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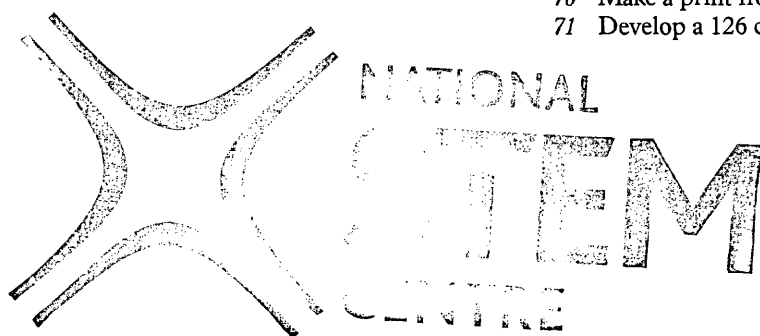
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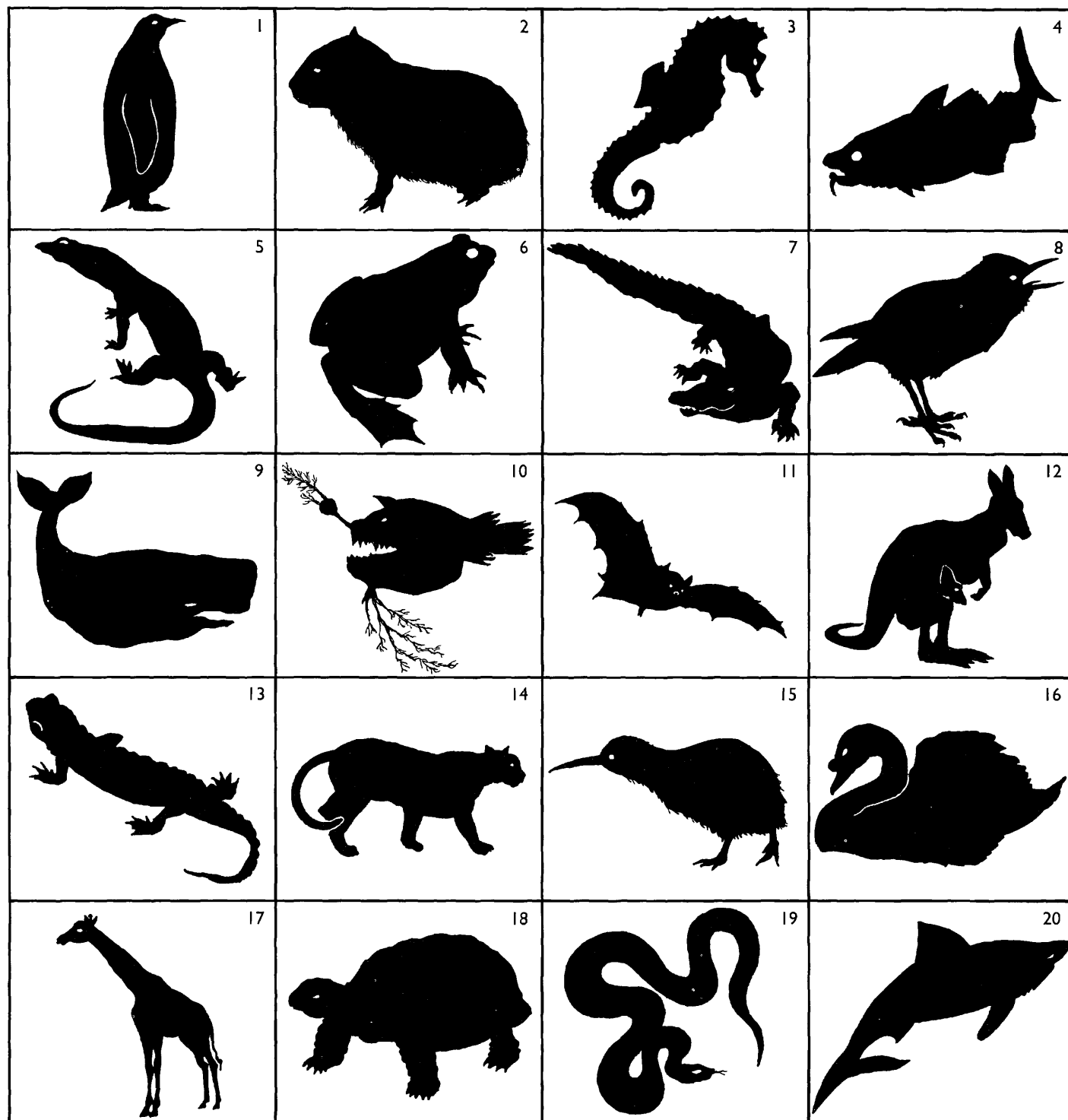
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How many of the animals on this page can you name? Try it.

Write down your ideas of the twenty names. A few are difficult, so if you get fifteen right you are doing well. Your teacher will give you the answers.

When you have solved the puzzle, cut along the black lines so that you have twenty little cards with animals on them. Now try arranging the animals into groups. Show your groups to a friend and explain how you made up the groups. Does your friend agree with you, or would he or she have grouped them differently? Discuss it.

How many different ways are there of identifying you? Each person is, thankfully, different from everyone else. As a scientist, you ought to be able to build up a good picture of some of the ways in which you are special. You can put your information onto a 'file card' drawn in your notebook or on a piece of paper like the one on this sheet.

Start with your fingerprints. Rub your fingertips on a chalky board, quickly wipe them,

then press each onto a piece of sticky tape. Stick these 'dabs' onto your file card. Sketch the main pattern on each to help you compare your prints with other people's.

Add details like colour of eyes and hair to your card. You might like to use 'tick boxes' along the top of your card as on the card on this sheet.

name :

blonde	mousy	ginger	brown	black	others	blue	green	hazel	brown	black
colour of hair						colour of eyes				



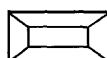
chisel teeth



fangs



front grinders



rear grinders

Now for your teeth! Dentists use the symbols on the left for chisel teeth, for fangs, for front grinders, and for rear grinders. Draw your teeth patterns, top and bottom sets, using a mirror to help you see. You can show your fillings as black blobs. Do you have all 32 teeth yet?

Add measurements to your file card such as your weight and your height, your handspan and your fingertip to elbow distance (which used to be called a 'cubit'). Can you think of any other measurements?



Inks that develop with heat

- 1 Ask your teacher for a mortar and pestle. Use it to grind up a small piece of onion.
- 2 Write a secret message with the onion juice. (An old-fashioned steel nibbed pen is best for this.) Wait for the juice to dry.
- 3 Put a tin lid on top of a tripod stand. Heat the lid gently for a few minutes.
- 4 Put the piece of paper with your secret message onto the hot lid and leave it for a minute or so.

⚠ Take care that the paper does not catch fire.

What colour is the invisible ink now? Can you think of a more convenient way of heating the paper?

- 5 There are other invisible inks that develop with heat – try milk, lemon juice, cola, and sugar in water.

Inks that develop with chemicals

- 1 Soak a ball of cotton wool in strong ammonia solution. Put it in the corner of a lunch-box with an airtight lid.

⚠ Be careful not to breathe in too much of the ammonia fumes.

- 2 Write your secret message with phenolphthalein (phenol-thaleen) solution. Wait until it dries.
- 3 Put the paper into the lunch-box and close the lid. Leave it for about half a minute then take it out and close the box.

What colour is the invisible ink now? Try to explain what has happened.

- 4 Write a new message in copper sulphate solution. Wait until it has dried.
- 5 Moisten a ball of cotton wool with ammonia solution and wipe it over the paper with your message.

What colour is the invisible ink now?

You could also try a message written in copper sulphate solution and developed with sodium carbonate solution.

Reporting on the uses of heating

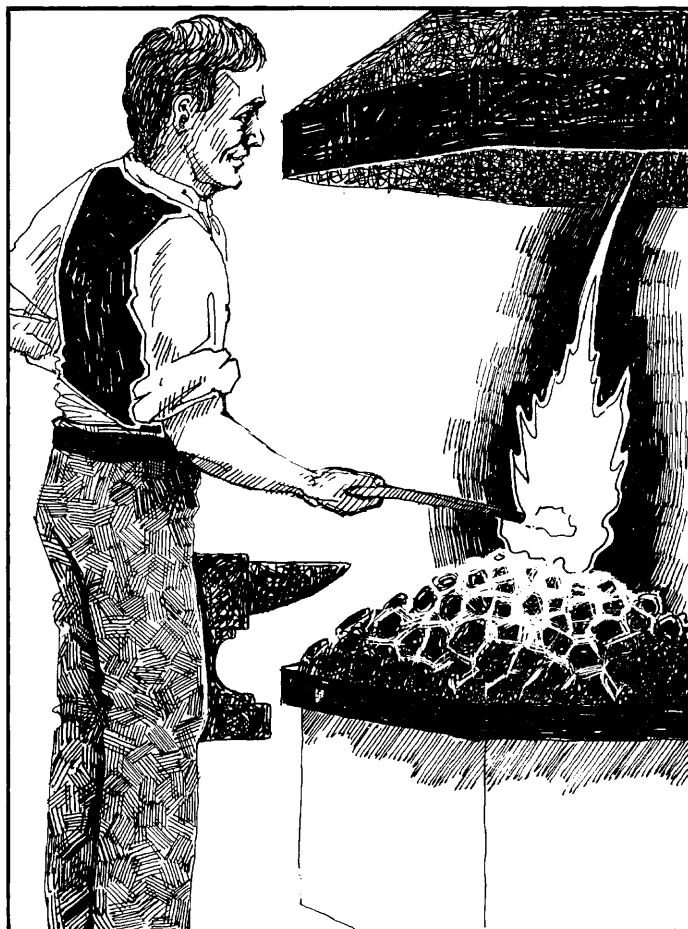
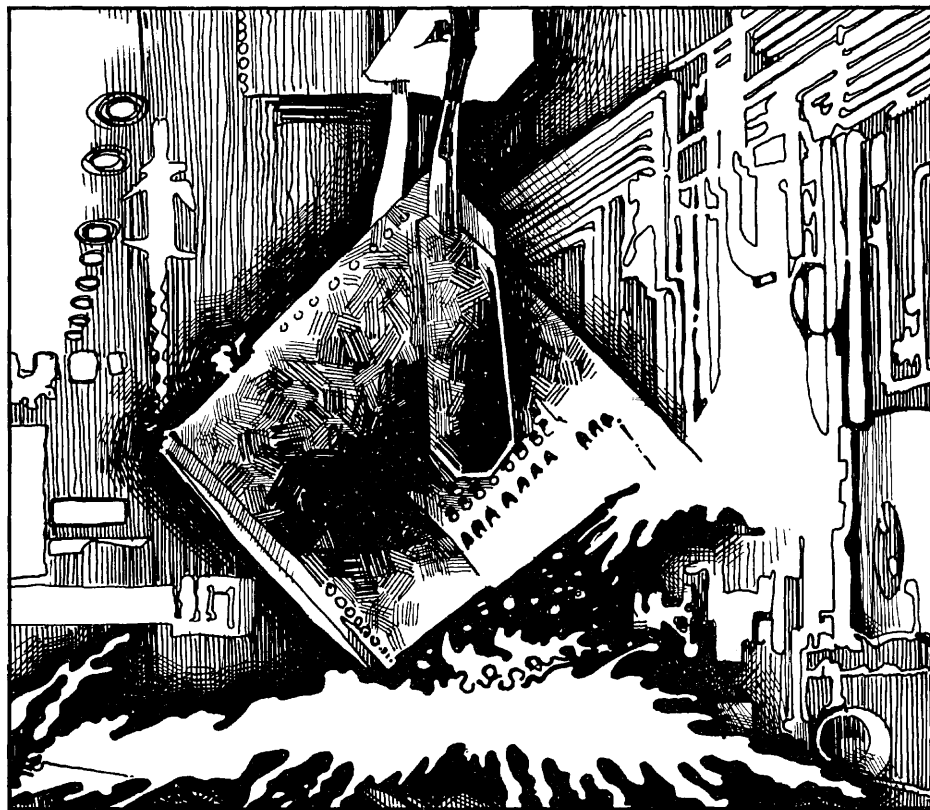
WORKSHEET

4

We humans use heat in many different ways. There are clues to some of them in the pictures on this sheet. Try to describe what is happening in each of them.

Write a report called 'The uses of heat'. Do some research in the school library to help you. Illustrate your report with your own sketches, drawings, and cartoons, or with pictures cut out from comics and magazines.

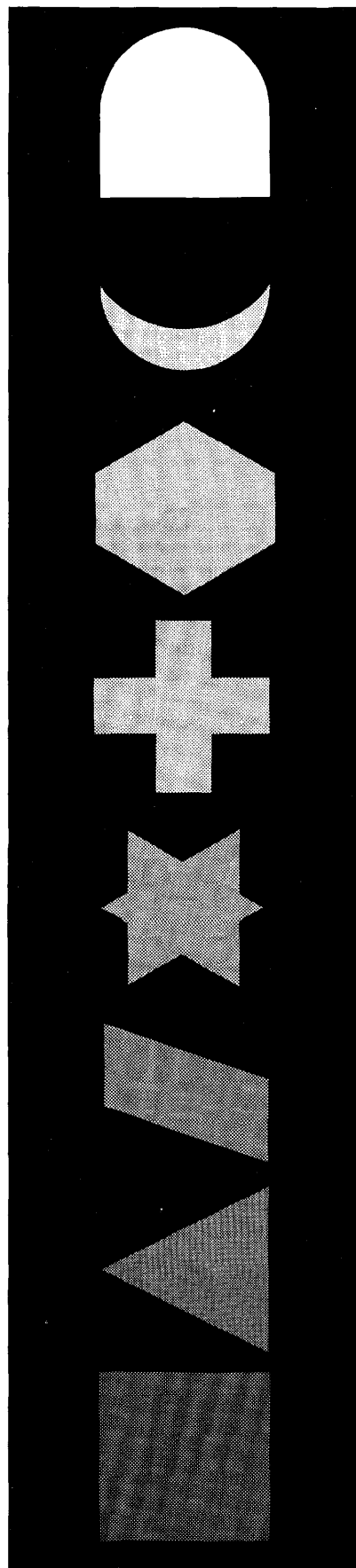
If your class collects lots of pictures, get together and use them to make a poster to put up on the science laboratory wall. Try to cover nearly all of the backing sheet of the poster with your pictures.

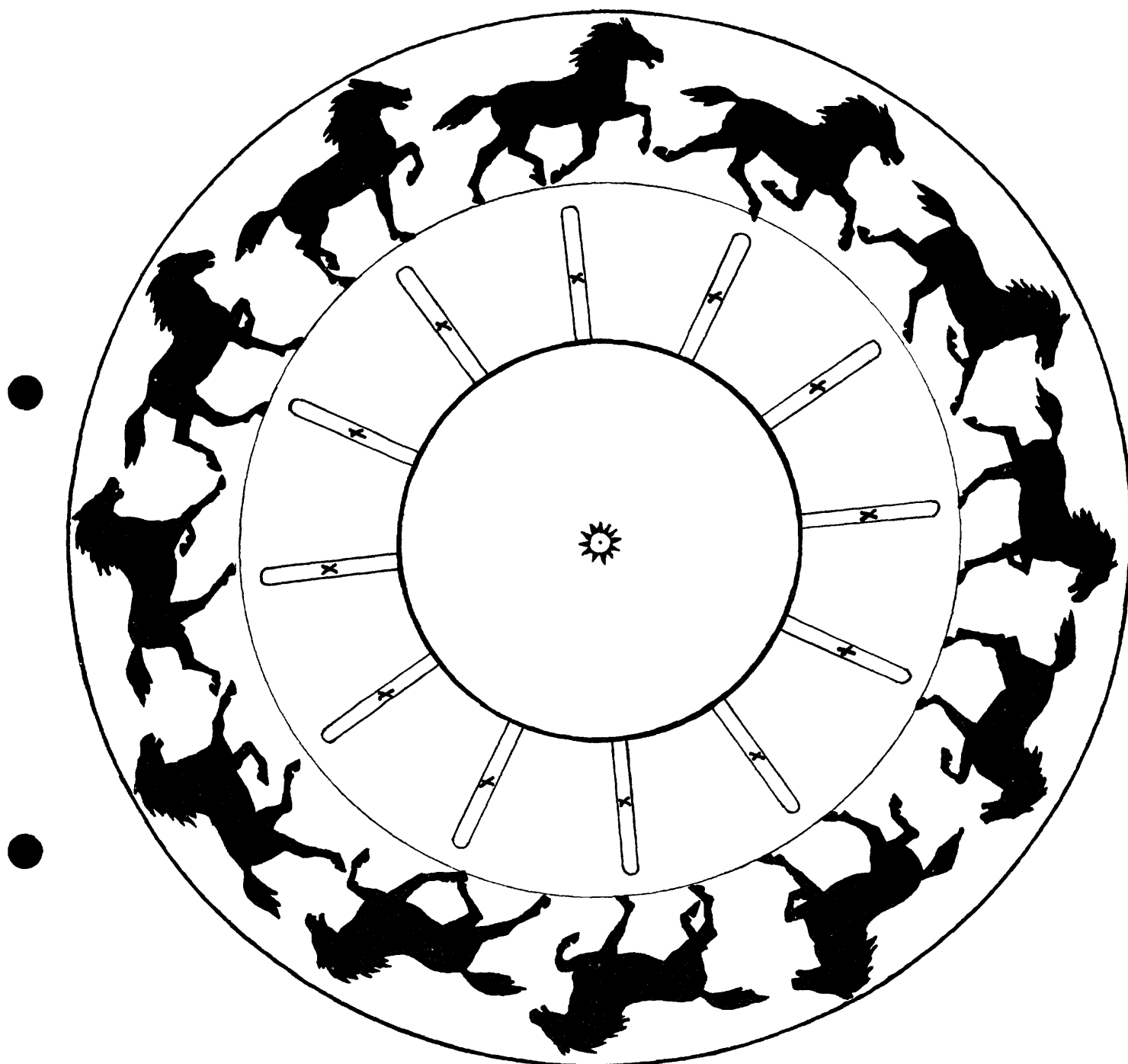


There are lots of different sounds. Some just seem to happen, others are made for a purpose.

Look at the sounds in the cartoon. How many of them are being made for a purpose? What messages are they carrying? Discuss these questions with your friends.







The praxinoscope was a Victorian toy which let people see 'moving pictures' long before there were cinemas or televisions.

1 Stick this page onto a card, let it dry, and cut round the edge of the disc.

2 With a sharp knife cut out all the slots marked with an 'X'.

3 Push a map pin or the point of a pair of compasses through the centre of the disc.

To see the effect, point the side of the disc with the horses at a mirror. Spin the disc while looking through the slits at the reflection.

You have probably read about Antonie van Leeuwenhoek (lay-ven-hook). His microscopes used a single tiny piece of glass ground into a perfect lens shape. No one is sure how he did it.

You can make a model microscope which will work in the same way. You may be able to get it to magnify a hundred times.

- 1 Make a hole about 2 mm across in a clean, dry milk bottle top.
- 2 Put a small drop of water in the hole.
- 3 Get your eye very close to the drop, with the thing you are looking at just under it.

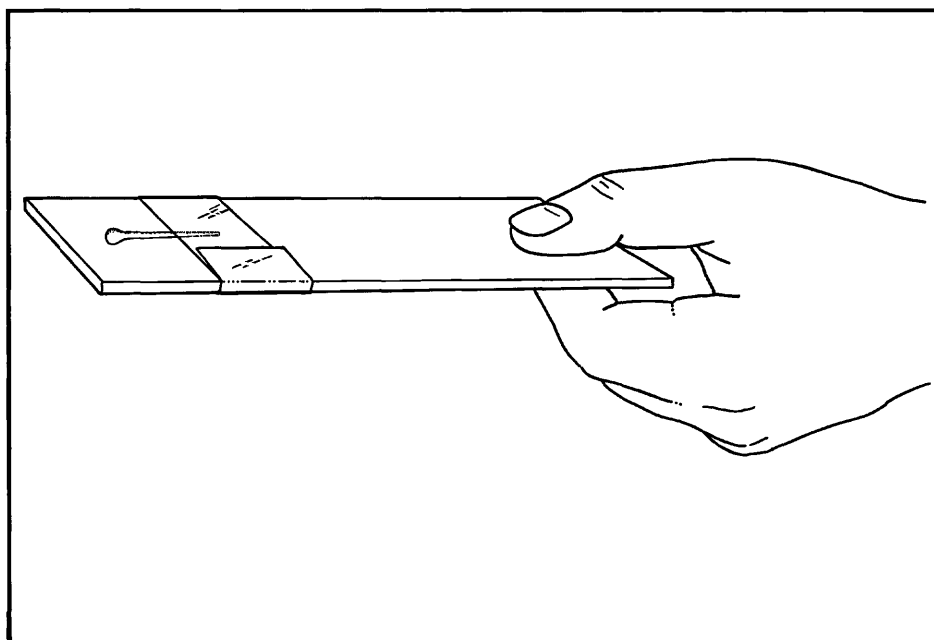
Try different sizes of holes. Which gives you the best results?

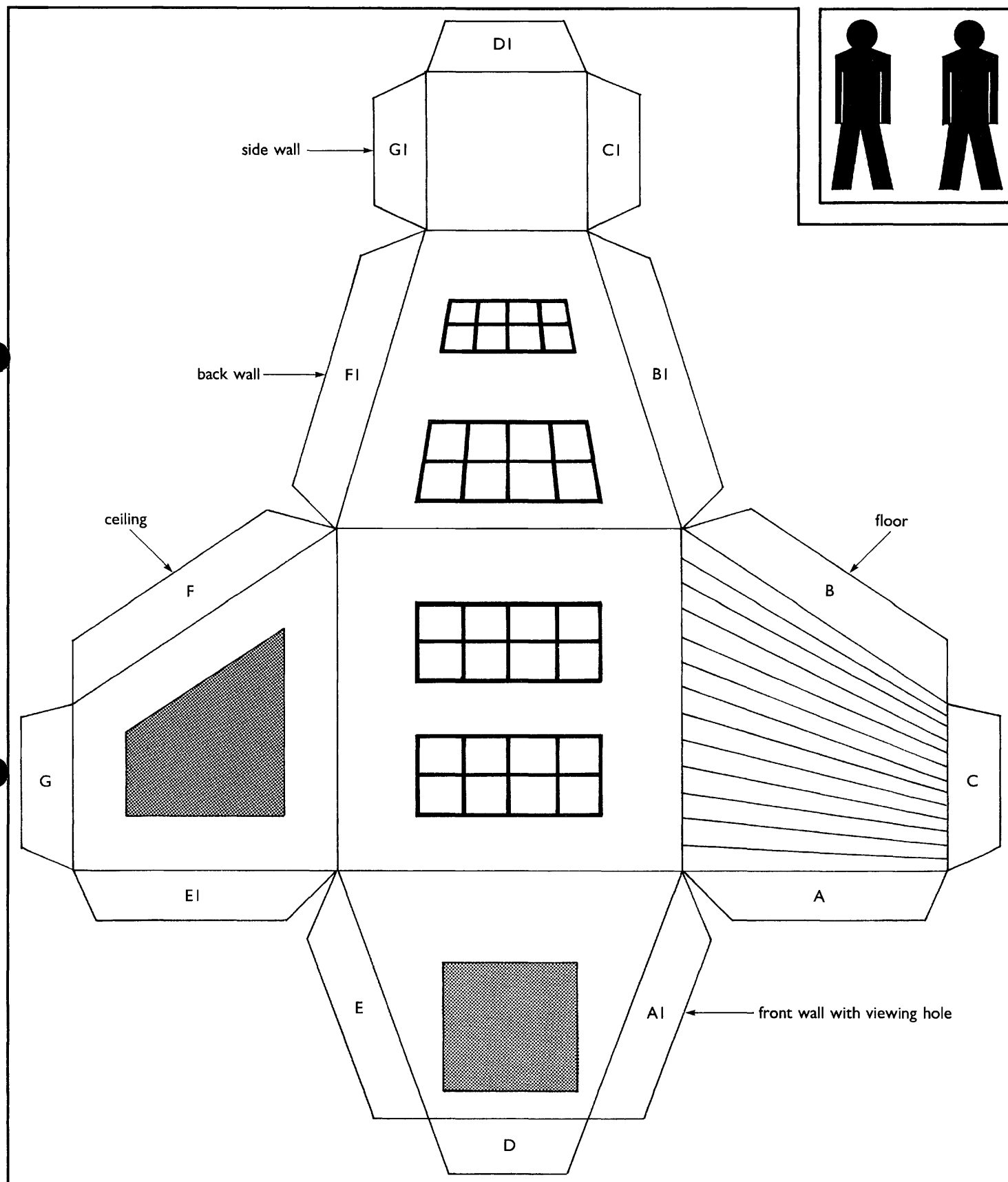


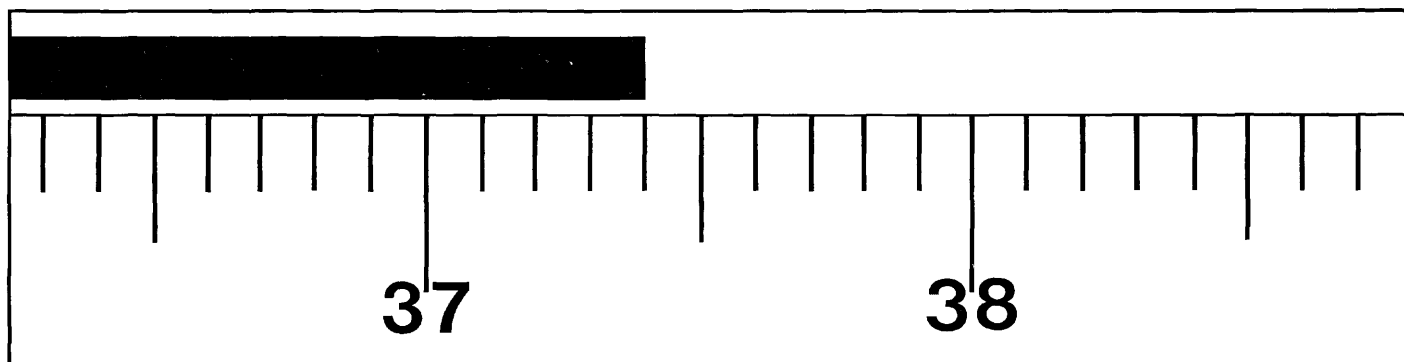
Another model microscope uses glass drops – your teacher will show you how to make one.

- 1 Take a piece of thick card 8 cm by 3 cm and make a hole near to one end.
- 2 Lay a glass drop on the card so that it rests over the hole. Tape its stem to the card (the drawing shows how).
- 3 Look through the glass drop in the same way that you used the water drop.

You could use a matchbox with its tray partly pushed out instead of the piece of card.







Here are the steps you should take when you want to read a scale. At first you will need to go through the steps one by one. With more practice you will be able to read a scale almost at a glance.

1 Make sure that you can see the measuring point clearly.

The measuring point might be the end of the thread of mercury in a thermometer, or it might be the end of something you are measuring with a ruler.

2 Look at the measuring scale.

The scale will be divided into sections by small lines which run across it. Some of the lines are longer than others. These longer lines normally have numbers written next to them. You can see two such lines in our diagram at the top of this sheet. They are numbered 37 and 38. We will call these longer lines 'main scale lines'.

3 Use the numbers on the main scale lines to make your first estimate of the reading.

In our diagram, your first estimate would be: 'somewhere between 37 and 38'.

4 Count the number of divisions between the main scale lines.

In our diagram there are ten divisions. Can you see that? If there are ten divisions, each one will be worth 0.1 of the main scale units. If there are five divisions, each will be worth 0.2 of the main scale units.

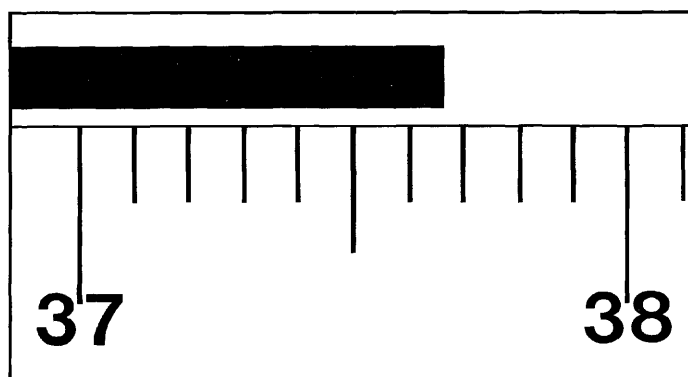
5 Count the divisions between the lower main scale line and the measuring point.

In our diagram there are 4 divisions between the 37 line and the measuring point. You could say to yourself: 'The reading is 37 plus 4 small divisions'.

6 Work out the reading.

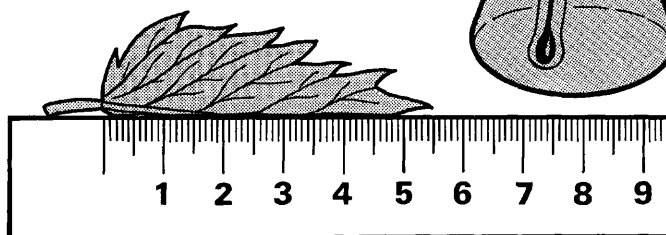
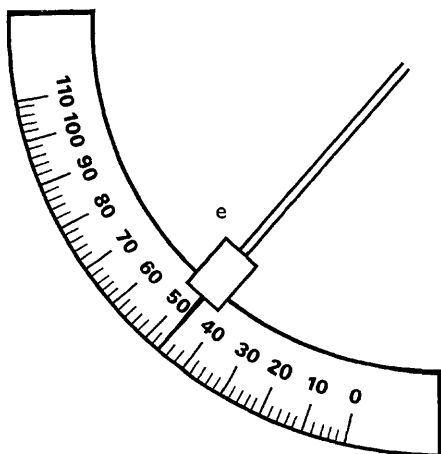
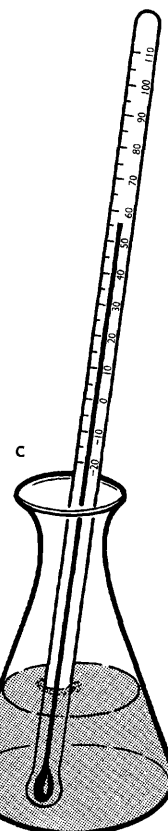
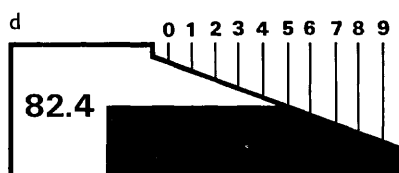
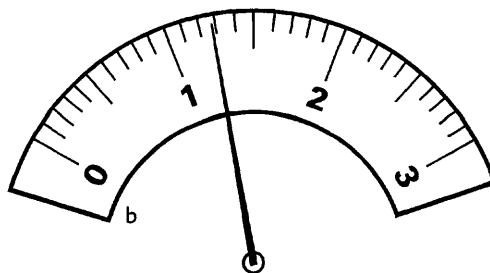
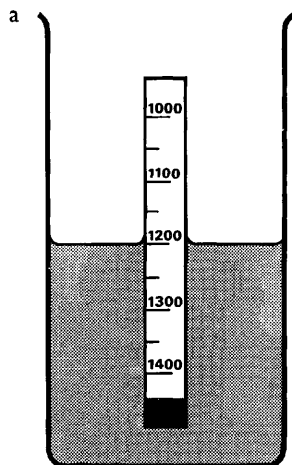
For our diagram you would say to yourself: 'Each division is worth 0.1 units. Four divisions equal 0.4 units. So the reading is 37 and 0.4, that is 37.4'.

If you can follow these steps you can read a thermometer to the nearest 0.1 of a degree. This is fairly simple if the measuring point is right on one of the scale marks, but what if the measuring point is like the one in the diagram below?



For the time being, all you need to do is decide which scale mark is nearest to the measuring point. In the diagram it is the seventh mark. Can you see that? You would say that the reading is 37.7.

