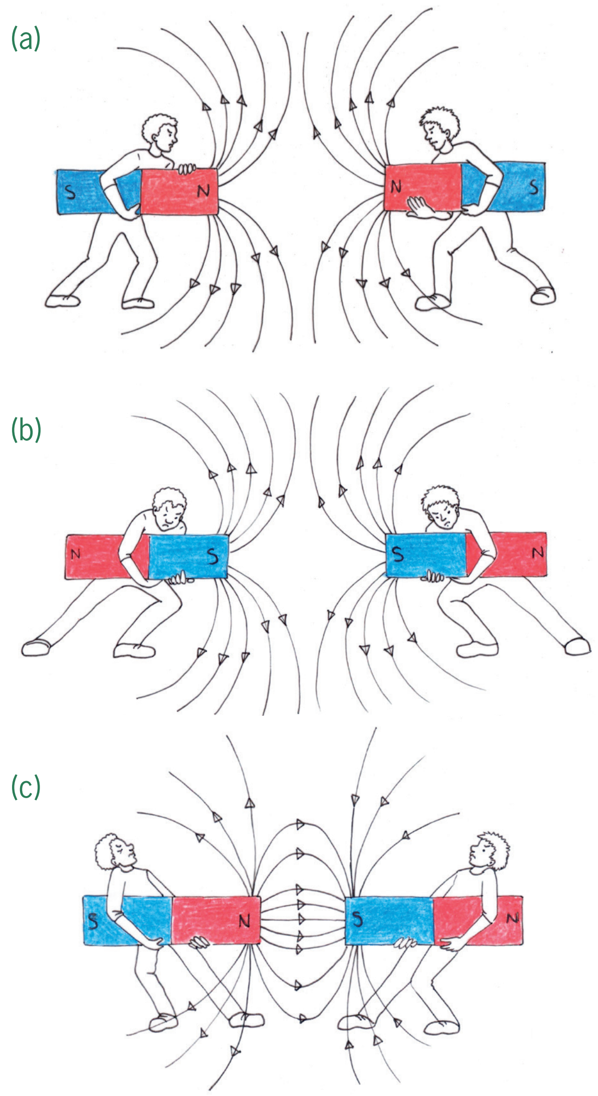


Figure 7

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).

   The magnets will attract each other. Opposite poles will pull towards each other and stick together if they touch.

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) LB p. 144

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.

Learners should sketch the general pattern that the iron filings make. Their drawing should show the iron filings closer together (a darker shade) close to the poles and lighter along the lengths of the magnet. It should also show the general curved shape of the magnetic field.

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.

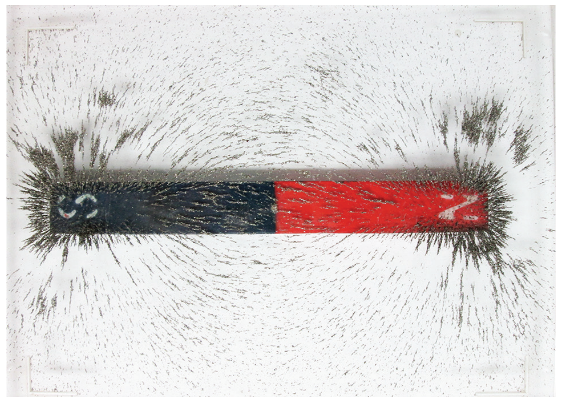


Figure 8

LB page 145

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.

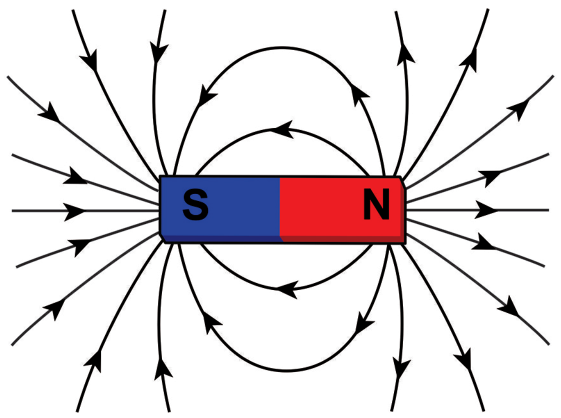


Figure 9

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.

Now, 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.

> The lines in the drawing should look like the lines drawn in Figure 7(c)
>
> If the learners' lines are incorrect, check whether they have positioned the magnets correctly in their investigation.

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.

> The lines in the drawing should look like the lines drawn in Figures 7(a) and (b).
>
> If the learner's lines are incorrect, check whether they have positioned the magnets correctly in their investigation.

Do your field lines look like those in Figures 7(a) and (b), where the magnets repel each other?

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12.3 Which substances will stick to a magnet?

Practical Investigation LB p. 146

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	✔	
ceramic		✔
iron nails	✔	
wood		✔
plastic		✔
copper		✔
paper		✔
coins	✔	

2. List the items that stuck to the magnet.

   pins, iron nails and coins

3. What do you notice about all of the items that did stick to the magnet?

   They are all made of metal. The learners should, however, note that not all the metallic objects were attracted.

4. Are all metals attracted to magnets?

   No, copper is a metal, but it is not magnetic.

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

LB page 147

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

13.1 Magnetic and non-magnetic materials

In this section, learners find out about the many different metals that are used to make things they use. Try to have examples of these metals in the classroom for them to test with magnets – in the weeks before the lessons, you will need to start collecting objects, such as those you see in the table on pages 212 and 213 in the Teacher Guide.

Learners are sometimes surprised to find that not all metals are attracted to a magnet – in fact only iron (and therefore, also steel), nickel and cobalt are magnetic enough for us to observe a force between them and a magnet. All the other metals are so weakly magnetic that we can't observe any force. This fact becomes important in the next section, where learners learn about separating metals using an electromagnet.

13.2 Case study: Recycling scrap metals

In this section, we want learners to realise that they should help in recycling metals, because the world they and their children will live in is short of metals. You can set up a debate using provocative statements such as this: "There is no good reason to collect and recycle cold drink cans because a cold drink can contains very little steel and almost no tin – why bother to pick up cans?"

On page 155 in the Learner Book, learners have to investigate how much of different types of waste/scrap (metal, plastic, etc.) can be collected at school. This is a whole-class activity. They should especially collect different types of *metal* waste (not only cans, but also, for example, wire and sheet). They should record this information by making a table. The table should show the names of different types of waste in the first column, and in the second column show the *amounts* of the different of types of waste collected at school, during one week.

Note that there may be different ways of saying how much (the 'amount') of a certain type of waste there is, for example, the number of items, total size/volume, total weight, total length, or total surface area. Learners should come up with suggestions and discuss in what way or ways they will quantify the amounts of different types of waste.

For individual homework, learners should add another column to their table, for waste collected *at home*, also during one week. So in the end, their table should show the amounts of different types of waste that were collected at school, *as well as* at home.

The teacher should make an example of the table on the board, and explain it, as some learners may be uncertain about how to tabulate information.

After completing their tables, the teacher should ask learners to make some conclusions from their tables. They can, for example, answer the following question: "Which types of waste do you find find at home that you do not find at school?"

The collection of waste (at school and at home) should already be done in the week before this chapter, so that the information is already available when this chapter is started.

In the next section below, you can find information about scrap dealers and recyclers. In rural areas, it is harder to find recycling businesses, but you could try phoning some of these businesses in the cities and ask them what they do about materials from small towns.

13.3 A recycling plan for your school

To organise this project, you'll need some sources of information. Go on the internet if you can, and follow some of these links.

Collect-a-can: http://www.collectacan.co.za/

This company specialises in recycling cold drink cans.

They organise school recycling competitions and help schools in their collecting and of course, they pay money for steel and aluminium cans. Schools are paid varying amounts, depending on whether they deliver to the centres or Collect-a-can must send a vehicle to collect. Aluminium fetches a higher price than steel.

Collect-a-can has branches around South Africa:

PRETORIA Tel: 012 804 9408 Fax: 012 804 2499 402 Rustic Street Silvertondale Pretoria PO Box 15707 East Lynn 0039	DURBAN Tel: 031 700 5935 Fax: 031 700 5956 13 Westmead Road Westmead Durban PO Box 15112 Westmead 3608	JOHANNESBURG Tel: 011 494 3623 Fax: 011 494 3626 12 O'Connor Road Aeroton Johannesburg PO Box 43304 Industria 2045
CAPE TOWN Tel: 031 700 5935	VANDERBIJLPARK UBC BRANCH Tel: 016 988 1330 Fax: 016 988 1332	TPS PLANT Tel: 016 988 2500 Fax: 016 988 1472 9 Henry Street Vanderbijlpark PO Box 790 Vanderbijlpark 1700

You can find **general information about metal recycling** on this website: http://www.urbanearth.co.za/articles/scrap-metal-recycling-south-Africa/

Other companies also have information you can use in the school project, such as:

Remade Recycling Company: http://www.remade.co.za/

Go onto the website and click on the links to:

- Buy-back centres
- What can be recycled? (On this page, follow the link to "Guide to earning extra money with Remade")
- How to start your own recycling business

Treevolution: A guide to recycling in South Africa: http://treevolution.co.za/guide-to-recycling-in-sa/

Petco: http://petco.co.za

Petco is a company that specialises in the plastic used for bottles, called Polyethylene Terephthalate or PET. There is a lot of interesting information on their website.

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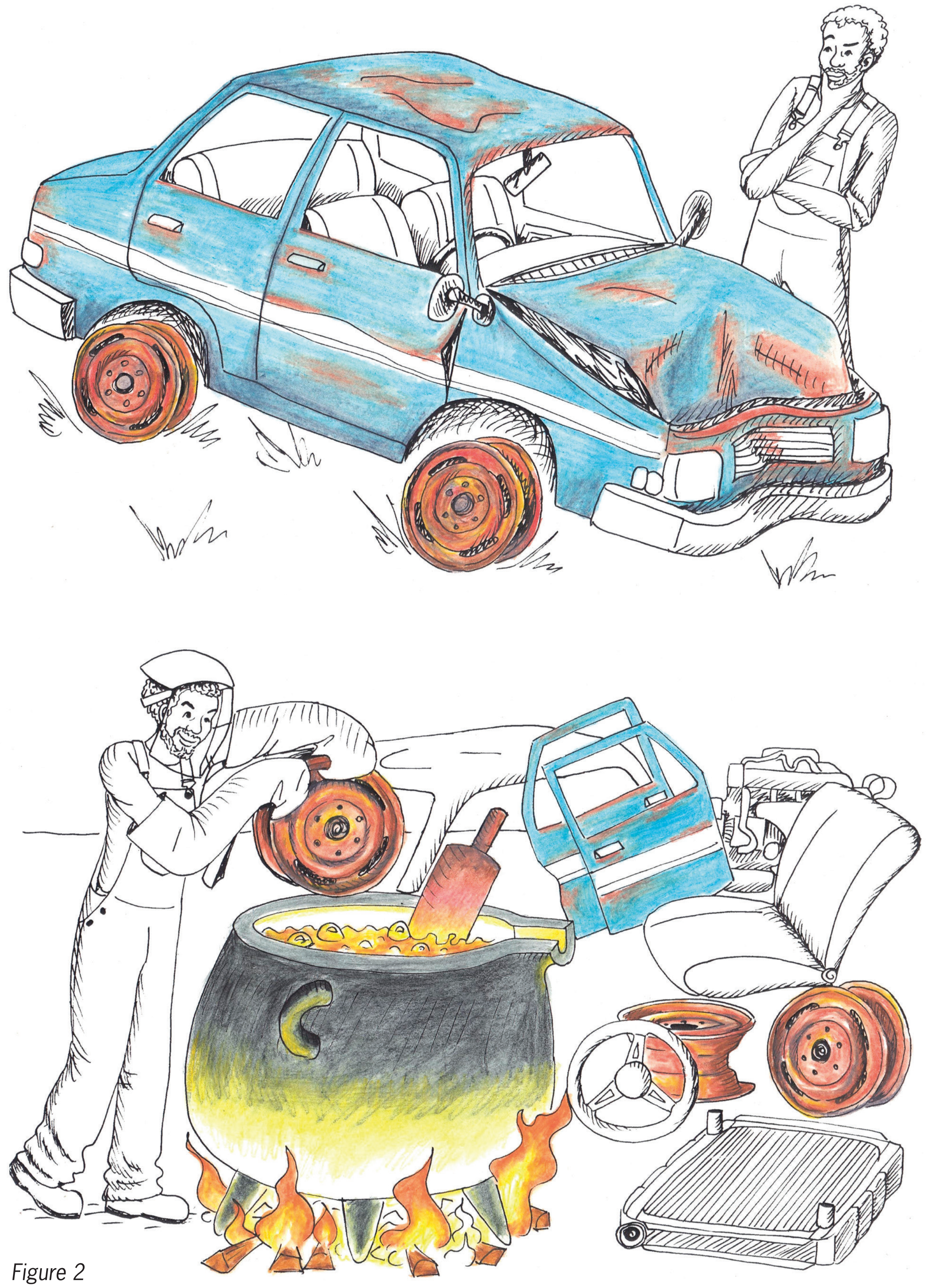

Figure 2

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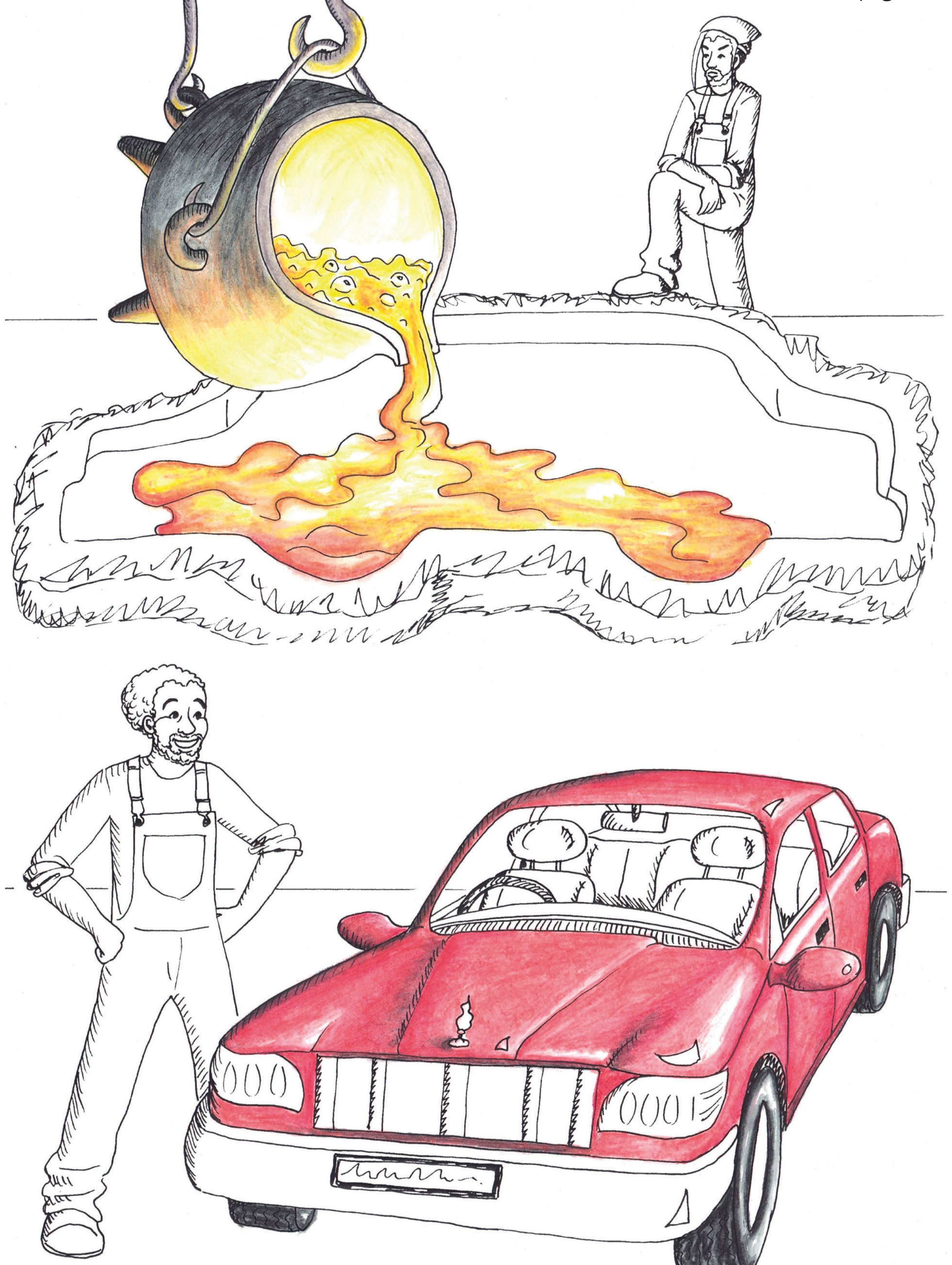


Figure 3

LB page 150

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:

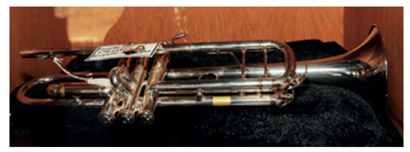
Steel electricity pylons

Cast-iron stove

Lead solder

Copper beading

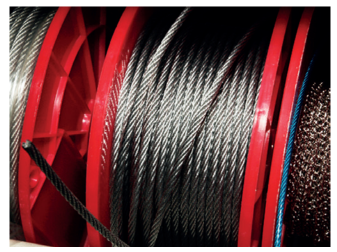
Brass horn. Brass is a mixture of copper and zinc.



Silver trumpet (brass coated with silver)

Gold earrings

Nickel cupboard fittings (steel coated with nickel)

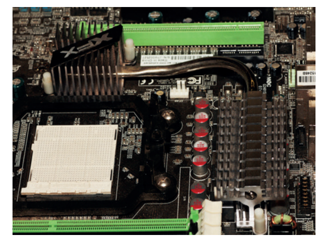


Steel cable

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

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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.

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

Investigation: Test which metals are magnetic LB p. 152

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.

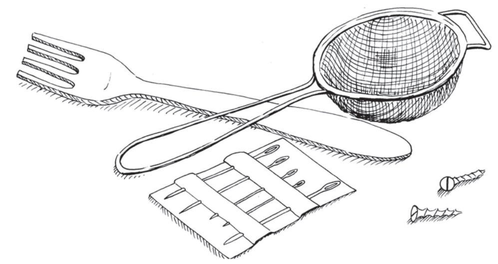

Figure 6: Things you find around the house: a fork, a strainer, needles and screws.

Object	Metal	Magnetic: Yes/No
Paper clips	Steel	Yes
Pins and needles	Steel	Yes
Cutlery	Steel or nickel	Yes
Household appliances	Steel	Yes
Nails	Steel or iron	Yes
Screws	Brass	No
Key ring	Aluminium	No
Vehicle (car or bus)	Steel or iron	Yes

13.2 Case study: Recycling scrap metals

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.

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?

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.

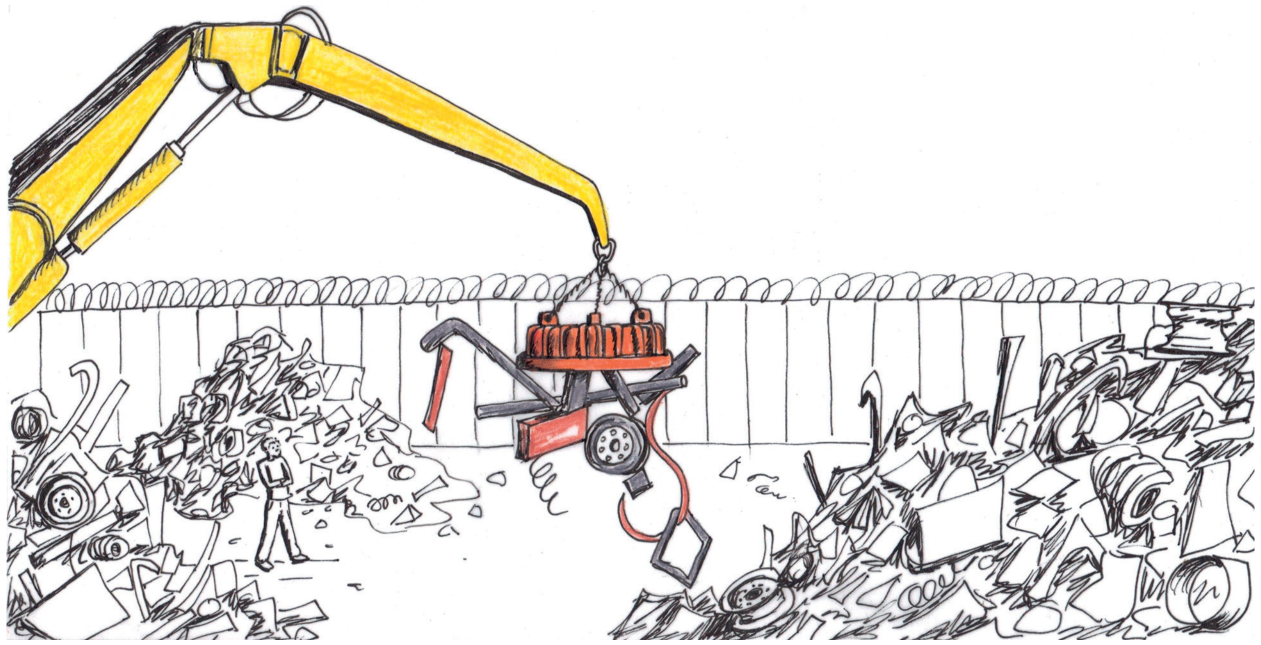

Figure 9: Scrap metal yards use magnets to sort piles of scrap metal.

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 — LB p. 154

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.

   There are many objects that scrap metal dealers should not buy. Anything that is stolen, and any metal that has been taken from a public place, for example copper wiring from electricity and telephone lines, iron from manhole covers in roads, copper taps and pipes from houses, or steel from railings on bridges.

2. List a few scrap metal objects that people can collect to sell to scrap metal dealers.

   Any metal that has been thrown away or discarded by individuals, companies or the government: cold drink cans for aluminium; car parts from scrapped vehicles for iron and steel; wiring and other parts of broken household appliances for copper, steel and aluminium.

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.

   Learners' answers should show an understanding that metal to be recycled must come from a genuinely scrapped source, or from an area where waste was collected. They can tell the scrap dealer exactly where and how they obtained the metals to satisfy these conditions.

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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 — LB p. 155

Before you start collecting materials, discuss in the 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.
- 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.

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

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13.3 Recycling plan for your school

Making money from recycling LB p. 156

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.

