Box 3

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SATIS 8-14

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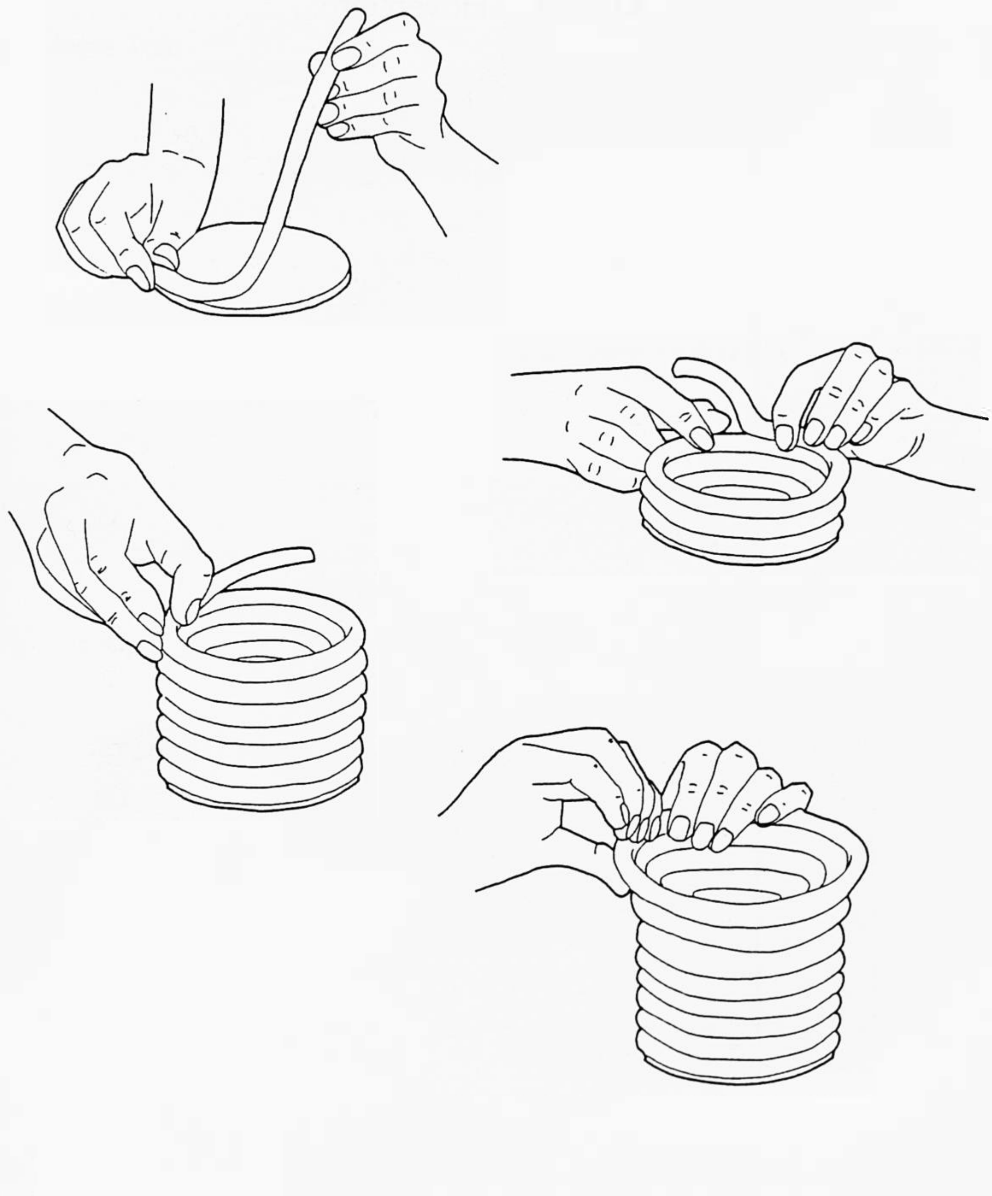
Book I



SATIS 8-14

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A letter to Einstein

What are children's ideas about scientists? Do they have a stereotype in mind? Albert Einstein might be seen to be close to that stereotype – a shock-haired, eccentric character – yet there is an approachability in his gentle, sympathetic face that many children warm to and find attractive.

Einstein had many thousands of letters written to him in his lifetime; the learned, the offensive and the cranky. Above all, he kept a huge collection of letters from children; and he wrote back to them. Some examples are reproduced.

Through 'Writing to Einstein' children can share their own thoughts about science and scientists. Possibly they can consider some of the 'bigger' issues of science and technology.

Contents

Part A
'Writing (a letter) to Einstein' or another scientist.

Part B
'Einstein the plumber' – career choices.

Part C
'A letter to the President' – discussing Einstein's prediction about the dangers of misusing nuclear power.

By using the unit pupils will

- gain more understanding of **the work of scientists.**
- recognise that scientists share ordinary human characteristics.
- recognise the futility of **racial stereotyping.**

Curriculum focus

To communicate, to apply and to investigate scientific and technological knowledge and ideas, and to understand the history of scientific ideas, are essential elements of a developing experience of science.

Pupils should be given opportunities to develop their knowledge and understanding of how scientific ideas change through time. They should study the development of some important ideas in science.

Managing the unit

You might like to reproduce the pictures of Einstein, or make them available.

You could read extracts from some of the letters, or make them available to pupils.

Pupils will need writing materials; notepaper (rather than file paper or exercise books) might help to simulate letter-writing.

Teacher notes

Part A
Writing to Einstein

Through reading the letters and replies of Einstein to a schoolchild, pupils are encouraged to write to:

- Einstein himself, or
- a famous scientist – living or dead, or
- a local scientist, who might be willing to reply.

Part B
Einstein the plumber

After Einstein's declaration that, given his life again, he would choose to be 'a plumber or a pedlar', pupils are asked to write to Einstein and present their views on his decision.

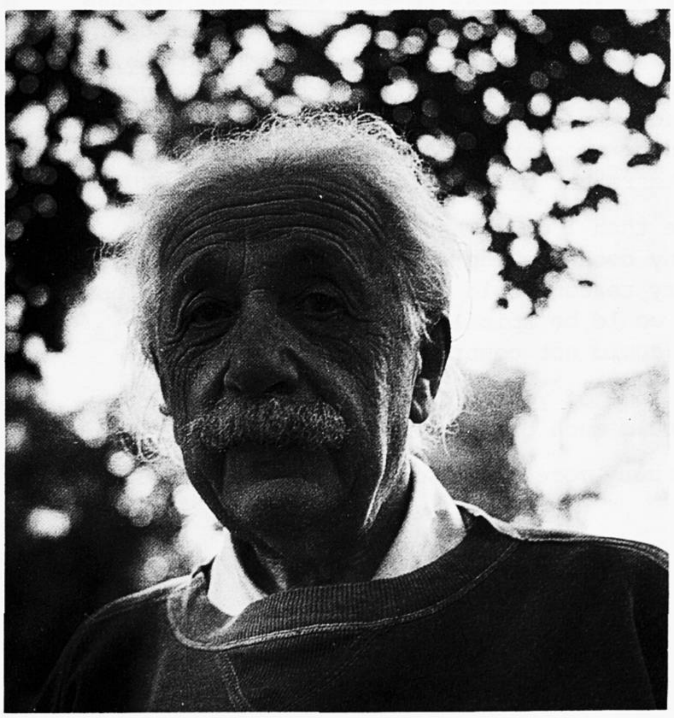
Part C
A letter to the President

Some of Einstein's famous letter of 1939 fore-warning about the dangers of the nuclear bomb is given to discuss. This leads to questions about prejudice – against science, against the able, and against people because of their racial or cultural background.

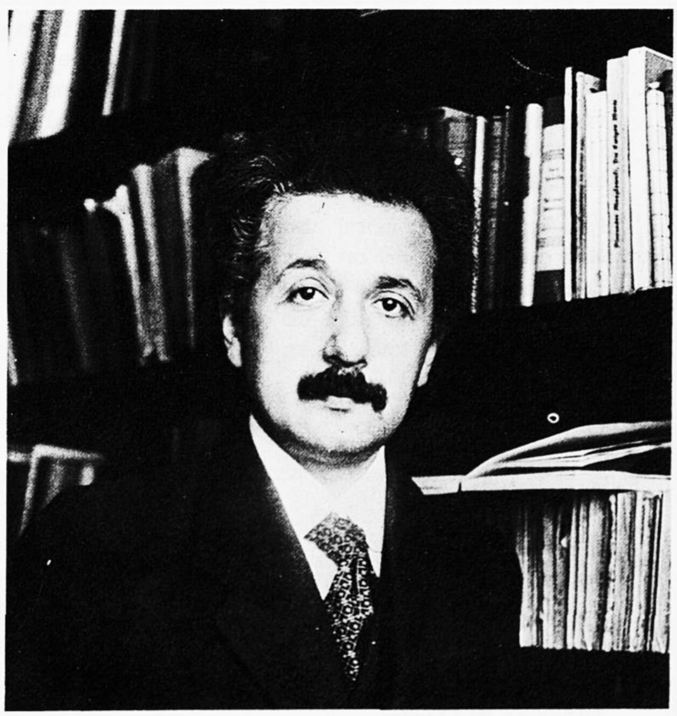
In all parts, pupils could use word processing.

Random facts about Albert Einstein

- He had some of the most brilliant ideas about science and mathematics this century.
- He had difficulty learning to play the violin. His teacher once said, 'Albert you will never learn to play until you learn to count!'
- He was appalled to see his ideas applied to the development of the atomic bomb.
- He had a staggeringly high measured IQ.



This photograph shows Einstein as most of us imagine him – a white-haired old man.



But this is Albert Einstein as a young man – lively, vigorous, with a brilliant mind – perhaps the greatest scientist of this century.

Writing to Einstein

Einstein received many letters from children. He replied to them all. Here are just two.

Tyfanwy Williams wrote to him from a school in South Africa.

St. Cyprian's School
Cape Town
South Africa

10th July 1946

Dear Sir,

I trust you will not consider it impertinence, but as you are the greatest scientist that ever lived, I would like your autograph. Please do not think that I collect famous people's autographs – I do not. But I would like yours; if you are too busy, it does not matter.

I probably would have written ages ago, only I was not aware that you were still alive. I am not interested in history, and I thought that you had lived in the 18th century, or somewhere round that time. I must have been mixing you up with Sir Isaac Newton or someone. Anyway, I discovered during Maths one day that the mistress (who we can always sidetrack) was talking about the most brilliant scientists. She mentioned that you were in America, and when I asked whether you were buried there, and not in England, she said, Well, you were not dead yet. I got so excited when I heard that, that I all but got a Maths detention!

I am awfully interested in Science, so are quite a lot of people in my form at school. My best friends are the Woodrow twins. Every night after Lights Out at school, Pat Woodrow and I call out of our cubicle windows, which are next to each other and discuss Astronomy, which we both prefer to anything as far as work goes. Pat has a telescope and we study those stars that we can see. For the first part of the year we had the Pleiades, and the constellation of Orion, then Castor and Pollux, and what we thought to be Mars and Saturn. Now they have all moved over, and we usually have to creep past the prefect's room to other parts of the building to carry on our observations. We have been caught a few times now though, so its rather difficult.

