TECHNOLOGY

Grade 7

Book 1

CAPS

Learner Book

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TERM 1

Chapter 1
What is Technology?

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

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Figure 1

Technology advances!

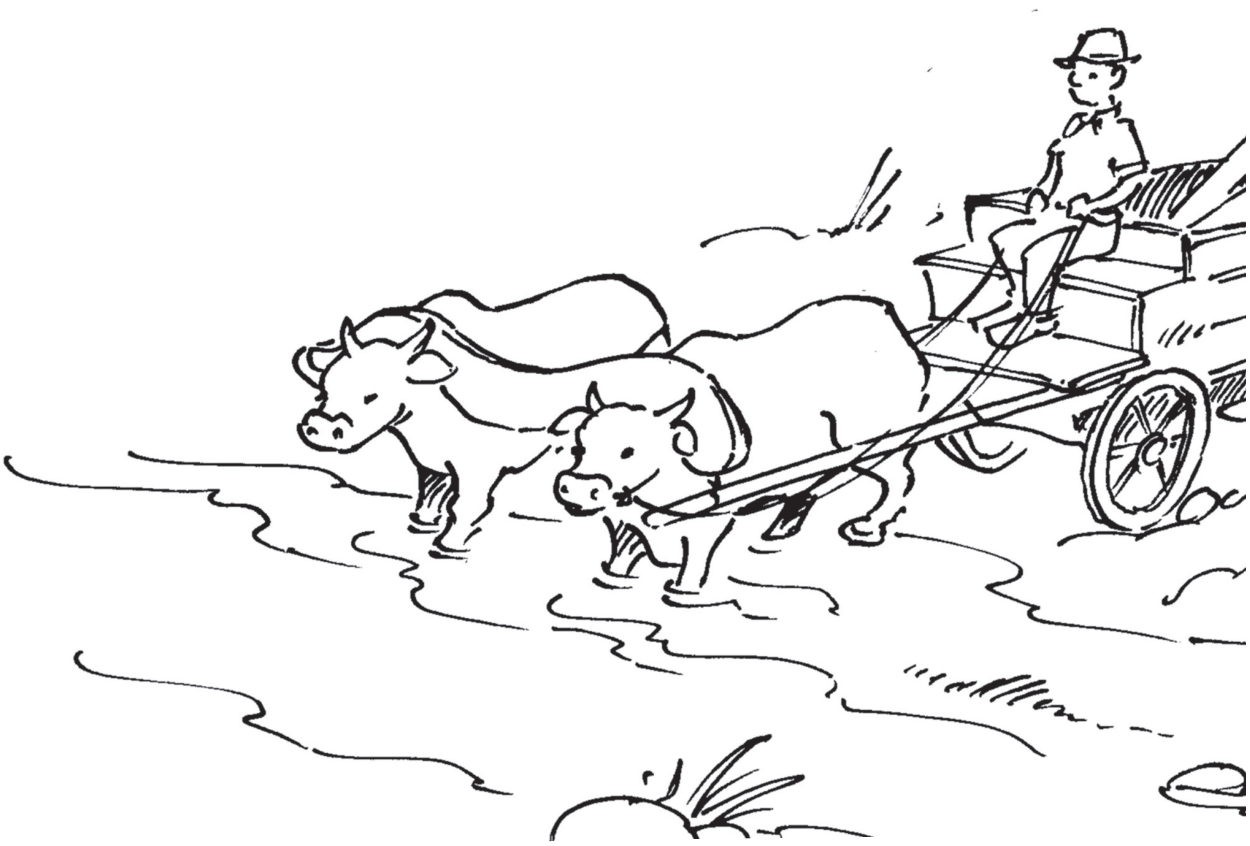


Figure 2: Transport technology 150 years ago

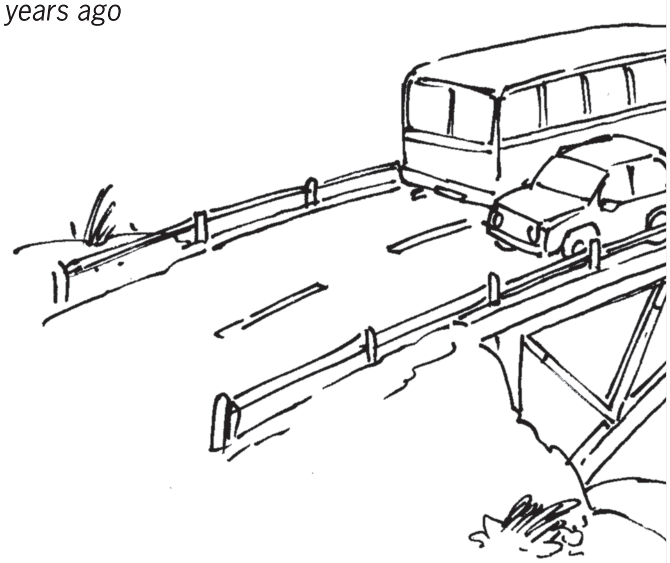
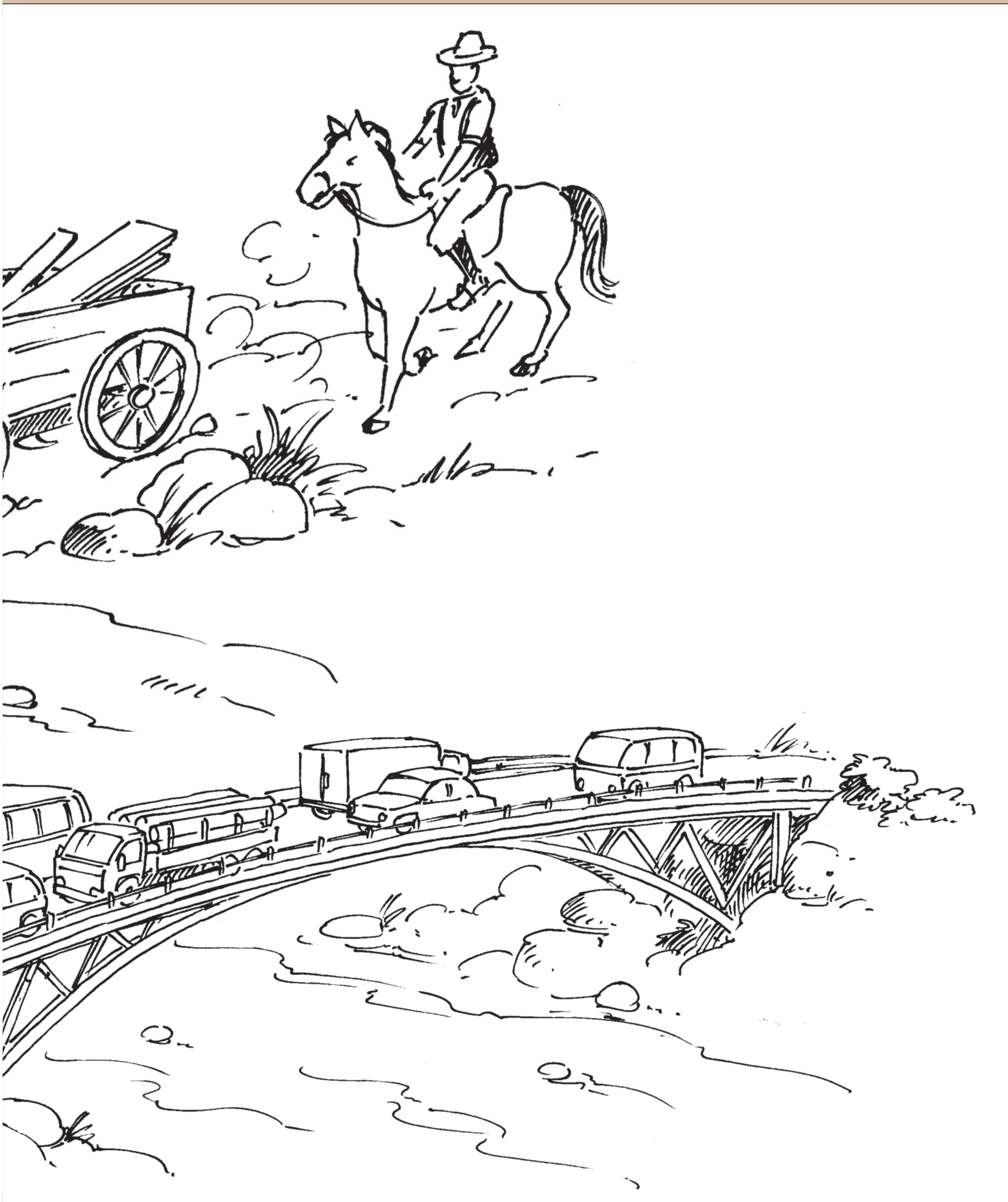


Figure 3: Modern transport technology



1.1 Materials, tools and plans

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

Figure 4

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

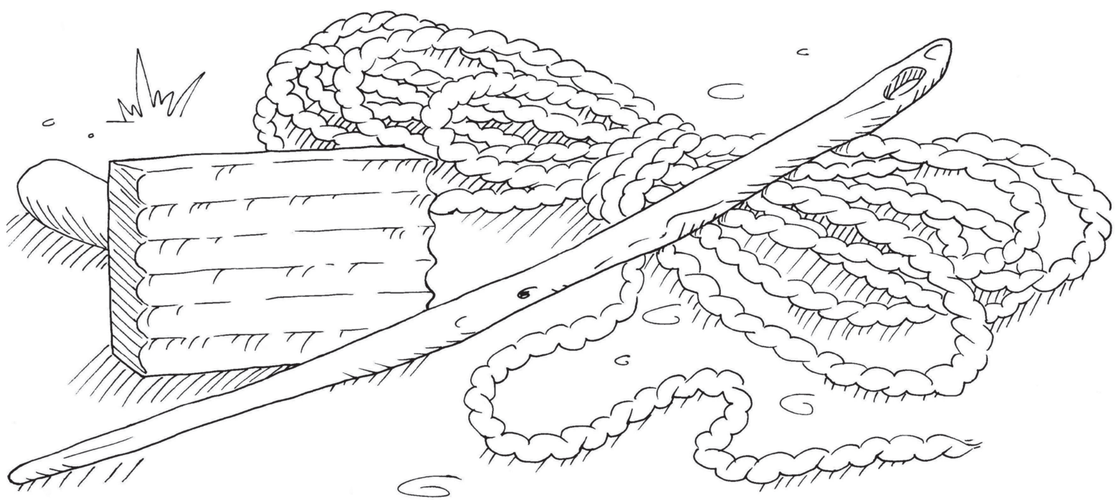


Figure 5: Some of the tools people use to make thatch roofs.

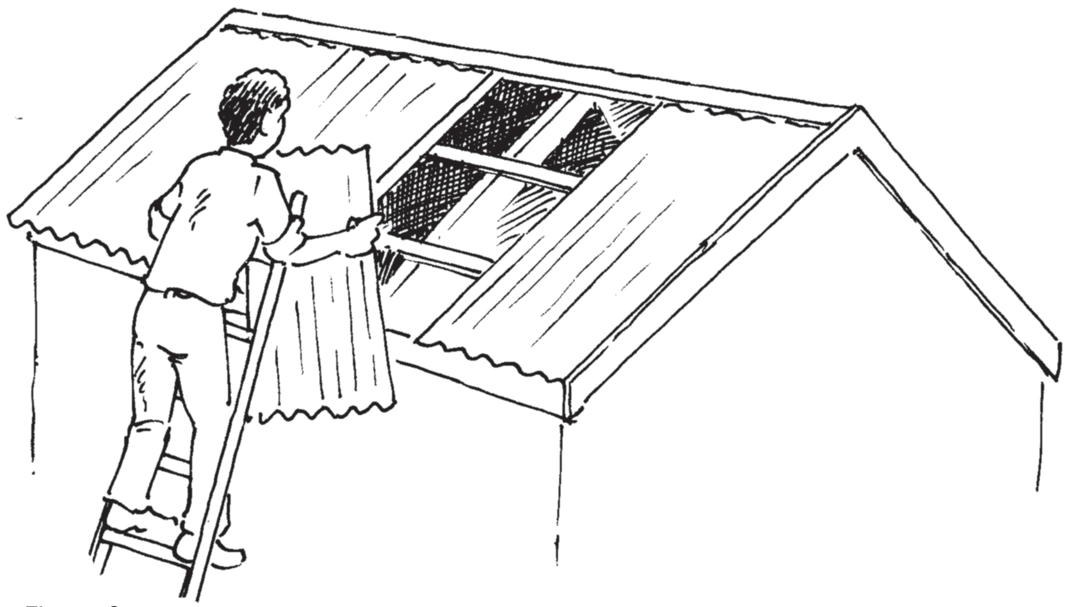


Figure 6

The people in the picture above are using corrugated roof sheets to cover their 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 is obtained by heating crushed rock to separate the metal from other substances. Roof sheeting is a **man-made material**.

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

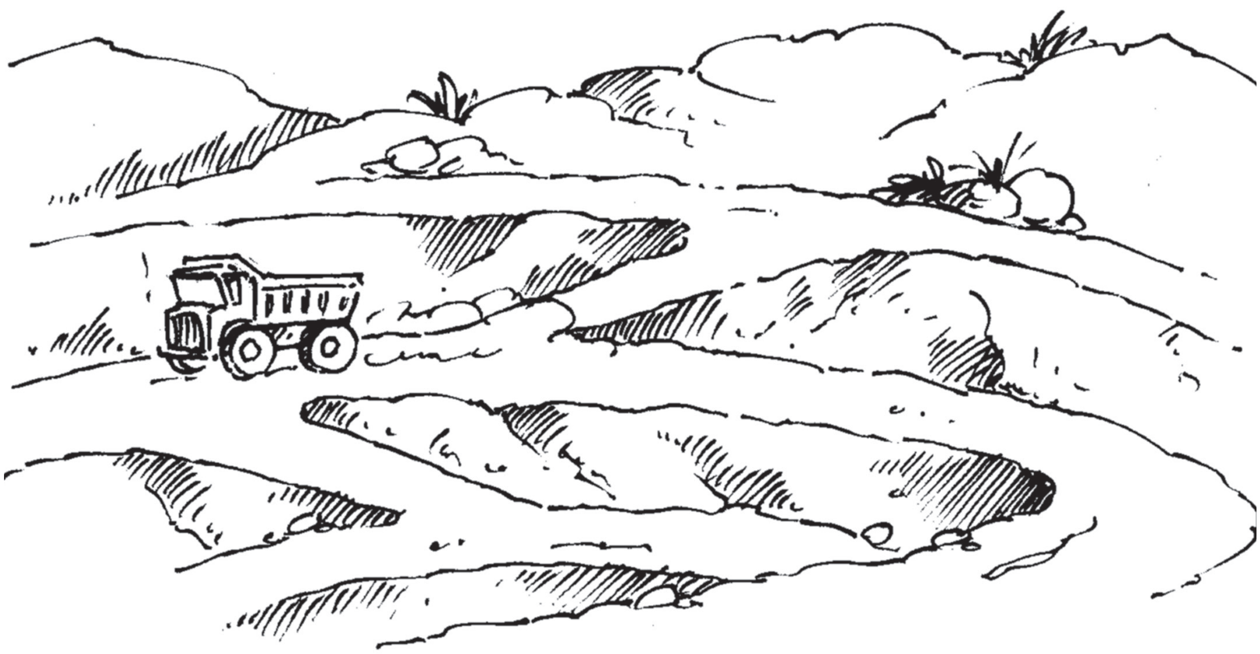


Figure 7: An open mine where rock that contains iron is collected, like at Sishen.

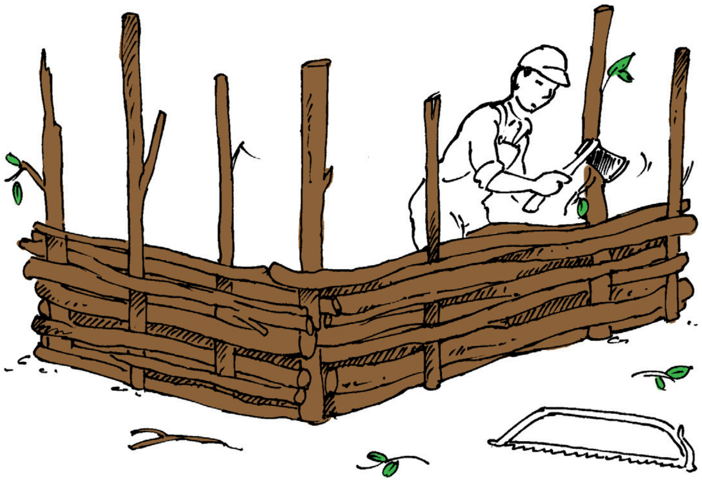


Figure 8: House A

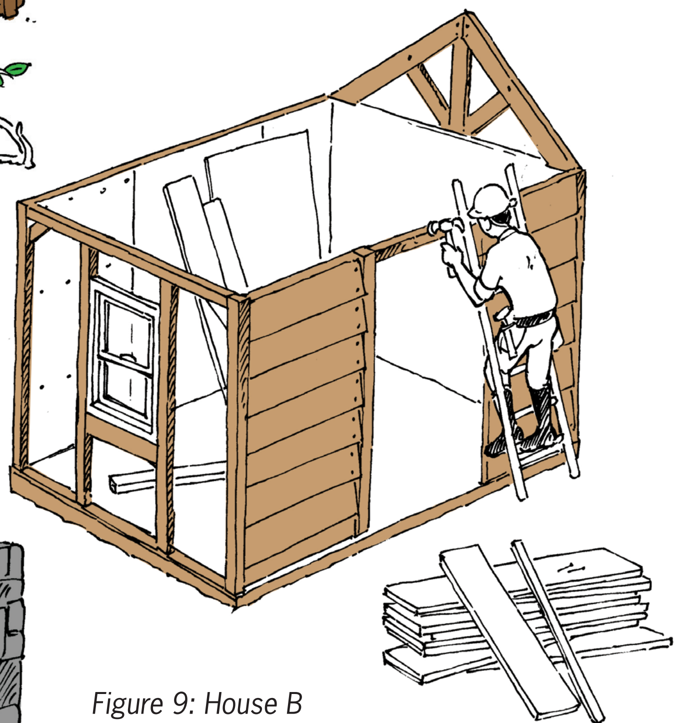


Figure 9: House B

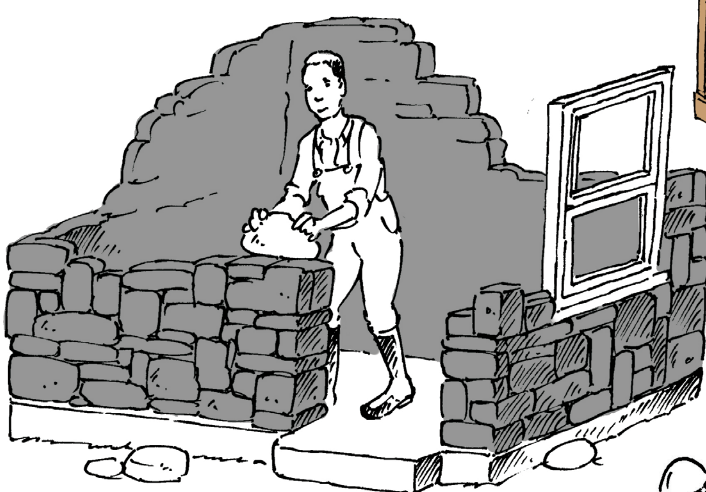


Figure 10: House C

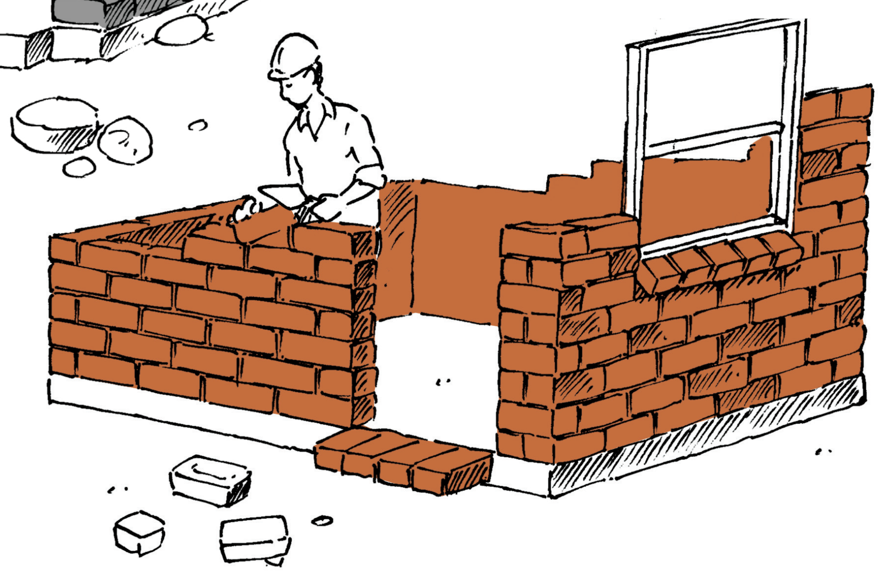


Figure 11: House D

Homework

1. (a) What material is being used to build the house in Figure 8?

   ....

   (b) Is this a man-made material or a natural material?

   ....

   (c) What tools are used by the people building the house in Figure 8?

   ....

2. (a) What material is being used to build the house in Figure 9?

   ....

   (b) Is this a man-made material or a natural material?

   ....

   (c) What tools are being used by the people building the house in Figure 9?

   ....

3. (a) What material is being used to build the house in Figure 10?

   ....

   (b) Is this a man-made material or a natural material?

   ....

   (c) What tools are being used by the people building the house in Figure 10?

   ....

4. (a) What material is being used to build the house in Figure 11?

   ....

   (b) Is this a man-made material or a natural material?

   ....

   (c) What tools are being used by the people building the house in Figure 11?

   ....

Technology Gr 7 LG Book A.indb 7 1/6/2014 9:43:17 AM

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. There are other examples of tools, like the ones below.

- 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 cellphones to talk to people that are far away from us. Cellphones are tools for communication. Two hundred years ago, there were no cellphones 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 are easy to use, like knives, forks and spoons.

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

Some tools are even more difficult to use, like a powerdrill. A person who wants to use tools like that must be trained.

About 50 years ago, when your grandparents were children, nobody had cellphones. 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 very 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.

One thing many people do is develop practical solutions to problems so that people can have the things they want and need. To do this, people 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.

All people use 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.

Something to think about

In a certain small town, people get their water from a dam about 3 km away. Then something very unfortunate happened. The dam wall broke during a flood, and it will take at least two years to build a new dam wall. Fortunately, there is an old well near the town, with enough water for all the people. But the well is very deep and at the moment there is no way to get water to the surface. The town is also in a rural area with no electricity.

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 so that other people will understand your plan?

Sibu communicated the plan to his father.

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 often work like this during the year.

1.2 Design a wheelbarrow

Be part of a story

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 it at a street market,
- you, and
- Mr Sethole, a carpenter. He works mainly with wood, but can also work with metal sheets.

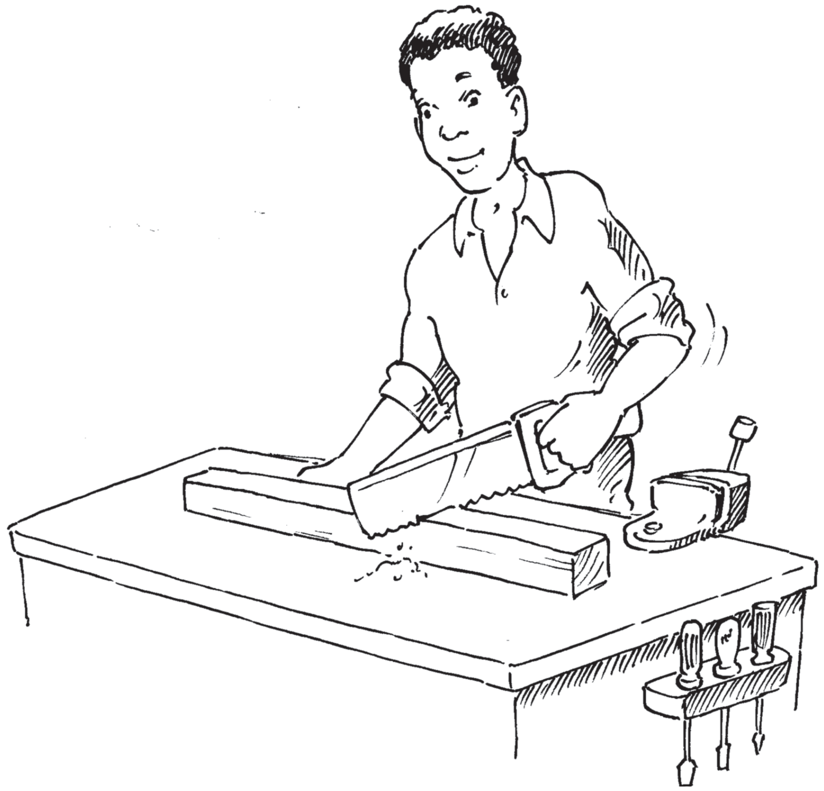


Figure 12: A carpenter is a kind of technologist, and makes things out of wood.

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

A wheelbarrow that Mrs April can buy in the shop looks like the one on the right. She says this wheelbarrow will not work well for her vegetables.

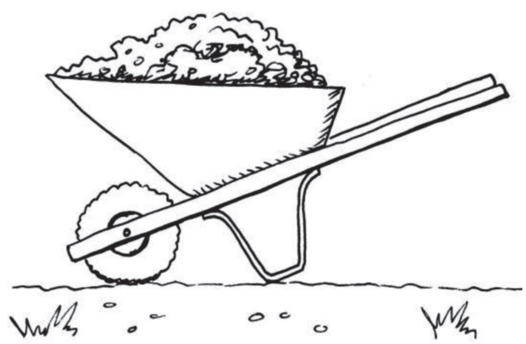


Figure 13

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

....

....

....

....

2. Try to think what answers Mrs April might give to your questions. Then write a short note below 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 here is sometimes called a **design brief**.

....

....

....

....

....

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?

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

....

....

....

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

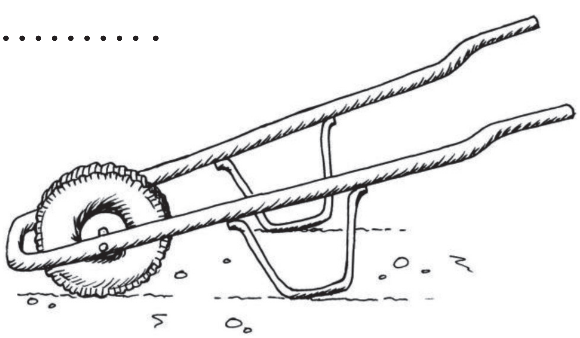


Figure 14

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

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.

....

....

....

You are still busy designing a wheelbarrow for Mrs April. At this stage, you should think about possible materials so that you can **select suitable materials** for making the wheelbarrow.

Next week

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

Chapter 2
How to say things with drawings

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

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2.2 Different types of lines in drawings 18
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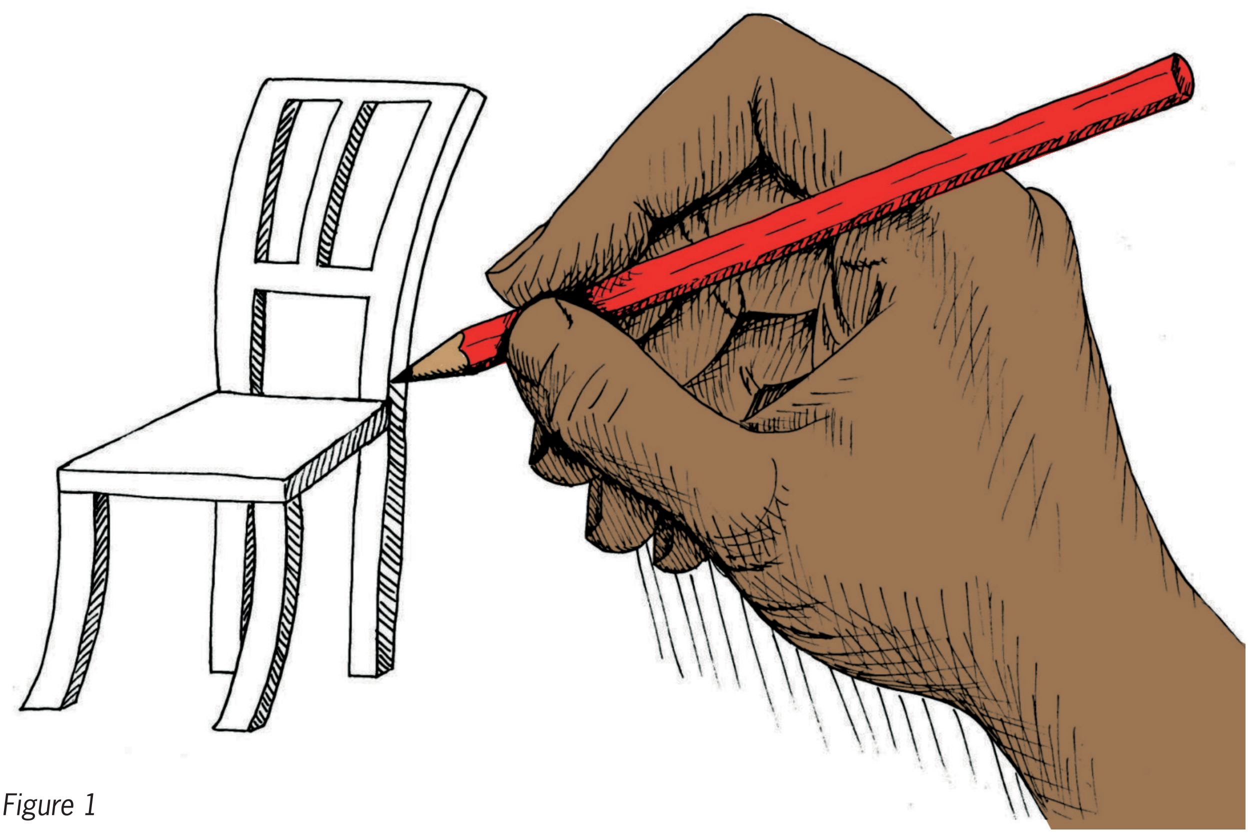


Figure 1

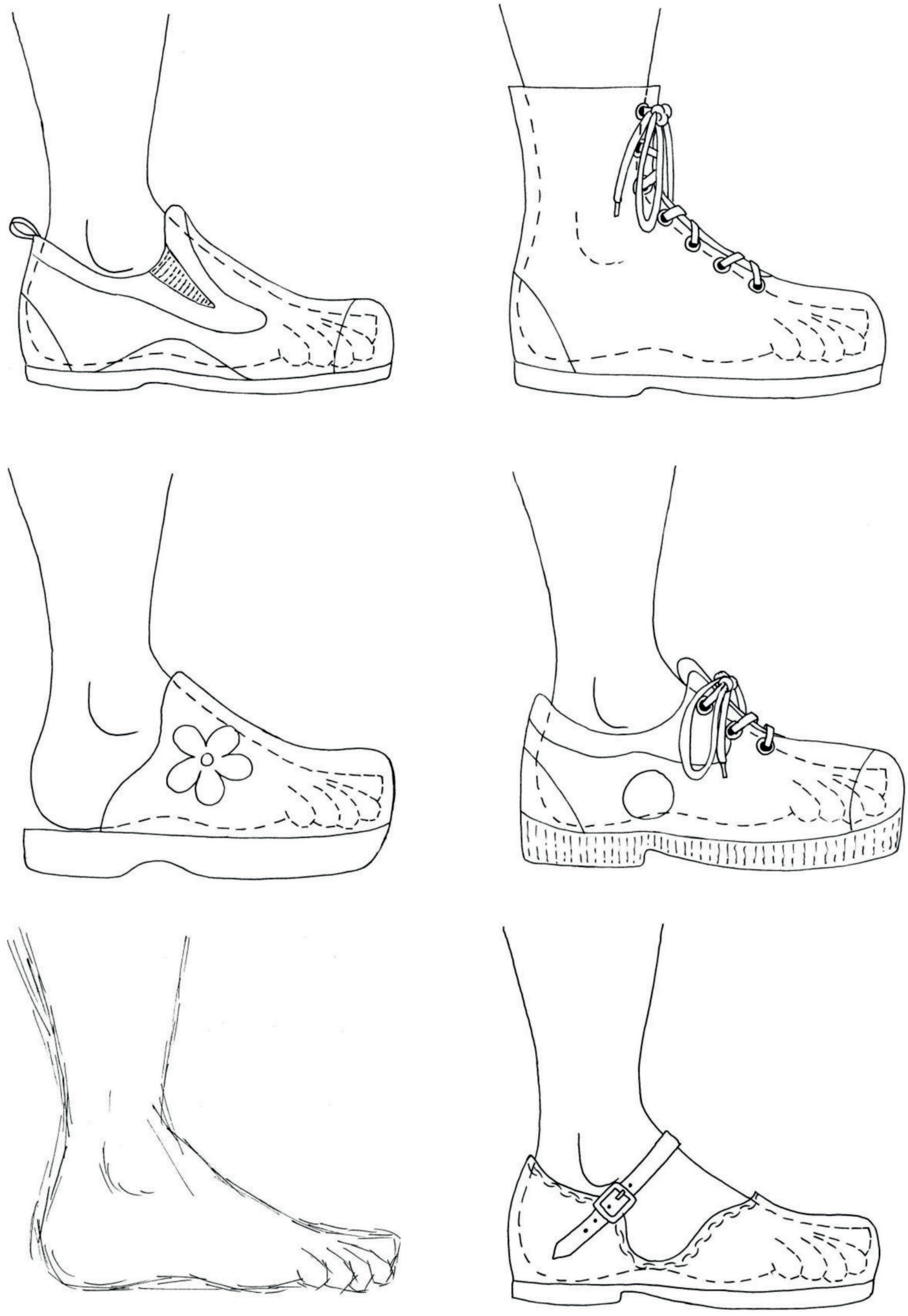


Figure 2: Drawings in a shoe design studio

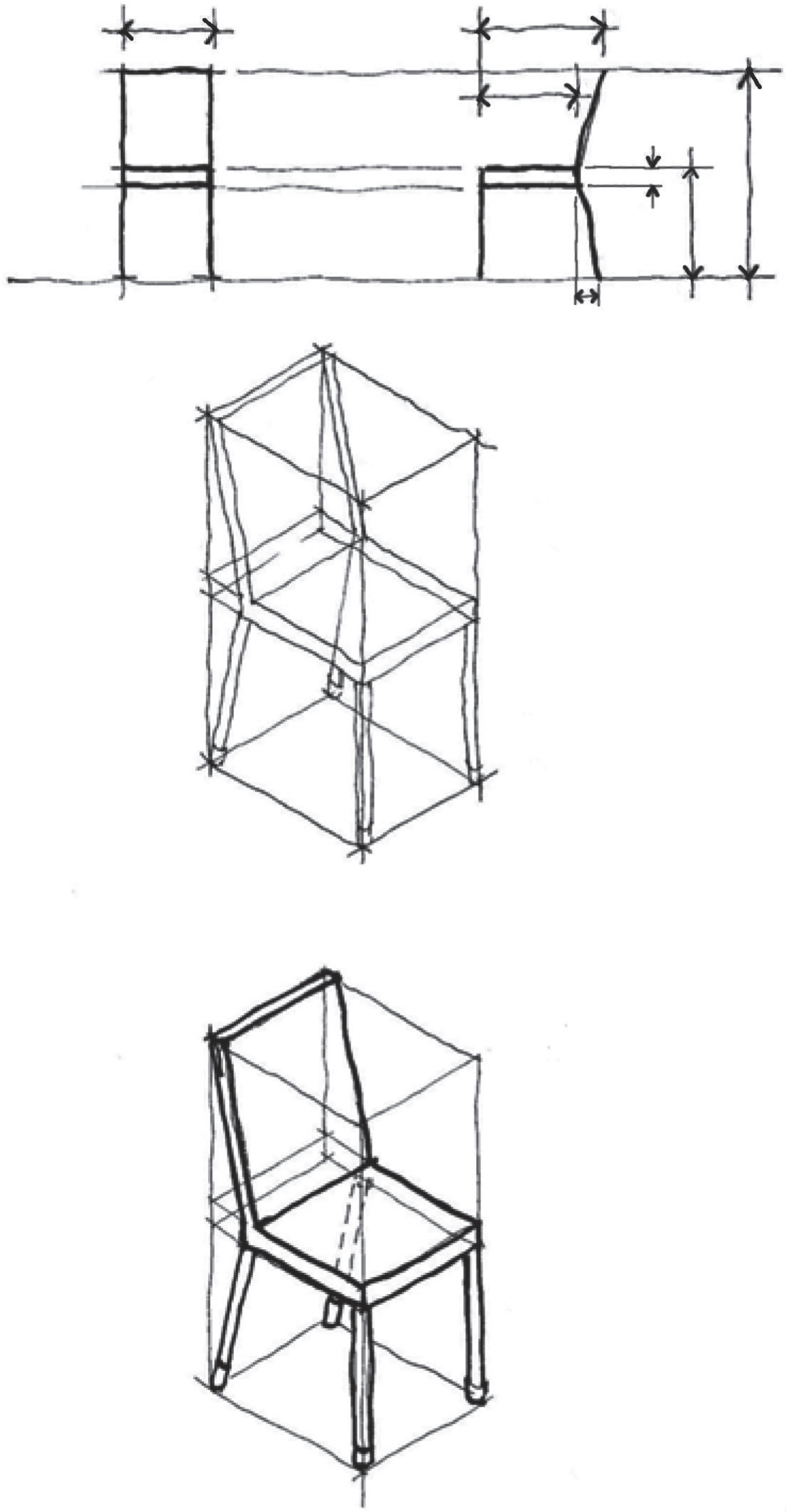


Figure 3: Drawings to design a chair

2.1 A new cupboard for the classroom

Your classroom needs a cupboard to store books.