In this question, learners must focus on the efficiency, expansion and maintenance of the recycling project. The additional points they should add will include ideas on how they will collect and then deal with large amounts of scrap metal. They should present ideas on how to generate excitement and enthusiasm for recycling by telling other people and classes what recycling achieves. The plans must include ideas on how the larger amounts of recycled goods can be collected and stored. It must include ideas on how the project will be ongoing: who will monitor the progress, who will educate others and who will investigate ways of increasing the collection. It should also include ideas on how the money collected from the recycled materials can be put to good use for the school. This will help to motivate and encourage the learners to work hard on the project.

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

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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.

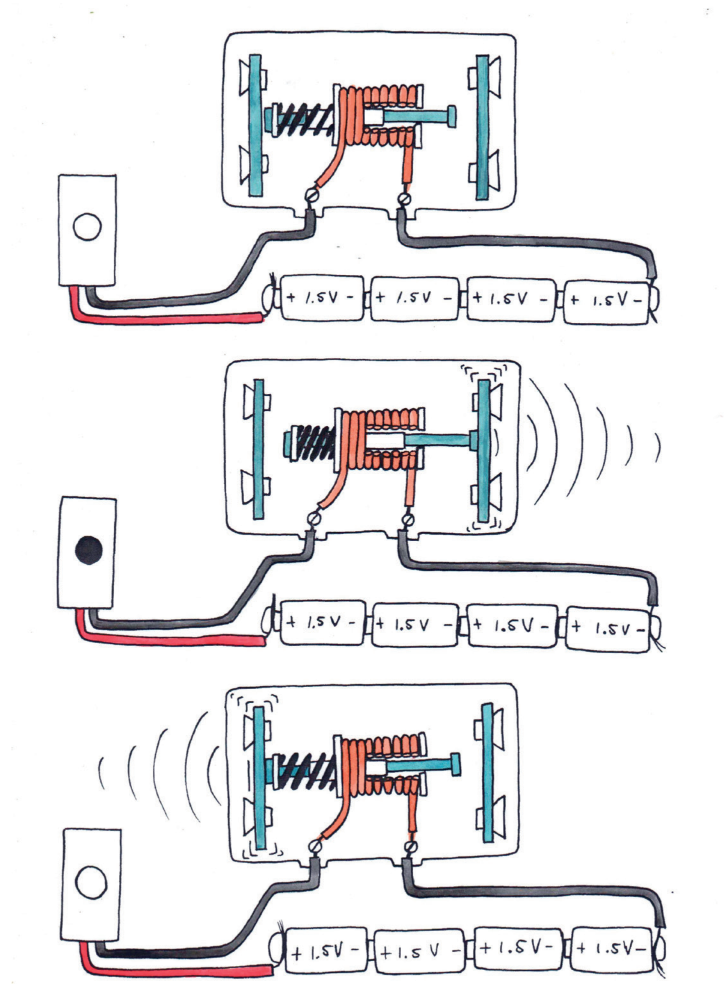


Figure 1: How does an electric door bell work? The coiled copper wire of an electromagnet forms part of the electric circuit.

14.1 Circuits and components

The learners may have done some of this in Grade 6 Natural Sciences and Technology, but this is a good place to revise circuits and components. You could tell them to keep their books closed, and ask learners to draw the symbols for a cell, battery, switch, etc. When they draw the symbol, they must also explain what the component does in a circuit.

14.2 Building your own electrical circuit

The learners should have built circuits before in Grade 6 Natural Sciences and Technology. However, if they have not done this practically before, they can do it now, and it can be an exciting activity.

Hand out a bulb, a cell and two or three lengths of electrical wire. Ask them to find as many arrangements as they can that will make the bulb light up. (They should find about three ways to make it light up.) Ask them also to note which arrangements do *not* light up the bulb. (They will find about three ways to place the bulb and wires that do not make the bulb light up.)

Ask some learners to come and draw on the board to show how they connected the components. They should have found that the knob on the bottom of the bulb must be connected to one terminal of the cell, and the metal screw-shaped contact on the side of the bulb must be connected to the other terminal of the cell.

14.3 Electromagnets

Make a simple electromagnet

This is an activity for groups of learners.

Gather the materials before the lesson.

Let the learners find out whether the nail can attract pins before it is wrapped with wire.

Figure 7 shows only a few turns of wire around the nail. The more wire they wrap around the nail, the stronger the magnetic force will be.

Ask the learners why the wire must be insulated. (Answer: If the wire were bare, the current would flow straight along the nail instead of following the twisting path around the nail. The nail is a conductor.)

You can ask the learners to include a push switch in the circuit. They should press the switch for only a short time to see the magnetic effect, and then release the switch. The reason is that the wire is a near-zero resistance path for current. If they leave the coil of wire connected to both terminals of the cell, the cell will work as hard as it can to produce the current and the cell's chemicals will soon react completely – in other words, the cell will be "dead". You know this is happening when you feel the cell getting hot.

Magnetically soft and hard steel

The learners will find that when they are passing current through the coil, and the nail is inside the coil, the nail attracts pins, paper clips and other steel objects. Then ask them to pull the nail out of the coil and test whether it still behaves as a magnet. They will find that it is now only a very weak magnet. It will attract pins only when they are very close to the nail. After a few hours, it will have lost almost all its magnetism.

This raises the question: How then do we make *permanent* magnets out of steel?

Remember that steel is iron mixed with small amounts of carbon and other elements. Some kinds of steel have very little carbon and this steel is easy to magnetise. However, it quickly loses its magnetism. This kind of steel is called magnetically soft steel. Other kinds of steel need much stronger currents and bigger coils to magnetise – they are more difficult and expensive to magnetise and they are called magnetically hard steel. The advantage of these kinds of steel is that they keep their magnetism. Permanent magnets are made of this kind of magnetically hard steel.

Scientific history about electromagnets

Michael Faraday in Britain and Joseph Henry in America both worked on electromagnetism in the years between 1820 and 1860.

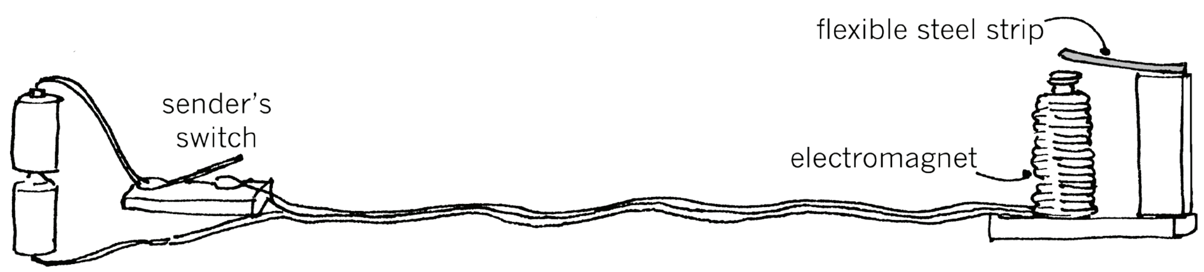
Joseph Henry read about work done in Germany and Britain on electromagnets and he built improved versions of that apparatus. He did not have insulated copper wire (it was many years before insulated wire was manufactured) so he took strips of silk from his wife's underskirt and insulated the wire by wrapping the strips around the wire. We don't know what his wife said about that, but he was able to wrap many turns of this insulated wire closely around a U-shaped iron core.

He was a science teacher and always tried to do demonstrations for his classes to make sure they understood what he was talking about.

He was appointed as a professor and was asked to make a really strong electromagnet. He made one that could hold up over 1 000 kg.

Joseph Henry helped Samuel Morse to develop the "telegraph". In the days before telephones, people could send messages along wires from city to city using the telegraph.

The class can make a simple model of a telegraph that goes all the way across the room. Look at the diagram here.



When the person sending the message presses the switch, the electromagnet at the end of the wire pulls the steel strip onto the electromagnet and it makes a clicking noise.

The sending-person and the receiving-person both had to know "Morse code". The clicks on the receiving end made up letters of the alphabet, and so the sender could spell out words. If the sender holds down the switch for a short time, it is called a "dit", and if the sender holds it down for a longer time, the signal is called a "dah".

The letter A is dit-dah,
the letter B is dah-dit-dit-dit,
C is dah-dit-dah-dit,
D is dah-dit-dit.

"Hello" will be dit-dit-dit-dit (pause)
dit (pause) dit-dah-dit-dit (pause)
dit-dah-dit-dit (pause) dah-dah-dah.

A	• ▬	U	• • ▬
B	▬ • • •	V	• • • ▬
C	▬ • ▬ •	W	• ▬ ▬
D	▬ • •	X	▬ • • ▬
E	•	Y	▬ • ▬ ▬
F	• • ▬ •	Z	▬ ▬ • •
G	▬ ▬ •		
H	• • • •		
I	• •		
J	• ▬ ▬ ▬		
K	▬ • ▬	1	• ▬ ▬ ▬ ▬
L	• ▬ • •	2	• • ▬ ▬ ▬
M	▬ ▬	3	• • • ▬ ▬
N	▬ •	4	• • • • ▬
O	▬ ▬ ▬	5	• • • • •
P	• ▬ ▬ •	6	▬ • • • •
Q	▬ ▬ • ▬	7	▬ ▬ • • •
R	• ▬ •	8	▬ ▬ ▬ • •
S	• • •	9	▬ ▬ ▬ ▬ •
T	▬	0	▬ ▬ ▬ ▬ ▬

LB pages 158–159

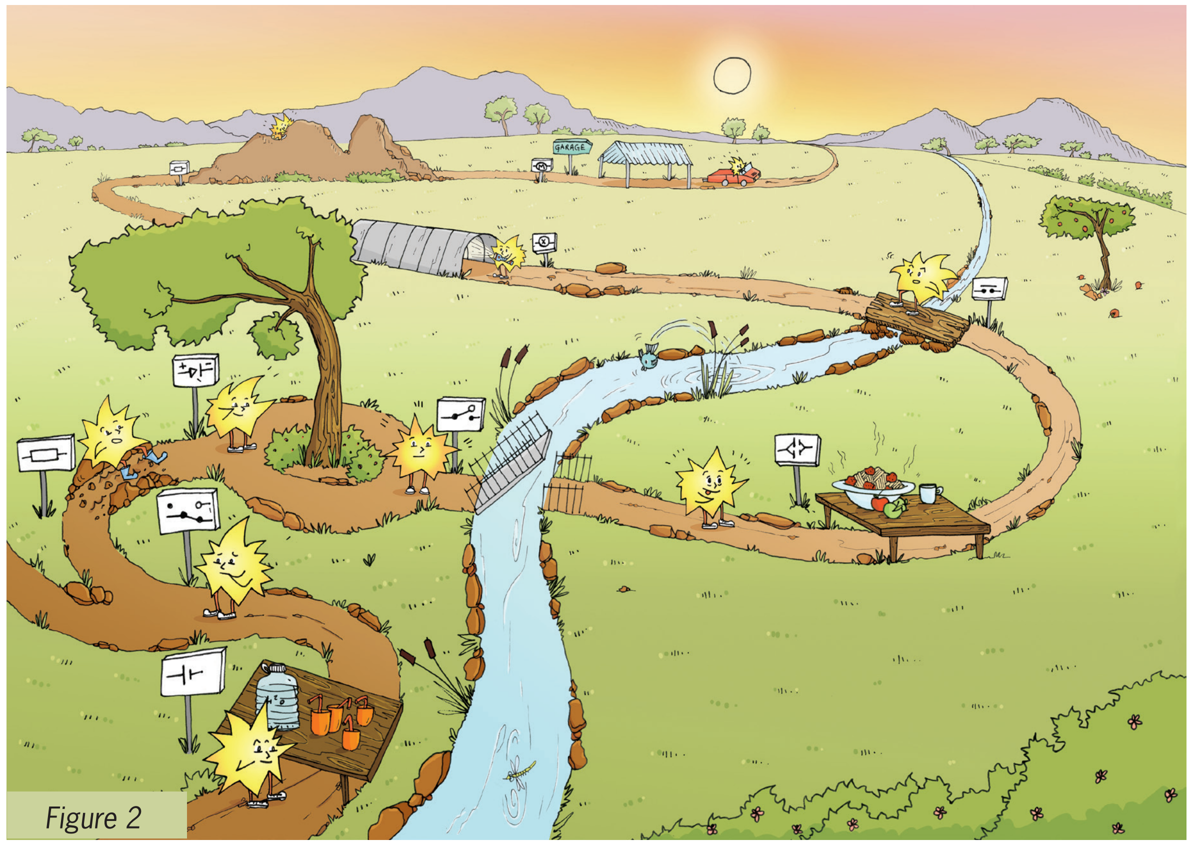


Figure 2

14.1 Circuits and components

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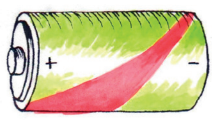
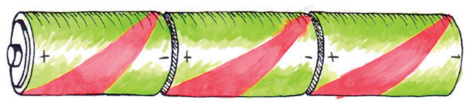
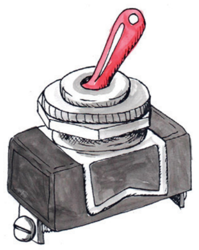
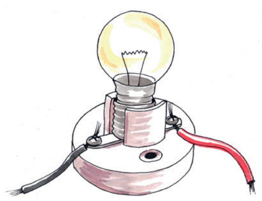
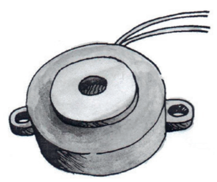
An electric circuit needs three basic things to work:

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		
buzzer		

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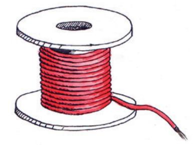
Name	Picture	Symbol
conducting wires		

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.

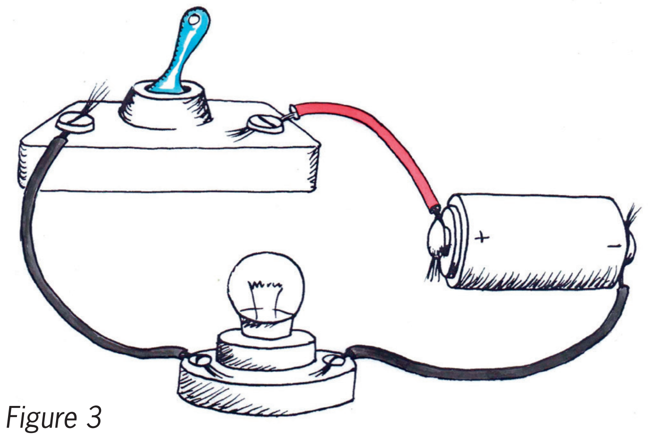


Figure 3

Questions to answer **LB p. 161**

1. What are the three things that you need to make an electric circuit?

   An energy source; a complete circuit and a load.

2. How do you think you can see if the circuit in Figure 3 is working?

   The bulb will light up.

3. If you made a mistake while putting the circuit together and the connections were not complete, what do you think would happen?

   The bulb will not light up.

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14.2 Building your own electrical circuit

Build simple circuits LB p. 162

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.

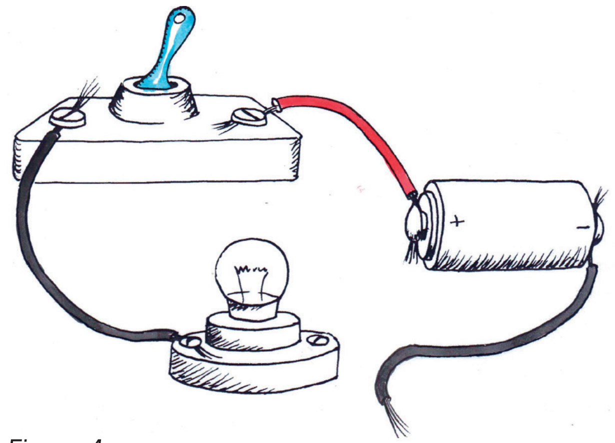


Figure 4

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?
   No, the bulb does not light up.
   (b) Why does the light bulb not light up?
   The circuit is not complete. The wire does not reach the bulb.
3. Now try the circuit in Figure 5.
   (a) Does the light bulb light up?
   Yes, the bulb lights up.
   (b) Why does the light bulb light up?
   The circuit is complete. There is a power source and there is a load (the bulb).

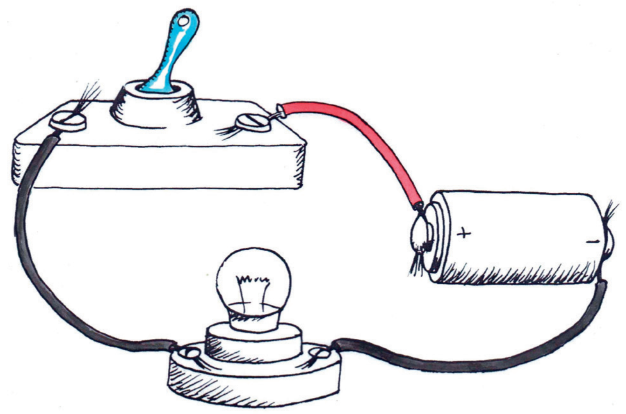
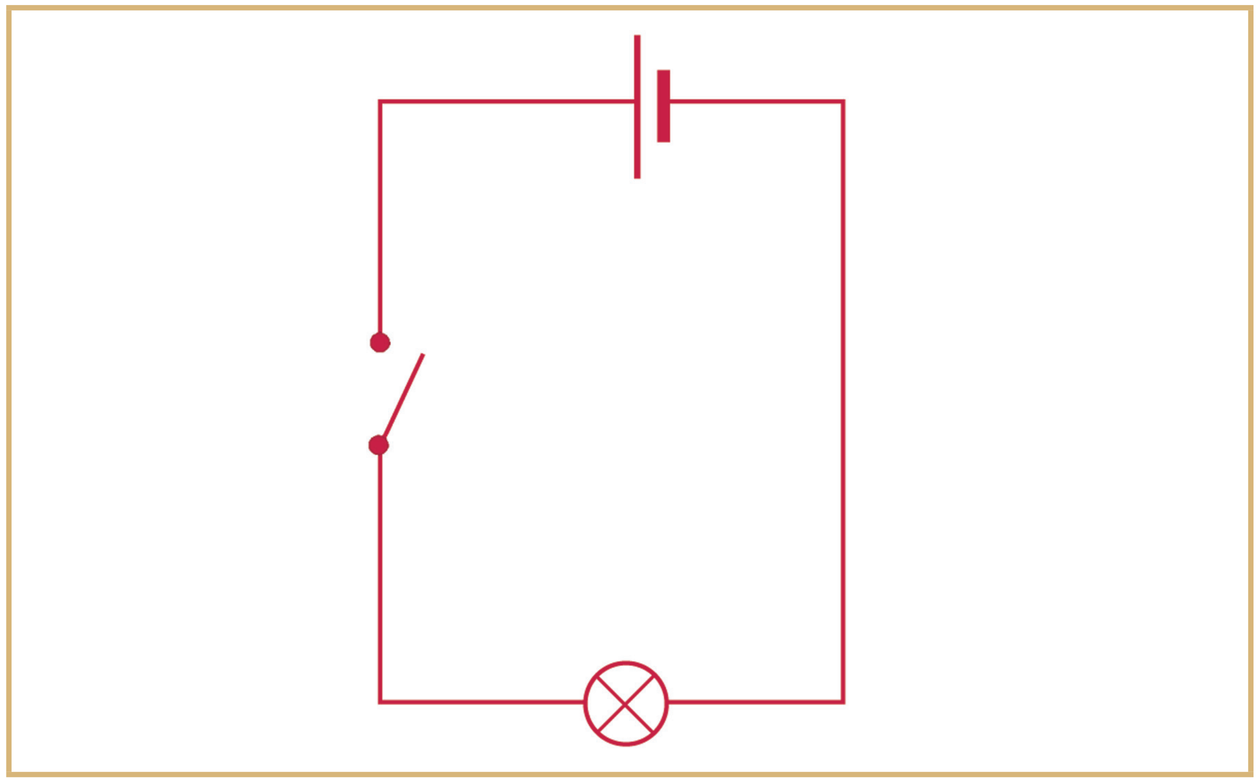


Figure 5

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?
   The cell is the energy source.
6. Which of the components in your circuit is the load?
   The bulb is the load.

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.

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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 LB p. 163

For this activity, you will need:

- 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.

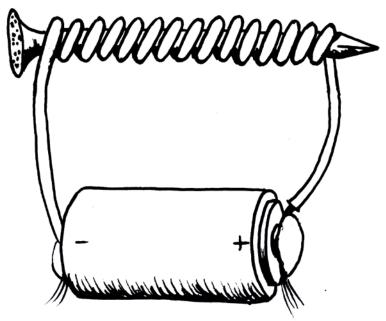

Figure 7: A simple electromagnet

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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.
3. Now connect one of the stripped ends of the wire to the positive terminal of your 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!

   There is no specific answer to this question. The learners can note if the magnet is working or not.

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?

   No, not anymore.

7. How can you use the electromagnet to pick up paperclips from one place and then put them in a different place?

   The magnet can be switched on and off by connecting and disconnecting one of the cell terminals.

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

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

LB page 165

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.

15.1 Machines combine simple mechanisms

So far, levers are the only mechanisms that learners have investigated. A mechanism makes it possible to move things further, faster or more easily. It can also change the direction of movement.

Different mechanisms can be used to serve different **purposes**, as learners have experienced with different classes of levers. Sometimes, a single mechanism is sufficient to achieve a purpose. In other situations, a combination of mechanisms is required.

Learners now start to recognise the difference between the "whole thing" that serves the whole design purpose (the **machine**), and the simple parts (the **mechanisms**) that are put together (combined) in a certain way to serve this purpose. Each of the simple mechanisms has its own purpose.

The picture and questions also guide learners to think about **structural parts** of the design of the machine, so that it will not fail (fall over, break etc.).

Learners explore all of the above by thinking about how a tower crane works.

They look at a design drawing of the crane, and then answer questions.

The tower crane uses **pulleys** in addition to levers. The next section is about how pulleys and rope/cable can be combined in ways that give a mechanical advantage.

15.2 Pulleys – mechanical advantage from ropes and cables

In Grade 7 Term 1 (Chapters 4 to 6), learners explored how there is a **"trade-off" between distance and force** when using a lever. They learnt that the term "mechanical advantage" is used to describe this trade-off in a quantitative/measurable way.

If the *distance moved on the output side* is more than the *distance moved on the input side*, then the *force on the output side* will be *smaller than the force of the input side*, and the other way around.

"Trade-off" means that if you want to have more of one thing, you have to give up (have less) of another thing. For example, you cannot spend more money and at the same time, save more money.

In this lesson, learners explore how a system of pulleys and a rope/cable that is weaved through it in a certain way, can also give a trade-off between distance and force.

The text and pictures help learners to think about different ways of connecting a rope/cable and pulleys. The rope and the pulleys, and the way that they are connected, are together called a pulley system.