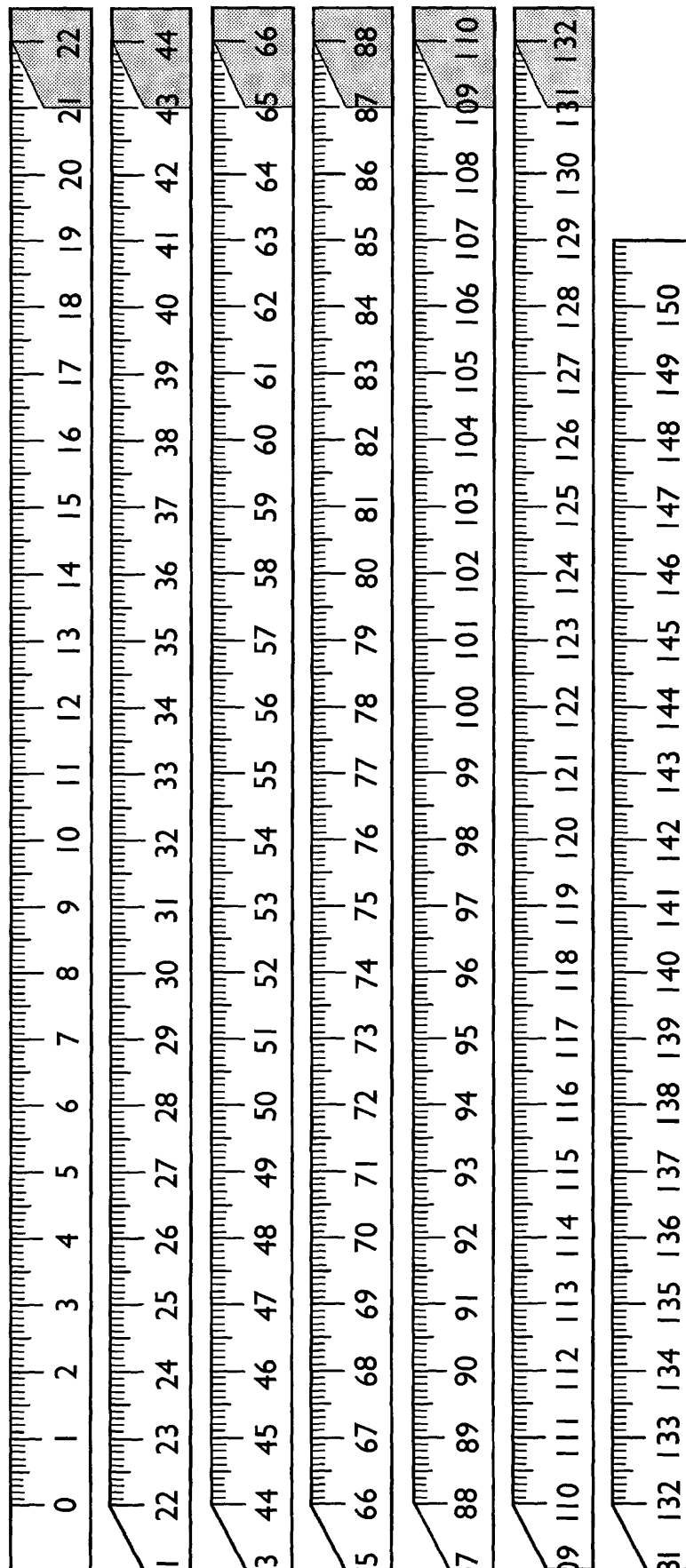
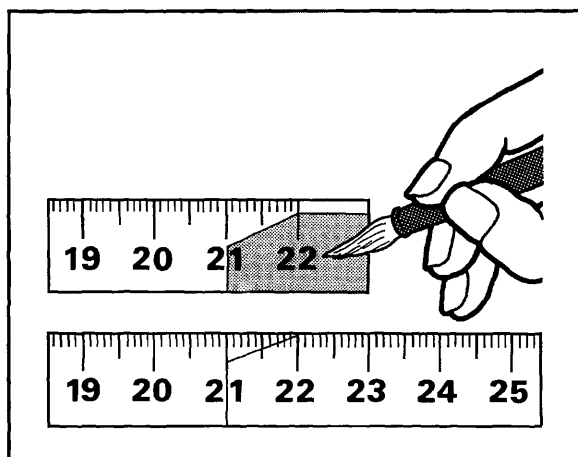
Now try the exercise on Worksheet 11.

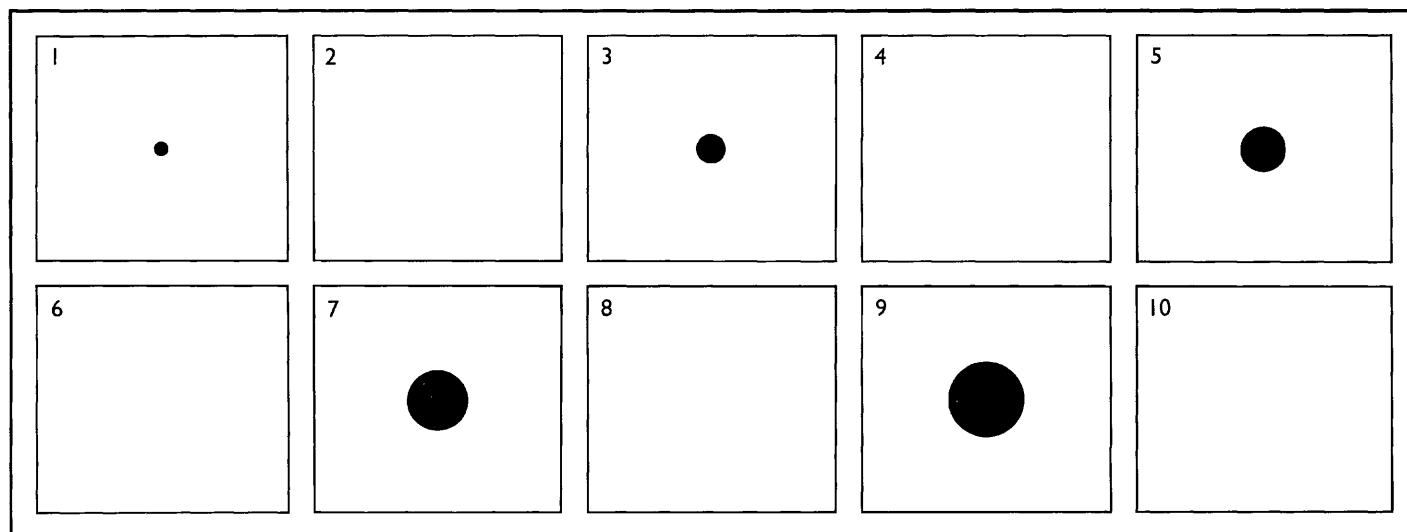


On this page we have given you a cut-out tape measure.

1 Cut out the strips carefully and stick them together as shown in the diagram. Your teacher will tell you what kind of glue to use.

You will have a tape measure that is 150 cm long.





You will need plenty of space for this investigation – the school hall or out in the playground will do. You need a partner, a very long tape measure (a surveyor's tape or several of your paper tapes), and some special cards which you have to make from the ten square frames on this page.

1 Cut out the frames and stick them onto five plain white postcards. Stick frame 1 onto one side of the first card and frame 2 onto the other side. Then stick frames 3 and 4 on opposite sides of the second card, and so on.

The sizes of the dots in the frames are 2 mm, 4 mm, 6 mm, 8 mm, and 10 mm.

2 Copy the table into your notebook.

Size of Object dot (mm)	Furthest distance dot can be seen (m)	Visual acuity
2		
4		
6		
8		
10		

3 When you are ready in the hall or playground, your partner should walk away from you for at least thirty paces while you hold onto the cards.

4 Now hold up the card with the 10 mm dot with the side with the empty frame towards your partner. When you are sure that he or she is looking at it, turn it round to show the dot, count three and turn it over again to show the plain side.

If your partner can tell the difference between the two sides, he or she must wave. If not, he or she must shrug (or give some other signal!).

5 The idea is to find the furthest distance that your partner can see the dot. So, when your partner shows that he or she *can* see the dot, they must take two paces back and stop while you show the card again. If he or she *cannot* see it, they must take two paces forward and stop while you show the card again.

When the dot can just be seen you can fill the result in the table. Leave the third column in the table blank for the time being.

6 Go on to the next smallest dot and find the greatest distance at which it can be seen. Continue until you have tested all five dots.

Scientists call the ratio of size of dot to seeing distance the *visual acuity* of a person. For example, if you can see a 2-mm dot 6 m away (6000 mm away), your visual acuity is '2 to 6000', or '1 to 3000' if you like.

7 You can now fill in the last column of your table.

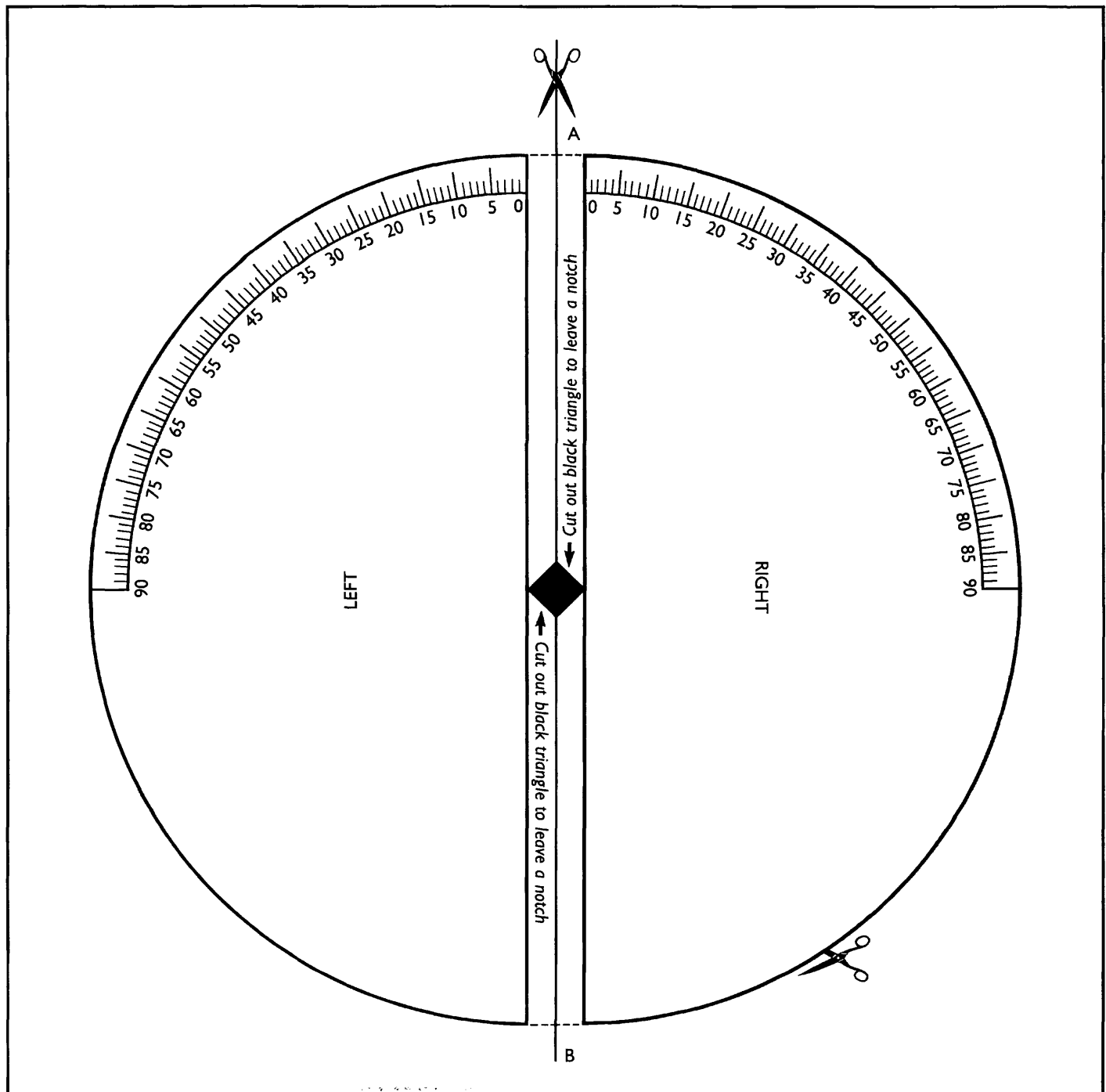
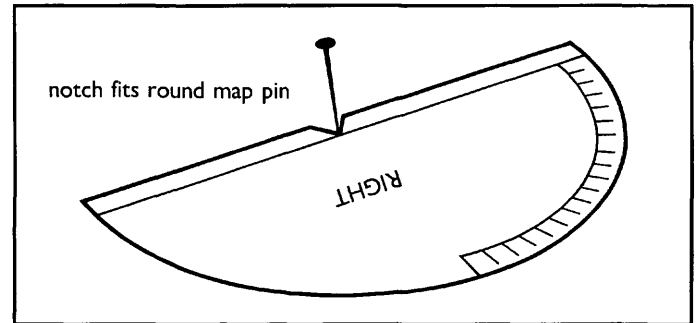
8 Your teacher will show you how to make the class's results into a bar chart poster.

Rangefinder protractors

WORKSHEET 14

Here are the giant protractors that you will need to make the rangefinder on page 132 of your science book.

- 1 Stick this worksheet onto a sheet of thin card and let it dry.
- 2 Carefully cut out the circle. Cut along line AB and then snip out the two notches.



Scientists and engineers often measure the heights of tall objects – buildings for instance – using an instrument called a clinometer. You can make a clinometer like the one in the picture.

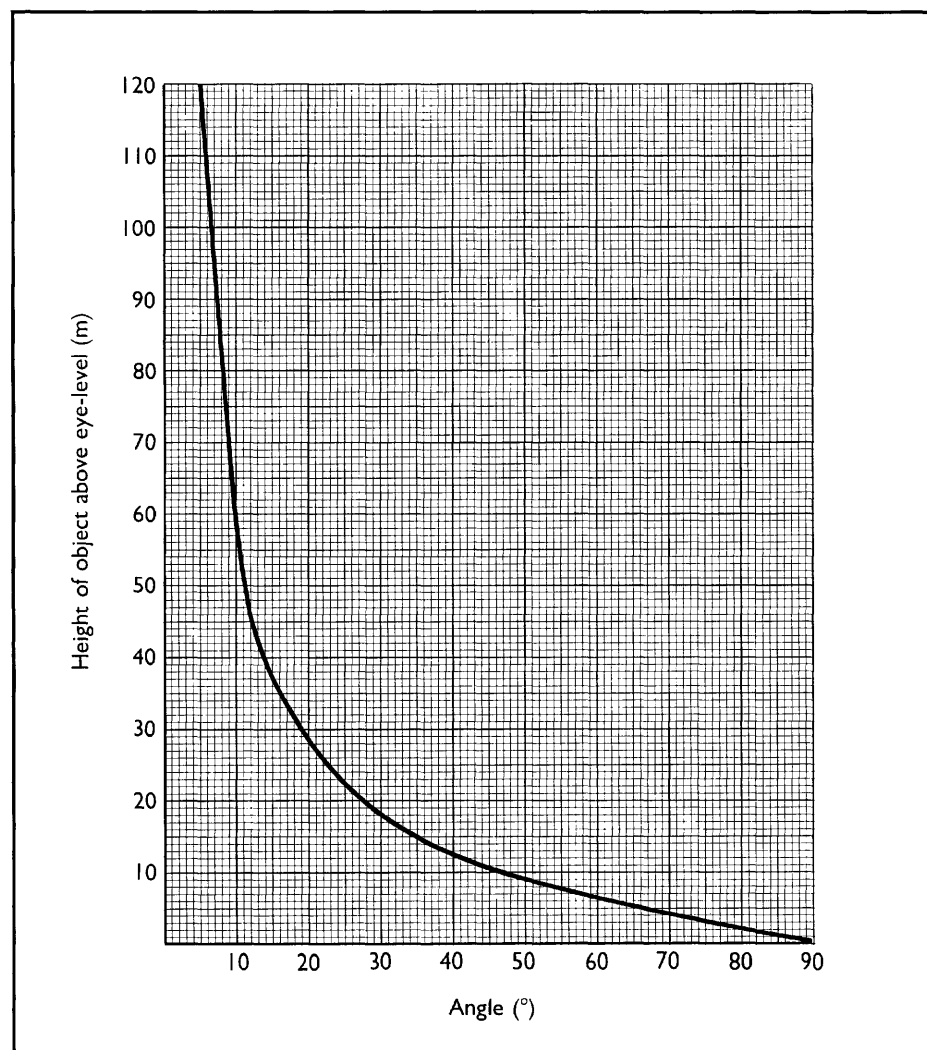
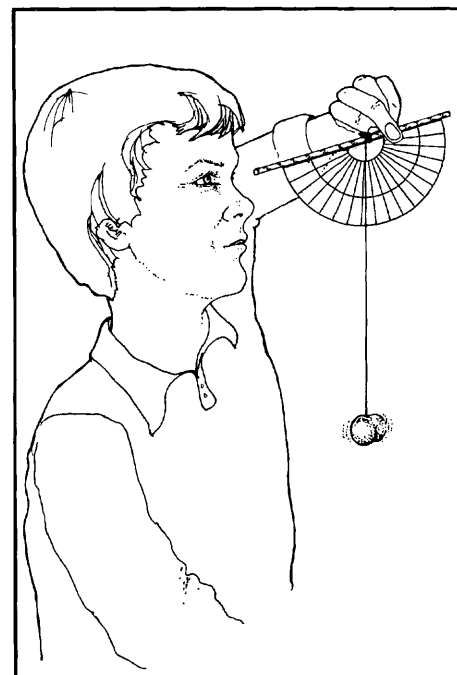
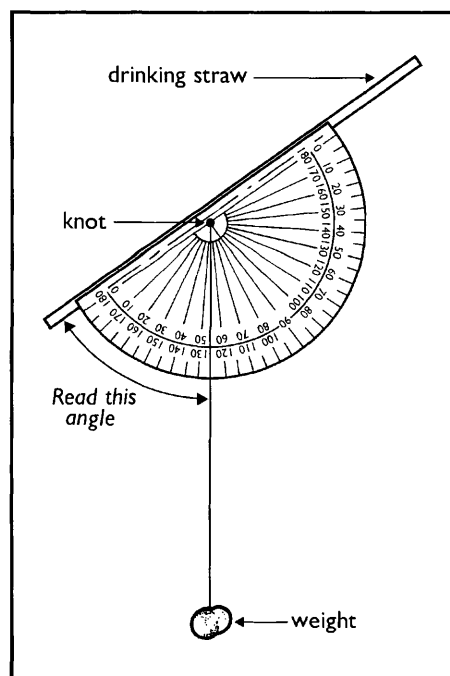
You will need a protractor with a hole made exactly at its zero mark (ask your teacher about this). You need a drinking straw, a length of thread, a small weight such as a blob of modelling clay, some glue, and a surveyor's metric tape measure.

- 1 Push the end of the thread through the hole in the protractor and tie a knot to stop it slipping back. Fix the small weight to the thread.
- 2 Stick the straw along the top edge of the protractor.

Using the clinometer

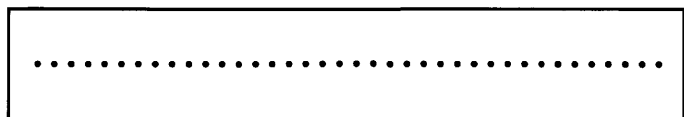
- 1 Stand exactly 10 metres away from your target object. (Measure this distance with the tape measure.)
- 2 Sight along (or through) the drinking straw at the top of the target object.
- 3 Get a friend to read the protractor where the thread cuts its scale. Check the angle very carefully.
- 4 Use the graph to find the height of the target object. Find the angle along the bottom then trace upwards to the line. Now trace across to the side and read the height.

Write about the clinometer in your notebook. Draw some pictures to show how it was made and how you used it.



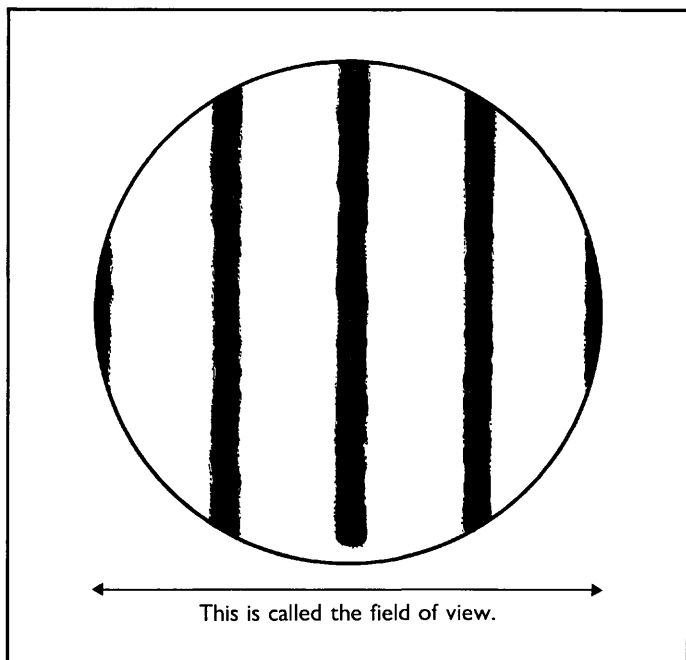
People who write science books often say things such as: 'Bacteria are so small that you could line up 250 across one of the full stops on this page'. No one can imagine 250 things, as tiny as that, lined up, but it tells you that bacteria are very small. How do scientists measure such things? How do they know the width of a full stop? You will know part of the answer when you have done this investigation.

You will need a microscope, set up on low power, and a transparent plastic ruler with millimetre marks. You will also need some printed full stops. Here you are!



1 Put the millimetre scale of your ruler under the microscope and get it in focus.

Now you should be able to tell the width of the bright circle that you can see through the microscope (scientists call this bright circle the 'field of view'). For example, suppose you get a picture like ours below. The heavy lines are the millimetre marks on your ruler (magnified, of course!). So the width of the bright circle is about 4 millimetres. Can you see that?



If you don't quite understand it, talk about it with your teacher.

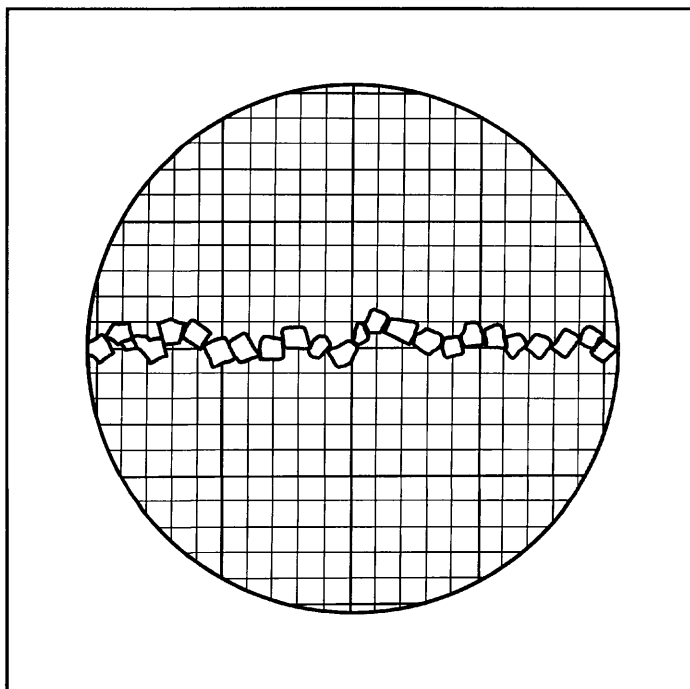
You can use what you know about the width of the field of view to measure the size of a full stop.

2 Put this sheet – or any other piece of paper with a full stop – under the microscope and focus on it.

3 Put the ruler on top of the page and, looking through the microscope, try to get the scale and the full stop in focus at the same time.

Can you say how wide the full stop is? How would it help you to have a line of full stops instead of just one?

4 Use the ruler method to measure some other small distances such as the width of a hair or a sewing needle, or the size of a pin prick or a salt crystal. (Hint: for the salt crystal, it will help if you can imagine a line of crystals stretching right across the field of view as shown below.)



Write about everything you have done. Imagine that you are writing a report for one of your friends who was absent and so missed the lesson.



Unless you are a goalkeeper who makes a lot of saves, you don't get much opportunity to 'feel' *inertia* – that is, the tendency of things to keep moving in a straight line at a steady speed. Forces such as friction, air resistance, and weight usually spoil the effect.

The instructions below tell you how to make a set of four pendulums. These have different inertias (different masses), and you will be able to feel the difference.

You will need four empty washing-up liquid containers, some string, four small washers, and some glue.

1 Pull the plastic nozzles off the tops of the containers. Thread a half metre of string through each nozzle. Tie a washer securely onto the end of the string (look at our drawing). Tie a good big knot.

2 Put different amounts of water in three of the containers: three-quarters fill one, half fill another, and one-quarter fill the third.

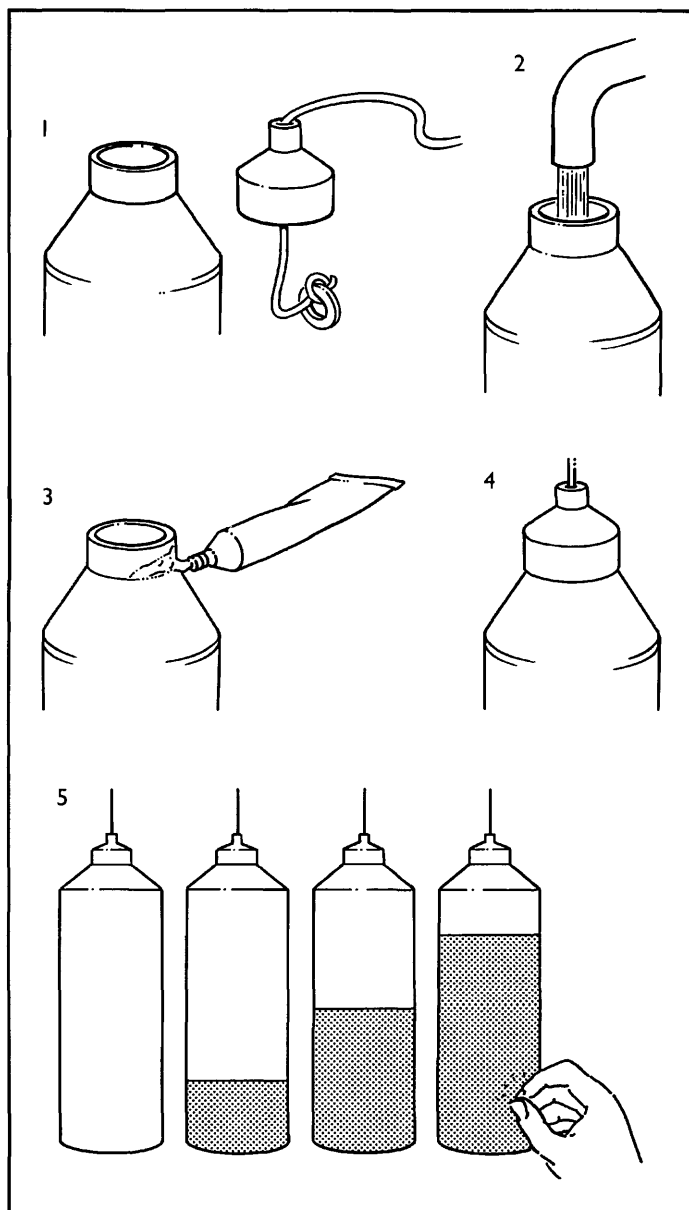
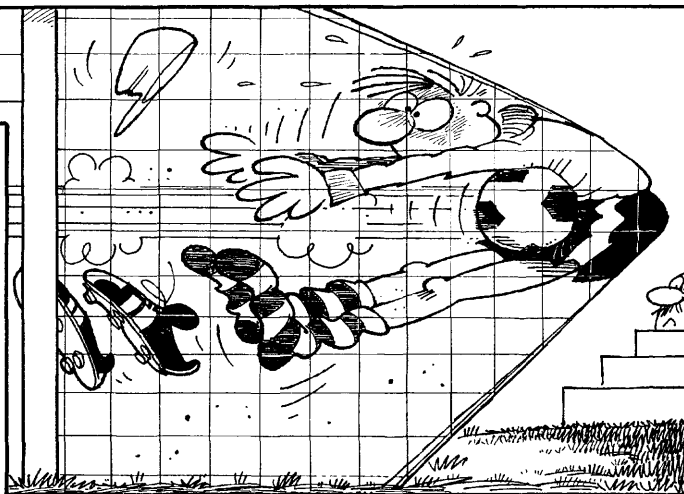
3 Glue the nozzles back on with the washers inside. Your teacher will tell you the best kind of glue to use.

4 Hang up the containers so that they are level. They don't have to be in order – in fact it will be more interesting if you mix them up.

5 When you have set the containers up, go along the line and flick each of them in turn. Feel the difference between them. Give them a push and see what it is like to stop them again.

6 Ask someone who does not know how they are filled to tell you the difference between them *without* lifting them up. He or she will probably say: 'They have different weights'. You will be able to say: 'How do you know? You didn't lift them up'.

The right answer is that you can feel that they have different inertias (different masses) – some are harder to start moving, stop moving, and change direction than others.



These instructions will help you to make one kind of sun-dial (a clock which uses the Sun's rays).

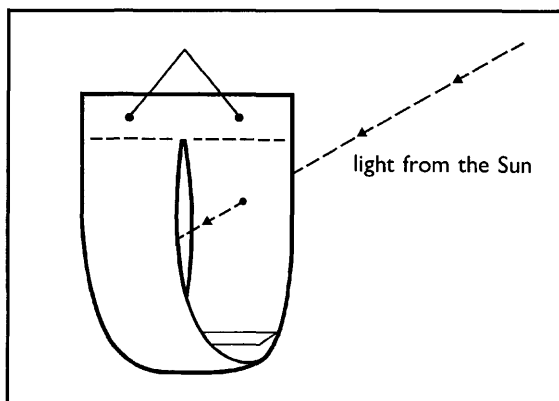
1 Stick this page onto a piece of thin card and leave it to dry.

2 Cut out the shape following the letters ABCDEFGHA. Now cut the slot going from F to T.

3 Punch the three holes shown by black dots.

You should have two strips of card joined together by a piece across the top.

4 Stick or staple TAB X onto TAB Y so that the two strips form a sort of twisted circle. The diagram shows how it should look.



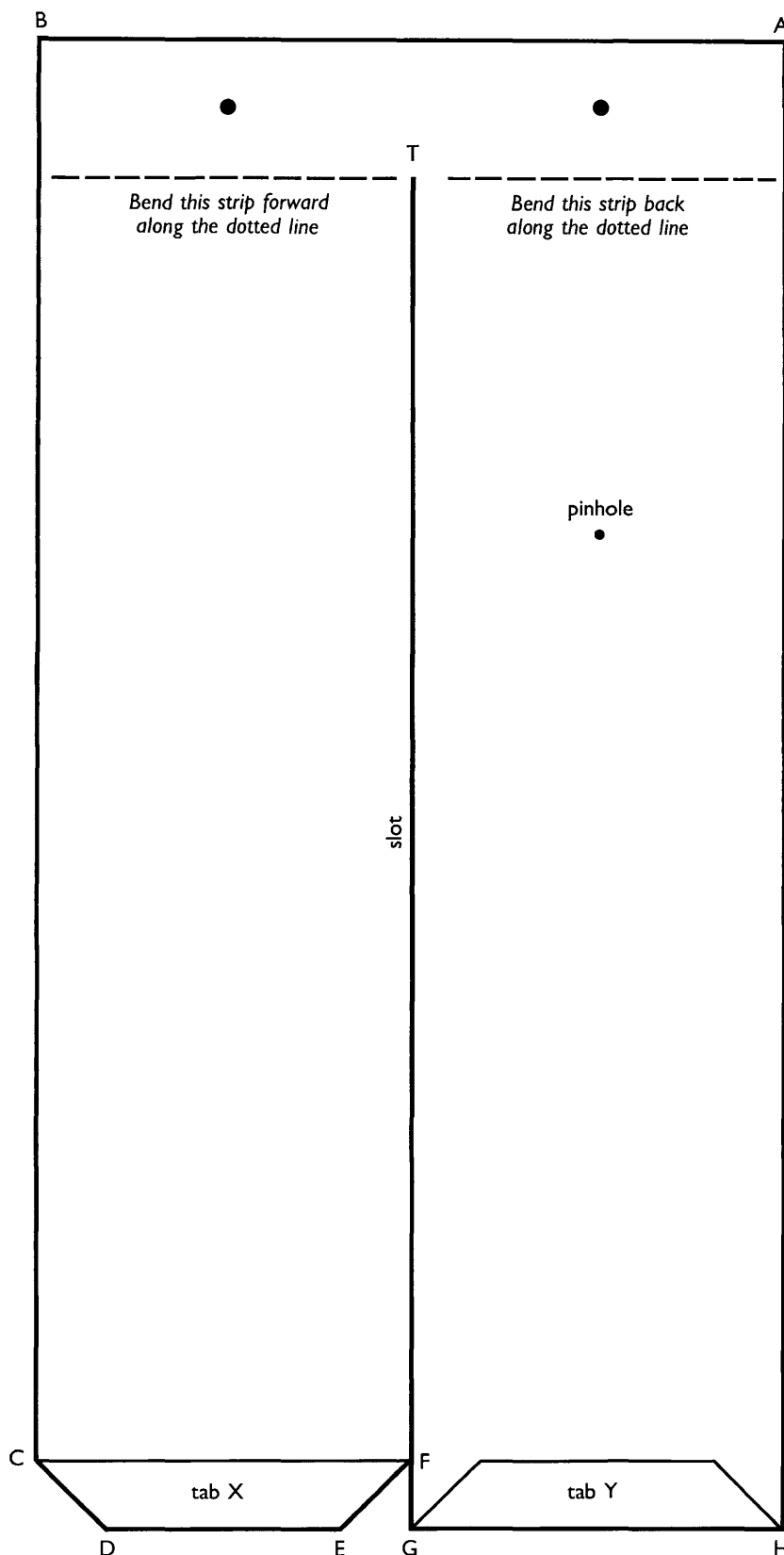
5 Thread a piece of string between the two holes so that you can hang it up. Hang it so that the small hole points towards the Sun.