1. How many doors should it have?

   ....

2. How many shelves should it have?

   ....

3. What should it be made of?

   ....

4. How high and how wide should it be?

   ....

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.

5. How deep should it be?

   ....

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

7. Make a bigger and better sketch of the cupboard. Write notes next to your drawing to show where the doors and shelves are. Also write notes to say how big different parts of the cupboard should be, in millimetres (mm).

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.

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

....

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".

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

....

2.2 Different types of lines in drawings

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

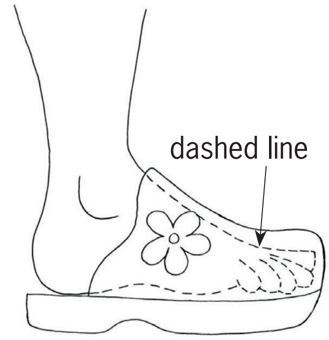


Figure 4

Dashed lines are used to show things that are hidden, like the foot that is inside this shoe.

1. Use dashed lines to show the bodies of the two people in the car below.

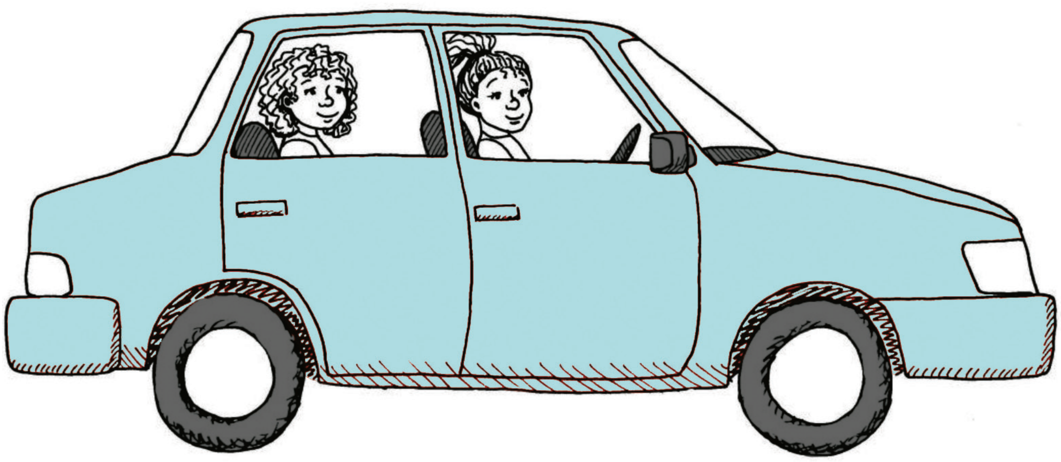


Figure 5

2. Draw dashed lines on the drawing of a cupboard on the next page to show four shelves inside.

A drawing like this 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. They 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. It is therefore not necessary to write "mm" after the number indicating a dimension on a drawing.

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

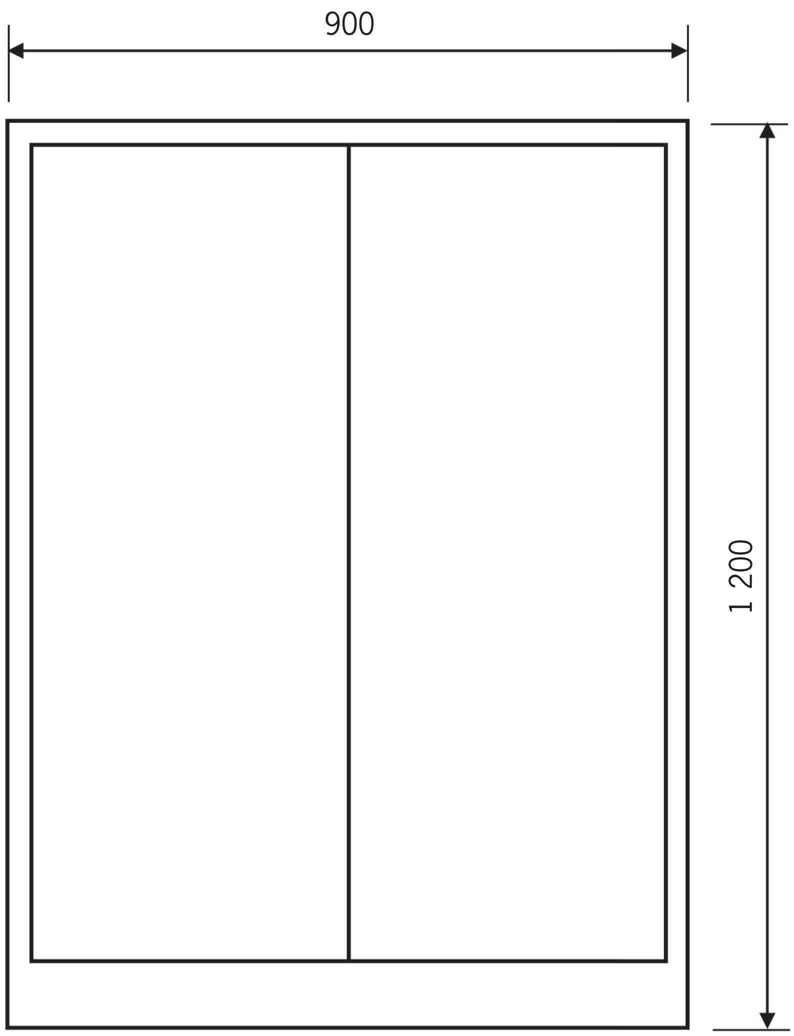


Figure 6

Figure 7

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

By looking at some drawings and practising 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

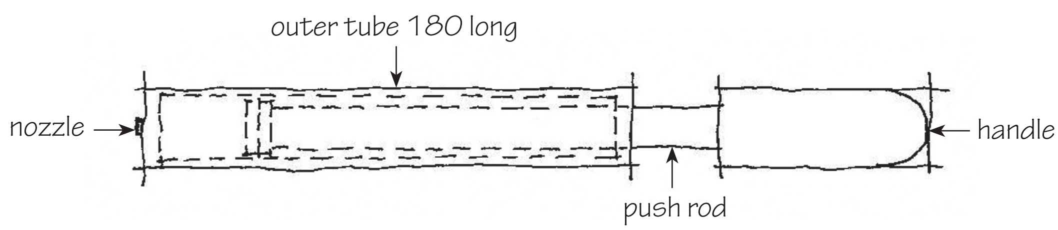


Figure 8

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

....

....

....

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

....

....

....

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.

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

....

....

....

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.

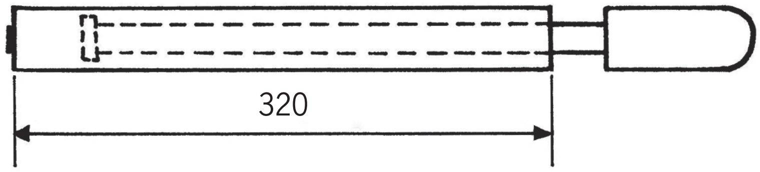


Figure 9: Bicycle pump. Scale 1:4

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

....

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

....

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

....

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

....

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

....

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

....

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

....

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

....

....

12. What is the scale of the working drawing of the cupboard three pages back? You will have to take measurements to find out what the scale is.

....

2.3 Free-hand sketching

Figure 10

The artist who drew the foot in Figure 10, first drew only light thin lines, like the ones shown on the right. She then used these feint lines as guidelines to draw the foot.

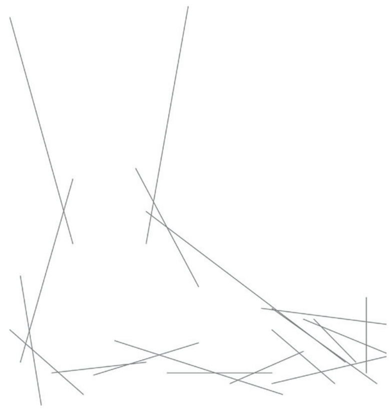


Figure 11

Sketching lines

> Use thin, feint lines for the guidelines, which are called construction lines.
> Use thicker, dark lines for the outlines of sketches.

1. Sketch a rectangle with rounded corners.

- Your drawing should be about two times as big as the drawing on the right. It is drawn to a scale of 3:1.
- Sketch a guide box. Do not use a ruler. Use light guidelines.
- Mark the corners with feint lines.
- Make the corners round.
- Now make the outline thicker.

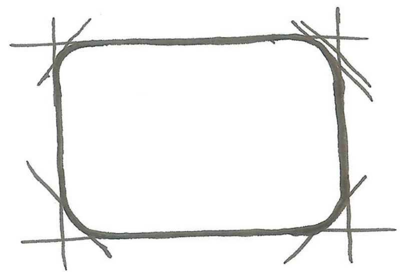


Figure 12

Homework

2. 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.

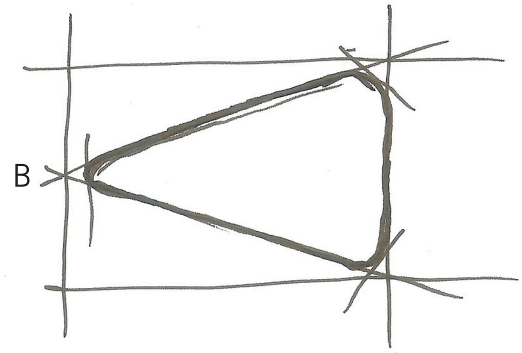


Figure 13

3. 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 Ds 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.

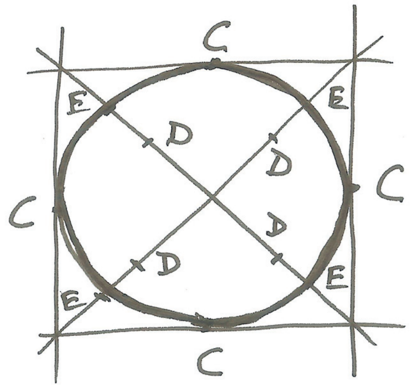


Figure 14

4. A drawing of a bicycle pump is shown on the next page. Make an accurate 1:4 scale drawing of the pump on the grid paper below.

Note the following:

- The grid shown below has 5 mm spacing between lines.
- Use a ruler and make sure you remember the different line types.

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

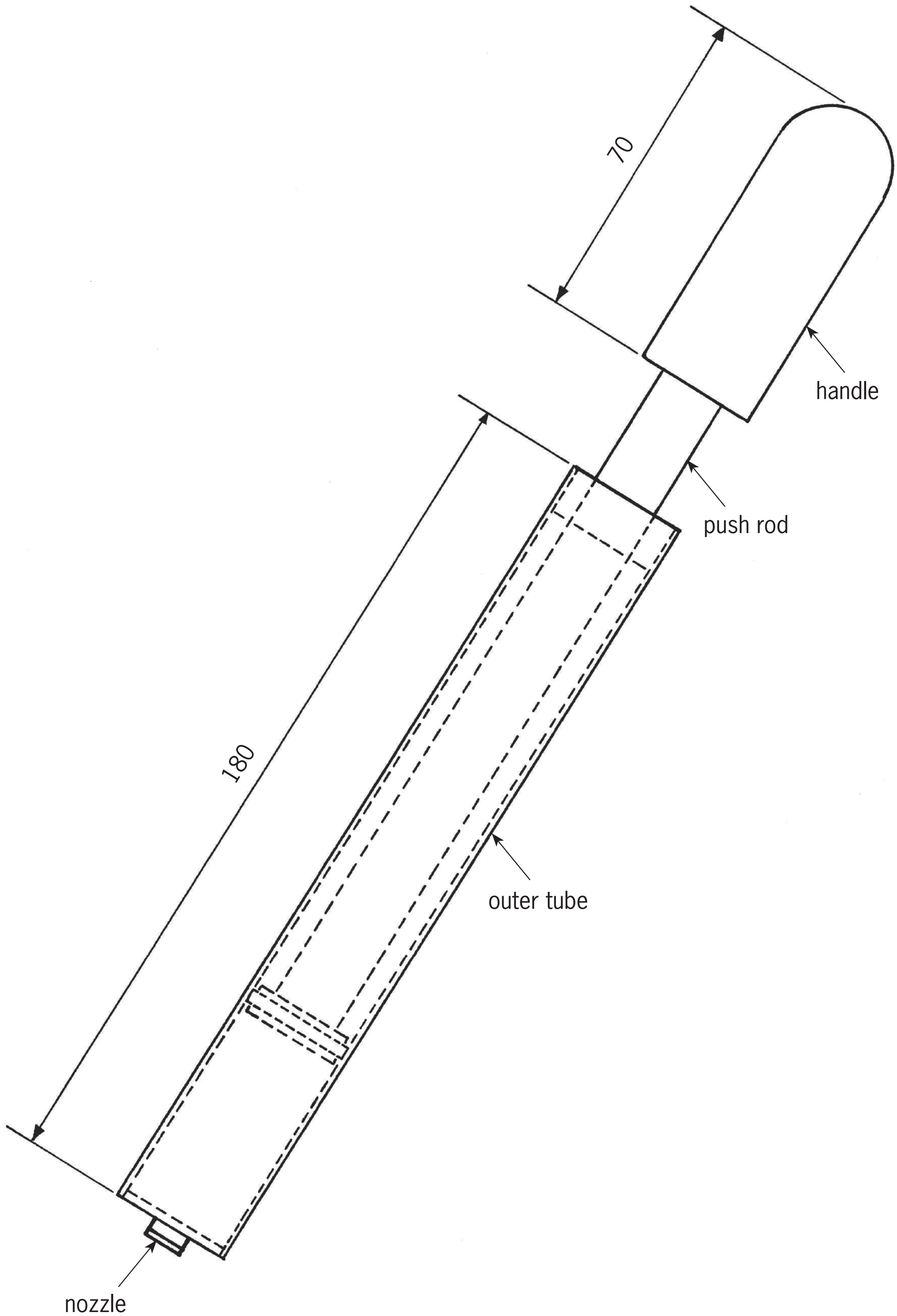


Figure 15: A bicycle pump

5. **The drawing at the bottom of the page shows the front view of a house. Make a bigger drawing of the front view of this house.**

   Note the following:

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

Front view of house

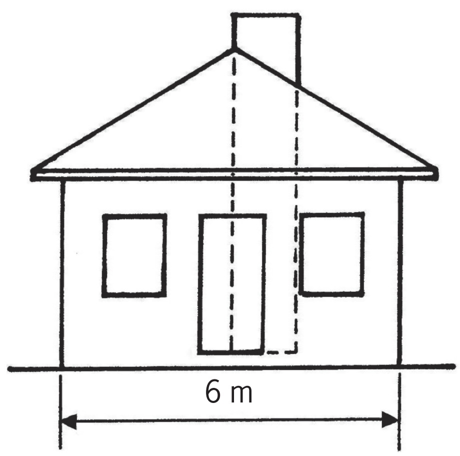


Figure 16

Next week

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

Chapter 3
Draw what you see

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

3.1 Two types of drawings 31

3.2 3D oblique drawing 33

3.3 Perspective drawing 39

Figure 1

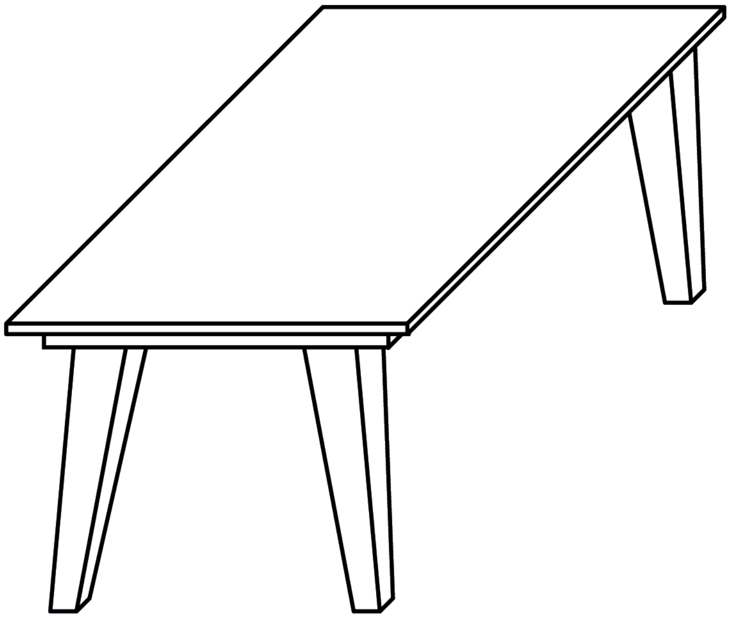


Figure 2 (Drawing A)

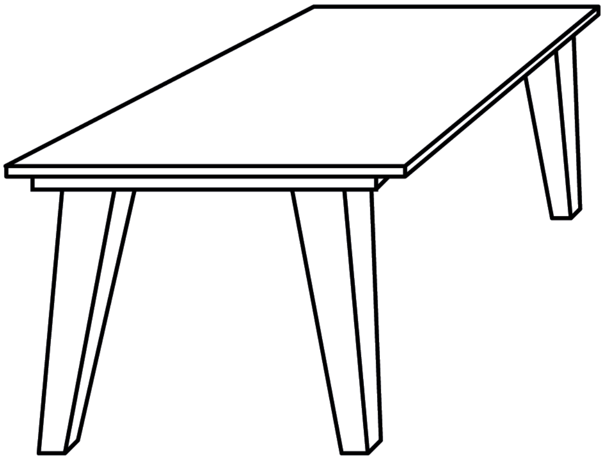


Figure 3 (Drawing B)

3.1 Two types of drawings

1. Look at drawings A and B again. Do you see drawings of two different tables, or two different drawings of the same table? Take your time and think carefully before you answer.

2. Look at drawing A and drawing B on the opposite page. Also look at drawing C and drawing D on the next page. Is drawing C or D the same as drawing A, only smaller? Explain why you say so.

3. How do drawings A and B differ?

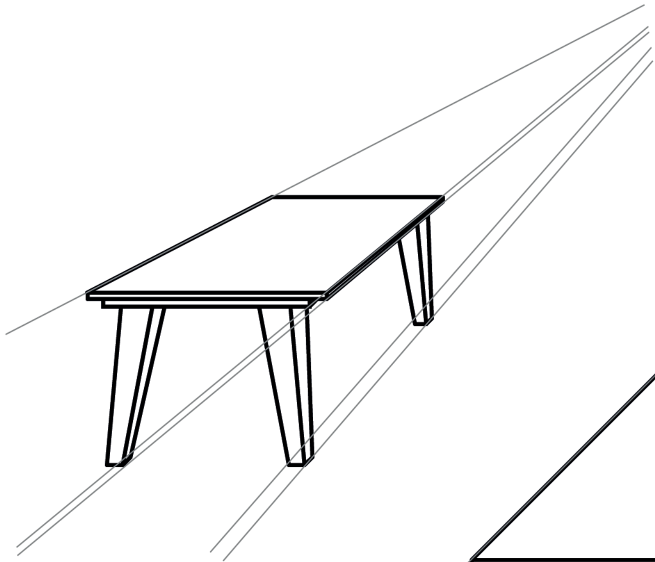


Figure 4: A perspective drawing (Drawing C)

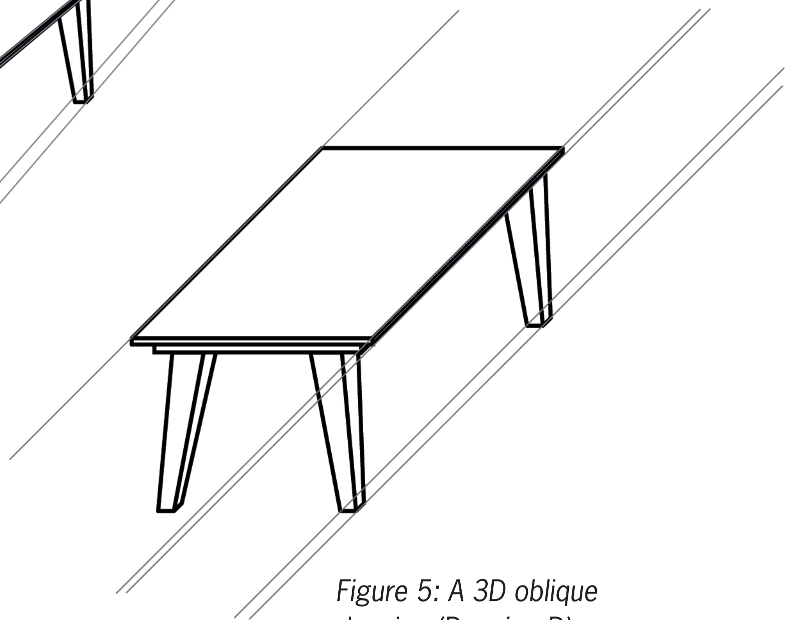


Figure 5: A 3D oblique drawing (Drawing D)

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

Drawings such as Figure 5 (drawing D) are called **3D oblique** drawings. They look different from what you actually see when you look at the object. Measurements can be taken from 3D oblique drawings.

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

3.2 3D oblique drawing

Make a 3D oblique sketch

You can make a good 3D oblique sketch of a stove if you follow the instructions given below.

It is easier if you first draw a box that shows the shape of the stove. Do that on the next page. Do not use a ruler.

To draw a box, first draw a rectangle to show the front of the box, as shown in step 1 below. Draw the rectangle in the left lower part of the page.

Draw another rectangle of the same size as shown in step 2 below. Then draw sloping lines as in step 3 to show the edges of the box that go from the front to the back.

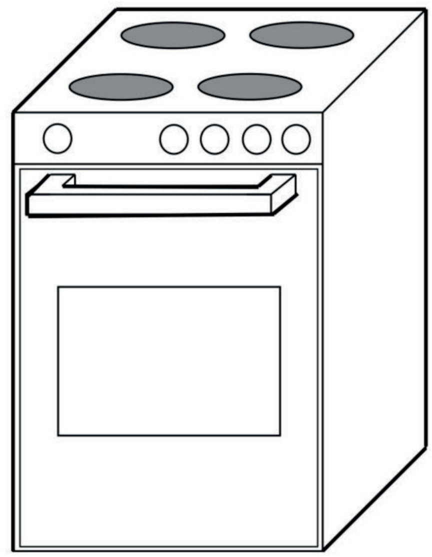
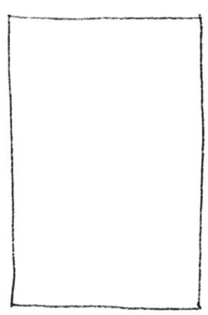
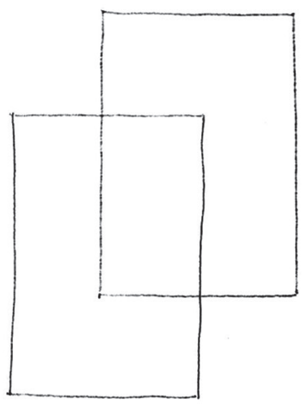


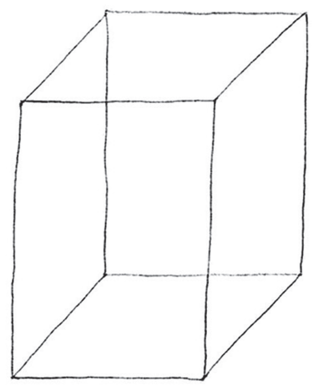
Figure 6



step 1



step 2



step 3

Figure 7

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

Make your 3D oblique sketch on this page. Make it big.

Change your box into a stove

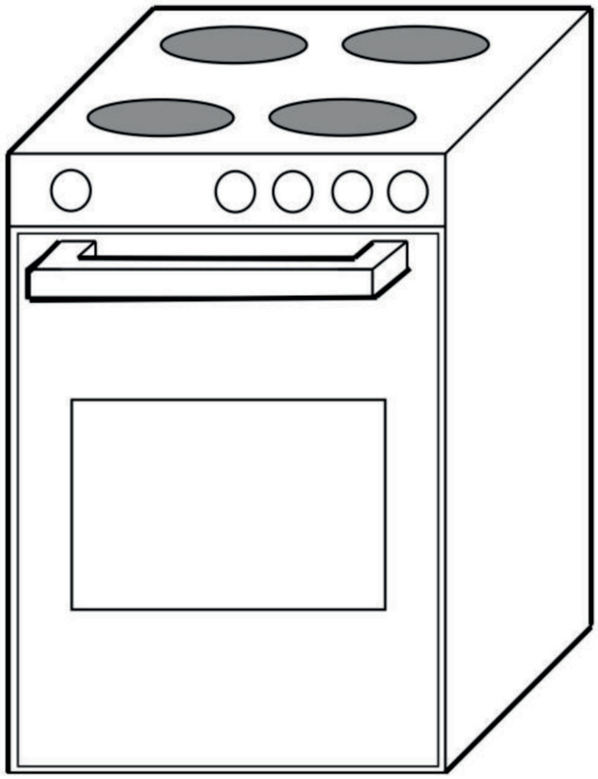


Figure 8

Now see if you can change 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 sloping lines coming forward.
- Make all lines that you can see on the objects thick.

Something to do at home

3D oblique drawings are easier to make on grid paper, like the one on the next page. Make a better drawing of the stove on the grid paper. One of the sloping lines is already drawn.

Technology Gr 7 LG Book A.indb 36 1/6/2014 9:43:28 AM

Accurate 3D oblique drawing

The drawing below is an accurate oblique drawing of the stove.

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

   ....

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

   ....

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

   ....

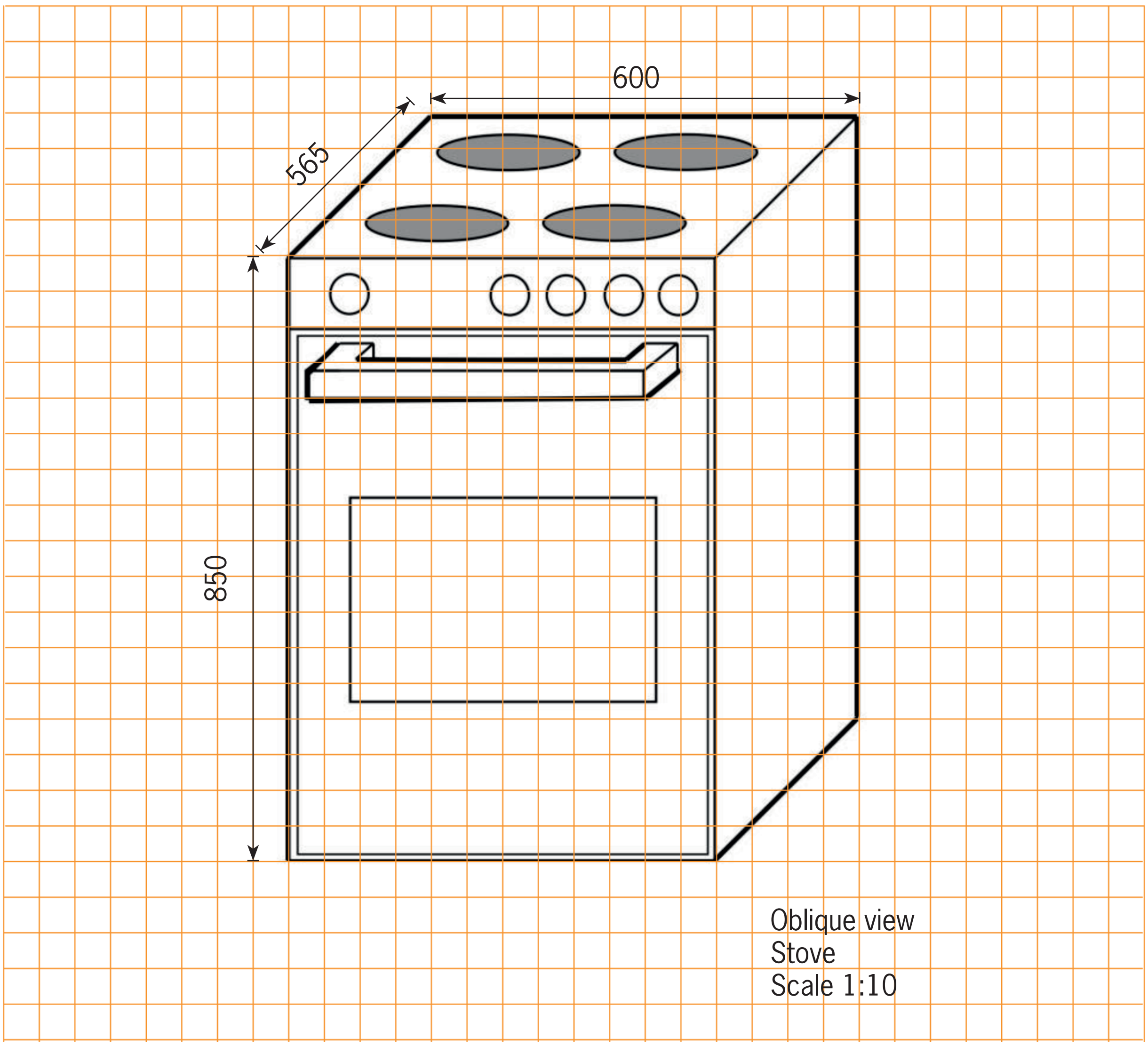


Figure 9

A few important things about oblique drawings

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

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

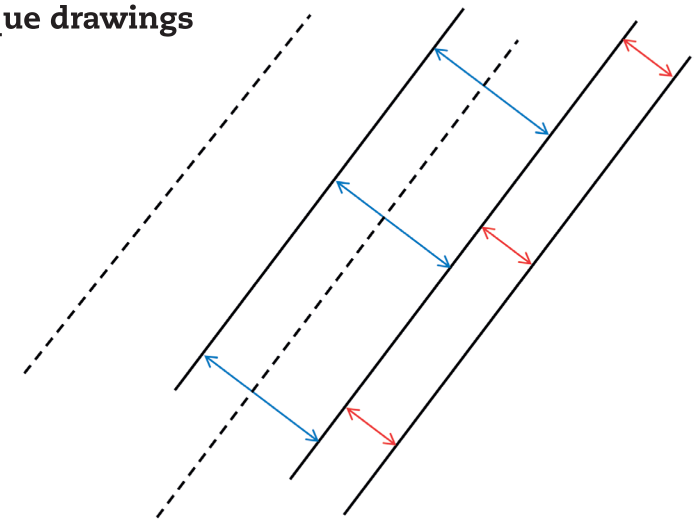


Figure 10

4. Use the grid on the previous page to 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 above.

3.3 Perspective drawing

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

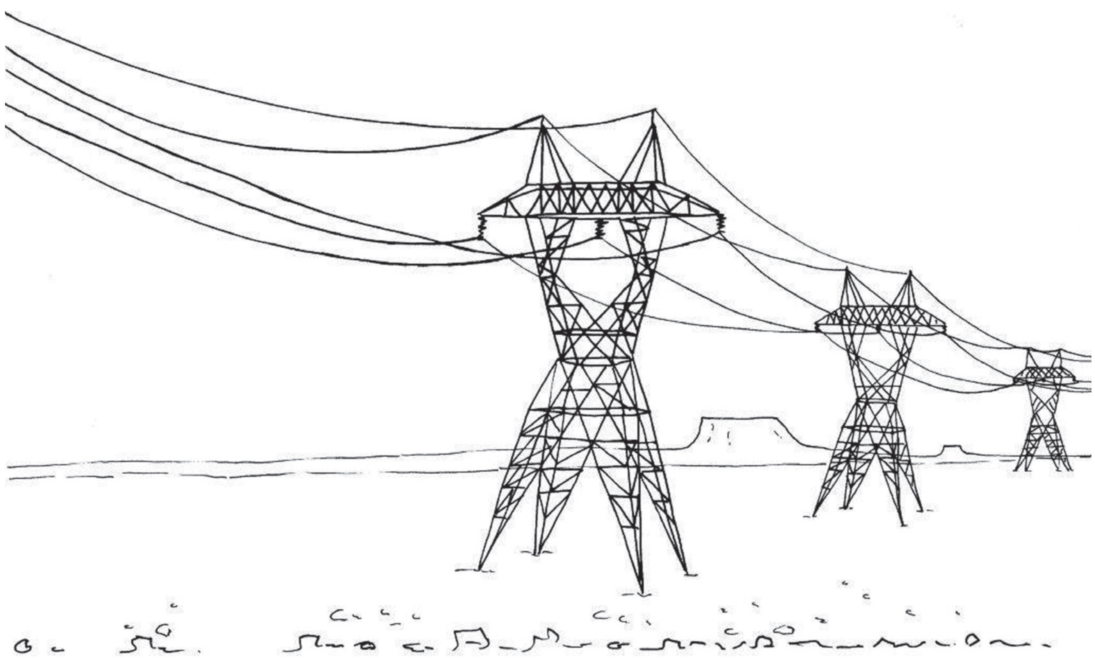


Figure 11

When you make a 3D drawing that shows things getting smaller in the distance, it is called a perspective drawing.