They then build a certain pulley system themselves, according to instructions. That system gives a mechanical advantage. The reason for this is not explained to the learners in this chapter. Rather, in this chapter their *intuition* about pulley systems is developed *in a practical way*. The questions that they answer give them hints that will eventually lead to an explanation (in Grade 9, Chapter 7). Having that practical memory and intuition will help them to understand why there is a mechanical advantage when they learn more about pulley systems in Grade 9.

The hints are:

- to count how many parts of the rope are moving up/down together with the *moving* pulley/pulleys (as opposed to the *stationary* pulley/pulleys),
- to notice that this is more than the one part of the rope that is being pulled, and
- to compare the distance that the rope is being pulled, with the distance that the moving pulley/pulleys moves/move in response to that.

This last hint aims to remind learners of the trade-off between distance and force that they have already investigated by studying levers.

For homework, they also make a four-pulley system.

They experiment with the different pulley systems, and in that way discover when they get a bigger or smaller mechanical advantage. In this way, they develop some intuition about why certain pulley systems give a mechanical advantage.

To develop this intuition, *every learner should do all the practical work*, including the homework, and investigate the difference between the two pulley systems.

You should supply each learner with the cheap everyday materials needed to do the homework, namely:

- a piece of string of at least 50 cm long,
- a paper clip,
- three pins, and
- four plastic curtain sliders.

Each learner should individually find recycled cardboard (e.g. an old cereal or cardboard box) on which to mount the pulley system.

15.3 Combining mechanisms

This section serves two purposes:

- Learners investigate how a winch works and how to build one. In the design of a crane in Figure 3 at the start of this chapter, they notice the pulley system to lift a load on the output side, but no mechanism is shown on that drawing for pulling in the rope/cable on the input side. In this section, they look at another design for a crane that shows such a mechanism on the input side of the rope/cable, namely a hand-driven winch.
- Learners practise combining pulleys, a winch and a lever to build a lifting system (crane). They will again do this during the PAT in the next chapter, but then they will build a different design of a crane.

Suggestion if time is limited for completing this term's PAT:

If time is limited during this week or for finishing the PAT before the end of the term, the following is suggested to save time:

Use this section only for learners to investigate and build a winch. Then, let them use that same winch as part of their model in the PAT. In other words, leave out the building of the lifting system in this section.

During this section, learners need to do at least the following:

- They look at the design of a lifting system to find out what you should do to make it lift a load. They look at Figures 8 and 13 to do this.
- They think about the structural strength that parts of the lifting system should have so that it will not fail/break.
- They identify the different mechanisms that work together in the lifting system, namely pulleys, a winch, and a lever.
- For each mechanism, they identify its purpose.
  The purpose of a mechanism is *not* always to get a mechanical advantage! Some of the mechanisms have other purposes, like only changing the direction of movement, or making space for the load to fit underneath the lifting system.
- They build the winch that they will use as part of their crane in the PAT.

The *strengthening of frame structures* (according to CAPS week 4) can be found in the PAT in Teacher Guide on page 248.

More about winches and rotational forces in Grade 8:

In Grade 8, Term 1, Chapter 5, learners will investigate wheels and gears, for which rotational movement is very important. After having done that, they will be able to understand winches better. So, winches will be revised in Grade 8, Term 1, Chapter 6.

At this point, in Grade 7, it is not a problem if learners still feel somewhat uncertain about how a winch can have a mechanical advantage. As long as they have had practical experience with a winch and developed some intuition.

LB page 166–167

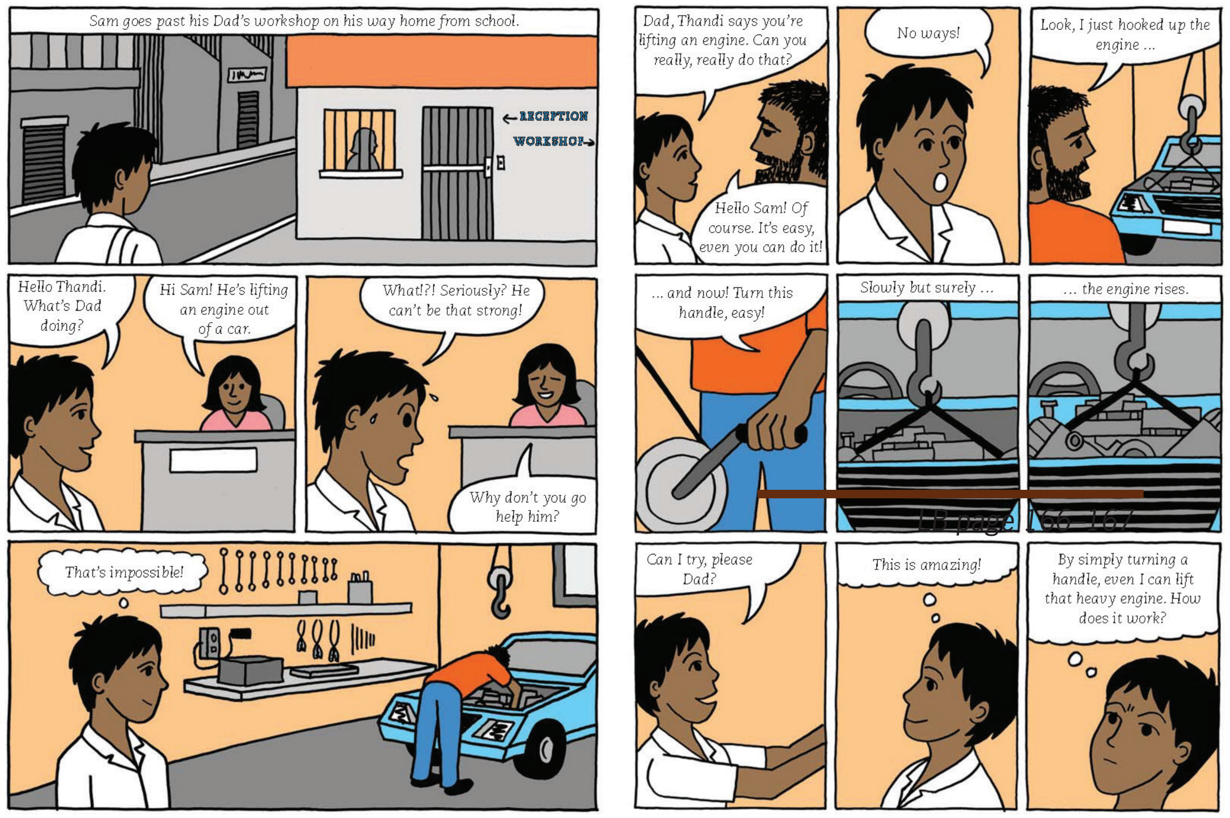

Figure 2

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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 LB p. 168

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?

   The main purpose of the crane is to lift objects that are too heavy to be lifted by people, and move these objects to another place, or another level.

2. What do the pulleys do?

   The pulleys allow the cables pulling heavy objects to change the direction in which they are pulling. [Note to the teacher: When pulleys are used in certain combinations, the resulting system of pulleys can give a mechanical advantage. Learners will learn about this later in the chapter.]

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?

The trolley moves along the jib of the crane, and so can position the hook above the loads.

4. Why does the crane need to **rotate**?

Rotate means to turn around an axis or centre point.

The crane needs to rotate so it can reach loads in different places, and then lift, rotate, and put them down where they are needed.

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?

It has a fulcrum, and an input force (effort) and an output force (load) is applied/exerted around this fulcrum

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6. Is the jib a first-class, second-class or third-class lever? How do you know?

The jib can be used as a second-class or a third-class lever, depending on where the trolley is. Both the load and the effort are on the same side of the fulcrum. When the trolley is close to the fulcrum, the load is closer to the fulcrum than the effort of the cables at the top of the jib, so the jib is then used as a second-class lever. The jib then gives a mechanical advantage, because a big movement of the effort is required to cause a small movement of the load. However, when the trolley is very far from the fulcrum, the load is further from the fulcrum than the effort, so the jib is then used as a third-class lever. The jib does not give a mechanical advantage then, but a distance advantage, because a small movement of the effort is required to cause a big movement of the load.
[Note to the teacher: The jib does not really rotate around the fulcrum, but rather remains in a horizontal position. However, it is useful to think of what would happen if it did rotate, in order to understand whether it gives a mechanical advantage or a distance advantage.]

7. What stops the crane from falling over when it lifts something?

It is balanced on the opposite side by the weight of concrete blocks.

8. Make a list of all of the mechanisms on this crane that help it to lift loads.

pulleys and levers

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.

the heavy base; the tower; the jib that is balanced by the concrete weights; the cables that support the concrete weights and the jib

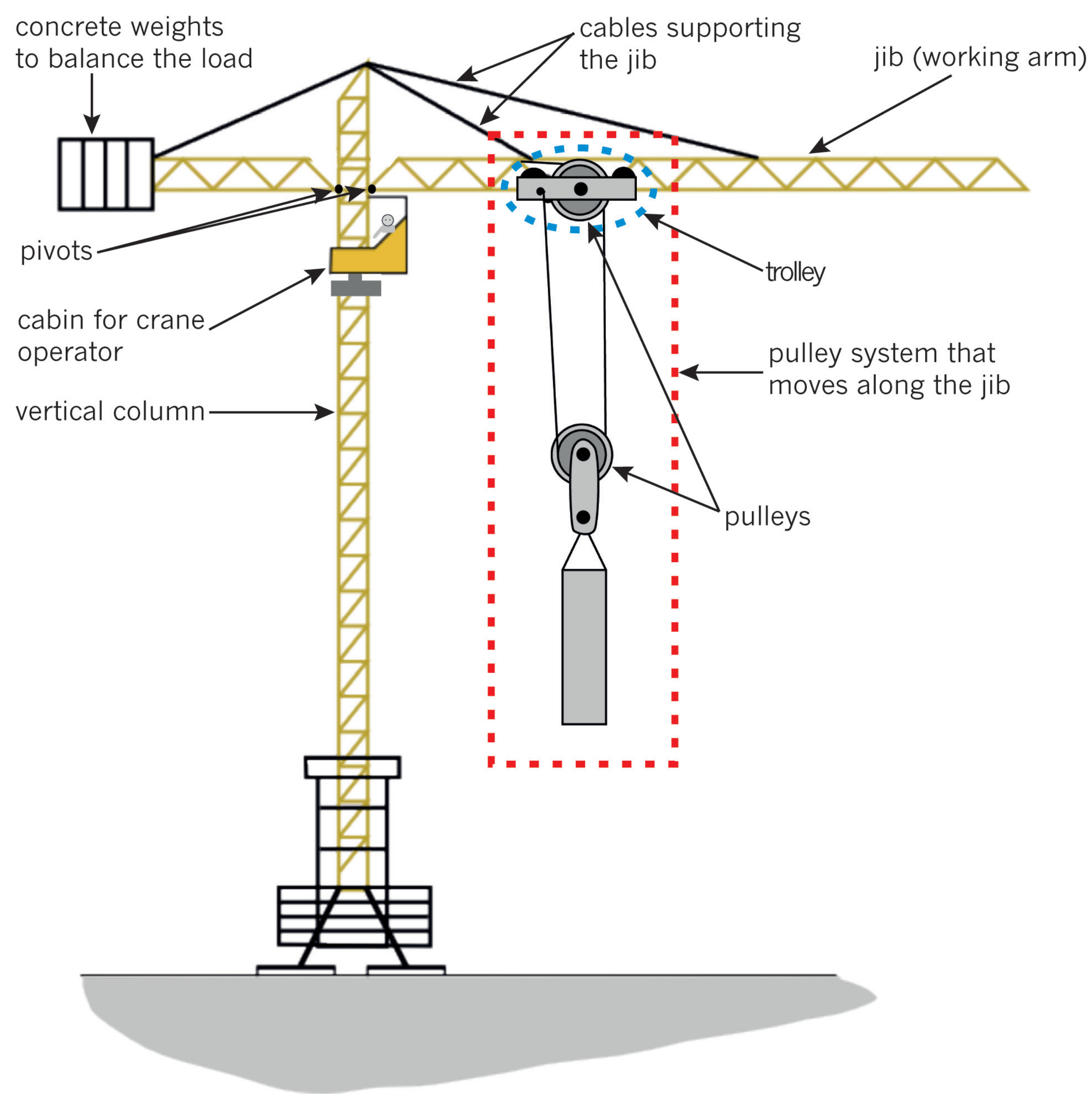

Figure 3: A tower crane uses many different mechanisms.

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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.

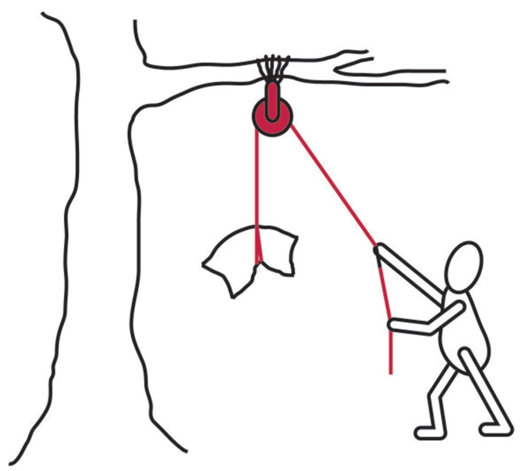

Figure 4: A man is using a rope and a pulley wheel to lift a heavy bag.

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 it 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.

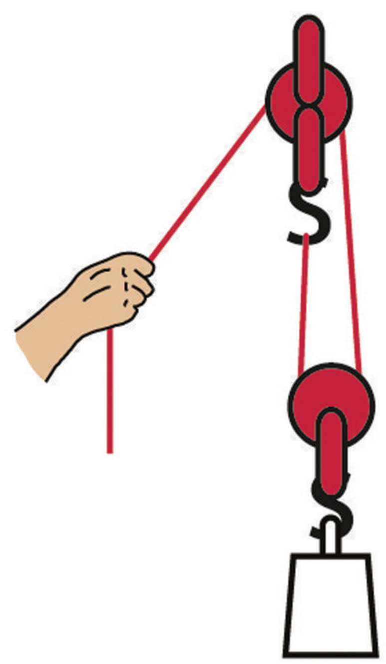

Figure 5: If you connect two pulleys to a piece of rope like this, you get a mechanical advantage.

Make your own pulley system

LB p. 171

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.

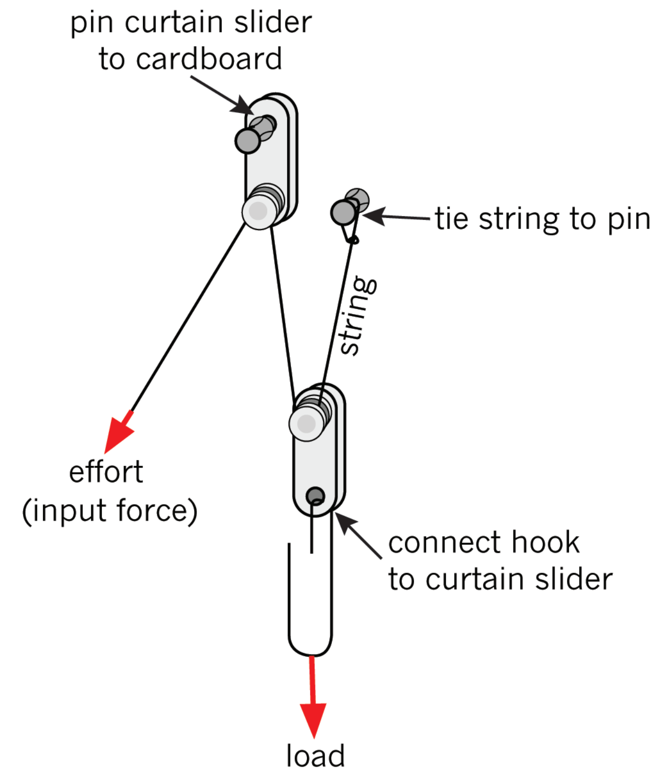

Figure 6: You can make a pulley system out of curtain sliders.

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?

   The load goes up. ....

2. How many parts of the string pull up the load on the output or load side of the system?

   two parts of the string ....

3. How many parts of string are pulled down on the input or effort side of the system?

   one part of the string ....

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.

   50 mm

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?

   It is twice as hard to lift the load without the pulley system.

An even easier pulley system — LB p. 172

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.

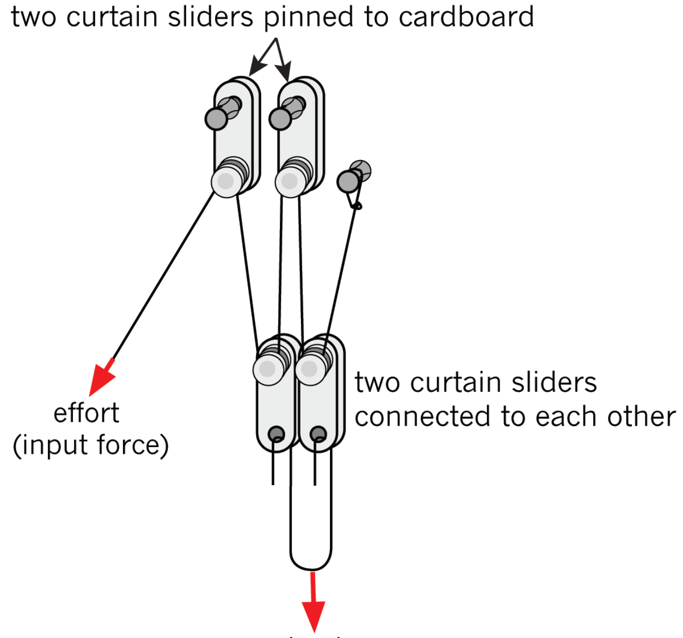

Figure 7: You will increase the mechanical advantage if you use more pulleys. There will be more lengths of string to lift the load.

1. What distance does the load lift when you pull the string down by 100 cm?

   25 mm

2. Describe what a pulley mechanism does.

   A pulley mechanism changes the direction of the force required to lift the load, making it easier to pull on the rope. It also gives a mechanical advantage that makes it easier to lift the load, the same way a gear system can.

3. What do you think pulley systems are mostly used for?

   Pulley systems are mostly used to lift objects, or to pull heavy objects up slopes.

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.

   There is far less friction on the rope when a wheel is used, requiring less effort to lift the load.

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15.3 Combining mechanisms

Make a lifting system — LB p. 173

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.

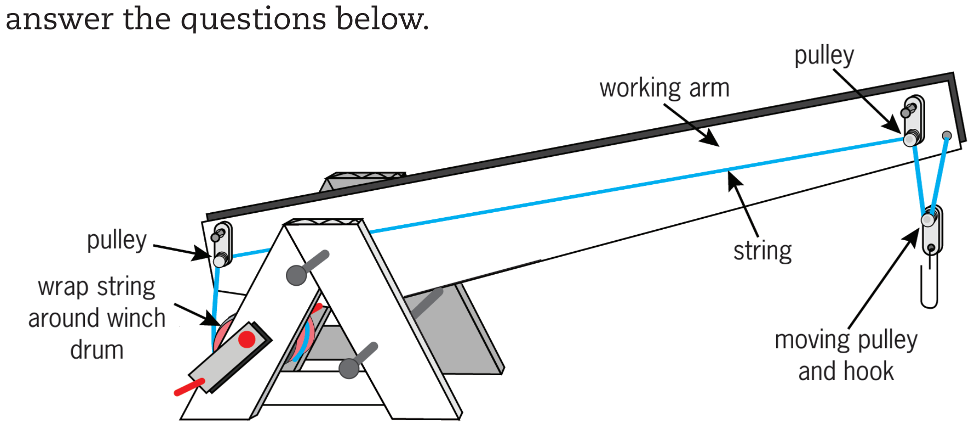


Figure 8: A lifting system that you can make

1. How does the pulley system in Figure 8 help to lift things?

   It changes the direction in which the rope should be pulled on the input side. It gives a mechanical advantage.

2. What does the working arm in this system do?

   It allows you to lift something that is far away from the winch that you turn.

[Note to the teacher: Some learners may wonder if the working arm will act as a lever, in other words whether the arm will lift up on the right side when the string is pulled in by the winch. That will not happen, because the working arm would give a distance advantage if it acted as a lever, which means that the input force would need to be greater than the output force (load). The pulley system on the right gives a mechanical advantage, so an input force smaller than the weight of the load is all that is needed to lift the load. That input force will be too small to lift the lever.

If you look at the working arm as a lever, the distance from the load (on the right) to the fulcrum on top of the A-frames is bigger than the distance from the effort (on the left) to the fulcrum. So it gives a distance advantage.]

3. Explain how you could use this system to lift a load.

   The pulley system is operated by the winch. The rope goes over the working arm. When the rope is pulled in by the winch on the left side of the working arm, the load is pulled up by the rope on the right side of the working arm.lever, which assists in lifting the load.

Make an A-frame for a fulcrum LB p. 173

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

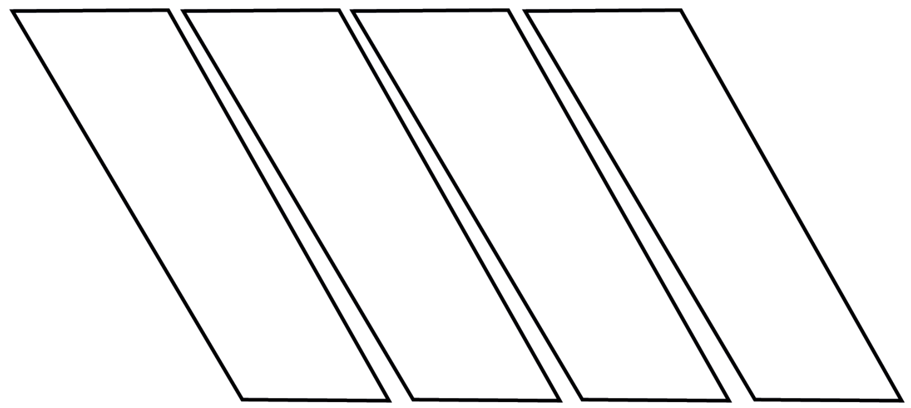


Figure 9: Use these four shapes to make an A-frame.

- 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.

LB page 174

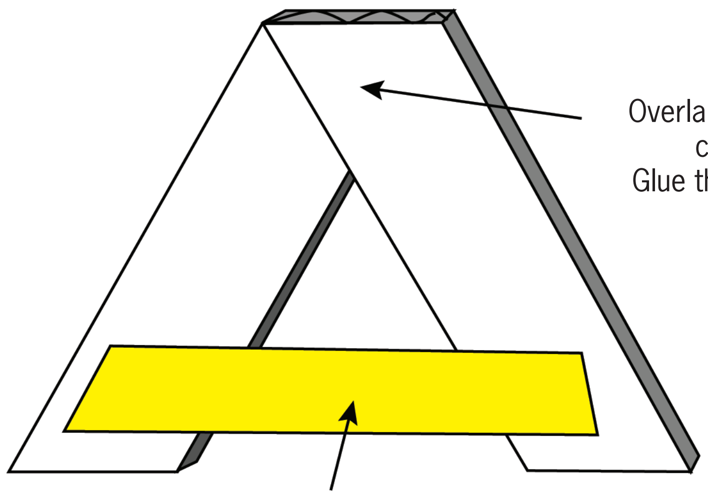


Figure 10: How to make an A-frame

Make a hand-driven winch LB p. 174

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.