Pat knows much more about the theoretical side than I do. What worries me mostly is How can Space go on for Ever? I have read many books on the subject, but they all say they could not possibly explain, as no ordinary reader would understand. If you do not mind me saying so, I do not really see how it could be spiral. But then, of course, you obviously know what you are saying, and I could not contradict!

I must apologise once more if I have taken up some of your valuable time. I am sorry that you have become an American citizen, I would much prefer you in England.

I trust you are well, and will continue to make many more great Scientific discoveries.

I remain,
Yours Obediently,

Tyfanwy Williams

Tyfanwy Williams

Writing to Einstein

August 25,1946

Miss Tyfanwy Williams
St.Cyprian's School
Cape Town,
So. Africa

Dear Tyfanwy!

Thank you for your letter of July 10th. I have to apologize to you that I am still among the living.

There will be a remedy for this, however.

Be not worried about "curved space". You will understand at a later time that for it this status is the easiest it could possibly have. Used in the right sense the word "curved" has not exactly the same meaning as in everyday language.

I hope that yours and your friend's future astronomical investigations will not be discovered anymore by the eyes and ears of your school-government. This is the attitude taken by most good citizens toward their government and I think rightly so.

Yours sincerely,

Albert Einstein

Albert Einstein.

Writing to Einstein

St. Cyprian's School
Cape Town

19.9.46

Dear Sir,

I cannot tell you how thrilled I was to receive your letter yesterday. I still find it hard to believe that the most famous scientist in the world actually answered my letter! Thank you very much. The news that I had your signature went round the school in no time, and gave everyone something to talk about.

At the moment we are having a Mathematics lesson. The Maths mistress does not like our form, so we are meant to be working on our own. (She has refused to teach us as we talk too much). It seems like the middle of Summer today; just the kind of day one cannot stay inside on. Outside birds are singing, and all that sort of thing, and here we sit learning that x and y is equal to something divided by something else! I wish I understood Maths, for it is needed in astronomical calculations I believe.

I forgot to tell you, in my last letter, that I was a girl. I mean I am a girl. I have always regretted this a great deal, but by now I have become more or less resigned to the fact. Anyway, I hate dresses and dances and all the kind of rot girls usually like. I much prefer horses and riding.

Long ago, before I wanted to become a scientist, I wanted to be a jockey and ride horses in races. But that was ages ago, now. I hope you will not think any the less of me for being a girl.

You can see the Southern Cross fine from the window of the room I have at school this term. I wonder if you have ever seen it: It is an awfully fine constellation, and when I am feeling fed up at night, after a day at school, I look at it, and it cheers me up no end. I have been lucky enough to have seen both Southern Cross and North Star, but I prefer our Southern Cross.

I say, I did not mean to sound disappointed about my discovery that you were still alive. In fact I was just the opposite, for it's much nicer for one's favourite scientist in history alive, than to know that he died something like a century ago. I still wonder about space going on for ever, but I was very much encouraged by your saying I would one day understand the theory of curved space. I had almost given up hope that I ever would. I have been told that one must be pretty well advanced both astronomically and mathematically, to agree with such statements. I am afraid that from a theoretical point of view, my astronomy is just about on a par with my Maths for the moment, that is I hope to improve both some day.

There is not any news at school except that we won the After-school Hockey last Saturday. Thank you once again, for your letter and signature.

Yours sincerely,

Tyfanwy Williams

Tyfanwy Williams

Writing to Einstein

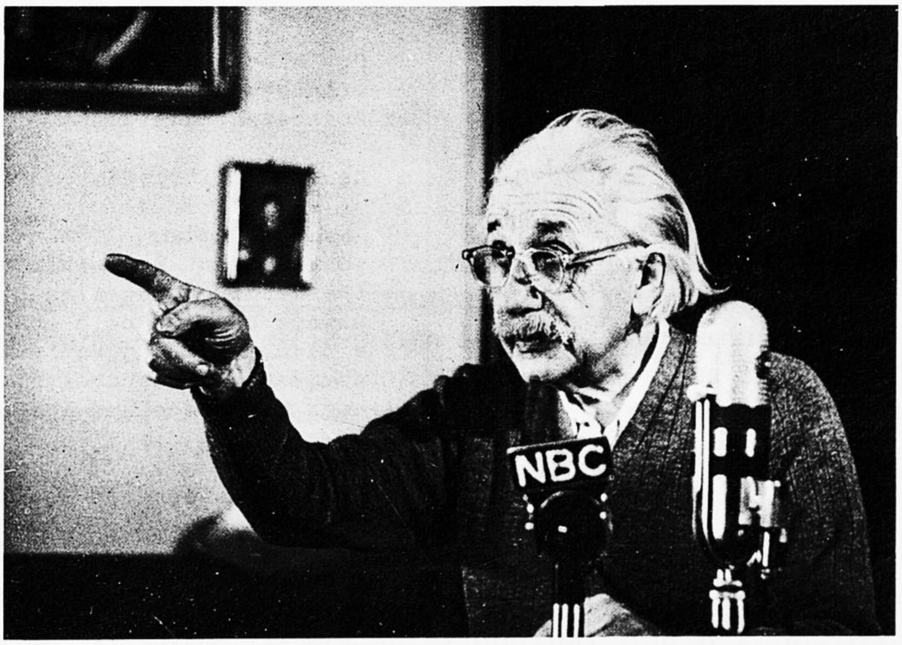
Einstein's answer to the second letter was:

'I do not mind that you are a girl. But the main thing is that you yourself do not mind. There is no reason for it.'

1 *How would you write to Einstein? What would you like to ask him? Remember that he was the greatest scientist of his time. Discuss this as a group, and write a letter to Einstein.*

2 *Who is the most interesting scientist you know about? What would you like to ask them? Write a letter to this person (living or dead) and ask them the questions only they can answer.*

3 *Write a letter to a local scientist – a teacher at your school, a friend, or a parent from your school. Ask them about their work, and about the problems that puzzle you.*



Einstein the plumber

In 1954, when he was 75 years old, Einstein wrote to the editor of *The Reporter* magazine. This was a time when many clever people – both scientists and those in the arts – were being mistrusted and threatened in America.

'If I were a young man again, and had to decide how to make my living, I would not try to become a scientist or scholar or teacher. I would rather choose to be a plumber or a pedlar in the hope to find that modest degree of independence still available under present circumstances.'

One of the many humorous replies was from R. Stanley Murray of the 'Stanley Plumbing and Heating Company'.

STANLEY PLUMBING & HEATING CO
CONTRACTORS
1212 SIXTH AVENUE
NEW YORK 19, N.Y.

November 11, 1954

Dr. Albert Einstein
Princeton University
Princeton, New Jersey

Dear Dr. Einstein:

As a plumber, I am very much interested in your comment made in the letter being published in the Reporter Magazine. Since my ambition has always been to be a scholar and yours seems to be a plumber, I suggest that as a team we would be tremendously successful. We can be possessed of both knowledge and independence.

I am ready to change the name of my firm to read: Einstein and Stanley Plumbing Co.

Respectfully yours,

R Stanley Murray

R. Stanley Murray

Imagine you are Einstein. You receive this letter. Is it a joke, or a serious proposal?

How will you reply?

Write a letter to Stanley Murray, thank him for his kind offer. Tell him what you plan to do about it.

A letter to the President

Einstein wrote this letter to the President of the United States, Franklin D Roosevelt, in 1939, just before the Second World War. In it, he predicted the invention of the atomic bomb. Most of his predictions in the letter were correct; but one was wrong – can you find it?

Imagine you were President Roosevelt. How would you reply to Einstein's letter? Is he right? Or is he just a crank? What can you say and do?

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable – through the work of Joliot in France as well as Fermi and Szilard in America – that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable – though much less certain – that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

A letter to the President

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is The Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States.

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsacker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,

Albert Einstein

(Albert Einstein)

A letter to the President

Here is President Roosevelt's reply:

THE WHITE HOUSE
WASHINGTON

October 19,1939

My dear Professor:

I want to thank you for your recent letter and the most interesting and important enclosure.

I found this data of such import that I have convened a Board consisting of the head of the Bureau of Standards and a chosen representative of the Army and Navy to thoroughly investigate the possibilities of your suggestion regarding the element of uranium.

I am glad to say that Dr. Sachs will cooperate and work with this Committee and I feel this is the most practical and effective method of dealing with the subject.

Please accept my sincere thanks.

Very sincerely yours,

FD Roosevelt

Dr. Albert Einstein,
Old Grove Road,
Nassau Point,
Peconic, Long Island,

Einstein's letter encouraged the Americans to launch the 'Manhattan Project' which built the atomic bomb and led to the destruction of Hiroshima and Nagasaki.

Einstein spoke out passionately against nuclear weapons. He was a pacifist who rejected war and violence, believing that disputes should be settled by peaceful means.

Albert Einstein died in 1955, one week after signing a letter urging scientists to get together to prevent nuclear war.

A letter to the President

Questions for development

1 *Is there such a person as 'a scientist'? What are they like? What makes them different from ordinary people?*

2 *Is possible to develop scientific ideas without the danger that someone will use them wrongly?*

3 *What are the big questions facing us today? What problems would you like Einstein to tackle for us?*

4 *Do all scientists have to be super-intelligent? Is there a place for very ordinary people in science and technology? Are they likely to make great discoveries?*

5 *Einstein answered all his letters – especially those from children. Yet he was a very busy man. What does that tell us about him?*

6 *Einstein was harshly treated by some people because of his racial background. These people hated all Jews, whoever they might be. Why is it senseless to hate a whole group of people? What does learning about Einstein tell us about individuals and groups?*

All to pot!

Clay is an excellent subject for a materials study. Widely available, varied, and with practical uses, it can be prepared and fired in most schools. This unit looks at its chemistry, and the changes it undergoes to produce a usable artefact.

There is a short amateur video to accompany this unit, called 'All to pot'. It traces the stages of work in a small pottery.

Contents

Part A
'All to pot!' – a factsheet on clays and clay products.

Part B
Exploring clay. Recording practical activities.

Part C
Making a pot.

By using the unit pupils will

- learn about the **chemistry of clay**, and the **chemical changes** that produce pottery.
- make their own observations of clay and its properties.
- learn about the work of a commercial pottery.
- make their own pots!

Curriculum focus

Pupils should have the opportunity to compare and study a range of physical properties, including density, and thermal and electrical conductivity of materials. The materials could be man-made or naturally occurring, and should be studied in everyday uses. This study should involve working with solids, liquids and gases and include … ceramics.

Pupils should be made aware of the range of sources of raw materials, including those derived from the air, rocks, fossil fuels and living things. The work should illustrate ways in which chemical reactions lead to the formation of new materials and relate to everyday processes …

They should investigate some natural material (rock or soil) and link the properties of minerals and rocks to their uses as raw materials in construction.

Managing the unit

Parts A and B are concerned with the physical and chemical properties of clay; Part C – coil, slab and slip pot making – is optional, and might be an activity for the art department. Earth clay is available in solid form or in plastic form. You are advised to buy it in solid form as it is messy to make up from powder. Pieces of clay can be sliced off this hunk easily with a string or wire tied to two empty cotton reels. Interesting textures can be made by scraping and pressing objects into the clay.