Look at this sketch of a fence. It has been drawn going back into the distance.

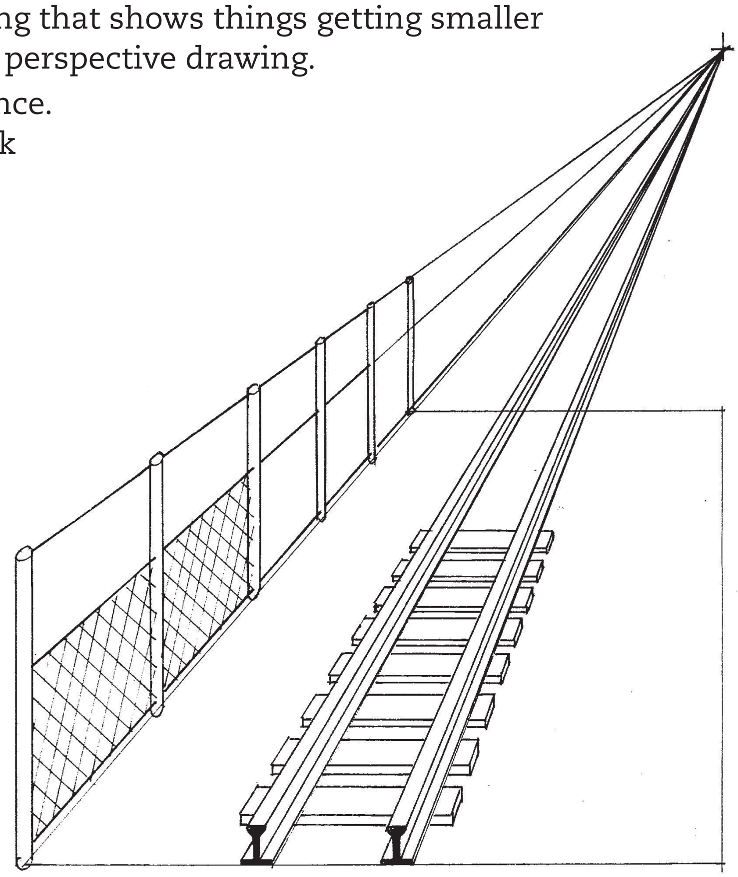


Figure 12

Use the steps below to draw the fence on the next page

1. From the bottom left-hand corner of your page, draw a fence post. This will be the tallest post because it is the 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 how tall something is.
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 fence wire.

Draw the fence on this page.

Draw a matchbox in perspective

In the bottom left-hand corner of this page, draw a rectangle to represent the front of the matchbox. Part of the rectangle is already drawn for you.

From each corner of the rectangle, draw a thin guideline to the vanishing point. You can use a ruler.

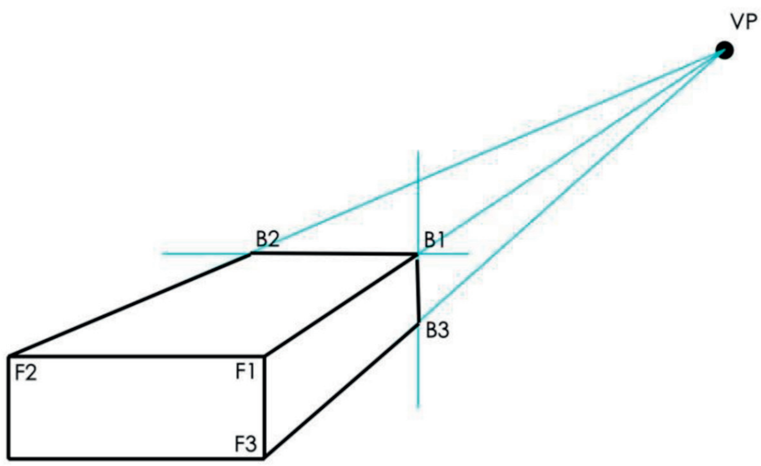


Figure 13

Moving back along the guideline from the vanishing point, mark off a point (B1), which makes the breadth of the matchbox look right.

From this point (B1), draw a **vertical** line down to the bottom guideline. This is the side edge at the back of the matchbox.

From the same point (B1), draw a **horizontal** line towards the left hand guideline. This will represent the top edge at the back.

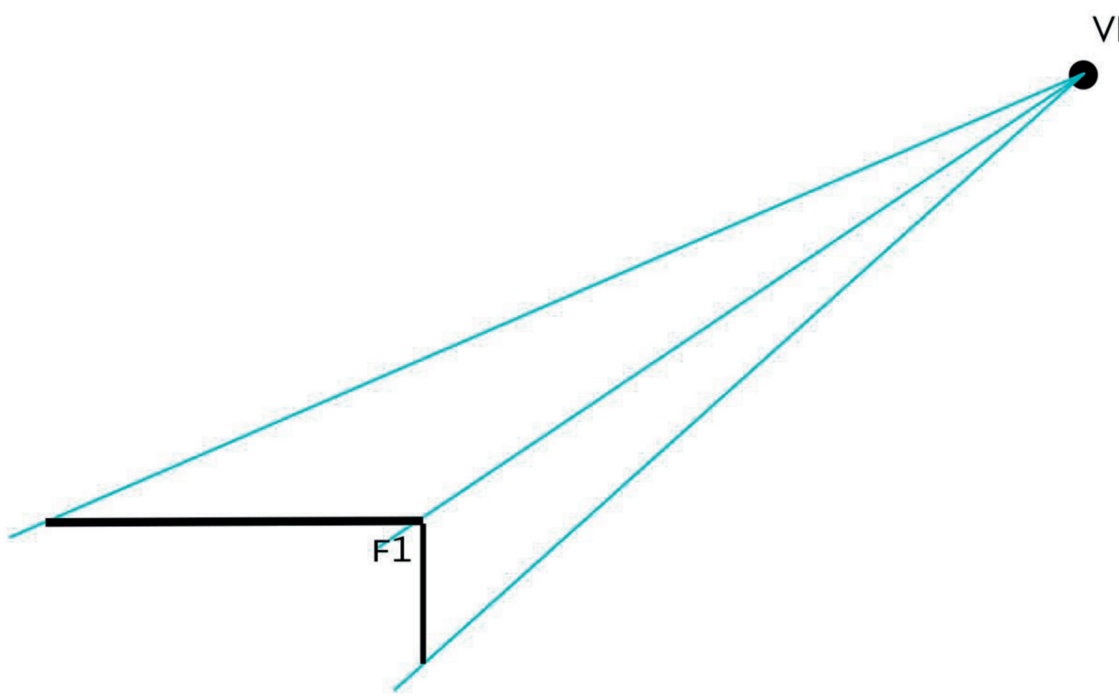


Figure 14

Perspective drawing with texture and shading

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

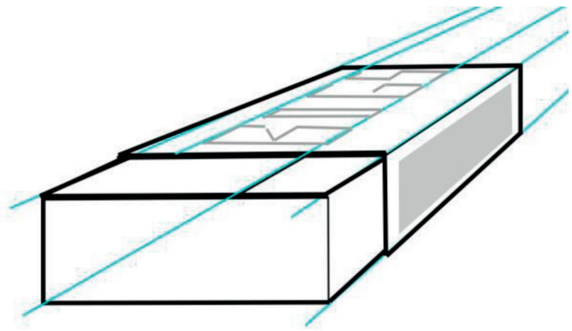


Figure 15

Draw an open matchbox using single vanishing point perspective in the space below.

Add more shading, and even colour

When a surface is flat, the whole surface looks as if it is the same colour. But 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 in the space below and do the following:

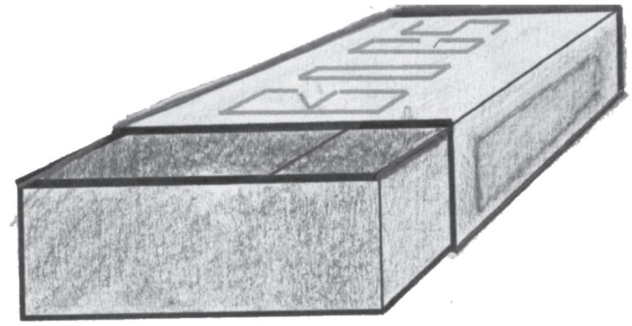


Figure 16

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

Next week

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

Chapter 4
Push and lift objects

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

4.1 Lift things with a lever 47
4.2 Move things without touching them 52
4.3 Do different things with levers 59

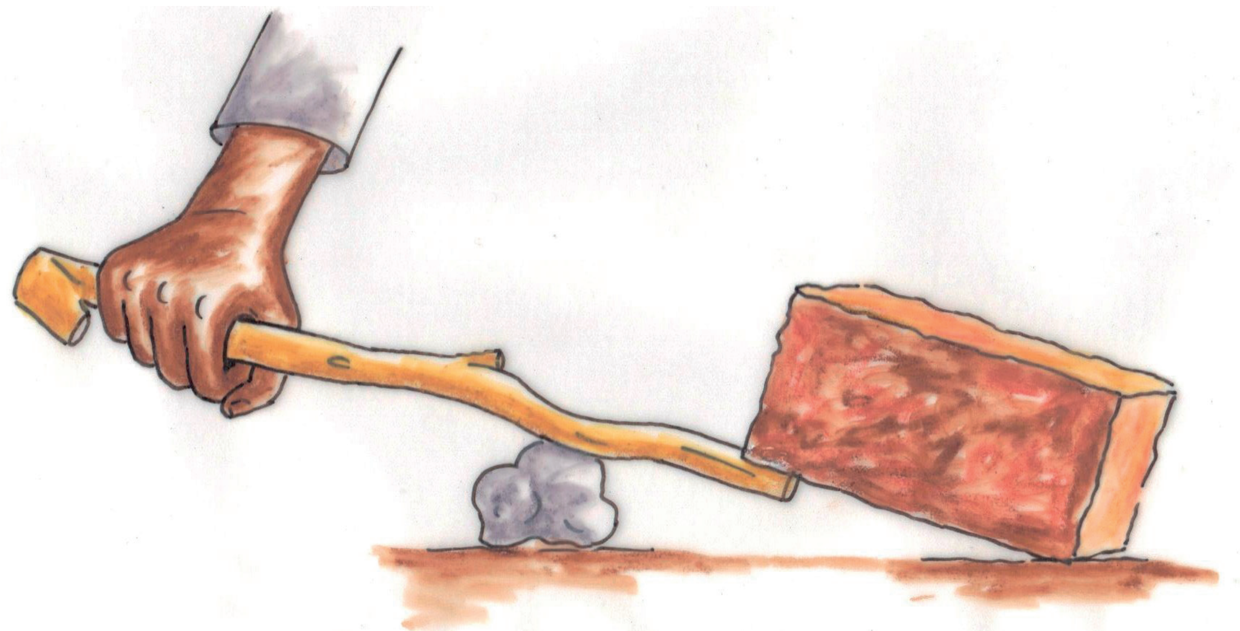


Figure 1

Special projects

If you have time to spare in class or at home, give one or more of these activities a try:

1. Build a working model of the water lever 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 diagrams on the next page. Try to see what properties of levers can be seen in the diagrams. Write captions for the drawings that explain what they show.

Figure 2

Figure 3: The buckets are used to take water from the well.

4.1 Lift things with a lever

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

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

....

....

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

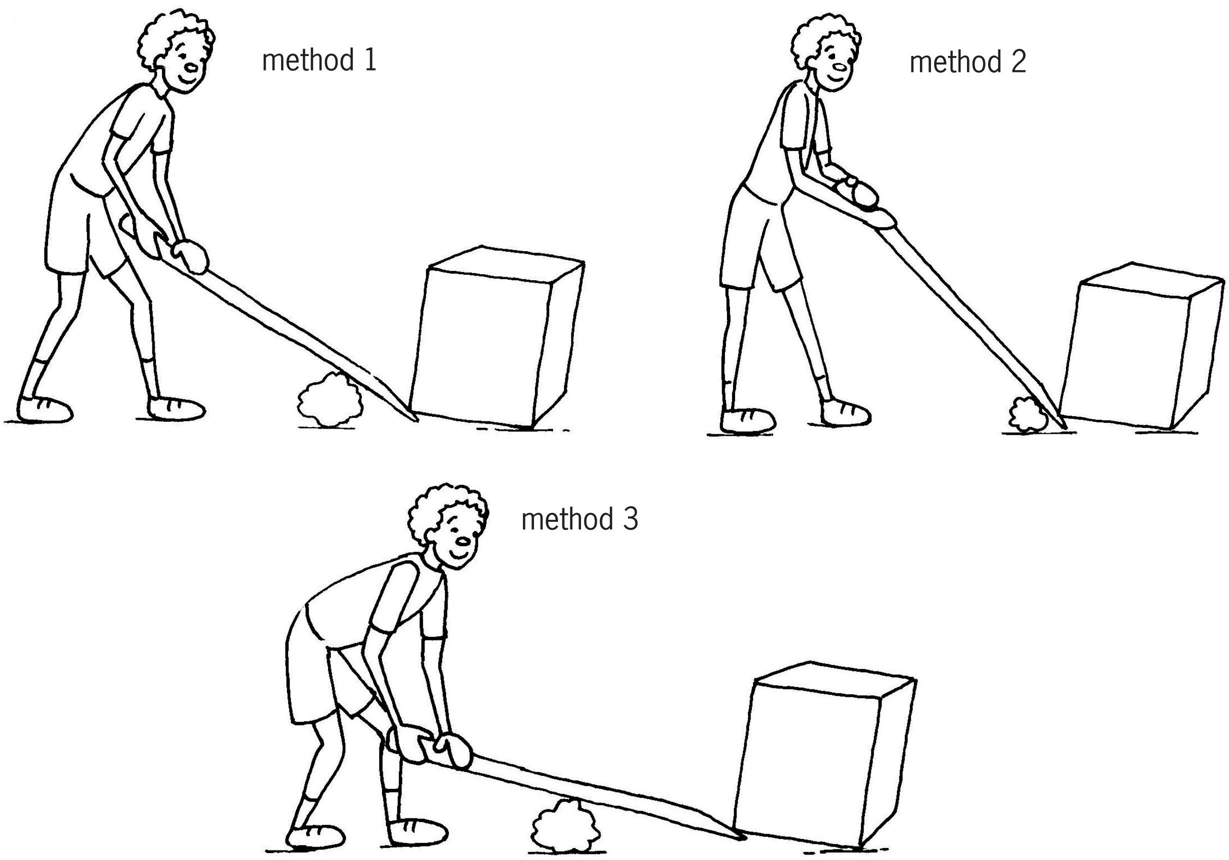


Figure 4

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

....

....

Join two classmates and work with a lever

You need three things for this activity:

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

Now do the following:

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

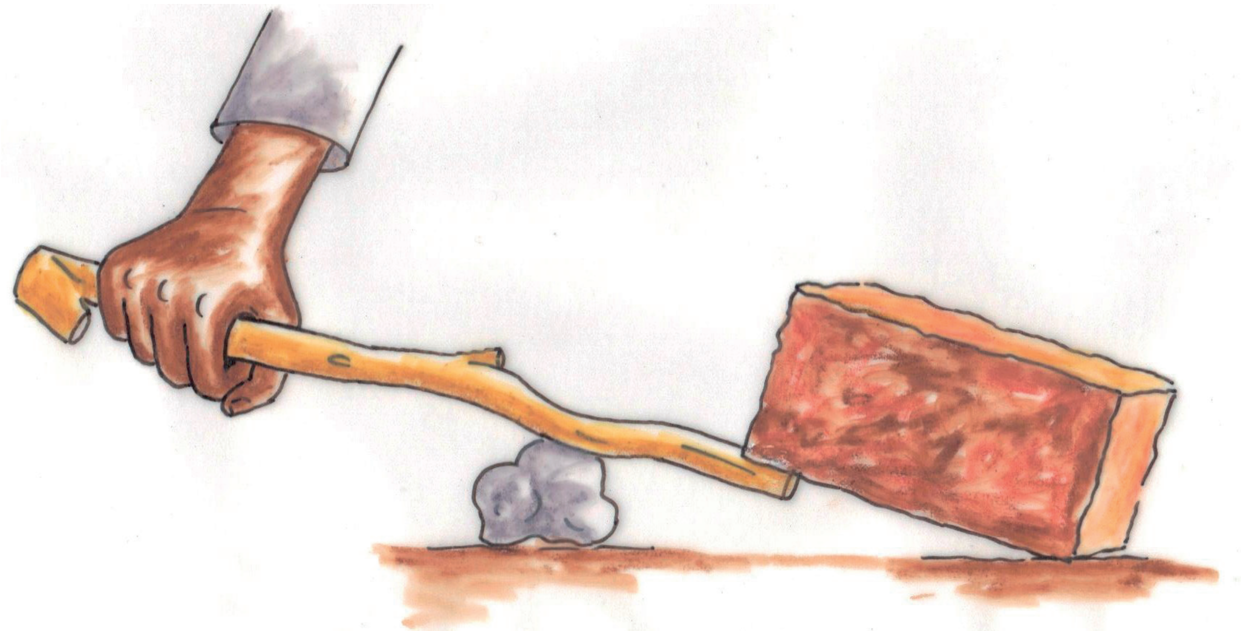


Figure 5

The point where the stick is supported by the brick or stone is called the **fulcrum** or **pivot point**.

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

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

   ....

   ....

If you did not do the above, do this:

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

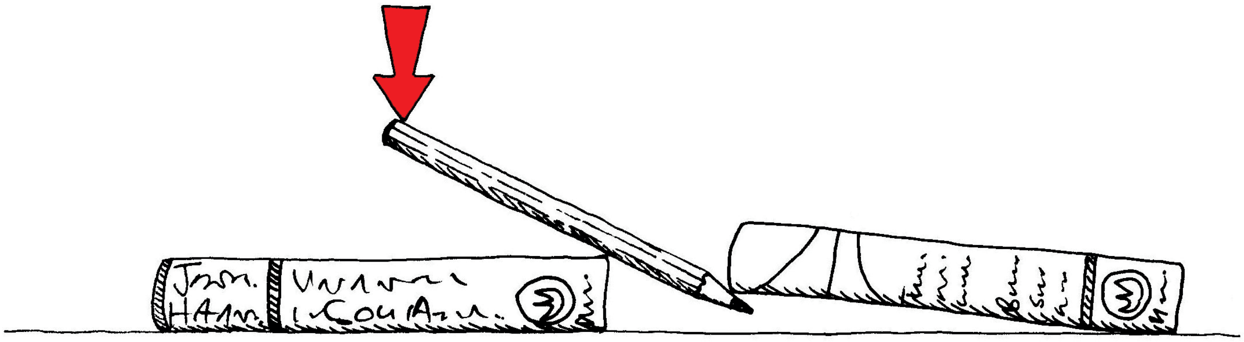


Figure 6

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

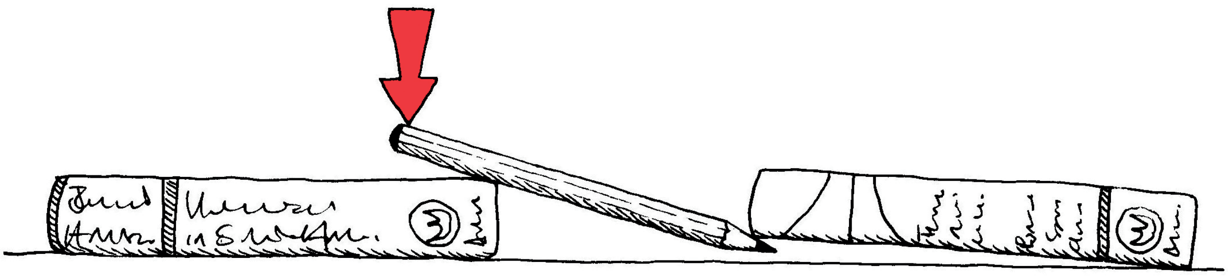


Figure 7

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

 ....

 ....

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

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.

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

Scientists and technologists use the 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.

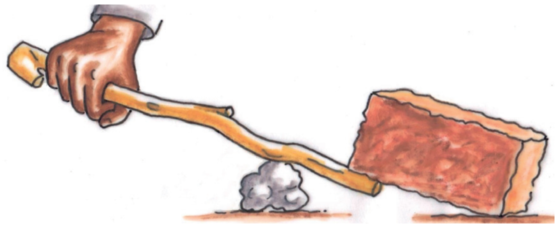


Figure 8: Mechanical advantage

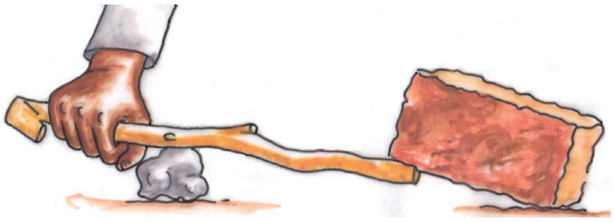
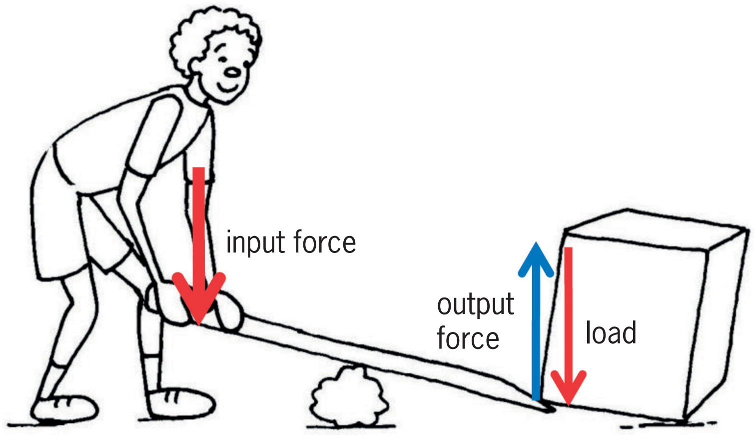


Figure 9: Mechanical disadvantage

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

   ....

> The downward push that Tom makes on the lever is called the **input force** or **effort**.
> The weight of the concrete block that tries to keep the other end of the lever down is called the **load**.
> The upward push on the load is called the **output force** or **effect**.



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

Figure 10

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

6. Where is the input force, the load and the fulcrum on each of these pictures? Write your answers next to the pictures.

> 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 that 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.

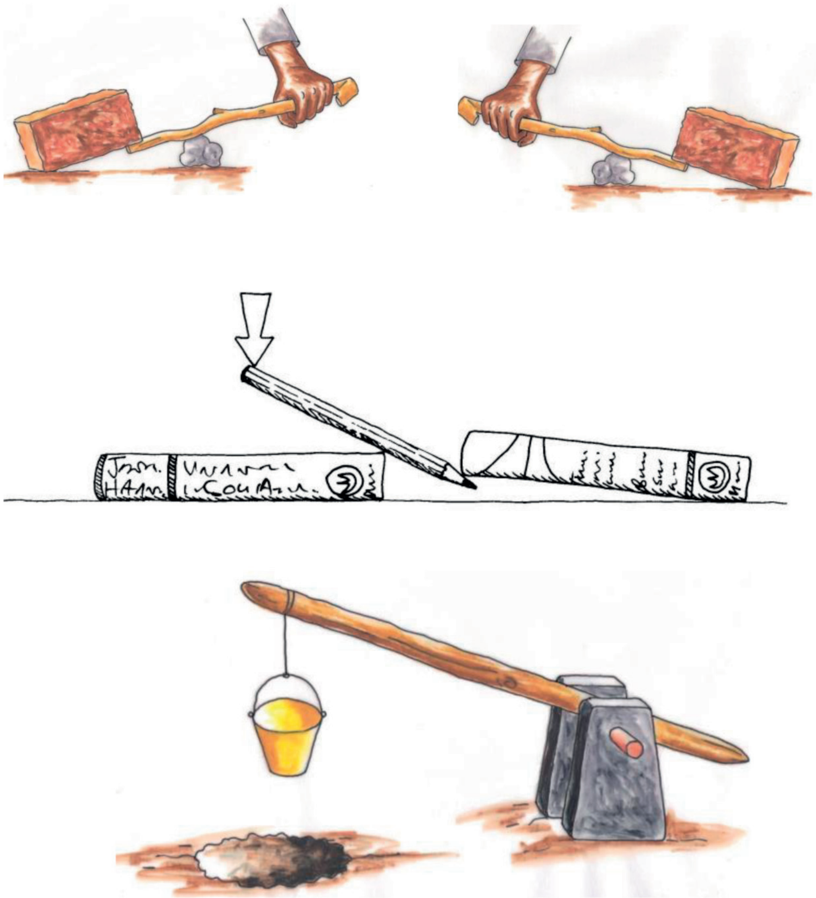


Figure 11

Important: something you need to do at home

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

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

4.2 Move things without touching them

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

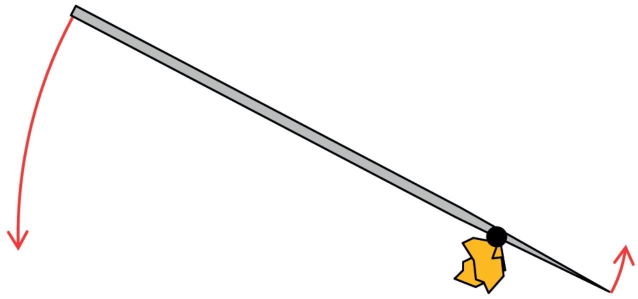


Figure 12

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

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

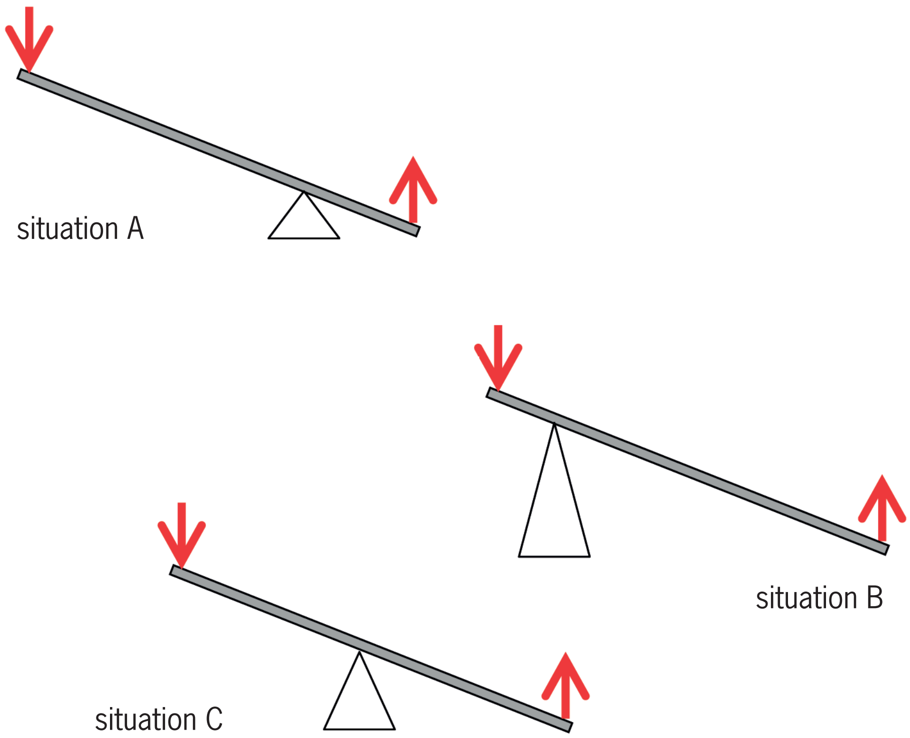


Figure 13

Make a lever with a base

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

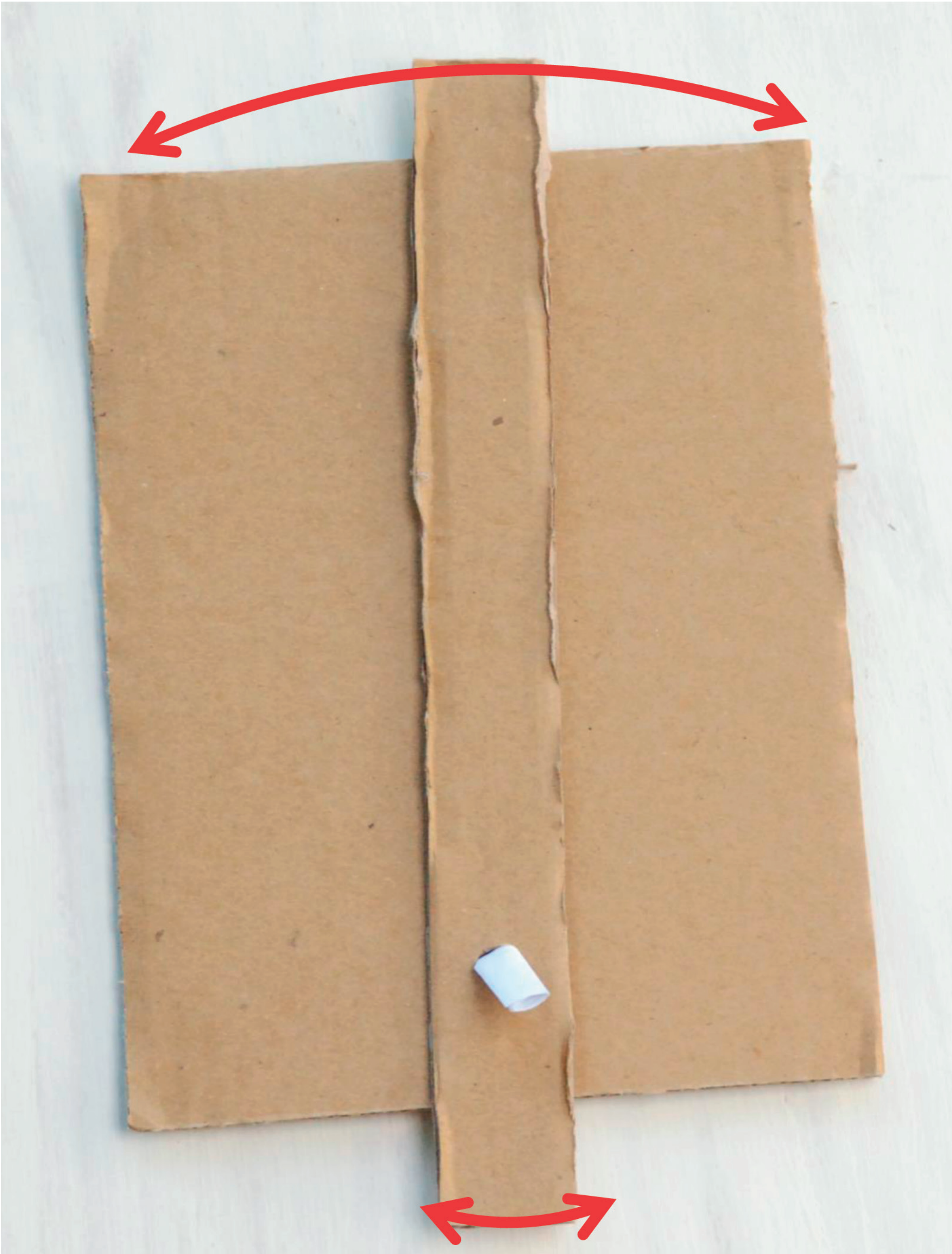


Figure 14

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

Instead of **fulcrum** we can say **pivot point**. It means the same.

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

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 on the previous page. Make sure you understand how your lever will work.