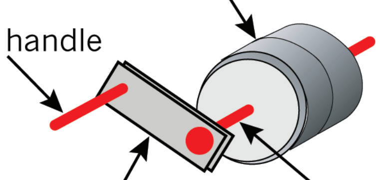


Figure 11: You can make a hand-driven winch drum by joining two milk-bottle tops together.

LB page 175

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.

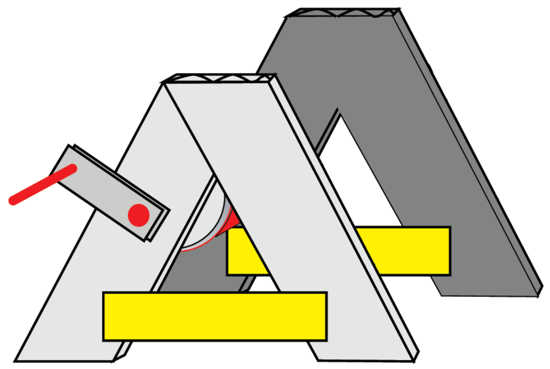


Figure 12: Put your crank and winder into your A-frame.

- 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.

LB page 176

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 centre 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.

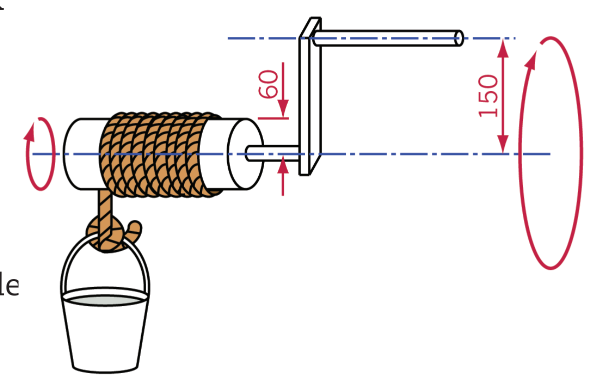


Figure 13: A hand-driven winch lifting a bucket of water.

Make a working arm LB p. 176

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.

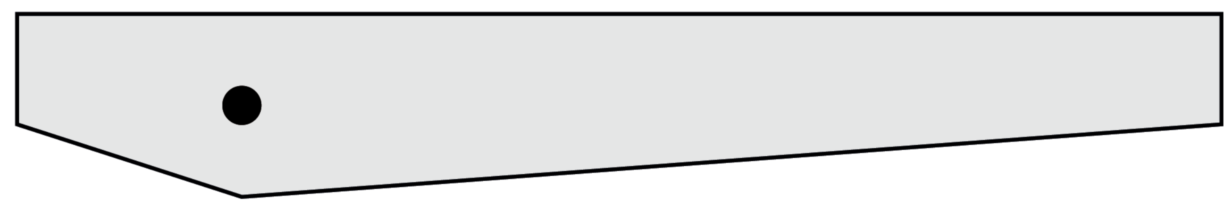


Figure 14: You can use this shape to make a working arm.

LB page 177

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.

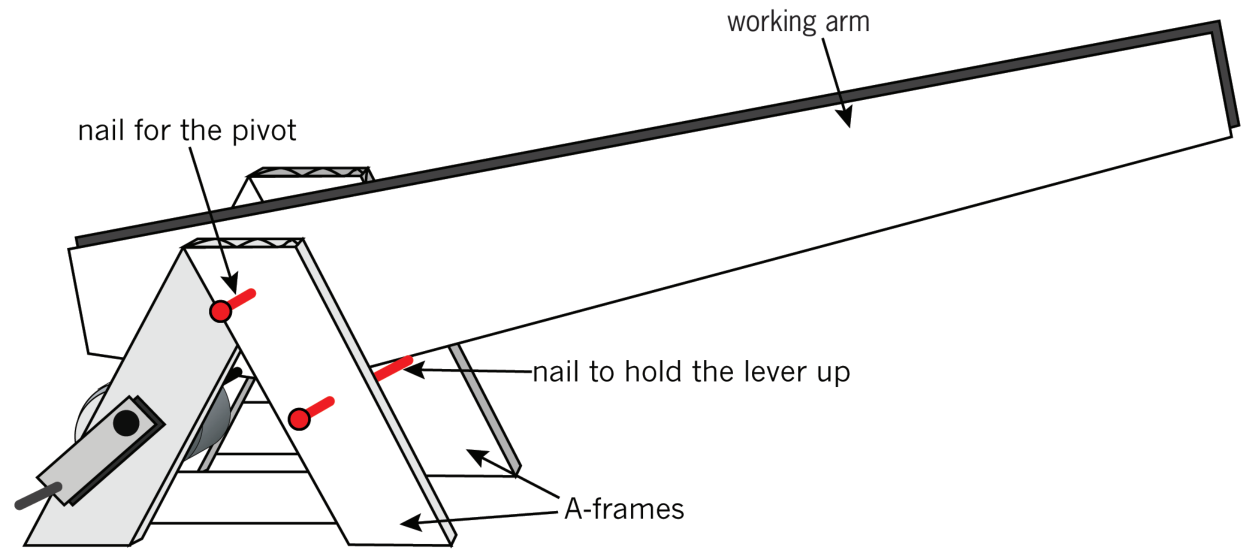


Figure 15: How to connect your working arm to your A-frames

Add a pulley system

LB p.177

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?

   The load is attached to the moving pulley and hook. When you rotate the crank in a certain direction, the rope is pulled in by the winch, and the load is lifted.

2. What shape do you think makes the A-frames on this system strong?

   The legs of each A-frame are tied to each other at the bottom by tape. The tape prevents the legs from sliding apart under the weight of the load. The two legs of the A-frame and the tape together form a strong triangular structure that can carry weight without changing its shape.

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.

   If the working arm is pulled down on the left side by a second winch, it will pivot on the fulcrum and assist to lift the load on the right side.

   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?

   The lever gives a distance advantage, because the distance between the fulcrum and the load (output) is bigger than the distance between the fulcrum and the effort (input).
   The working arm acts as a first class lever, because the fulcrum is between the effort and the load.

4. Name the simple mechanisms that are combined to make the lifting system you described in question 3.

   winch, pulleys, lever

> **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.

5. a) Does the winch give you a mechanical advantage? Explain your answer.

   The winch gives a mechanical advantage because the distance between the axle (the fulcrum) and the crank handle (input) is bigger than the distance between the axle and the circumference of the drum (output). See Figure 13.

   b) How can the mechanical advantage of the winch be increased?

   The winch can use a longer crank and/or a drum with a smaller radius. (But the radius of the drum should not be too small, because it should still be easy for the cable or rope to wrap/bend around the drum.)

6. Does the pulley system give you a distance advantage? Explain your answer.

   No, the pulley system gives a mechanical advantage, because the load moves less than the effort.

What have you learnt?

LB p. 178

1. Give an example of a machine that uses a crank.

   A bicycle uses two cranks: one for each pedal.

2. Give an example of a machine that uses pulleys.

   A lifting/hoisting system in a car-repair workshop uses pulleys.

3. How can some designs of pulley systems give a mechanical advantage?

   It changes a big input movement into a small output movement. So the input force (effort) will be be less than the output force (load).ad).

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

LB page 179

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]

Materials required for the PAT:

- unlined A4 paper for sketching
- graph paper for oblique drawing
- used paper, e.g. A4 or old telephone directories
- waste cardboard, thin, e.g. cereal boxes
- short pieces of thin wire (1 to 2 mm thick) to make connection pivots
- paper clips
- paper fasteners
- string
- wood glue ("cold glue")
- long thin wooden dowels or "sosatie" sticks. You should cut these into shorter pieces, unless learners have saws and sawing blocks, and have learnt to do this safely.
- metal washers
- metal nails
- short pieces of iron wire or iron bolts or nails (for the cores of electromagnets)
- insulation tape
- battery holders
- 1,5 V cells

Tools required for this PAT:

drawing equipment: pencil, eraser, ruler, geometry kit

plastic cups or plates (to keep wet cloths/sponges in); it can be waste

scissors

craft knives and cutting mats to protect desks (optional). Only allow learners to use these if you have already trained learners how to use craft knives safely.

small pliers or wire cutters

at least 8 paper punches

Safety:

Have a basic First Aid kit in the classroom (disinfectant, plasters and bandages) and bleach to clean any blood spills.

Take care when learners work with sharp tools (scissors, nails or awls)

All tasks/questions are essential for the design process, even if no marks are allocated.

All tasks/questions in the PAT should be completed/answered, even the tasks/questions for which *no* marks are allocated for evaluation. This is because all the tasks/questions are essential parts of the design process. So, if certain tasks/questions are not done, then learners will not be able to do the subsequent tasks/questions successfully.

Week 1

Design Part 1 (30 minutes)

Learners should have revised the contents of Chapters 8 and 9 in preparation for this design work. The teacher should briefly revise those aspects related to the strengthening of structures that learners will need to apply in their designs.

The purpose of the illustrations in Figure 1 and Figure 2 is to stimulate creative thinking in order to solve problems. The situation, in italics, sets the scene and explains how a problem was solved. It is followed by information about this PAT that tells the learners about the problem they must solve, what they must build (a model crane) and what the electromagnet must do.

Design brief with specifications and constraints

This is an individual activity for assessment. Learners should use the information given in Design Part 1 to complete this task. The answers to the bulleted questions will form the *design brief* (what the problem is). Then, they will list the *specifications* (what the crane must be like, and what it must do and what the electromagnet must do) and the *constraints* (materials available to them, and time constraints).

Investigate cranes (30 minutes)

This is an individual activity for assessment. Learners have prior knowledge about pulleys and winchess; they investigated, experimented and built pulleys and a winch in Chapter 15. Learners study the four images (Figures 3, 4, 5 & 6), draw rough copies of the images, and identify the pulleys (P) and winches (W) on their drawings.

Look at this model crane

This is an *investigating* activity. Learners, working in pairs, look at photographs of a model of a crane. They should think of reasons for why different parts of the model were made like is was. They should describe the purpose of each part. What design choices were made so that the product is fit for its purpose?

They must note the design (shape) of the model. It is a frame structure similar to the cell phone tower they built last term. Look at the wide base that spreads the weight of the load; it makes the crane stable so that it will not topple over. Look at the application of triangulation; the whole structure consists of triangles.

Observe the *materials* used:

- strong, rigid, well-made paper tubes, with neatly flattened ends where the joints are,
- firm cardboard, and
- a wooden dowel as the pulley.

Observe the *joints*:

- Where glue was used to make a joint, you can barely see the glue, so only a very thin layer of glue was used (see the joint between the cardboard and the paper tube in Figure 10).
- The holes punched through the flattened ends of the paper tubes make it easy for the paper fasteners to pass through it (see Figure 11).

A successful structure must be well designed, be made from materials that are suitable and strong enough for the structure to carry its load, and be well made with strong joints.

Sketching and perspective drawing (60 minutes)

These are individual activities that will be assessed. If the learners completed the previous activity well, they will be well prepared for this *design* activity. The instructions are clear (they must sketch two different designs). The "Things to look at" instruction helps them to focus and include all the relevant information.

Week 2

Planning to make the crane (30 minutes)

Planning is part of *making*. Learners work in teams of three or four for task 1, and on their own for tasks 2, 3 and 4. The team selects one design or produce a new design, which they will build. Each learner then makes a list of the materials and tools they will use and writes about some safety rules when using the tools they mentioned. The Learner Book shows them the step-by-step order of work as a flow diagram.

Plan to make an electromagnet (30 minutes)

The class works through the information given and go back to Chapter 14 to refresh their knowledge about electromagnets. They continue on their own and answer the questions. Refer them to the illustrations on page 164, showing the different components of an electromagnet. They make their own flow diagrams for the step-by-step order of work. This *make* activity and the flow chart will be assessed.

Draw a circuit diagram (30 minutes)

This activity will be assessed. Refer learners to Chapter 14, and instruct them to read the instructions before they draw the circuit diagram of the electromagnet.

Start building the crane and electromagnet (30 minutes)

Learners have until the end of week 4 to build their cranes. They will be assessed for these processes. Instructions about what they should achieve in the 30 minutes are given.

Week 3

Build the crane (30 × 4 = 120 minutes)

This is part of *making*. Keep learners motivated and productive. Instructions about what they should achieve in each of the four 30-minute lessons are given. By the end of the 120 minutes, the crane must be completed.

Week 4

Build the electromagnet (30 × 2 = 60 minutes)

This forms part of making.

Remind learners that they have to work quick enough to finish this in the available 60 minutes.

Revise and draw: Oblique drawing (30 minutes)

Revise work done in Term 1. (Refer learners to Chapter 3.) Work through the instructions for oblique drawings, and how to determine scale. Once learners understand the above, they make an oblique drawing (using squared grid paper) of a part of their model crane. Learners work individually.

Develop an evaluation sheet (30 minutes)

Question 1. This task is for assessment. Learners work individually.

Question 2. Team activity, not assessed.

Question 3. Assess own model, not assessed.

Week 5

Evaluate the other models (30 minutes)

This is a team *evaluating* activity. Talk to learners about what it means to be objective when evaluating something.

Prepare your presentation (30 minutes)

This is a team activity. Remind learners of the following:

- They only have 30 minutes available to plan their presentation.
- They should divide the work among the team members.
- One of them must draw the circuit diagram on the board during their presentation.
- They must plan and remember the order in which they will do their individual presentations.

Reflection and evaluation (30 minutes)

This is an *evaluation* activity. Learners have to think about what they did and how they did it. Impress on them to be objective. They evaluate their own activities.

The teacher can suggest the following questions to the learners, as a way to guide the learners when they evaluate:

- How well was the task completed?
- Are there mistakes?
- What was done well?
- How could you improve the design and model if you had more time?

Deliver your presentations (30 minutes)

This activity is for assessment. Discuss the assessment rubric with the class, so that everyone knows what is expected. Each learner will be assessed.

Week 6

Presentations continued (30 × 4 = 120 minutes)

Make sure that each learner has the opportunity to deliver their oral presentation. You must control the time keeping of each presentation strictly to ensure that every learner has a turn.

This activity is for individual assessment of each learner – different learners in the same team may get different marks.

Discuss the assessment rubric with the class so that everyone knows what is expected.

LB pages 180–181

Figure 1

Figure 2

Week 1

LB page 182

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.

   A scrap metal dealer needs to separate magnetic waste from non-magnetic waste. They need an electromagnetic crane that is strong, can be moved, and that can lift magnetic material. It must be possible to switch the magnet on and off, so that magnetic material can be picked up somewhere and dropped. elsewhere. It will benefit the community by helping to recycle old metal. [3]

2. Identify the specifications.

   (a) List the specifications for the model crane.

   The crane will be used to sort magnetic waste from non-magnetic waste.
   The crane has to be strong (not break), rigid (not change shape) and stable (not topple over). It should be built with a solid frame structure that is strengthened through triangulation.
   It needs to have an electromagnet that can be switched on and off. The electromagnet will be hang from the end of an arm, so that it can lift and lower waste material.
   A winch, a cable and pulleys should be used to lift and lower the arm that supports the electromagnet. [7]

   (b) List the specifications for the electromagnet.

   The electromagnet has to be strong enough to pick up steel paperclips, nails and coins.
   It must have a switch so that it can be switched on and off to lift and drop the materials.
   It will have a soft core made of a bundle of short lengths of wire. [4]

3. Identify constraints, if there are any.

   My model can only be built from materials that are cheap and/or that I can easily find.
   Learners should specify two or more time constraints, such as the following:
   I only have 60 minutes to plan to make my model (first half of week 2).
   I only have 150 minutes to make my crane (last 30 min of week 2, the whole week 3).
   I only have 60 minutes to make my electromagnet (first half of week 4). [1]

[Total: 15]

Investigate cranes

LB page 183

(30 minutes)

Identify winches and pulleys

Work on your own. This task will be assessed.

1. Look at the four images of cranes 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?

   Figures 3 and 4 have pulley systems with two or more pulleys. [10]