Clay is messy. Desk and table tops can be protected with a plastic bin liner that has been cut open and taped down. (The plastic liner can be thrown away afterwards.)

Save all excess clay in an airtight container to prevent it drying out. If storing for longer than a few days, make a hole in the clay with a thumb and fill the hole with water.

Clay can clog drains so scrape the excess into a storage container.

Children need to wear some protective clothing when working with clay – an old shirt is ideal. If clay does find its way onto school clothing then it should be allowed to dry completely and brushed off.

Pupils may wish to save the clay objects they have made. Allow the objects to dry thoroughly and they can be painted with poster paints and varnished. Of course, this will not make them waterproof.

It is not advisable to fire the clay products made by young pupils as any air bubbles trapped in the clay – or escaping combined with water – will explode and someone will be very disappointed.

The teacher factsheet on clay may be appropriate for some pupils.

The Gladstone Pottery Museum
Uttoxeter Road
Longton
Stoke on Trent
ST3 1PQ

0782 319232

encourages visitors to its working museum. Contact the Curator, Angela Lee.

See 'Changing substances' in *The Material World* (Nelson Balanced Science) by John Holman for more detail.

Teacher notes

Part A

All to pot!

Pupils are asked to read a factsheet on clay. A number of key words are given in bold. They are asked to draw up flowcharts to explain how a flowerpot and a china plate are made.

The sheet introduces the chemistry of clay, and deals with the changes that take place when clay is dried and fired.

Clay has a giant layer structure. Water molecules separate the layers of silicon, aluminium, oxygen and hydrogen atoms when the clay is wet; that's why the clay is malleable. Drying the clay evaporates these water molecules, and the clay becomes crumbly instead of slippery. Firing the clay joins the layers together. The clay is hard; the change is irreversible.

Part B

Exploring clay

This part asks pupils to observe and explore the qualities of clay. It helps to have more than one clay available. Pupils will ask you for water, fired clay, and glazed and coloured pottery. These should be available from your art department.

Question 9 asks the reasons for choosing slip casting for industrial pottery. The answers are:

Slip casting does not need skilled potters.

Using moulds, all the pots will be identical in size.

Higher rates of production are possible.

Note that slip casting can produce complex and irregular shapes, too. But slip moulds are expensive to produce.

Part C

Making a pot

Using a small amount of clay, pupils are asked to make a coil or slab pot. It is sufficient to air dry this. Note the precautions above about firing.

Factsheet on clay

There are many different clays.

Kaolin is a natural, white clay containing mainly silica and alumina. It is like a crystal in structure, which makes it very strong.

Kaolin is a **primary** clay; you find it where it was made. This clay is used to produce white or light coloured finishes. It can withstand very high temperatures.

Ball clay contains similar chemicals to kaolin, but it is finer and more **plastic**. After firing it turns almost white. Ball clay has been moved – perhaps by water – from where it was made to where you find it. It is a **secondary** clay.

Fireclay is similar to kaolin but contains more **iron** which gives the clay a buff colour when fired. This clay can withstand high heat and so it is used as firebrick and as lining and shelves for kilns.

Stoneware is a mixture of several clays plus silica and alumina. This mix results in a clay with good properties of plasticity, colour, and firing temperature. When fired, this clay becomes hard and **vitreous** (it has a glass-like finish) and is able to hold water without being glazed. After firing it usually turns light grey. It's very like earthenware, but fired at a higher temperature.

Earthenware is made from natural clay and is fired at lower temperatures (950 °C and 1150 °C). The fired clay is red brown, **matt,** and will not hold a liquid. Originally, this was the name given to any local clay. For the last two hundred years, we have used it for a mixture of ball clay (25 %), china clay (25 %), flint (35 %), and china stone (15 %).

Porcelain is a specially prepared clay containing kaolin, ball clay, **feldspar** and flint. The clay is white, hard, won't absorb water, and is fired at a high temperature (1450 °C). This clay is not very plastic and is hard to work.

Bone china is the type of porcelain used in Britain. It is made of 25 % china clay, 25 % china stone, and 50 % bone. Bone china is hard, intensely white, and allows light to pass through it.

All to pot!

Try this

Read this carefully. Then draw a flow chart of the stages in making

- a flowerpot.
- a china plate.

What is clay?

Clay is a **granite-type rock** that has decomposed into tiny particles over millions of years. It might be found in the same areas as the 'parent' rocks, or at the bottom of lakes or lagoons where they have been washed from some high rock formation. Most clay, as it comes out of the ground, is mixed with rocks, pebbles and sand. It must be made pure before it can be used.

The potter prepares clay for working by **benching** or wedging the clay. A lump of clay is cut in half with a piece of wire. One half is lifted up and slammed hard onto the table, then the other half is thrown on top of the first. The process is repeated over and over again, until the cut clay is completely smooth and free from air bubbles.

Benching clay takes a good deal of strength. It removes all the air trapped in the clay. If any air is left in the clay then it will **expand** in the **kiln**. The pot is likely to crack or even explode while drying or being **fired.** Now the potter shapes the pot and leaves it to dry.

When the clay dries, **water** leaves the clay and the tiny particles are left stuck together. A clay pot usually takes about two or three days to dry at normal temperatures.

The first potters discovered that dried clay pots could not be used for their cooking because the clay cracked over an open fire. Water and other liquids can seep through the tiny **pores** in the dried clay. Slow heating and cooling hardens clay that is free of air bubbles, so that it soaks up water without going soft – like a flowerpot!

Fired clay is hard or brittle. But it is not waterproof. It needs to be glazed.

A **glaze** is a mixture of chemicals which, at a very high temperature, **react** together to form the shiny, colourful surface that you have seen on pottery.

The glaze is liquid, and the fired clay is dipped into the liquid or the glaze may be painted onto the pot. The method used will depend on the size of the pot, and the type of pattern the potter wants to create.

One of the first glazes was made from galena, or lead sulphide. Many glazes use potentially harmful or poisonous.

The glazed pot is fired in a kiln heated either by electricity, gas or oil. During firing the chemicals in the glazes will be oxidised or reduced.

Oxidation is the addition of oxygen to a substance. If the kiln atmosphere is rich in oxygen, the glaze appears clear and bright.

All to pot!

Reduction is the removal of oxygen from a substance. Oxygen is removed from the metal oxides and they become metal elements. The glaze appears shiny and lustrous.

Reduction firing releases **carbon** into the kiln. The carbon takes the oxygen from iron and copper oxides in reduction glazes. The normally green copper then becomes a ruby red and the iron oxide a grey-green colour.

You can make pots from **slip** by pouring the creamy mixture of clay and water into special **plaster of Paris** moulds. The moulds absorb the water from the slip, and so the clay builds up as a cast.

But why doesn't this layer stop the rest of the water being absorbed from the clay? The answer is that **alkalis**, added to the slip, make it very liquid, although it doesn't contain much water. This is because it acts as a **deflocculent** – it stops the clay particles sticking together.

Exploring clay

The craft of pottery is more than seven thousand years old. Things that are made from clay and then dried and baked hard in a hot oven called a kiln are known as **ceramic** materials. They include bricks and tiles as well as pottery.

Look closely at a lump of clay. How would you describe it? Think about its colour.

1 *Describe your clay.*

Is it hard or is it soft?

Is it smooth or is it rough?

Is it warm or is it cold?

What is its smell?

What is in clay and where does it come from?

Clay, like sand, is formed from rocks which have been broken down by the action of wind, rain, rivers and even glaciers. Clay particles are much smaller than sand particles and contain a different mixture of chemicals. Soil contains groups of clay, and sand particles stuck together forming crumbs of soil.

When you touched your lump of clay did you notice how soft and wet it felt? This is because the tiny clay particles are covered with a layer of water and this makes them stick together more strongly than sand particles.

2 *Add a little water to your lump of clay and 'work it' with your fingers. Try stretching the clay. What do you notice?*

The plasticity of clay (being able to stretch and squeeze it) is very important to the potter.

3 *Take a small piece of the clay (about the size of your little finger) and add more water to it. What has happened to the clay?*

The added water trickles into the tiny gaps between the clay particles and is held there. Liquid (or runny) clay is called slip.

Ask your teacher for a piece of dried clay.

Compare it with the lump of clay you had at the start. Try snapping the dried clay with your fingers.

Clay that has been left to dry in the air becomes hard. But it is not very strong and can break easily.

4 *Ask your teacher for a piece of clay that has been baked or 'fired'. Is it the same colour as the air-dried clay?*

Exploring clay

5 Does it have a gloss (shine) or is it matt (dull)?

During the firing process the colour of the clay changes because the different chemicals in the clay are changed into new substances which have a different colour.

6 Place a few drops of water onto the fired clay. What do you notice happening?

7 Does the fired clay become soft when water is added to it?

The hard fired clay will never again become soft, even if left in water for hundreds of years.

These chemicals are used to make glazes:

Chemical	Colour of glaze
Vanadium Oxide	Yellows
Chromium Oxide	Greens (pink in some glazes)
Manganese Oxide	Purple Brown
Iron Oxide	Browns and Blacks
Cobalt Oxide	Blues
Nickel Oxide	Greys
Copper Oxide	Greens, Purples (Reds in some glazes)
Uranium Oxide	Yellows and Reds
Tin Oxide	White

How do potters make their wares waterproof?

The earliest potters found that when their air-dried pots were slowly baking, impurities in the clay, such as fine sand or even soot from the fires, formed a layer that strengthened and waterproofed the pots. These potters had made an important discovery. They had discovered the first glazes.

This glazed surface, as well as looking pretty, makes a waterproof coating for both the inside and the outside of the pot. It is the glazed finish inside a coffee cup that keeps the liquid there until it has been drunk!

Have a look at the samples of glazed pottery.

8 What chemicals were used to glaze your pottery samples?

The first potters moulded the clay into shape with their hands, or coiled long 'snakes' of clay round and round to build up the sides of bowls and jugs. The pots were then decorated by scratching patterns or by pressing cord or matting on the wet clay. Patterns were also painted on with different coloured clays.

Slip casting

Imagine you are a potter. You've just had an order for five hundred celebration drinking mugs from a school. They must be identical. They must be well shaped. And they must be ready by the end of next week. You haven't enough skilled potters to make them.

You think of slip casting.

Slip casting uses hollow moulds. There is no need to throw and mould pots. Pots can be produced very quickly. You call in some casual labour. Now you can do the job!

9 Explain why you would choose slip casting, rather than throwing pots.

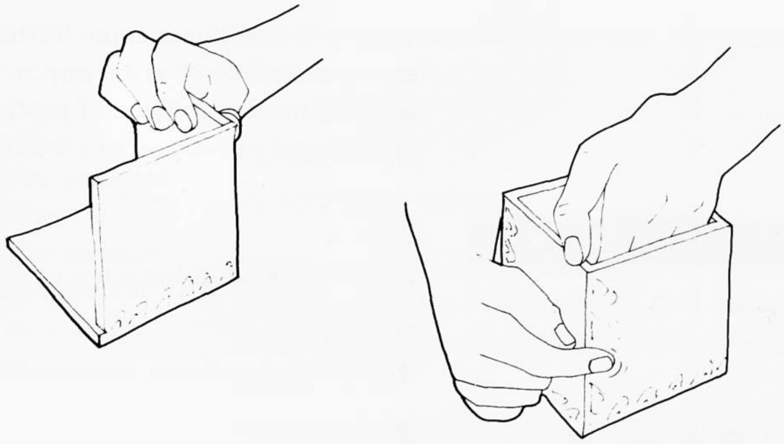
Mould making is a skilled job. Moulds are expensive. Nothing is without cost!