6 If you look at the inside of the ring, you will see a spot of light where the sunlight shines through the hole.

7 Use a wristwatch to mark the position of the dot every hour. Put the time next to the mark.

Now you should be able to use the ring to tell the time – as long as the Sun is out that is!

8 Check your marks after a day, and again a week later. Is your clock still correct?



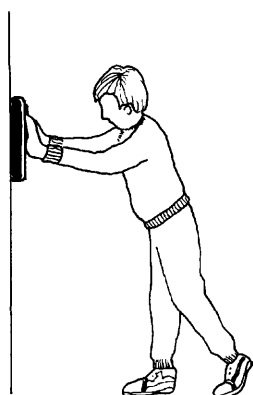
The pictures on this sheet show you how you use a set of bathroom scales (calibrated in newtons we hope!) to measure the forces you can apply with different sets of your muscles. You will need to work with a partner so that one of you can take the reading while the other pushes and pulls.

Try out the measurements. See if you can work

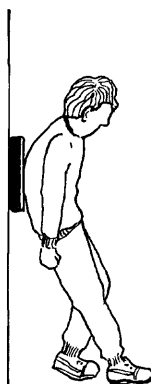
out which of your muscles are tightening up as you apply the forces.

By the way, not everyone knows that muscles can only pull on bones – they cannot push against them. So if you are pushing in one place, it must be because your muscles are pulling somewhere else.

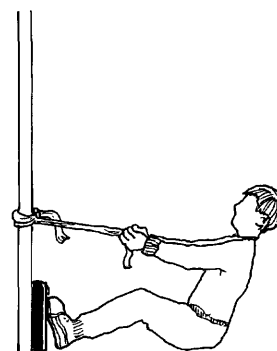
Don't forget to write down your measurements.



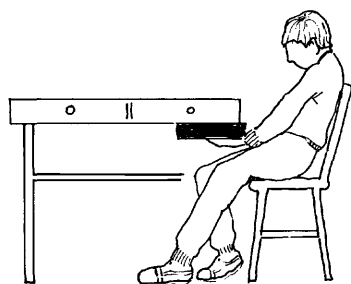
Push against a wall
– try both hands.



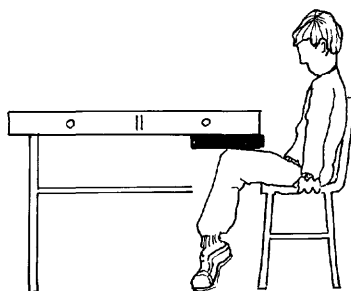
Pushing back.



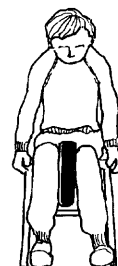
Using your legs.
Is there a better way?



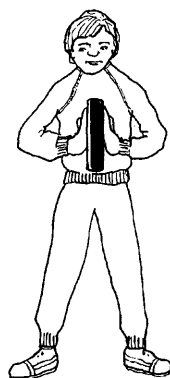
Pushing up against the bottom of a
table. Which muscles are you using?



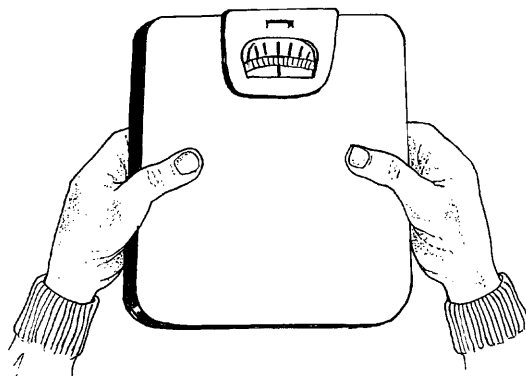
Push up with your knees. Which
muscles are you using here?



Squeeze your
knees together.

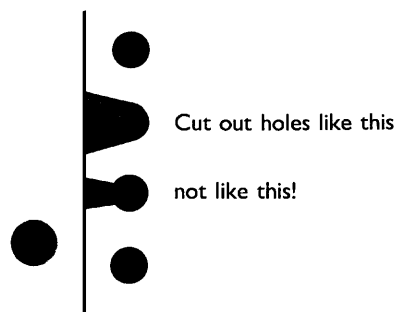


Squeeze!
Try it with your arms
above your head too.



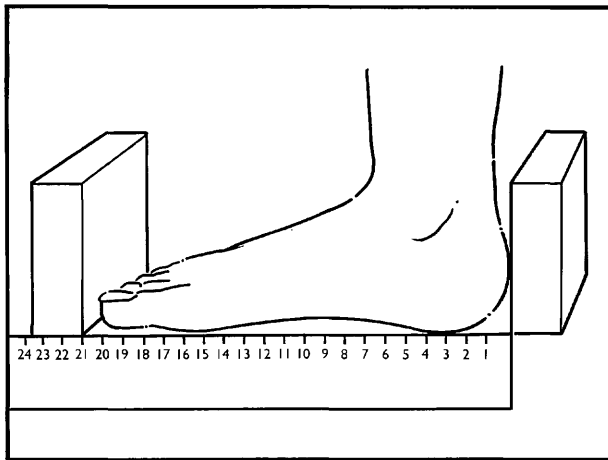
Don't forget your gripping force.

blonde	mousy	ginger	brown	black	others!	blue	green	hazel	brown	black	up to 139	140 to 149	150 to 159	over 160	male	female	Jan
Hair colour					Eye colour					Height (cm)			Sex		Month of birthday		
Name: _____																	
																	Feb
																	Mar
																	Apr
																	May
																	Jun
																	Jul
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																	Sept
																	Oct
																	Nov
																	Dec



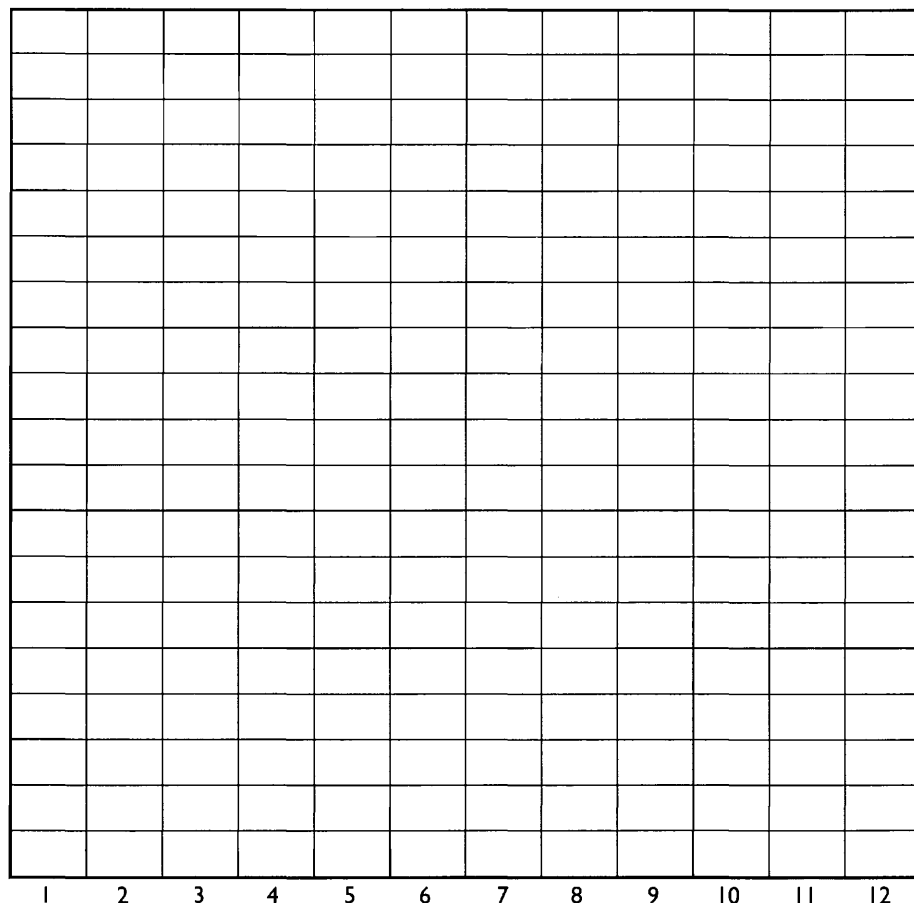
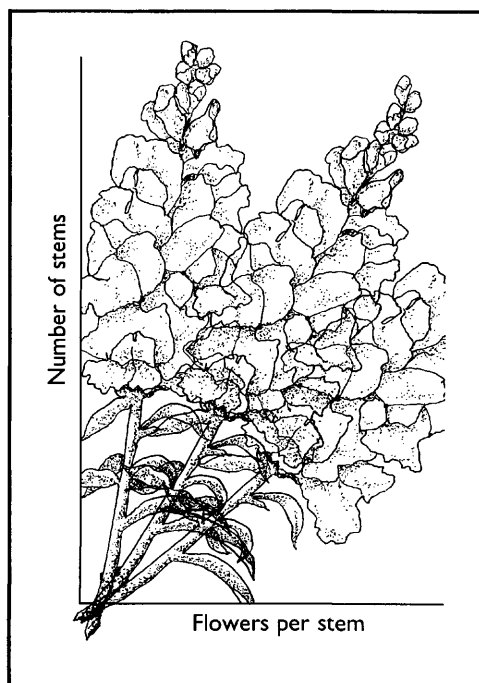
You can use this chart to find the size of shoe you should be wearing from the length of your foot in centimetres. Measure the length of your feet in centimetres (both of them – they may be different!), and use a ruler to read across the chart starting from the scale on the left.

Notice that English shoe sizes would go up smoothly from children's to adults', except that, after size 13 (children's) the counting starts again at 1. So an adults' size 1 is really a children's size 14.



Clarks COMPARISON OF MEASURES			
Centimetres	Paris Points	English Sizes	American Womens Sizes
11	16	1	
	17		
12	18	2	
	19		
13	20	3	
	21		
14	22	4	
	23		
15	24	5	
	25		
16	26	6	
	27		
17	28	7	
	29		
18	30	8	
	31		
19	32	9	
	33		
20	34	10	
	35		
21	36	11	
	37		
22	38	12	
	39		
23	40	13	15
	41		
24	42	1	25
	43		
25	44	2	35
	45		
26	46	3	45
	47		
27	48	4	55
28		5	65
29		6	75
30		7	85
31		8	95
32		9	105
		10	115
		11	125
		12	135

Draw a normal distribution curve



Do you know what snapdragons look like? They are popular flowers – you often see them in parks and gardens. Imagine a large bed of snapdragons with hundreds of stems, each with several flowers on it. Suppose you wanted to pick a bunch.

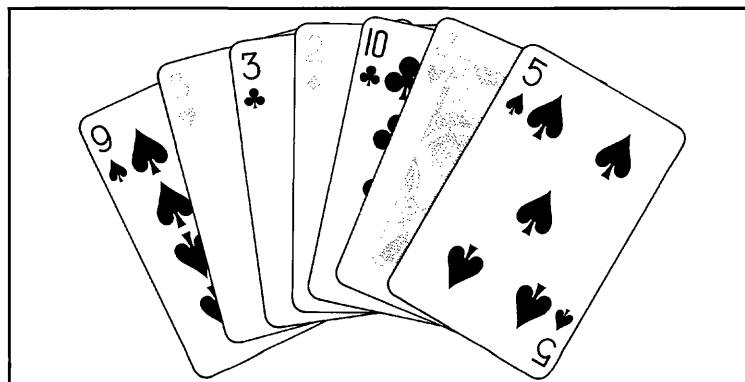
The first stem you picked might have 6 flowers on it, the next only 2 flowers, the next 7, and the next 9. You might decide that there was no pattern to the number of flowers – you couldn't predict how many the next one would have. However, if you picked hundreds of stems, and counted the number of flowers on each, you could plot a bar chart. You would put the number of flowers per stem along the bottom, and the number of stems with that number of

flowers up the side. Then you would see a pattern.

You would have a very special graph – one of the most famous and useful in science. It is called the *normal distribution curve* or just the *normal curve*. Follow these instructions to see what it looks like. . . .

We have given you a grid which has 12 columns of 'boxes'. You have to colour in a different number of boxes in each column. In column 1 you colour in only one box, in column 2 colour in two boxes, in column 3 colour in four boxes. The table below shows how many boxes to colour in each of the 12 columns.

Column	1	2	3	4	5	6	7	8	9	10	11	12
Boxes to be coloured	1	2	4	9	15	19	19	15	9	4	2	1



This is a card game for four players. Three players are called 'Investigators'. One player is called 'the Designer'. You can take turns to be the Designer.

Read all the instructions before you begin.

This is the way the game goes: the Designer deals the cards to the Investigators and puts the last one face up in the middle. Then each player in turn puts one card face up in the middle ('on the stack', we say). The Designer says 'Right' or 'Wrong' – we will tell you why shortly. If 'Right' the card stays on the stack. If 'Wrong' the Investigator picks it up again and puts it face down in front of him or her.

The Designer knows whether the card is Right or Wrong because he or she has made up a secret rule (a pattern statement!) about the way the cards have to go down. For example, it might be: 'A black card must be followed by a red card'. The Designer has to write the secret rule on a piece of paper and hide it away before the game starts. The Investigators have to try to work out the rule by seeing which cards are Right and which Wrong.

Do you get the idea? This is how to play the game, step by step:

1 Designer makes up a secret rule and writes it down. Cards are dealt, with the last in the middle.

2 Investigators take turns to put a card 'on the stack' in the middle, all the time trying to guess what the secret rule is.

3 Designer says 'Right' or 'Wrong' each time (depending on the secret rule).

4 If 'Right', Investigators leave their cards face up on the stack. If 'Wrong', they take them back and put them face up on their 'returns heaps' in front of them.

5 Play goes on until all the cards are on the table (either on the stack or on the Investigators' returns heaps).

This is *Half Time*.

6 The Designer's score is worked out like this:

- Find the Investigator with the smallest returns heap. Count the cards in it.
- Double the number.
- Take the number from the total of the other two investigators' returns cards. The number you get is the Designer's score for the game. But play carries on. . . .

7 The second half begins. Now the Investigators take turns to try to get rid of one of their returns cards onto the stack. The Designer says 'Right' or 'Wrong' as before.

8 The game goes on until one of the Investigators runs out of cards, or until no-one can go.

9 The Investigators work out their scores. Each doubles the number of cards he or she has left, and takes it away from the total number held by the other two. If the game ended by one of the Investigators 'going out' of cards, he or she gets 6 bonus points.

10 All the scores are written down and someone else has a go as the Designer and makes up a new secret rule.

Many people, including a few scientists, believe that you can tell people's characters by studying the features of their writing. Most scientists are not sure – they want more *evidence* before they decide. Here we have chosen just one feature of handwriting for you to study – the letter 't'. We have given you the things about people's characters which go with the different kinds of 't' – according to the handwriting experts that is.

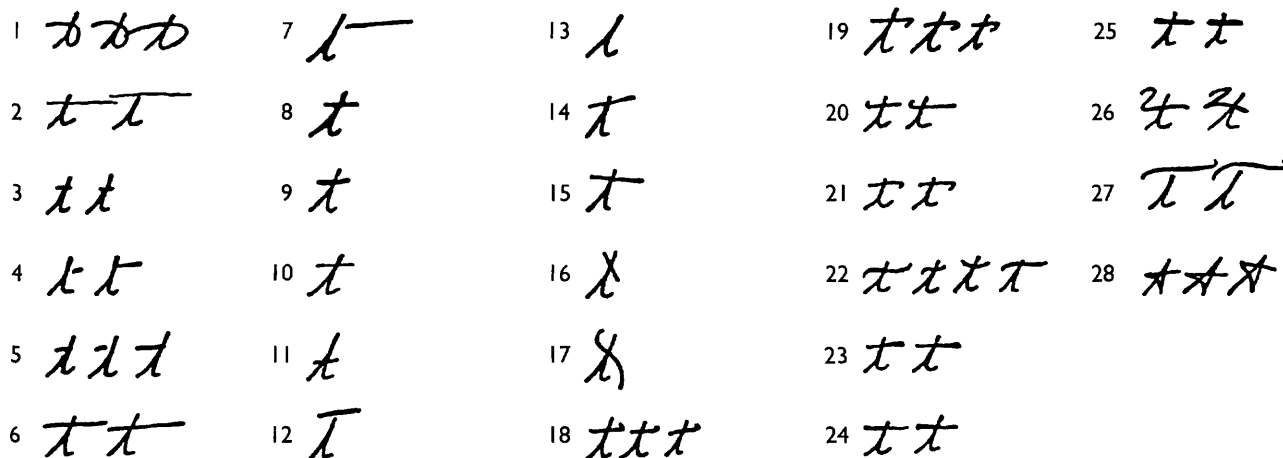
The experts have looked at many other features – the size of the handwriting, whether it slopes backwards or forwards, whether it stays on the line, and how far apart the lines are. They have

also looked at all the separate letters. You could read about these features and what the experts think they mean.

There are two things for you to do now:

1 Analyse your own letter 't's. See if you agree with the experts. Analyse your friends' letter 't's too.

2 Design a scientific investigation of handwriting analysis. Work out a *scientific way* of testing whether it works or not. Discuss this with your teacher and classmates.

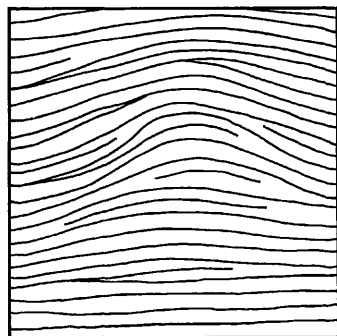


Character traits for handwritten letter 't's

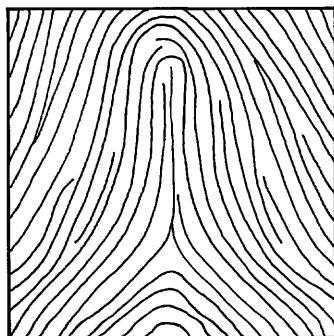
- 1 Selfish, jealous
- 2 Lacks self-confidence
- 3 Bit of a 'stick in the mud'
- 4 Energetic, lively
- 5 Cautious, procrastinates
- 6 Impatient, rushes things
- 7 Creative, acts on impulse
- 8 Weak-willed, placid
- 9 Determined, wilful
- 10 Gives in easily
- 11 Kind, modest
- 12 Irritable, imaginative
- 13 Careless, absent-minded
- 14 Ambitious, a bit 'pushy'
- 15 Obstinate
- 16 Stubborn

- 17 Entertaining, a good mimic
- 18 Rather greedy, envious
- 19 Strong-willed, tenacious
- 20 Straightforward, frank, witty
- 21 Matter of fact, amusing
- 22 Quick, sarcastic
- 23 Slow tempered
- 24 Explosive tempered
- 25 Confident, self-opinionated
- 26 Practical joker
- 27 Bit of a 'show-off'
- 28 Easily offended, sensitive

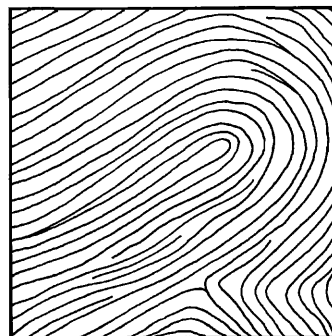
It is important to notice that a handwriting expert would never say anything unpleasant about the subject unless the unpleasant traits showed up in several different ways in the handwriting.



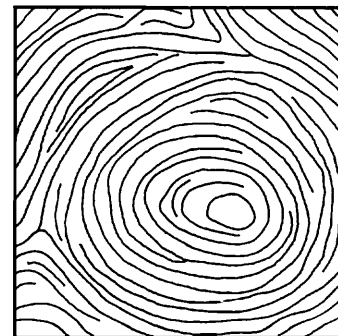
arch



tented arch



loop

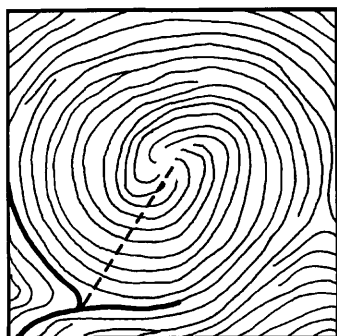


whorl

About 150 years ago, scientists realized that everybody's fingerprints are different from everybody else's. It wasn't long before the police were using the idea to identify suspects from the prints they left behind. Nowadays the police have collections of millions of prints. These are sorted, stored away, and looked up again when needed, by computers. Fortunately the prints can be *classified* into different types – which makes the collection much easier to deal with.

You can see a simplified version of the classification system on this page. There are four main kinds of shape pattern: arches, tented arches, loops, and whorls (say 'wurls'). You can also get mixtures of loops and whorls called 'composites'.

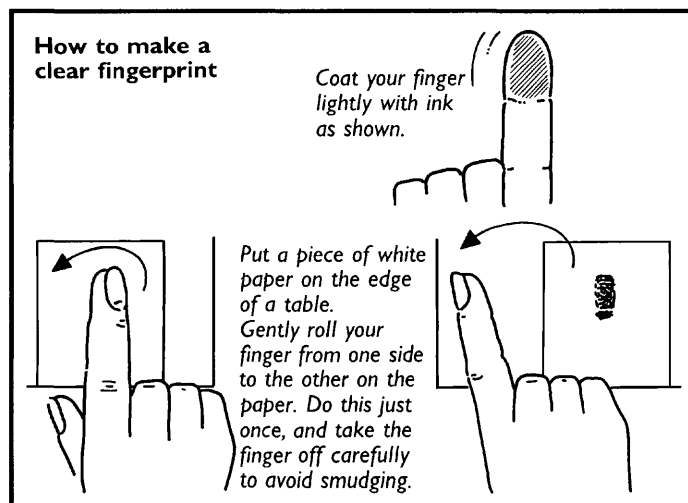
As well as classifying a print into one of these types, you can do a *ridge count* on it. You look for a place where three ridges come together to make a sort of 'Y' shape (it is called a *tri-radius*). Then, with the help of a magnifying glass, you count the ridges between the tri-radius and the middle of the pattern.



whorl with a ridge count of nine

Of course, before you can classify your prints, you need to take them, and there are several ways of doing this.

- 1 Dust your fingers with coloured blackboard chalk, then press them onto transparent sticky tape.
- 2 Press your hand onto the top of a photocopier machine and make a copy of your whole hand.
- 3 Use a piece of card to spread fingerprint ink thinly and evenly onto a microscope slide. Then roll your fingers one by one onto the slide.
- 4 Use a special pad to ink your fingers.



If you use methods 3 and 4 you need to be careful not to smudge your prints as you press your fingers onto the paper.

Off you go then! Take your prints and classify them into the different types.

Have a go at a ridge count.

When everyone in the class has done it, you could organize a 'detective game' using everyone's prints.

Here is a list of supermarket goods. Can you sort them into the best groups for supermarket shoppers?

To try it, cut out the labels, then get a large sheet of paper and draw a map of an imaginary supermarket with counters, shelves, and cold cabinets. (Try not to copy your local supermarket.) You can put the labels on the shelves on your map.

baked beans	single cream	sweet-corn	UHT milk
pears	crumpets	butter	tinned soups
orange juice	tomato purée	lard	soft brown sugar
tea	semolina	Marmite	frozen haddock
Coca-Cola	spaghetti rings	marmalade	tinned sardines
gin	ice-cream	tea cakes	self-raising flour
peas	wholemeal flour	Frosties	sultanas
frozen pastry	ice-cream topping	yoghurt	chocolate biscuits
frozen chicken	apples	cakes	eggs
fresh milk	bananas	polished rice	frozen sweet-corn
packet soups	apple juice	brown rice	soft margarine
caster sugar	lemonade	macaroni	vinegar
tinned tuna fish	wine	lemon juice	raspberry jam
frozen plaice	cabbage	jelly	frozen bread dough
cream cheese	frozen beans	frozen beefburgers	Weetabix
cake mixes	frozen beef	dogmeat	muesli
raisins	frozen raspberries	tinned tomatoes	double cream
chocolate Easter eggs	milk powder	oranges	Christmas puddings
tinned sweet-corn	potatoes	pineapple juice	rice pudding
margarine (for baking)	artificial sweetener	coffee	dried spaghetti
cooking oil	frozen cod	soda water	Oxo cubes
strawberry jam	Cheddar cheese	whisky	trifle mix
sliced bread	plain flour	frozen peas	golden syrup
cornflakes	currants	frozen lamb	dog biscuits
porridge oats	chocolate bars	frozen TV dinners	

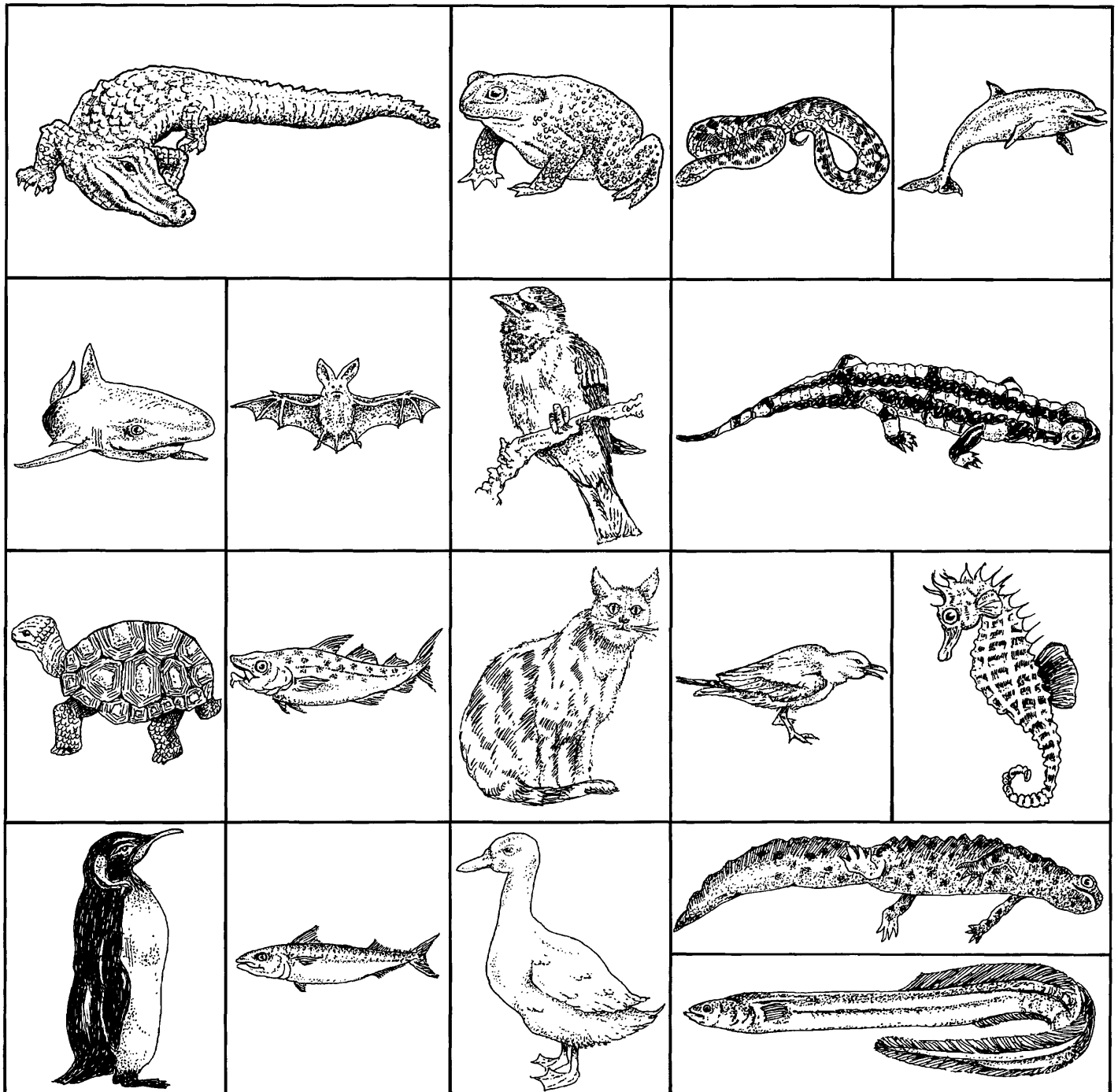
Classify the animals

WORKSHEET 27

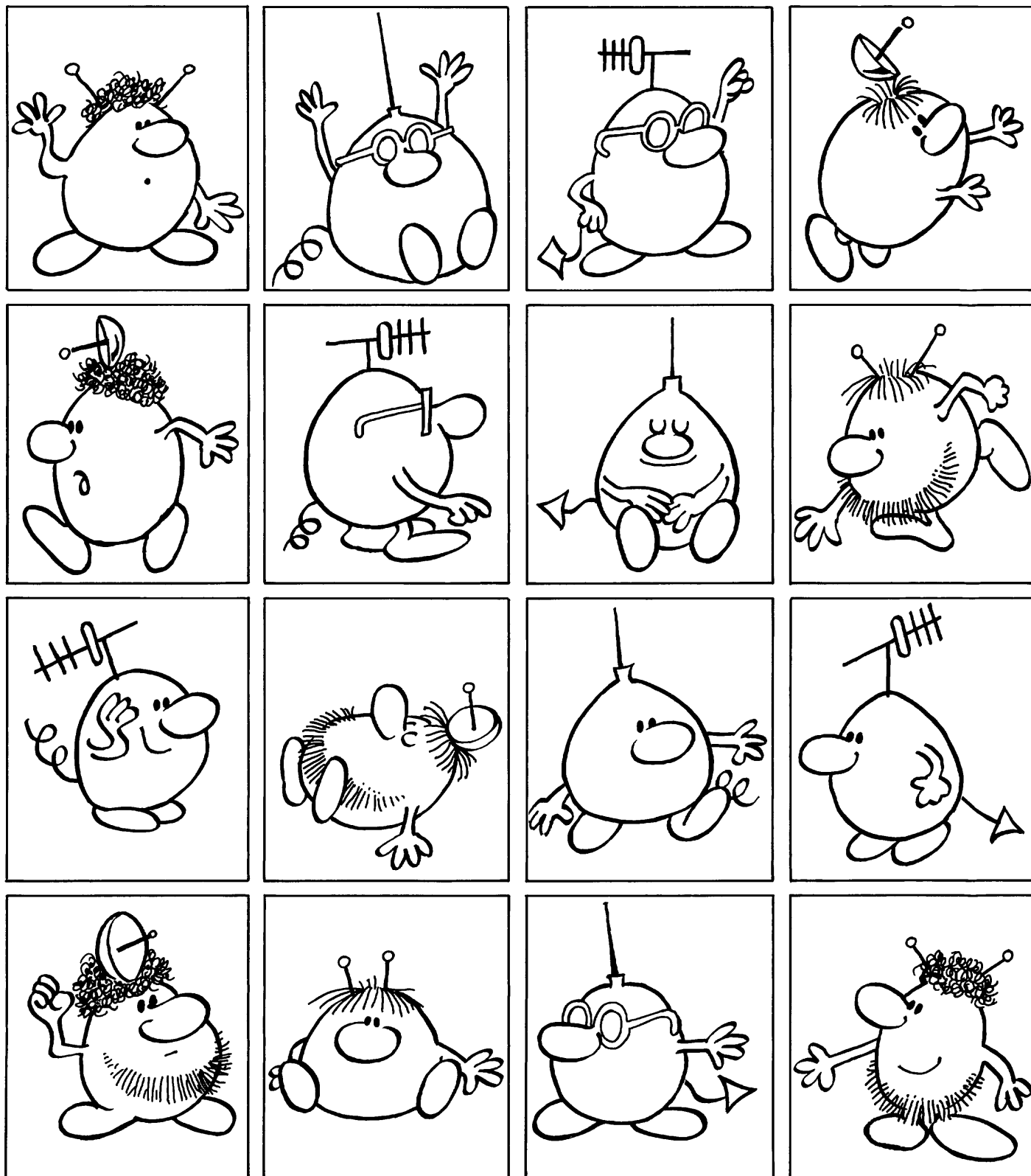
The animals on this worksheet are the same as those on page 84 of your science book.