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

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

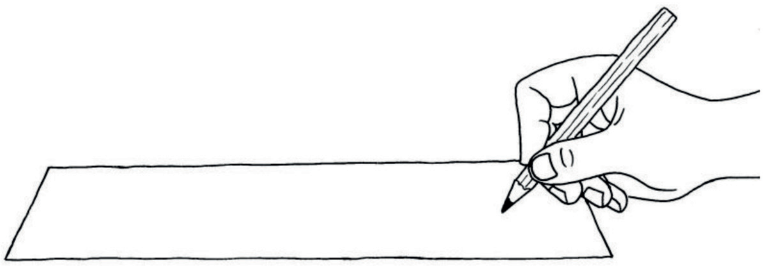


Figure 15

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

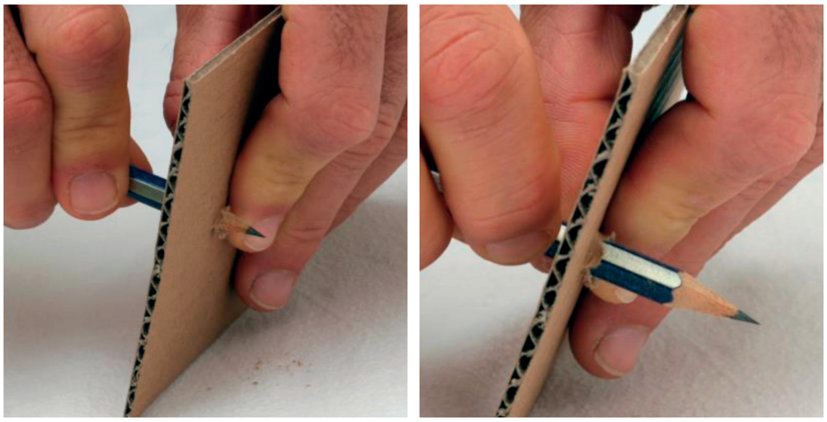


Figure 16

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

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

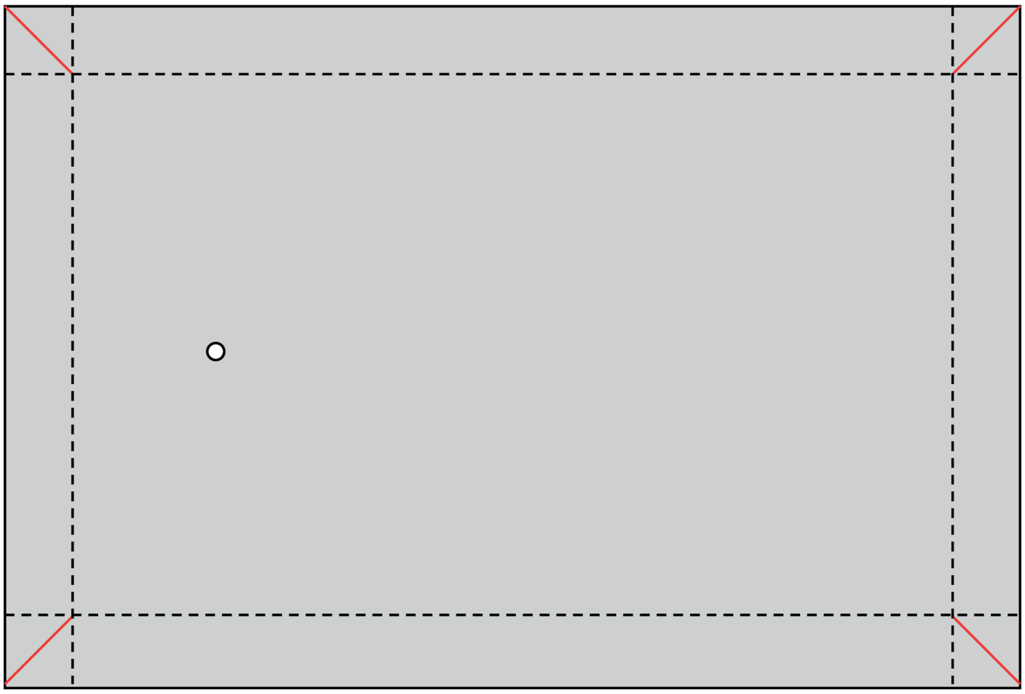


Figure 17

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

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

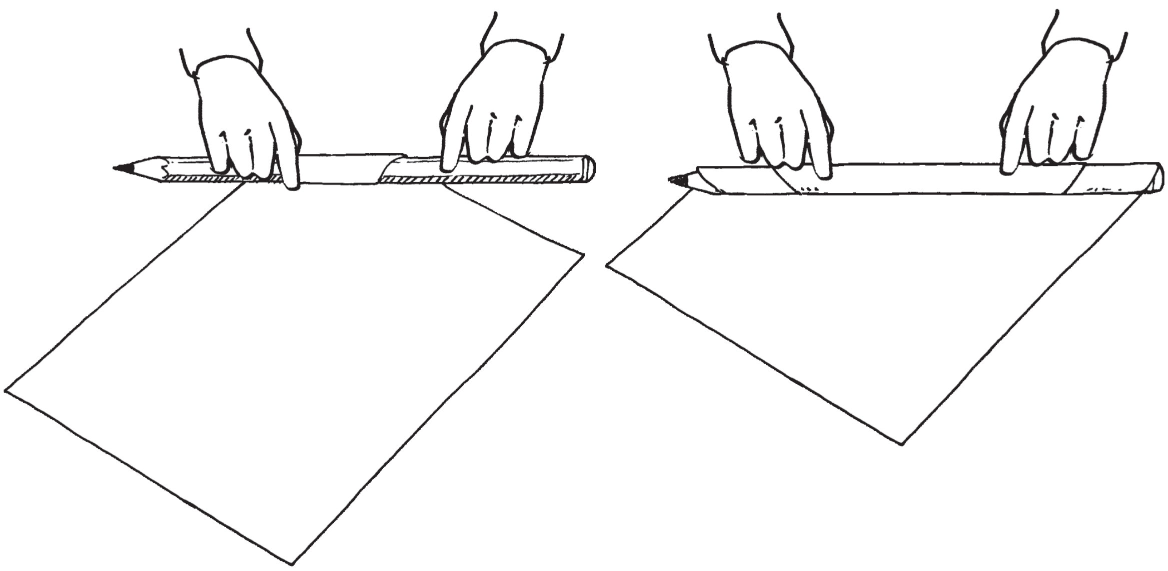


Figure 18

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

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

smooth side of a punched hole

rough side of a punched hole

Figure 19

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

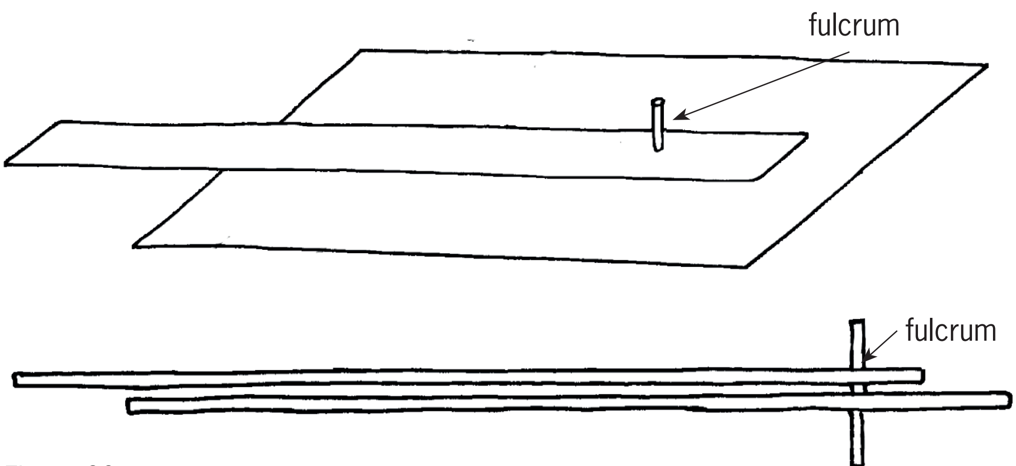


Figure 20

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

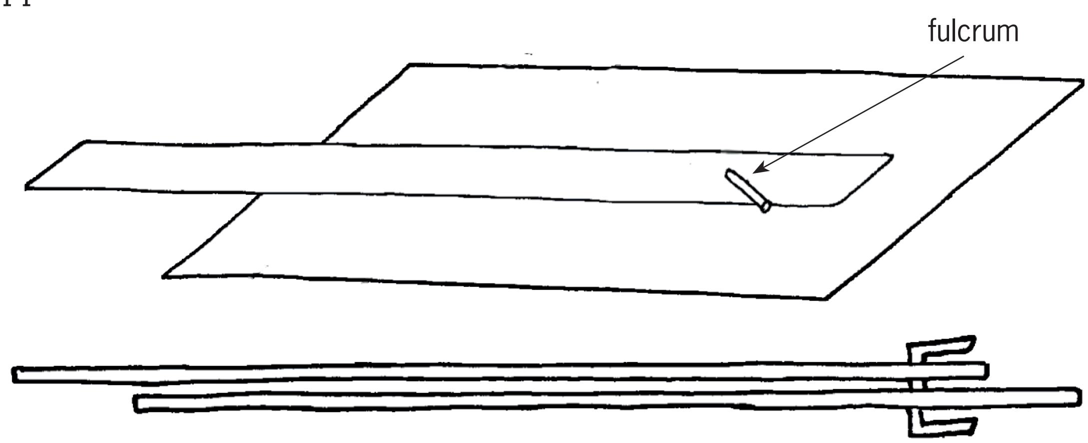


Figure 21

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

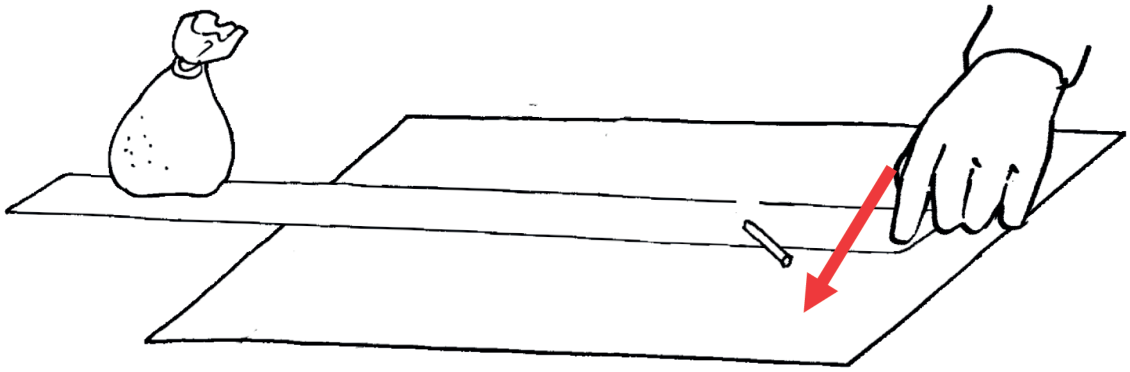


Figure 22

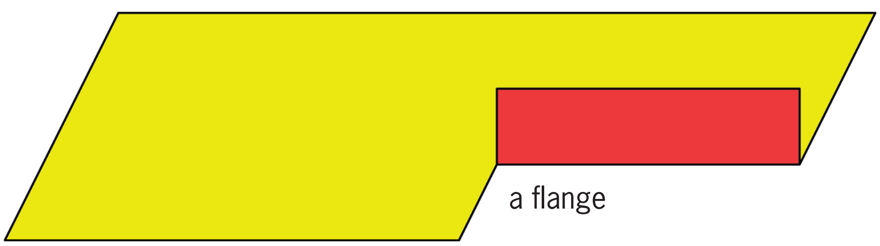
8. It may not work very well. Think a bit, and then describe how you can improve your lever so that it will work better when you want to move the bag around.

 ....

 ....

Here are two improvements that you can 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.



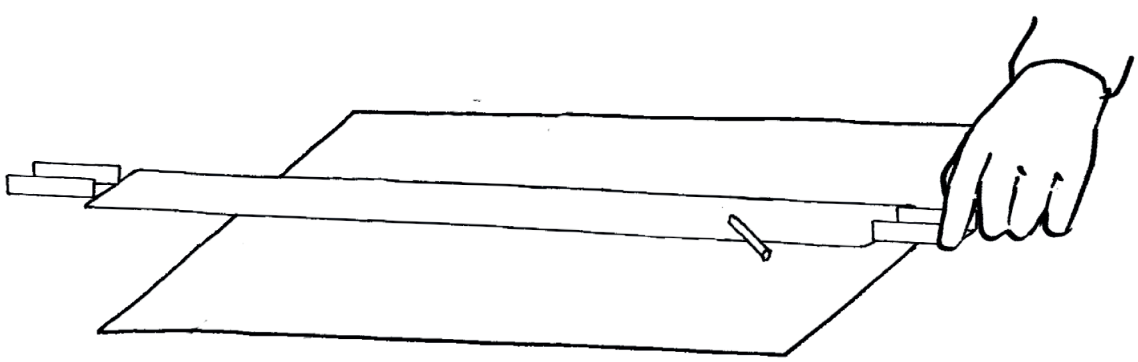


Figure 23

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

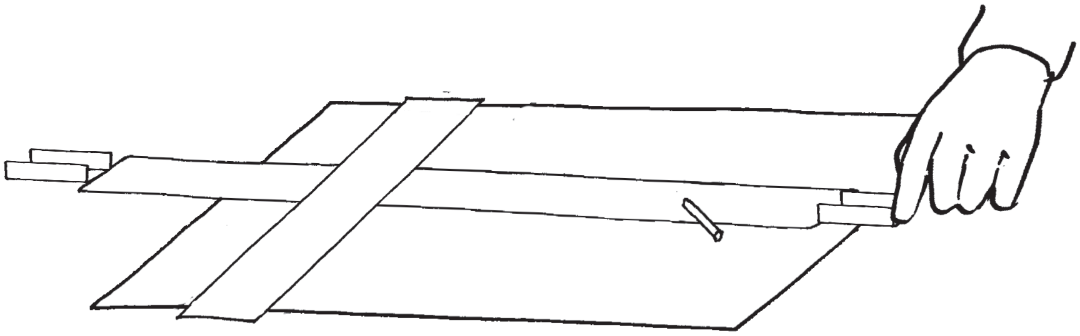


Figure 24

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 mini-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.

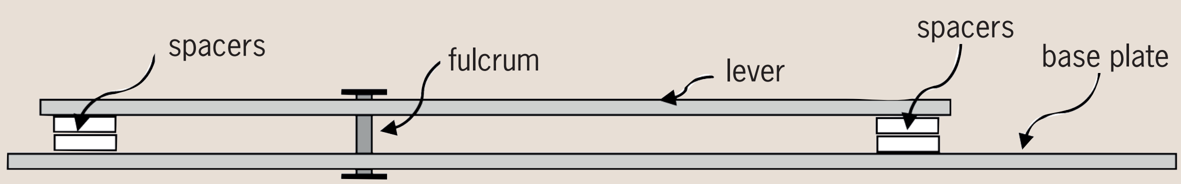


Figure 25

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.

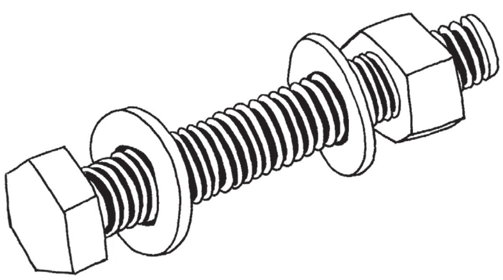


Figure 26

4.3 Do different things with levers

Change 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

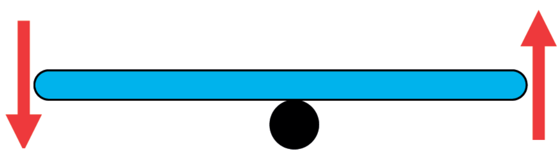


Figure 28

In the above case, the output movement is in the opposite direction than the input movement. Linkages 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 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 linkages (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? Make an arrow on the diagram to show the direction.

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

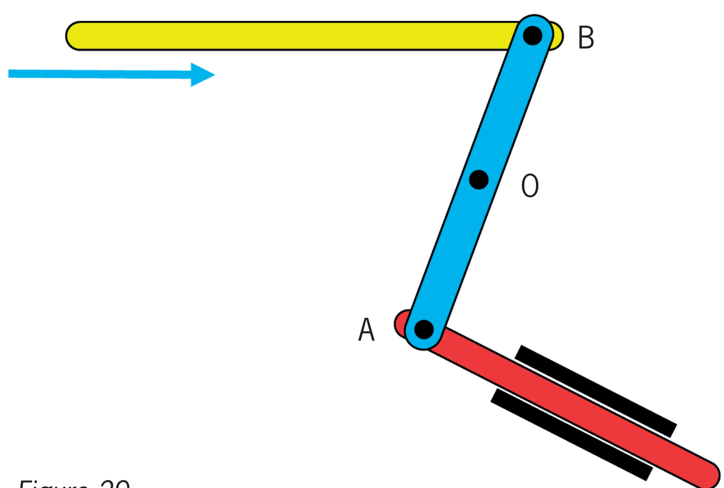


Figure 29

Evaluate a design

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

Do you think Simon's design will work?

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

Also suggest how he can improve his design.

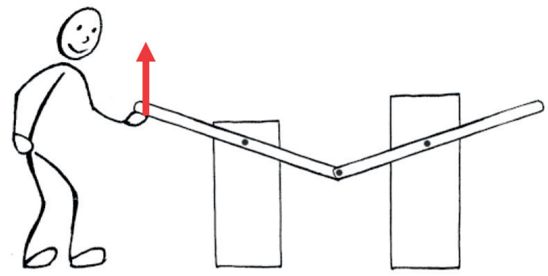


Figure 30

....

....

....

Redesign a water lever

Have another look at Figure 3 on page 46. 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 older and sick people, who are not so strong, find it very difficult to do this.

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

Next week

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

CHAPTER 5
Other classes of levers

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

5.1 The three classes of levers 63
5.2 Practical examples of different classes of levers 66
5.3 More practical examples of different classes of levers 69

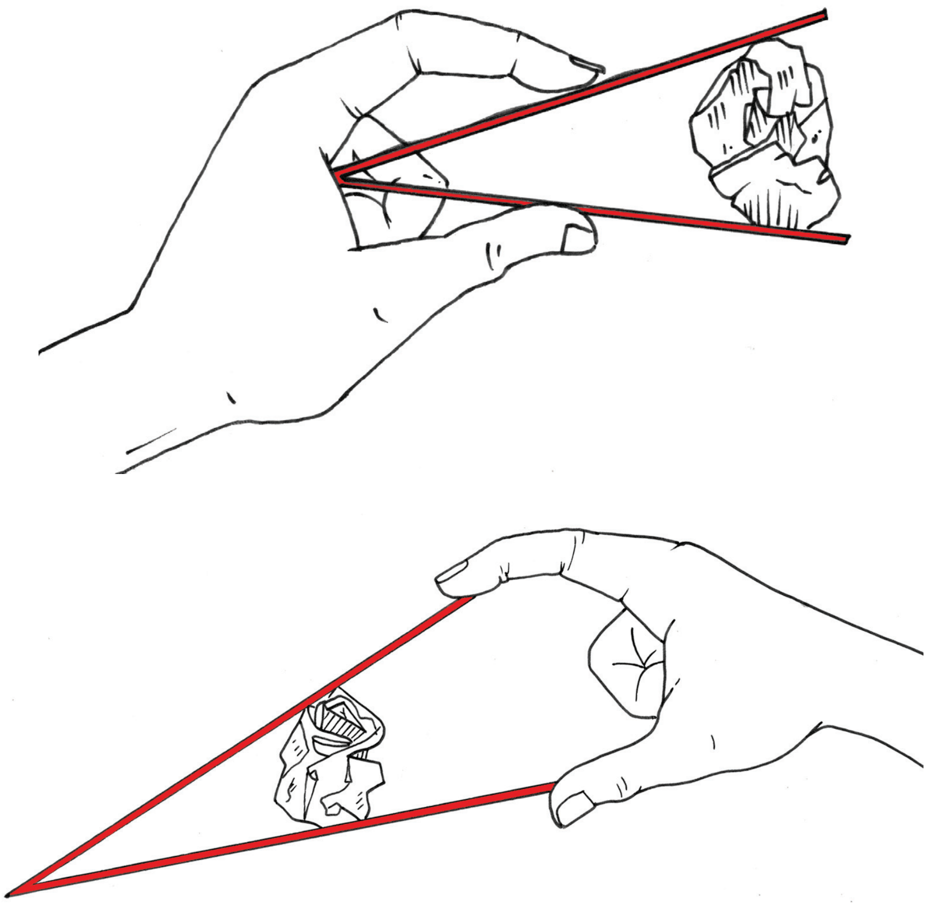


Figure 1

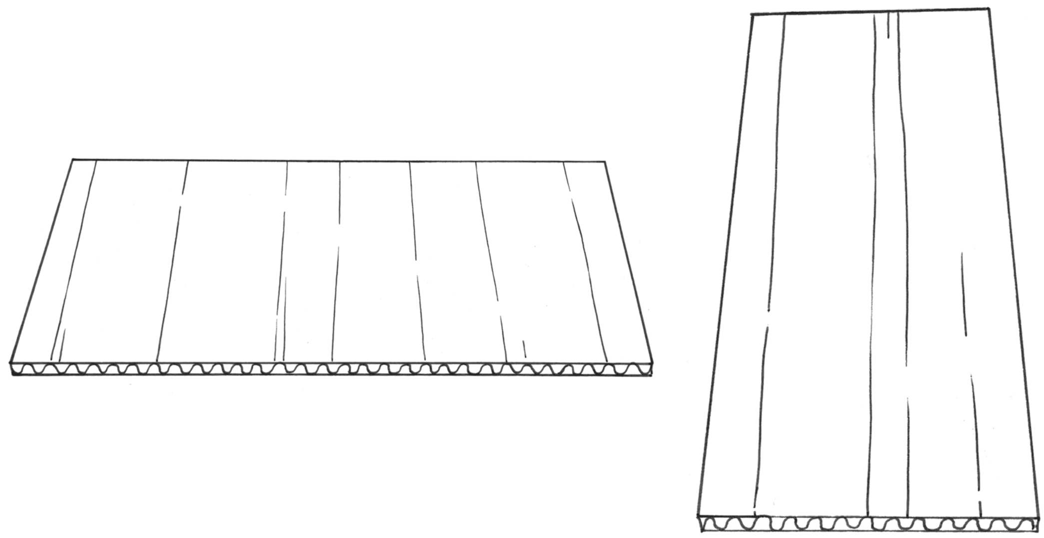


Figure 2: These pictures show two corrugated cardboard sheets of about 20 cm long and 10 cm wide. The one piece has the corrugations over the width, and the other piece has the corrugations over the length.

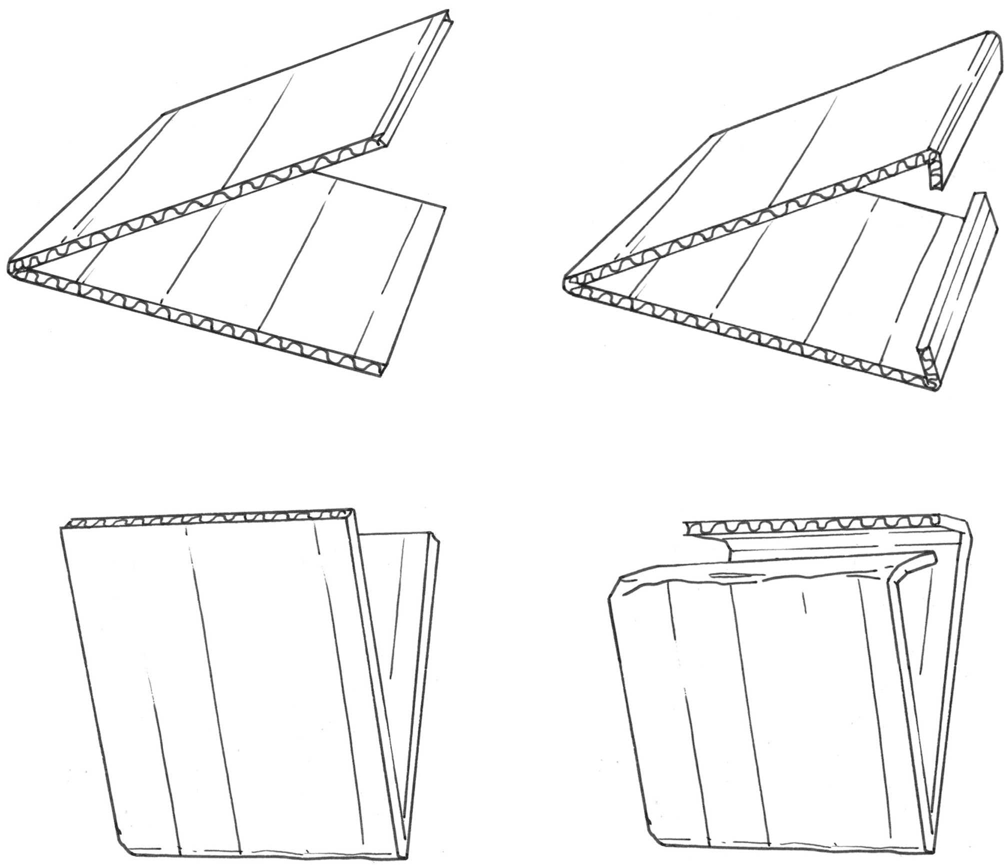


Figure 3: Both pieces are folded in the middle to form springs. The edges are folded to form flanges.

5.1 The three classes of levers

Lift your finger in three different ways

Put your pencil on the desk in front of you.

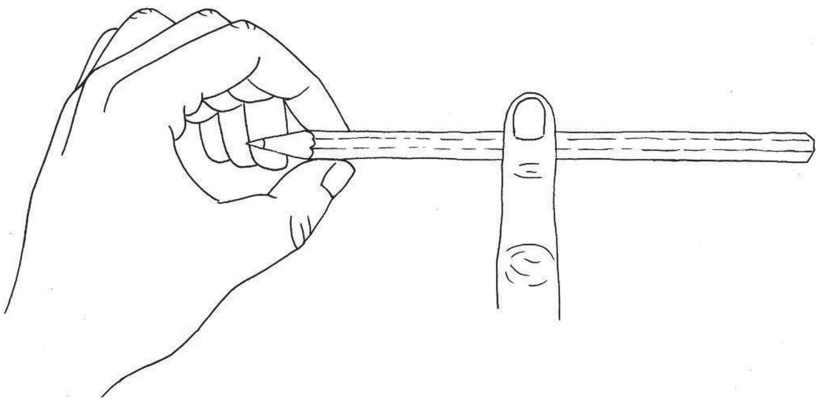


Figure 4

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

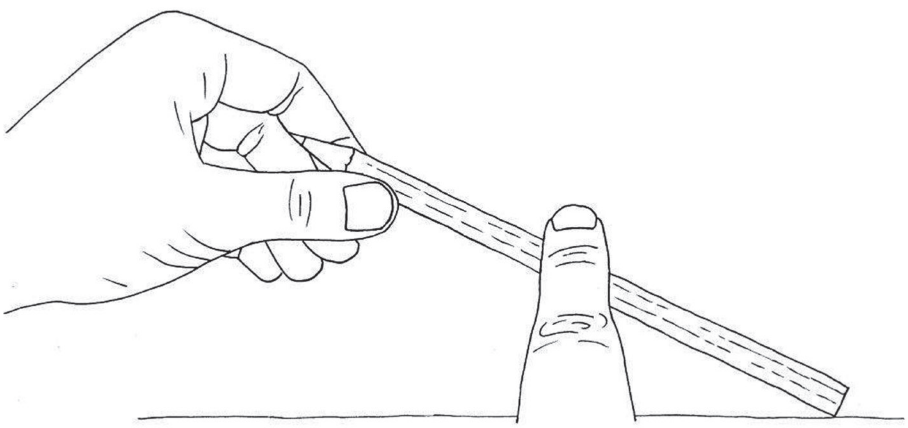


Figure 5

1. The fulcrum of the lever is at the right end of the pencil, where it rests on the desk. Mark the input force with an arrow on the sketch above. Where is the load?

   ....

2. In Figure 5 the input force is at one end of the lever, and the fulcrum at the other end. How is a first-class lever different from this?

   ....

Press the pencil down at the sharp end 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.

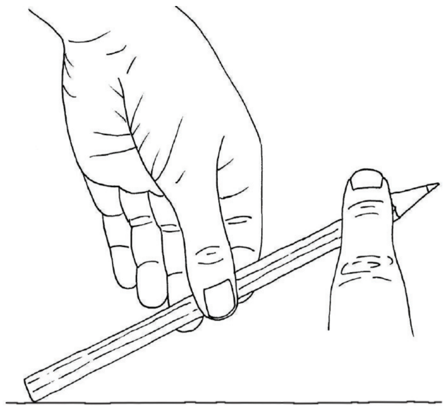


Figure 6

3. The fulcrum of the lever is at the left end of the pencil, where it rests on the desk. Mark the effort with an arrow on the sketch above. Where is the load?

....

4. In the above case, the load is at one end of the lever, and the fulcrum at the other end. How is the situation on the previous page different from this one?

....

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

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

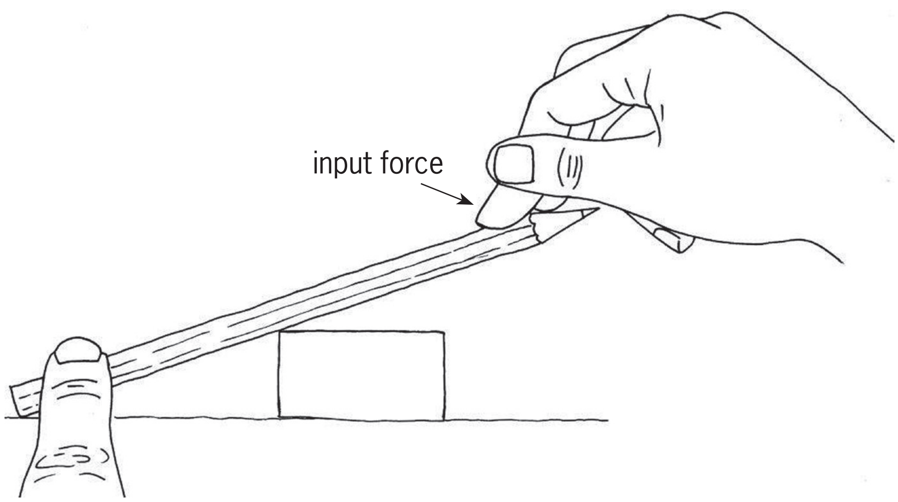


Figure 7

5. Do the experiments on the previous two pages again. When do you get the biggest mechanical advantage: when you use the pencil as a second-class lever or when you use it as a third-class lever?

....

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

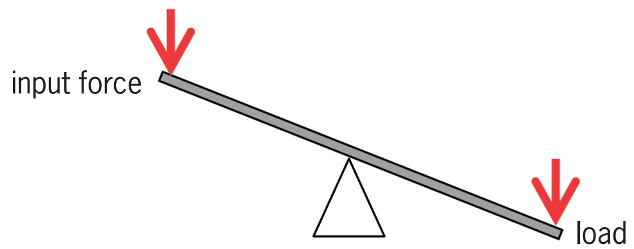


Figure 8

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

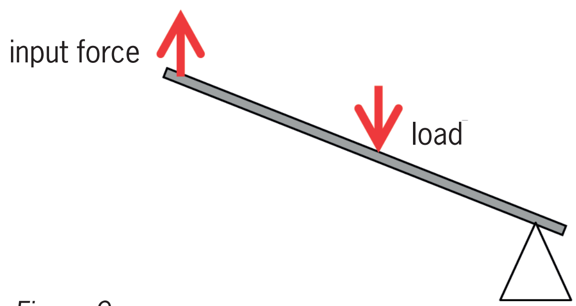


Figure 9

Fulcrum is another word for pivot point.

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

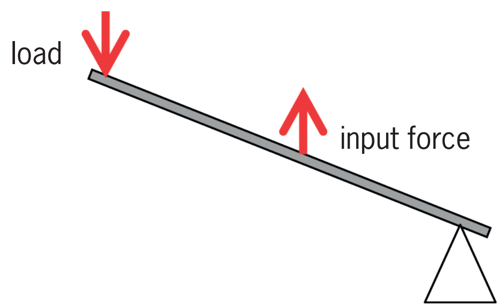


Figure 10

5.2 Practical examples of different classes of levers

This boy will swing the hammer to hit the nail into the wall.

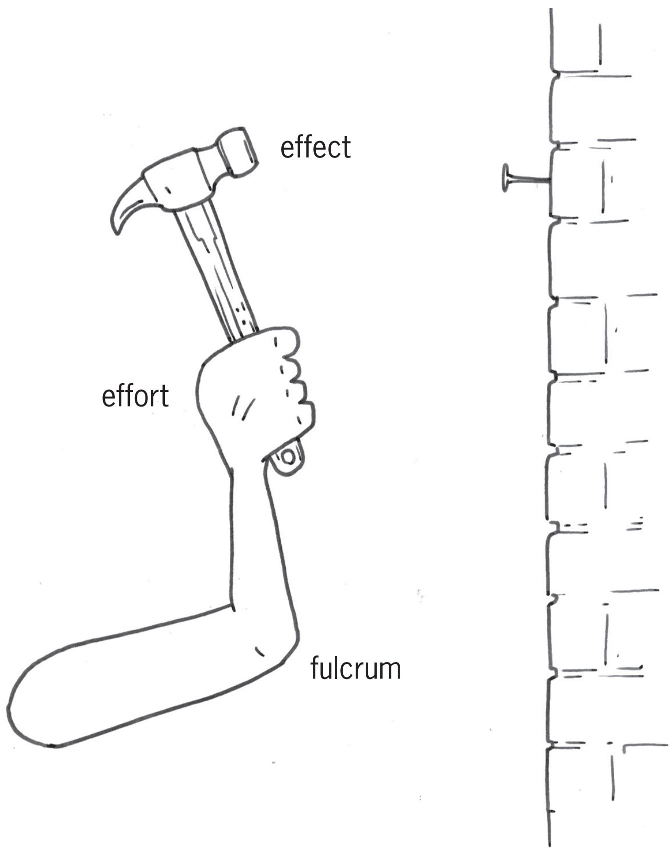


Figure 11

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

1. Is his forearm and the hammer a first-class lever, a second-class lever or a third-class lever?

   ....

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

   ....

3. Rest your right elbow on your desk, then pick up something with your right hand while keeping your elbow on the desk.

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

   Do you feel the muscle movement inside your arm?

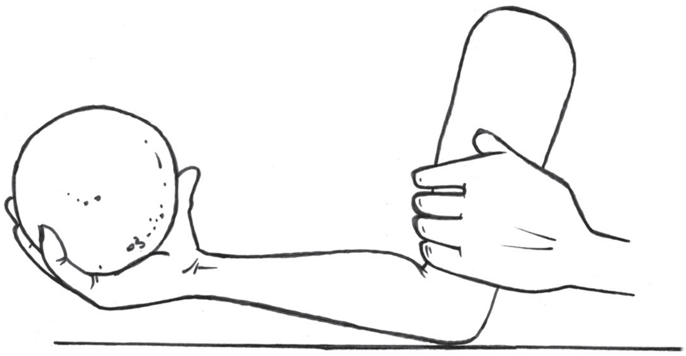


Figure 12

The diagram below explains how your arm works.

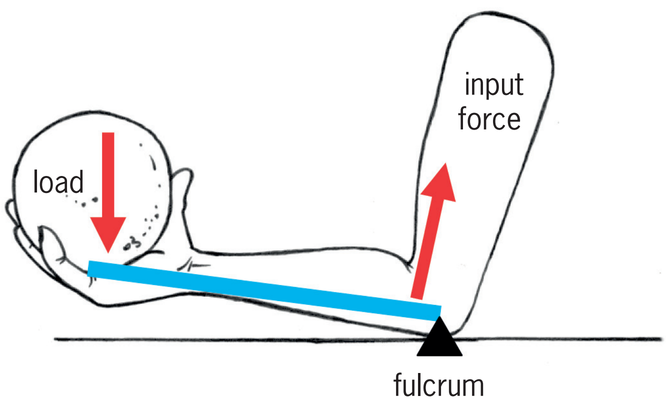
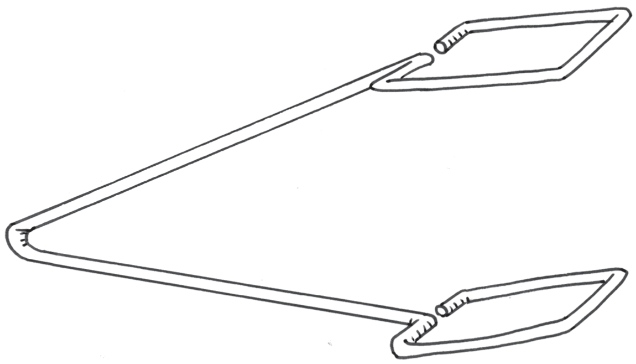


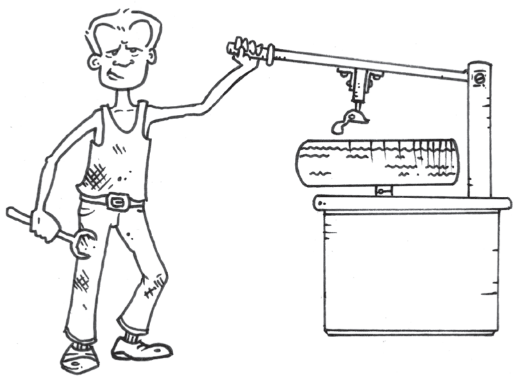
Figure 13

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

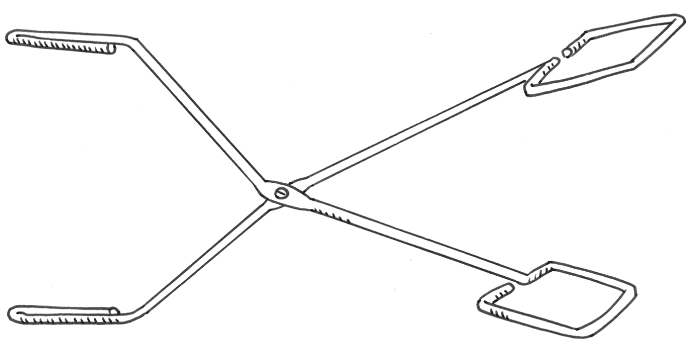
4. In each of the pictures below, draw a small triangle to indicate where the fulcrum is, and an arrow to indicate where the input force is. Make a letter L to show where the load is. Also state in each case what class of lever it is.