Making a pot

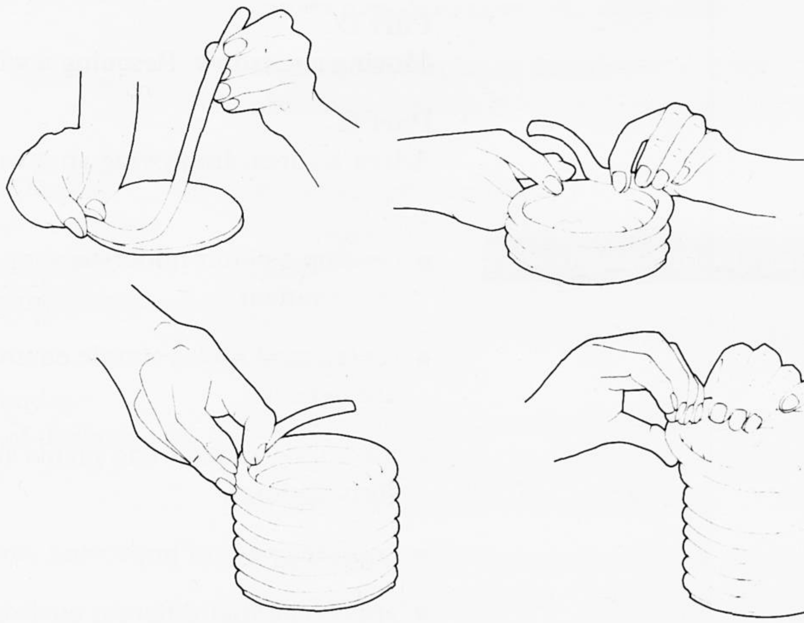
Try this

Use your lump of clay to make a model or pot. Here are some ideas you might like to use:

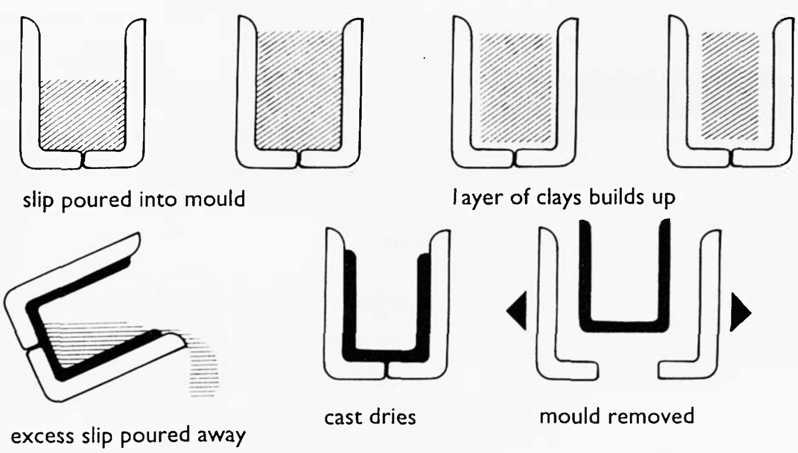
Slab pots Roll out your lump of clay using a roller or bottle to form a flat slab. Cut five equal squares from the slab and fix them together as shown in the picture.

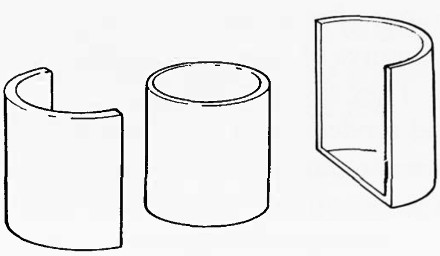


Coil pots Squeeze the lump of clay in your hands to make a sausage shape. Flatten some of the clay to make a bottom for your pot about six centimetres in diameter. Break off a piece of the sausage and roll it on the workboard until it is about 1 cm thick. Coil the clay around the base to make a pot.



Slip pots You will need a mould and access to a kiln for this.





When you have finished ask your teacher if you can watch the video called ALL TO POT!

Audit your environment

This unit introduces some fresh ways of looking at your own environment. How is environmental quality judged? What constitutes an environment in need of protection? How far should we go to protect and preserve that environment?

Contents

Part A
Float a frisbee! Using a toy as a **quadrat**.

Part B
Triple-ess eye. **Sites of Special Scientific Interest**.

Part C
All along the line. A simple **transect**.

Part D
Moving a meadow. Rescuing a wildflower **environment**.

Part E
Adopt an area. Improving an area near you.

By using the unit pupils will

- develop a better understanding and appreciation of their own environment.
- understand how a simple environment may show small local differences.
- learn how animals and plants show adaptations to their surroundings.
- consider ways of improving environments without damage.
- appreciate that different environments make different demands on animals and plants.

Curriculum focus

Pupils should consider the benefits and drawbacks of applying scientific and technological ideas to themselves, industry, the environment and community. Through this study they should begin to understand how science shapes and influences the quality of their lives.

Pupils should study a variety of habitats at first hand and make use of secondary sources to investigate the range of seasonal and daily variation in physical factors, and the features of organisms which enable them to survive these changes. They should come to appreciate that beneficial products and services need to be balanced against any harmful effects on the environment.

Teacher notes

Part A
Float a frisbee!

This part asks pupils to look very closely at their area using a modification of the 'random quadrat'. A frisbee, paper or plastic plate, thrown at random, will disclose different plants and animals. If pupils are set the challenge of finding different plants and animals with every throw, they quickly learn to throw into varied areas – longer grass, path edges – where different species will be found.

Where collecting will not cause damage, specimens can be taken back for identifying and for study.

Part B
Triple-ess eye

An SSSI ('Triple-ess eye') – a Site of Special Scientific Interest – is subject to restrictions and controls. This part looks at the reasons for selecting an SSSI, and the effects on the owner and visitors.

A paired roleplay between a farmer and a naturalist tackles some of the issues of declaring an SSSI.

Part C
All along the line

String and a hand lens (magnifying glass) are used for a simple transect. Pupils are asked to record the plants and animals they discover. A good transect will cross some changes – a path edge, or a hedgerow.

Part D
Moving a meadow

A real life story of how a wildlife meadow was moved and relaid. Pupils are asked to write (or draw) a flow chart of the proces.

They need to think about planning; matching the area; clearing the site; matching the soils and aspect; cutting and transporting the meadow; laying it; ensuring that the plants will grow; aftercare.

Part E
Adopt an area

Pupils are asked to think of ways in which they would record the changes in an area during a day; the instruments to use, where and how to place them.

They are asked to design an experiment to discover whether light, or changing temperature, causes daisies to open and close daily.

Both are examples of experimental design; an obvious follow-up is to try them in practice.

Teacher *information*

The Nature Conservancy Council was split in April 1991 into:

The Nature Conservancy Council for England (English Nature);

The Nature Conservancy Council for Scotland, which merged with the Countryside Commission to form the Scottish Natural Heritage Council;

The Countryside Council for Wales, formed from the Nature Conservancy Council for Wales and the Countryside Commission for Wales; and

The Joint Nature Conservation Committee 'overseas, national and international issues'.

This was a result of the Environmental Protection Act of September 1990.

Float a frisbee!

You will need

A frisbee
A safe, clean, open space

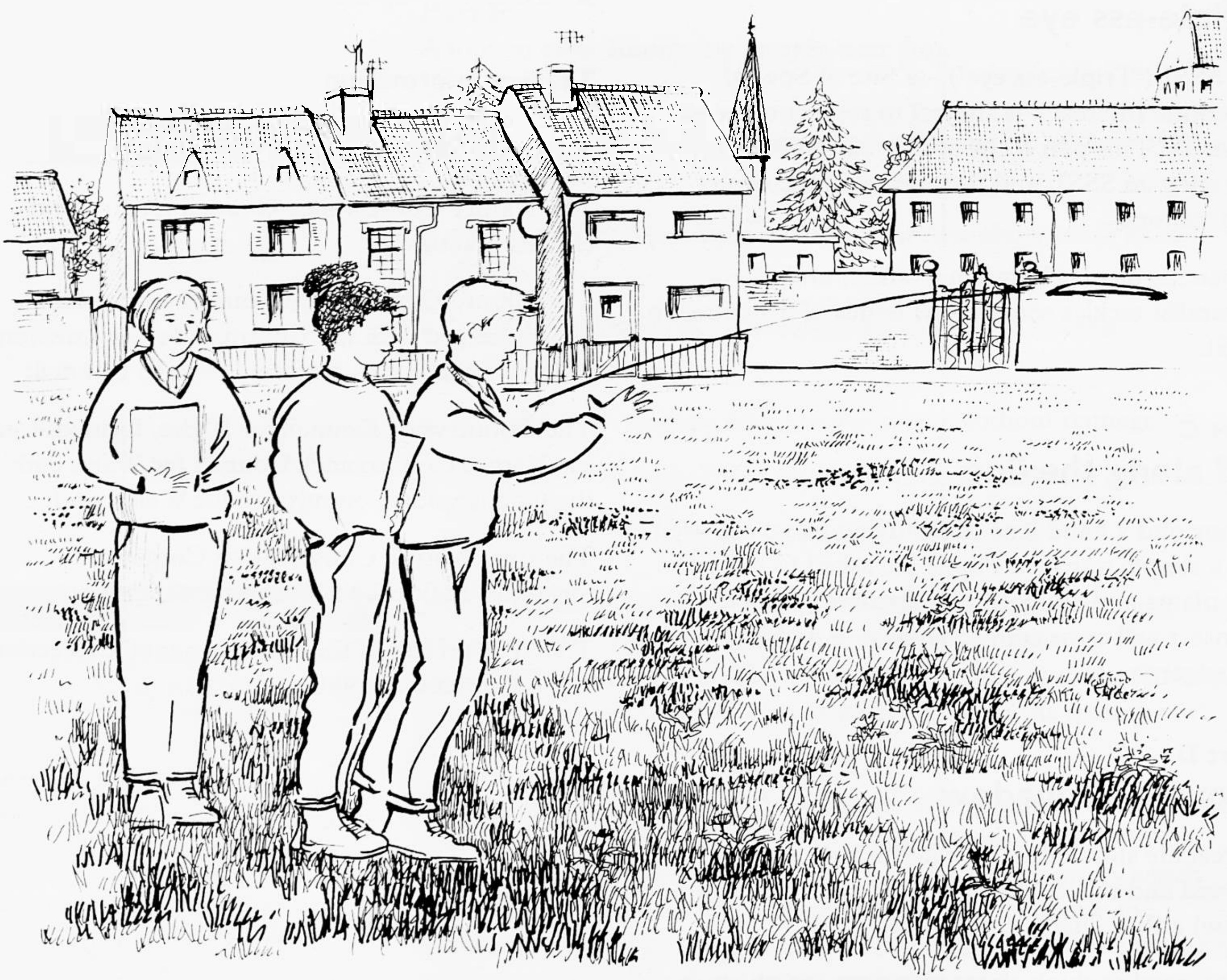
How can you find out what plants and animals live on a piece of land? A fun way is to get some friends to throw a frisbee with you! Only don't try to catch it!