There are many differences between the animals – some have wings, some do not – some have legs, some do not. And there are many similarities – they all have eyes for instance. They have something in common which you cannot see in any of the pictures. You are asked to guess what this is.

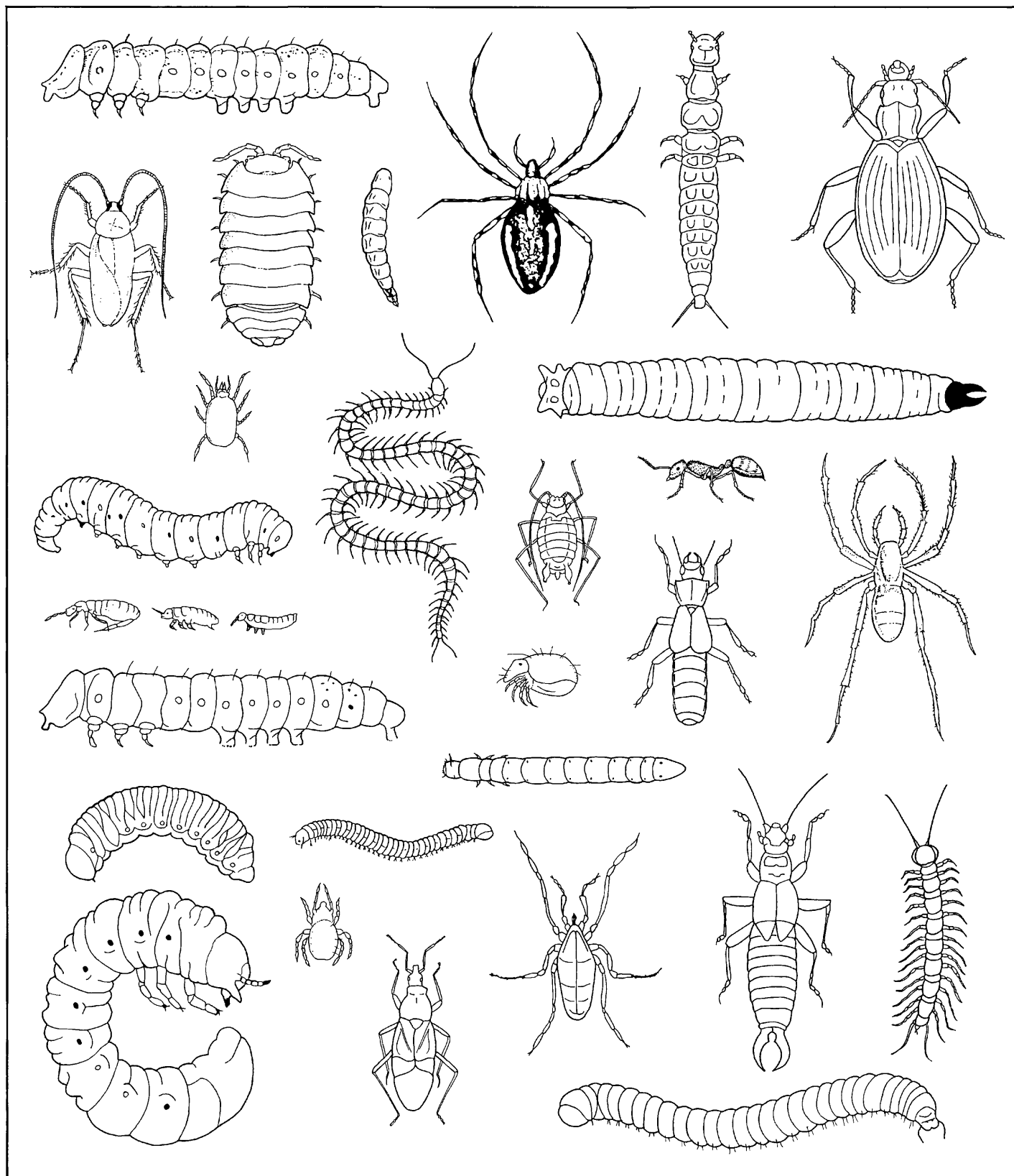
But that's just a starter. The main job is to cut out the animals and move them about to sort them into groups. When you have finished you have to be able to make pattern statements which say what links together the animals in each of your groups.



Here is the collection of space creatures ready to be cut out so you can use them to practise designing a key – as on page 158 of your science book.



The animals on this worksheet are for you to identify using the key on page 160 of your science book.





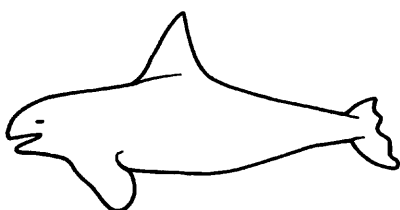
Pilot whale



Narwhal



Porpoise



Killer whale



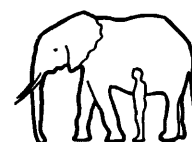
Dolphin



Blue whale



Sperm whale



African elephant and Man

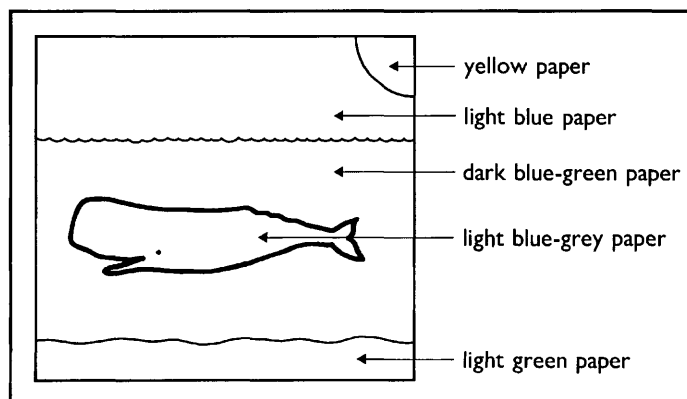
Use the pictures of whales on this worksheet to make a whale poster.

1 Trace the pictures onto a sheet of transparent acetate for an overhead projector.

2 Use the projector to throw enlarged pictures of your tracing onto a sheet of blue-grey paper taped to the wall.

3 Trace the enlarged pictures, then cut them out of the blue-grey paper.

4 Make a background sheet (our diagram shows how), and stick the whale cut-outs onto it.



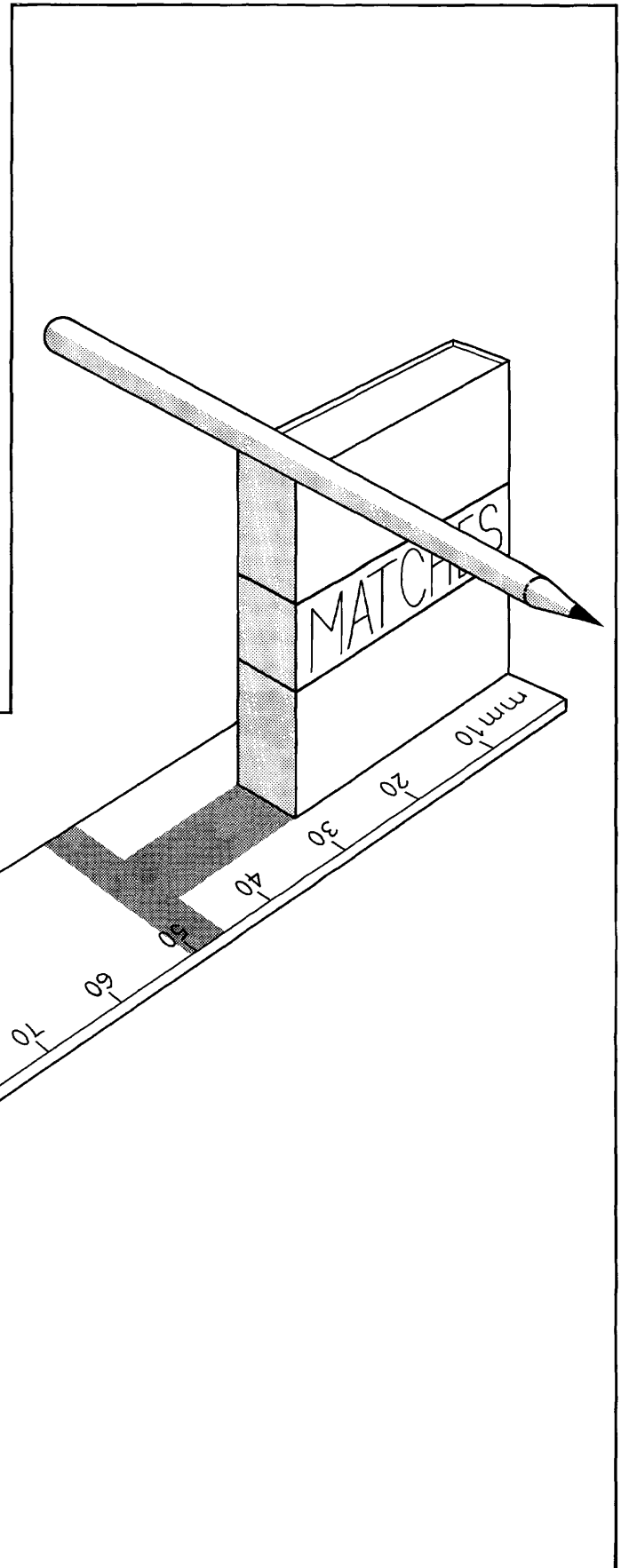
Make a sun bar

Perhaps about 3500 years ago, ancient Egyptian scientists made sun clocks which they could carry about – just as we carry wristwatches today. There is a picture of a sun clock like this, called a ‘sun bar’, on page 51 of your science book.

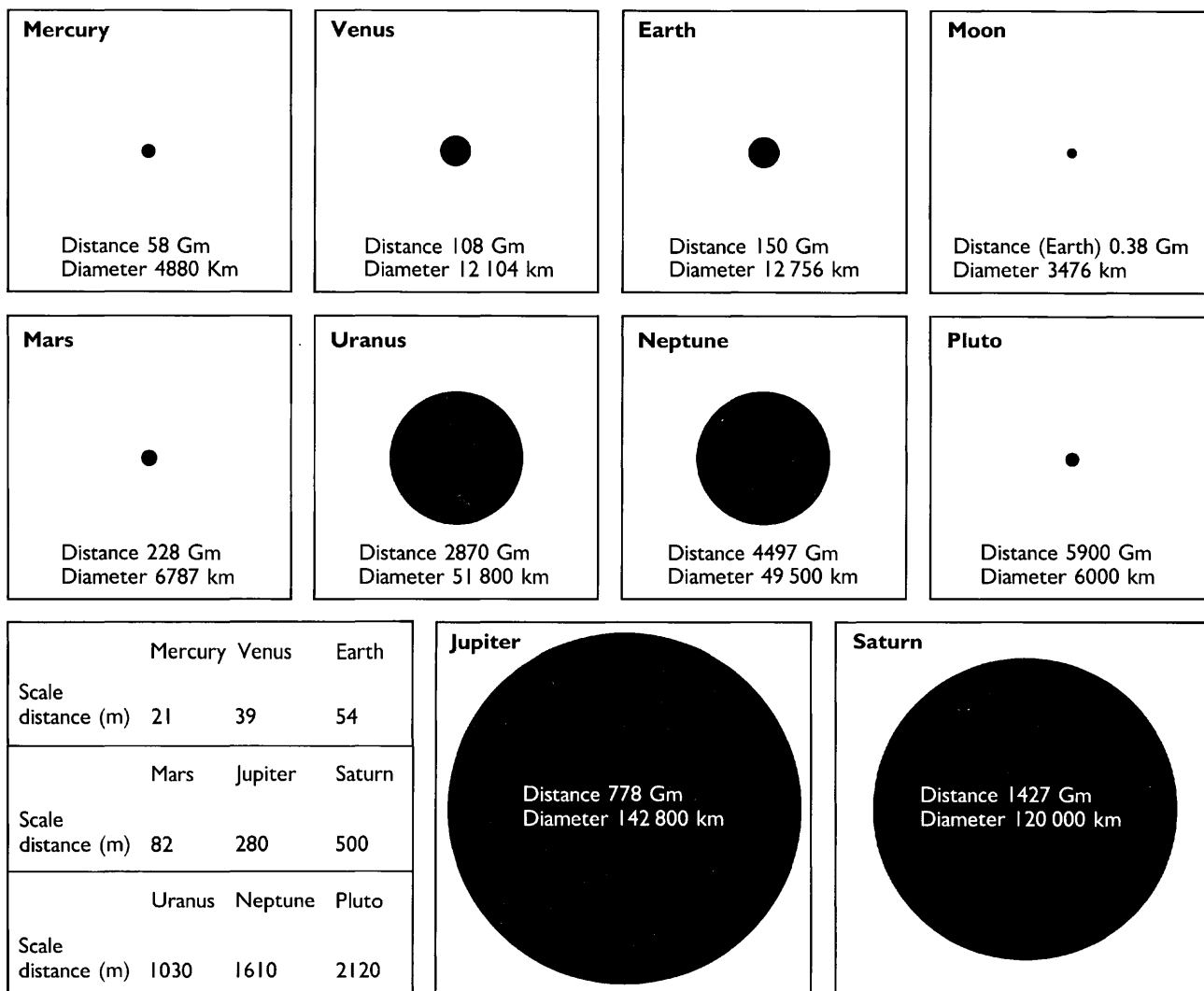
You will need the following things to make a model ‘sun bar’: a ruler, an empty matchbox, a pencil, and some glue or sticky tape. You also need a sunny day! The drawing shows how to put the model together.

To use the ‘sun bar’, you point it at the Sun and look at the shadow on the ruler. That is all we are going to tell you. You have to decide how to position the instrument so as to get an accurate and reliable reading. And you have to decide how to tell the time from the shadow.

Can you solve these puzzles? Make up the sun bar model, and try it out.



Make a scale model of the Solar System



You will need a long metric tape measure and the cut-out cards from this page to make the model. To stand for the Sun you will also need a large disc, diameter 50 cm, cut from the yellow card. You will need to set up the model in a big open space such as the school playing-fields.

1 Give someone the 'Sun' to hold, and measure 21 metres away from him or her. Have someone stand there holding the 'Mercury' card. The dot on the card shows how big Mercury would be if the Sun was 50 cm across.

2 Go another 18 metres, so you are 39 metres from the 'Sun'. Have someone stand there holding the 'Venus' card. Notice that Venus is

much bigger than Mercury but still tiny compared with the Sun.

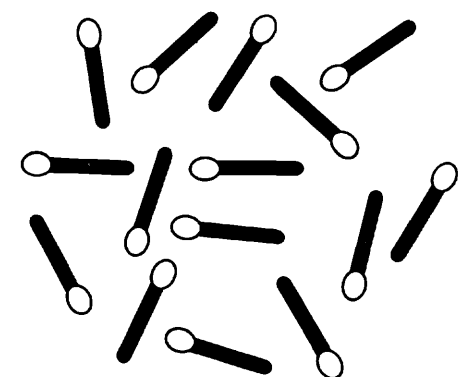
3 'Earth' comes next, 15 metres beyond 'Venus' or 54 metres from the 'Sun'. Someone should hold the 'Moon' card 14 centimetres from 'Earth', off to the side. Notice how small the Moon is compared with the Earth.

4 It is quite a long walk to 'Mars', 28 metres further away. Position this next.

5 When you have positioned 'Mars', you can get the distances of the other planets from our table. You may have problems positioning the cards. Can you solve them?

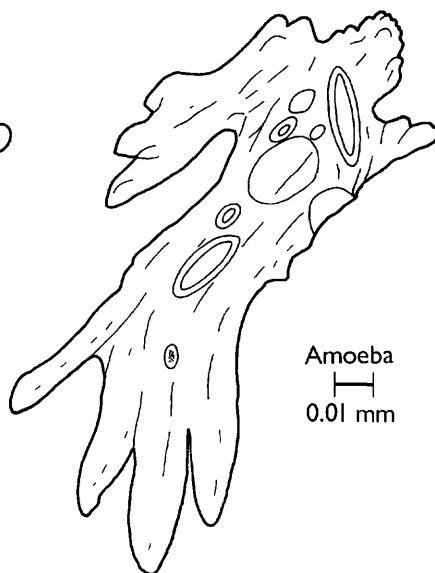
Make a microbe poster

WORKSHEET 33



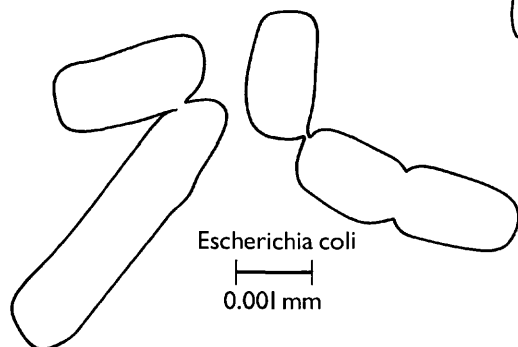
Clostridium tetani (tetanus)

0.001 mm



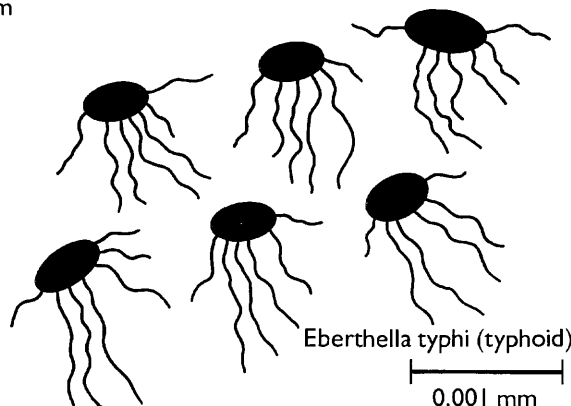
Amoeba

0.01 mm



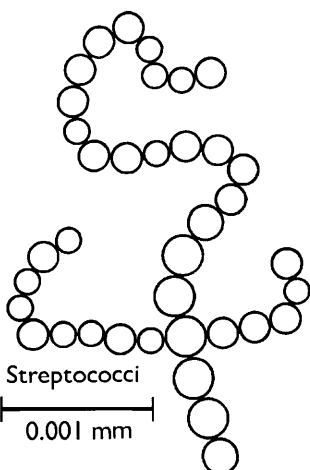
Escherichia coli

0.001 mm



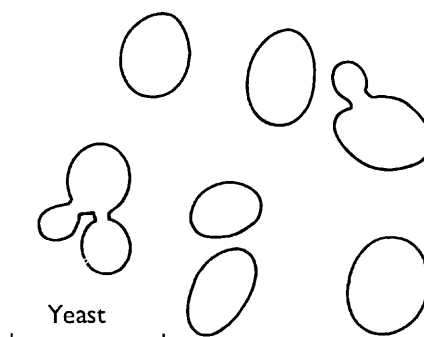
Eberthella typhi (typhoid)

0.001 mm



Streptococci

0.001 mm



Yeast

0.001 mm

Here are some drawings of microbes for you to use to make a poster. You can trace the drawings onto a transparent acetate sheet and use an overhead projector to project them (any size you like) onto a sheet of coloured card pinned to a wall. Then you can draw round the pictures on the card, cut out the microbes, and stick them onto a backing sheet.

There's only one snag. We have drawn the microbes about the same size as each other – though we have given you their true sizes. For your poster you should work out a way of showing them so they are the right size compared with each other. Talk about this with your teacher.

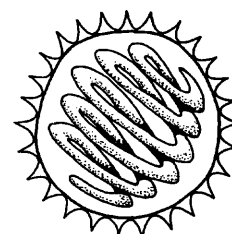
When you have finished tracing, cutting out, and sticking, try to find out something about each of the microbes:

Is it dangerous, harmless, or useful?

If it is useful, what is it used for?

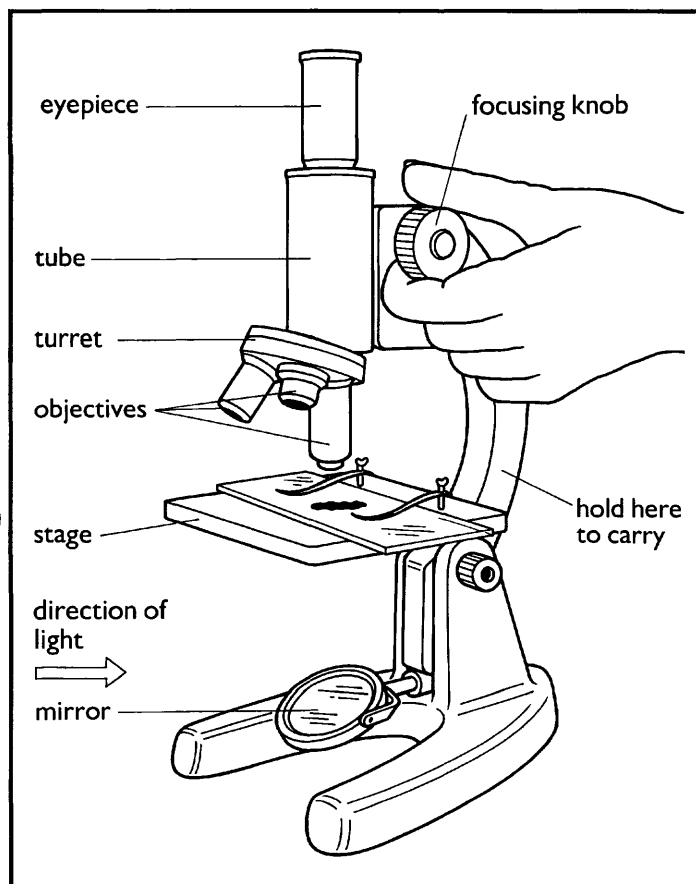
If it is dangerous, what disease does it cause?

Put the name of each microbe, and the answers to these questions, on small white cards and stick them on your poster.



Influenza virus

0.0001 mm



Your microscope may not be quite the same as the one in our picture. Don't worry about it – they all work in the same way.

Read right through steps 1 to 5 before you do anything.

1 Your microscope may have only one objective lens at the bottom of its tube, or it may have three mounted on a turret. As you can see, the one in the drawing has three. The turret can be turned to change from one to another.

Study the eyepiece lens (it is labelled on the drawing) and the objective lenses. Can you see some strange words written on their sides (such as ' $\times 10$ ')? Make a note of these words.

2 If your microscope has a turret, turn it so that the ' $\times 5$ ' objective is lined up with the tube.

3 Find the focus knob and, before you look through the microscope, turn the knob so that the objective and stage move very close together.

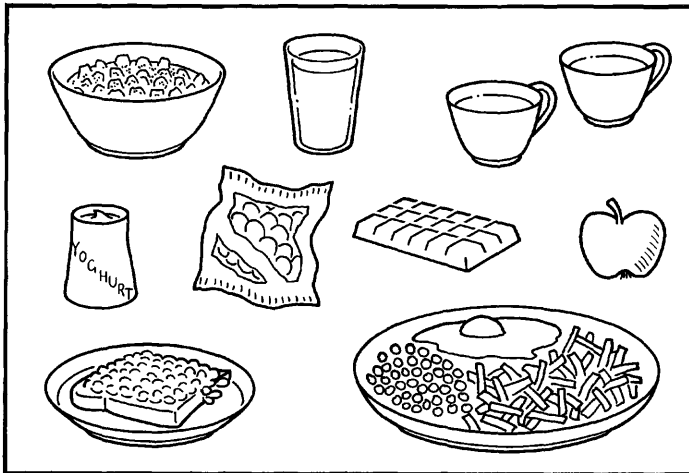
⚠ Avoid moving the objective towards the stage whilst you are looking through the microscope. This way you run less risk of damaging the objective or smashing a slide.

4 Next get the lighting right. Put your microscope where light from a window or a lamp shines on the mirror under the stage.

⚠ Be careful to avoid direct sunlight. Then, looking through the eyepiece (at last!), move the mirror so that it sends plenty of light up through the tube.

5 Put a slide onto the stage, and move it so that one of its edges crosses your view. It will look like a fuzzy, ragged line. Use the knob to slowly move the objective away from the stage until the edge of the slide comes into sharp focus. Move the edge of the slide out of the way and you are ready to go.

Monitor the energy value of your food



You could say that your body is a 'walking chemical factory'. 'Raw materials' (your food) are taken in and processed into the substances your body needs. 'Waste products' – carbon dioxide gas, sweat, urine, and faeces – are released. Thousands of chemical reactions are taking place in 'the factory' all the time. These reactions make new tissues (such as skin), repair damage, work your muscles, and keep you warm.

Scientists have made thousands of measurements on foods. Each type of food has been given a number which shows how useful it is for the jobs of working your muscles and warming you up. These numbers are called the *energy values* of the foods.

Energy values are important to dieters. If foods do not take part in the reactions which work your muscles, they take part in others which make fat and water. If this happens too much, you will put on weight.

To avoid it, you need to keep the total energy value of your food within certain limits. This worksheet and the data on Worksheet 36 will show you how to do that.

You will need some beads or counters in two colours, about 15 of each colour, in a box.

1 Make a record of all your meals in one day. We call it a meal every time you take in 'raw materials', whether it is a 'proper meal', a snack, a few sweets, or just a drink. Fill in a table like the one we have started above.

Time	Meal	Menu
8.00 a.m.	Breakfast	cornflakes, milk (1/5 pint), sugar (2 tsp) tea with milk and sugar (2 cups)
11.00 a.m.	Snack	crisps (1 pkt) Mars bar coffee with milk and sugar (1 cup)

2 Look at the data on Worksheet 36. This worksheet shows the energy value of different foods by telling you how many counters to take for each. Notice that a counter of one colour (we have shown it in black) stands for a unit of energy value, and one of the other colour (shown white) stands for half a unit.

Go through your list of foods for the day, find each of them on Worksheet 36, and take the right number of counters for each. For example, you would take a half counter for cornflakes (can you find 'breakfast cereals'?), and a unit counter for the Mars bar.

3 When you have finished, add up your counters and compare the number with our table.

Number of counters
12–13.5

Comments
almost enough for a grown man* doing a heavy job

8–11.5

reasonable for your age – aim for the top end if you want to put on more weight or for the bottom end if you want to lose it*

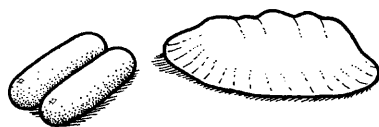
6–7.5

hardly enough for a six-year-old boy or girl

4 Make a few notes to answer these questions. Where did most of your units come from? How could you reduce or increase your total most easily?

* Except during pregnancy, women need one or two units a day less than men. For example, a male office worker can take about 10 without putting on weight, but a female office worker can take only about 9. There is a similar difference between boys and girls of your age.

This Worksheet is intended to be used with Worksheet 35. Here we tell you the energy values of common foods. A black spot stands for one unit of energy value, a white spot for half a unit.



A Meat and Meat Products

For each average portion of meat in pastry, such as toad in the hole, jumbo sausage roll, cornish pasty, chicken pie, steak and kidney pie:

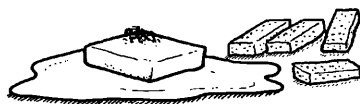
take ● ●

For each average portion of roast meat, fried or grilled liver, bacon rashers (3), beefburgers (2), sausages (2), a 'quarterpounder', luncheon meat, stew, or curry:

take ●

For each average portion of boiled ham or lean corned beef:

take ○



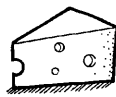
B Fish and Fish Products

For each average portion of fried fish, fish fingers, fish in butter, cream, or sauce:

take ● ○

For each average portion of tinned salmon or tuna:

take ○



C Milk Products and Eggs

For each pint of milk:

take ● ○

For each portion of cheese (except cottage cheese):

take ●

For butter or margarine (1 pat), yoghurt (pot), cream (portion), or one egg boiled, scrambled, or fried:

take ○



D Bread, Cereals, etc.

For pizza (1 small topped), or fried bread (1 slice):

take ●

For bread (2 slices), cream crackers (3), breakfast cereals, porridge, spaghetti in sauce, ravioli in sauce, rice:

take ○



E Vegetables, Fruit, and Nuts

For raw brazil nuts (a few), roasted peanuts (small bag), baked potato with butter, chips (small portion), fried mushrooms or onions:

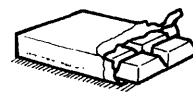
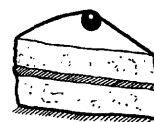
take ●

For boiled potatoes (2), crisps (packet), baked beans (2 portions), banana (medium), prunes (2 portions), fruit salad:

take ○

For all other fresh and stewed fruit without sugar, and all other green vegetables and salads, for every ten portions:

take ○



F Sugary Foods

For pancakes and syrup:

take ● ● ●

For a cake, fruit pie, chocolate bar:

take ● ○

For a portion of custard, sponge pudding, trifle, sweet biscuits (2), boiled sweets, Mars bar etc.:

take ●

For sugar (5 teaspoons), honey (3 teaspoons), golden syrup (1 teaspoon), portion of ice cream, rice pudding:

take ○



G Drinks

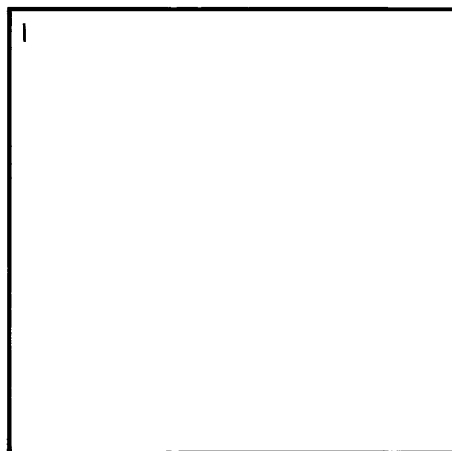
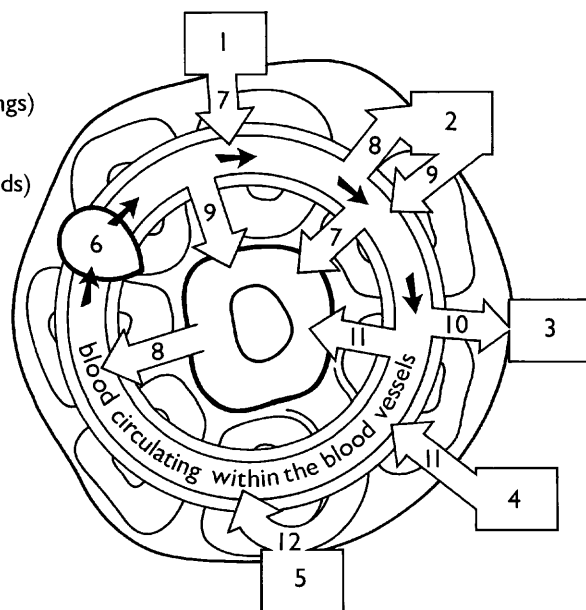
For lemonade, cola, soup (1 cup):

take ○

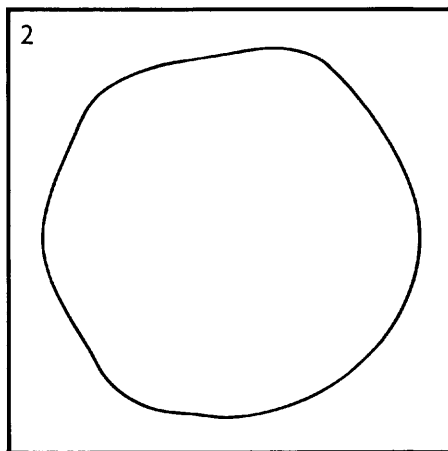
For tea or coffee, take counters only for the milk and sugar you have in it (see sections C and F).