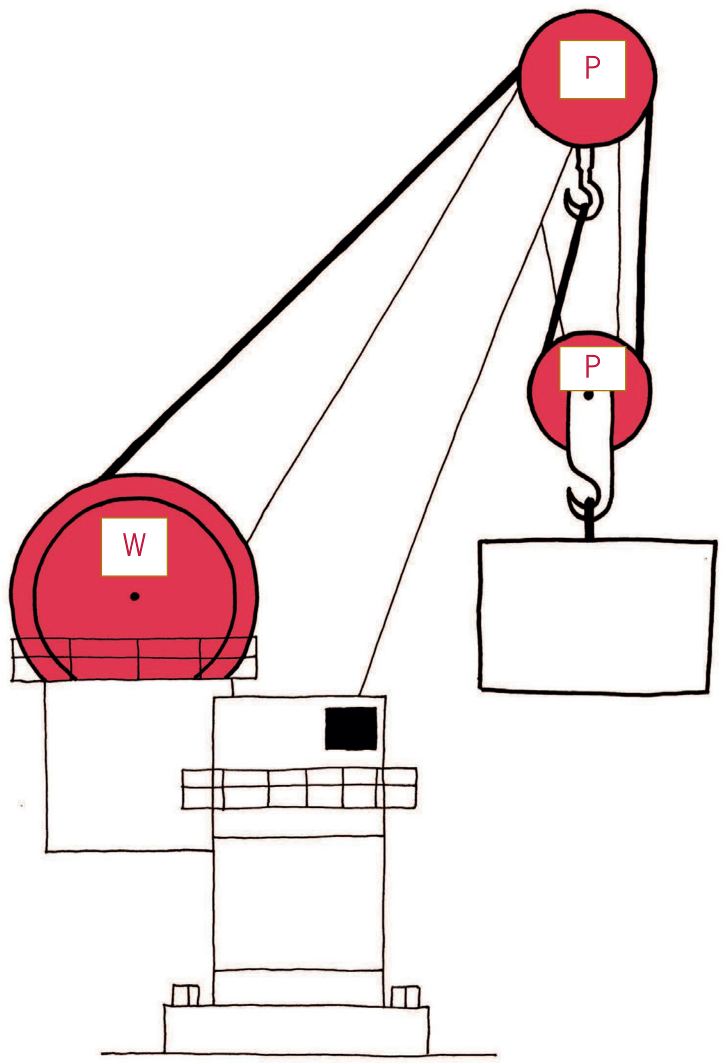


Figure 3: Crane in harbour

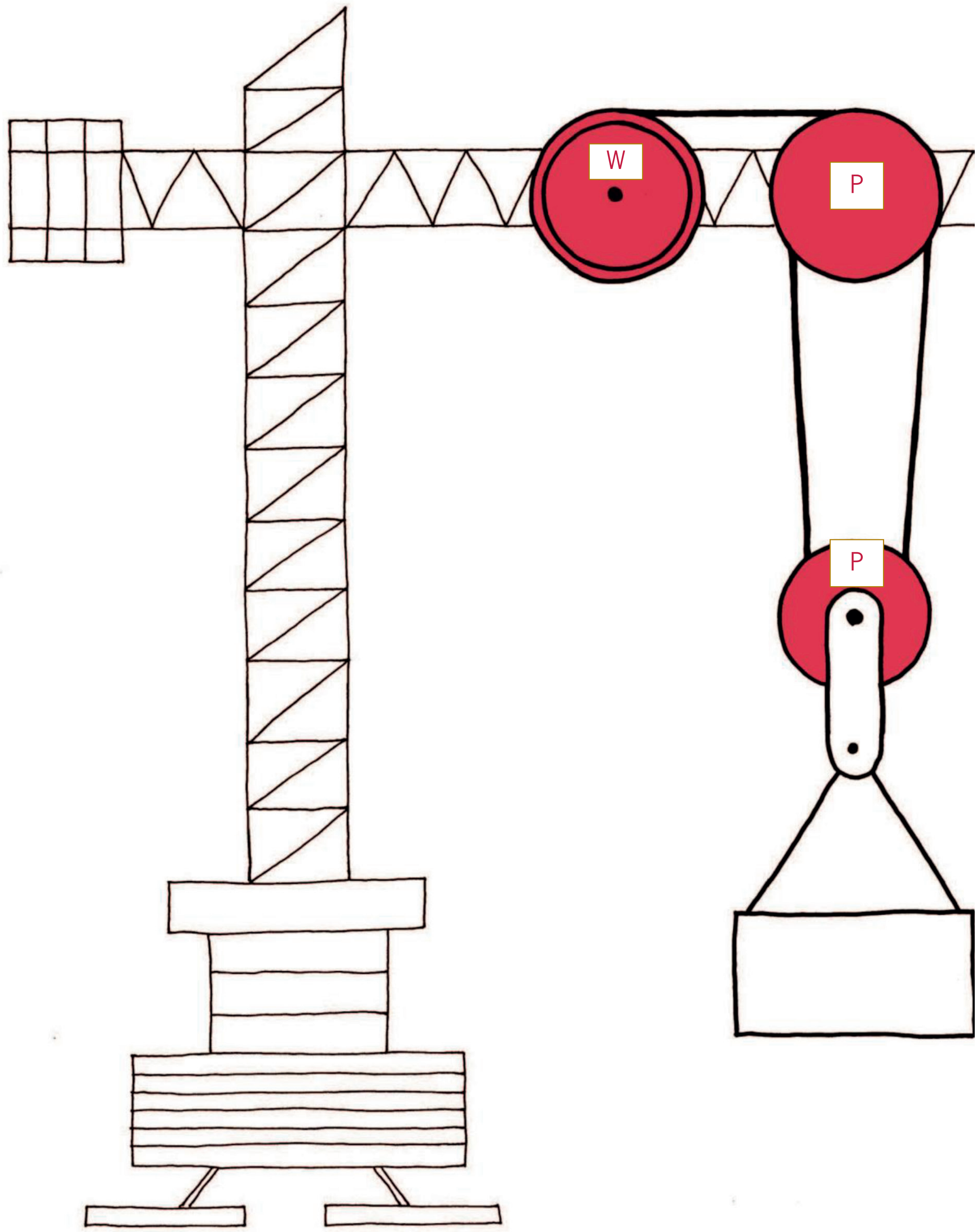


Figure 4: Tall builder's crane

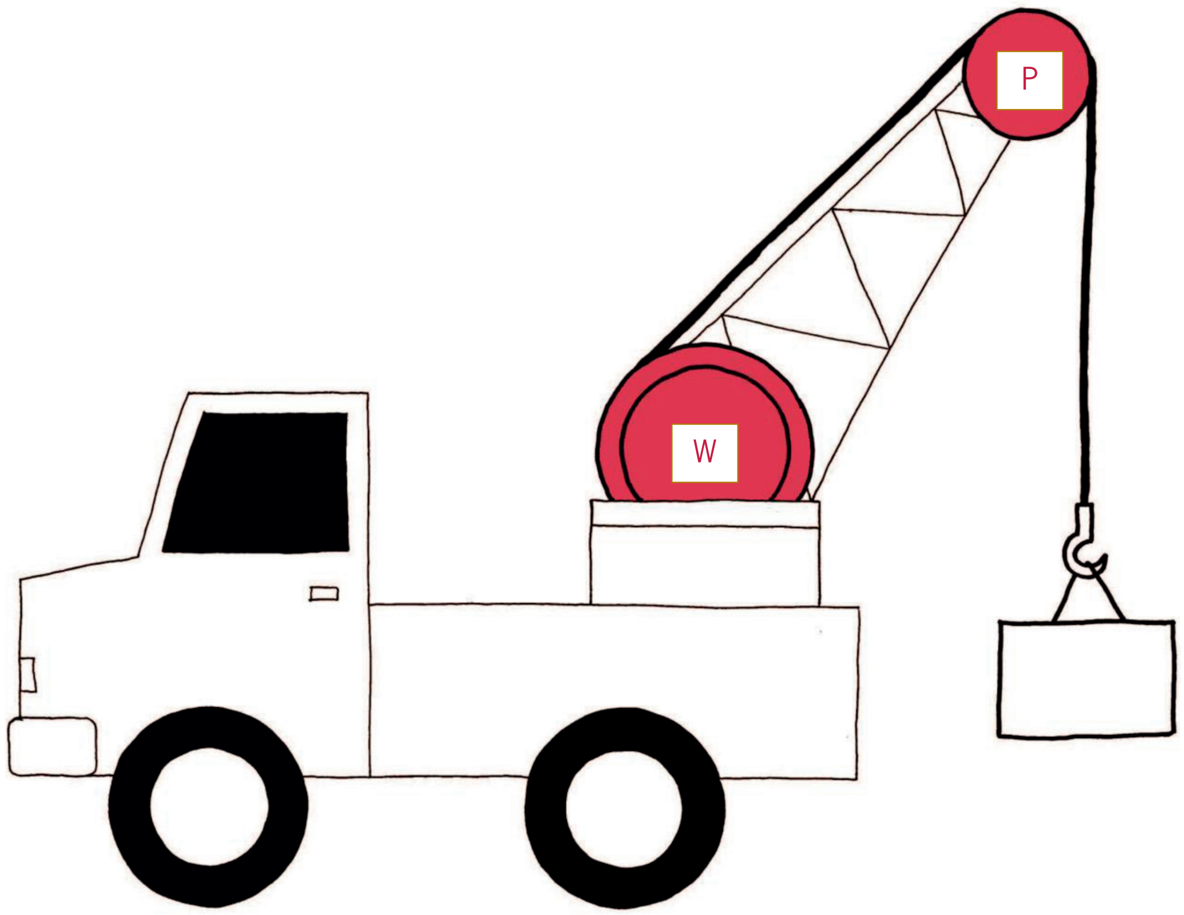


Figure 5: Crane on a truck

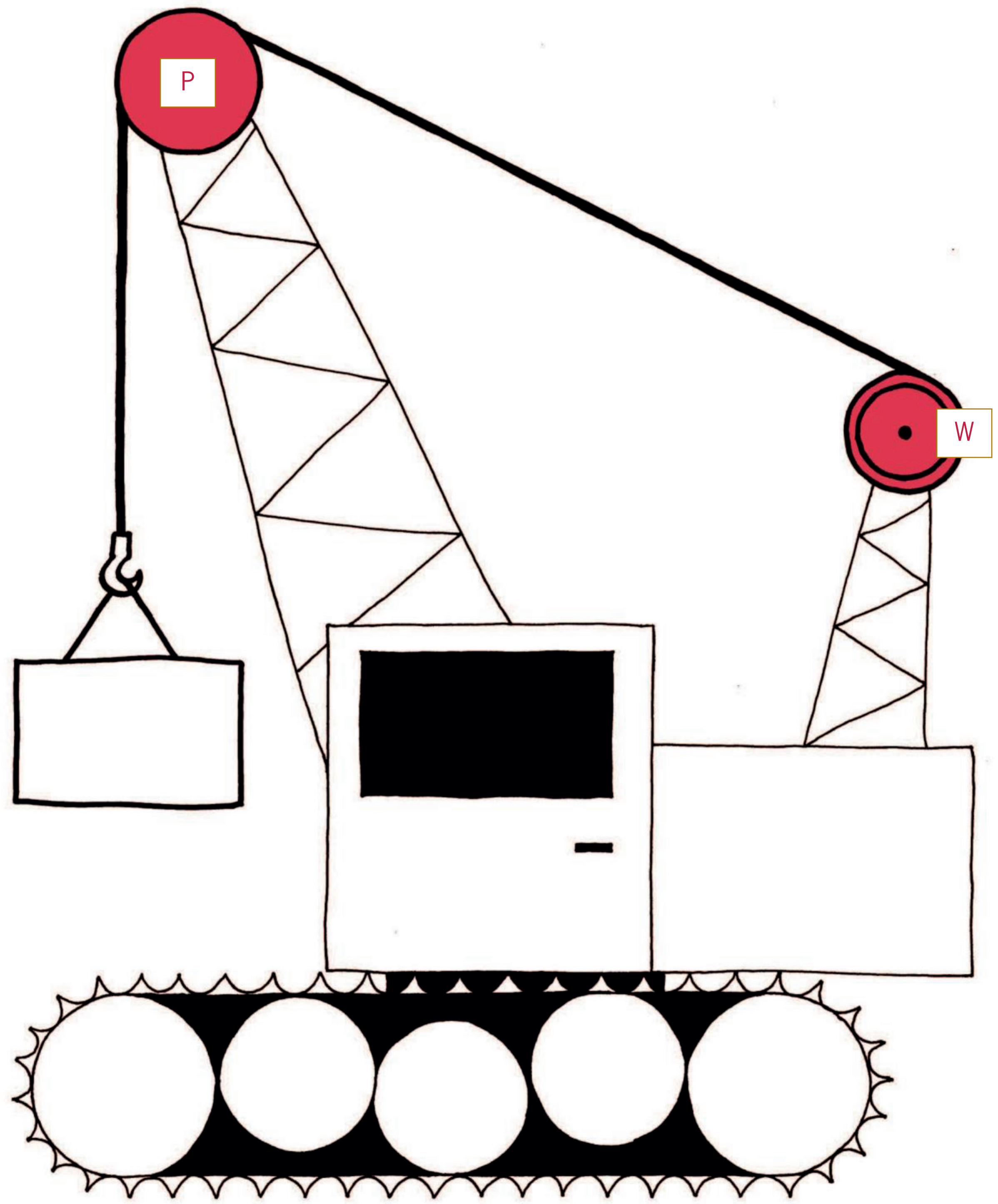


Figure 6: Crane on caterpillar tractor

Look at this model crane

LB page 186

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

LB page 187

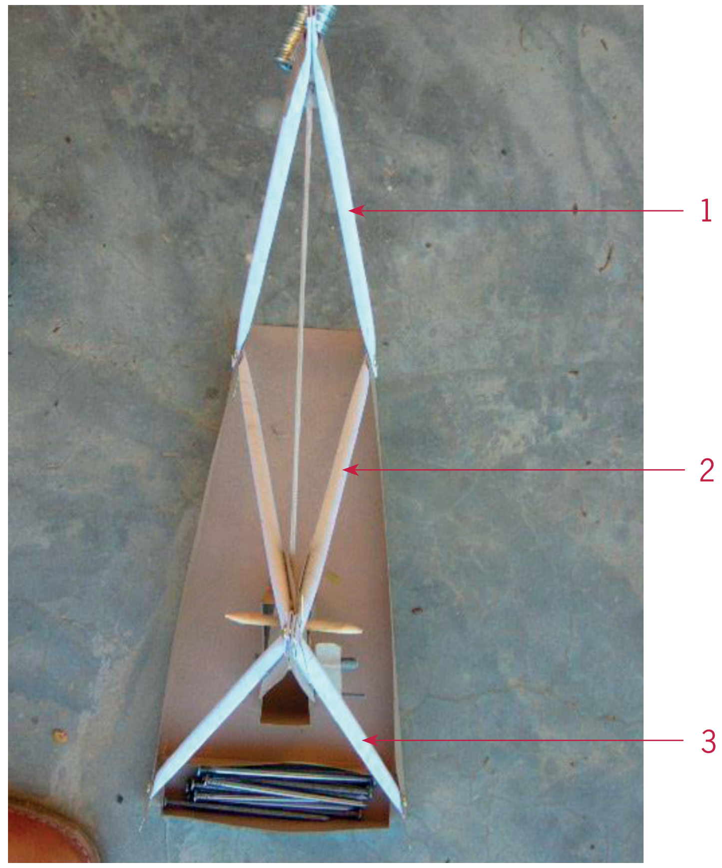


Figure 9

Figure 10

LB page 188

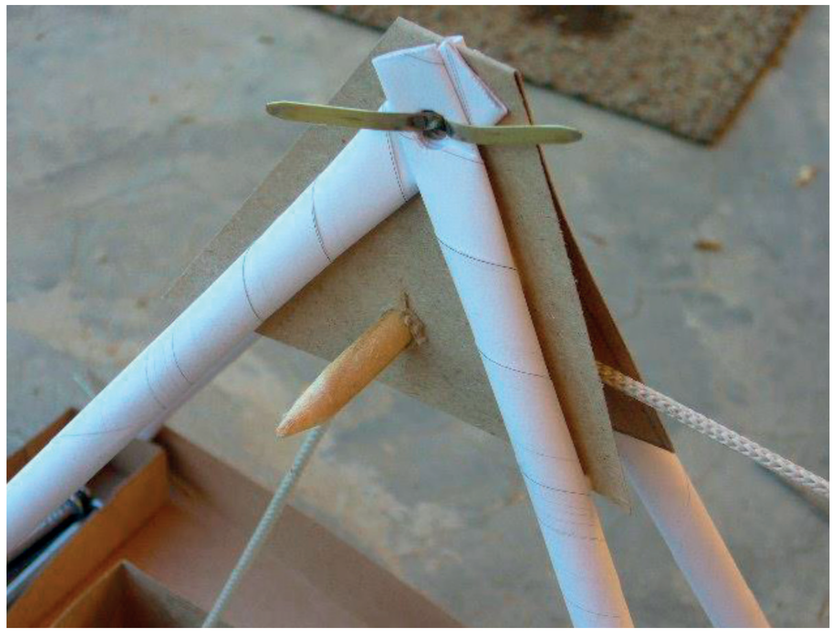


Figure 11

Figure 12

LB page 189

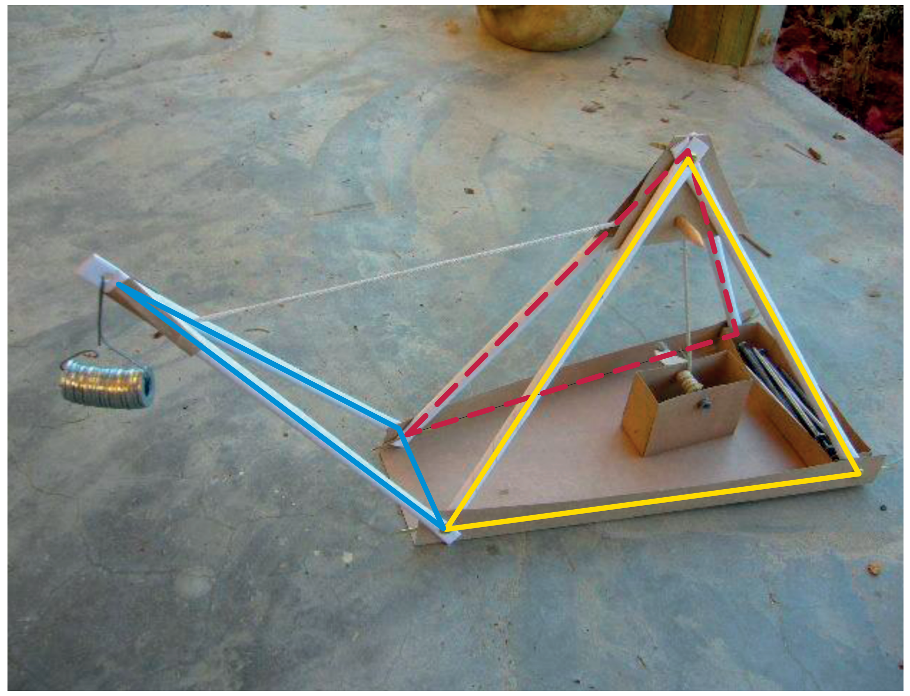


Figure 13

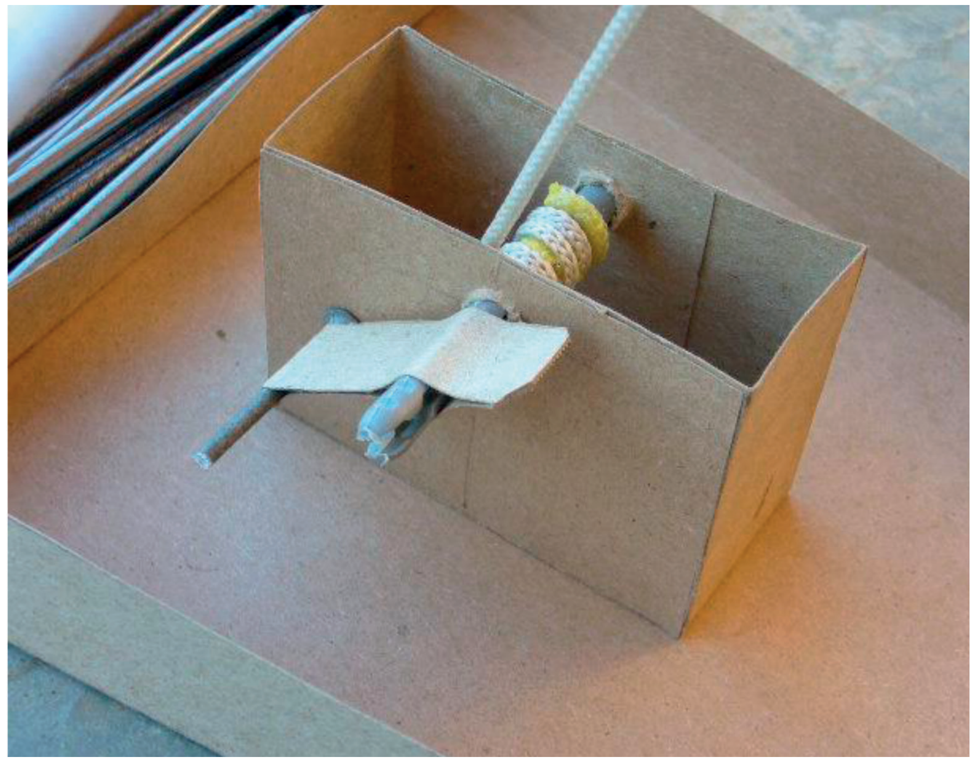


Figure 14

Figure 15

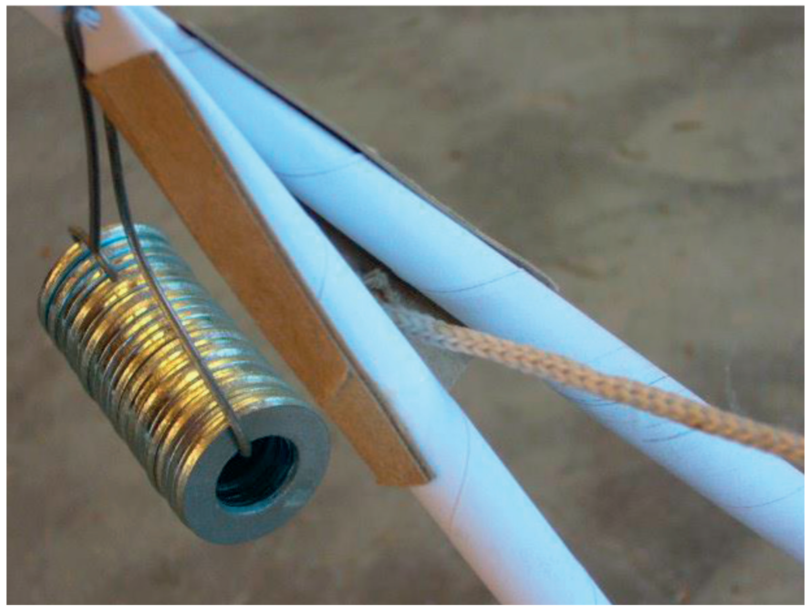


Figure 16

LB page 190

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?

   Three triangles were used to make the crane.
   Note that when these triangles are put together they will form other triangles, if you view the crane from a different angle. The learners must ignore these.

2. Show your partner the triangles in Figure 13. How many are there?

   The three triangles are marked in Figure 13 in the Teacher Guide.

3. List the materials used to build this model.

   Paper; paper tubes; cardboard; string; wooden dowels; nails; wire; plastic cylinder; wire or paper clip; copper paper fasteners; glue; metal washers and thin cloth/sponge.

4. Identify the materials used for the joints on this model.

   Cardboard, glue, paper fasteners and paper tubes.

5. Look at Figures 11, 12 and 13. Look at how the pulley is made. What material is the pulley made of?

   A wooden dowel.

6. Look at Figure 14. List the materials used to make the winch.

   Plastic cylinder or wooden dowel for the drum, cardboard for the crank and the housing, nail for the crank handle.

7. Note where and how the weight has been attached to the end of the pulley. Explain what you see.

   The weight (washers) is attached to the end of the lifting arm with wire (or a bent paper clip).

8. What is the purpose of the box of nails at the back of the crane?

   The weight of the box of nails on the one side balances (counteracts) the effect of the weight of the load on the other side. This prevents the crane from toppling over. The box of nails can be called a "counterweight". (See Figure 3 in Chapter 15 for another version of a counterweight.)

Sketching and perspective drawing

LB page 191
(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

Check the learners as they produce the sketched designs to ensure they have met the criteria.

[10]

4. Draw your other design in single vanishing point perspective. Your drawing doesn't have to be drawn to scale. Use this check list 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?	

Ensure that the learners have answered 'yes' or 'no' to each question in the tables for Questions 3 and 4.

Check that the learners use single vanishing point perspective in this sketch.

Week 2

LB page 192

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.

   Paper, paper tubes, cardboard, string, wooden dowels, nails, wire, glue, paper clips, metal washers and paper fasteners.

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.

   Ruler, scissors, craft knife, pliers to cut wire, pencil or pen, and glue.

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.

   When using a knife, always cut away from your hand.
   When you pass scissors to another person, give it to them with the handle facing the other person.
   When you cut wire, be careful not to catch your fingers in the pliers.
   Learners can write down any other rules that they think of.

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.

LB page 193

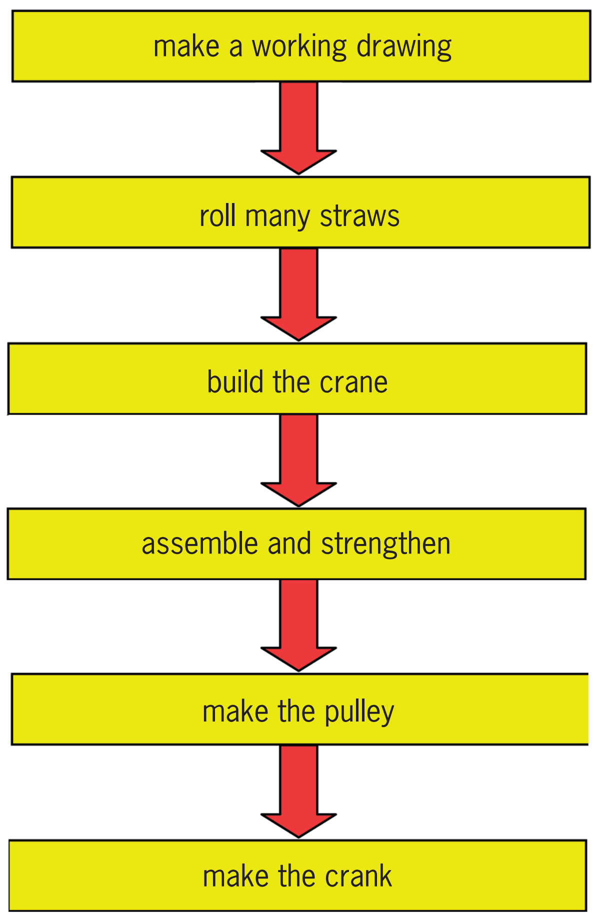


Figure 17: A flow diagram for building a model of a crane

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.

LB page 194

1. List the materials you will use for the electromagnet.

   insulated copper wire or telephone wire; an iron bolt or a bundle of cut (3 cm) lengths of iron wire; insulation tape; 4D cells; battery holder; a switch and extra wire to connect the parts

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.

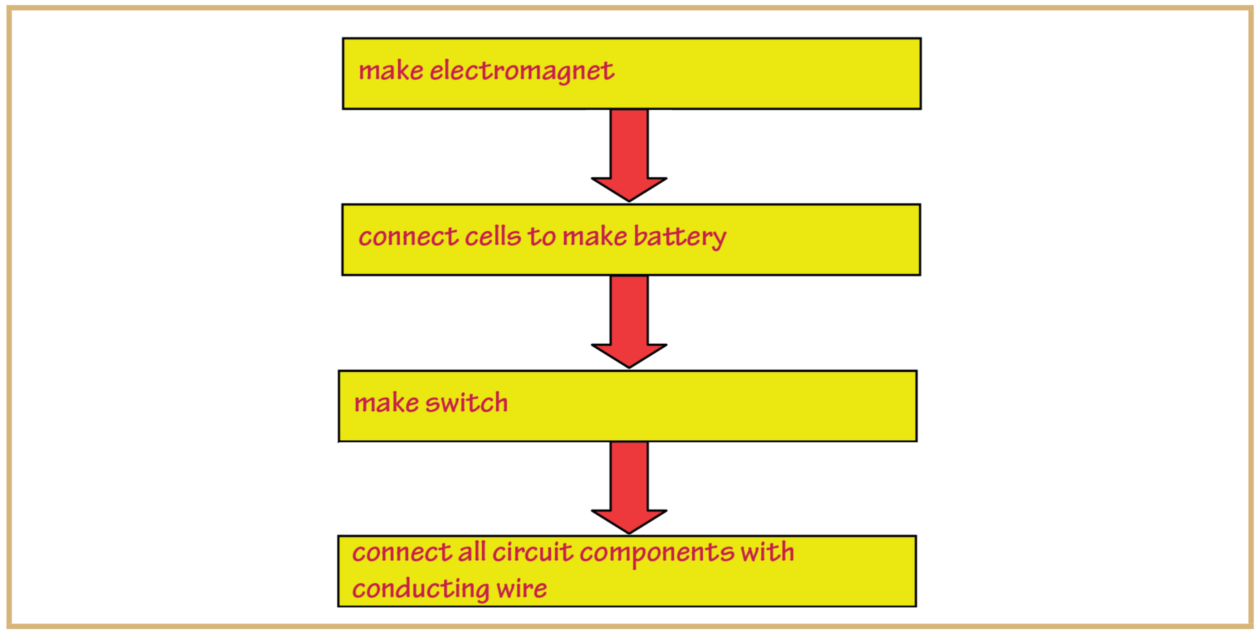
2. List the equipment you will use to build the electromagnet and its circuit. Make sure you use the correct tools. Don't cut wire with scissors.