Each time the frisbee lands, look under it, and try to find something new – something that you haven't seen before; a leaf, a seed, a small plant.

1 *How many can you find in one small area?*

2 *Does it matter where you throw the frisbee?*

3 *What could you use instead of a frisbee? A plastic plate, perhaps?*



'Triple-ess eye'

You will find every piece of land you look at is special. But not every piece of land can be left just as it is. We need land for building, and for farming. How can we protect the extra-special sites – the ones with unique plants and animals, or too precious to damage?

They may be chosen as an **SSSI – a Site of Special Scientific Interest.** Possible SSSIs are surveyed by scientists. If they find out that the area is special – it has plants and animals on it that are rare, or there are special conditions that support an unusual population of plants or animals – then they ask that it be made an SSSI.

For three months, there are discussions between the owners of the land, and the scientists. All the evidence is heard. Then, if it is agreed that the site should be protected, it becomes an SSSI, and building, farming, trapping of animals, and picking or damaging of plants, is controlled.

5671 sites in Great Britain had been chosen as SSSIs in March 1991. English Nature, the Scottish Natural Heritage Council, or the Countryside Council for Wales will tell you if there is one near you!

Try this

Read this with a friend. Each take one side, and argue for it.

You are a **farmer**, and the owner of a piece of meadowland that you have been using for grazing for some years.

Recently, a rare plant was discovered growing on the land, and now scientists want to make it an SSSI.

You don't want to damage the plants, either, but you have a business to run, and your land has to work for you. You can still let animals graze the meadow, but now you want to put down herbicide and fertilizer to improve the grass, and the scientists won't let you.

Perhaps they would buy the field from you and you could buy land elsewhere?

You are a **scientist** with English Nature, the Scottish Natural Heritage Council, or the Countryside Council for Wales.

You have been told that a population of very rare plants is growing on a local meadow. There are very few in the country, and you want to make the meadow an SSSI.

The farmer is being difficult; he uses the meadow for grazing but now he wants to put down herbicide and fertilizer, and you know that the rare plants will be destroyed.

You have very little money to spend on the project.

Write a report on what you each had to say.

All along the line

You will need

5m of string
A hand lens

An area of land is not the same all over. Differences in conditions can provide places for different sorts of plants and animals. A hedge, a path or its edge, some uncut grass, or a few stones, can make a different living place.

Try this

One easy way to see this is to stretch a piece of string across some ground. Five metres of string will do.

Start at one end, and go along it slowly, bending or crouching down.

Look carefully at everything that touches the string. You might need a magnifying glass.

You could draw a line in your notebook, and draw or mark the plants on it. Mark any animals, too. You might be able to name some. If not, give the plants names or labels of your own. The most important thing is to look for change.

Why do the living things change as you go along the line?

Moving a meadow

When TESCO planned to open a new store in Solihull, near Birmingham, they chose a site called Shelly Green Hay Meadow, which had many rare wild flowers.

To save the meadow, volunteers from Warwickshire's Nature Conservation Trust cut thousands of turves from the meadow, together with the wild flower roots, put them on wooden palletts, and moved the meadow to a new site by lorry.

The Trust chose a site with conditions as close to the original meadow as possible. They tried to match the original soil, the direction of the field to the sun, and the original slope. There, they lay down the cut turves like a huge chessboard.

It wasn't possible to use the meadow as it had been before – with a hay crop in the summer, and cattle grazing on it in the winter. Then there was wet weather, and there were problems with drainage. These all affected the meadow. It wasn't possible to save all the different types of wild flowers in these changed conditions.

Here is a flow chart for putting on your shoes and socks!

Find pair of shoes
↓
find matching socks
↓
sit down
↓
put on left sock
↓
put on right sock
↓
put on left shoe
↓
put on right shoe
↓
stand up!

Areas like Shelly Green Hay Meadow are very delicate; moving them is a difficult and expensive business. The Trust expects it to be some years – if ever – before the meadow can be quite as beautiful as it once was.

Try this

Read 'Moving a meadow'. Write a flow chart for all the stages needed to move the meadow. You might start with 'measure the meadow' or 'choose a new place to put it'!

Will your flow chart ensure that the new meadow is a success?

Adopt an area

You aren't likely to have an SSSI – a Site of Special Scientific Interest – in your school grounds. And you probably haven't got a meadow worth putting on a lorry to save! But you can find out more about your special area. In particular, you can find out how it changes!

It will change with the seasons, of course; in summer or winter, with the rain, sun, and snow. The summer is warmer, and the days are longer. The sun is brighter, and it's probably drier. The trees will have leaves, shading the ground.

1 *Can you think of any other seasonal differences?*

But there are daily changes, too. Changes in temperature, brightness, wetness; and others.

2 *How would you test for them?*

3 *How would you make a graph of the changes on a piece of the school grounds through a school day?*

Make an action plan.

List the materials – especially the instruments you would use.

4 *Where would you put the instruments?*

5 *How would you read them – and how often?*

6 *How would you record your results?*

A friend notices that daisies are open in the day; but the same daisies are closed at night.

7 *Write an action plan to find out if it is light, or temperature, or a mixture of both, that opens and closes the daisies.*

You could use datalogging to record your results.

Free soap

This unit was one product of the Harare Generator, an international curriculum development project that took place in January 1991.

Its development was the result of a SATIS-like activity. Teachers told each other science based stories and this was one that emerged.

Lizzy and Tendai's experiences with 'Free Soap' offer a cross-cultural context for science activities. People who come into African cities looking for work are usually without money. Their only option is to squat – to put up a temporary shelter. This is illegal in most cities. Many African countries lack the funds to support them.

When squatter camps are bulldozed, no alternative is provided. People are told to return to the rural areas.

Contents

Part A
'White hands' – a story and questions.

Part B
Testing the water samples.

Part C
'What to do?' Discussion, role play, and design.

By using the unit pupils will

- learn that **chemical pollution** is an international problem.
- discuss a strategy for investigation.
- practically **analyse water samples**.
- investigate **pH and neutralisation.**
- devise a range of ways for resolving the pollution problem.

Curriculum focus

Pupils should be given opportunities to develop their awareness of the importance of science in everyday life, and, building on their earlier experience, their growing knowledge and understanding, and their increasing maturity, to study how science is applied in a variety of contexts. Through this study they should begin to understand how science shapes and influences the quality of their lives.

Pupils should be encouraged to develop investigative skills and understanding of science through activities which ... are set within their everyday experience and in wider contexts, and which require the deployment of their investigative skills, and the use and development of scientific knowledge.

Using indicators, they should classify aqueous solutions as acidic or alkaline on the basis of their pH and investigate the reaction between acids and bases.

Pupils should investigate practically, and by the use of secondary sources, the properties of water, the water cycle, conservation of water resources, and the effect of water on the Earth's surface.

Managing the unit

Do not attempt Parts B and C until Part A has been done. Part A could easily be done for homework the night before they tackle the experiment in Part B. Preparation of the role play in Part C could also be a valuable homework activity.

Trial schools extended the unit by

- finding ways to neutralise the effluent.
- making soap.

The unit fitted well into environmental care projects. Part C was enjoyably explored by one expressive arts department.

Teacher notes

For Part B you will need two prepared water samples, labelled 'upstream' and 'downstream'.

Remind pupils that the water samples must not be tasted or allowed on the skin. Eye protection must be worn.

Upstream water sample

You will need plain tap water at room temperature. Each group will need 20 cm^3. Add a little sand to simulate river water.

Downstream water sample

To 500 cm^3 of tap water in a 1000 cm^3 beaker, add 5 cm^3 of bench(2 @ mol dm-3) Sodium Hydroxide solution and about a spatula load of soap flakes (or parings from a soap bar). Stir until the soap has dissolved to give a cloudy solution. Just before the start of the lesson, warm to about 10 °C above room temperature. Add a little sand. Each group will need about 20 cm^3 of solution. Prepare in advance of Part B.

Answers to some of the questions

2 At this stage, pupils will only be able to suggest that some kind of effluent from the factory is involved.

3 Tests will need to be done on the effluent water, comparing it with control samples of water from upstream of the factory.

4 & 5 The downstream sample is cloudier, warmer and has a more alkaline pH.

6 & 7 Soap manufacture involved boiling fats and oils with an alkali, usually sodium or potassium hydroxide. This is saponification. It is likely that some of the excess alkali is being discharged with the effluent.

8 The excess alkali could be neutralized with acid. At its simplest, this could be done by collecting batches of effluent water and adding enough dilute acid to give a neutral pH. A more sophisticated system might involve a continuous flow of dilute acid controlled automatically by a device linked to a pH sensor.

Pupils will also need

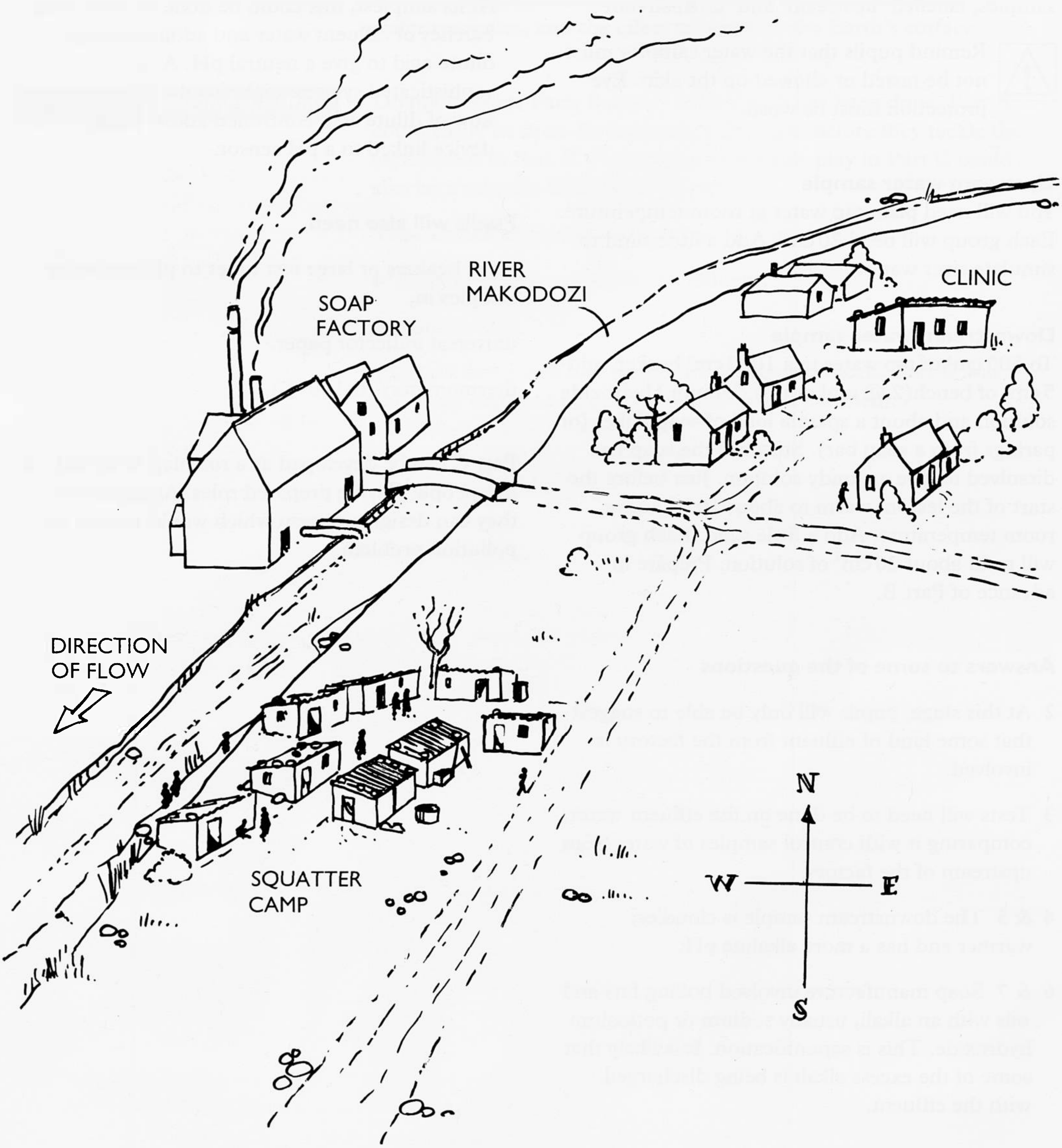
small beakers or large test tubes to put the water samples in,