(a) kitchen tongs



(b) man pressing down mechanical tyre lever on stand



(c) another kind of kitchen tongs

Figure 14

5.3 More practical examples of different classes of levers

Figure 15

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

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

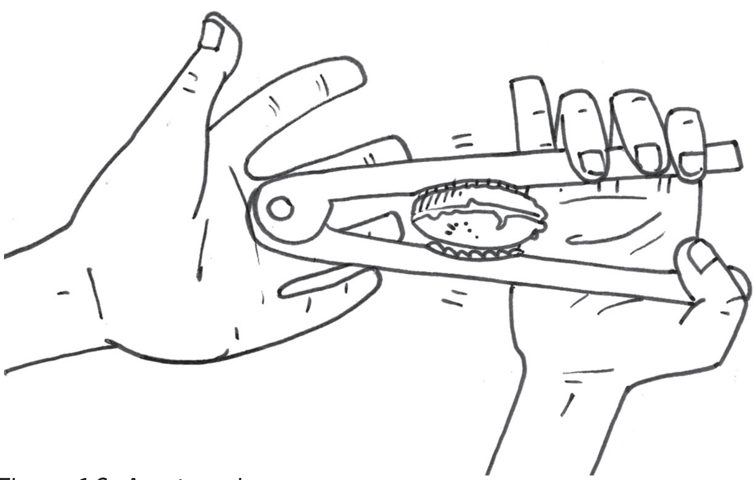


Figure 16: A nutcracker

Make a lever on a base plate

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

Figure 17

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

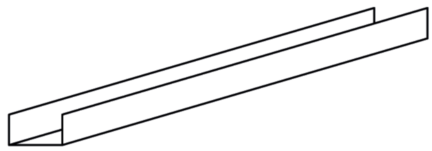


Figure 18

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

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

....

....

....

Next week

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

Chapter 6
Tools with two or more levers

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

6.1 Pairs of first-class levers 73
6.2 More tools with levers 77
6.3 Many levers in one device 80

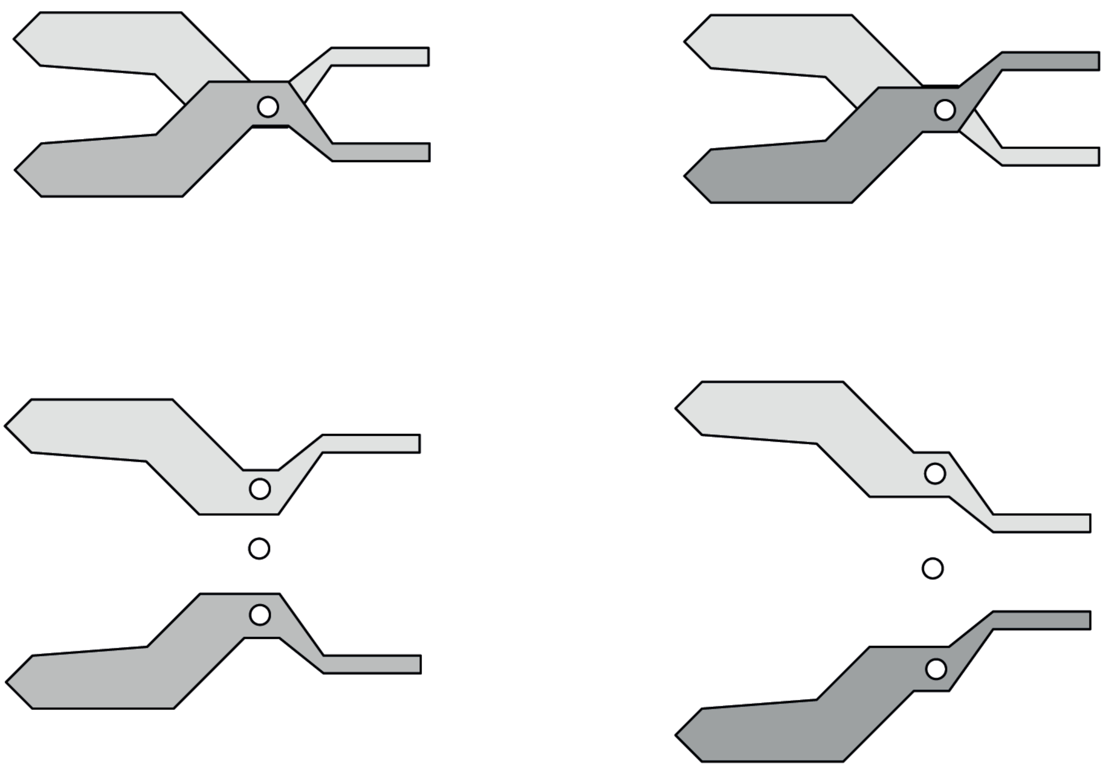


Figure 1: A set of pliers consists of two levers attached at the same pivot point.

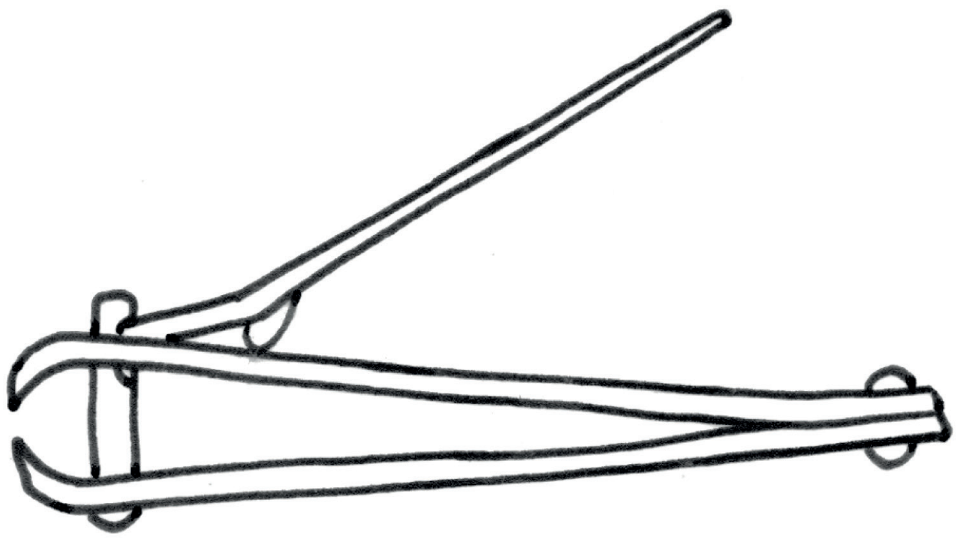


Figure 2

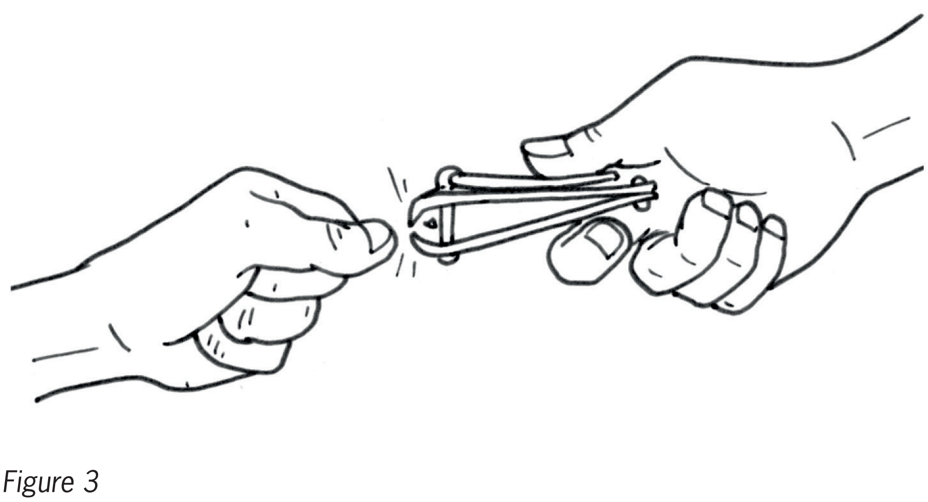


Figure 3

6.1 Pairs of first-class levers

Work with scissors in different ways

First 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.

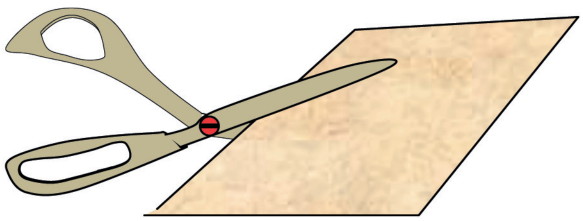


Figure 4

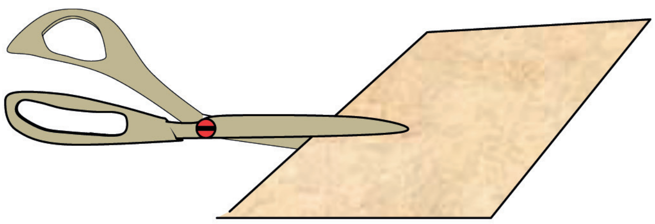


Figure 5

1. What is the difference between these two methods of using scissors?

   ....

   ....

2. With which method will it be the easiest to cut? Explain your answer.

   ....

   ....

   ....

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

   ....

   ....

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4. In diagrams A, B and C below, the input force on the blue blade is indicated with a red arrow in each instance. In diagram A the load on the blue blade is indicated by a black arrow.
   (a) Draw an arrow to show where the load is in diagrams B and C.

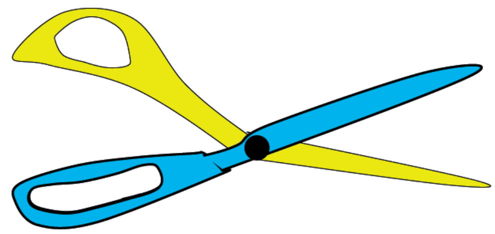


Figure 6: A pair of scissors is actually two blades that are linked together so that they work like two levers.

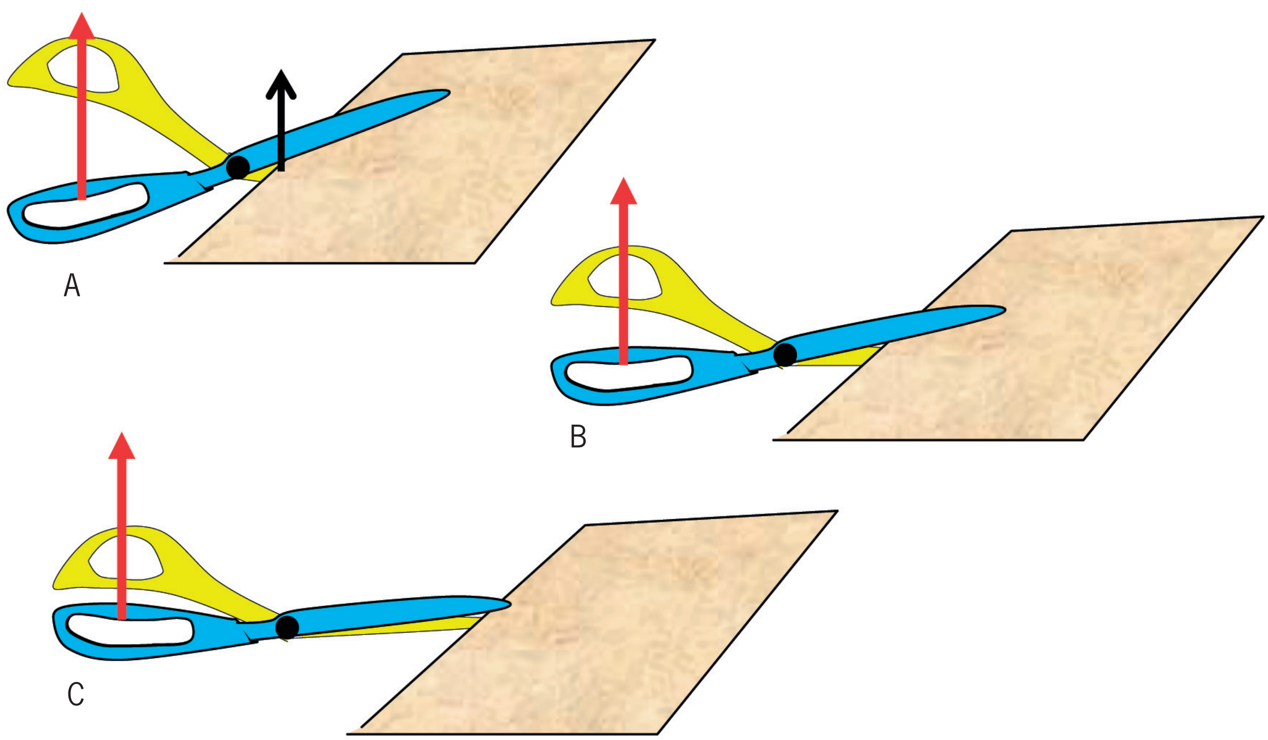


Figure 7

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

....

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

....

Can scissors cut thick objects?

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

....

....

Figure 8

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

....

....

....

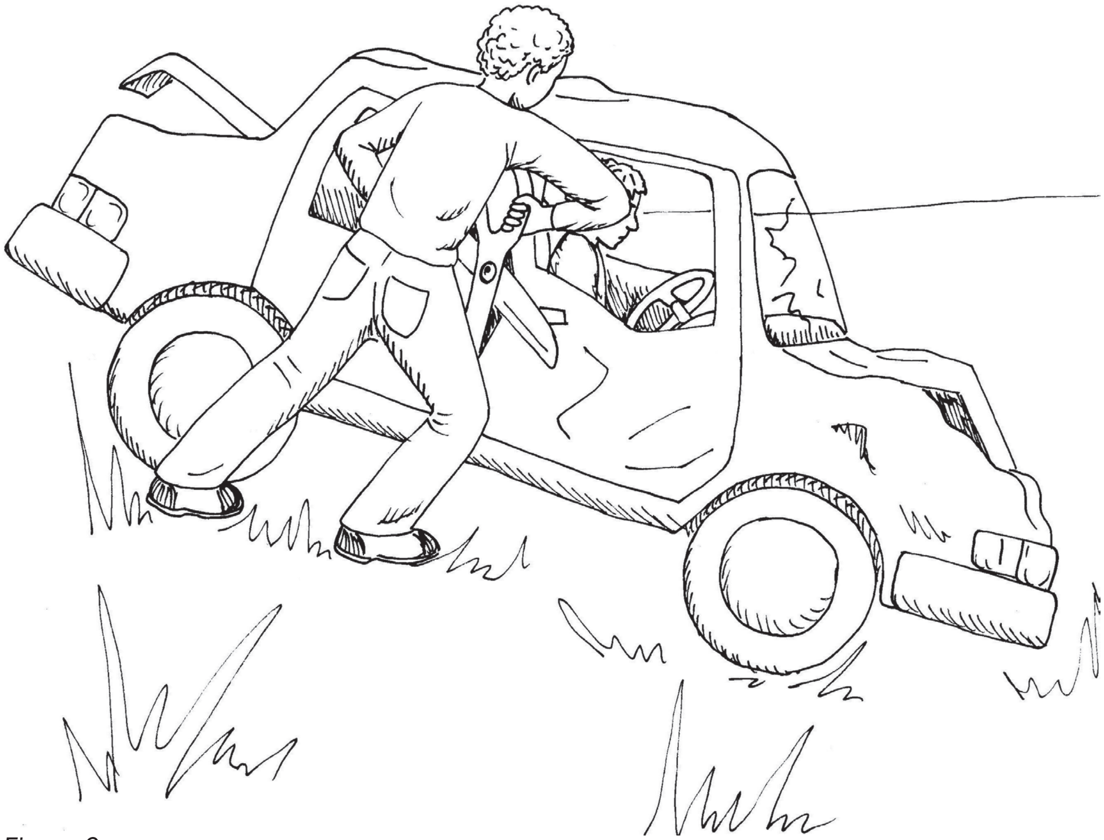


Figure 9

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

....

....

....

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

....

....

....

....

6.2 More tools with levers

What is the best way to crack a nut?

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

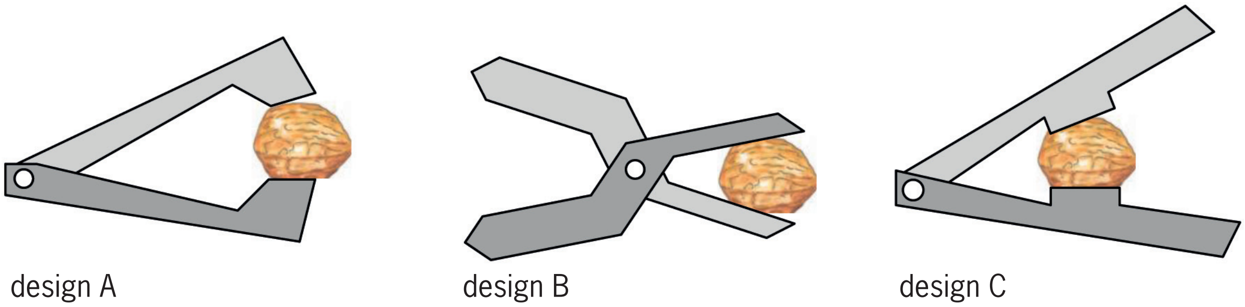


Figure 10

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

   ....

   ....

   ....

2. Quickly draw a hand in each case below to show how you can press the hardest on the nut.

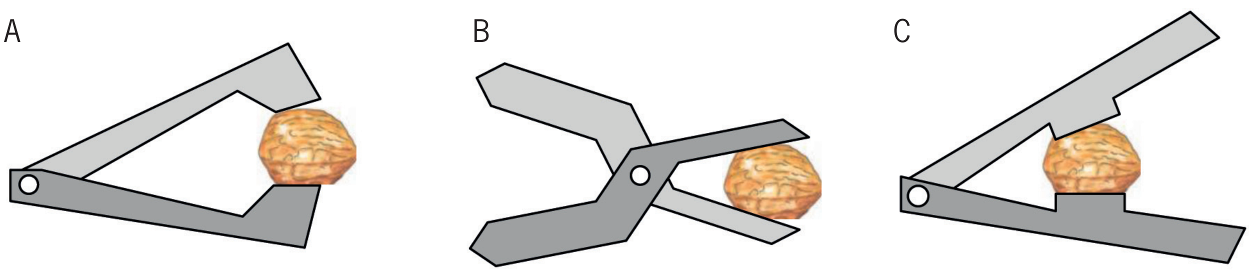


Figure 11

3. Mark and **label** the input force, load and fulcrum clearly on each of the above drawings.
4. Which of the three nutcrackers do you think will work best? Explain why you think so.

   ....

   ....

   ....

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

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

5. Describe the differences between type A and type B kitchen tongs.

....

....

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

....

....

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

....

....

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

....

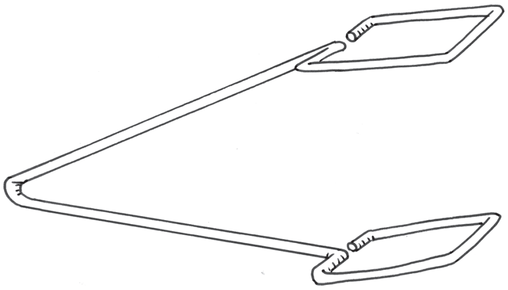
....

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

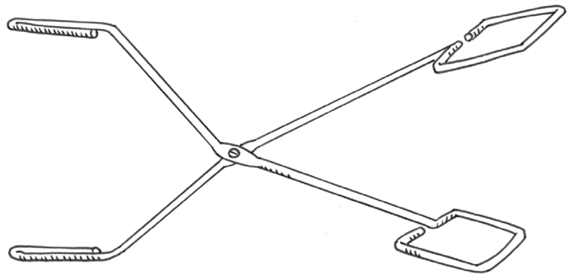
10. Which class of lever did you choose for your design in question 9?

....

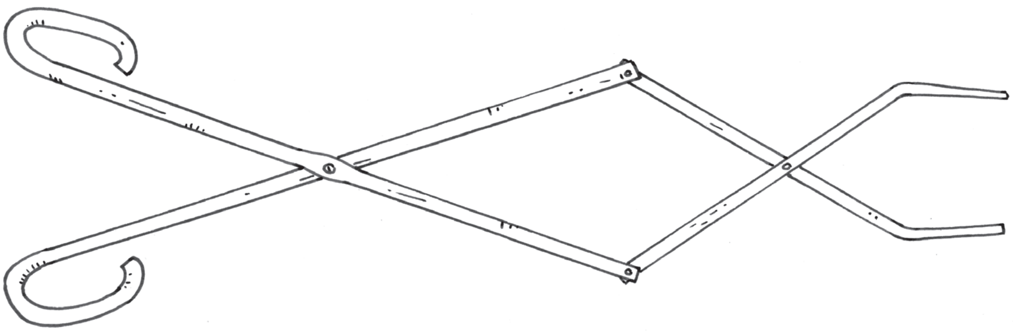
11. Make a free-hand drawing of tweezers with a different class of lever than the tweezers in your first design.



kitchen tongs type A

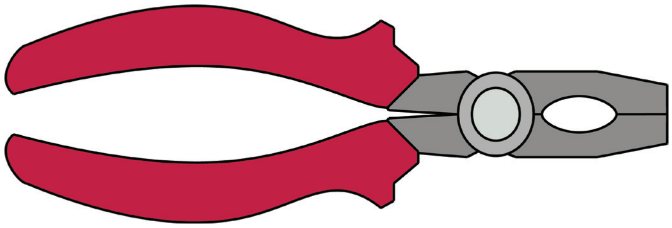


kitchen tongs type B

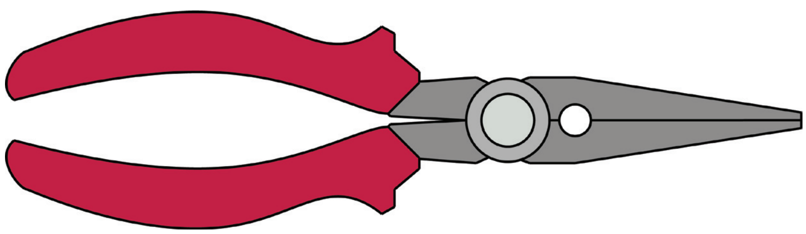


kitchen tongs type C

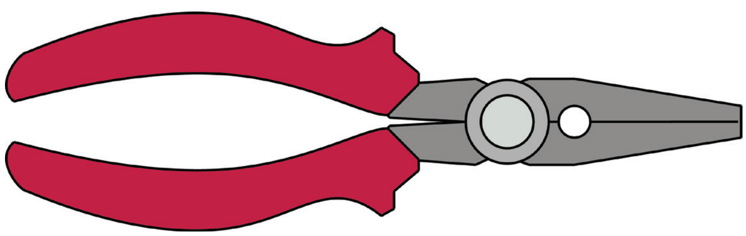
Figure 12



type A pliers



type B pliers



type C pliers

Figure 13

6.3 Many levers in one device

Examine and redesign a nail clipper

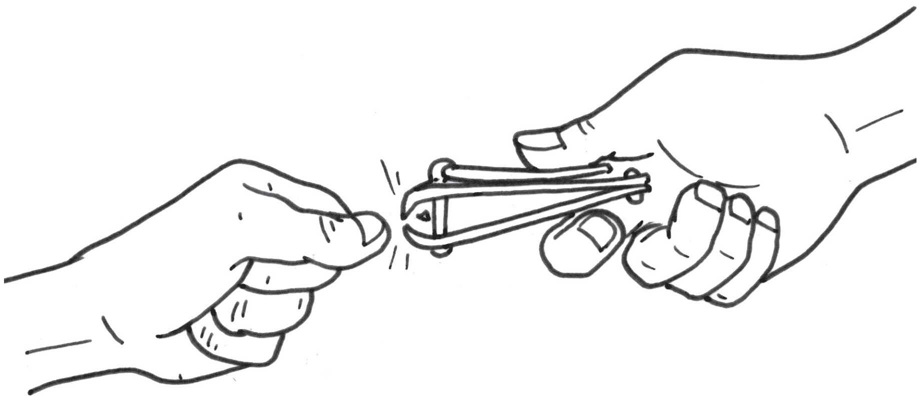


Figure 14

A bigger drawing of the nail clipper on its own is shown below, and a **schematic diagram** of a nail clipper is shown on the next page.

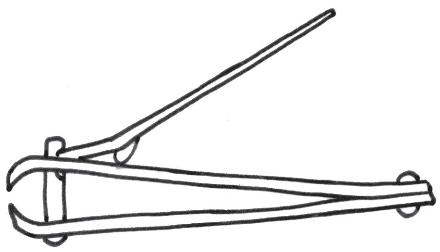


Figure 15

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

1. Look at the red part on the diagram on the next page. It is a lever. What class of lever is it when the nail clipper is used?

   ....

2. Show the effort and load on the red lever with arrows and labels. Also show the pivot point with a small triangle and a label.

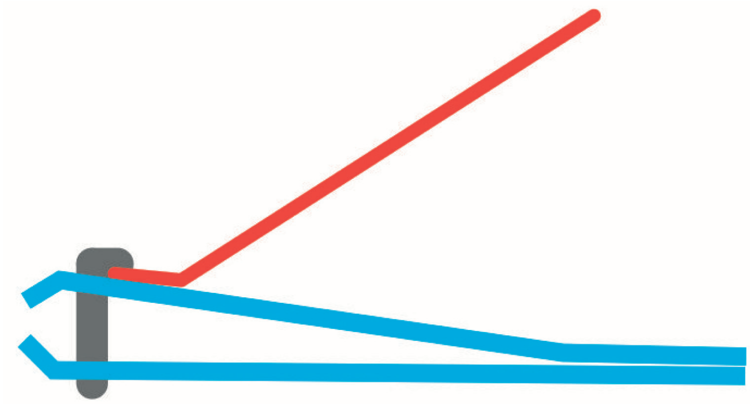


Figure 16

3. The blue part of the nail clipper is a pair of levers. Are they used as first-class, second-class or third-class levers?

....

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

....

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

....

....

....

6. Can the above design be changed so that the nail clipper could cut harder objects than finger nails, for example pieces of metal? Make a schematic drawing to show how that could be done and explain why it will have a greater mechanical advantage than the design above.

....

....

....

Investigate another combination of levers

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

The four yellow dots show **linkages**, like the linkages 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**.

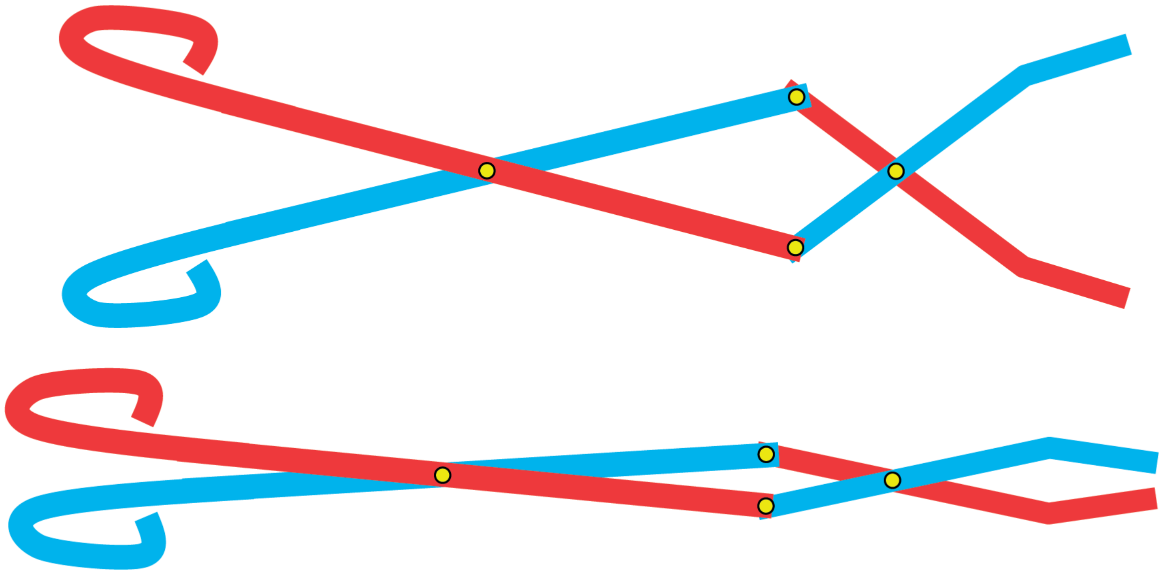


Figure 17

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

....

2. Which of the yellow linkages in the drawing are pivots for levers, and which only connect one lever to another? Show this by writing labels on the drawings above.

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 Mini-PAT
Design a life-saving tool

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

It is a good idea to make a few trial designs before you make the final model. There is a lot to find out, to think about, to plan and to prepare before you can even start with a project. For the next two and a half 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.

Week 1

Another way to move objects from a distance 86

Week 2

Scenario 96

Week 3

Make a working drawing 105

Week 4

Complete your model 108

Assessment

Design:

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

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

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

Make:

Planning to make .... [15]

Completed model .... [20]

2D working drawing .... [10]

[Total marks: 70]

Figure 1

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

Figure 2

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

Incidents like this 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 in first aid. They can do many things that doctors can do.


Figure 3

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

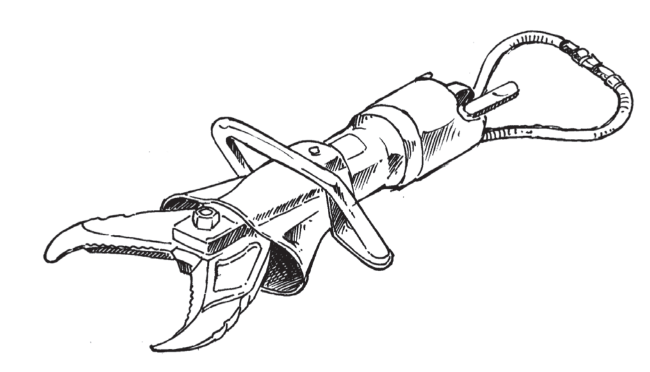


Figure 4

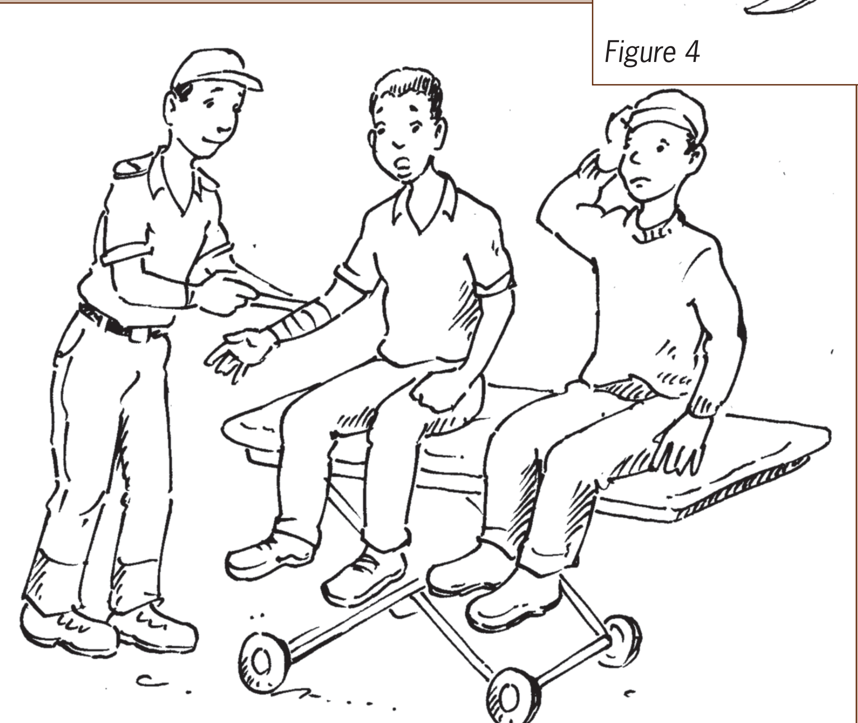


Figure 5

Week 1

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

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

When you worked with levers, you learnt the following:

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

You can also change and control movement by using syringes.

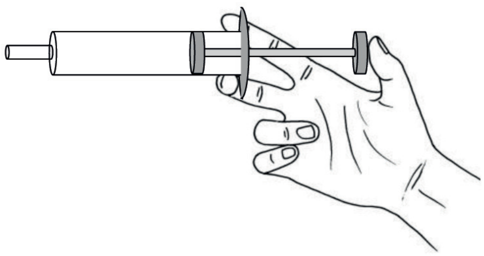


Figure 6: This is how you should grip a syringe so that you can push the plunger in with your thumb.

Now you do it.

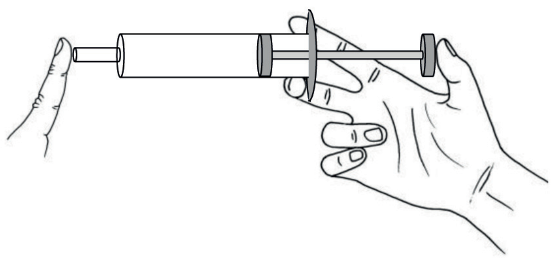


Figure 7: Close the outlet tube tightly with a finger, then try to push the plunger in.

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

   ....

   ....

   ....

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

....

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

....

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

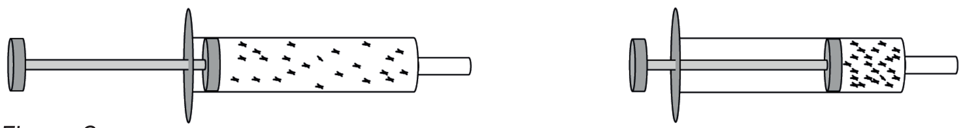


Figure 8

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

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

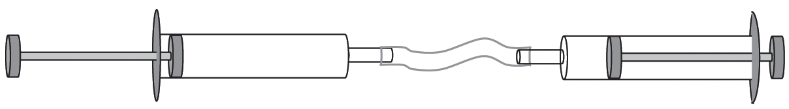


Figure 9

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

press here… …to move something here

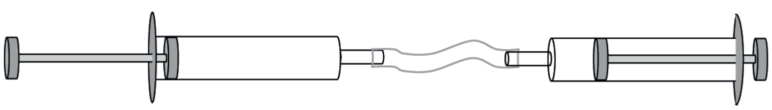


Figure 10

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

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

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

....

