Introduction

The **Scientific Eye** programmes seek to awaken an interest in science by provoking viewers to think and act scientifically. Each programme examines a topic relevant to the 11–14 science curricula of England, Wales, Scotland and Northern Ireland. Individual problems or stories are used to illustrate more general scientific ideas. Real-world science, novel experiments, and stories of landmarks in the history of science, are brought graphically alive through drama, cartoon and imaginative on-screen investigations, helping students to develop their knowledge and understanding of scientific processes and ideas. The programmes actively encourage students to develop and use the fundamental scientific skills of observing and questioning, coming up with ideas, making and testing predictions, and evaluating and communicating their results and explanations.

An important element of the programmes concerns the nature and interpretation of evidence. As students develop their own mental models to explain scientific phenomena, they will begin to think as scientists: they will have their own ideas which they will want to test. The programmes provide stimuli for investigations, and additional information and evidence to enable students to consider other ideas. By encouraging evaluation of alternative theories, the programmes help students to move towards ideas and explanations which have general acceptance and which they find personally satisfactory. Students can also evaluate the laboratory investigations they see on screen, consider the usefulness and accuracy of the observations being made, and come up with their own ideas and explanations. The programmes also show how scientific ideas continually develop and change, perhaps as a result of new techniques, or through flashes of inspiration.

This Study Guide presents imaginative ways of getting students to think and act scientifically. It contains a range of photocopiable activity sheets for each programme. The following icons indicate the kind of skills involved as students rise to the challenges posed by each activity:


use of knowledge and ideas


discussion

vocabulary


researching and gathering information


data handling and interpretation

exploring opinions and values


creative writing and role play


practical investigation

contents

Subtitles
All **Channel 4** series for schools are subtitled on Teletext for the deaf and hearing-impaired.

Changing State Overview

Before watching the programme

What are your ideas about:

- how we can classify objects made from different materials?
- why solids, liquids and gases behave the way they do?
- what happens when chemicals change state?

How might you test your ideas?

After watching the programme

What evidence do you have that supports the following scientific ideas?

a Everything is either a solid, a liquid or a gas, or a mixture of these.

b Solids, liquids and gases have different properties. These can be explained in terms of the arrangement and movement of their particles.

c The different properties of solids, liquids and gases mean that they can have different uses.

d We can change the state of something by either heating or cooling it.

e Different materials change state at different temperatures.

Try to think of more ways to test whether these ideas make sense.

Now try these

Here are some more questions about CHANGING STATE for you to discuss and investigate.

1 Why do different substances change state at different temperatures?

2 Why do we have to bite and chew solids but drink liquids?

3 Which chemicals change state when they are put in a fridge?

4 Which chemicals would change state if they were warmed in a saucepan?

5 How are the properties of materials linked to what we use them for?

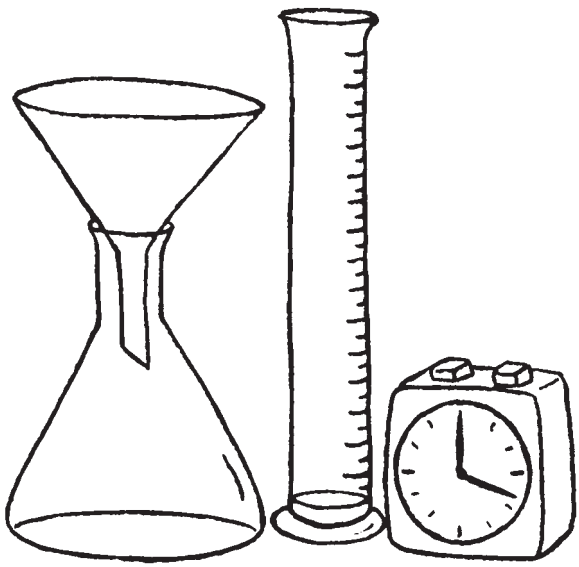
Do you have any questions about CHANGING STATE that you want to discuss or investigate?

Key Words

solid	properties	condense	particles	liquid	rigid
evaporating	temperature	gas	melting	volume	freezing
matter	boiling				

Go with the Flow!

Different liquids flow at different rates, depending on how runny they are. Using the apparatus shown, you will investigate how fast liquids flow.



▶ Discuss how you could measure the flow rates of different liquids. Suitable liquids might be oil, water and meths.

▶ How would you make sure that your tests are fair and that your results are accurate and reliable?

▶ Which liquid will flow the fastest and which will flow the slowest? Using what you know about particles in liquids, can you explain your prediction?

▶ What do you think would happen to the flow rate if you were to heat up the liquids? Plan and carry out an investigation to see if you are right.

States of Matter Snap

Preparing for the Game

1 Cut out the cards and arrange them into three groups representing the three states of matter. You may find that one card can fit into more than one group.

2 Separate each group into 'examples' and 'properties'. Try to think of other examples and properties of each state. You could make up some more cards for these.

3 When you are sure you have got the right cards in each group, it is time to start playing the game.

Playing the Game

▶ In groups of two to four, deal out the cards. You might wish to use two sets of cards for each group.

▶ Play a game of snap, turning over one card at a time and seeing if it matches the last one on the pile. Some of the cards obviously match (for example 'oil' and 'can be poured'), while others don't match at all (for example 'cotton wool' and 'boils'). Discuss any that you are not quite sure of, asking your teacher if necessary.

▶ You can then make up other games. For example, try to match up properties with examples by turning over one 'property' card at a time and thinking of another example that fits the property, or vice versa.