You can make a poster to show the movement of all the different substances into, around, and out of your 'body machine'. The large drawing shows how your poster will look when it is finished – yours will be in colour of course. The drawing doesn't look like your body, but it isn't intended to; it is what scientists call a 'schematic diagram'. The small drawings show how to build up the poster. You can use an overhead projector to trace the shapes you need onto coloured paper (ask your teacher about this).

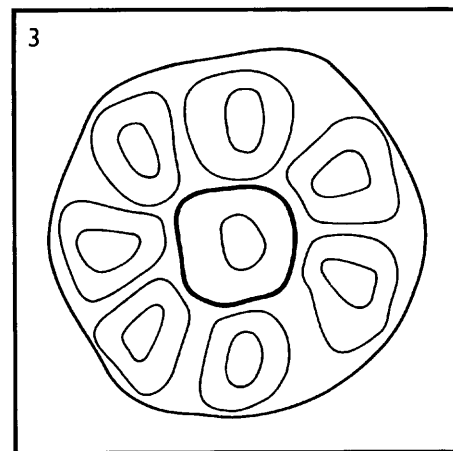
- 1 digestive system
- 2 respiratory system (lungs)
- 3 excretory system
- 4 endocrine system (glands)
- 5 lymphatic system
- 6 the heart keeps the blood circulating
- 7 food
- 8 carbon dioxide
- 9 oxygen
- 10 waste products
- 11 substances controlling cell activity
- 12 excess fluid from around cells



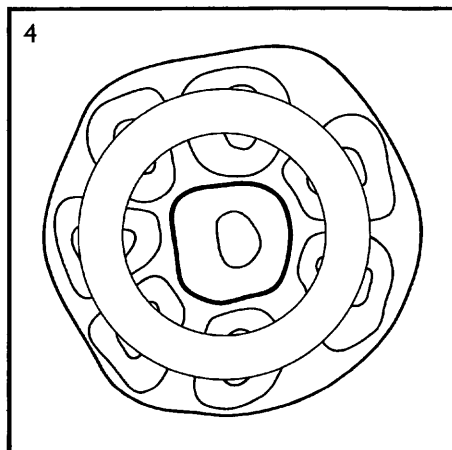
Start with a backing sheet (dark grey or brown)



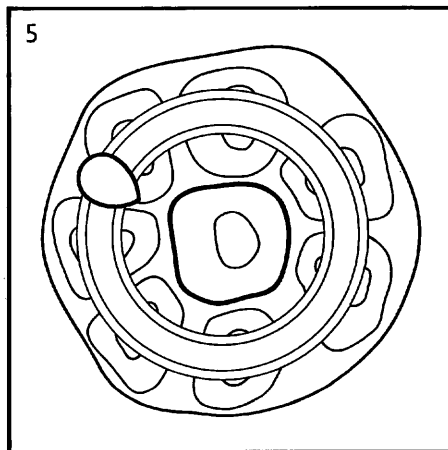
Cut out and stick on the 'body base' (buff)



Cut out and stick on the 'cells' (yellow)



Cut out and stick on the 'blood vessel ring' (mid-brown)



Cut out and stick on the 'blood ring' and 'heart' (red)

- 6 Add the arrows and 'system boxes'.
Use these colours:

oxygen	light green
waste	grey
carbon dioxide	mid-green
control substances	light blue
food	pink
cell fluid	white

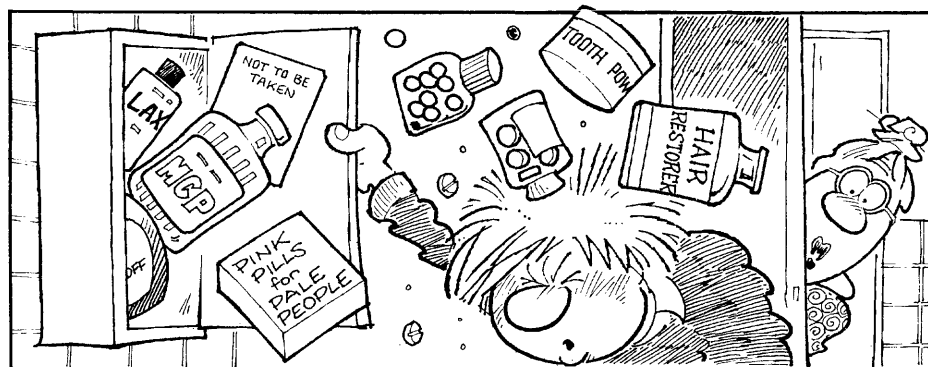
Your teacher will give you a selection of booklets which contain information about how to stay healthy and avoid accidents. Carefully read the booklets and take from them important actions that should be done (or avoided!) so that you can stay healthy. Enter them in the table shown here.

You may be able to get more information from your own health centre, doctor's surgery, dentist, optician, or chemist – but remember to ask before you help yourself to leaflets!



Staying healthy	
Do's	Don't's

- 1** With your parents' help or *at least with their permission* have a look at the medicines which you have at home. Divide them into two groups.
- Off the shelf medicines – those that you can buy over the counter at a chemist's shop.
 - Medicines which have been prescribed.

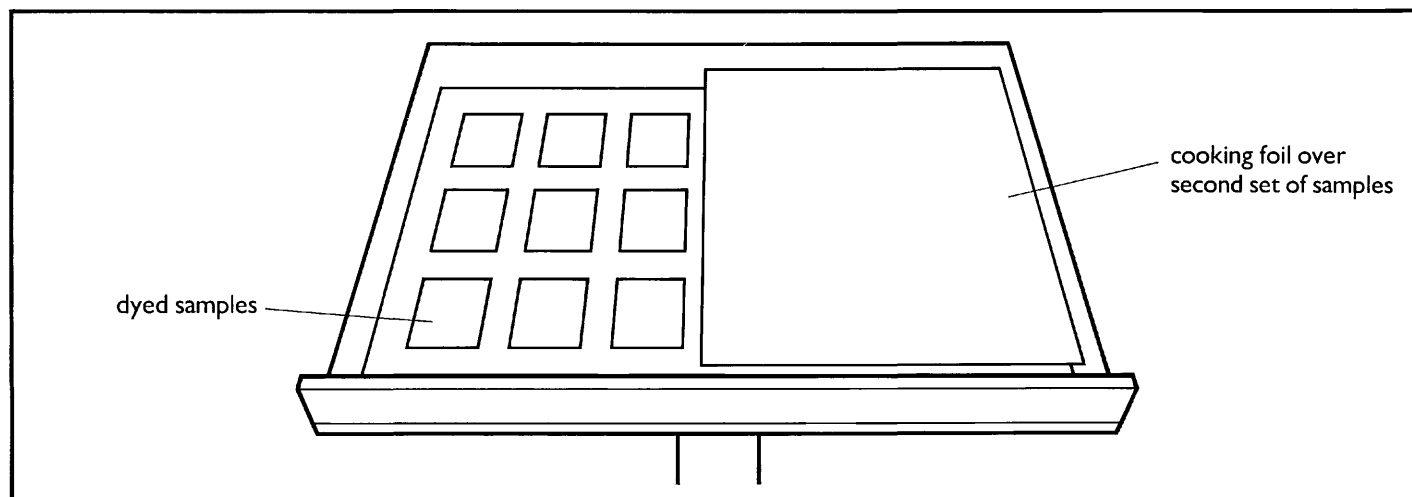


- 2** Fill in the table shown here.

Medicines	Off the shelf	Prescribed
How many types?*		
Most common type?*		
How many are out of date?		
How many have child-proof tops?		
External use only?		
Pills?		
Syrup?		
Other?		
Any prescription courses not used up?		

*E.g. For headaches, stomach problems, etc.

- 3** When everyone in your class has completed the survey, pool your results and discuss them.



When dye makers find a new dye or colour, they have to make a great number of tests on the dye to make sure that it is good enough to use. What sort of tests do you think they do?

You have made your own dyes and you can make more during the year as different plants become available. Now you should think about testing them as the dye makers do.

Some tests have to be long-term tests, such as testing whether or not the dye fades in sunlight. This could be done by pasting two sets of dyed samples to a board, covering one set of samples and leaving the others exposed to sunlight. It could take months for changes to be noticed.

Before you start your dye-testing programme, you will need to plan and make some decisions. Here is a list of some of the things that you will need to think about, but you can probably add to it.

How many dyes will you use?

How many different fabrics should be used?

Are you going to mordant the fabric or fabrics?

What are the important things to test for?

Will you need to do a wash test?

Can the dyes be mixed to give new colours?

Does mixing affect the fastness of the dyes?

What other information can you find out? (Are some plant materials better than others – roots better than bark, or flowers better than berries – and are summer plants better than winter, and so on?)

When you have done your thinking and decision-making in a small group, work out what equipment you will need and then discuss it with your teacher.

Good luck . . . and don't forget to think about how to display your results!

Here is a list of food colourings which are in common use in this country. Food colourings are given a number beginning with E1. Food additives beginning with other numbers could be preservatives or sweeteners.

Colours

- E102 Tartrazine (yellow)
- E110 Sunset yellow
- E123 Amaranth (red)
- E124 Ponceau 4R (red)
- E133 Brilliant blue FCF (blue)
- E155 Chocolate brown
- E141 Chlorophyllins (green)
- E150 Caramels (brown)
- E160b Annatto (yellow/orange)

Some of these dyes have been banned in America and Norway, and their use is restricted in some other countries, because of fears that they may cause illness.

1 Get together with your classmates and arrange to collect food wrappers. Look at the ingredients panel to find out which colours are used.

2 Record the number of times that different colours are used and display your findings.

3 Try to answer these questions.

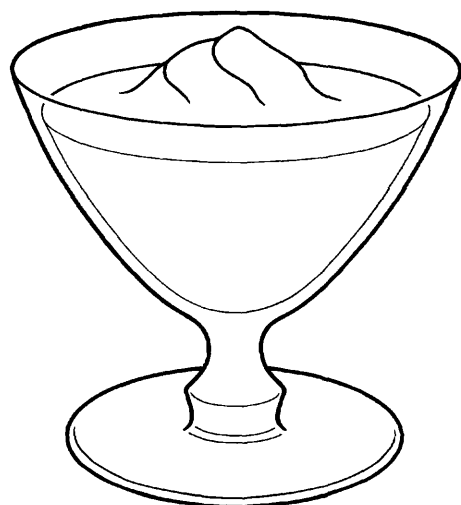
Which food colouring was used the most frequently?

Were there any surprising uses of colours?

Were there any strange combinations of colours?

Do you think that all of the foods needed these added colours?

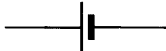
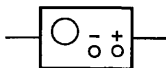
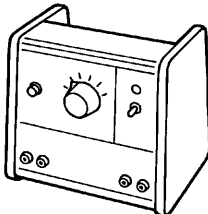
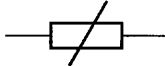
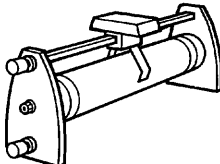
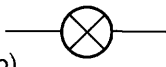
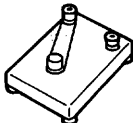
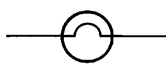
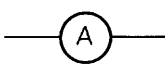
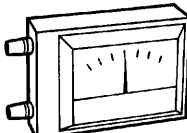
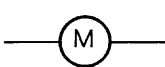
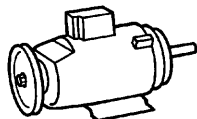
Did you find products that claimed not to contain any artificial colouring? Why do you think manufacturers do this?



- E322: lecithin
- E339: sodium dihydrogen orthophosphate
- E450a: trisodium diphosphate
- E477: propane-1,2,-diol esters of fatty acids
- Ingredients: sugar, modified starch, hydrogenated vegetable oil, emulsifiers (E477, E322), gelling agents (E339, E450a), casinate, lactose, whey powder, flavourings, colours (E102, E110, E160a), antioxidant (E320).
- E110: sunset yellow FCF
- E160a: alpha-, beta-, and gamma-carotene
- E320: butylated hydroxyanisole
- E102: tartrazine

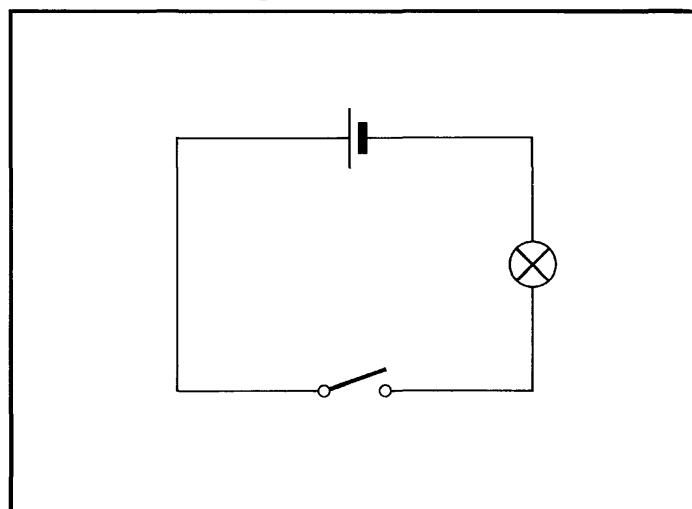
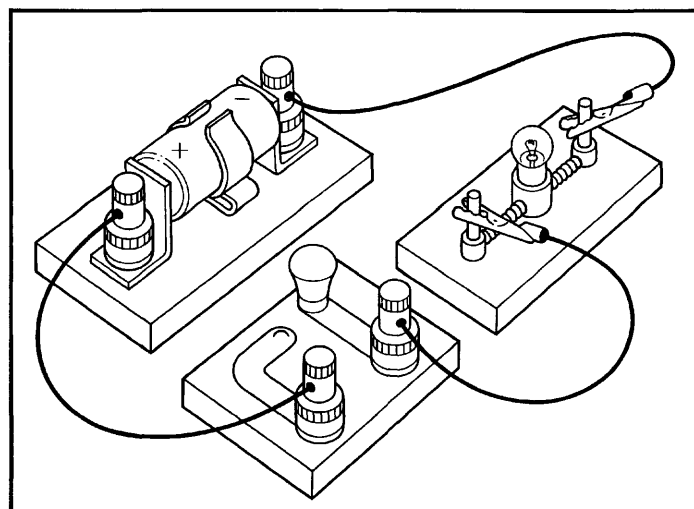
The different things, such as a bulb or battery, which you use in electric circuits are called *circuit components*. Scientists all over the World have agreed on a set of symbols for the

components – so they can always understand each others' diagrams. Here are pictures of some circuit components with their symbols beside them.

battery			resistor		
power pack (this is not an 'official' symbol but you may find it useful)			variable resistor		
bulb (when used to show that electric current is flowing – a signal bulb)			switch		
bulb (when used to light things up)			ammeter		
			motor		

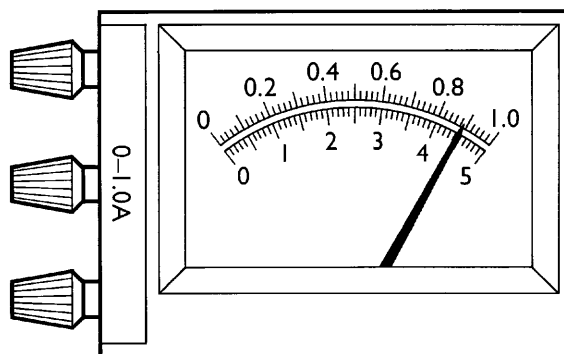
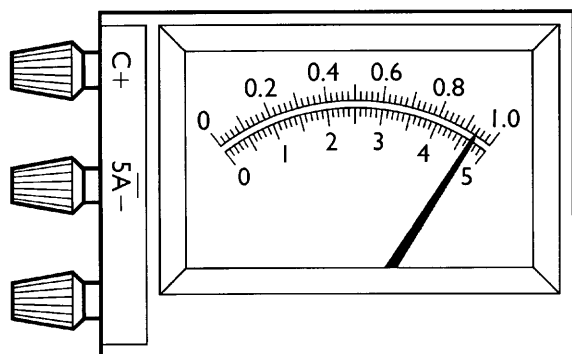
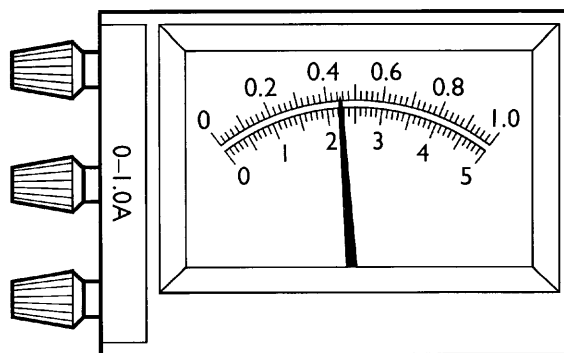
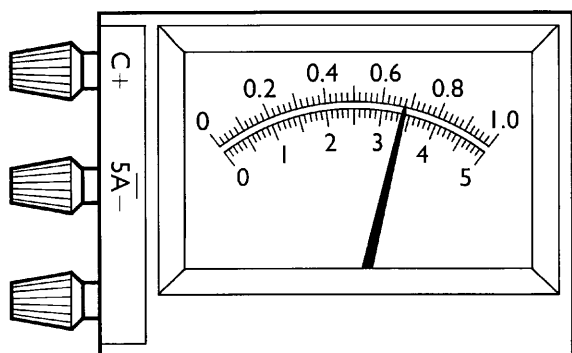
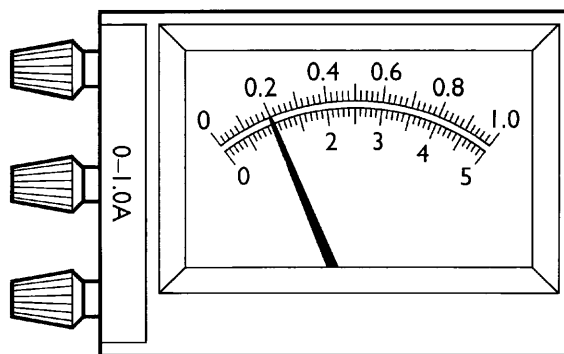
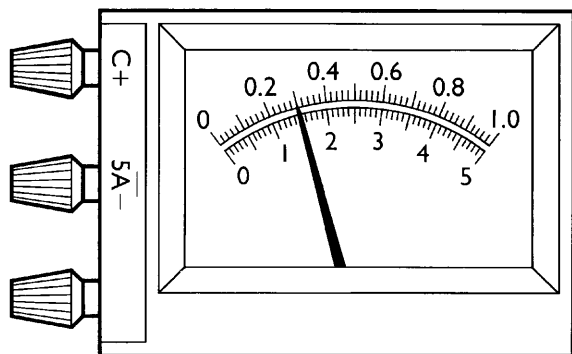
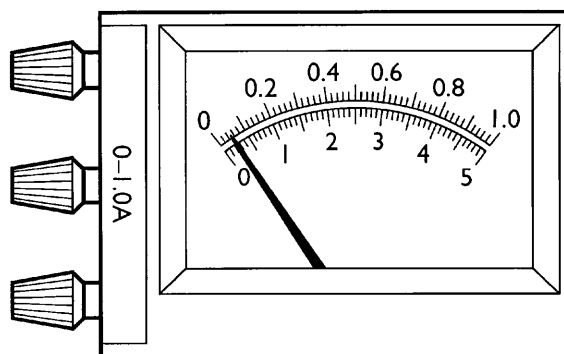
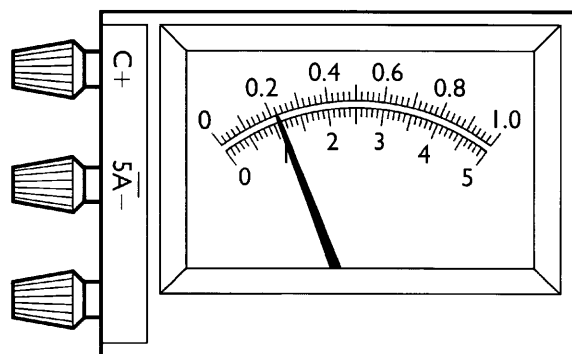
Here is a simple circuit consisting of battery, bulb and switch.

When scientists draw complete circuit diagrams they always use straight lines and square corners. An example is shown below.



Test yourself: reading ammeter scales

Can you read the eight ammeter scales in the drawings? Try it and write your answers down. Your teacher will give you the correct readings.



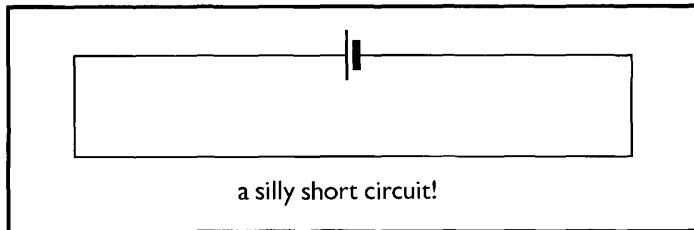
We are going to give you some puzzles to try. They will build up your understanding of how circuits work and how circuit diagrams are drawn.

Before we begin, we must tell you about the circuit designer's nightmare – *short circuits*.

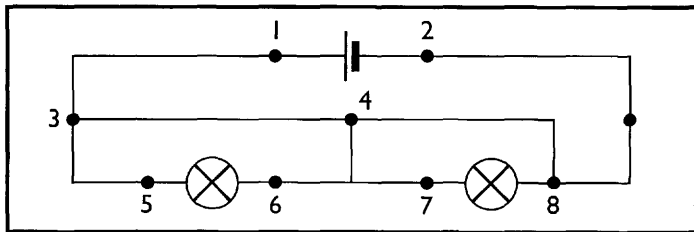
You know that a battery gives a sort of push to get electricity moving in the wires and components. If we make it too easy for the battery, it will get a big current going but will soon run out of push ('go flat'). How can this happen?

It will happen if you make a pathway that goes from one side of a battery to the other without going through any components. Such a pathway is called a short circuit or 'short'.

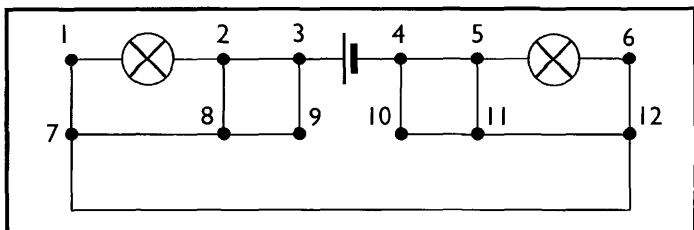
Here is a very simple (and very silly!) short circuit.



There is a short in this circuit. Follow the numbered dots: 2–8–4–3–1. The bulbs would not come on, and the battery would quickly go flat.



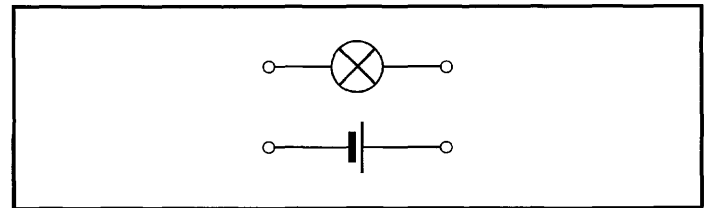
This is the kind of mess you get into if you just keep adding connections to a problem circuit. Can you trace the short? Write the numbers down to show it.



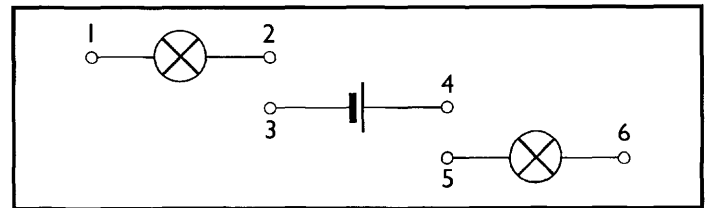
To avoid a short circuit disaster, you should always leave one side of the battery unconnected until you have carefully checked your circuit. It is a good idea to get a friend to check it for you too.

Now here are the puzzles. Keep a record of your answers by drawing a circuit diagram.

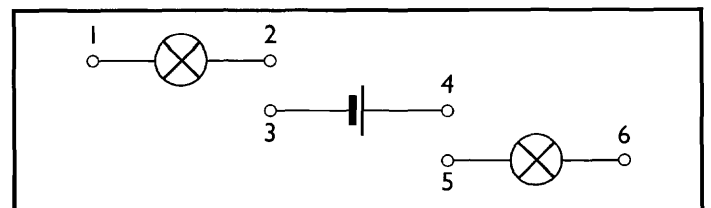
Puzzle 1 (Easy!) Connect the battery and bulb so that the bulb comes on.



Puzzle 2 (A bit harder!) Connect the battery and two bulbs together so that both bulbs come on.



Puzzle 3 (Quite difficult!) If the bulbs are only dimly lit, try to find another way to connect them to the battery so that they are brightly lit. If they are bright, try to find the version that lights them dimly. Ask your teacher for help if you need it.

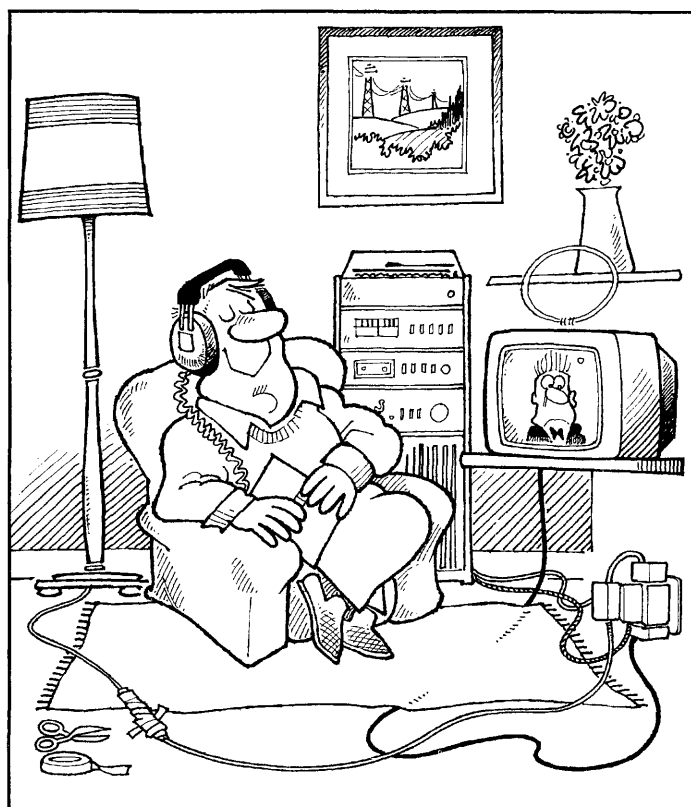
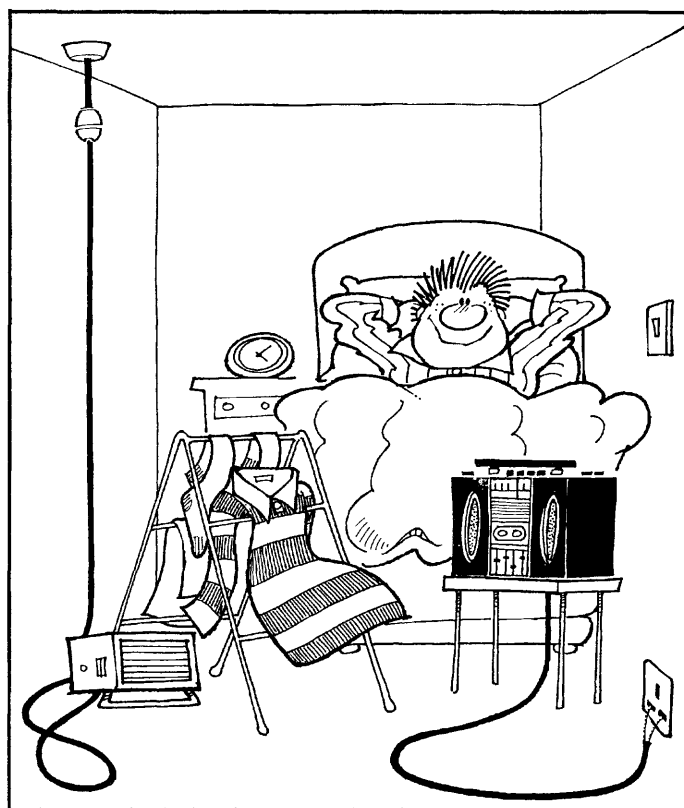
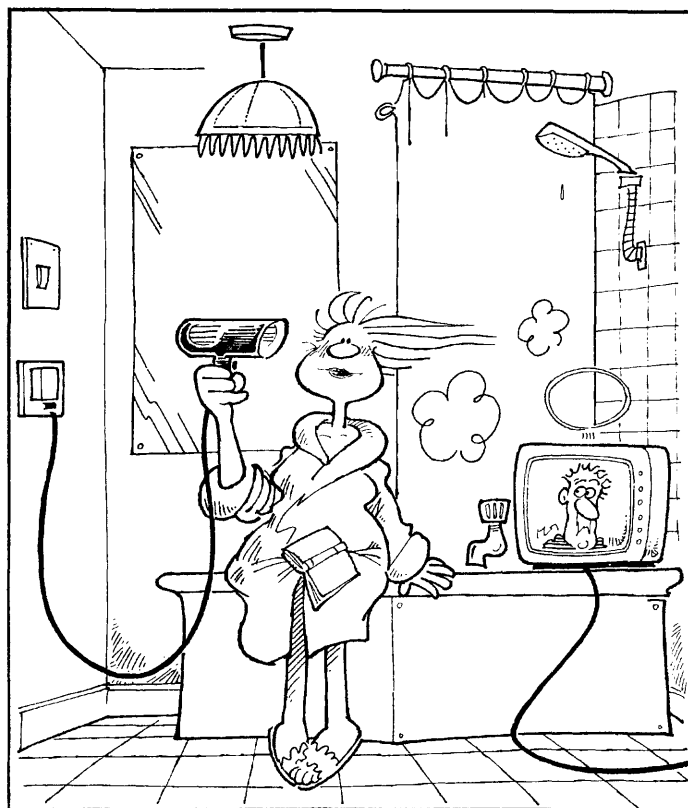


Puzzle 4 Start with the brightly lit version of the two bulb circuit. Add a switch so that you can turn off both bulbs at once.

Puzzle 5 Add another two switches to the Puzzle 4 circuit so that you can turn off one bulb without turning off the other.

Your teacher may have some more puzzles for you.

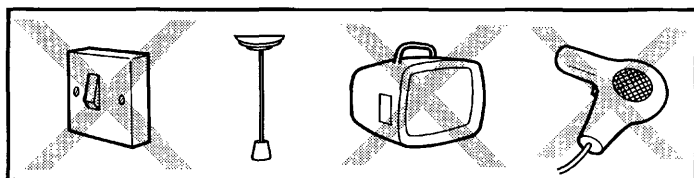
The people in this house are making a lot of silly and dangerous mistakes to do with electricity. How many can you spot?



In the bathroom

The 'push' from the electricity mains can get a current going in soapy or dirty water or through your body. If your skin is warm and moist the current will be large enough to be fatal. There should be no power points (except for special shaver points) and no switches (except for cord-pull types).

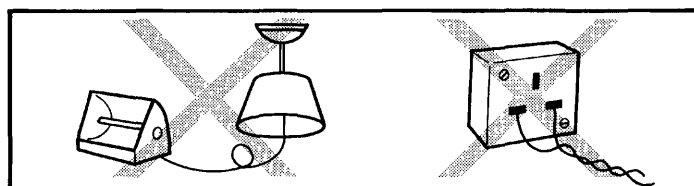
Portable mains-operated gadgets such as fires and radios are very dangerous if used in the bathroom.



In the bedroom

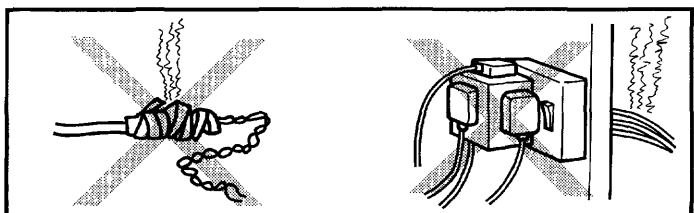
It is dangerous to plug a power appliance into a lamp socket – the high current could cause the wires in the ceiling to catch fire. They are designed to carry only the small currents needed for lighting. Also, the fire must be 'earthed' and the lamp socket doesn't have an earth wire.

Wires should never be pushed straight into a socket without a plug. The poor connection could result in dangerous sparks.



In the lounge

The maximum power loading for a mains socket is 3000 watts (3 kilowatts, kW). You can exceed this if you plug in too many high power



appliances. If you use adaptors, they should be fused, and you should add up the power ratings of the things you plug in. Multiple sockets are preferable to adaptors.