   Scissors; small pliers or a wire cutter, and insulation tape.

3. Write at least one safety rule to follow while making the electromagnet.

   I will be careful when using sharp pliers to cut wire.
   I will not leave wire strips lying around.
   I will not use scissors to cut wire.

4. Draw a flowchart of the method you will follow to build the electromagnet and its circuit. This task will be assessed. [5]



Draw a circuit diagram (30 minutes)

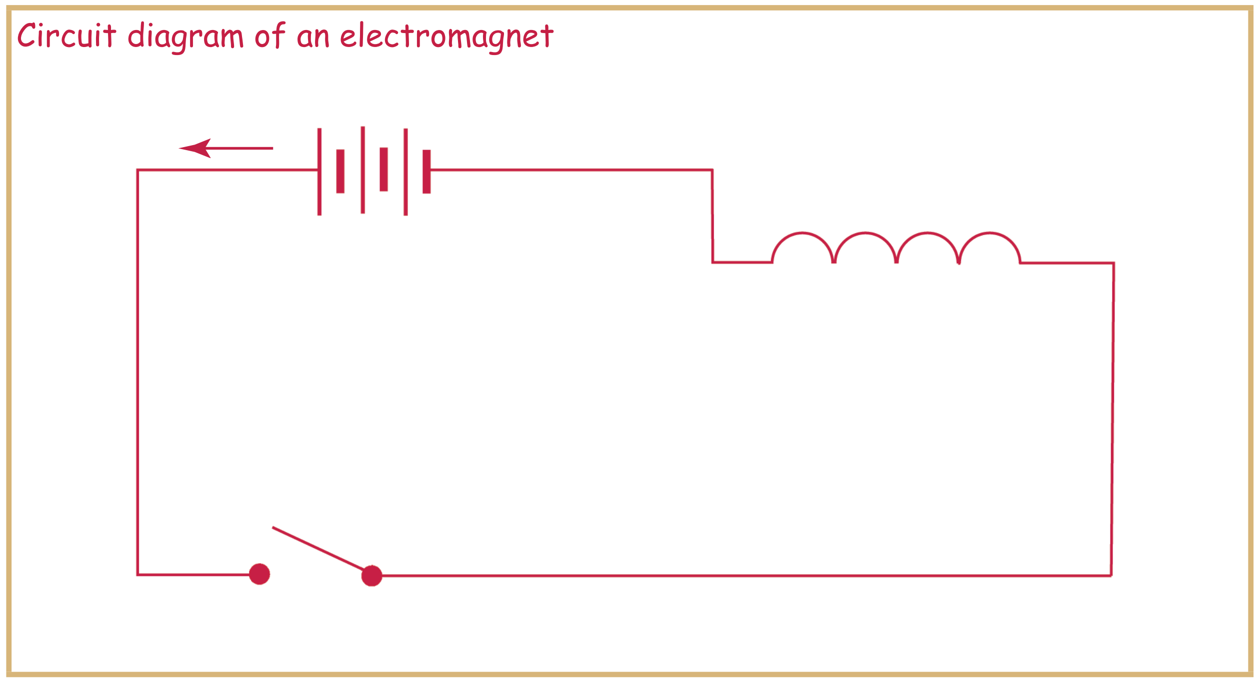
Your teacher will assess this task. We draw working drawings before we start making a model. When you plan to make a circuit, you first draw a circuit diagram.

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 as shown below. [8]

Figure 18: Circuit symbol for an electromagnet



LB page 195

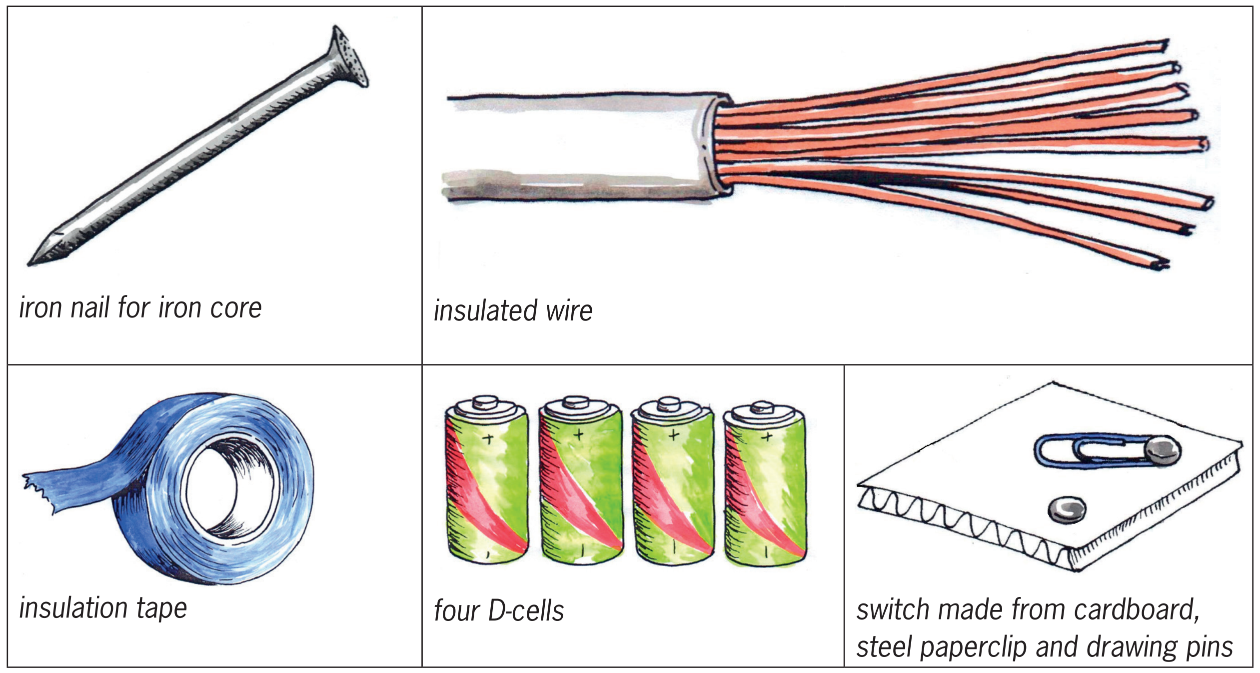


Figure 19: Materials used to make an electromagnet

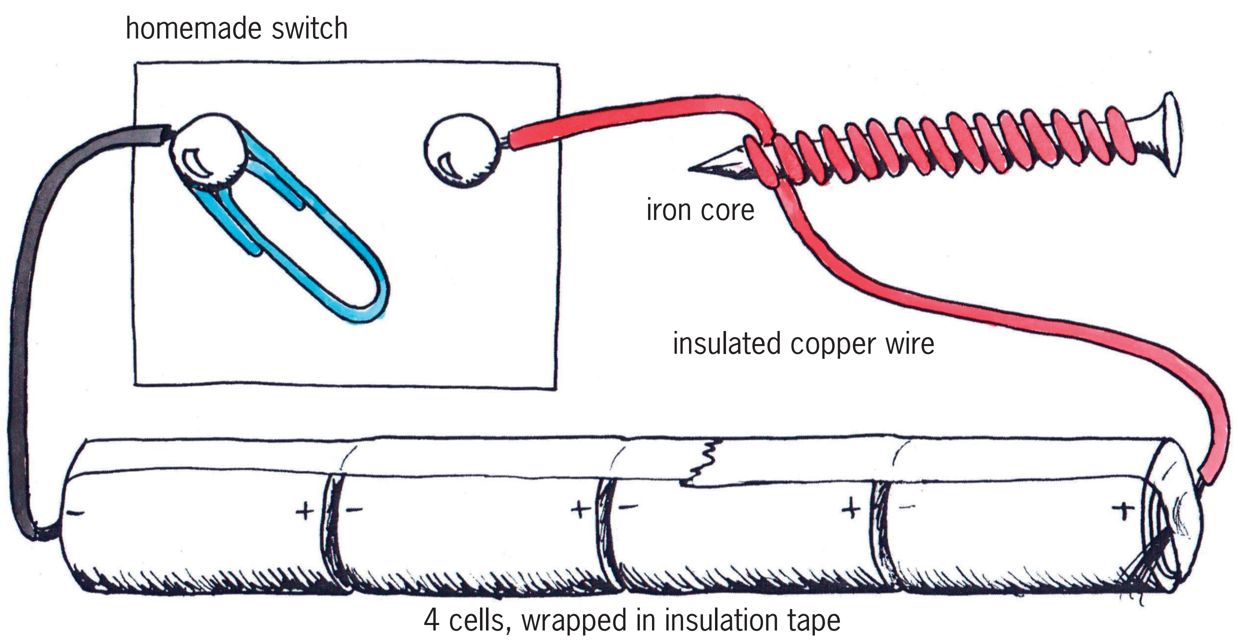


Figure 20: Electromagnet

LB page 196

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 times 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. [12]

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

LB page 197

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

LB page 198
(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.

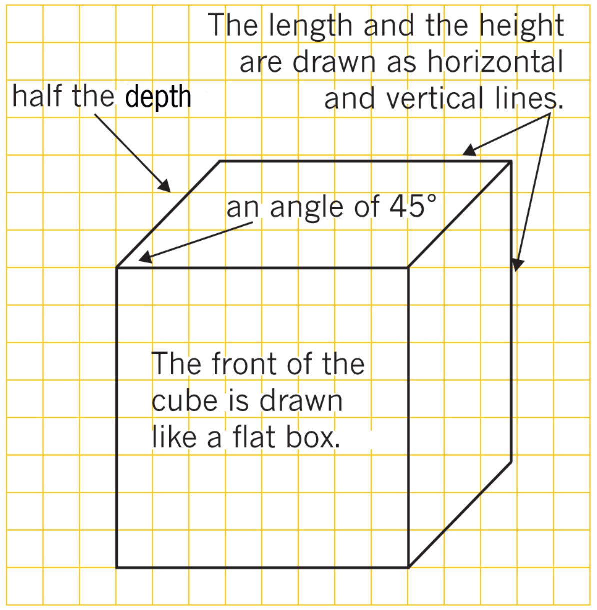


Figure 21: How to draw an oblique drawing

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.

Check that the learners have selected a part of the crane that will challenge them adequately, for instance not just the base. When assessing the oblique drawing, ensure that the scale is correct and is indicated on the grid. Ensure that the drawing is obliquely sketched as they have been taught.

Develop an evaluation sheet

LB page 199
(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.		
The crane structure needs to be strong and stiff, and built on a solid frame that is strengthened by triangulation.		
The crane must have an electromagnet that hangs from the top of an arm. It must be possible to lift and lower the arm using the winch.		
The electromagnet must be able to switch on and off, to lift and drop the materials.		
The electromagnet has to be strong enough to pick up steel paperclips, nails and coins.		
The crane must be stable when lifting a load. It must not topple over because of the load it is lifting.		

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

LB page 200

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.

LB page 201

- 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	☺	😐	☹

LB page 202

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.			

You can add additional criteria to the above if you feel it will help the assessment. The mark is out of a possible 10, so you can add as many criteria as you think necessary.

You must assess each member of each group's presentation in terms of the criteria you have chosen, so it is important that each member of each group contributes to the presentation. This must be emphasised before the presentation.

There are 150 minutes for the presentations, so each group will have plenty of time to give a comprehensive presentation. Make sure that they have prepared adequately.

Week 6

Presentations continued ($30 \times 4 = 120$ 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

LB page 203

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.

This is the first of three chapters about emergency situations. In this chapter, learners will find out about different situations that cause people to become refugees, such as natural disasters and war. They will think about and discuss different problems that the refugees face. They will also think and talk about the needs of the refugees when they arrive in a foreign land, as well as the problems the rescue aid workers face with an influx of people that need water and food.

Figures 1 and 2 show different situations and set the scene. It should stimulate the learners' thought processes (particularly those learners who learn best visually) about the reasons why people might become displaced, and the challenges faced by displaced people.

Additional resources that will help demonstrate reasons why people become refugees and the problems faced by refugees once they arrive in a foreign land:

pictures and photographs of refugee situations

newspaper articles about refugee situations

someone in the community who has first-hand experience of being a refugee

17.1 Situations that cause people to become refugees

This is an activity for the whole class. The first three paragraphs introduce learners to emergency situations, and explain the term 'refugee': a person who is forced to leave their home as a result of a disaster or an emergency situation. Such a person may be moved to a safe place close by their homes, or they may move to another country far away from their homes. War and natural disasters, such as floods and drought, which often occur on the African continent, are reasons why people become displaced. Read through the text and discuss the content with the class. Allow time for input from learners, as some may have second-hand or even first-hand experience of a similar disaster. Take care, as this is a sensitive issue and such learners may still be traumatised by their experience. Never force a child to talk about their traumatic experience.

Sometimes, refugees move to a safe place that is close by, and at other times they have to travel to another country.

17.2 Initial problems facing refugees

Here learners find out about the speed at which emergency situations come about. Some disasters, like floods, occur suddenly and there is no time to prepare for them. Others, like drought or war, occur over a long time-period and people have the opportunity to plan their escape from the situation. In some situations, the refugees would have left their homes with nothing but the clothes they are wearing or only with a few items that they can carry.

The learners find out about the different situations influencing the mix of people affected by anemergency situation. The mix of people will affect the needs of the group. Groups with many babies and young children, or children without parents, or many old people, all will have very specific needs. The mix of able-bodied adults versus people who need care will affect the group's ability to be practically of use, or even be partially self-sufficient. The questions that follow, which address these situations, can be an individual or a paired activity, depending on the abilities of the learners in your class.

17.3 Refugees in a foreign land

Learners access a case study about an emergency situation and refugees. They apply their newly-acquired knowledge, as well as their insight and critical thinking skills, to answer the questions that follow.

Extend this lesson by asking and encouraging the class to think about the long-term problems refugees face. For example, not being able to speak the language of the host country, finding a permanent place to live, finding work as often refugees are not qualified to work, adjusting to a new culture as everything is strange and new, and the effect of missing relatives and friends.

LB pages 204–205

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

LB page 206

17.1 Situations that cause people to become refugees

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.

LB page 207

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.

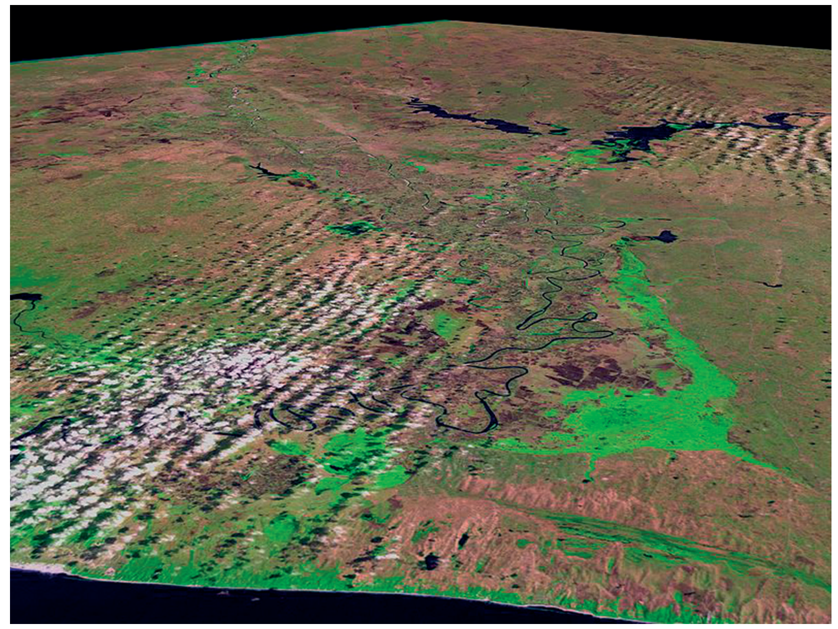


Figure 4: This satellite picture of the disaster area in Mozambique was taken before the flood.

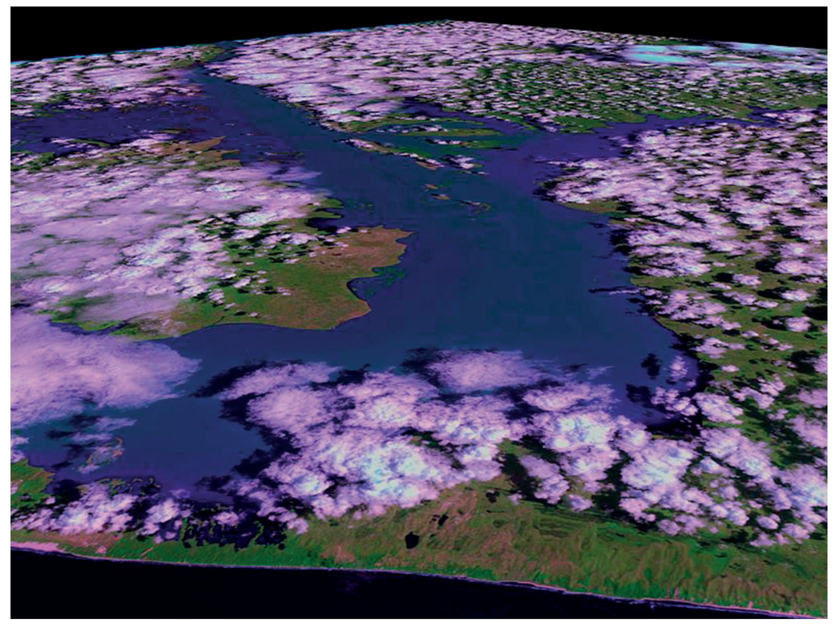


Figure 5: This satellite picture of the disaster area in Mozambique was taken during the flood.

LB page 208

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.

LB page 209

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 — LB p. 209

1. Which emergencies happen suddenly, without warning?

   Fires, floods and conflicts like war can happen without warning.

2. How will these sudden emergencies affect each of the following:

   (a) the mix of people in the group?

   In wars, men and older boys often have to leave. The people who remain behind are mostly women, the aged, children and disabled people.

   (b) the amount of food and water refugees have with them?

   Sudden emergency situations often mean that there is no store of food, and access to clean water may be limited. When it is caused by fire or flood, most of the provisions will have been destroyed, leaving the people without supplies.

   (c) the ability of refugees to build their own shelters?

   When fires and floods have destroyed settlements, the materials to rebuild are often also destroyed or washed away, and tools are not available. In wartime, if people have to move, they may not be able to find suitable materials, have the tools, or even find suitable ground to build on.

3. Which emergencies happen slowly, over a longer period of time?

   Droughts and loss of crops happen over a longer period of time

4. How will these slower emergencies affect:

   (a) The mix of refugees in the group?

   When food or water is scarce, weaker people will become ill and possibly die sooner. Old people, sick people and infants will be the first to suffer. Men and women might leave the settlement to try find work or food in other areas, and this will reduce the number of strong people.

   (b) how much food and water will they have with them?

   Food stores and water will reduce very quickly if they are not resupplied. Food has to be brought in from other places, and sometimes the little water that is left for the people becomes polluted and needs to be cleaned.

(c) whether they can build their own shelters or not?

A drought should not affect shelters, but it won't be possible to build many new shelters because there will not be wood for frames or reeds and grass for thatching.

5. Which emergencies are the most difficult to plan for? Explain why you say so.

Sudden emergencies such as floods and fires are unexpected and are more difficult to plan for. Communities can plan in some ways for these emergencies, but it is difficult to store enough food.

6. Which emergencies are easier to plan for? Explain why you say so.

Longer term emergencies can be planned for, since there is accurate weather forecasting that can predict when long droughts will occur. Communities can plan for these droughts by storing food, looking for alternative sources of water, and making sure that the elderly and the young will be properly cared for during difficult times.

17.3 Refugees in a foreign land

LB page 210

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

LB p. 210

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.

Because it is a war situation, the younger men will probably have to join the army. The group will consist mainly of women, children, and older men, sick and disabled people.
The people who will need the most attention are young children, the elderly and people who are ill or disabled.

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?

The refugees will have only what they could carry, so probably no materials or tools. The host nation will have to supply them with shelter. This will probably be temporary, so tents and simple shacks will be put up.

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?

The refugees will need the same amount of food and water in their camp as they lived on before. They will need to eat nutritious food that will keep them healthy. Growing children and young adults will need more food than the elderly.
Water will need to be plentiful and clean. Dirty water can carry diseases such as cholera, which is deadly.

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 nutritious foods are the easiest to find in your area?
- Which nutritious foods are the cheapest to buy in your area?
- Which nutritious foods are easy to prepare?

Chapter 18
Processing food for emergency situations

LB page 211

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.