universal indicator paper,

thermometers (0-100 °C).

Part C can be developed as a roleplay, with each of five people playing prepared roles. Alternatively, they can design a system which would resolve the pollution problem.

White hands


RIVER
MAKODOZI
SOAP
FACTORY
CLINIC
DIRECTION
OF FLOW
SQUATTER
CAMP
N
W
E
S

White hands

Tendai lives in a squatter camp in Kenya. There are many camps like this, usually outside big cities. Poor people without houses live in shelters built from corrugated zinc, wood and cardboard.

This is a story told by Tendai:

'One day as I was getting ready to go to school, two large bulldozers drove into our squatter camp. Over a loud speaker, we were told to move out immediately. The area was to be used for building a new housing complex. So my parents, my sister, Lizzy, and I together with all the other people living in the camp, had to leave and look for a new place to live.

I must say that we were lucky! Old Mahobho found a very nice place for us along the Makodozi river. The place was not far from a soap factory. We could hardly believe our luck, when we discovered that the water in the river was soapy! We had actually discovered "Free Soap"! We would wash as much as we wanted and my mother did not have to buy washing soap.

About two weeks later, Lizzy's hands began to turn white. Nobody in the family worried much about it because she had always been sickly. Three days later two other women also developed white hands. When more than twenty other people developed the same problem, we became alarmed. By this time Lizzy's hands had started to crack and develop sores. This rapid spread of the disease reminded us of the measles epidemic of the previous year which had killed several children.'

1 What would you have done if you had developed white hands?

2 What do you suspect was the cause of the white hands?

3 Suppose you are a scientist who has been asked to investigate the problem. What would you do?

Testing the water samples

This is what the squatters decided to do:

Mahobho brought all the affected people together and accompanied them to the health clinic. The sister in charge had no treatment for white hands and so referred them to a doctor at the city hospital. The doctor suggested sending scientists to the area to investigate the cause of the epidemic.

Now imagine that you are one of the scientists and your task is to test the river water. You have been given two samples of water. One from the upstream and one from downstream.

Try this

For each sample:

a Observe the appearance.What does it look like?

b Test the pH using Universal Indicator paper.

c Measure the temperature.

Then complete the table below:

	Upstream water sample	**Downstream water sample**
Appearance		
Temperature		
pH		

1 Is there any difference between the two water samples?

2 If there is a difference, what is the difference?

3 What could have caused this difference?

4 How do you think the substance got into the water?

5 a How could the problem be cured so the downstream river water is safe to use?

b Use your idea from (a) to design a simple system that could be fitted into the outlet for the discharge water.

What to do?

Actors

Mahobho
The doctor
The manager of the soap factory
The local councillor
The social welfare officer

Introduction

Eventually the scientists found the cause of the problem. Alkaline Sodium hydroxide was being discharged into the river from the factory, mixed with soapy water. The alkali could be neutralized by acid before the water is discharged – but this will cost £5000 to set up. The factory owners say they cannot afford it. This meeting is to decide what should happen.

Rolecard

Mahobho

You are a community elder. The people listen to you because of your wisdom and experience. You chose the squatter camp site because it was close to clean water and the soap factory had work for the people of the camp. You are angry and disappointed. The people will expect you to find somewhere else.

The local councillor says that squatting is illegal. In the eyes of the councillor, you are not an important person, just another illegal squatter. The soap factory manager says the problem is solved – but is that true?

Your people are poor, but they have a right to a place to live – and to work.

Rolecard

The doctor

You work at the City Hospital. You were the first to recognise the seriousness of the villagers' illness. You suggested that Government Scientists be sent to the area. The latest tests show that the water is safe, but will the problem happen again? Can you be sure that the people are receiving the best possible health care?

You insist that the town council provide water for the squatter camp that is clean and safe.

Hovercraft

Over one hundred years ago an Englishman, John Thornecroft, took out a patent for a hovercraft, rather like the ones we see today. The hovercraft 'floats' above water or land, instead of touching it. With its cushion of air, the craft travels rapidly because there is little friction. Thornecroft's idea was not developed at the time, but in 1954 another Englishman, Christopher Cockerell, had the same idea. He experimented with tin cans and a 'reversed' vacuum cleaner. When air was blown in, the tins lifted and the working hovercraft had been invented. He went on to make balsa wood models before the full size prototype made its maiden voyage across the English Channel on 25th July 1959.

Hovercraft attributes can best be investigated by re-creating a working model.

By using the following plans for an air-intake as a starting point, investigations can be made into how to make the model work to its best advantage. This can be related to wider issues about the history and use of hovercraft.

Contents

Part A
Putting on the pressure; basic ideas behind hovercraft design.

Part B
Modelling a hovercraft.

Part C
Electric circuit.

Part D
Development file.

Part E
Cross-Channel choice.

Part F
Hovercraft history.

By using the unit pupils will

- model a working hovercraft.
- explore air pressure.
- model and test pneumatic systems.
- apply basic electrics.
- investigate hovercraft efficiency.

Curriculum focus

Pupils should be given opportunities to develop their awareness of the importance of science in everyday life ... to study how science is applied in a variety of contexts.

Pupils should be given opportunities to develop their knowledge and understanding of how scientific ideas change through time. They should study the development of some important ideas in science.

Pupils should investigate a wider range of components in electrical circuits and appreciate the means of controlling electricity using a variety of components such as ... switches. Their investigation should be in the context of everyday applications and devices including electric motors.

Pupils should discover that forces can act to change the shape of things, to begin to move or stop them, and should investigate the factors involved in producing and maintaining motion. This work should make references to friction and be related to human and vehicular movement with particular reference to road safety.

Managing the unit

The basic hovercraft design given works very well. It can be developed in a range of ways to improve load-carrying and investigate cushion-of-air machines.

It is very heavy on batteries, and will quickly wear down even the Duracell type. Running it on a lead from a battery box doesn't model the real hovercraft.

Parts B and C detail the actual modelling. The other parts are optional.

Teacher notes

Part A

Putting on the pressure

You will need

a range of plastic syringes of different sizes,

tight-fitting plastic tubes,

plastic tee-joints,

vaseline to lubricate the syringe barrels.

Part B

Modelling a hovercraft

You will need

copies of the design plan,

thin, stiff card (cereal boxes are ideal),

polystyrene ceiling tile or corriflute sheet,

thin plastic carrier bags,

glue,

strong clear tape,

scissors,

craft knives,

cutting boards,

5" diameter (13 cm) plastic propellors,

small electric motor (3-4.5 volt, or 9 volt).

⚠ Care with craft knives.

Trying various hovercraft sizes is suggested; 10" by 12" (25 by 30 cm) is a good size.

Part C

Electric circuit

You will need

thin bell wire,

a small on/off switch (directions are given to model one),

batteries to match the motor – either a 9 volt powerpack, or four AA batteries,

wire stripper,

glue,

strong clear tape.

⚠ Do not use thin wire with rechargeable batteries – heating danger.

Small battery boxes ensure good contacts. Careful placing of the batteries will balance the finished hovercraft.

Part D

Development file

Use this to record the model design, and the performance.

Part E

Cross-Channel choices

You will need

a range of Cross-Channel brochures – including the hoverspeed service – to compare times, costs, etc. Share experiences and opinions in groups.

Part F

Answers

1 John Thornecroft lacked the technology to realise his idea. Sir Christopher Cockerell applied skills of experiment and invention to his models, and was able to apply technology to the full size product.

2 There were few machines that could make the transition from water to land, and travel as efficiently on both.

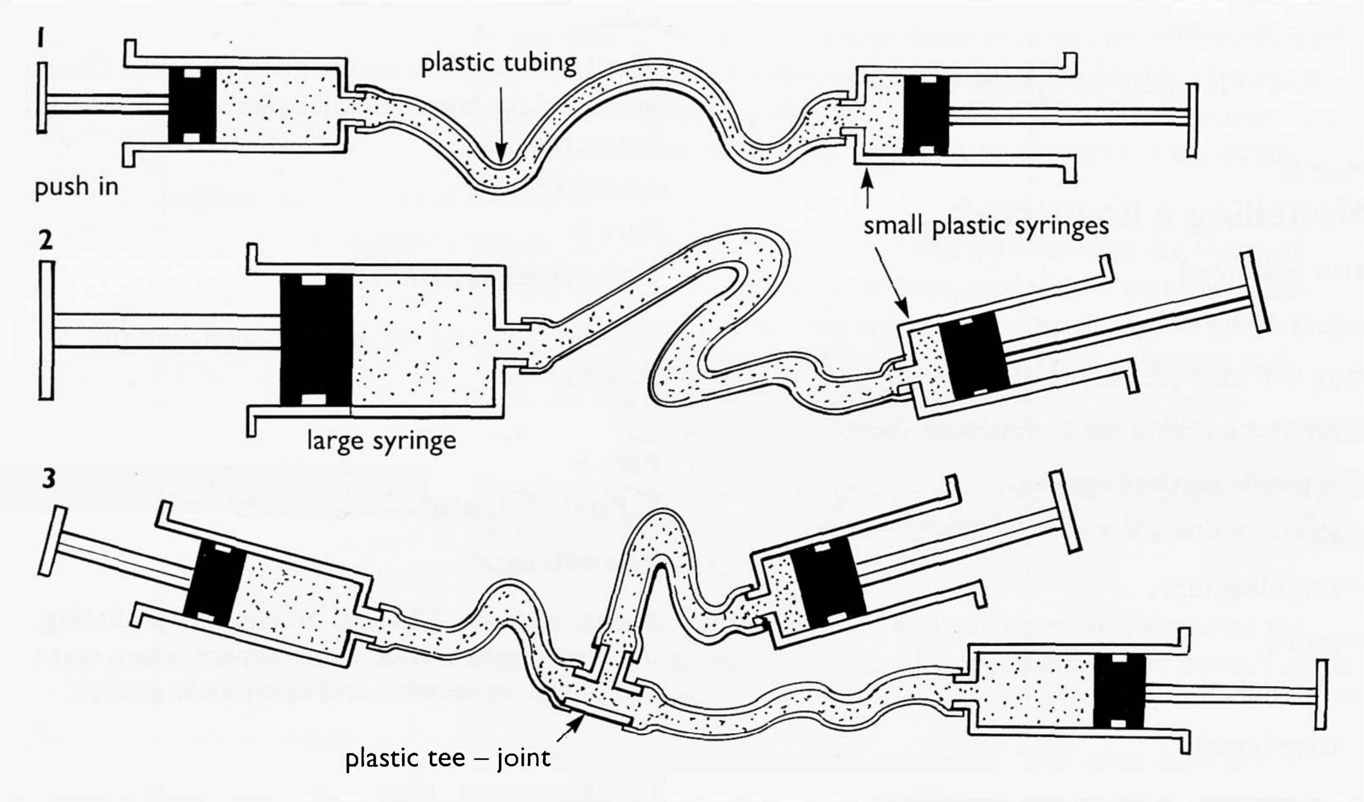
3 Hovercraft offer rapid access over rough and varied terrain; but are heavy on fuel.