If a cable is too short you should use a special connector to extend it (or, better, replace it with a longer piece). Bad connections usually mean dangerous sparks.

Wires under carpets can cause falls, particularly in old people, and may break as they are trodden on. People also fall over wires trailing across a room.

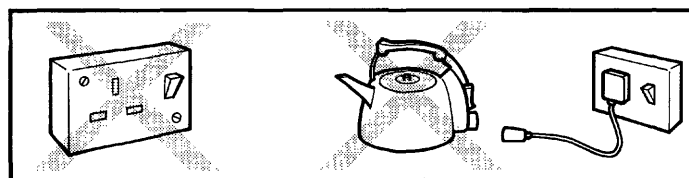
In the kitchen

If you think someone has had an electric shock, the last thing to do is to touch them. First, *switch off at the mains*, then get help. If you must pull them clear, hook a broom handle in their clothes and pull on that.

Small children in a kitchen may not be properly supervised because the adult with them is busy preparing food. Dangers include sticking metal objects into an empty electric socket (dummy plugs are available to prevent this), pulling a hot iron off a table, and, of course, the cooker.

It may be difficult to see that radiant rings on the top of an electric cooker are hot – even more so with a ceramic hob.

The flex of an electric kettle should not be left switched on and unattached to the kettle.



*How did you score
(how many things did you spot)?*

10 or over Well done! You should be quite safe!

8 or 9 Good, but watch out for the ones you missed.

7 or under Be careful! You may be a walking disaster area!

Make an 'Age of the Earth' strip chart

It is impossible for us to imagine a million years, let alone the enormous period of hundreds of millions of years since the Earth began.

We can get just a hint of it if we ask: 'Suppose the lifetime of the Earth could be shrunk into one year, when would the important events happen?'

We know enough about the history of the Earth to make a chart of this imaginary year. You can make such a chart from a length of tally roll (such as is used in cash registers), or a length of 9-cm computer printer paper.

1 Measure a strip of the paper 730 cm long, and cut it.

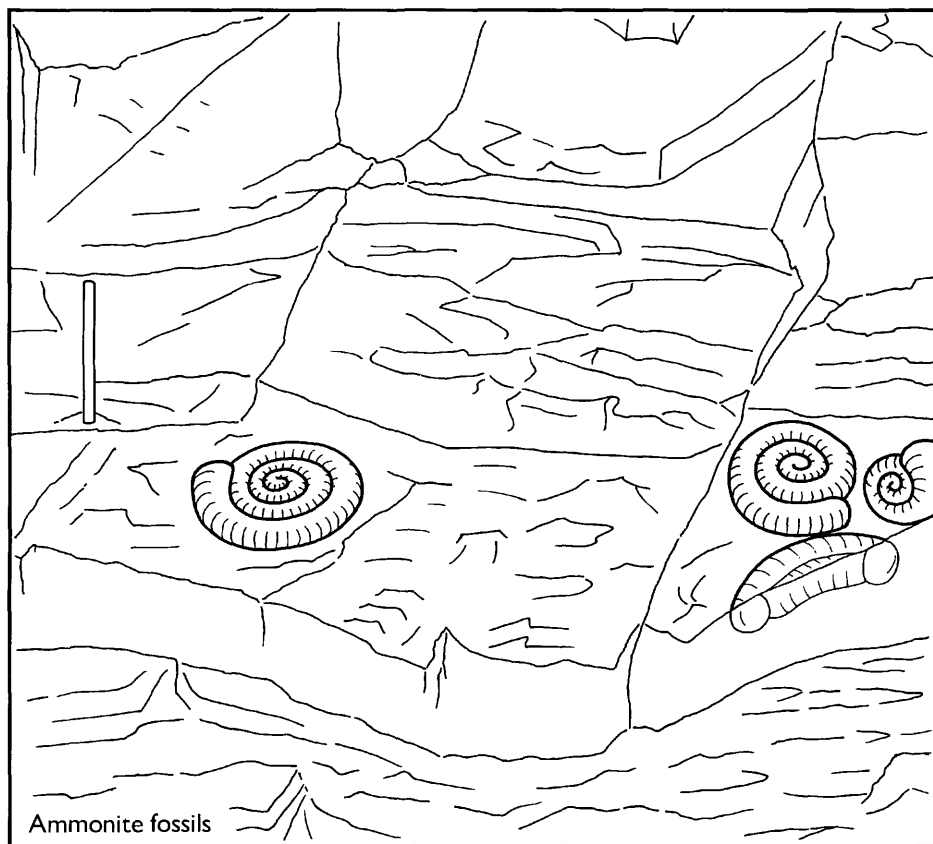
2 Mark on the strip the days of the year, one every 2 cm, then the months.

3 Use the table on this sheet to put the events of the 'Earth calendar year' on the strip.

4 Look in library books and magazines to find pictures of the different organisms mentioned (the first fish with jaws, for instance). Draw small copies of these and stick them onto your chart.

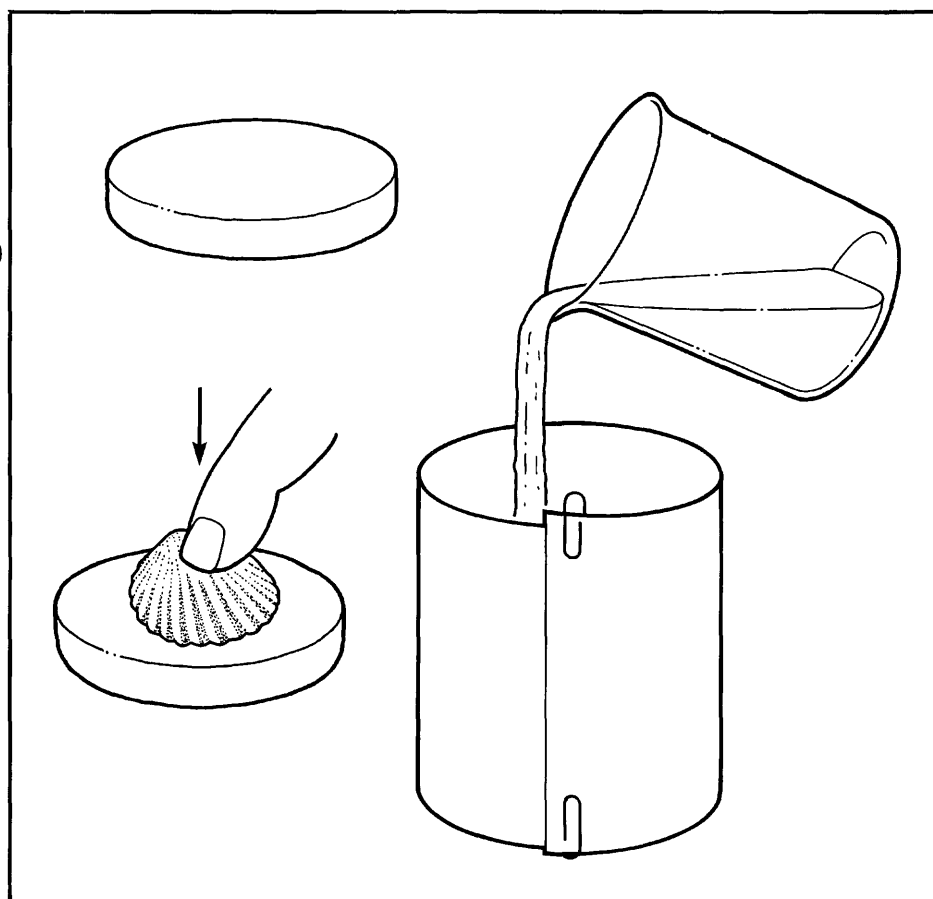
Now your only problem is to find somewhere to display the chart!

Date	Event
January 1	Earth has solid crust
February 13	Oldest rocks in our museums formed – in volcanoes?
April 27	Life begins! Algae appear in seas
May 5	Bacteria appear
July	Amoeba (single-celled animals) appear
August	Animals and plants developing steadily in the seas
November 27	First fish with jaws
November 29	Plants grow on land
November 30	First trees
December 2	Insects appear
December 3	Amphibians appear
December 6	First reptiles
December 13	Dinosaurs appear
December 15	First mammals
December 18	First birds
December 21	Plants with flowers
December 27	Ape-like creatures
December 29	Late at night, apes
December 31	23.50 hours, first humans appear



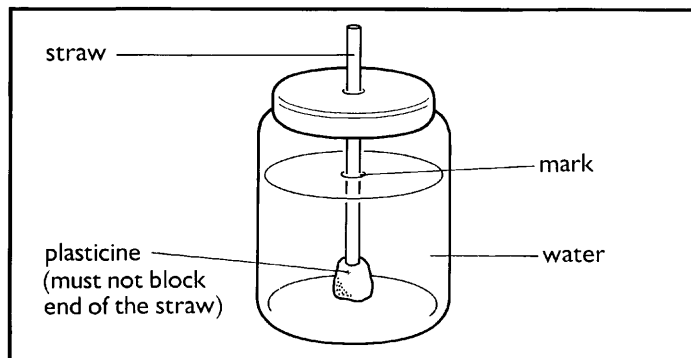
Ammonite fossils

Fossils are the remains or prints left by plants or animals in sedimentary rocks. They are very important to scientists because they can tell us what life was like millions of years ago, can give us clues to the ages of rocks, and can show how the rocks have moved.



You will need a beaker, some card, paper-clips, Plasticine, plaster of Paris, and a leaf or shell.

- 1 Make a Plasticine disc about 5 cm across and press your specimen (leaf or shell) into it.
- 2 Fit the cardboard around the disc so as to make a tube, fastened with paper-clips.
- 3 Make a creamy solution of plaster of Paris. Pour it into the tube to cover your specimen. Tap the lower end of the tube with a pencil to get rid of trapped air bubbles.
- 4 Put the tube in a warm place to set the plaster. When it has set, take away the tube, Plasticine, and specimen. You should be able to see your fossil in the plaster.



Here is another way of testing a liquid – perhaps to see if it is water.

- 1 Make a 'floater' by fixing Plasticine to one end of a drinking straw so that it floats upright in water.
- 2 Use a waterproof marker to mark the water level on the straw.
- 3 Tip out the water and repeat the investigation with cooking oil.

Which liquid holds up the straw best: water or cooking oil?

- 4 Repeat the experiment with different liquids. Clean your floater with a cloth or tissue between each test. You will have to think of a way of reminding yourself which mark is for which liquid. Here are some liquids you might try:

methylated spirit	milk
paraffin	turpentine
sugar solution	white vinegar
salt water	

- 5 Your teacher will give you three unlabelled liquids. Use your floater to find out which one is pure water.

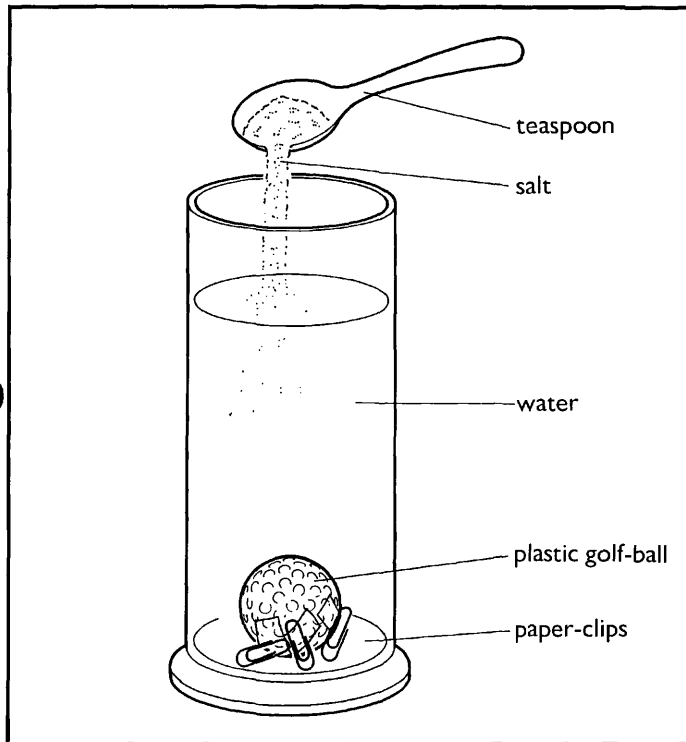
- 6 How salty is sea water?
How could you use your floater to help you find out?

You could, for example, make up samples of salt solution, each of a different strength, and compare how well your floater floats in each.

You could also find out how well it floats in some real sea water provided by your teacher.

Think about the details of the experiment and then have a go.

Do things float better in fresh water or in sea water? Here is an investigation to help you find out.



1 Three-quarters fill a tall glass beaker with tap water (fresh water).

2 Place a plastic golf-ball on the surface of the water. It should float. Attach just enough extra weights (paper-clips will do) to make the golf-ball sink to the bottom of the jar.

3 Add salt to the water, a teaspoonful at a time, stirring it in. Watch what happens.

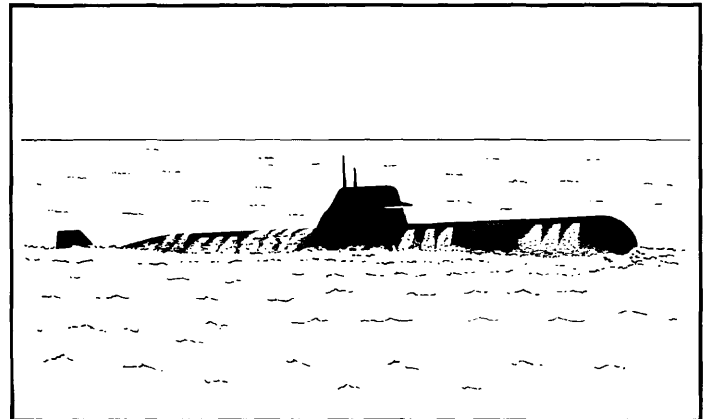
Do things float better in fresh water or in sea water?

Could you get the golf-ball to stay half-way up?

Try out your ideas.

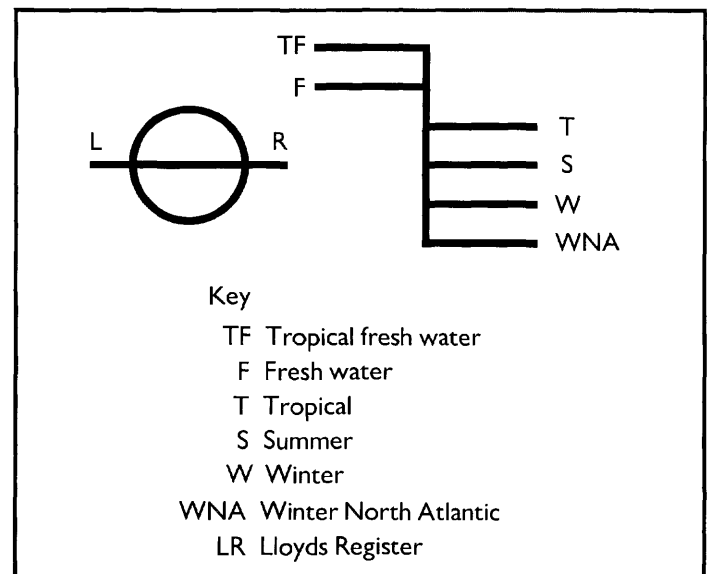
More about floating and sinking to think about

The golf-ball floats on the surface when its weight (the downwards force) is balanced by an upwards force provided by the water. Your investigation shows that salt (sea) water provides a bigger upwards force than fresh water.



A submarine can float and sink as its captain orders. How does it do this?

Without altering the amount of salt in the water, how could you make a floating golf-ball sink?



This picture shows you the marking that you can see on the side of most large ships. It is called the Plimsoll line after Samuel Plimsoll. He was born in Bristol in 1824 and spent a lot of time in the city's docks. He knew that many of the ships which sank did so because the owners had overloaded them. He campaigned successfully for a law to be passed which made it necessary for ships to have marks on them showing safe loading levels.

Think back to the work you have just done. Why is the Plimsoll line not one simple straight line?

What makes steel rust?

WORKSHEET 51



If you bought a brand new car, you wouldn't be very pleased if it soon started to rust. Before car makers could find ways of preventing rust, they had first to find out what caused it. The bits of a car that can rust are made of steel. So what makes steel rust? Here is your chance to investigate.

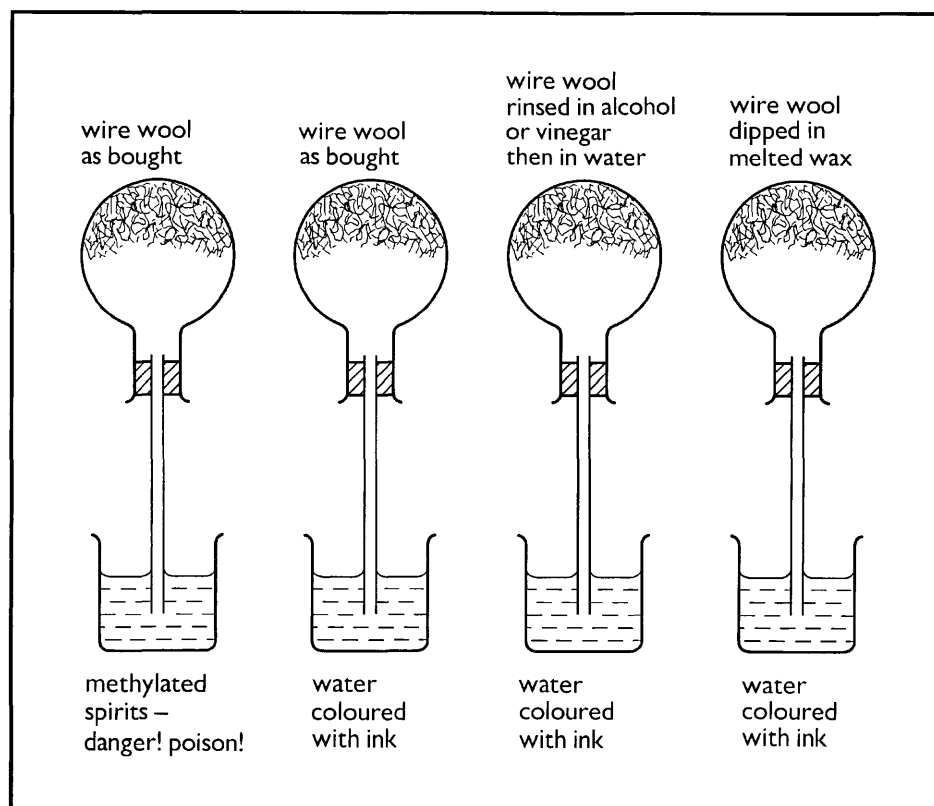
Before you read on, write down why you think steel rusts. The cartoon shows some of the things people in your class might say.

It would be very difficult to try out all the ideas at once. You can investigate it with the apparatus shown in our diagrams. Go about it like this.

1 Before you set up the flasks try to predict how each of them will look after a few days. Write down your predictions.

2 Set up the flasks. Leave them for a few days and look at them again. How have they changed? Check your predictions.

3 Try to explain what happened to each of the flasks. Write down your explanations. Discuss them with your classmates and teacher.



Do you live in a hard or soft water area?

The water we drink has many types of chemicals dissolved in it. In some areas the water contains a lot of a chemical called calcium sulphate or a chemical called calcium hydrogen carbonate. Water with either of these chemicals dissolved in it is called *hard water*.

The chemicals in hard water make it difficult to get a lather using soap, and a nasty scum is produced. Special washing powders have had to be developed for use in hard water areas.

Water without these chemicals is called *soft water*. Only a little soap is needed to get a good lather.

Here is an investigation you can do to see if you live in an area with hard or soft water.

1 Add one soap flake to a 5-cm depth of tap water in a test-tube, cork it, and shake it.

2 If a good lather doesn't form, add another soap flake and shake again. Go on adding soap flakes (one at a time) and shaking the test-tube until a good lather is produced.

How many flakes were needed?

3 Repeat the experiment with samples of hard and soft water provided by your teacher. Compare the results with your own water sample.

Is your water hard or soft?

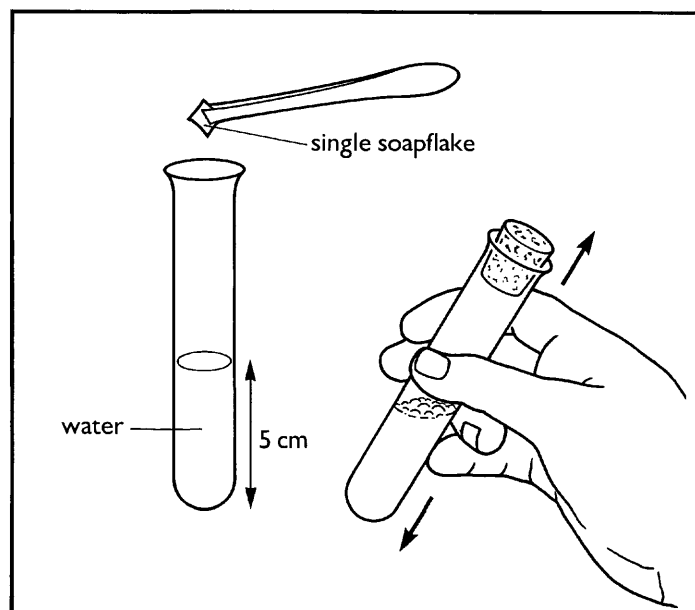
4 Use a book from your school library to find answers to these questions.

How is the 'fur' inside a kettle produced?

Where would you expect furring to be a greater problem, in a hard or soft water area?

How are stalagmites and stalactites formed?

(And which is which?)



For rows A to J of the table, you should fill in two columns every day, one in the morning and one in the evening. Rows K to N are for readings every 24 hours.

A Cloud cover	—	—	—	—	—	—	—
B Cloud type and height (looking west) Cloud type and height (looking east)	—	—	—	—	—	—	—
C Precipitation	—	—	—	—	—	—	—
D Visibility	—	—	—	—	—	—	—
E Wind speed	—	—	—	—	—	—	—
F Wind direction	—	—	—	—	—	—	—
G Air temperature (°C)	—	—	—	—	—	—	—
H Air pressure	—	—	—	—	—	—	—
I Water vapour content	—	—	—	—	—	—	—
J Changes	—	—	—	—	—	—	—
K Rainfall (cm)	—	—	—	—	—	—	—
L Maximum temperature (°C)	—	—	—	—	—	—	—
M Minimum temperature (°C)	—	—	—	—	—	—	—
N Sunshine (hours)	—	—	—	—	—	—	—

Names, symbols, heights, and shapes of clouds

Names and heights (in Britain)	Symbols	Shapes	Comparisons
Cirrus (mare's tail) 6000 to 12 000 m			9 kilometres
Cirro-stratus 6000 to 12 000 m			8 kilometres
Cirro-cumulus (mackerel sky) 6000 to 12 000 m			7 kilometres
Alto-cumulus 2000 to 6000 m			6 kilometres
Alto-stratus 2000 to 6000 m			5 kilometres
Cumulo-nimbus (storm cloud) base 600 to 1500 m tops may be 7500 m			4 kilometres
Cumulus base 600 to 1500 m tops may be 3000 m			3 kilometres
Strato-cumulus 500 to 2000 m			2 kilometres
Nimbro-stratus (rain cloud) base 100 to 600 m			1 kilometre
Stratus (hill fog) 60 to 600 m			

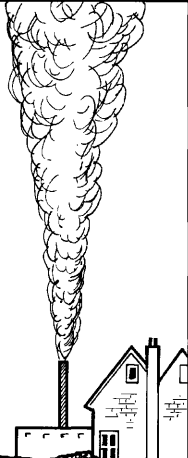
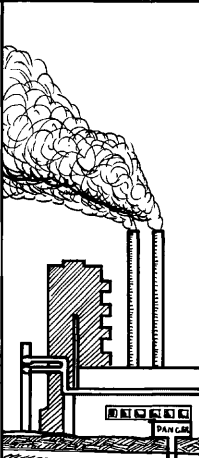
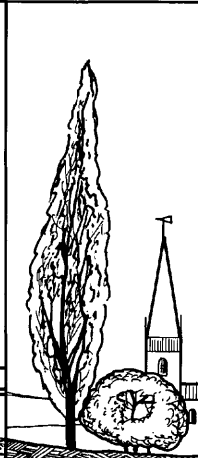
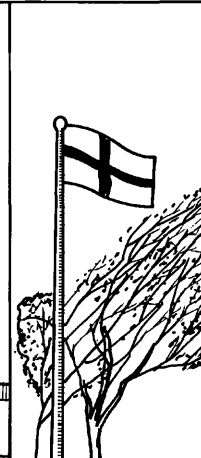
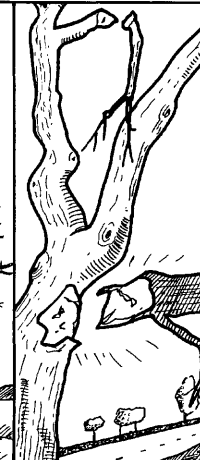
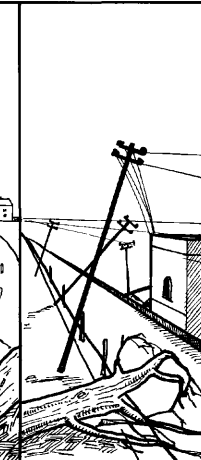
Wind force chart

WORKSHEET 55

You can estimate the wind speed by using the descriptions of different forces of wind

shown in the table. The set of descriptions is called the 'Beaufort Scale', after Admiral

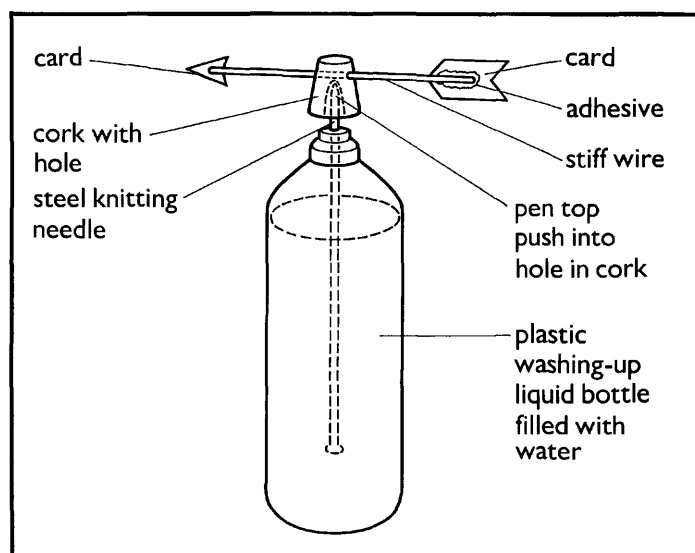
Sir Francis Beaufort who worked it out more than a century ago.

Force	0	1	2	3	4	5
Description	Calm	Light air	Light breeze	Gentle breeze	Moderate	Fresh
Wind speed	—	1–5 kph	6–11 kph	12–19 kph	20–29 kph	30–39 kph
Effects						
Calm; smoke rises vertically	Direction of wind shown by smoke drift, but not by vane	Wind felt on face, leaves rustle, ordinary vane moved by wind	Leaves and small twigs in constant motion; wind extends light flag	Raises dust and loose paper; small branches are moved	Small trees in leaf begin to sway; crested wavelets form on inland waters	
Weather Symbols						
6	7	8	9	10	11	12
Strong	Moderate gale	Gale	Strong gale	Whole gale	Storm	Hurricane
40–49 kph	50–61 kph	62–74 kph	75–87 kph	88–100 kph	101–116 kph	117–130 kph
						
Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	Whole trees in motion; inconvenience felt when walking against wind	Breaks twigs off trees; generally impedes progress	Slight structural damage occurs; chimney pots and slates removed	Seldom experienced inland; trees uprooted; considerable structural damage occurs	Very rarely experienced; widespread damage occurs	
						

A wind vane

You can make a model wind vane like the one in our diagram (or to your own design), if you have not already done it in Year 1.

Remember that the wind direction is the direction the wind *comes from*.



An anemometer (wind speed measurer)

You will need a plastic protractor (a large one – about 15 cm across), a table tennis ball, a small spirit level, about 40 cm of wooden rod, a screw, some plastic cement and some very thin nylon cord ('monofilament' from a fishing supplies shop).

To make the anemometer

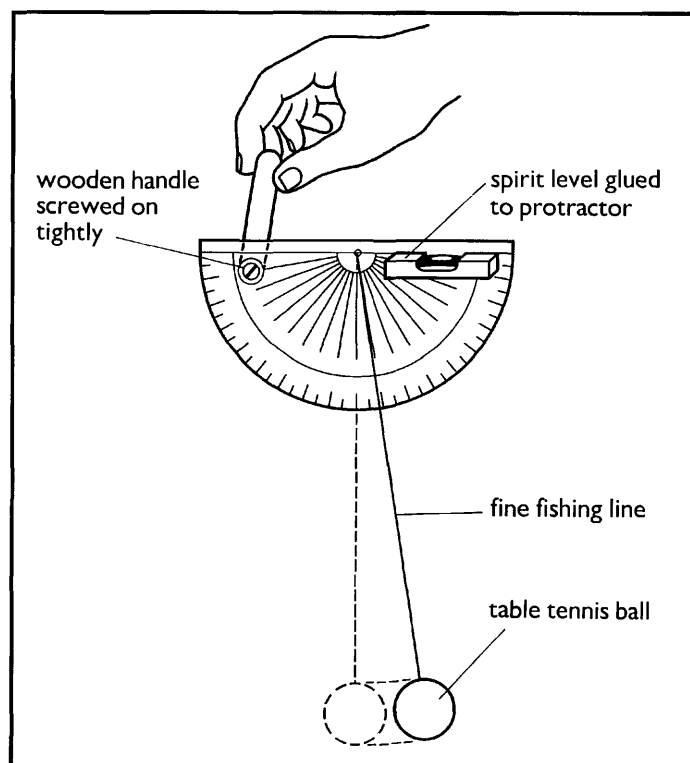
- 1 Pierce the ball with a sewing needle at two exactly opposite points.
- 2 Thread the cord through and fasten the free end with a dab of plastic cement.
- 3 When it is dry, trim off the surplus cord.
- 4 Make a hole in the protractor for the handle-fixing screw. Ask an adult to do this for you, using a hot steel knitting needle – with care, the protractor is probably flammable!
- 5 Screw the handle on tightly.
- 6 Cement the spirit level parallel to the base-line of the protractor.

7 You will need the help of an adult again – to make a small hole at the index mark of the protractor (the 'centre of the circle').

8 Pass the upper end of the suspension-cord through the index-hole.

9 Adjust the length of cord between the hole and the upper surface of the ball to 30 cm.

10 Cement the free end to the rear surface of the protractor.



To use the anemometer

- 1 Stand with your right shoulder facing into the wind.
- 2 Hold the handle at arm's length in your right hand.
- 3 Level the protractor using the spirit level.
- 4 Read off the angle on the protractor scale.
- 5 Use the conversion table below to find the wind speed.