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

Fill a syringe with water to investigate this.

Step 1

Some air bubbles may get caught inside.

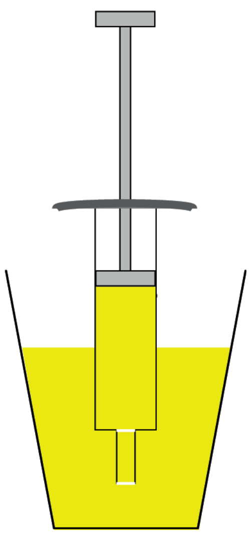
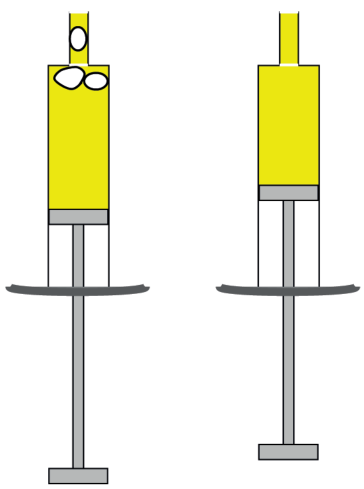


Figure 11

Step 2

Hold it upside down and press the air bubbles out.



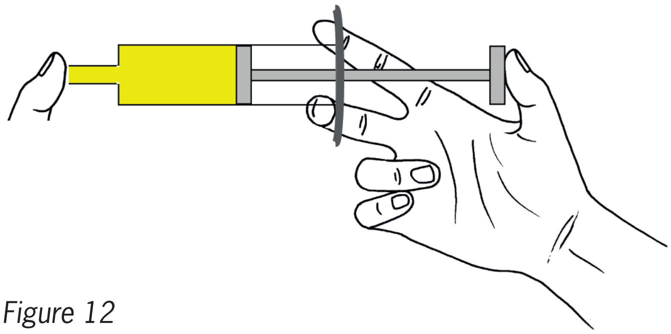


Figure 12

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.

 ....

A liquid cannot be compressed.

It is slightly difficult to get the air bubbles out when you fill two connected syringes with water. The pictures on page 88 show us how this can be done.

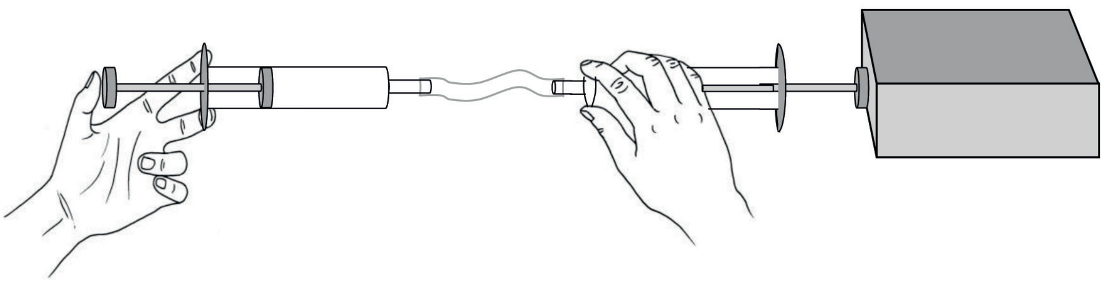


Figure 13

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

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

 ....

An important investigation

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

 ....

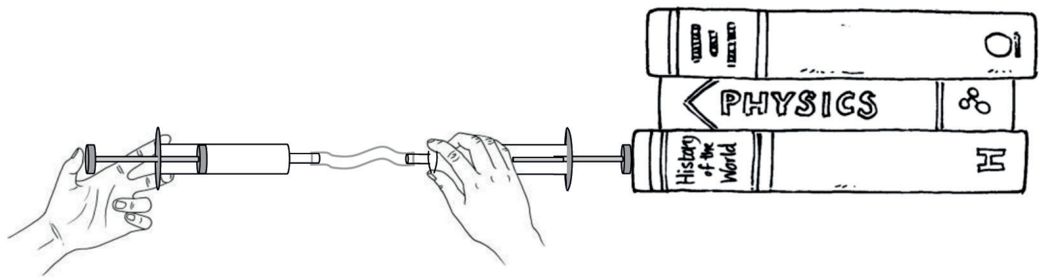


Figure 14

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

 ....

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

 ....

 ....

 ....

 ....

 ....

 ....

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

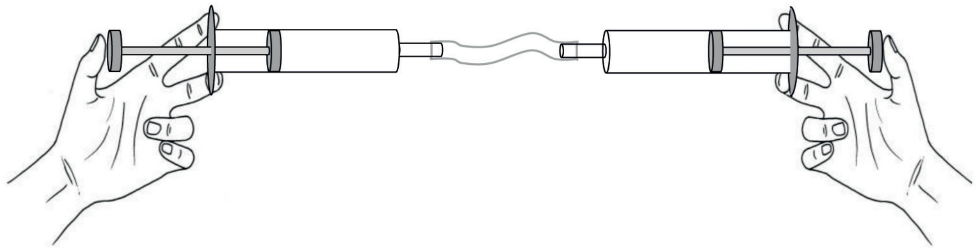


Figure 15

Do this while the syringes are filled with air. Also do it while the syringes are filled with water.

4. What difference do you feel between the pneumatic pushing device and the hydraulic pushing device?

....

....

....

....

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

....

More investigations

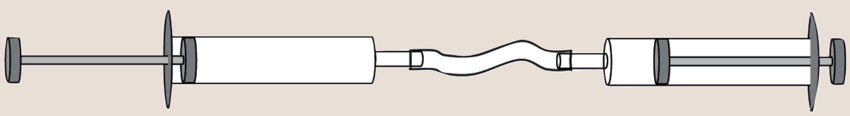


Figure 16

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

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

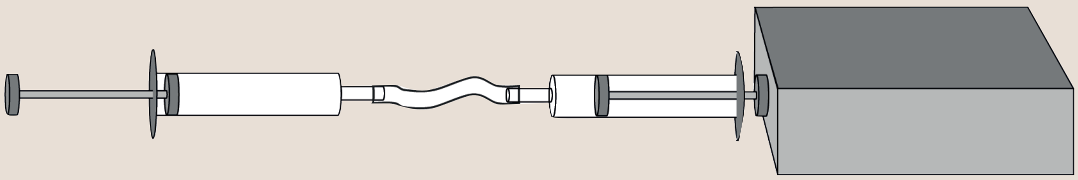


Figure 17

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

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

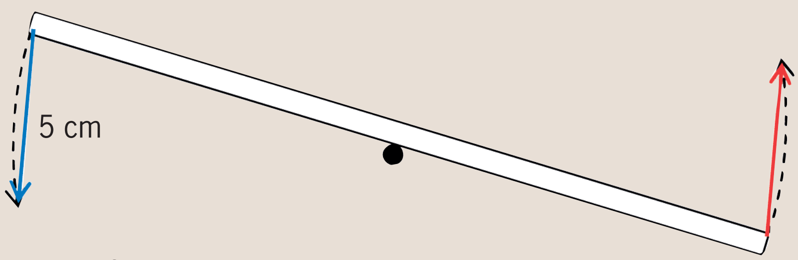


Figure 18

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

Swop distance for strength

Think, predict and investigate

The syringe on the left is thicker than the syringe on the right.

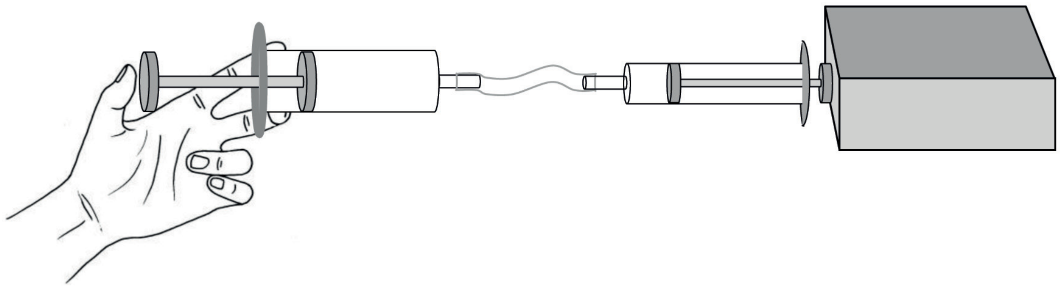


Figure 19

1. 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.

   ....

   ....

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

   ....

   The syringe on the right is thicker than the syringe on the left.

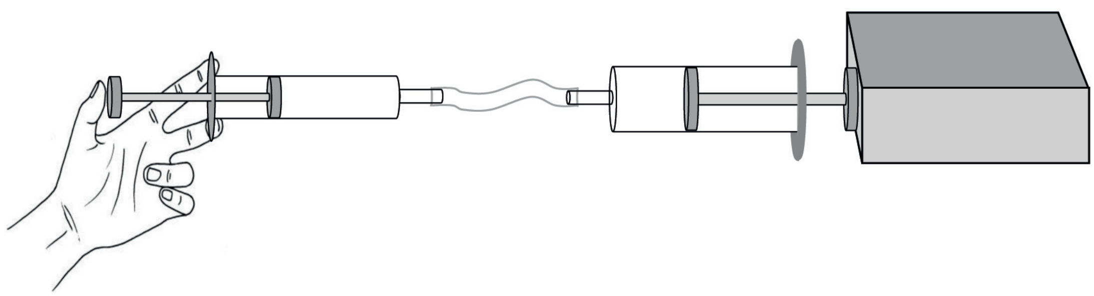


Figure 20

3. 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.

   ....

   ....

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

....

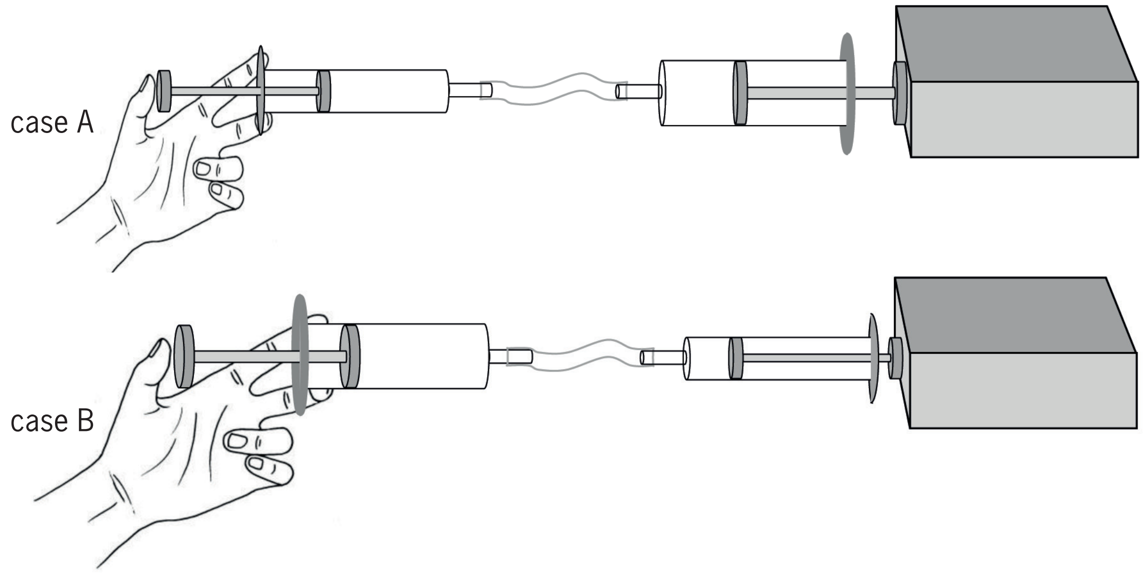


Figure 21

(b) Do a few experiments to check your answer to the previous question. Write a short report in the space below.

....

....

....

....

....

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

....

....

....

....

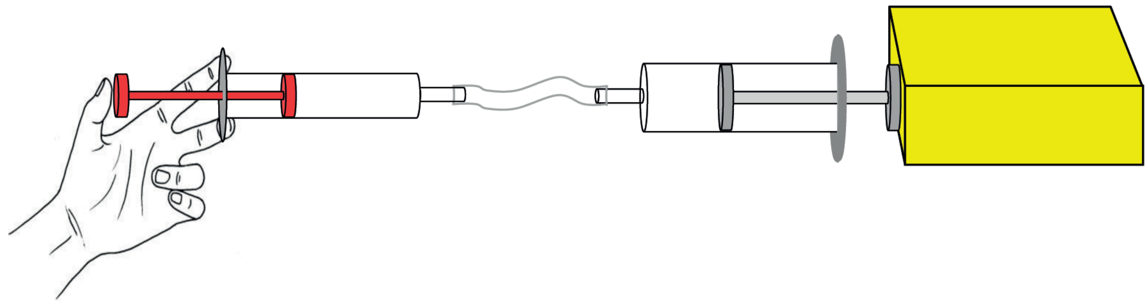


Figure 22

In the above diagram, 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*.

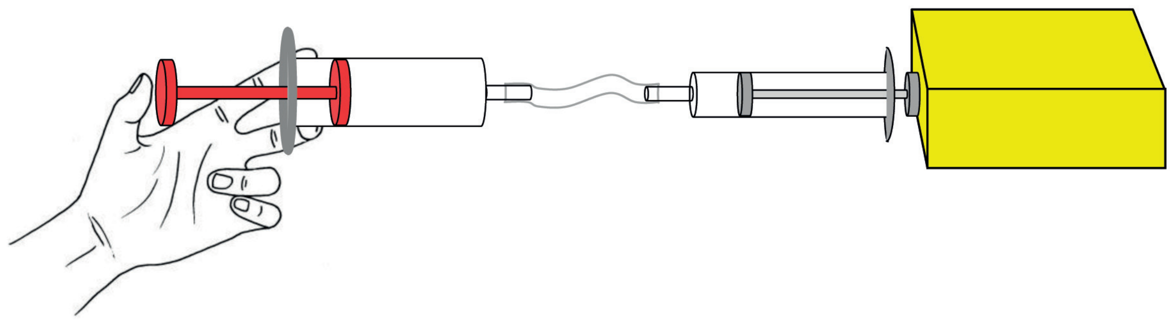


Figure 23

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

Week 2

Scenario

(30 minutes)

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

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, that makes large openings to free people who are trapped.

Figure 24

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 on the previous pages to answer the questions below.

1. What problem did the paramedics encounter at the accident scene?

   ....

   ....

2. Who will use the rescue tools?

   ....

   ....

3. Where will the rescue tools be used?

   ....

   ....

4. In what way will the tools help?

   ....

   ....

5. Now write the design brief. Use your answers to questions 1 to 4 to help you. Start your paragraph with:

   I should design and make a … [4]

   ....

   ....

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)

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

....

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

....

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

....

7. Identify the **constraints** on the materials.
   I should use the following materials to build my model: [3]

Constraints are limits to what can possibly work. For example, the fact that a shopping bag can break when 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.

....

....

....

....

....

....

....

....

....

....

....

[Total: 12]

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

Technology Gr 7 LG Book A.indb 99 1/6/2014 9:43:56 AM

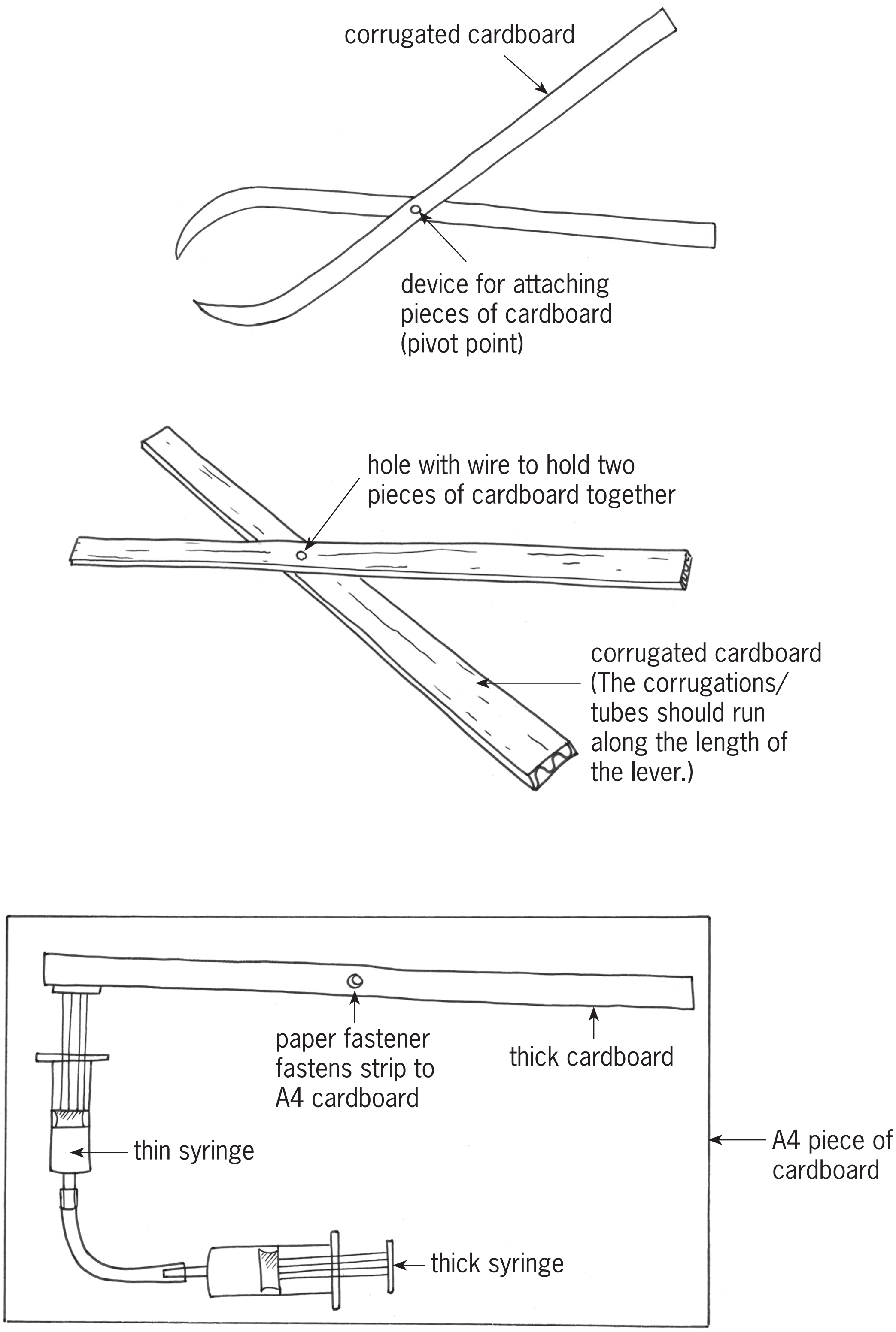


Figure 26: Drawings made by other learners

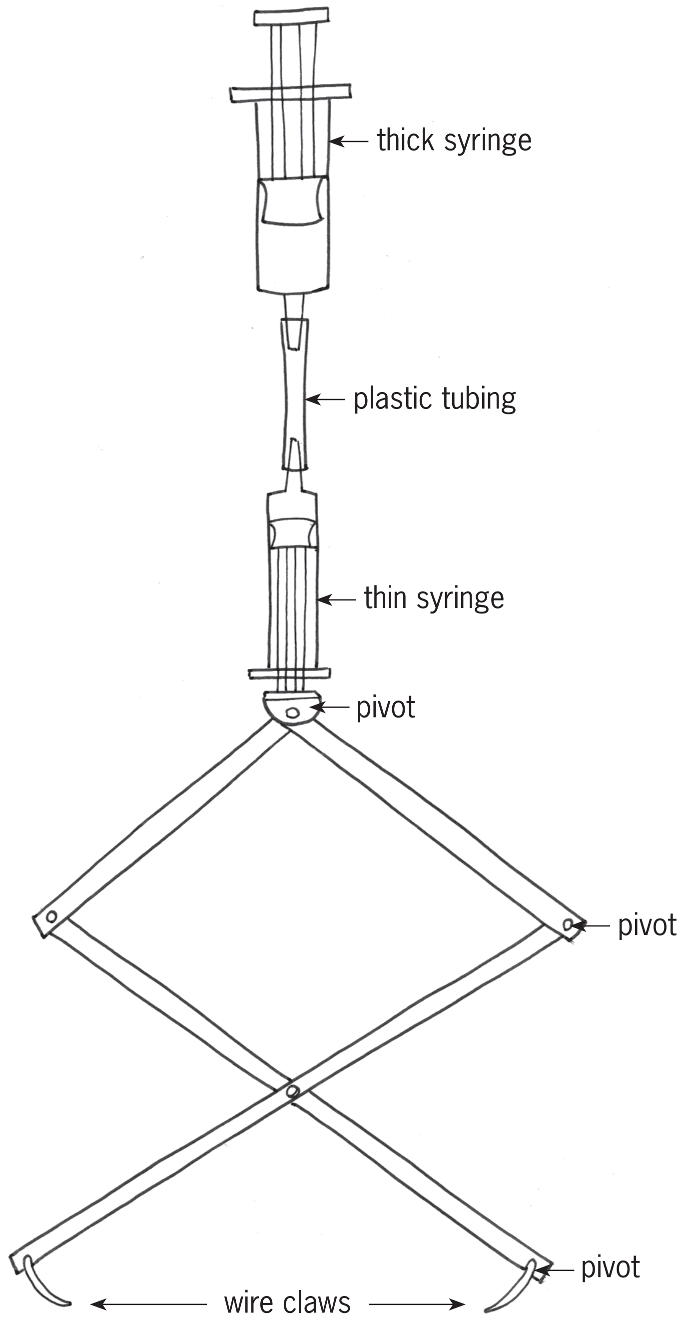


Figure 27: More drawings made by other learners

Now make a rough sketch of your own design

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

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

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

[Total: 7]

Planning how you will make your model

1. Make a list of all the **materials** you plan to use to build your model. You have listed them 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? And what will you use to attach the syringe to the backing sheet and the lever? [6]

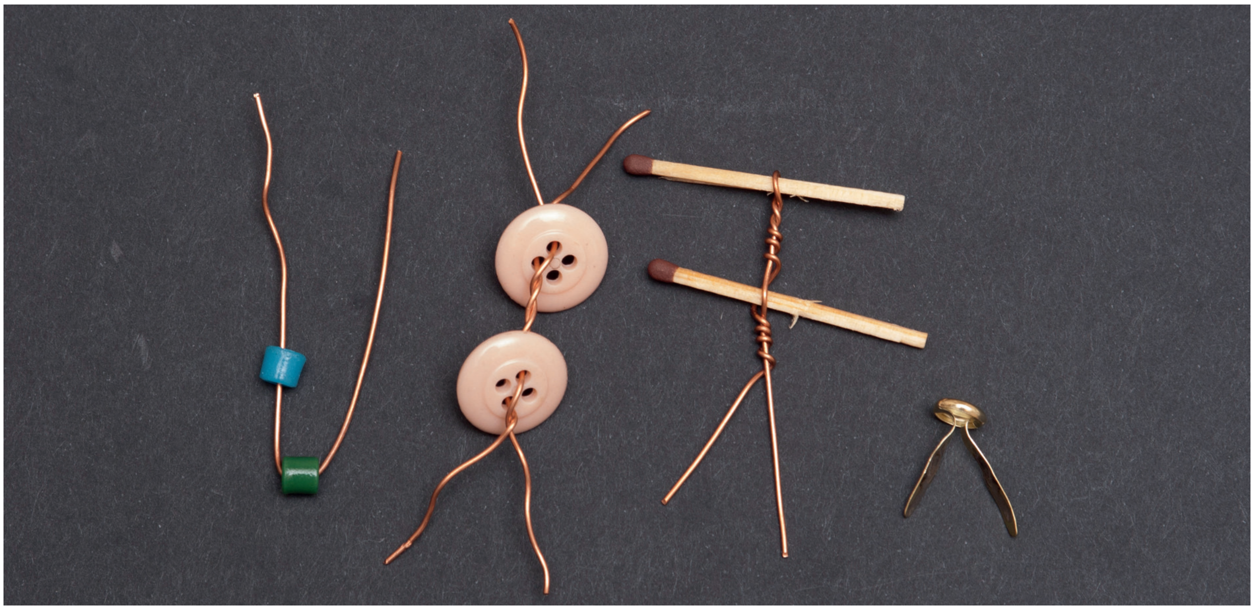


Figure 28: Here are different pivots and ways to attach pieces of cardboard that were used by other learners. Some were bought and some are hand-made.

....

....

....

....

2. Make a list of the **tools** you will use to build your model. A nail to make holes can also be called a tool. [4]

....

....

....

3. Some tools can be dangerous if they are used incorrectly. Write down a **safety** rule for one of the tools that you will use. An example of a safety rule is shown on the right. (2)

Safety warning

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

....

....

....

....

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

Step 1: Draw the shape of the levers on the card.
Step 2: Cut out the card levers.
Step 3: Make a hole for the pivot point/fulcrum.
Step 4: Assemble the hydraulic system using two syringes with different sizes and tubing.
Step 5:

....

....

Step 6:

....

....

Step 7:

....

....

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 5 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.

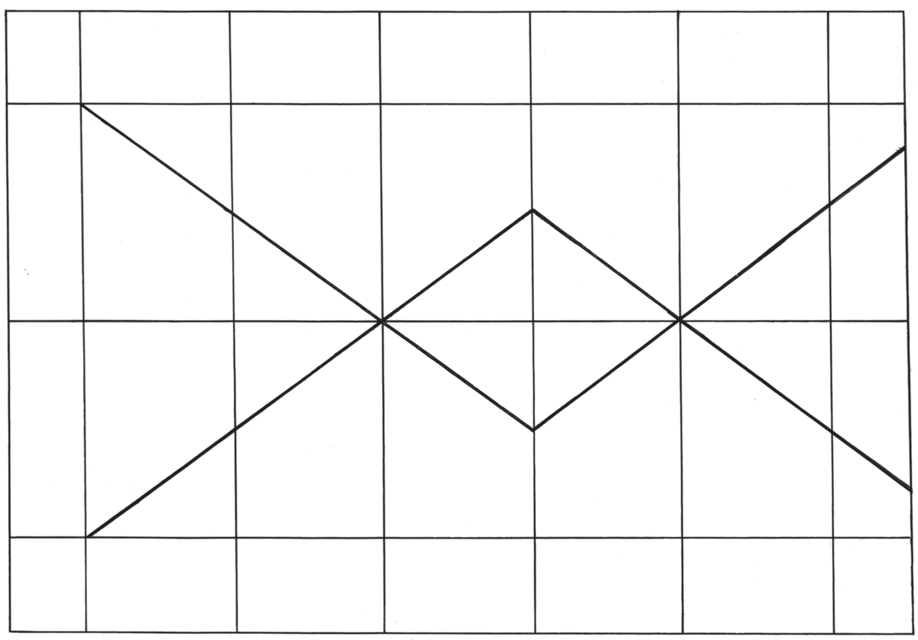


Figure 29: An "outline block" drawing of a lever system

Make a 2D working drawing of your model

Start by drawing an **outline block** to work in, on the next page. Look at Figure 29 on the previous page as an example.

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 compared with the other parts. This means that the proportions will be right.

Use only light, feint lines for the block, because these lines are all guidelines.

Once you have drawn your block, complete the 2D drawing of your model.

Use the list below as a list to ensure that you have done everything properly and included everything. Your teacher will use these to assess your drawing.

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

[Total: 10]

Make your drawing on this page.

Week 4

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

Remember to work safely and neatly. Pack away you 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.
- You can choose materials other than those that you planned for the pivot.

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

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

Make an oblique drawing (30 minutes)

Make a three-dimensional drawing of a syringe

Draw one of the syringes you used in your model in 3D oblique.

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

Look at the drawings in the margin of this page.

Draw on the grid paper on the next page.

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. This is called the "rear lines".
5. Go over all your outlines. They have to be dark lines.

[6]

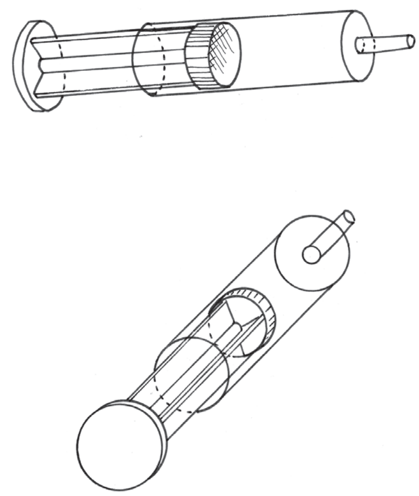


Figure 30

Use the list below as a check list 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

Chapter 8
Shells, frames and solids

Right now, you are sitting at a desk on a chair. 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.

8.1 Things called structures 114

8.2 Man-made and natural structures 119

8.3 Types of structures 123

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

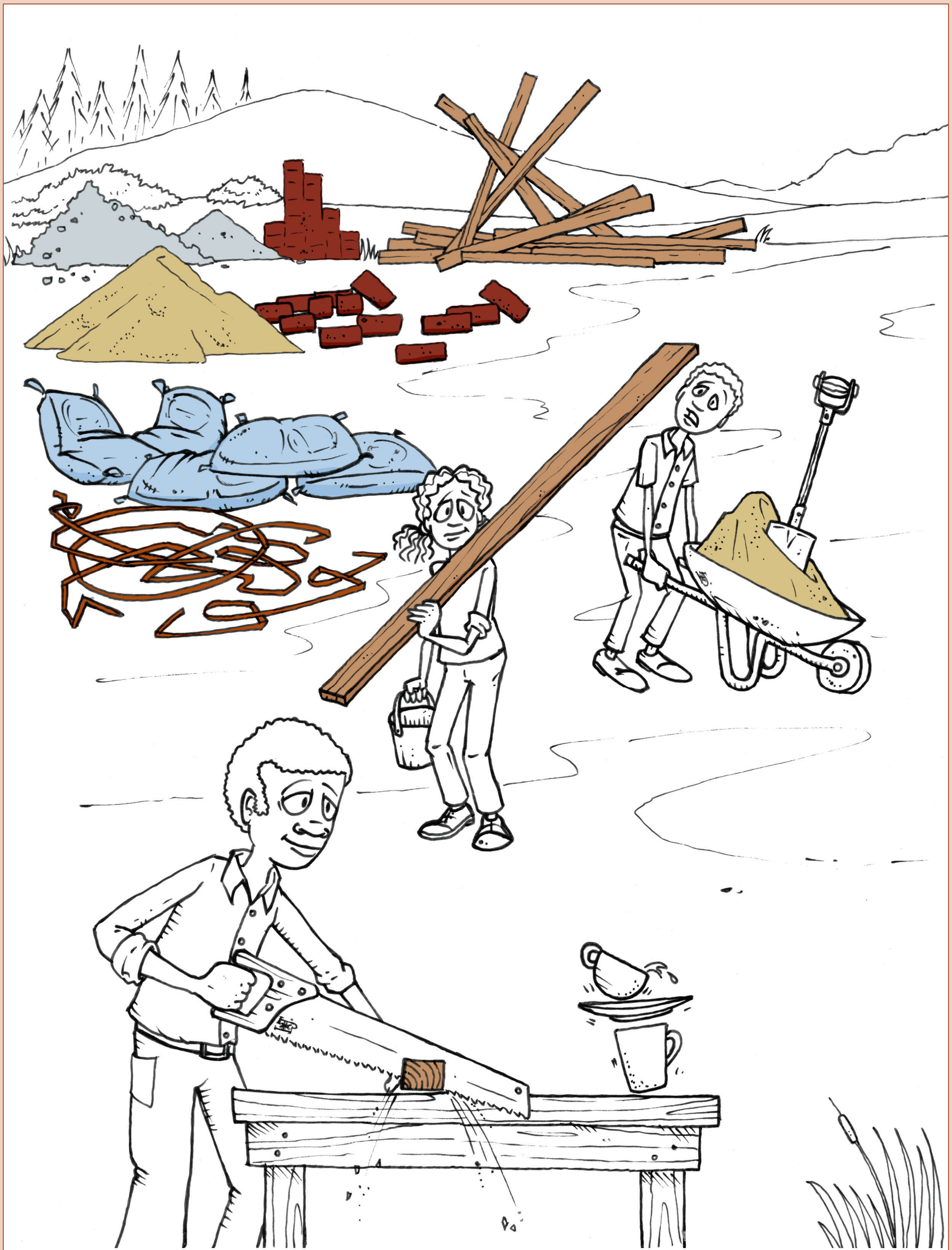


Figure 2: What does it mean to construct something?

Figure 3: What does it mean to construct something?

8.1 Things called structures

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

1. What is this object called?

....

....

....

2. What is it used for?

....

....

....

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

....

....

....

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

....

....

....

5. Is it used to support something?

....

....

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

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

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

   ....

Figure 5: The bridge spans the stream.

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

A small business situation

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

Figure 6

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

....

....

....

....

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

....

....

....

....

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

....

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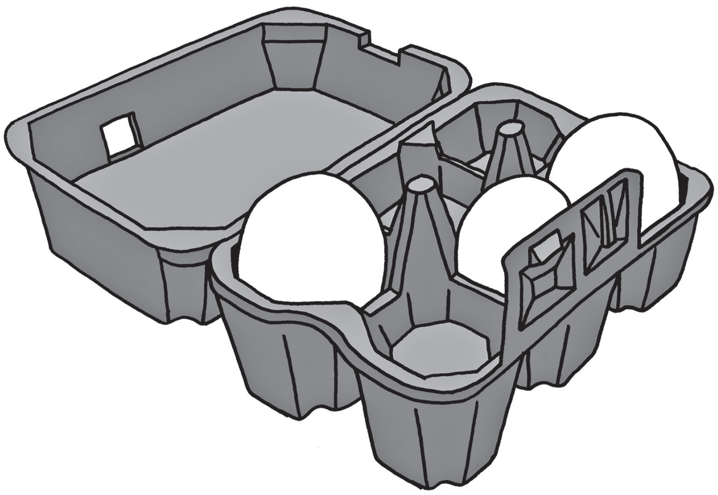

Figure 7

4. Why are eggs packed in special containers such as the one you see in this picture?

....

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

....

6. Suppose a woman wants to buy 2 kg of flour from you. Will you ask her to hold out her hands so that you can put the flour in her hands, or will you make another plan?

....

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

....

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?

....

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

....

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.

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

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

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

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

....

....