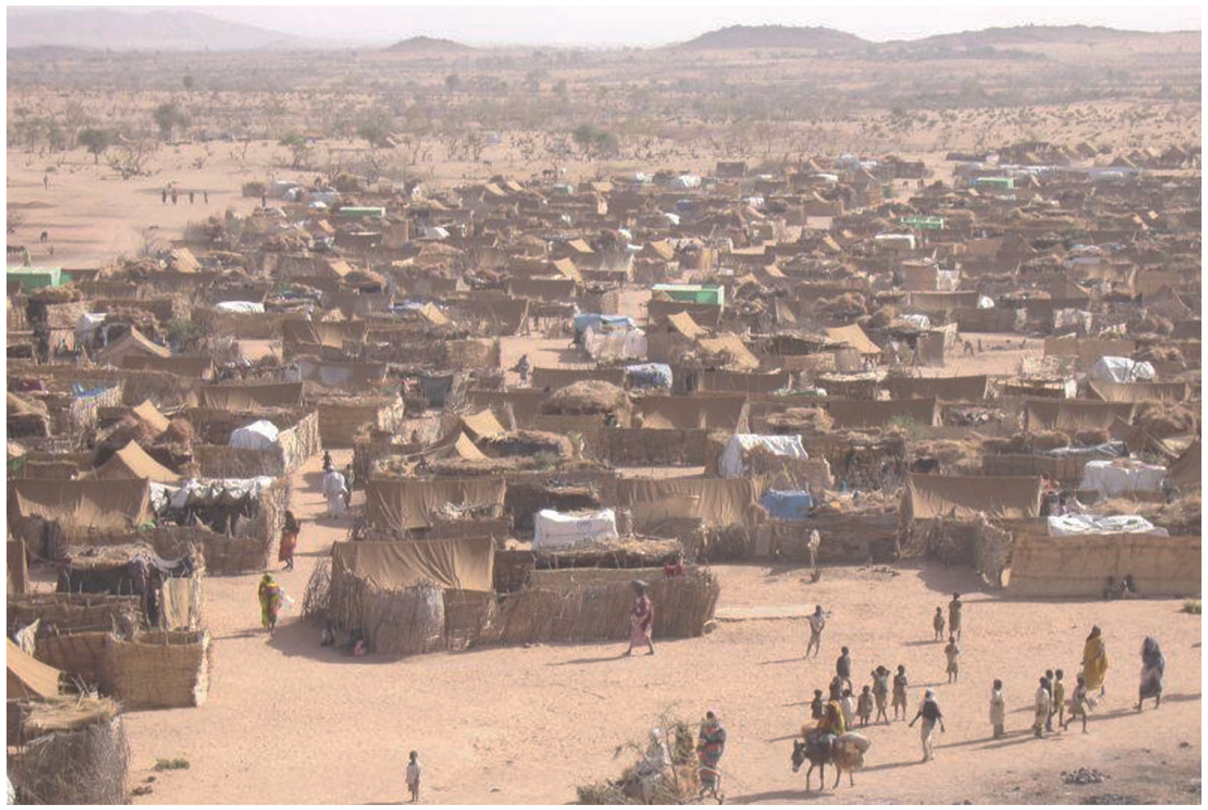


Figure 1: A refugee camp in Darfur, Sudan, in North Africa

In the previous chapter, learners found out about situations that result in people leaving their homes with few possessions and little or no food, as they left their homes in a hurry and they took only what they could carry.

This chapter looks at the type of food suitable to use in refugee situations. Refugee camps are often set up in open areas with little infrastructure. This affects the type of food that can be stored and used. Dried and processed food is a practical choice, as they can be transported and stored without a great loss due to food going off and becoming inedible.

Learners will do *investigations* and write a *design brief* with *specifications*, to plan a meal for people in a refugee situation. This forms part of the design process (investigate, design, make, evaluate, communicate). In the next chapter, they will complete the task, and make and evaluate a food item.

Figures 1 to 3 are designed to create an awareness of the facilities and housing in a refugee camp, the minimal cooking facilities that may be available, and of different foods that may or may not be practically suitable when there are a few or any cooking or storage facilities.

Additional resources about food choices:

Pictures, packaging and photographs of different processed and dried food.

A poster showing the five food groups, with examples of types of food that belong in each of the food groups.

Information about healthy eating and good food choices, for example pamphlets from government health departments and businesses.

18.1 Investigate types of food

This lesson starts by learners recalling the homework tasks from Chapter 17. They were asked to list food that is readily available in their area, foods that are relatively cheap and foods that are suitable for large groups of refugees. They learn that different people have different nutritional needs: children need more protein than adults or the elderly do, as they are still growing, babies who should be breast- or bottle-fed need milk formula and elderly people need food high in vitamins and minerals to help prevent them becoming ill. They learn that people need healthy food, not necessarily expensive food, to keep them well and to prevent disease and infections.

Learners discover that a balanced diet is a diet where the food eaten in one day includes food from all the food groups. Foods that contain all the nutrients: carbohydrates for energy; protein to build tissue; fats and oils to help fight disease, protect our internal organs and give us energy; vitamins and minerals for good health, as they help prevent infections. Specific vitamins and minerals have specific tasks. For example, Vitamin C fight infections and Calcium build strong bones and teeth, to name only two. They learn that water, although not a nutrient is important for our bodies to digest and absorb the food we eat.

Food is divided into food groups (Meat and meat products; Grains and grain products; Milk and milk products, Fats and oils; Fruit and Vegetables) to make the planning of meals easier. Food with similar nutrients is grouped together in these food groups.

The learners compare and discuss their homework notes in pairs, and decide together what they would serve to refugees. They may choose one learner's idea for a meal, or they may combine their ideas to create a new meal.

Figures 7, 8 and 9 provide important information that learners will find useful when designing a meal in section 18.3.

18.2 Investigate your refugee camp

This is an activity for the whole class. The learners must decide as a class about the issues relevant to their group of 100 refugees of mixed ages. There are three decisions to be made namely:

- Where to find, how to transport and how to cook the food?
- Is there clean water available? Discuss the importance of water for cooking and cleaning.
- Nutritious food and the possibility of a menu – not serving the same food day after day.

Once the class has made their decision, each learner records the decision in their exercise books.

18.3 Write a design brief to feed your refugee camp

Learners apply more steps of the *design* process. They write a *design brief* with *specifications* and start *designing* a meal suitable to be served to refugees. They use what they learnt from their investigations in the previous chapters, about refugee situations and nutrition, to make a table showing the amounts of ingredients needed to feed one baby, one child, one adult and one elderly person. You can write the suggestions on the board for everyone to copy.

For the tables of ingredients that learners have to complete on page 219 of the Learner Book, there can be different lists of ingredients, depending on what kind of ingredients are available in the area where the school is, cultural preferences about food, and costs. Therefore, the answers for those tables that are shown in the Teacher Guide, are *only one example* of a possible list of the ingredients of a meal. Learners may create good lists of ingredients that are different from the example answers.

Work through the information "Design a meal for 100 refugees" with the class. Make sure that all learners understand and can do the calculations.

Make sure that each learner writes the *specifications* listing the *types of ingredients* and the *amounts* of those ingredients.Support learners who struggle with the calculations.

LB pages 212–213

Figure 2

Figure 3

18.1 Investigate types of food

LB page 214

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.

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LB page 215

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.

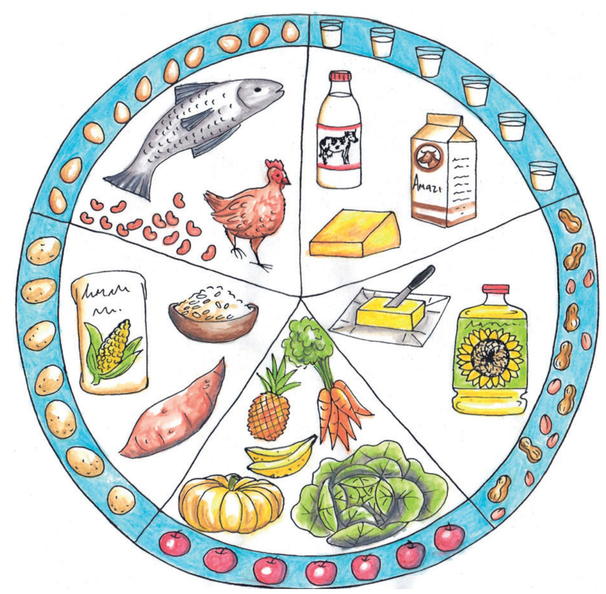


Figure 4: A balanced diet consists of food from all five food groups every day.

LB page 216

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

LB p. 216

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.

LB page 217

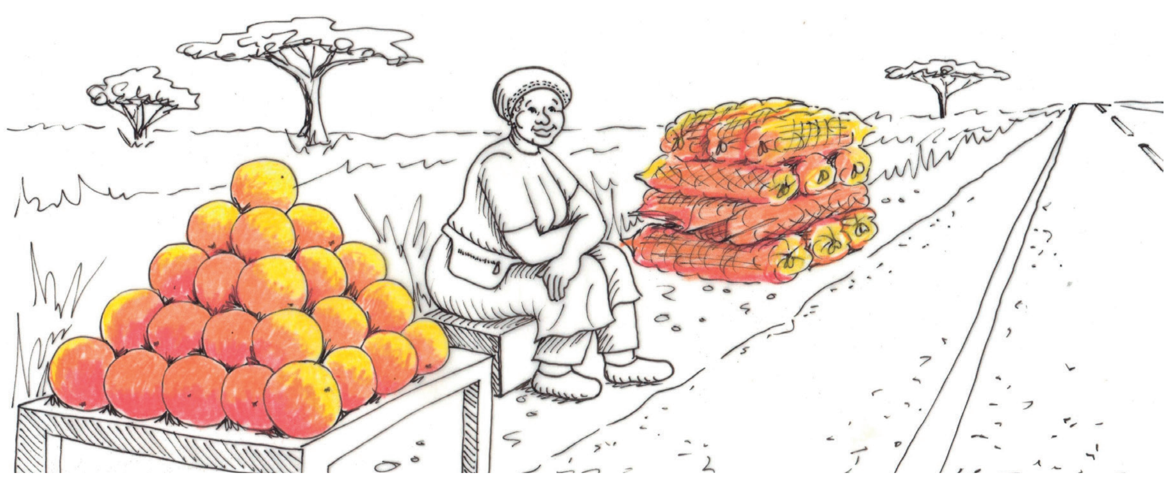


Figure 7: Oranges have lots of Vitamin C to help prevent colds and flu. They are cheap and widely available in winter.

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

LB p. 218

1. What type of food did you choose? Write down why you chose it.

   Check the learners' answers to this question. They have to base their food choices on availability, cost, nutrition and ease of preparation. If any learner suggests food that does not qualify, have them look at the nutrition wheel to think of another suggestion.

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.

   The learners have to take the ability of the various age groups to eat certain foods into account. Young children and elderly people cannot chew hard food and children need extra nutrition.

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.

   The learners should focus on food that is easily obtainable and inexpensive. The learners have to show that they understand that large supplies have to be available to feed the group on an ongoing basis.

4. Is the food nutritious? Write down why you think the food you have chosen will keep the refugees healthy.

   Check that the learners have provided mixed meals with all the food groups, including fresh vegetables.

5. Is it easy to prepare? Write down the reasons for your answer.

   The food needs to be cooked in large amounts, so the learners have to understand that a lot of ingredients will be cooked in single pots. They also need to understand that fuel, such as wood or gas, has to be available.

18.2 Investigate your refugee camp

Whole class work: Make decisions LB p. 218

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)	20
Children (6–15 years old)	30
Adults (15–65 years old)	40
Old people (older than 65 years)	10

- 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

The group must approach external groups for assistance. Social services, a few businesses, church groups or charities might offer help. They should find out where they can obtain food and a way of transporting it. They need to locate pots, pans, utensils and plates or bowls for people to use.
The group has to find an area with clean water so that food can be cooked, utensils and pots cleaned, and general cleanliness followed in the cooking process to avoid illness. As long as it is nutritious, the people can be fed the same food for as long as necessary, to keep them healthy.

LB page 219

18.3 Write a design brief to feed your refugee camp

Listing the ingredients and quantities per meal per person

Before you work out how much food you need for 100 people, work out how much food you need for one meal for one person. 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)
Tinned fish	$\frac{1}{4}$ tin
Tomatoes	$\frac{1}{2}$ tomato
Salt	5 ml

Amount of each ingredient needed to feed one child

Ingredient	Amount
Samp	Two thirds of a cup (200 grams)
Tinned fish	$\frac{1}{2}$ tin

Tomatoes	1 tomato
Salt	10 ml

Amount of each ingredient needed to feed one adult

Ingredient	Amount
Samp	1 cup (300 grams)
Tinned fish	1 tin
Tomatoes	1 tomato
Salt	10 ml

Amount of each ingredient needed to feed one old person

Ingredient	Amount
Samp	Half a cup (150 grams)
Tinned fish	$\frac{1}{2}$ tin
Tomatoes	$\frac{1}{2}$ tomato
Salt	10 ml

Design a meal for 100 refugees

LB p. 220

Once you have completed the tables above, 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

LB p. 220

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.

Name of ingredient	Amount of the ingredient needed
Tinned fish	65 tins
Samp	21,5 kilograms
Tomatoes	85 tomatoes
Salt	900 ml

This is based on a calculation using 20 babies, 30 children, 40 adults and 10 elderly people. Learners should multiply the amounts of food required per person, per meal. The learners have to do their own calculations based on the foods they have chosen and the amounts they have proposed.

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

LB page 221

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

In the previous chapter, learners *investigated* the types of food refugees need to stay healthy while they are in an emergency situation. They learned about nutrients (carbohydrates, protein, fats and oils, vitamins and minerals) and about food groups. They learned that food with similar nutrients are grouped together in these food groups (Meat and meat products; Grains and grain products; Milk and milk products, Fats and oils; Fruit and Vegetables) to make the planning of meals easier. They also learnt that water, although it is not a nutrient, is important for our bodies to digest and absorb the food we eat.

They *investigated* and calculated portion sizes for different age groups. They then *designed* a balanced meal and wrote a *design brief* for a meal for a 100 refugees of different ages. Now they will continue working through the design process when they *make* and *evaluate* their meals.

Figure 1 shows the different steps for making a meal. Point this out to the class, as it will help focus their attention on the steps they must formulate in the first activity.

Materials and equipment required for this chapter:

tasting bowls and tasting spoons
washing-up bowl
water
dishwashing detergent
drying cloth

19.1 Method for preparing part of a meal

Refer learners back to last week's work, as well as the homework task – the meal they planned. Ask them to think again, *evaluate* and make sure that their chosen meal is tasty, nutritious and that the ingredients are easy to find.

Learners must write down the steps for preparing the meal in **sequence**. In other words, they must write the steps in the order that those steps should be followed to cook a type of food, or to make a dish. Next to each step, they will write how (the instruction) and why (the reason) they follow that particular step. They will find examples on pages 224 and 225 of the Learner Book.

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.

Suggest that the learners work in rough first. They will be able to *evaluate* and add steps, and change steps or reasons, once they looked at the completed set of instructions critically. This will save them from rewriting the set of instructions neatly more than once.

They will not be able to complete this task in class and will have to complete it at home, as homework. They may ask an adult at home to help them with the task. They must record the name of the person that helped them with the task.

Once back at school, they will discuss their plans with a partner and rewrite the plan if alterations or additions are made.

19.2 Prepare the food (homework)

This is a homework activity. With the help of an adult at home, each learner will follow their own plan and prepare, and *make* their dish. They cook only for one person, not for 100 people. They will collect the ingredients, and follow their plan carefully when cooking the dish. If they adapt the plan, they must write and record the change on their original plan. They must also explain the reason why they changed their plan. This information will be used when they evaluate their *making* sequence in Section 19.3. They must follow good **safety practices** to prevent burns and fires.

Still at home, each learner will taste their dish, and judge and *evaluate* its flavour, its taste and its texture, if it is easy to chew and swallow. They will also judge and *evaluate* its nutritional value by applying their prior knowledge. They will then write down the result of their *evaluation*.

Once they finish the tasting session, they will store the dish in a suitable clean, sealed container that can be transported to school and store it in a refrigerator or cool place overnight.

19.3 Evaluate the food

Learners bring their meals to school, and a spoon that they will use to taste the different dishes. Instruct them to wash their spoon after each tasting, so that they don't contaminate someone else's dish by using a dirty spoon. Explain to them that this is important for preventing the spreading of disease, in case somebody is ill. Working in groups of four, they taste their own and their three partners' food items, and then complete the *evaluation* of each of the four dishes.

They then *communicate* their *evaluation* of each of the dishes to their partners, suggesting how the taste, texture and flavour of each of the dishes may be improved.

Having received feedback from their three partners, they write an *evaluation* of their own dish once they have read the example provided in the Learner Book carefully. This is followed by a paragraph listing everything they learned in this chapter. Once again, an example of such a paragraph is provided as a guideline.

LB pages 222–223

Figure 2: Ingredients for an easy-to-cook, healthy meal.

LB page 224

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.

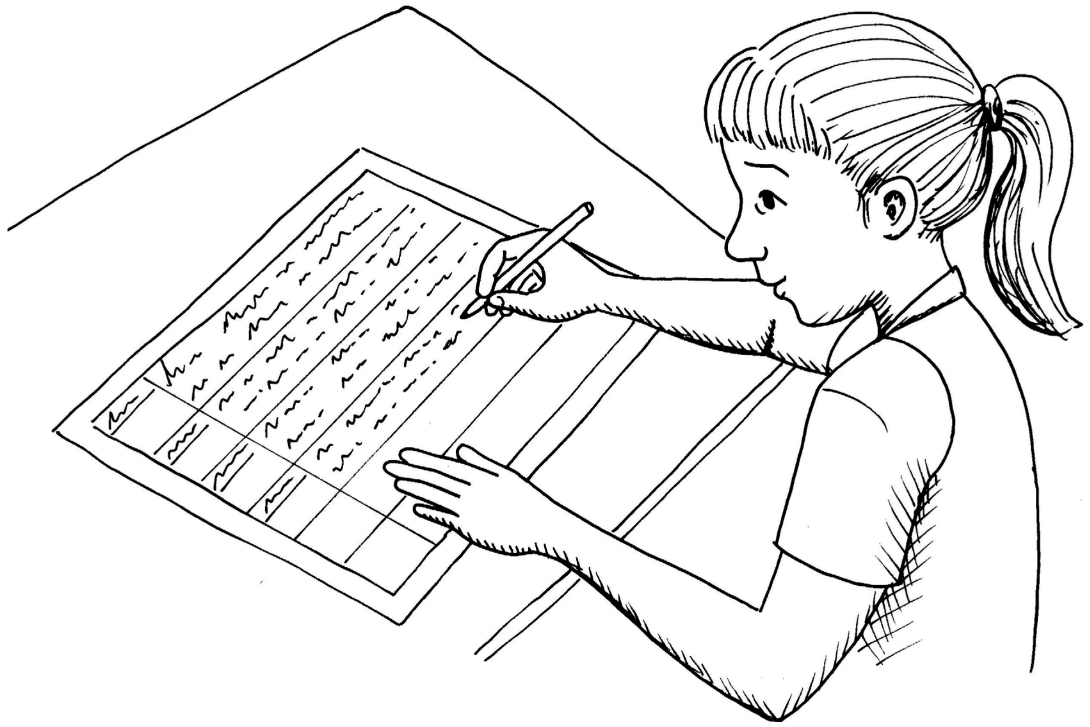


Figure 3: Draw up a table that shows what you need to do to prepare the food from start to finish. Write the instruction and reason for each step in the column next to each step.

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:

LB page 225

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.

LB page 226

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.

LB page 227

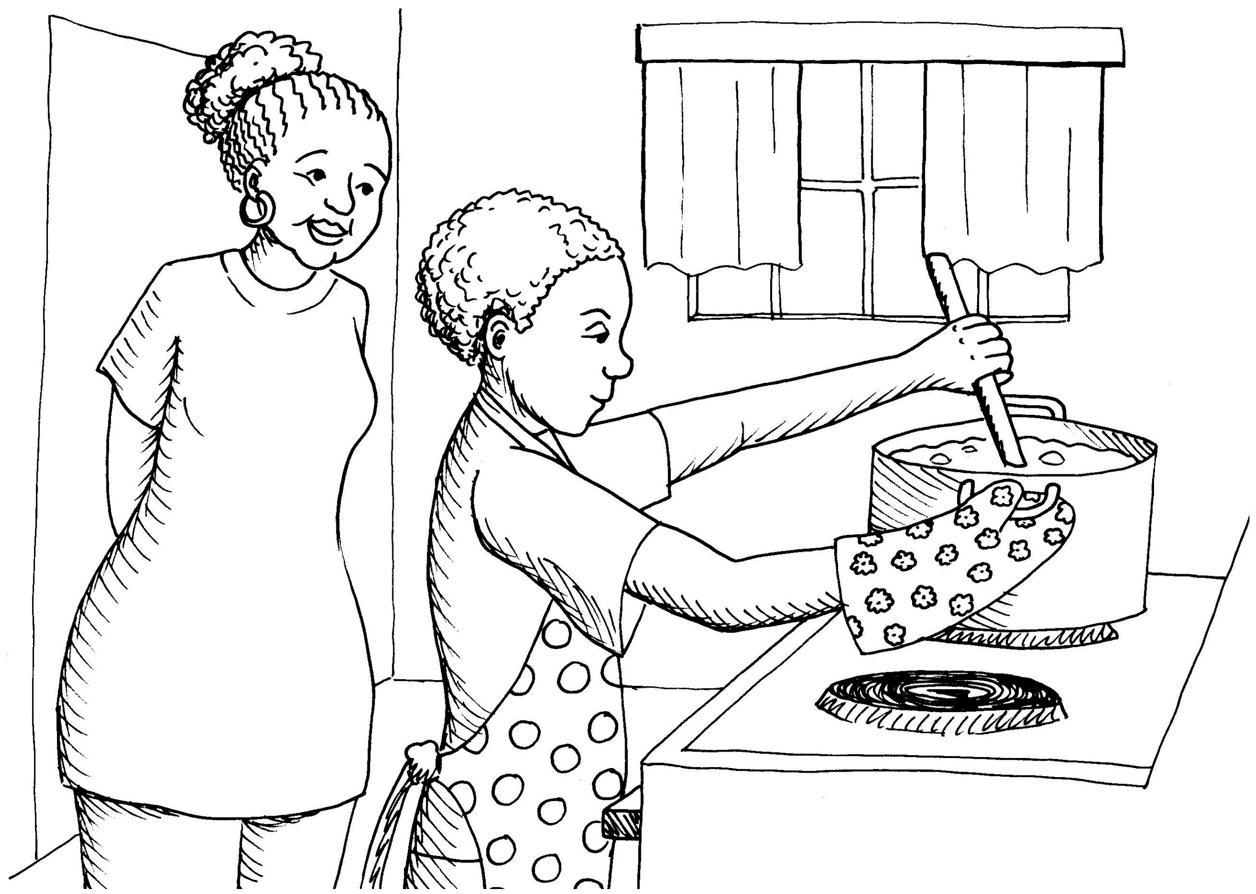


Figure 5: Ask an adult to help you with the ingredients and the cooking.

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.

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 three or 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.

LB page 228

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: The taste is not that important (although the refugees might have to eat it for quite some time, so it should be considered), but nutrition and texture **have** to be good. If any learners have answered "no" to any questions, ask them why. If it is texture, it is probably cooked for the wrong length of time, either too short or too long. The nutritional content should have been understood from Chapter 17.		

Give each other feedback on your meals

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.

Evaluate your own meal

Now write an evaluation of your own meal based on the feedback you received. Write your evaluation in paragraph form.

For example:

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

LB page 229

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.

This chapter looks at the development of technology in the textile world. Learners study the fabric and other materials used to make protective clothing. Learners find out more about people who work in emergency services such as fire fighting, police, army, ambulances, sea rescue and mountain clubs. They explore the tasks some of these services perform, the clothes the emergency workers wear, and the equipment they use. They find out about the *properties* required for the clothing worn by emergency workers doing specific jobs.