Hovercraft are used to supply inaccessible parts of the world. Pupils could discuss their efficiency and cost-effectiveness.

Putting on the pressure

Air has great strength under pressure. The greater the pressure difference between the air under pressure and the atmosphere, the stronger the force is, and the more work it can do.

You can explore compressed air using these closed pressure (pneumatic) systems.

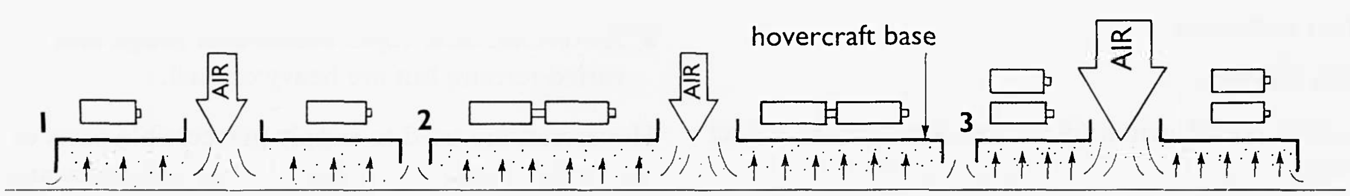


1 When air is squashed or compressed, do you think it could lift the hovercraft?

2 Does doubling the area under the hovercraft double the weight it can carry?

3 Does doubling the pressure have the same effect?

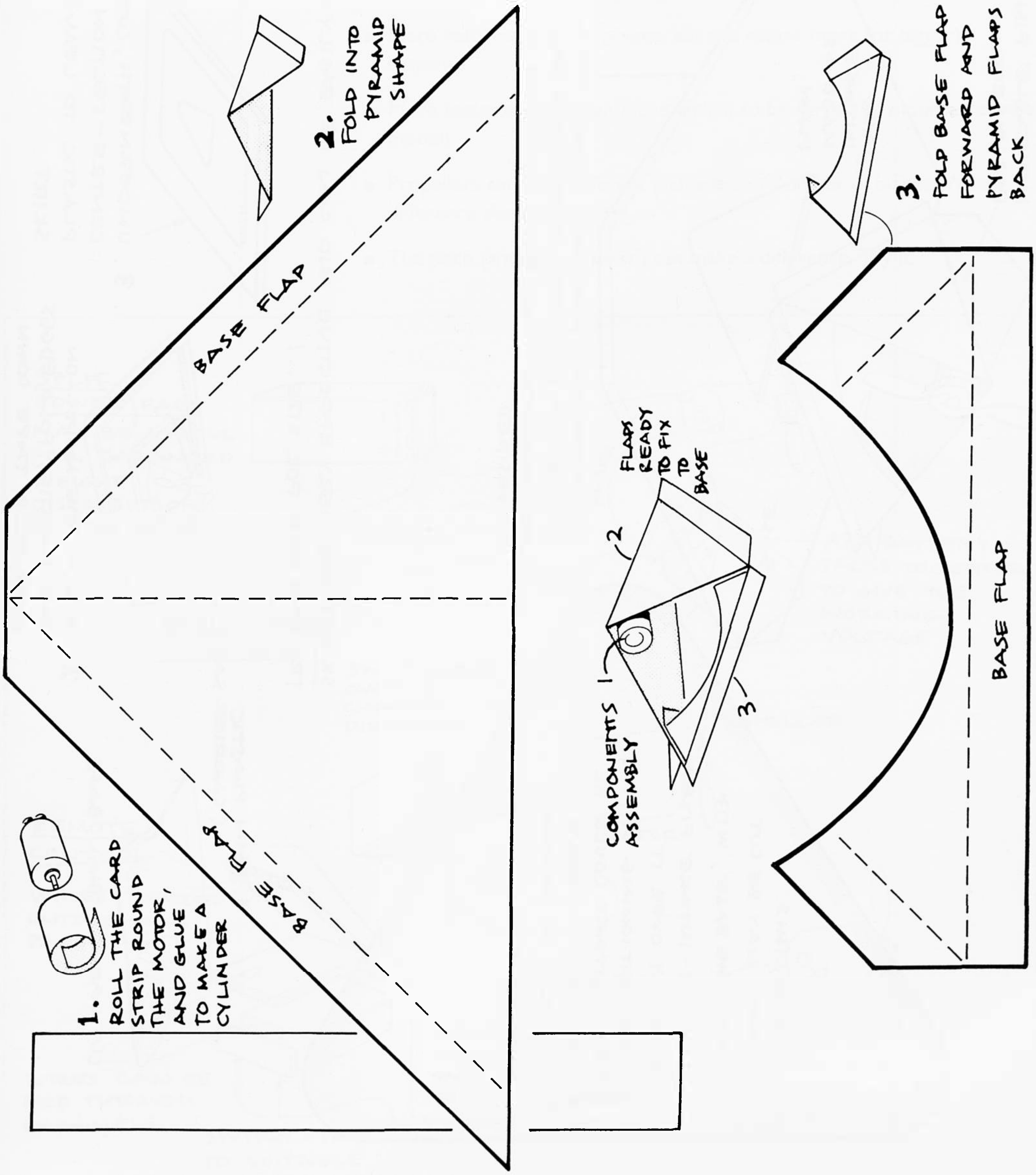
Basic principles for hovercraft design



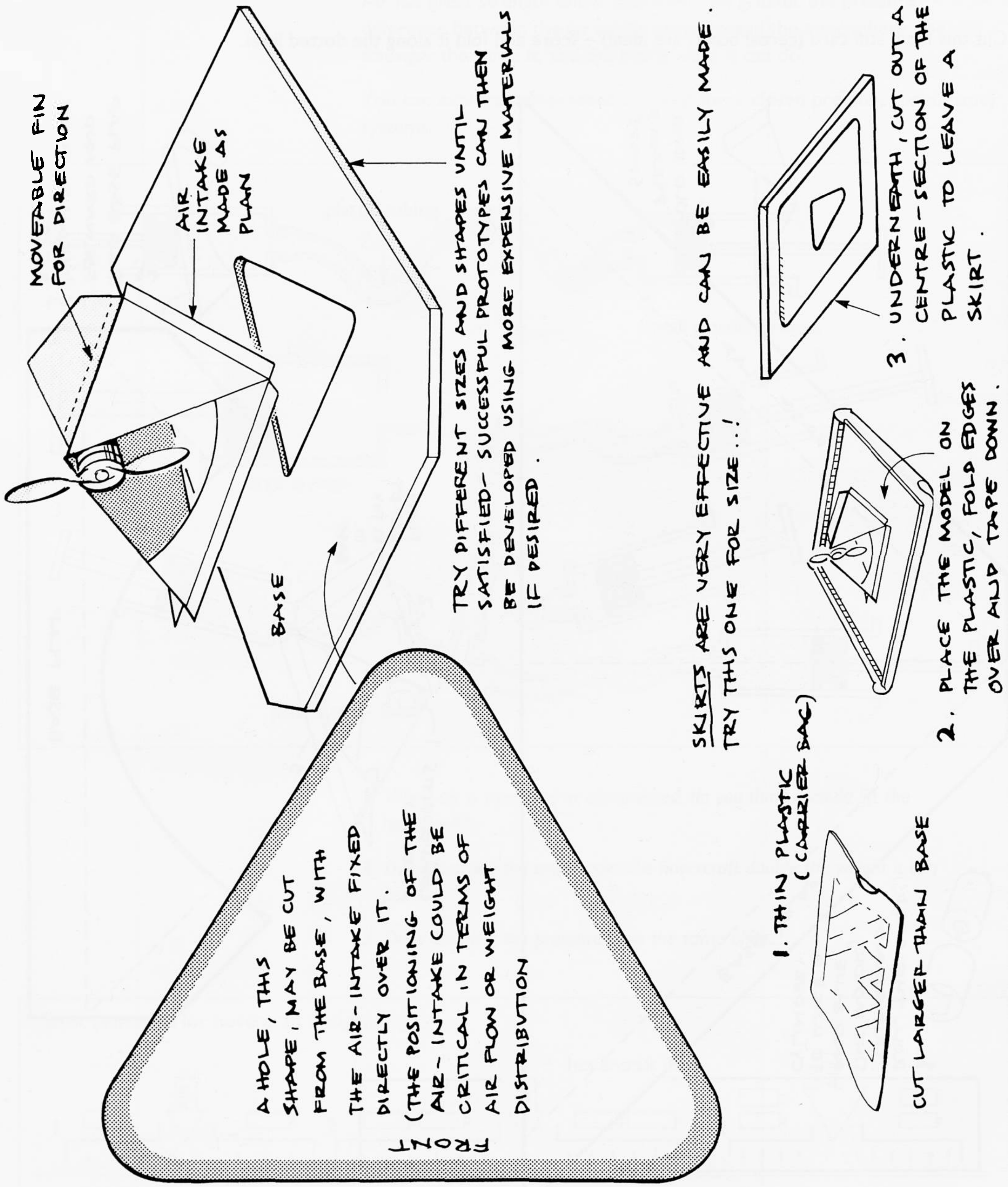
Modelling a hovercraft

Air intake

Cut this from stiff card (cereal boxes are ideal) – score and fold it along the dotted lines.