8.2 Man-made and natural structures

Figure 8: A termite mound

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

The material (soil) is reworked by them 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 lots of 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 that **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, then classify them as **man-made structures** or **natural structures.**

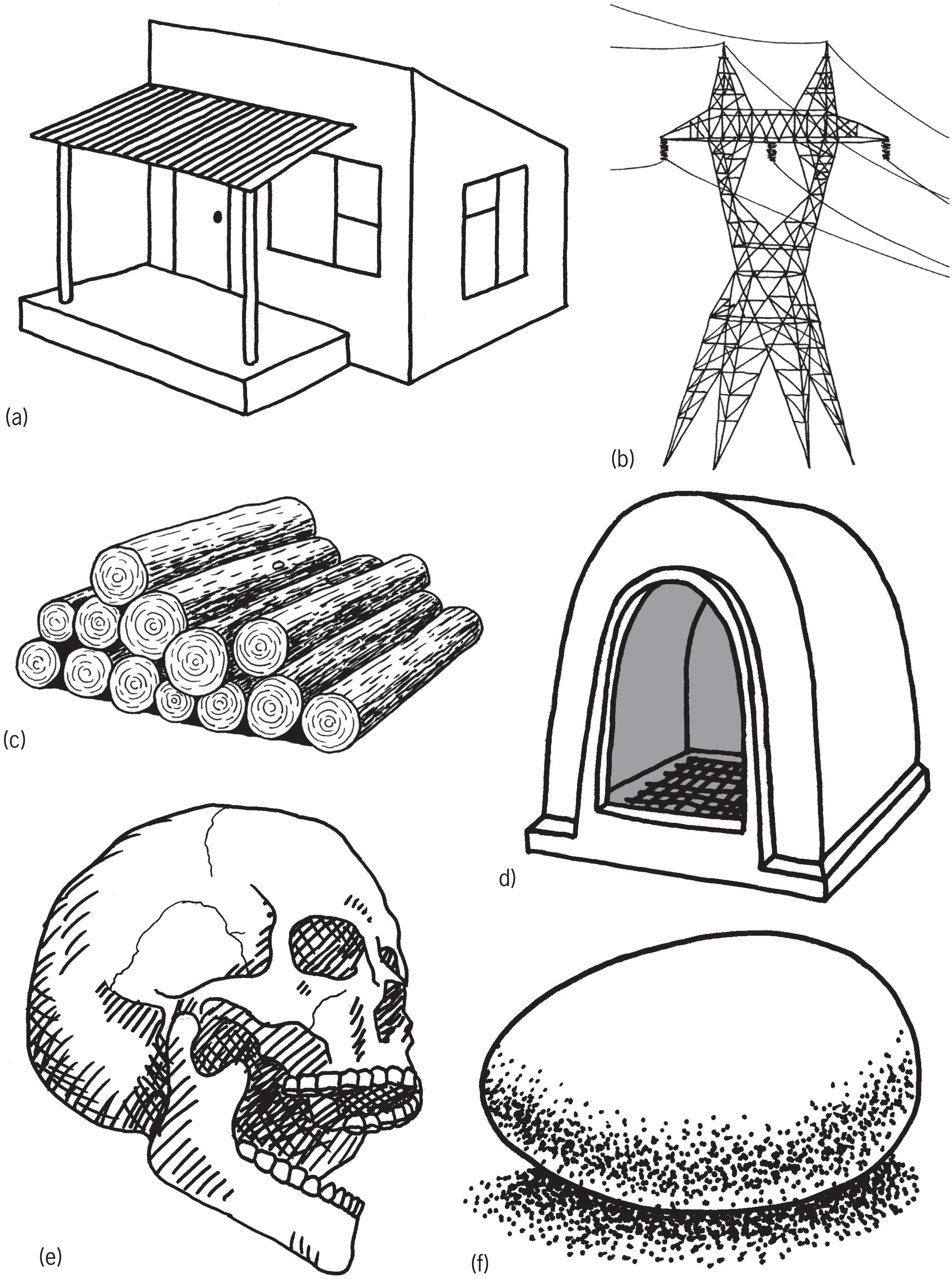

Figure 9

Figure 10

Classify structures

1. Classify the 12 structures on the previous two pages as man-made or as natural structures.

Man-made structures	**Natural structures**

2. What other natural structures can you think of?

....

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

....

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

....

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

....

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8.3 Types of structures

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

Shell structures

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

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

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

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

Figure 12: Bees store their honey in honeycombs.

Figure 13: A rubber tyre is a shell structure.

Figure 14: A coffee mug is a shell structure.

Frame structures

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

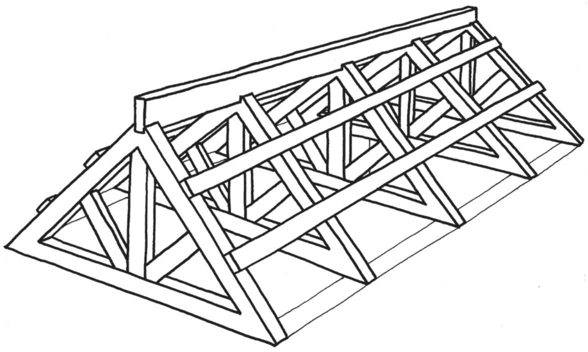


Figure 15: This roof frame is a frame structure made from wooden planks, a natural material. The planks support the roof.

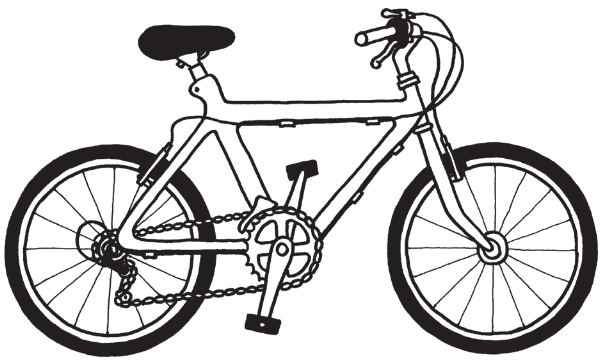


Figure 16: A bicycle frame consists of different metal pipes.

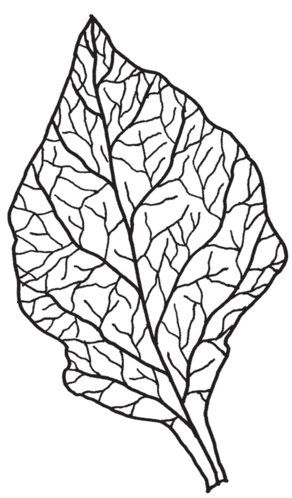


Figure 17: A plant leaf. Look at its veins. They form the frame of the leaf.

Solid structures

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

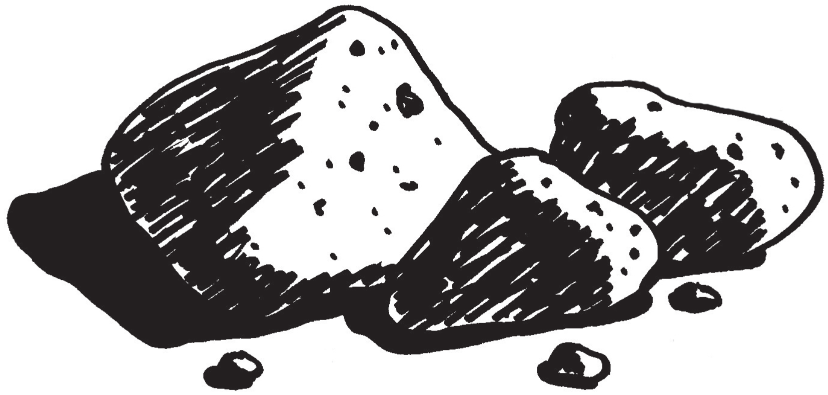


Figure 18: Stones

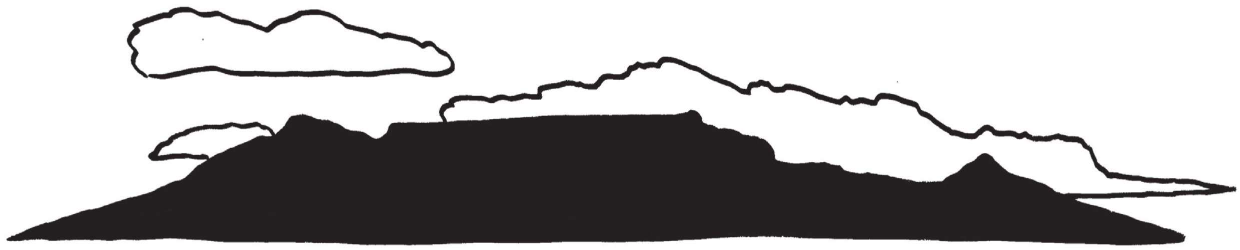


Figure 19: Table Mountain

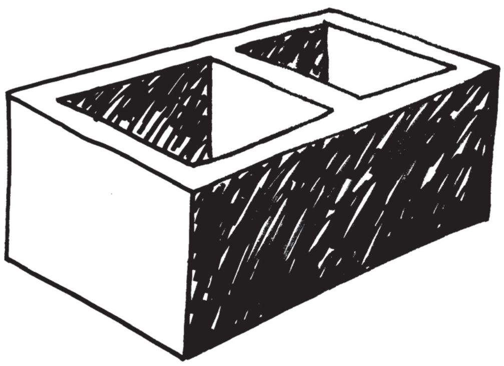


Figure 20: A cement brick

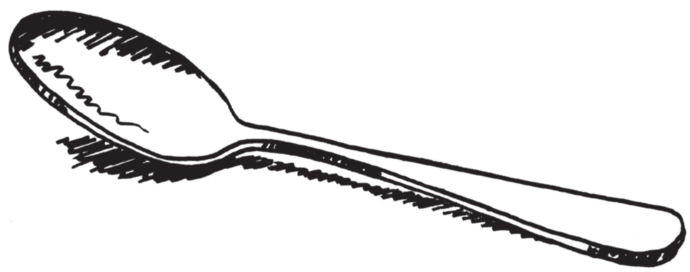


Figure 21: A teaspoon

Combined structures

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

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

Identify types of structures

1. Classify the following structures in the table below as **shell, frame or solid structures:**

   a house; electricity pylon; tortoise shell; cellphone tower; human skull; brick; garden chair; spiderweb and dog kennel; wooden logs; chicken eggs and rocks. You can look at pictures of these structures on the previous pages.

2. Write more examples of each of the different kinds of structures in the table.

Shell structures	Frame structures	Solid structures

Support for water tanks

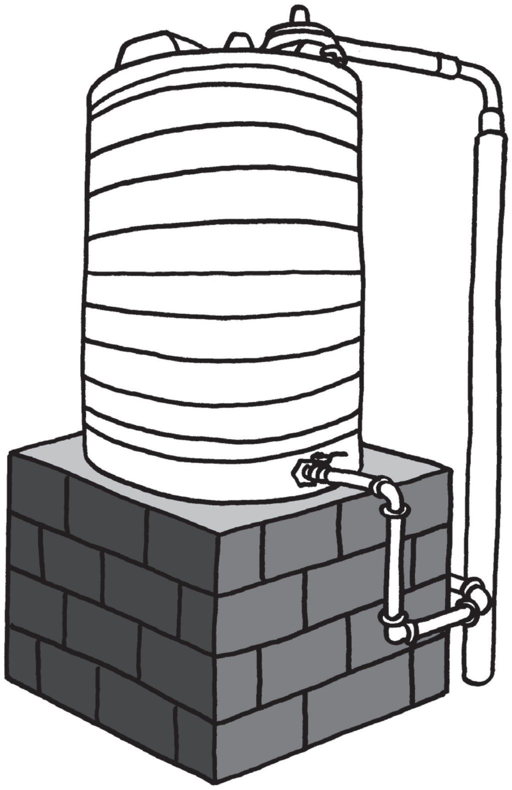


Figure 22: A water tank on a solid brick stand

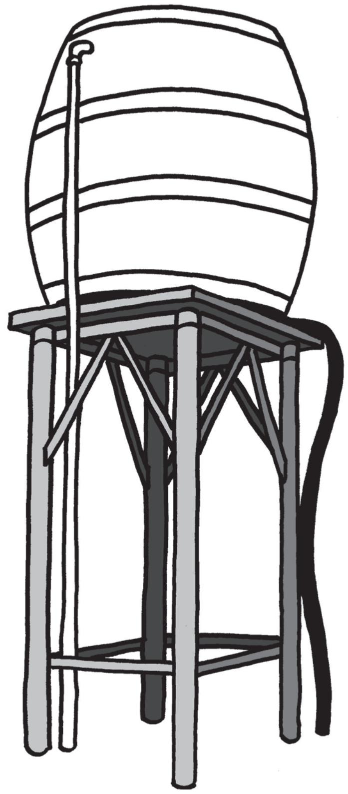


Figure 23: A water tank on a metal-frame stand

1. Name all the structures that you can see in the pictures above. In each case, say what kind of structure it is, and what its purpose is.

....

....

....

....

....

....

2 Compare the support structures for the two water tanks.

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

....

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

....

....

3. Make a free-hand sketch of the metal frame stand and the tank here:

Next week

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

Chapter 9
Frame structures

In this chapter, you will look at frame structures such as cellphone 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 cellphones.

9.1 Strong frame structures 132
9.2 Communication systems 137
9.3 Action research: strengthening structures 139

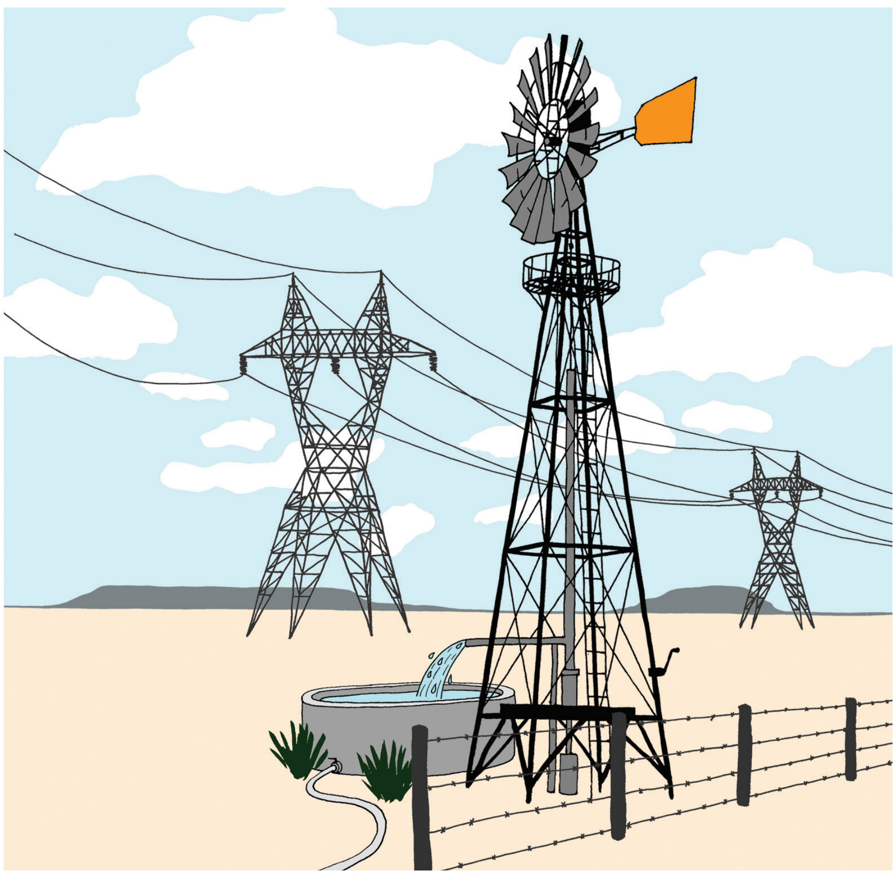


Figure 1

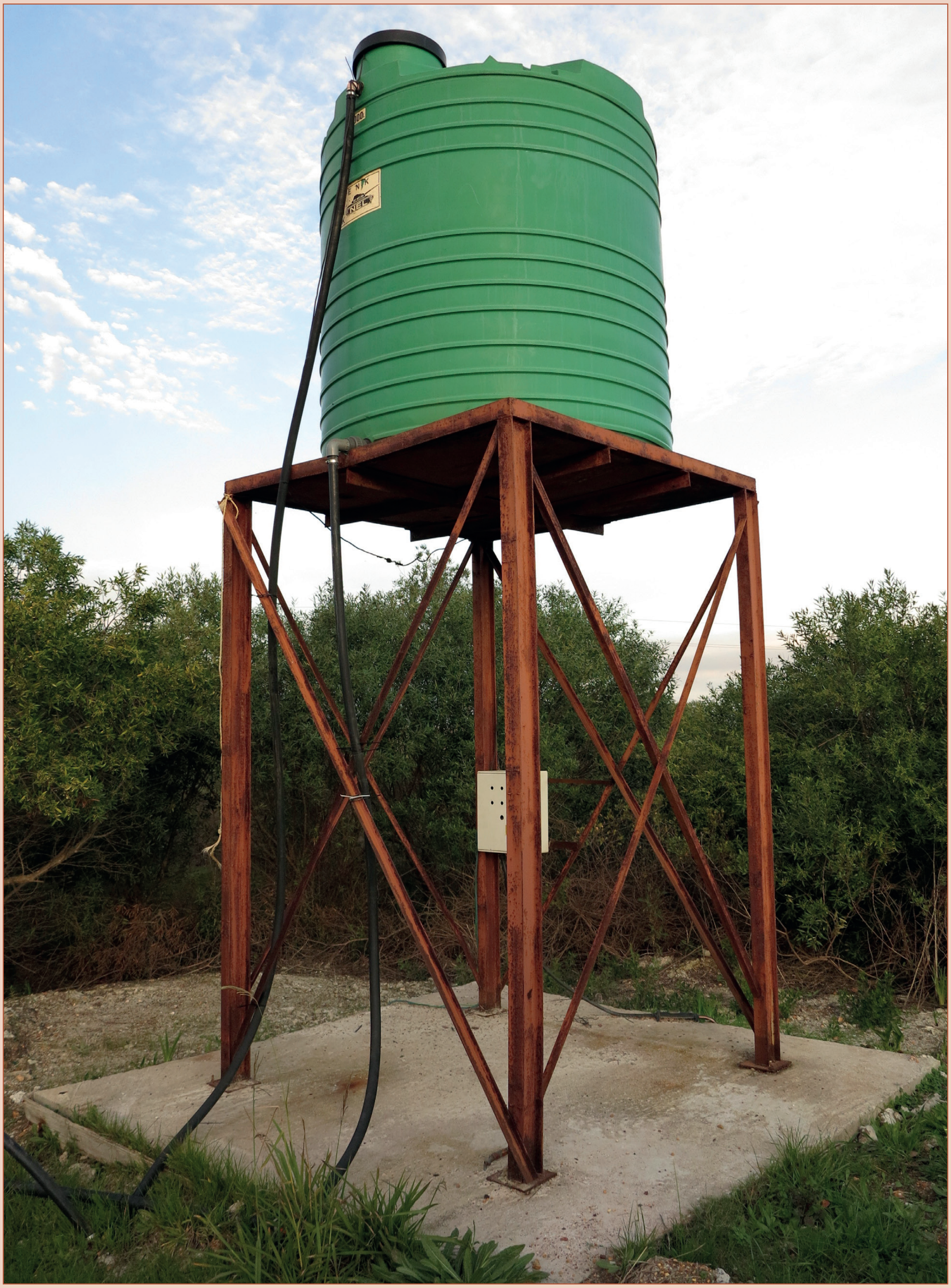


Figure 2

Figure 3

9.1 Strong frame structures

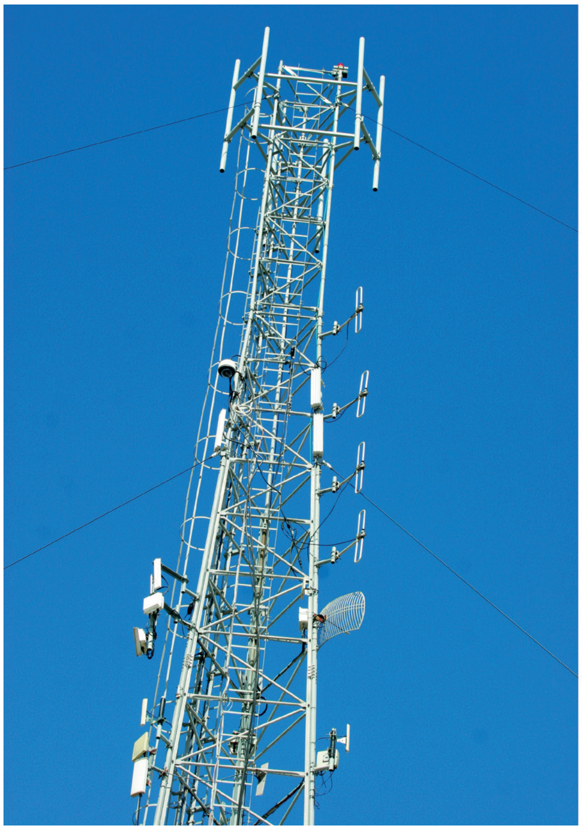


Figure 4: Cellphone tower


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

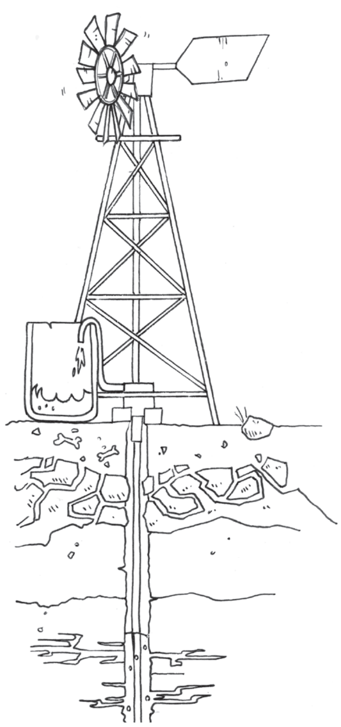


Figure 6

1. Draw lines on the diagram on the left so that it looks more like the tower of a windmill or a cellphone. Do not use a ruler. Just make a quick free-hand sketch.

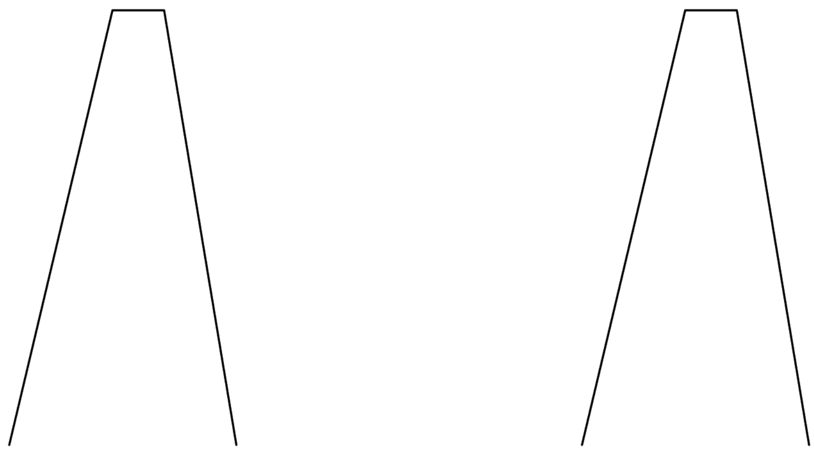


Figure 7

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

....

....

Examine more towers

Figure 8: Electricity pylons

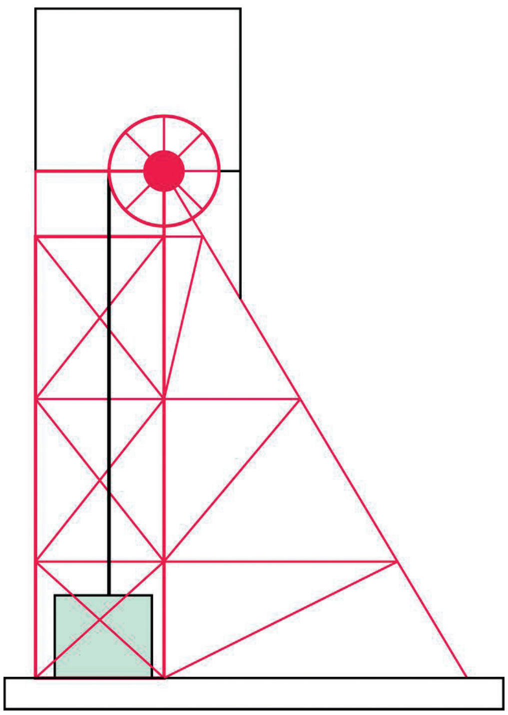


Figure 9: Mine headgear


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

Figure 10

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

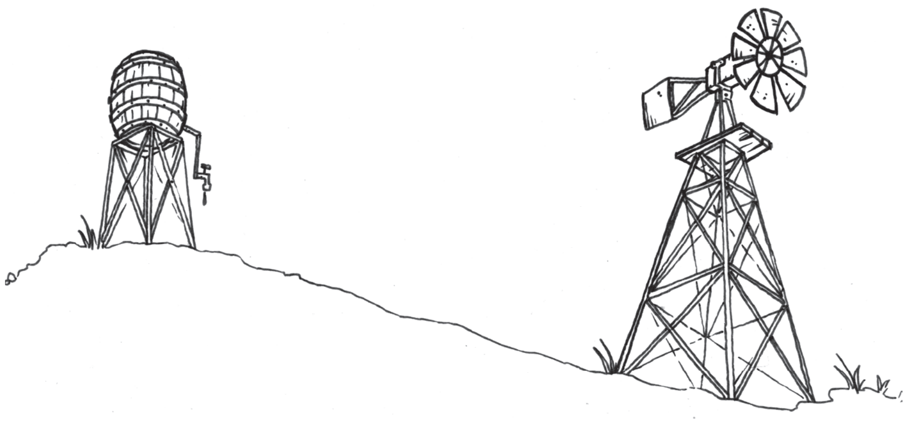
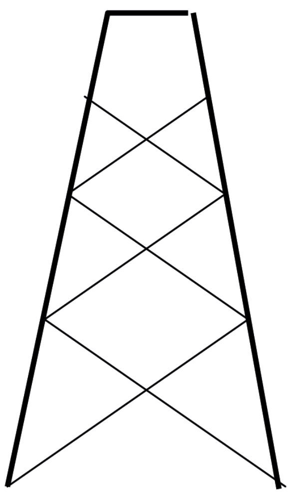


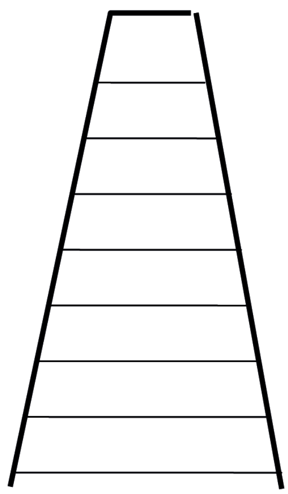
Figure 11

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

....



design A



design B

Figure 12

2. Draw dark lines on the sides of a triangle in design A. Are there any triangles in design B? How many triangles are there in design A?

....

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

....

....

9.2 Communication systems

Landlines or cellphones: which is better?

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

A mobile phone is another name for a cellphone.

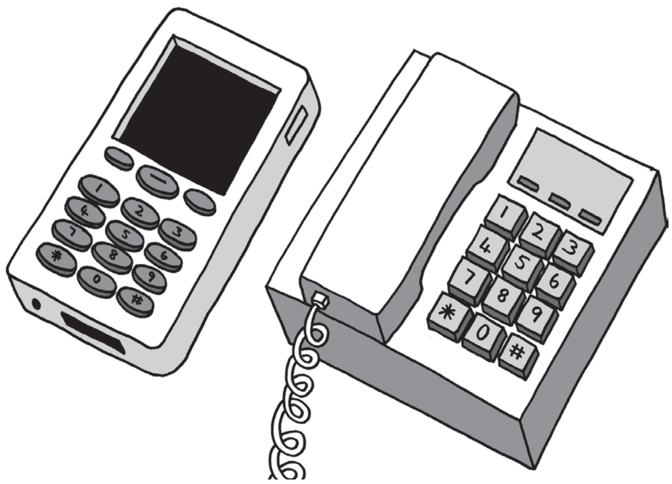


Figure 13

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

....

....

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

....

....

....

....

....

....

3. Describe four advantages and four disadvantages of using landline phones, and of using cellphones, in the table below.

Device	Advantages	Disadvantages
Landline phones	....	....
Cellphones	....	....

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

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.

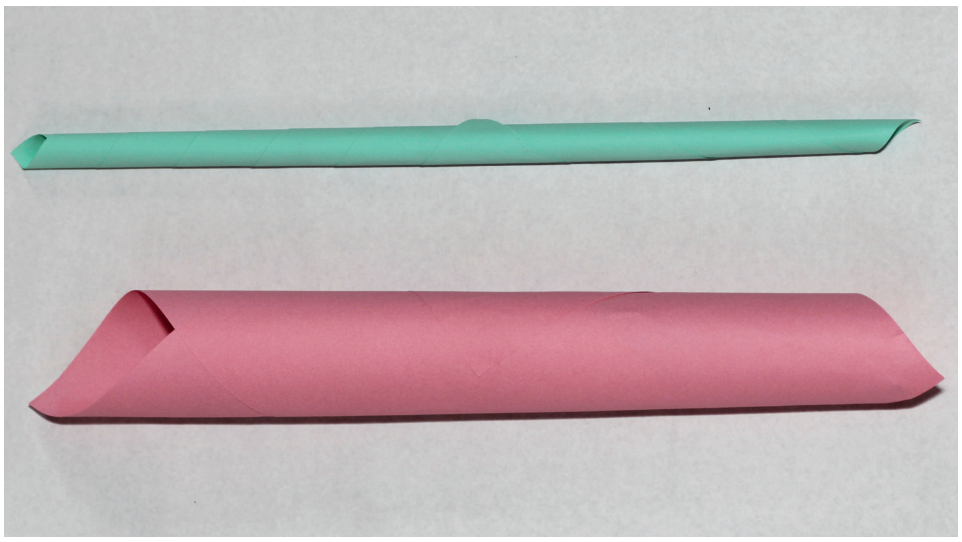


Figure 14

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 the easiest?

....

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
⅓ cup sugar
1 ½ cups water
1 big spoon vinegar

Method

Mix the flour with sugar in a pot.
Add ½ of the water. Stir.
Add the rest of the water and stir.
Add the vinegar.
Heat until the mixture gets thick and shiny.
Leave to cool.

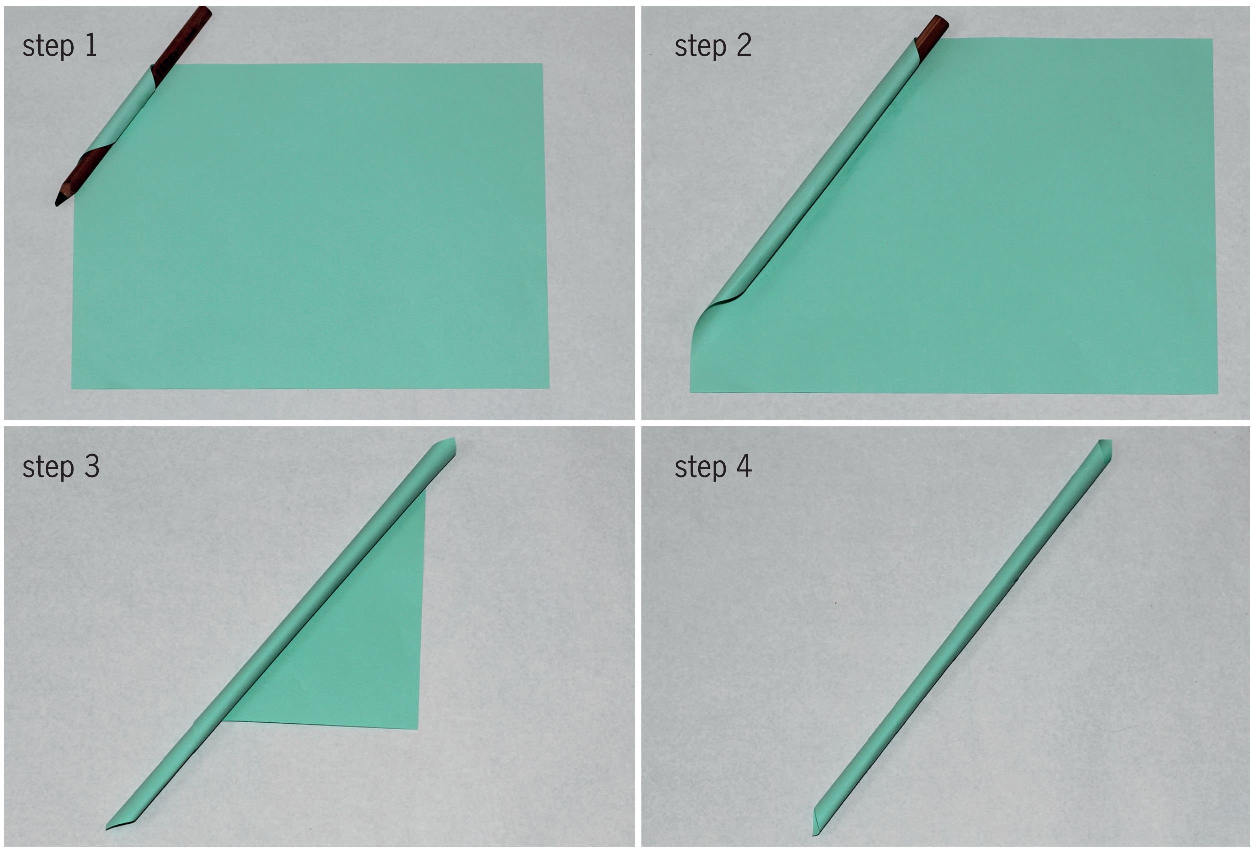


Figure 15

Activity 2: Stiffen cardboard by folding

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

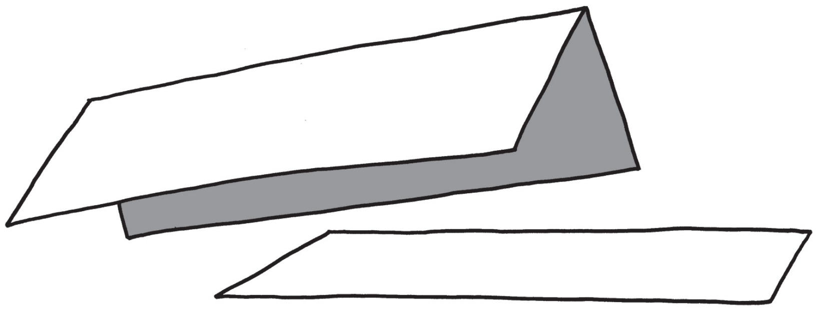


Figure 16

1. Which of the two pieces of cardboard will bend easier?

   ....

   Investigate to check your answer.
   One person holds the flat strip of cardboard across two books as shown below. The other person presses down in the middle of the sheet of paper.