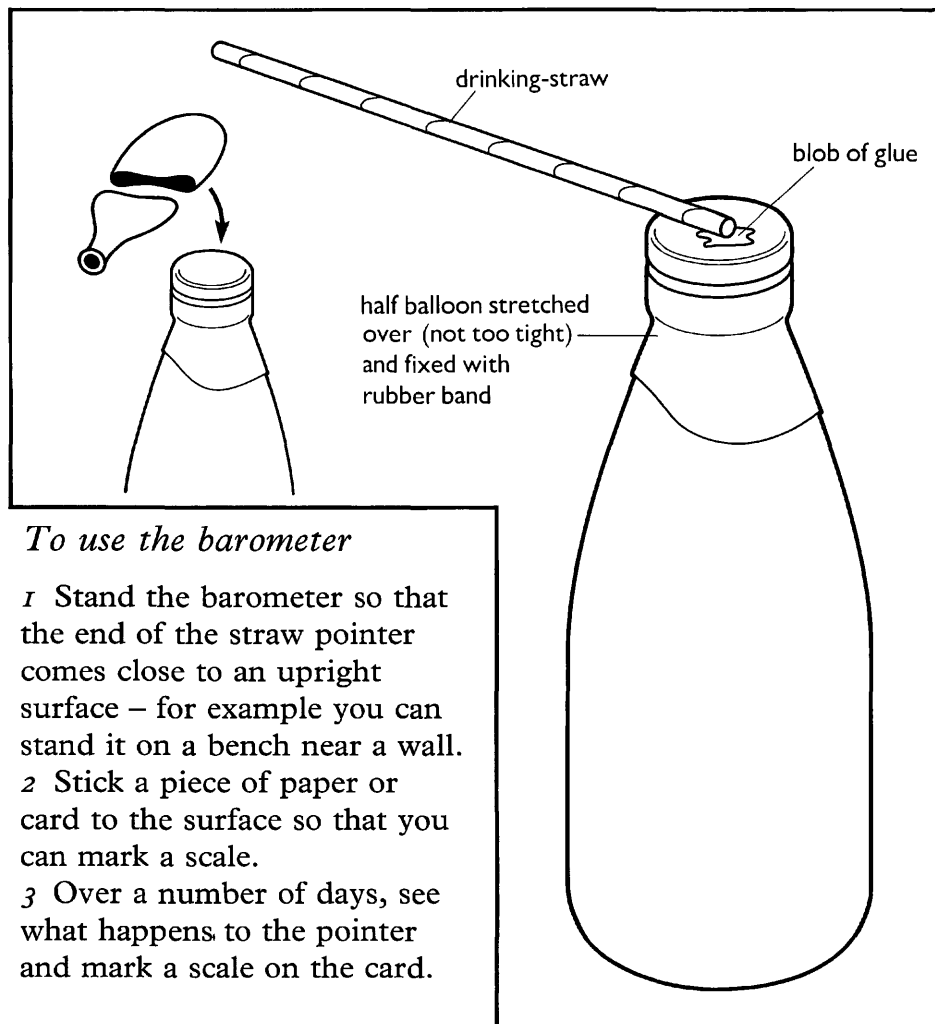
metres per second	1	2	3	4	5	6	7	8	9	10
angle between cord and horizontal	89°	87°	83°	78°	72°	64°	57°	50°	43°	37°

A bottle barometer (air pressure measurer)

You will need a milk bottle, a balloon, a drinking straw, plus some rubber latex glue and a rubber band.

To make the barometer

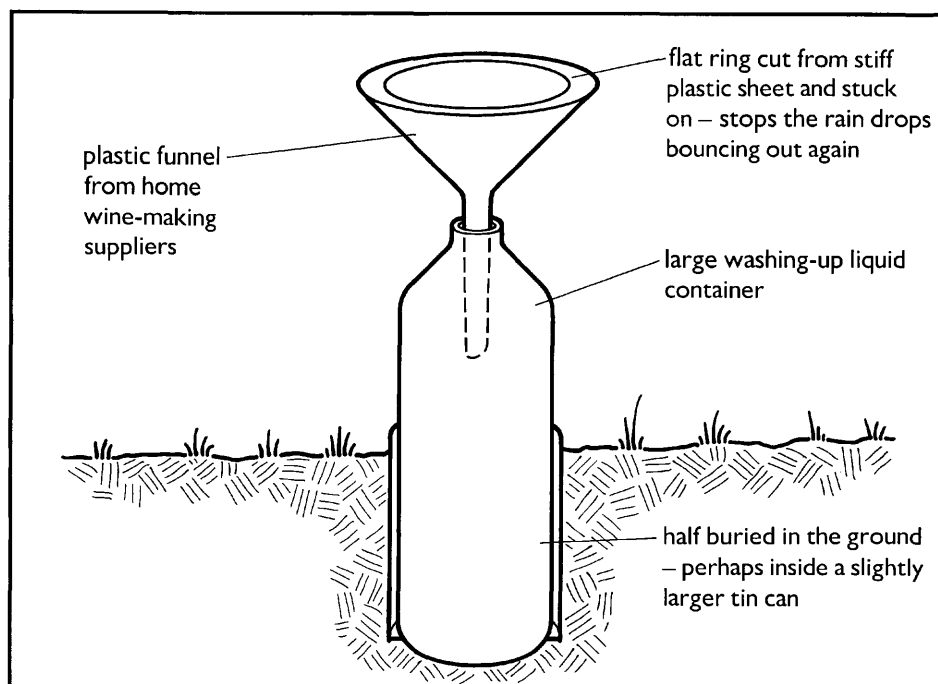
- 1 Cut the balloon in half.
- 2 Make sure the bottle is completely dry inside.
- 3 Coat rubber glue round the top.
- 4 Stretch the balloon rubber over (not loose, but not very tight either).
- 5 Fix tightly with the rubber band (the glue and the band must make an air-tight seal).
- 6 Put a dab of glue in the centre of the rubber surface on the top.
- 7 Stick on the drinking straw by its end.



A rain gauge

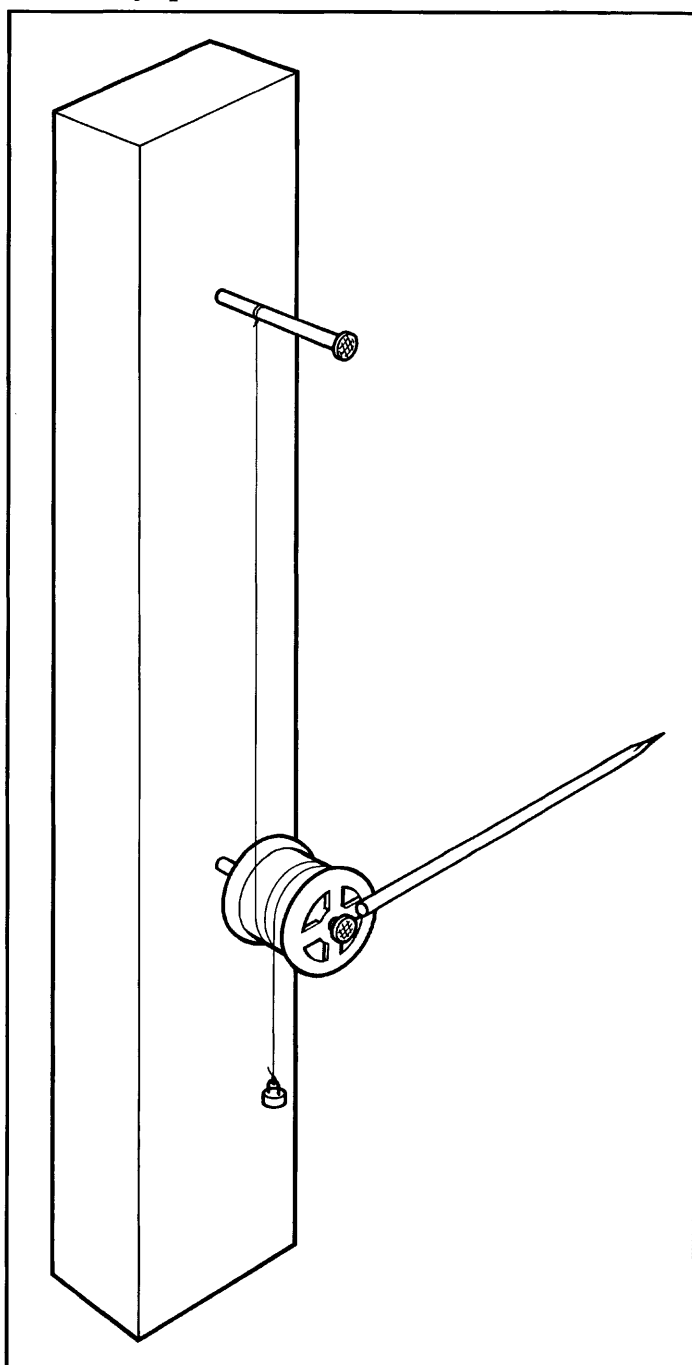
The drawing shows how you can set up a simple rain gauge. To use it you need to know the area of the mouth of the funnel. If you do not know how to work it out, your teacher will help.

- 1 Use a measuring cylinder to measure the volume of the rain you collect (in cm^3).
- 2 Divide this volume by the area of the funnel (in cm^2) to get the rainfall figure in cm.



A hair hygrometer (water vapour measurer)

You will need a 20-cm length of 2-cm × 4-cm softwood batten, round nails about 7 cm long, a small empty cotton-reel, a small weight with a mass of about 50 g, a drinking straw, a human hair at least 30 cm long, a small beaker of dilute sodium hydroxide solution, quick-drying adhesive, tweezers, a stirring rod, a hammer, and safety spectacles.



To make the hygrometer

- 1 Tap one of the nails into the batten about 50 cm from one end and on its centre line.
- 2 Thread the cotton-reel onto the other nail and tap this nail into the batten, also on its centre line, and about 10 cm from the other nail.
- 3 Stir the hair in the dilute sodium hydroxide solution for about half a minute to remove any **▲** grease from it. Wear safety spectacles!
- 4 *Handling it with the tweezers*, rinse it in clean water and put it on a clean sheet of paper to dry.
- 5 Tie or glue the hair to the first nail.
- 6 Holding it in the tweezers, wind the other end of the hair two or three times around the cotton-reel. Tie the weight to the end.
- 7 Fix the batten upright with a stand, boss, and clamp.
- 8 Stick the drinking straw to the reel to act as a pointer.

Human hair changes its length as the air gets drier or damper. So you have made an instrument which indicates the amount of water vapour in the air.

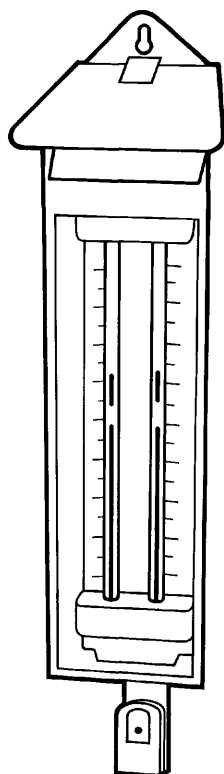
To use the hygrometer

- 1 Position your hygrometer so that the pointer moves over a scale fixed to a wall.
- 2 Find which way the pointer moves by putting a few centimetres of warm water into a bucket, and carefully putting the hygrometer upright into the bucket. Be careful not to wet the hair. Cover the bucket with a wet towel. After a few minutes the air in the bucket will be holding as much water vapour as it can (it will be *saturated*) and the instrument will be reading its maximum value.
- 3 Put it against the scale and mark the scale 'MAX'.
- 4 Your teacher will be able to suggest how you can put the hygrometer in perfectly dry air to get the minimum reading. He or she may also be able to suggest how you can mark your scale with some other values between 'MAX' and 'MIN'.

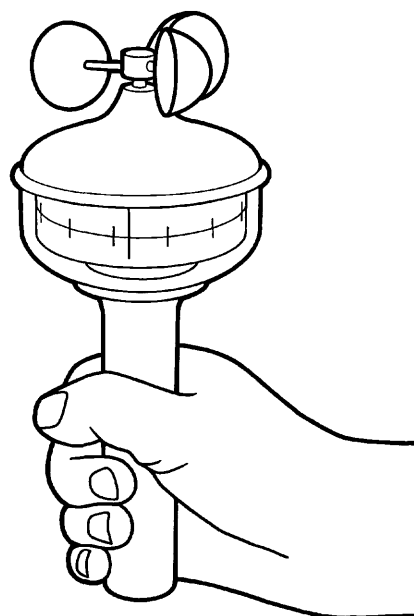
Studying factory-made weather instruments

Here are some factory-made instruments used by weather scientists. You may have some like them in your school. Can you find out how they

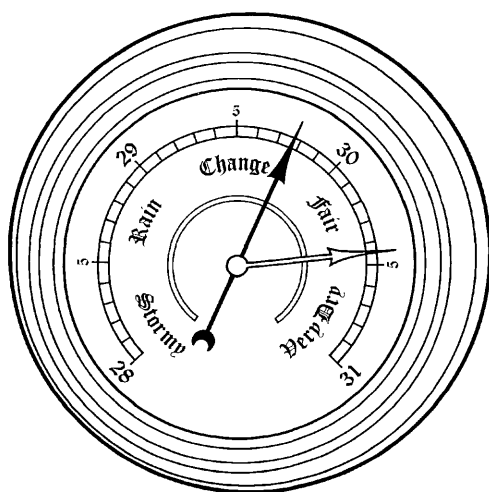
work? Try it, and write about them in your notebook. Draw some pictures to illustrate your notes.



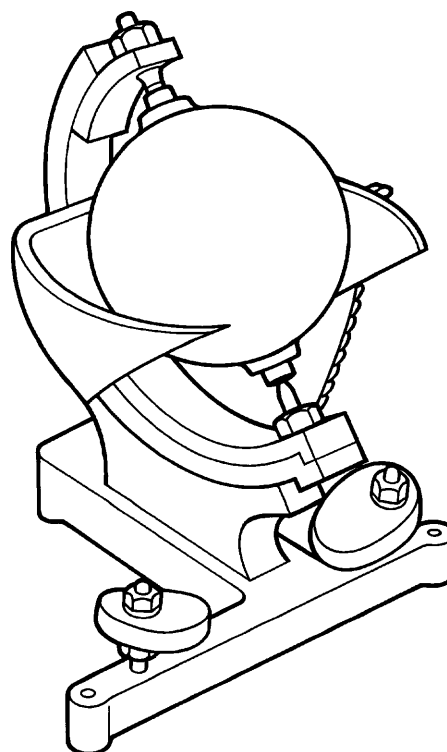
Thermometer (maximum and minimum)



Anemometer (hand held)



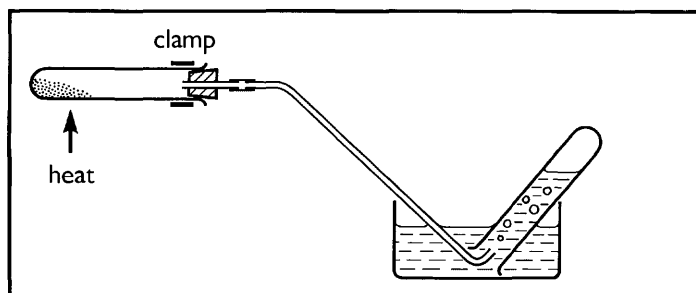
Aneroid barometer



Sunshine recorder

Investigating the effect of heat on potassium manganate(VII)

You probably know that when you heat potassium manganate(VII) it loses mass. You can probably guess why that is. This investigation will give you some scientific evidence for your ideas. It will also show you another of the scientists' 'tricks of the trade' called 'collecting a gas over water'.



The drawing shows how to set up your apparatus. The test-tube on the left is made of 'hard' glass because you are going to heat it. It contains about 2 g of potassium manganate(VII).

Make a list of everything you need and read the instructions right through before you begin. Make sure you have safety spectacles.

1 Carefully study the arrangement at the righthand side of the drawing. To set it up you will have to lay the test-tube flat in the trough to fill the tube with water. Then, *without taking its mouth out of the water*, put the test-tube in position over the end of the delivery tube. You should practise this a few times before you begin.

2 Lay another test-tube flat in the trough ready for use if you need it.

⚠ Put your safety spectacles on.

3 Light your Bunsen burner and set it to give a colourless flame.

4 Hold the base of the burner in your hand and heat the lefthand tube. Waggle the flame about to heat the tube evenly and gently.

5 You should see bubbles of gas coming out of the end of the delivery tube, going up into the collecting tube, and pushing out the water.

Carry on heating while your partner does instruction 6.

⚠ If you stop heating even for a moment, cold water may creep back up the delivery tube and into the hot test-tube, breaking it.

6 When the tube is full of gas *keep its mouth under water* but move it away from the delivery tube. Seal it, under water, with a rubber bung.

7 Carry on heating. Put your spare test-tube in position over the delivery tube and collect more of the gas.

8 Take the delivery tube out of the trough of water. Put your burner down on the bench and out of the way.

Now you can make an important pattern statement:

■ If you heat potassium manganate(VII) a gas is produced. The loss of gas probably accounts for the loss in mass.

The next question is: what is the gas?

9 Test the gas in one of your test-tubes like this: Keep wearing your safety spectacles.

a Light a wooden splint.

b Blow out the flame on the splint so it is just glowing.

c Put the glowing end of the splint into one of your test-tubes of gas. Watch what happens.

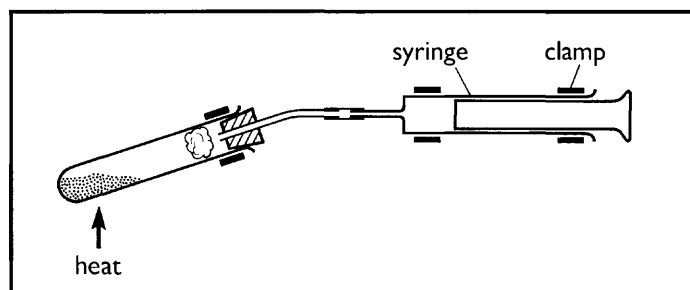
There is only one gas which has this effect on a glowing splint. Can you name the gas? If not, try to find out from books in the library. (Try looking up 'Gases' and 'Tests for gases'.)

Ask your teacher to show you the effect of putting some other burning substances into test-tubes of the gas.

Investigating the gas from heated potassium manganate(VII)

You know that potassium manganate(VII) gives off a gas when you heat it, and you know that this gas is rich in oxygen – it will relight a glowing splint. But is the gas only oxygen, or is it mixed with something else? This investigation will show you a way of finding out.

Your aim will be to find the mass in grams of one centimetre cube of the gas. Scientists call the mass of one centimetre cube of anything its *density*. They have made tables of the densities of many substances including gases.



1 Study the drawing of the apparatus. Can you see the potassium manganate(VII)? Your teacher will give different people different masses of this. Some will have 100 milligrams, some 200 milligrams, and so on up to 500 milligrams.

2 Notice the heatproof fibre plug in the test-tube. This is to stop bits of solid getting up into the syringe and damaging it.

3 Weigh the test-tube containing the potassium manganate(VII). Weigh to the nearest milligram, and write down the result.

4 Set up the apparatus, and set the plunger of the syringe at zero (plunger right down).

5 Light your Bunsen burner and set it to give a colourless flame. Put on your safety spectacles.

6 Hold the burner by its flat base and use it to heat the test-tube. Keep the flame moving round the tube.

7 Keep heating until you can get no more gas from the potassium manganate(VII) (until the plunger of the syringe stops moving).

8 Let the apparatus cool down then take the reading of your syringe and write it down.

9 Weigh the test-tube again.

10 Get together with your classmates and teacher and put all your results into a table like the one at the bottom of this page.

11 Notice that you can get the mass of the gas which has come off by working out the loss in mass of the test-tube and contents. Do this and put the results in the table.

12 Plot the results on a pair of axes. Put 'Mass of gas given off (g)' on the x axis and 'Volume (cm³)' on the y axis. Discuss with your teacher the best way to draw a graph through the points.

Can you see how to use the graph to work out the mass of one centimetre cube of the gas? Discuss it.

The standard value for the density of oxygen is 1.429 milligrams per centimetre cube (mg/cm³). How does your result compare with that? Are you satisfied with your result?

What could have caused your value to be different from the standard value?

What could have caused your readings (of mass or volume) to be higher or lower than they would have been if the apparatus was perfect?

What mistakes might you have made?

Discuss all of these questions.

13 Write about the investigation. Draw a diagram of the apparatus. Put all your results down.

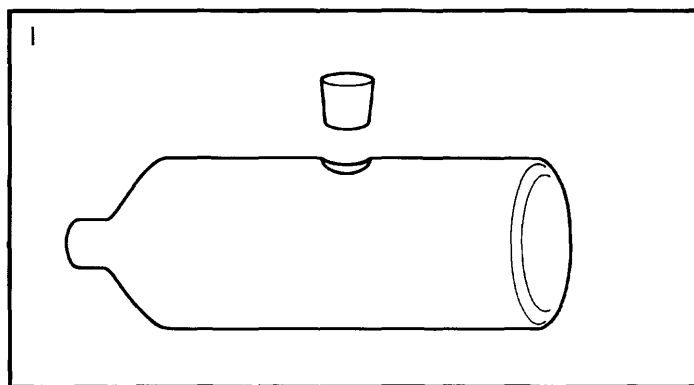
Mass of potassium manganate(VII) + test-tube before heating	Reading of syringe before heating	Reading of syringe after heating	Mass of potassium manganate(VII) + test-tube after heating	Loss in mass of test-tube + contents
	0			

Make a fizzy rocket

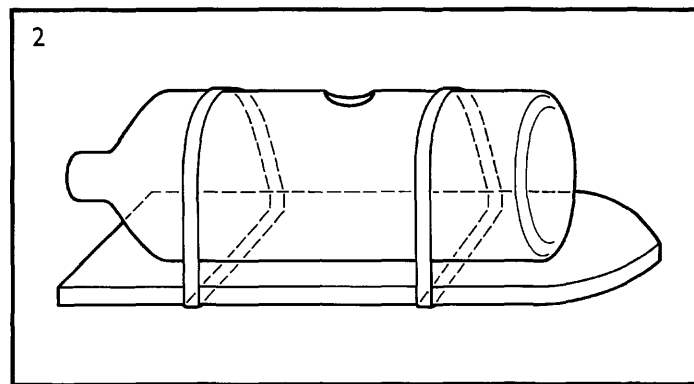
You will need a plastic washing-up liquid bottle, a cork or rubber bung, a piece of balsa wood cut in the shape of a boat and large enough to carry the washing-up liquid bottle, and two rubber bands. You also need two chemicals: sodium hydrogen carbonate (known by non-scientists as bicarbonate of soda), and some dilute hydrochloric acid.

⚠ You should wear safety goggles.

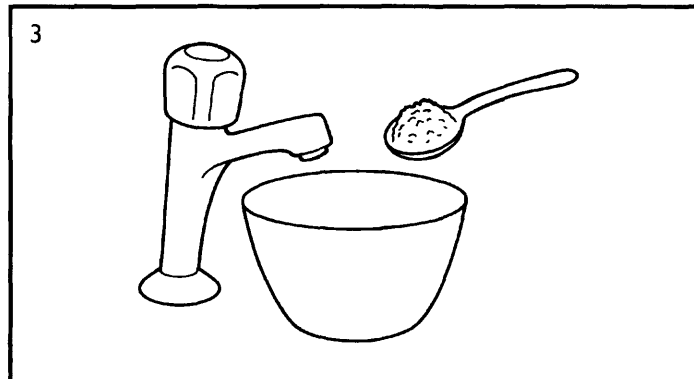
1 Cut a hole in the bottle just large enough to take the cork. It should be a tight fit.



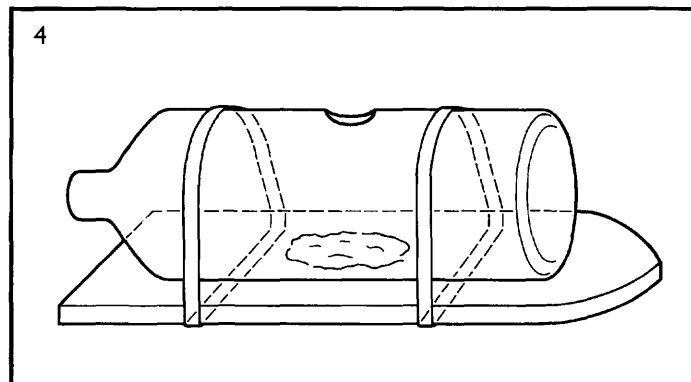
2 Fix the bottle onto the boat-shaped piece of wood.



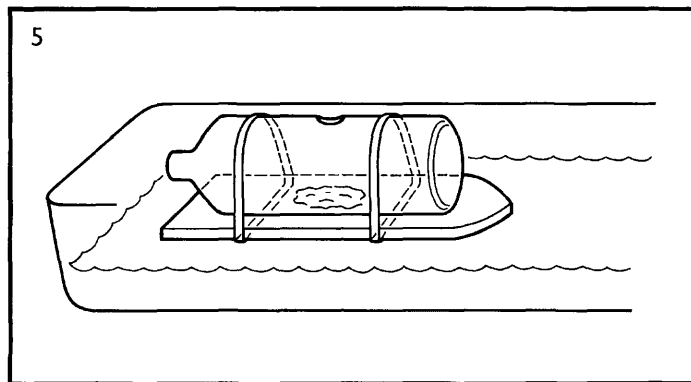
3 Mix some sodium hydrogen carbonate into a paste with water.



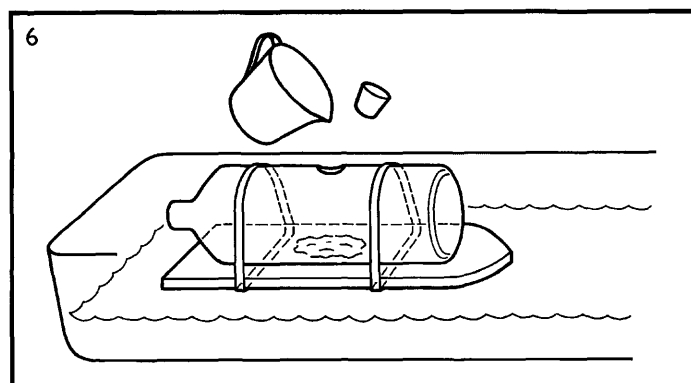
4 Put the paste into the bottle just under the hole and spread it out as much as you can.



5 When you are ready, float the rocket in a large sink or bath full of water.



6 Pour some of the acid onto the paste and quickly put in the cork. Away it should go!



⚠ Some acid may spray out of the nozzle. Keep out of its way. If you get any acid on your skin, rinse it off with cold water.

We have left plenty of room for you to experiment with this design. For example, you can try different amounts of paste and different amounts of acid; and you can try different sorts of boat, or try it on a wheeled vehicle. Over to you!

Make a rocket poster

WORKSHEET

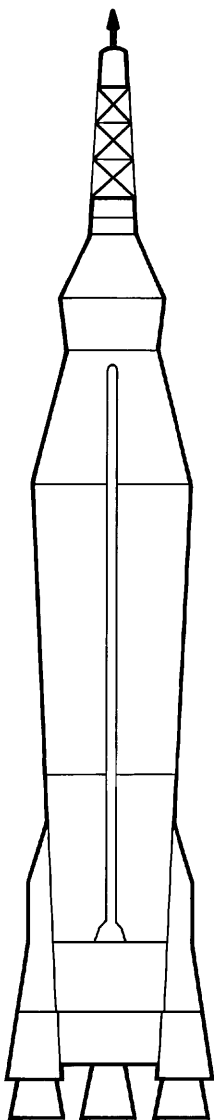
63

Here are some drawings of rockets you can use to make a poster. You can trace the drawings onto a transparent sheet and use an overhead projector to project them (any size you like) onto thin white card pinned to a wall. You can trace them, cut them out and stick them onto a coloured backing sheet (dark blue would be good).

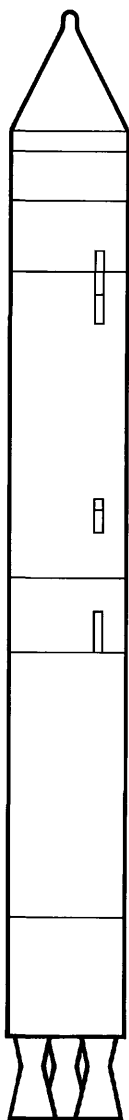
There is only one snag. We have drawn the rockets the same length as each other – though

we have given you their true lengths. We have left it for you to work out a way of showing them so they are the right size compared with each other.

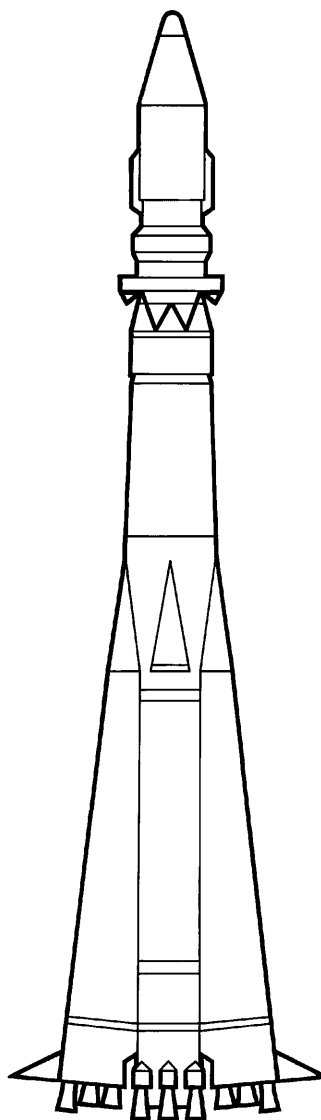
When you have finished it will be a good idea to look up some information about each of the rockets – for instance, what they were used for. Put the information on small pieces of coloured card and stick these on your poster.



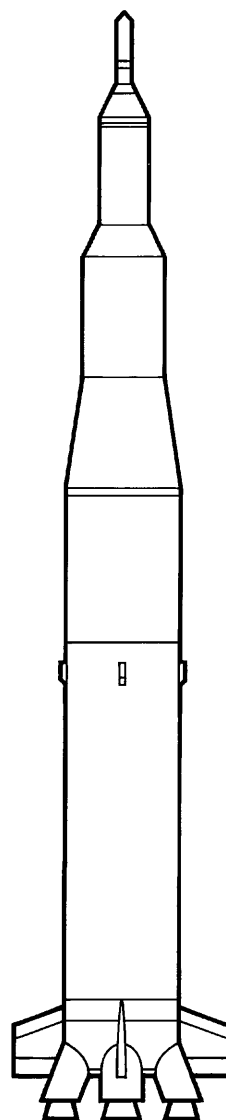
Mercury-Atlas
30 m



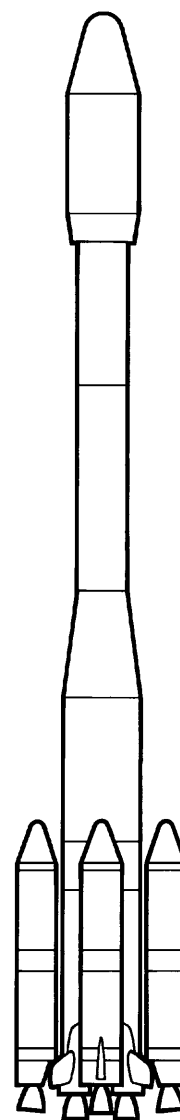
Gemini-Titan
32.5 m



Vostok
38 m



Saturn V
110 m



Ariane
58.5 m

The drawing shows a Space Shuttle fitted onto its reusable booster rocket and drop-tanks of fuel. You can copy this onto card, cut it out, and pin it on a notice board to start your Shuttle display. Add other pictures, information on the history of the Shuttle (we will give you a list of questions to help), missions past and present, models if anyone in your class can lend them.

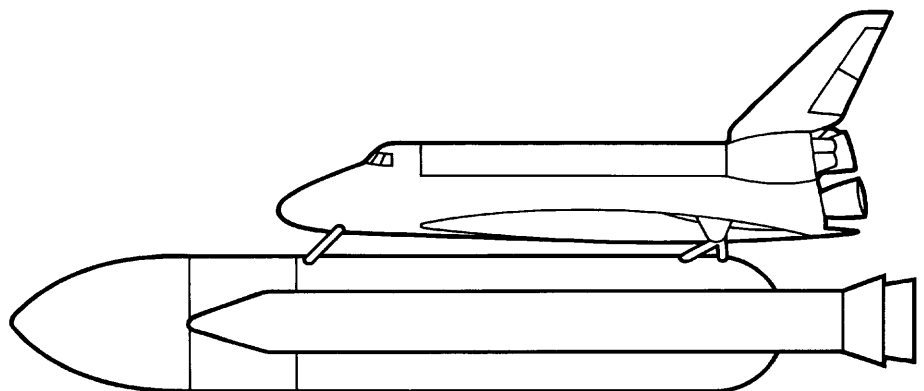
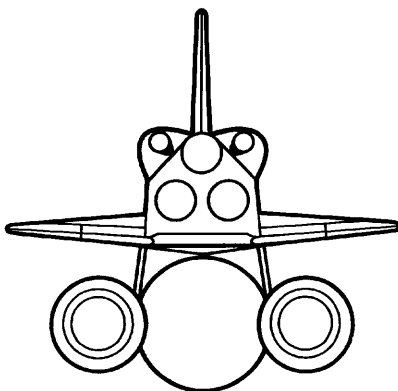
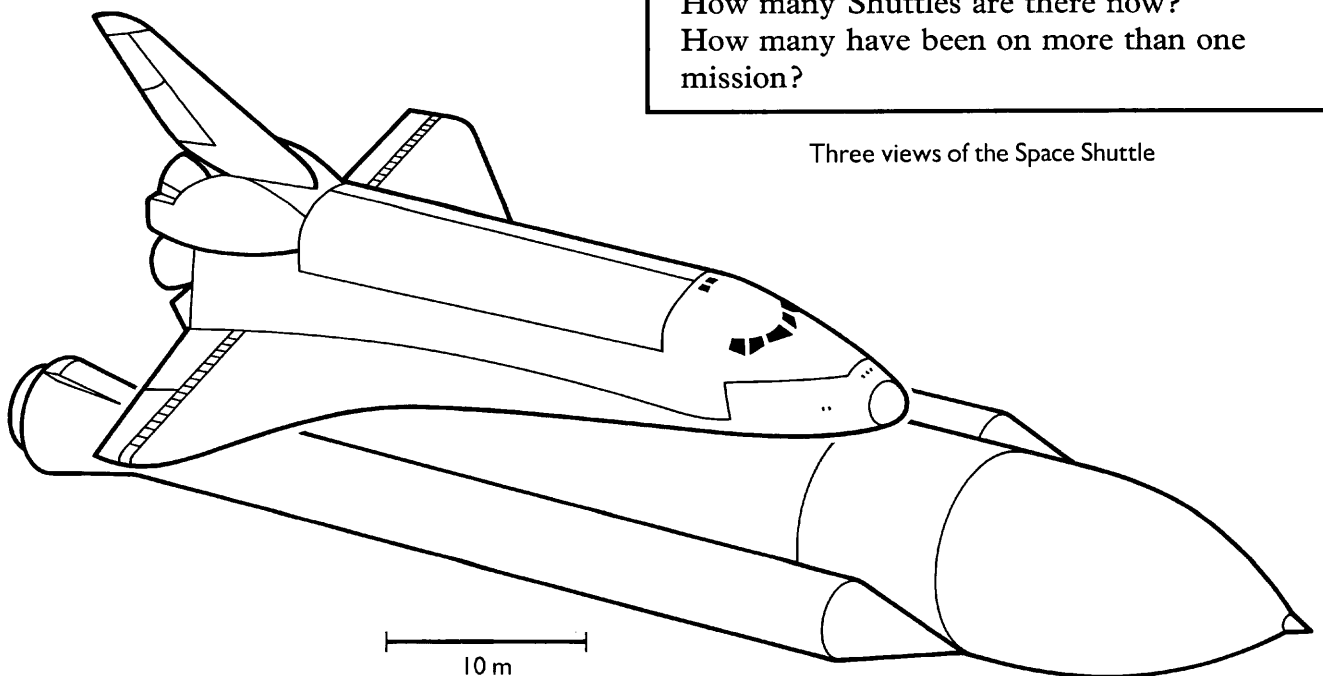
Here are some questions to start you off.