At the same time, learners develop awareness about the services these people perform. In that way, they will hopefully become more careful to prevent accidents in their own communities.

The purpose of this section is to prepare learners for the PAT that follows this chapter, where they will have to build a waterproof and windproof shelter.

Figures 1 and 2 show emergency situations and the clothes that the emergency service workers wear. These introduce the topic, stimulate interest and spark discussion.

Additional resources that may be of use:

Pictures and newspaper articles of/about emergency situations

Photos or examples of protective clothing

Organise a visit to an emergency service such as the local fire station.

Invite a representative from an emergency service to talk to the class. Big factories and mines have such services.

20.1 Emergency services

Introduce this as a whole class or small group activity. Encourage individual learners to contribute and talk about different emergency situations and the response of emergency workers. In most situations, speedy reaction is essential to minimise the effect of the disaster. Ask the learners to think about the training such emergency workers should have and what specialised personal protective equipment (PPE) they need to protect themselves from harm. Thereafter, learners should individually give written answers to the questions.

20.2 Clothing for emergency workers

Learners will learn more about the properties of the PPE used by fire fighters and sea rescue emergency workers. The names of the textiles are of lesser importance. What is most important, is the **properties of the textiles**, in other words what the textiles must or must not do when exposed to heat, water, etc. The labels to the illustrations in Figure 4 describe the properties of the materials. Point this out to the class before they start this individual activity. Keep learners on task by reminding them of the time constraints. Instruct the class to complete the written answers before they *communicate* their item of protective clothing by drawing it. Some learners will tend to spend too much time on the drawing.

Each country has an organisation that sets regulations about the use of protective clothing and other equipment by people doing different kinds of jobs. In South Africa, the government's department of labour regulates this, as part of the Occupation Health and Safety act (OHS).

The regulations can be seen on the internet at http://www.labour.gov.za/DOL/legislation/regulations/occupational-health-and-safety/regulation-ohs-general-safety-regulations.

The South Africa Bureau of Standards (SABS) tests safety equipment from different manufacturers to see if it meets the standards set by the OHS. Only equipment that pass these test are certified to comply with the OHS.

20.3 Investigate protective clothing and emergency equipment

Learners will work in groups of four or three. Groups should not be larger than four, because the bigger the group, the more likely it will be that someone will not contribute. Small groups promote involvement.

They will *investigate* the kinds of protective clothing worn by fire fighters and sea rescue workers. Each learner should contribute constructively to the discussion, before they complete the table. Then learners work on their own to answer the set of questions, which summarises and consolidates their learning.

LB pages 230–231

Figure 2: Sea rescue workers also wear specifically designed protective clothing.

LB page 232

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 LB p. 232

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.

Emergencies	Emergency services
Fire	Fire brigade, paramedics
Traffic accident	Ambulance services and paramedics, tow trucks, sometimes also fire brigade
Drowning in sea, dams or rivers	Life guards on beach, National Sea Rescue Institute (NSRI), paramedics
Floods and earthquakes	Disaster management teams, emergency helicopters for transport when roads cannot be used, paramedics
People lost and/or injured in mountains	Mountain clubs, emergency helicopters, paramedics
Miners trapped because of collapse of a tunnel	Emergency drilling and winching services, paramedics
Collapsed buildings	Fire brigade, paramedics
People fighting with guns and/or other weapons	Police, national defence force, paramedics

Learners will produce two different tables, with the entries depending on the area they live in.

Note: A paramedic is a person who provides emergency medical services. There is usually a paramedic on an ambulance.

LB page 233

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 LB p. 234

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.

   Learners can give their own examples.
   1. A fire in a settlement.
   2. A factory fire.
   3. Swimmers swept away by the current in the sea.
   4. A boat caught in a storm.

2. Write a list of special protective clothes you think they should wear in each situation.

   Fires: Fire-resistant clothing, helmet, gloves, goggles and boots.
   Sea rescue: Warm waterproof clothing, helmet, gloves, life jacket, boots, wetsuits for rescuers who have to swim and/or dive.

3. Write down the textiles their clothes should be made of.

   Fires: Fire-resistant material such as cotton or wool. Strong plastic helmet and goggles. Leather gloves and boots.
   Sea rescue: Rubber (neoprene) wetsuit and gloves. Rubber boots with non-slip soles. A rubber jacket for very cold weather. Strong, tight-fitting plastic helmet. Life jacket made from rubber and filled with material that floats.

4. Draw a picture of one type of protective clothing that you have written about.

   Encourage the learners to think of an item not already illustrated above. They must say what it is made from, and what it is used for.

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 LB p. 234

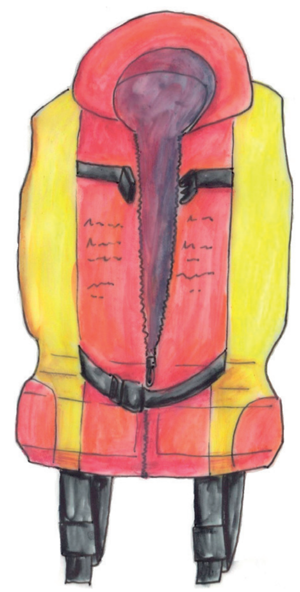
Work together in groups of four.

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 below will give you more information.

LB page 235

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 LB p. 236

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
gloves	leather	fire resistant	rubber	waterproof and warm
helmet	strong plastic	protects fire fighters from falling objects	strong plastic	protects rescuers from knocking their heads on floating debris or in a crash
goggles	strong plastic and thick glass	protects fire fighters' eyes from smoke and sparks	strong plastic and glass or Perspex	protects rescuers' eyes from salt water and helps them see when they have to swim

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?

   Rescue workers need as much protection as possible from the emergency situation, whether it is fire or water, to enable them to do their jobs, rescue other people and stay safe themselves.

2. What clothes should fire fighters wear, and what equipment should they carry when they respond to a call?

   Fire fighters need to be completely covered in fire-resistant clothing, with strong boots, gloves, helmets and goggles. They need to have the right equipment for the type of fire they are attending: burning of wood and/or other plant-material, burning of oil and/or and explosive gas, electrical fire, or burning of poisonous materials. They are experts and know what to take in each case.

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?

   In refugee camps, the biggest dangers are fire and disease. For fires, the equipment mentioned above is used. In the case of outbreaks of disease, medical workers will wear protective clothing, rubber gloves and cotton masks to protect them.

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

LB page 237

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]

Materials required for this PAT:

- cotton fabric with a fairly tight weave
- matches
- commercial silicone spray
- candles
- petroleum jelly (Vaseline)
- PVA paint
- transparent plastic contact sheeting (sticky-backed plastic)
- cooking oil
- turpentine
- borax
- boric acid
- washing powder waste paper for paper dowels, e.g. used telephone directories, or elephant grass
- wooden dowels (you should cut the wooden dowels into suitable pieces, unless learners have saws and sawing blocks and have learnt to do this safely)
- soft wire, paper clips and/or paper fasteners for joints
- glue
- unlined A4 paper for sketching

Tools required for this PAT:

- spray bottles
- paint brushes
- scissors or craft knives
- small plastic bowls
- metal trays or wooden boards
- metal tongs or wooden pegs
- saw for wood
- sawing block
- small pliers or wire cutters
- drawing equipment: pencil, eraser, ruler

Safety:

In the practical exercises in this PAT, learners work with matches and flammable materials, potentially toxic chemicals, sharp scissors and saws. Accidents can happen, so have a basic First Aid kit in the classroom (disinfectant, plasters and bandages) and bleach to clean any blood spills.

All tasks/questions are essential for the design process, even if no marks are allocated.

All tasks/questions in the PAT should be completed/answered, even the tasks/questions for which *no* marks are allocated for evaluation. This is because all the tasks/questions are essential parts of the design process. So, if certain tasks/questions are not done, then learners will not be able to do the subsequent tasks/questions successfully.

Week 1

Investigate Part 1: Let us look how our ancestors lived (30 minutes)

Learners *read* about the first people to live in southern Africa, who were hunter-gatherers, and who travelled from place to place in search of food (they were nomadic).

After reading, learners work in pairs to *answer questions*. The questions force learners to think about the **materials** used by the first people to build **temporary dwellings**. They have to think about the availability and properties of those materials, the building methods applied, and the effect of those dwellings on the environment.

Investigate Part 2: Permanent homes of our indigenous people (30 minutes)

Learners find out about migration of most of our indigenous ancestors from the north, starting about 2 000 years ago. These people did not live like the first people. They grew crops and kept cattle, and they lived in areas where the land was fertile and where there was water. As they were not nomadic, they built homes that are more permanent.

The *investigation* questions, as the previous set of questions, are designed to stimulate critical thinking, and to serve as background information for the learners' own designs for shelters. The questions once again focus learners' attention on the different properties of different building materials.

You can introduce this section with questions to find out what learners already know. It is good teaching practice to start a lesson with the 'known' before moving to the unknown.

Investigate Part 3: Dwellings in informal settlements (30 x 2 = 60 minutes)

This section deals with urbanisation in South Africa in the 21st century. People move from rural areas to large towns and cities, looking for work and a better life for themselves and their families. They mostly start life in the big city by living in informal settlements, where they build homes using any materials that they can find or buy cheaply. Many of the materials they use are harmful to ones' health or can be dangerous or hazardous under some circumstances. Some of these materials give off fumes, others catch fire and burn easily, etc.

Figure 11 on page 246 shows some of the building materials commonly used. This *investigation* is designed for learners to identify, *evaluate* and think critically about materials used for building shacks, and about the advantages and disadvantages of the different materials. Focus their attention on possible dangers to health, fire hazards, durability, waterproofing etc.

Week 2

Let us help the disaster management team (30 minutes)

The text on "The scenario" sets the scene for this PAT's design challenge. It provides the information for the *design brief*. The suggested *design specifications* are also indicated, in bulleted form. The learners will be referred back to these in week 3.

Information on how to make fabric waterproof and fire resistant are provided in preparation for the experiments during the next lesson.

Waterproofing and fireproofing (30 minutes)

The learners will *investigate* in groups of six. Half of the groups will experiment with different methods of making a textile waterproof. The other half of the groups will experiment with different methods of making a textile fire-resistant.

In each group, learners will work as three pairs, with each pair trying a different method of treating the textile.

The number of learners in the class may not exactly be a multiple of six. So the teacher may have to make some groups smaller. It is fine if some smaller group try out only two different methods instead of three.

If there is an uneven number of learners in the class, then let one learner treat a textile by herself/himself, instead of in a pair. Check on that learner in case she/he needs help. However, it is important for safety that any burning test should only be done by two learners working together.

Investigate Part 4: Testing samples (30 minutes)

The groups will *investigate* the degree of success of the different treatments they applied to their fabric samples. With each set of experiments, there will be an untreated sample of fabric that learners use to compare their results against. This untreated sample is called a control sample. Learners identify the most effective method to make fabric fire or water-resistant.

Learners must take care when they do the burning test, as they work with fire and fabric that can burn. Prepare for the test as stated in the Learner Book. Have a First Aid kit handy. Remember not to rub cream on a burn. Immerse burns in cold water or hold the burnt skin under cold running water for a few minutes.

Make Part 1: Waterproof the fabric for the model (30 minutes)

This is an individual *make* activity for assessment.

Week 3

Design Part 1: Design brief for the model shelter (30 minutes)

This is an individual *design* activity for assessment. Learners will design a frame structure. Refer them back to chapters 8, 9, 11 and 16, where they learnt about and made frame structures.

Learners use the information given regarding scale, and refer back to the scenario given earlier, to formulate and write the design brief. They identify and list the specifications.

Design Part 2: Design sketch (30 minutes)

This is an individual *design* activity for assessment. Learners use plain, unlined A4 paper for their sketches. They must make a rough pencil sketch of their proposed frame structure, label the sketch showing the different parts of the model shelter, and identify the materials they will use. Impress on them that the sketches should communicate as much detail as possible so that others can use the drawing to build the structure. They will need to make separate sketches for the frame structure and the cloth covering of the shelter. They must draw the different parts in proportion. (It is difficult for a Grade 7 learner to draw to scale).

Make Part 2: Construct the model (30 minutes × 2 = 60 minutes)

This week, learners build their models. This is an individual *make* activity for assessment. Your task is to keep them motivated and productive. Monitor their time management and keep them on task. Also monitor their building skills. Ask questions and make suggestions to guide the learners who struggle. Have a First Aid kit in the class in case of injuries. Use the seven bullets listed for assessment.

LB pages 238–239

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

LB page 240

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 place to 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.

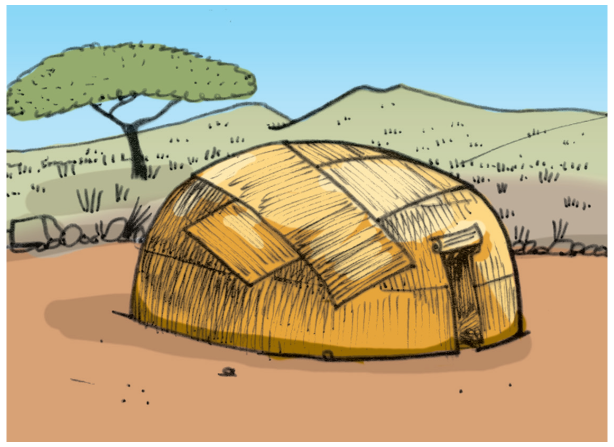


Figure 3: Khoi hut

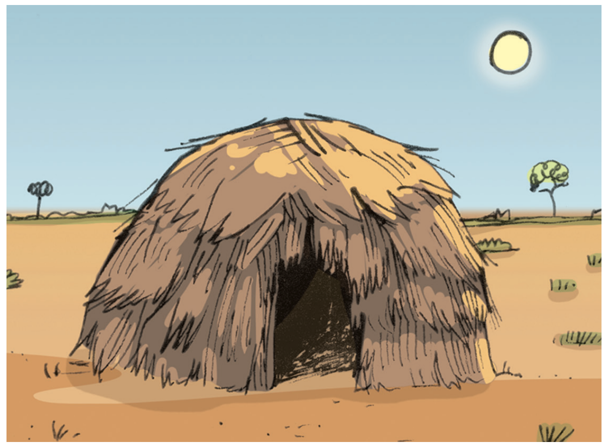


Figure 4: San hut

LB page 241

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?

   Green sticks for frames; reeds and grasses for covering.

2. Where did they find the materials they used?

   The materials grew around them where they camped.

3. Were the building materials suitable for the environment where the Khoi and San lived? Explain your answer.

   The materials were suitable because they provided windproof and waterproof shelters, and did not need to be carried from camp to camp.

4. What happened to the huts and materials they left behind once they moved on to another place?

   They were left behind. The materials would decompose and make compost, which helped the land produce more materials.

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.

   No, they came from the environment; they all grew naturally; they all would have decomposed to help the environment recover.

6. Why did the Khoi and the San people need their structures to be temporary?

   They were nomadic (travelling) people, and did not live in the same home permanently.

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.

Migrate: to permanently move from one place in a country to another place or another country.

Indigenous: people originating in a particular country.

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.

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.

LB page 242

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

LB page 243

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

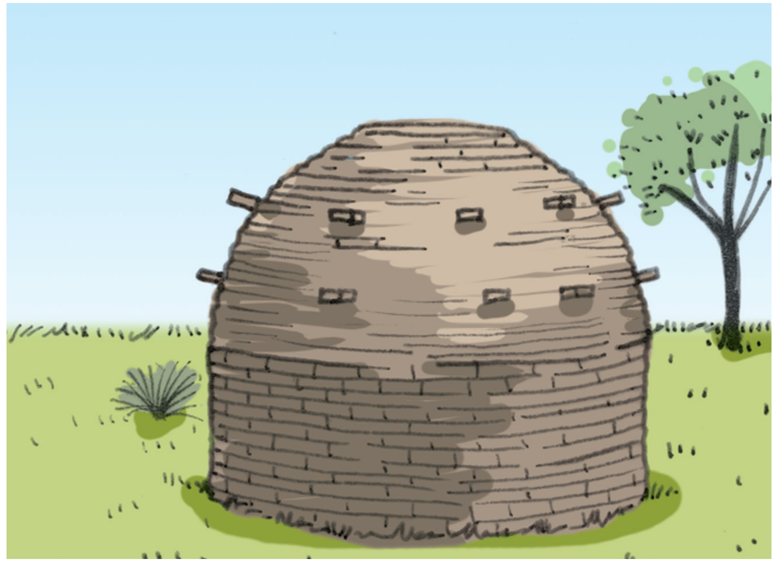


Figure 9: Corbelled hut

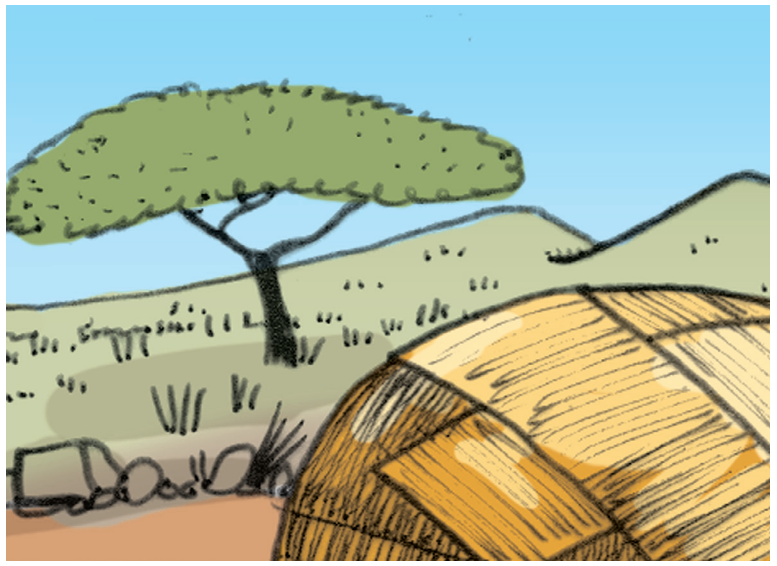


Figure 10: Matjieshut

LB page 244

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?

   They had started to farm the land and stayed there, not moving every year.

2. What makes their dome-shaped huts better than those that the Khoi and the San people built?

   They were bigger and stronger, and had two layers: thatch and grass mats. This gave better insulation against the heat and cold.

3. Why do the people that build 'rondavel' huts choose to use mud as building material?

   Mud can be made into bricks, and dries very hard, making a strong wall. It lasts for a long time. It can be decorated as well.

4. What is the advantage of using thatch as a building material?

   Thatch is easy to find. If done properly, it is waterproof, windproof and provides good insulation.

5. What is special about the homes of the Ndebele people?

   They used mud bricks that they decorated. This made the houses distinctive and attractive.

6. Are the materials used to build these homes suitable for building homes? Explain your answer.

   Yes they are. If the house is built properly, it will last for a long time. They can be easily repaired because the material is always available.

7. Would any of the building materials they use harm the environment? Explain your answer.

   The materials have no impact on the environment. They come from the environment and will decompose back into the soil, which will enrich it. Mud bricks will eventually dissolve into sand.

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.

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.

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.

Figure 11

Look at the materials used to build shacks

LB page 247

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 or not 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.
Corrugated iron sheets	Roofing	It is suitable because it is waterproof and strong. Iron will eventually rust and leak.
Wooden planks	Walls, windows, doors, roof	Wood is good for short-term use, but will rot if it is not painted. It also burns easily.
Plywood sheeting	Walls, ceilings, roofs, windows	It is good if used on the inside of a shack, but will soon rot if it is exposed to the weather. It will also burn.
Flattened metal from containers	It can be used to cover holes, and as material for a roof.	The pieces are never very big, so they will probably leak. They are dangerous because they have sharp edges.
Rubber and plastic sheeting	Used for waterproofing	Will perish quickly in the sun. Dangerous if there are small children around because they can suffocate.
Tyres	To hold down a roof	They can be effective, but are dangerous when they produce fumes.
Glass	For windows	Only works if it is the right size and in a frame. Dangerous to use, and very difficult to cut to shape.
Wooden poles	Framework for shacks	Suitable if they are strong. They need to be put into the ground to be stable so the shack does not shift in heavy winds and storms, causing structural damage.
Asbestos sheeting	Walls, ceilings, roofs	Asbestos is fire resistant, but its fibres are extremely dangerous so should not be used

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.

They are better because they grow naturally and there is always a supply for repairs. They don't pollute the environment. They won't last as long, but can be replaced without cost.

Week 2

LB page 248

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".

LB page 249

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 eight. Each group will split up into four 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

LB page 250

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		✔	
PVA paint		✔	
Sticky-backed plastic	✔		
Cooking oil and turpentine	✔		

Copy and complete:

1. The most effective method is:

   sticky-backed paper

2. The least effective method is:

   [Note to the teacher: It could be any of the other treatments, depending on the weather and how well the learners were able to apply the treatment to the fabric.]

   Cooking oil and turpentine are highly flammable and messy to work with.

   Candle wax will crack when it's dry and cold, and will melt on a hot day.

   Petroleum jelly is messy to work with.

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)	flames strongly	continues to burn
Borax solution	flames	continues to burn slowly
Borax and boric acid solution	flames	continues to burn slowly
PVA paint and sand	does not burn	does not burn

Copy and complete:

1. The most effective method is:

   PVA paint and sand

2. The least effective method is:

   borax solution

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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 if vegetable fibre (cotton/linen)	moves towards flame	burns quickly, with flame	continues to burn	burning paper	grey ash
Sample 2 if animal fibre (wool/silk)	pulls away from flame	burns slowly without a flame	smoulders and dies	burning hair	dark blob that turns to powder when touched
Sample 3 if synthetic fibre	tip of fibre melts	burns and melts	continues to melt for a short time	acid smell	hard black blob, almost like melted plastic

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, without a flame	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, with a flame	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 black blob of plastic

1. Which of the textiles is the least flammable?

   Learners should find that animal fibres are the least flammable.

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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 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 at least 50 cm × 50 cm. The fabric need not be 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.

   I need to design a shelter for emergency situations. It must be easy to set up and pack away. The shelter must be sturdy, windproof and waterproof. It must be able to shelter six refugees comfortably and safely for a month. The model I make must take all these facts into account, and be built to scale, based on a waterproof cloth that is 50 cm × 50 cm. [3]

2. Identify and list the specifications you have been given.

The shelter needs to be:
- sturdy.
- easy to set up and take down.
- easy to transport.
- easy to store.
- waterproof and windproof
- big enough for six people to live in for as long as a month.

It needs to have a framework that is covered with a waterproof cloth. It needs to shelter up to six refugees for a period of up to one month. The model that I build needs to use a cloth that is 50 cm × 50 cm. . I should choose the size (and therefore the scale) of the model so that it uses most of this size cloth. The model cannot use more cloth than this.

[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]

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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]

Square grid paper, 5 mm spacing

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Isometric grid paper, 10 mm spacing. Hold paper so that this text is horizontal.