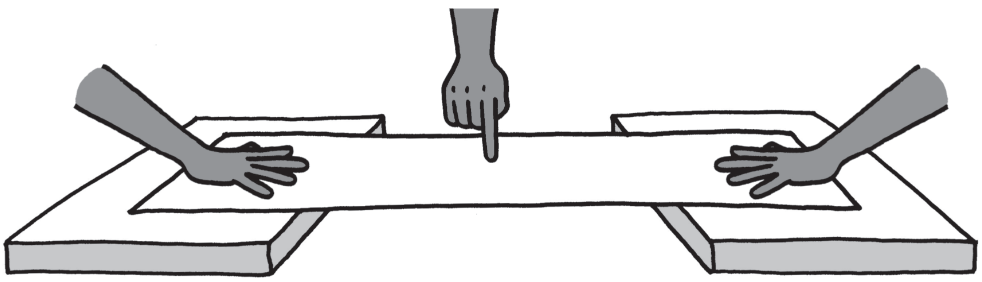


Figure 17

Do the same with the folded strip.

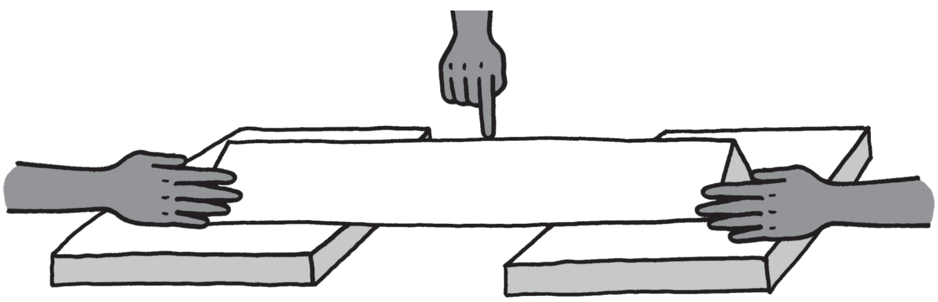


Figure 18

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

....

Activity 3: How to make shapes stable and strong

Work in groups of four.

Materials:

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

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

....

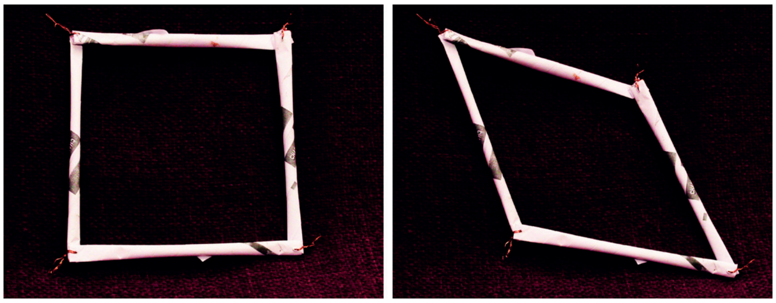


Figure 19

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

....

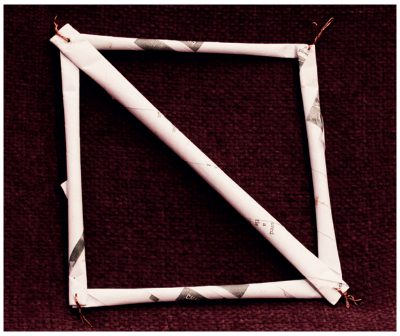


Figure 20

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

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

4 Look at the shapes 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?

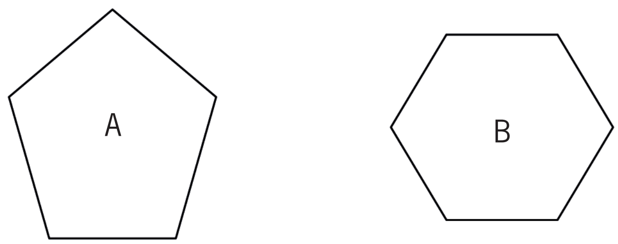


Figure 21

5. Copy the two shapes. Now fill in 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?

....

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

....

8. Share your drawings with three other learners. Take a good look at where they placed the diagonal members to make their shapes stable.

Use triangulation to make paper strong

1. The drawing below is of one side of a bridge. It is not finished yet. Complete the drawing to show how triangulation will be used.

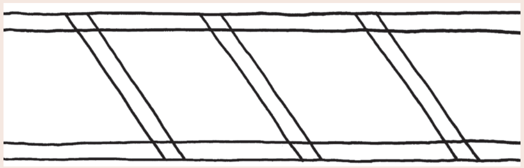


Figure 22

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

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

   The triangular frame can take pressure from the side as well.

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

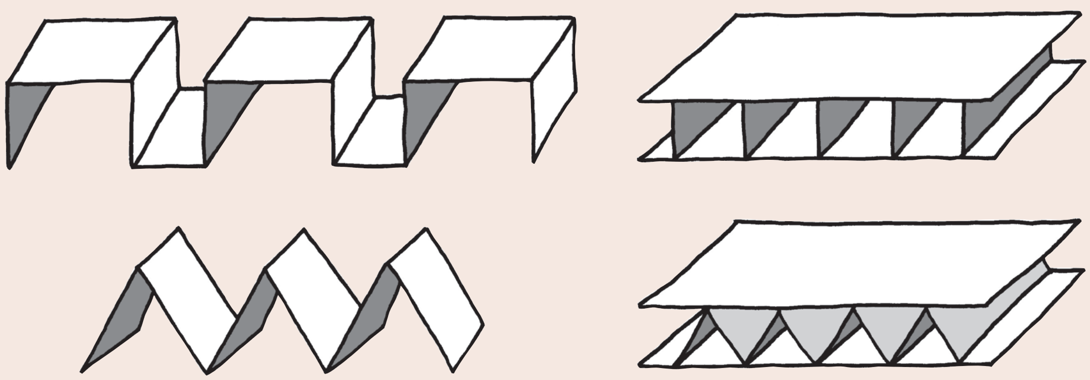


Figure 23

Next week

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

CHAPTER 10
Things to consider

In this chapter, you will learn about **design issues**. Design issues are things to think of when something like a cellphone 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.

10.1 Why do cellphone towers look like they do? 147
10.2 Things tower designers think about 150
10.3 Give clear instructions 151

Figure 1

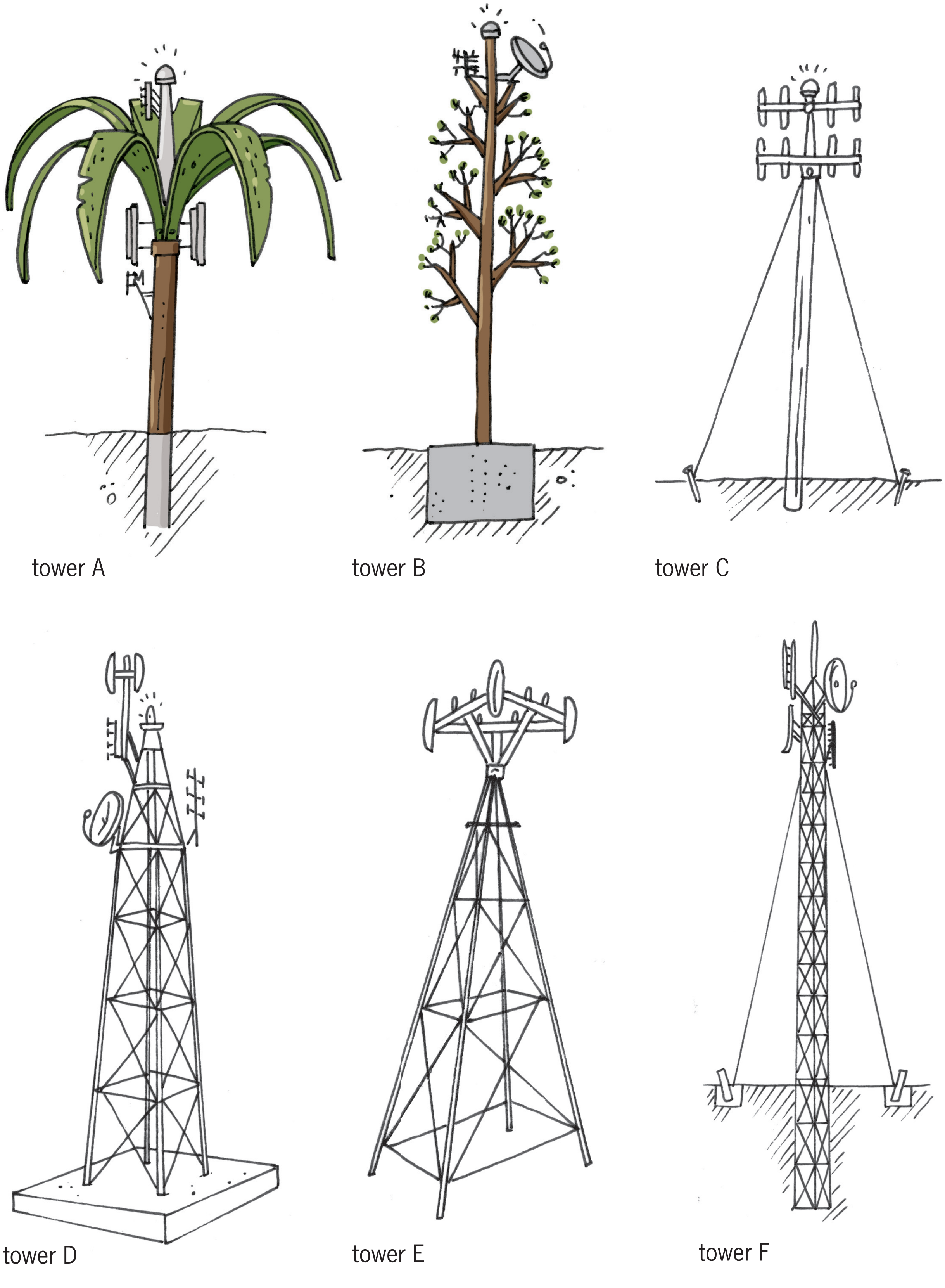


Figure 2

10.1 Why do cellphone towers look like they do?

Examine a few cellphone towers

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

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

   ....

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

   ....

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

   ....

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

   ....

> When an ugly object stands in a beautiful environment, people say the object causes **visual pollution**.
> When an object falls over easily, people say it is **unstable**.
> The lower part of an object like a tower, on which it stands, is called the **base**.

5. Which of the towers on the previous page has the widest base? Why was it designed to have such a wide base?

   ....

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

   ....

Centre of gravity

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

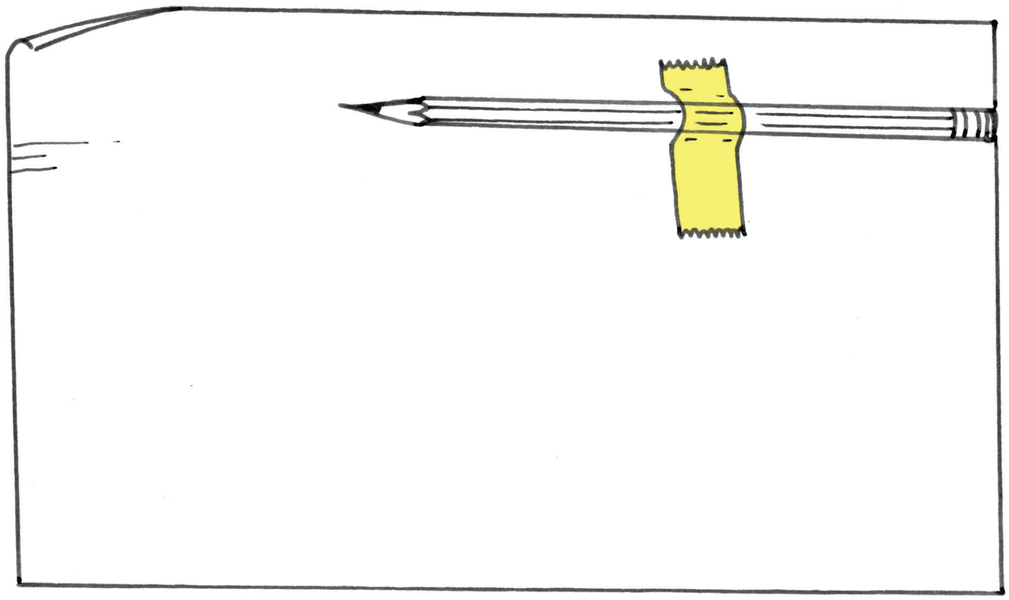


Figure 3

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

Figure 4

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

   ....

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

2. What is more stable: an object with a low centre of gravity or an object with a high centre of gravity?

   ....

3. Which tower on page 146 has the highest centre of gravity?

   ....

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

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

4. Look at the sketches of the six towers again. For each tower, say which method or combination of methods was used to make it stable.

....

....

....

....

....

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

....

....

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

....

....

....

7. Some of the towers are built from solid concrete or fibre glass. Other towers are metal structures. Why do you think the metal towers have triangles in them?

....

....

....

10.2 Things tower designers think about

What questions will you ask?

Suppose a new cellphone tower will be built in an area with no cellphone 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 cellphone tower. The document will be given to the engineers who will design and build the cellphone 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.

....

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10.3 Give clear instructions

Write a design brief and specifications for school desks

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.

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

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

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

Evaluate and improve your document

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

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

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?

   ....

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

5. Rewrite your design brief with specifications in the space below and on the following page. Include a single vanishing point perspective drawing.

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Write one more design brief and specification

In the space below, write a design brief and a specification for an FM radio or a cellphone. Use the drawings on the next page to help you.

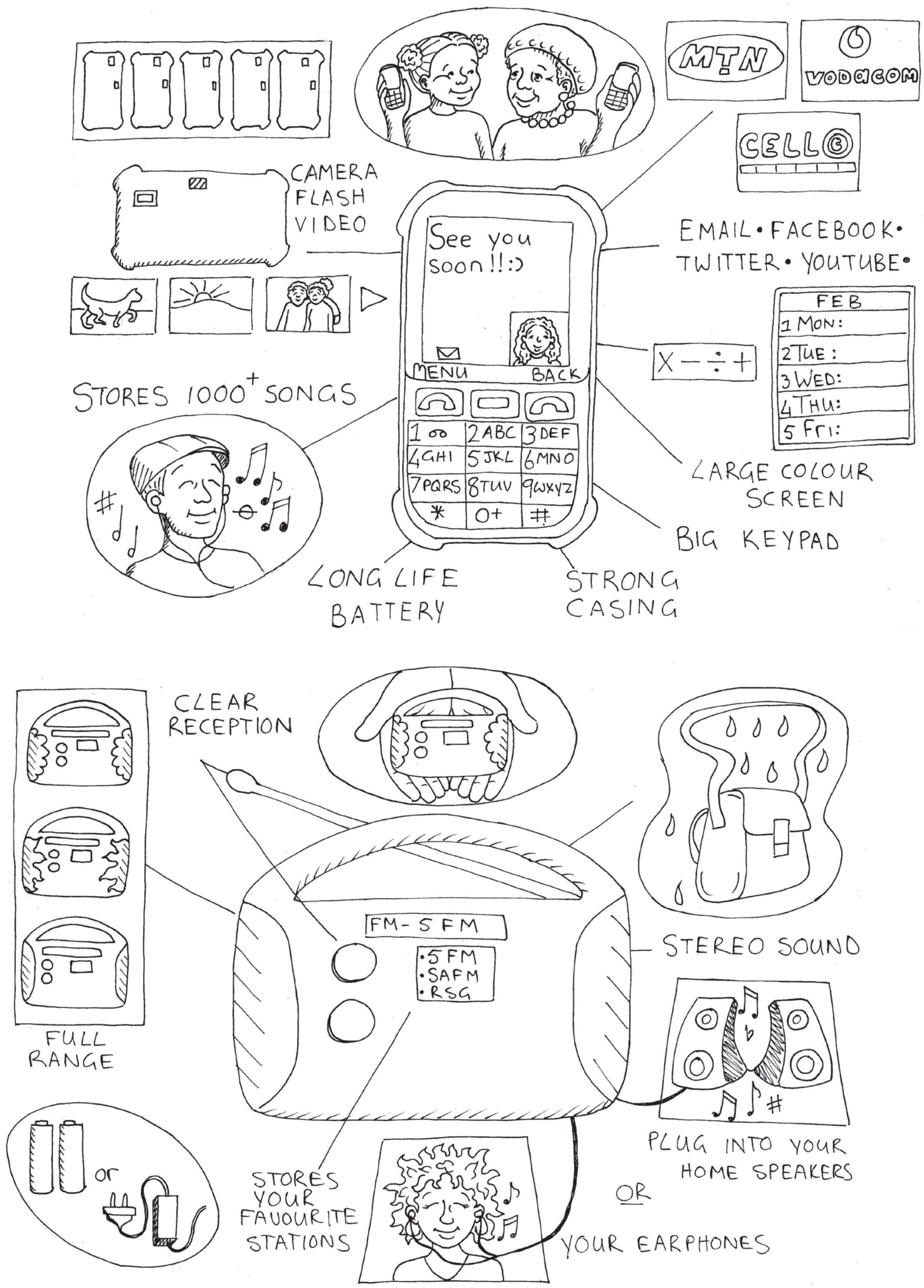

Figure 5

Next week

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

Chapter 11 Mini-PAT
A model cellphone tower

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

Over the next six weeks you will design and build a model of a cellphone 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.

Week 1

Make a few decisions 160

Week 2

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Week 3

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Week 5

Finish building 180

Week 6

Plan your presentation 186

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 marks: 70]

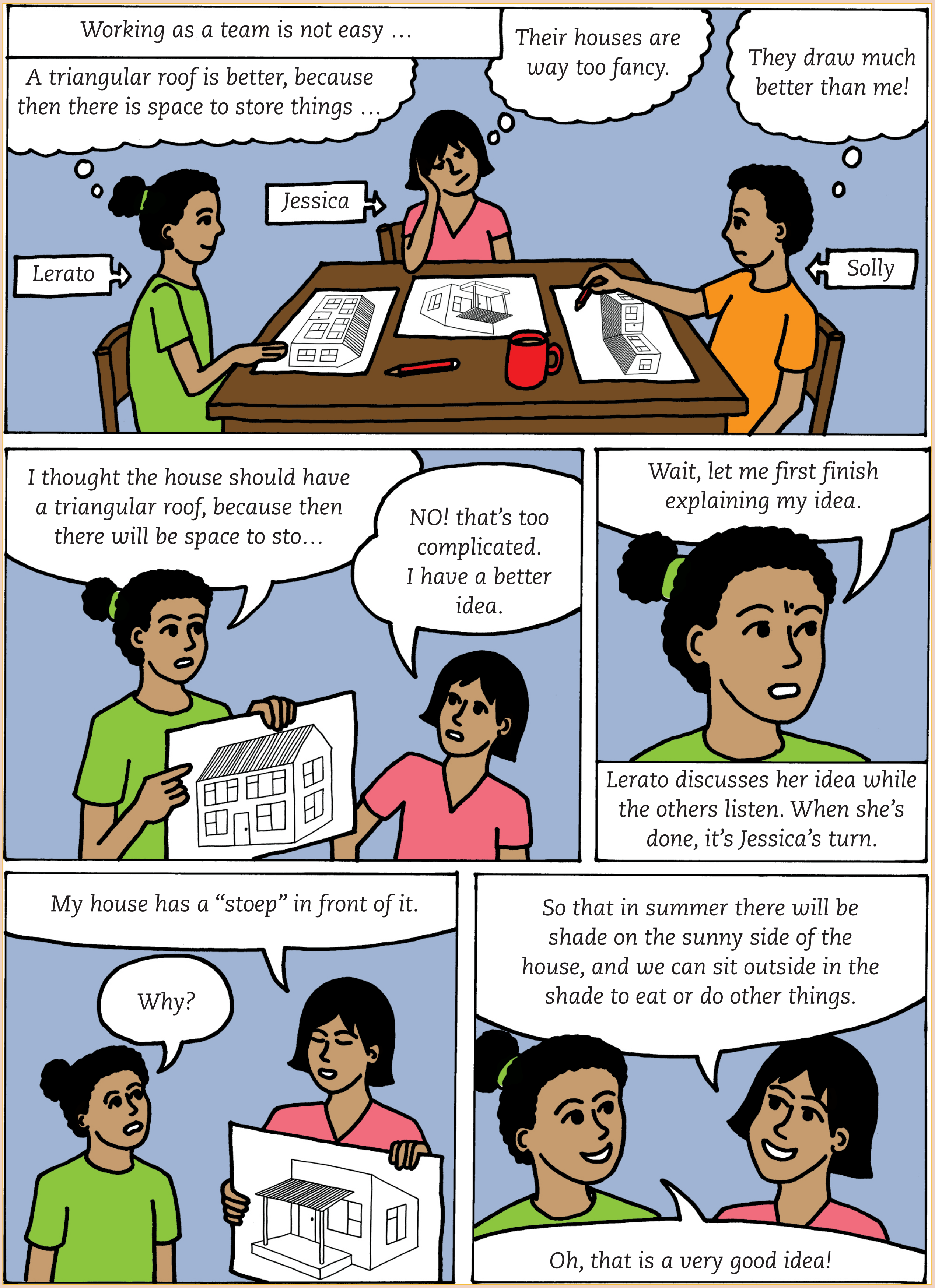
Working as a team is not easy …
A triangular roof is better, because then there is space to store things …
Their houses are way too fancy.
They draw much better than me!
Jessica
Lerato
Solly
I thought the house should have a triangular roof, because then there will be space to sto…
NO! that's too complicated.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

Figure 1


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

Figure 2

Week 1

Make a few decisions (30 minutes)

Your village is about to get cellphone coverage. A cellphone 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 cellphones. 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.

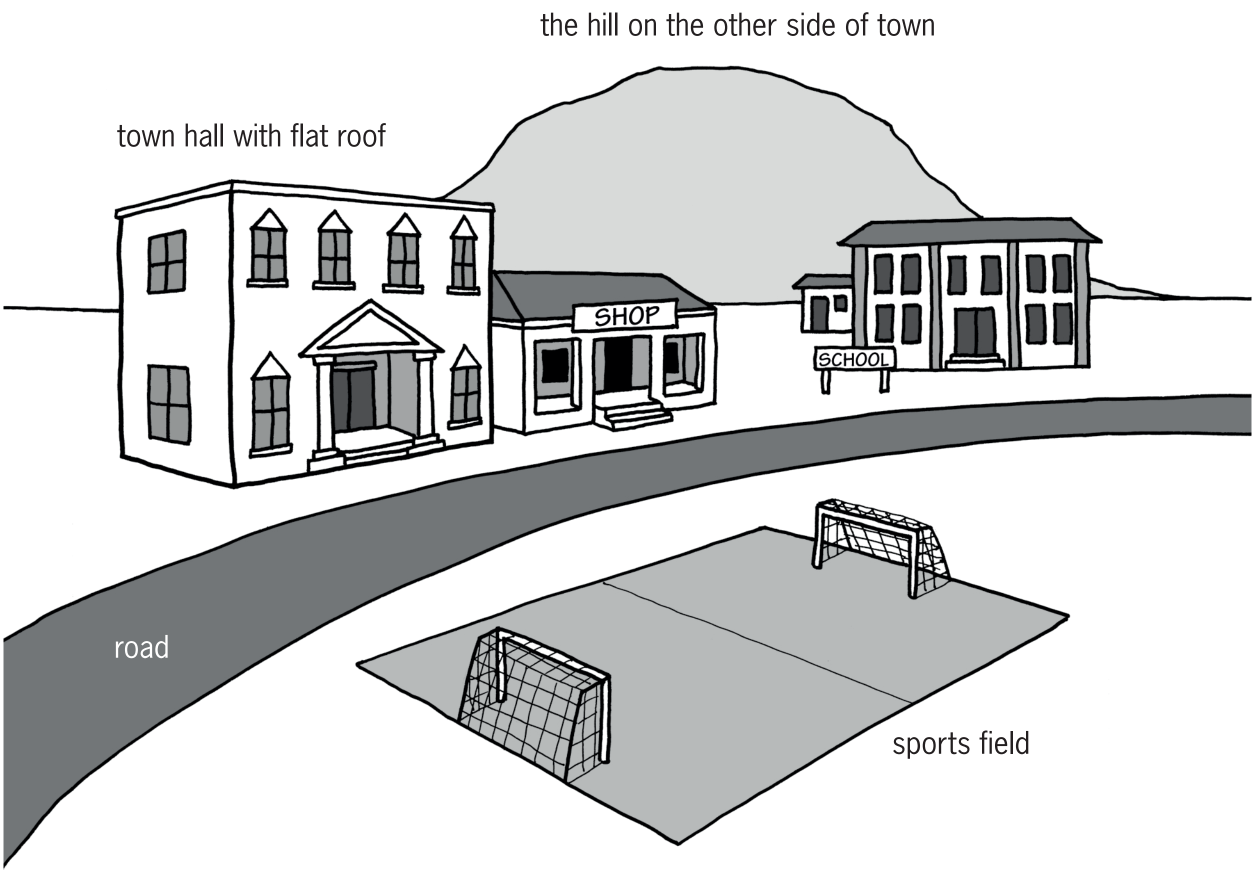

Figure 3

1. Read the story above the picture at the top of the page again, then look at the pictures of six different cellphone towers in Chapter 10. Which of those towers will make the people in your village happy?

   ....

2. The cellphone 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 cellphone 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 . . ."*

   Write down your answer below. You can mention more than three things if you want.

   ....

   ....

   ....

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

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

3. Look at the picture of the village on the previous page. Where do you think the cellphone tower should be placed? Also decide what type of tower it should be, and make a rough drawing of the tower on the right place in the picture.

The cellphone 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 cellphone 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 below of what you think the tower should look like. Also make notes so that you will be able to remember later what you were thinking today.

Design brief, specifications and constraints (30 minutes)

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

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

1. Write the design brief.

(a) What is the problem? [1]

....

....

(b) Who will be happy about the new tower? [1]

....

....

(c) How will it help them? [1]

....

....

....

(d) Now write the design brief. Use the answers of the questions you have just answered. Start your paragraph with:

I must design and make … [2]

....

....

....

....

....

....

....

2. Identify the specifications.

(a) How should the tower be designed so that it will not look ugly? [1]

....

(b) What should be at the top of the tower? [1]

....

(c) Write down another specification, in your own words. [1]

....

....

(d) Write down another specification, in your own words. [1]

....

....

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

....

....

3. Identify the constraints.

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

....

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

....

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

....

....

....

....

[Total:15]

Plan for camouflage and strength (60 minutes)

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

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

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

Figure 4: Some insects camouflage themselves very well

Figure 5: An animal that camouflages itself well

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

1. How will you camouflage your tower?

....

....

....

....

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

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

2. How will you make sure that your model cellphone tower is stable?

....

....

....

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

....

....

....

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

....

....

....

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Make your sketch here:

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.

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.

Write the notes in the space below.

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.
- the need to avoid visual pollution.

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

....

....

....

....

Learn to make strong joints (60 minutes)

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

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

You will now practise making strong joints to help you build the model cellphone 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

1 cup flour

⅓ cup of sugar

1 ½ cups of water

1 big spoon vinegar

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.

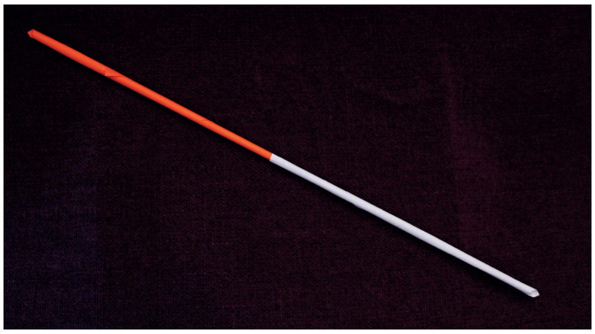
Heat the mixture until it gets thick and shiny.

Leave the mixture to cool.

Look at the sketches on the next page.

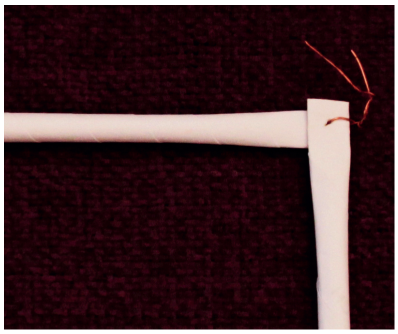
- Partner 1 makes joints A, B and E.
- Partner 2 joins straws, as shown in C and D.
- Partner 3 joins three straws with a paper "gusset", as shown in F.

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

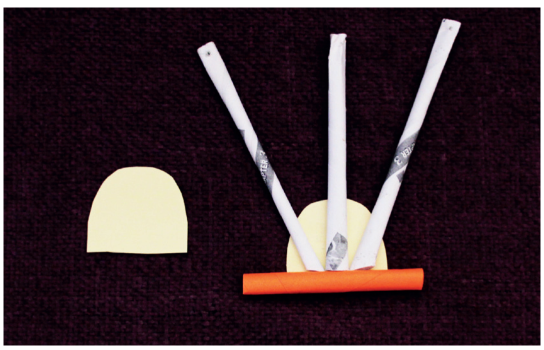


A. Joining two straws by pushing one straw into the other one

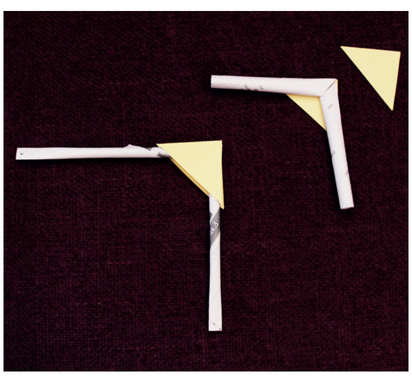
B. Joining two straws by pasting with glue



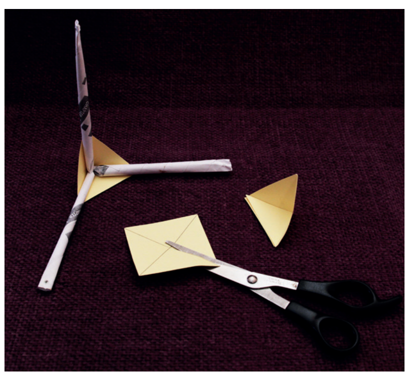
C. Using wire to make a joint



D. Using a card gusset to strengthen a joint



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



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

Figure 6

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

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

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

Do not rub anything on the burn.

Use tools safely

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

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

Week 3

List resources and make a working drawing (30 minutes)

Work on your own.

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

1. You have already made a design for a cellphone tower. Look at it again. Make a list of everything you will need to build the model.

2. Make a working drawing of your model on the next page. 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.

Make your working drawing here, a 2D single view.

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 in the space below. Also make a copy of the drawing of the whole tower on the next page.

Make the drawing here:

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 the start **"planning to make"**.

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

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

1. Make a list of all the materials you plan to use to build your model. (2)

   ....

   ....

   ....

   ....

   ....

   ....

   ....

2 Make a list of the tools you will use to build the model. Even a nail to make holes with can be called a tool. (2)

   ....

   ....

   ....

   ....

   ....

3 Think of your safety when using tools. Some tools can be dangerous if they are used incorrectly. Write down one safety rule for one of the tools you will be using. (2)

   ....

   ....

4 Think about the order of work. This is a list of all the steps you follow when you make the model. Below is the first step. Add a few more steps. (4)

Step 1. Roll straws from scrap paper.

Step 2.

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Step 3.

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Total [10]

Week 4

Build the model

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

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

Remember to work safely and neatly.

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

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

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

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

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

First build the tower without the platform.
You have this period and the next two periods to do 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. Use the space below.

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Make a 2D working drawing (60 minutes)

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

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

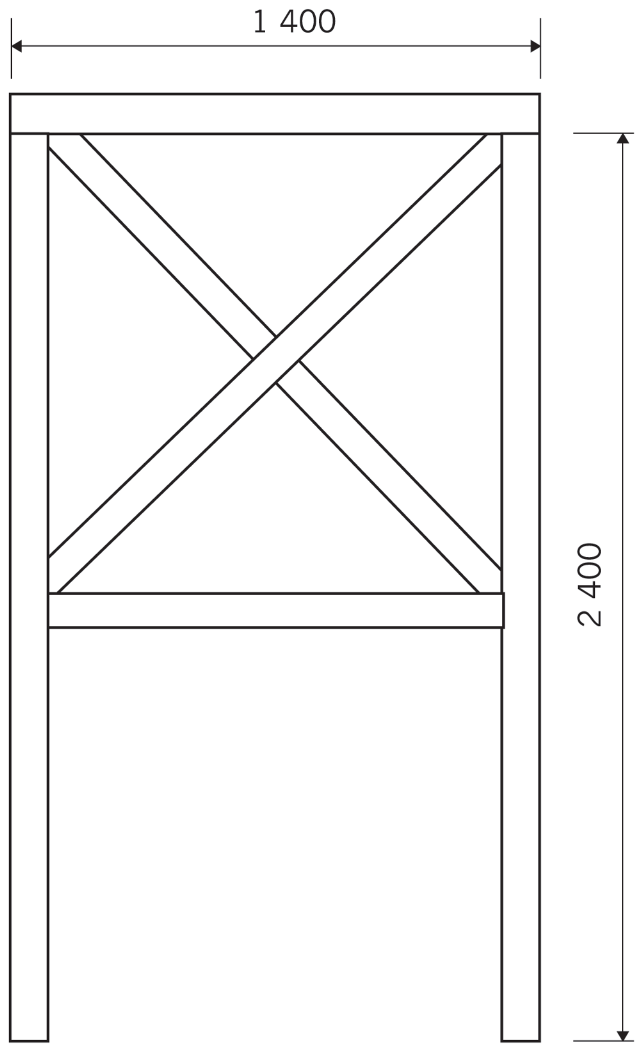
Your teacher will assess your drawing.

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

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

Criteria for working drawings	**Tick**
The drawing has a heading.	
The heading includes the view that the drawing is drawn in, which is the front view.	
The outline of the drawing is darker than the dimension lines.	
The dimensions have only been written down once.	
The dimensions (measurements) are written in millimetres. You don't 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

Make your own working drawing of the model cellphone tower on this page.

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 that, 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 mini-PAT, you were given the information that you used for your specifications. Now use this information as your evaluation **criteria**.

Criteria are ideas you use to judge something.

1. Change each of the criteria into a question you will ask, and write the question in the evaluation sheet below. Work as a team.
   - 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.

Criteria	**Good 3**	**Medium 2**	**Poor 1**

2. Work on your own. Use the evaluation sheet on the previous page 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. Write your questions into the following two evaluation sheets. You will use these sheets to evaluate towers built by other teams.

Criteria **Model of team A**	**Good 3**	**Medium 2**	**Poor 1**

Criteria **Model of team B**	**Good 3**	**Medium 2**	**Poor 1**

Week 6

Plan your presentation (60 minutes)

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

1. Plan your presentation.
   - All the team members have to talk about the work they did when they built the tower.
   - One learner has to show and explain the design sketch. Tell the group how you planned to make the tower fit in with the surroundings.
   - One learner should talk about the problems the group experienced.
   - One learner should talk about how the group tested the tower.
   - Decide who will start and who will talk next.

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. Use the space below to write notes about what you will do.

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

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