When was the Shuttle designed?
When was the first one launched?
What was its mission?

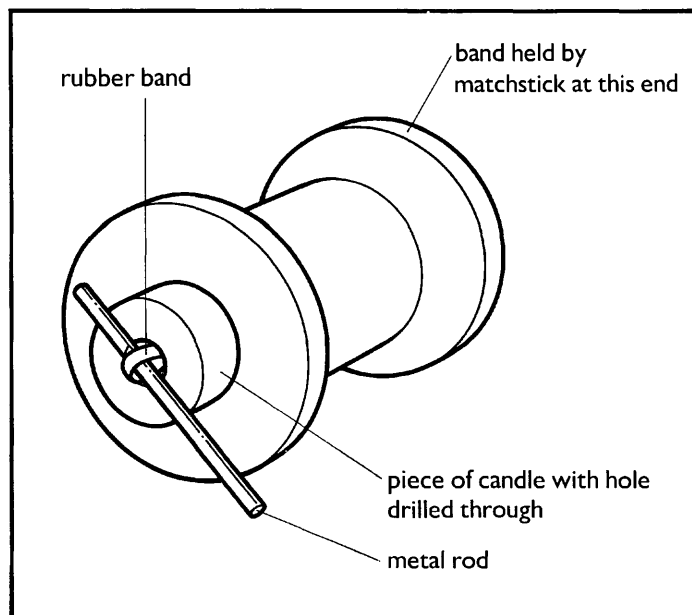
How many missions have there been to date?
What problems have there been on the missions?
What has gone wrong?

What was the main feature on each mission?
How many Shuttles are there now?
How many have been on more than one mission?

Three views of the Space Shuttle



Make a rubber band 'tank'



You can make a cotton-reel tank like the one in the drawing. Wooden cotton-reels are better than plastic (perhaps you can find out why). If you have to use a plastic one you will need a metal washer about the size of a 5p piece. If you cannot find a cotton-reel at all, wooden dowel drilled out will do. You will also need a candle, a rubber band, a matchstick, and a small metal rod or nail.

Our drawings show how to make the 'tank'. When you have made it you can investigate its performance. Here are some questions to help:

How far will the tank go on one wind? (Or on two winds, three winds, etc?)

Can you make a pattern statement about this?

Will the tank climb a slope?

How steep a slope can you make it climb?

How could you help it climb steeper slopes?

Where does the tank's 'fuel' come from?

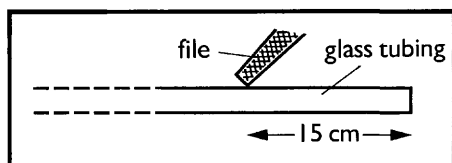
You can make a spinning aeolipile like Hero's.

You will need: a tin with a tight-fitting lid and with two holes cut into the side to take two tight-fitting one-hole rubber bungs; glass tubing (5-mm diameter, 4-mm bore is about right); nylon fishing-line; a fishing swivel; a file to cut the glass; and a Bunsen burner.

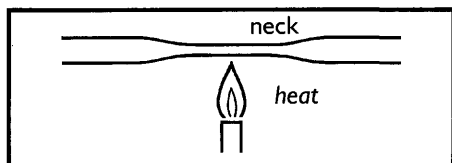
⚠ You must ask an adult to do the metal and glass cutting and the glass modelling for you. Wear safety spectacles.

1 Make sure the bungs fit snugly into the holes.

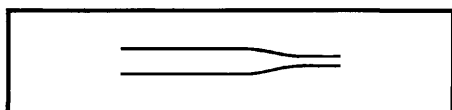
2 Measure 15 cm of glass tubing. Scratch a nick into it with the file. Then, *holding the tubing in cloth or paper*, snap it cleanly apart.



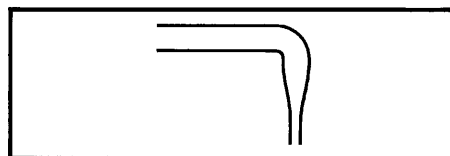
3 Heat the middle of the tubing in a hot Bunsen flame, twisting the tubing all the time. When it begins to soften, take it out of the flame and pull it out a bit to make a neck, as in our drawing.



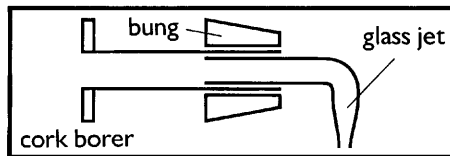
4 Use the file to make a nick in the centre of the neck, and snap it as before.



5 Heat and soften the glass again in the middle of the thick bit. Make a right-angle bend. Repeat with the other piece of tubing. You now have your jets.



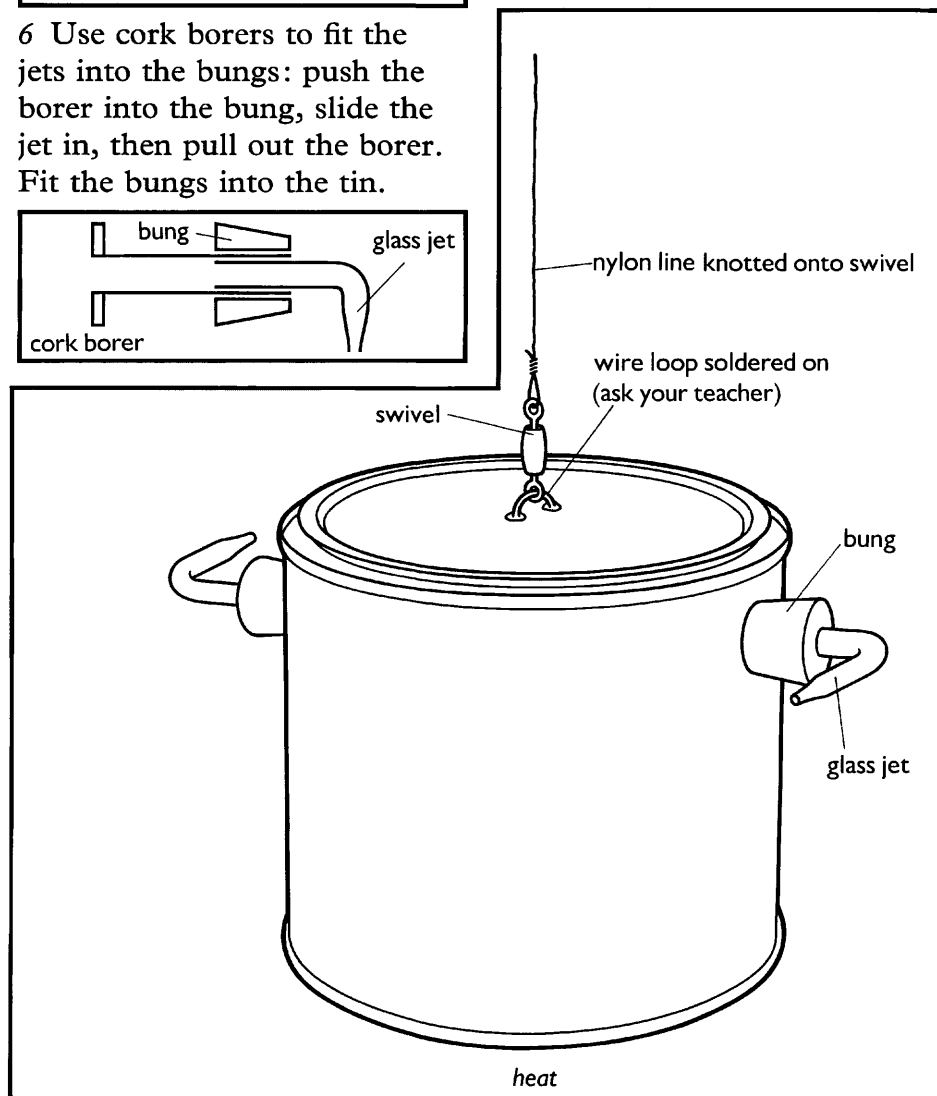
6 Use cork borers to fit the jets into the bungs: push the borer into the bung, slide the jet in, then pull out the borer. Fit the bungs into the tin.



7 Attach the line to the swivel and the swivel to the top of the tin lid.

8 Put a little water in the tin and put the lid on tightly.

9 Hang the tin by the thread from a firm support. Heat the tin from the bottom with a Bunsen burner. *Care!*



10 Try to answer these questions about its performance.

Does the angle of the jets make any difference?

Does it run smoothly?

Can you improve the design?

Make a water pump

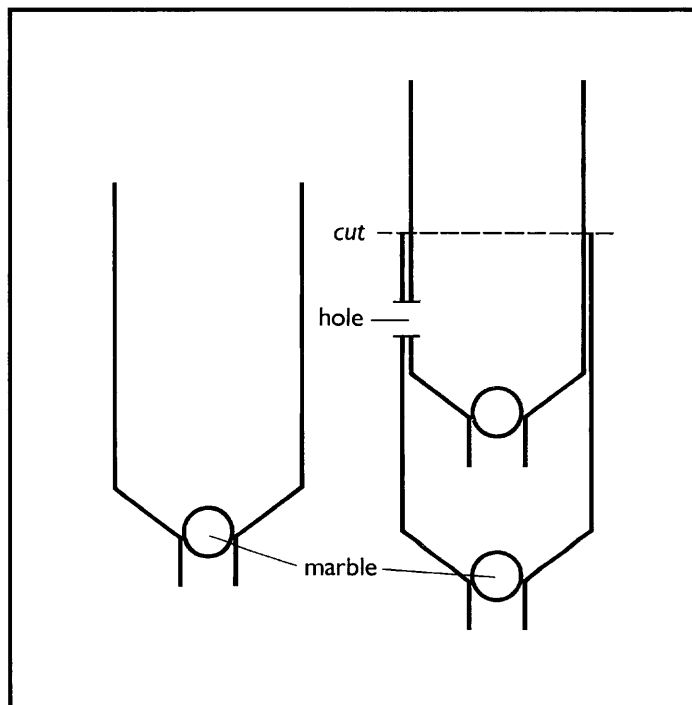
WORKSHEET

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You will need: two empty washing-up liquid bottles, two marbles, a plastic cup, and a length of plastic tubing.

To make the water pump

- 1 Cut the bottom off one bottle (care!) and drop in a marble to make a valve.
- 2 Force the other detergent bottle half way down the first bottle and cut it off level. Drop in another marble to act as the second valve.
- 3 Bore a hole in the side through both bottles, slightly smaller than the plastic tubing (so that it makes a good fit). Push the tubing through the hole.
- 4 Make a hole in the bottom of a plastic cup and force it over the open end of the bottles.



To use the water pump

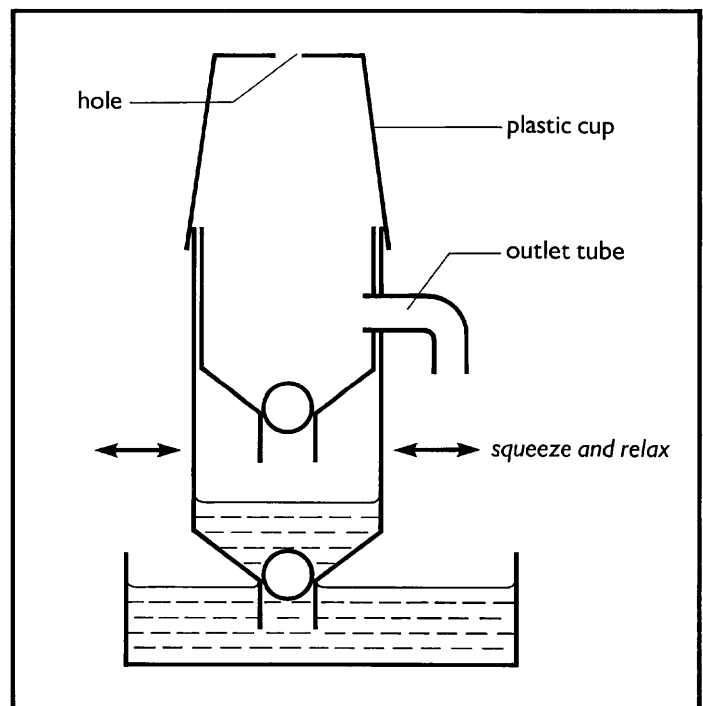
1 To make your pump work, first 'prime' it by pouring a little water into it through the cup, then put it, mouth downwards, into some water.

2 Squeeze the lower bottle and then relax. Keep doing it again and again. Soon it should start to work.

Can you explain how it works?

What size marbles work best?

Could you use things other than marbles?

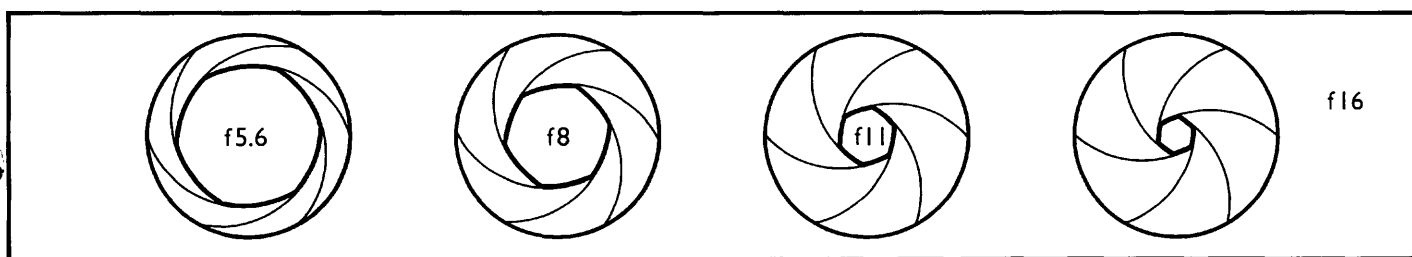
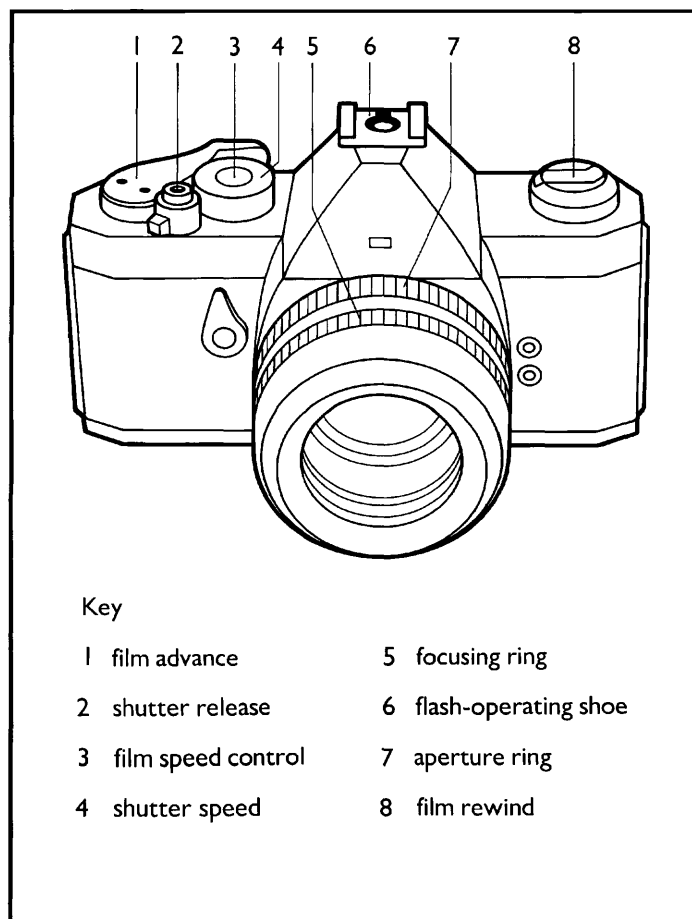


Here is a typical modern single lens reflex (SLR) camera. This type of camera has an important advantage. A mirror and prism system shows you the exact picture you are going to take before you take it. For example, whatever your distance from your subject, you can get it in sharp focus with the focusing ring.

When you look through the viewfinder of such a camera you see a display – coloured lights or a pointer and scale – which show you how to set the shutter speed and aperture. But what difference do they make?

Aperture

One way to control the amount of light getting into the camera is to control the size of the opening (the 'aperture' or 'stop') just behind the lens. Each stop lets in twice as much light as the one on its right. As you move the aperture ring you can watch the viewfinder display and get it just right. The numbers of the stops come from a complicated formula which you don't need to know about.



Shutter speed

Another way to control the amount of light getting in is to change the shutter speed. A fast shutter speed will 'freeze' the movement of your subject. Each speed lets in twice as much light as the next one on the right (see the diagram below). You need at least 1/60th of a second to avoid fuzziness caused by camera shake.

Film speed

Your choice of film matters too. The more sensitive (or 'fast') the film, the less light it needs for a correct exposure. But, the faster the film the less good it is at showing very fine detail. Film speed is measured in ASA. 200 ASA is twice as sensitive as 100 ASA. The camera has a control for adjusting its electronics to different film speeds.

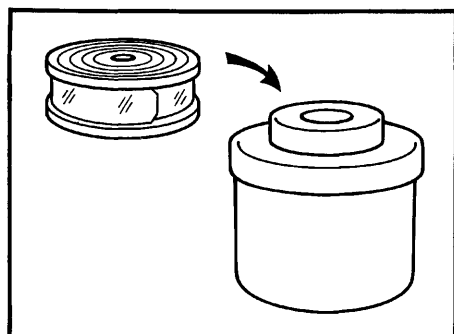
2 1 $\frac{1}{2}$ $\frac{1}{4}$ $\frac{1}{8}$ $\frac{1}{15}$ $\frac{1}{30}$ $\frac{1}{60}$ $\frac{1}{125}$ $\frac{1}{250}$

Here are the instructions for processing a black and white film from an SLR camera (see Worksheet 68). Wear eye protection and wash your hands afterwards.

Load

1 Take the lid off the developing tank and study the film holder. Notice the way it is shaped to hold a film in a spiral.

2 With your hands in a lightproof changing bag, load the film onto the spiral of the developing tank. Put the spiral into the tank and close it.

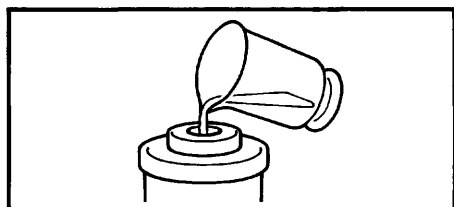


Develop

3 Mix the concentrated developer solution with water, following the instructions on the bottle.

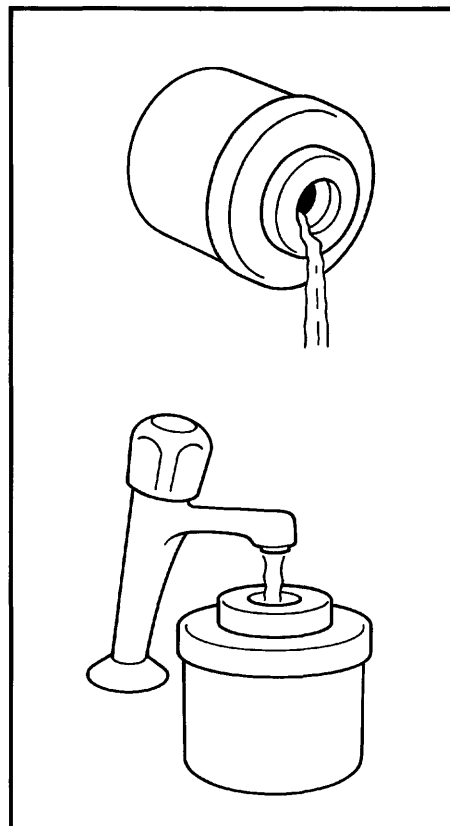
4 Find the development time from the developer instructions.

5 Measure 250 cm³ of mixed developer and pour it into the tank. Leave it for the correct time, agitating every minute.

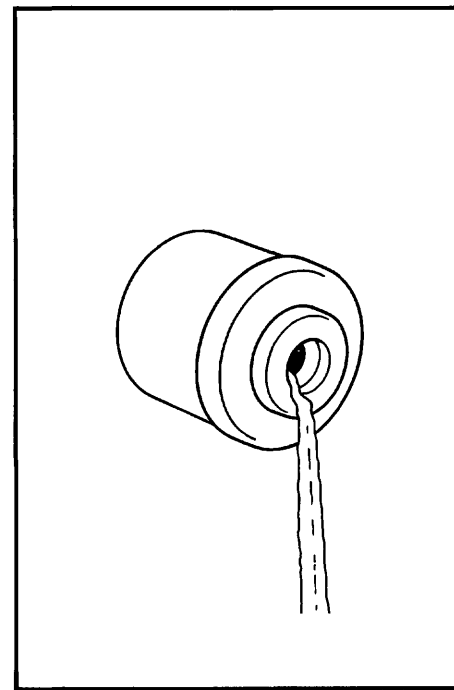


Wash

6 Empty the tank and refill it with clean water. Repeat this three times.

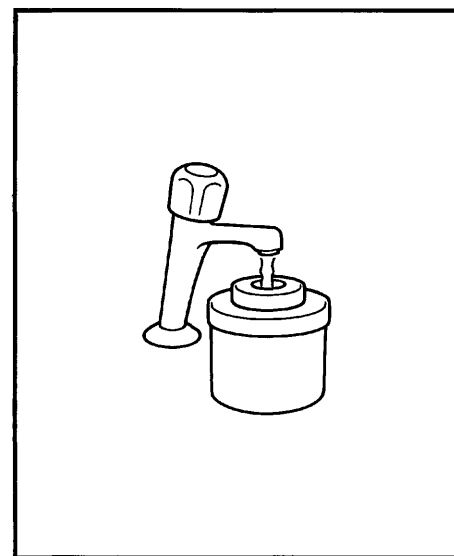


8 Empty the tank – save the fixer solution.



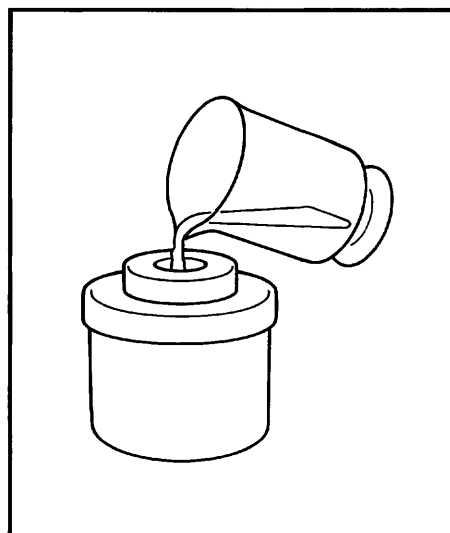
Wash

9 Wash the film again with four tankfuls of water.



Fix

7 Measure 250 cm³ of fixer solution. Pour it into the tank. Leave it for 5 minutes.

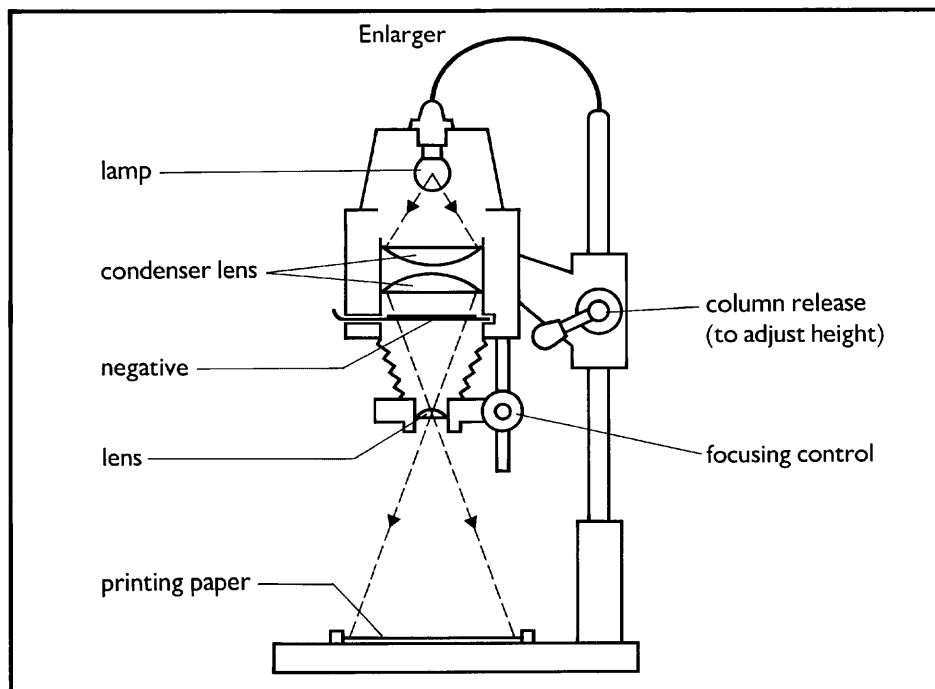


Dry

10 Hang up your negatives to dry. Look at them through a magnifying glass, but avoid putting fingermarks on them.

We have assumed that you will use an enlarger (such as that in our drawing), and that you will be working in a darkroom lit by a coloured 'safe-light'.

- 1 Check that the enlarger negative carrier is clean.
- 2 Feed the negative into the carrier – careful of fingermarks!
- 3 Switch on the safe-light.
Switch off the room light.
Switch on the enlarger.
- 4 Adjust the enlarger height to give you the image size you want.
- 5 Open the aperture wide.
Focus the enlarger.
- 6 Reduce the aperture about 3 stops. Switch off the enlarger.
- 7 Take *one* piece of printing paper out of the box and *close the box*.
- 8 Cut the paper into four equal pieces, and put three back in the box.

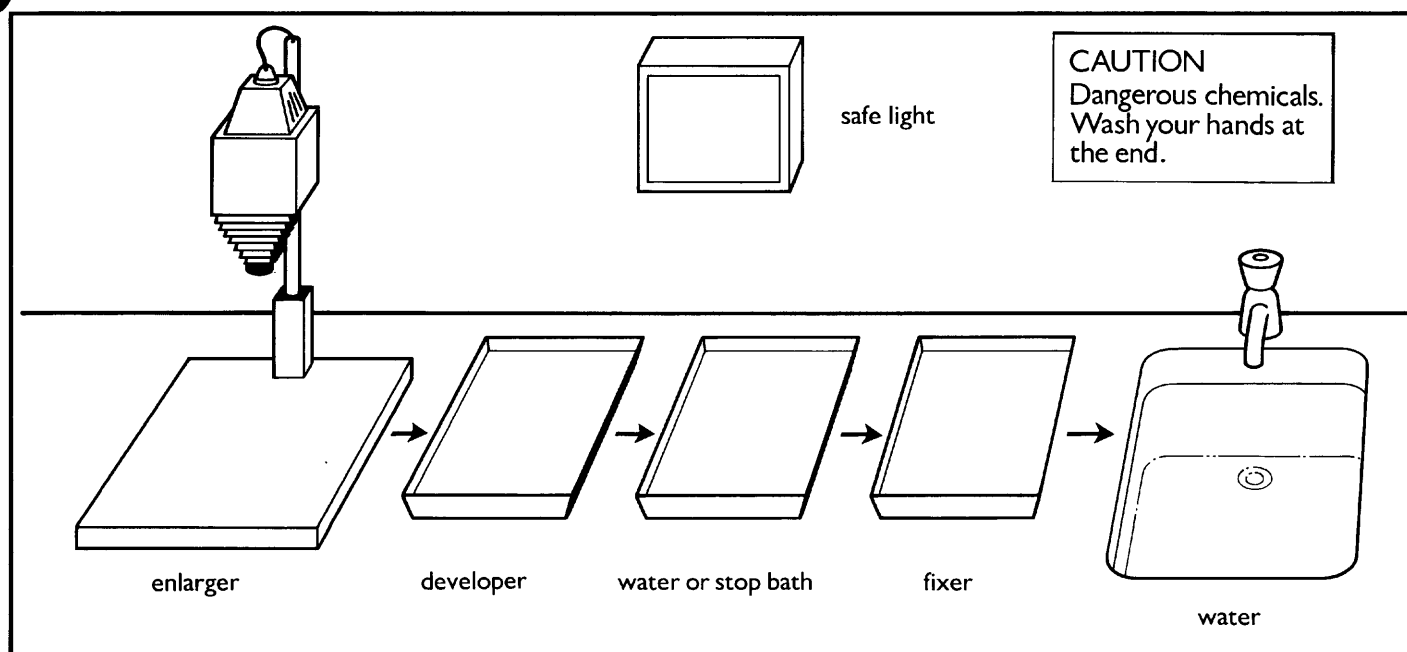


- 9 Put the fourth in the middle of the enlarger stage, switch on for five seconds and switch off.
- 10 Mark this test print '5 seconds' on the back, and put it back in the box.
- 11 Repeat steps 9 and 10, taking one piece of paper at a time from the box and exposing one for 10 seconds,

one for 15, and one for 20. Don't forget to write the exposure time on the prints.

12 Develop and fix the four test prints, following our diagram. Choose the best exposure time.

13 Use this exposure time to make a good print on a fresh piece of paper.



You will need:

ice-lolly stick (as a winder-on), a beaker large enough to take the cassette, and developer/fixer solution made up as in the box opposite.

⚠ Process your film as follows. *Wear rubber or plastic gloves, and eye protection.*

- 1 Put the cassette into the beaker. Put the end of the lolly stick into the winder slot.
- 2 Pour in developer/fixer to cover the cassette.
- 3 Turn the lolly stick anti-clockwise to unwind the film a bit. *Count the number of turns.*
- 4 Wind the film back the same number of turns.
- 5 Wind the film *half* the number of turns anti-clockwise, then wind it back again.
- 6 Keep winding it a little back and forth for at least five minutes.
- 7 Take out the cassette, let it drain, and put it into clean water.
- 8 Open the cassette and carefully rinse the film in clean water for about one minute.

Developer

Dissolve the following substances *one by one* in 400 cm³ of warm (50 °C) distilled water. Make up to 500 cm³. Wear eye protection!

anhydrous sodium sulphite	50 g
hydroquinone	12 g
metol	6 g
sodium hydroxide	10 g

Fixer

Dissolve the following substance in 500 cm³ of distilled water.

sodium thiosulphate	90 g
---------------------	------

When you are ready to use the solutions, mix them together.

One litre of solution should process 10 films if you filter it carefully each time and keep it in a stoppered bottle.