Modelling a hovercraft



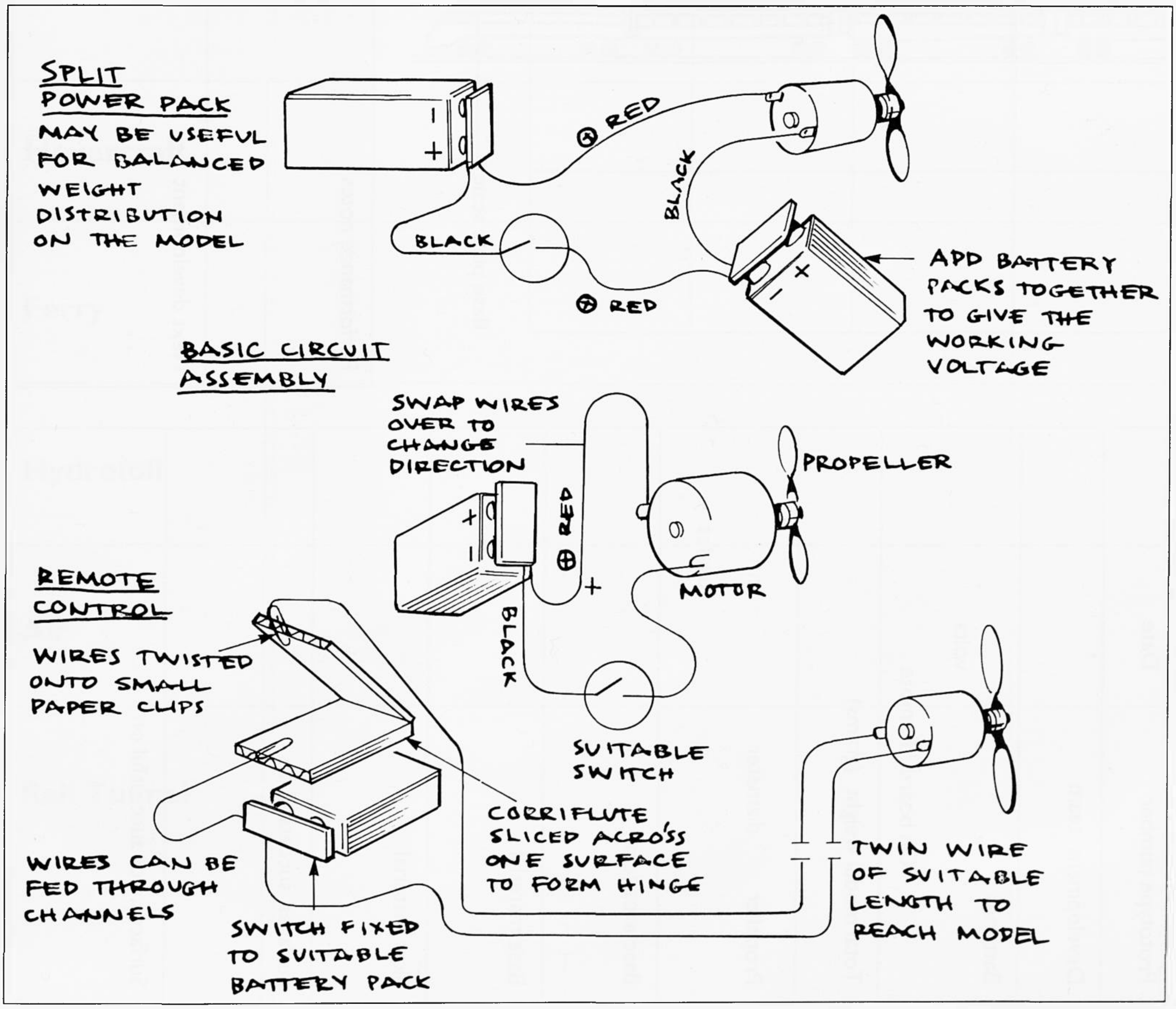
Electric circuit

Power points

1 What is the voltage range of the motor?

2 Have you got the right batteries for the motor?

- More volts mean more power, but this means more (or bigger) batteries.
- More batteries will mean more weight to be carried (if mounted on the model).
- Propellers can have different diameters or number of blades. What difference does that make?
- The pitch (amount of 'twist') can make a difference. Try it.



Development file

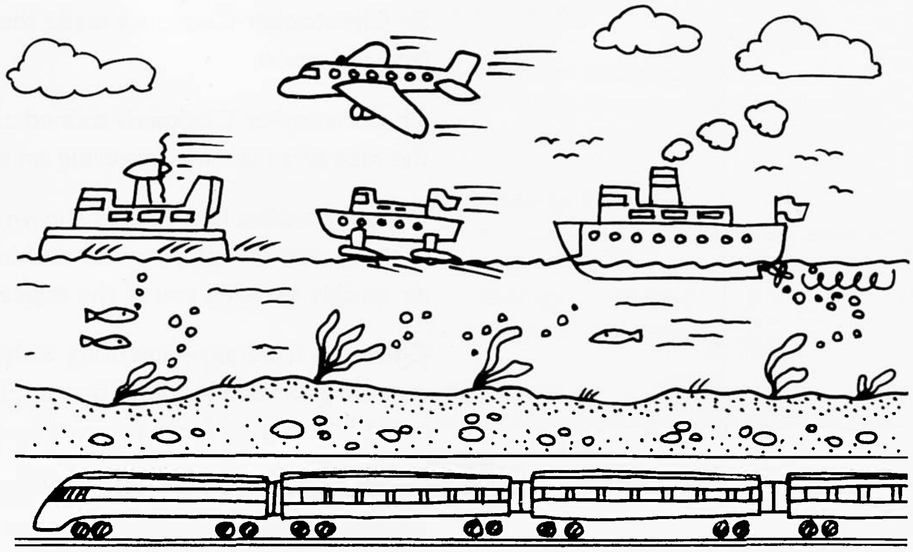
Base plan: scale 10 cm

Performance notes	
Next development	

Prototype number	Date
Development team	
Batteries .... volts	On board / Remote
Total model weight (grams)	
Propeller diameter .... cm	.... blades
Base area (cm^2)	
Base material	
Skirt material	
Surfaces, successful on	
Surfaces, not successful on	

Cross-Channel choices

The hovercraft is just one of several ways to cross the Channel. What do these offer in terms of cost, time, safety, comfort and convenience?



Hovercraft	
Ferry	
Hydrofoil	
Air	
Rail Tunnel	

Hovercraft history

John Thornecroft, an Englishman, thought up the hovercraft over a hundred years ago; but he never built one.

Sir Christopher Cockerell made the first hovercraft. It could travel over land and water.

Sir Christopher Cockerell trained as an engineer. He was fascinated by the idea of a machine travelling on a cushion of air.

Other scientists had already shown that a machine like an upside-down tea tray would float on an air cushion, pumped down from above; but the air quickly escaped round the edges.

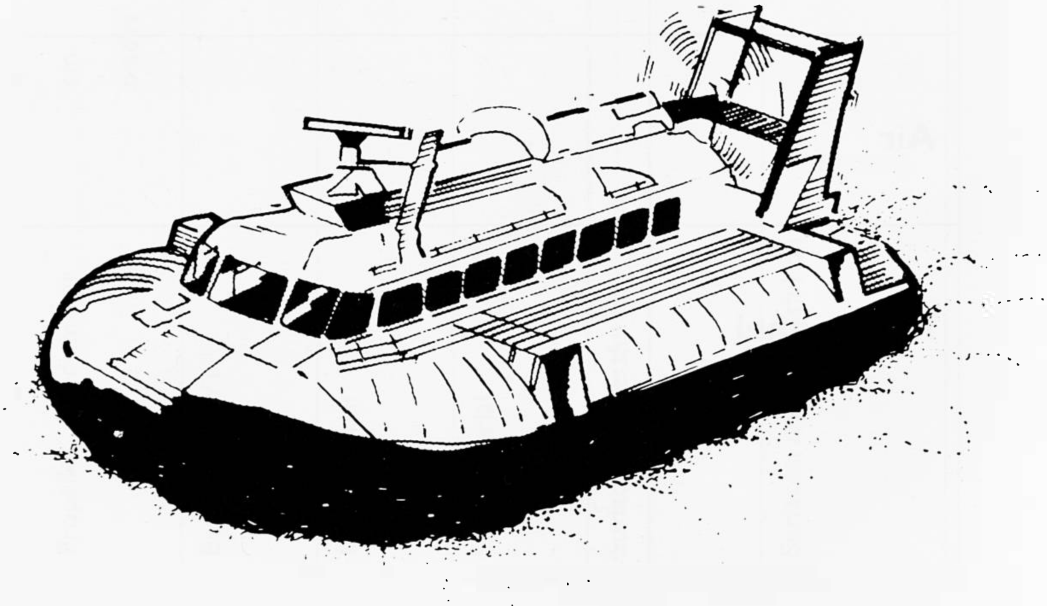
Cockerell tried experimenting with models made from old tins and a vacuum cleaner. He found that air, blasted down from jets underneath, could be stopped from escaping by a rubber skirt.

His first hovercraft tests in 1959 were very exciting. His experimental hovercraft travelled along the water near Southampton at 30 knots then climbed the beach and settled down in the sand dunes.

The hovercraft called SR-N1, built by Saunders-Roe, could cross the Channel in two hours. The bigger SR-N4s take cars and passengers to France.

But Cockerell's invention is of greatest use in countries with poor road and rail systems, where it can travel up rivers and through deserts.

1. *Why do you think John Thornecroft never built a working hovercraft?*
2. *Why was the first hovercraft so amazing to watch?*
3. *Hovercraft are used in countries with poor road and rail systems. Why do you think that is?*



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A letter to Einstein
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Box 3

BOOK 1 UNITS

Free Soap
Investigating pH, taking a story as a multicultural starting point

Audit your environment
Looking at your local environment and the establishment of an SSSI

A letter to Einstein
What is a scientist? Writing to scientists about their work

All to pot
Exploring the physics and chemistry of clay and ceramics

Hovercraft
Understanding hovercraft principles by practical modelling

SATIS 8-14

What to do?

Rolecard

The manager of the soap factory

Your factory discharges water into the river. You were told that the chemical discharges were reasonable and that they were within the law. It's not your fault if ignorant people choose to wash in the river. The squatter camp is illegal, anyway.

You believe you have done everything possible to keep the water clean. You would like to see the squatter camp moved on. There is always a slight risk of an accidental discharge of chemicals and then you would be in trouble again. More improvements would be too expensive. You would have to close the factory.

Rolecard

The local councillor

You represent the people of the nearest town. You encouraged the soap company to come to this site in the first place. It has employed many of the people from the town. Now the squatters have arrived and are taking jobs at the soap factory. Squatting is illegal, and these people ought to return to the countryside where they belong. There are not enough jobs for the people of the town. The squatter people ought to be working in the fields. Stopping the chemical discharge into the river would be expensive, and if there are any further problems, the soap factory might well close down. This would leave town people out of work. You would like to see the squatter camp moved on.

Rolecard

The social welfare officer

You are concerned about the people, and especially about their health and welfare. You have been told that everything possible has been done to prevent another chemical discharge into the river – but you are not so sure. Others would like to see the squatter camp moved on – but their previous homes were bulldozed, and if they are moved on again, they will only squat elsewhere. It is about time the town council got to grips with the squatter problem. If the squatters are moved on, they should be provided with inexpensive housing, schools, clinics, and clean water. You suspect that the local councillor wants to move the camp on so that he can get jobs in the soap factory for his family.