States of Matter Snap Cards

is solid	has particles that are far apart	air
is liquid	has particles that are close together	clouds
is gas	melts	flour
has a fixed shape	freezes	cotton wool
is see-through	boils	string
has a fixed size	evaporates	polythene
takes the shape of its container	condenses	mud
fills its container	can be squashed	glue
has particles that don't move	cannot be squashed	toothpaste
has particles that move fast	can be poured	jelly
changes shape	is hard	oil
flows	rubber	wax

Salty Water Overview

Before watching the programme

What are your ideas about:

- what makes sea water salty?
- how salt dissolves in water?
- where we get salt from?
- how we can get drinking water from sea water?

How might you test your ideas?

After watching the programme

What evidence do you have to support the following scientific ideas?

a Undissolved material can be removed from water using a filter. Filtered water can still contain dissolved chemicals and microbes.

b Some chemicals dissolve in water to form a clear solution. When salt dissolves it breaks up into particles too small to see.

c Sea water contains a number of different dissolved salts in varying amounts.

d When sea water is evaporated, the dissolved salts are left behind.

e Salty water is denser than fresh water. Objects float better in salty water.

Try to think of more ways to test whether these ideas make sense.

Now try these

Here are more questions about SALTY WATER for you to discuss and investigate.

1 How is your water at home made fit to drink?

2 Does your school have a machine for making distilled water? How does it work?

3 Some microbes in water cause disease. How could these be removed?

4 How can the various salts in sea water give you clues to where it came from?

5 Why does some salt have iodine added? Is anything added to your salt at home?

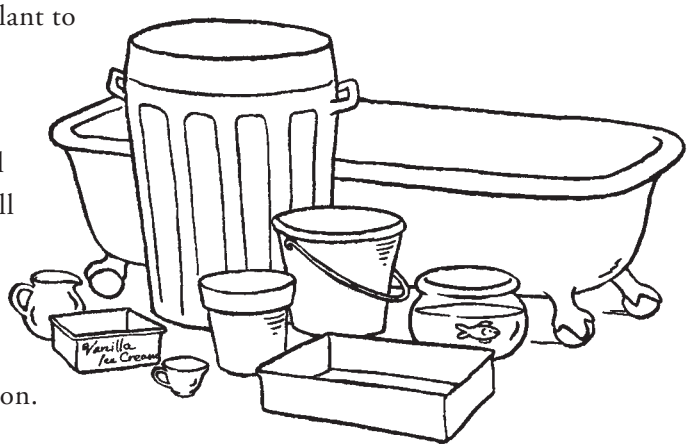
Do you have any questions about SALTY WATER that you want to discuss or investigate?

Key Words

soluble	filter	insoluble	suspension	solution
dissolve	solvent	evaporate	solute	density

A Seasonal Problem

The Sea Salt Company is building a new plant to harvest salt by evaporating sea water.



What is the best shape for their new salt pans? Should they be deep so that they will contain more water? If they are shallow, will the water evaporate more quickly? Does it matter what shape they are?

▶ Plan an investigation to find out the best shape of tank for fast salt production.

▶ Collect a range of containers and try out your ideas.

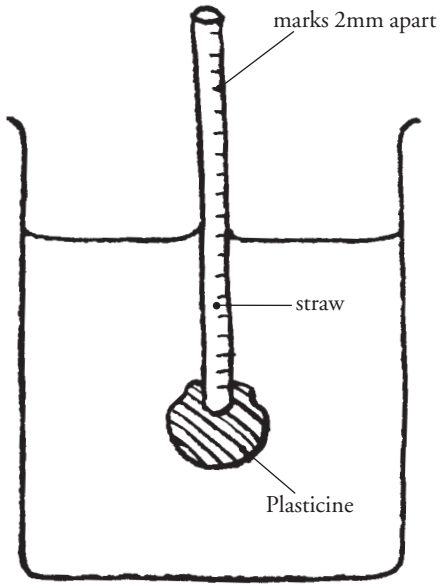
How Strong is the Solution?

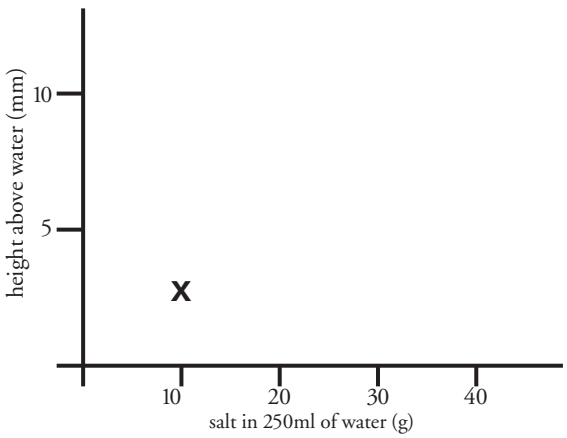
Once the Sea Salt Company's new plant is running, they will need to keep an eye on the strength of the salt solution. As the water evaporates, the salt will get more concentrated.

One way to measure the strength of the salt solution is to use a float. When the solution is stronger, it is more dense, and the float will float higher.

▶ You can make a float using a straw and some Plasticine.

▶ Make four different solutions by adding measured amounts of salt to 250ml of water in a beaker. Choose the amounts of salt carefully to give a good range of solutions. You should be able to dissolve up to 50g of salt.





▶ Try your float in water first. Adjust the amount of Plasticine so that the float is low in the water. Now try the float in the other solutions.

▶ Record the number of marks above the surface of the water.

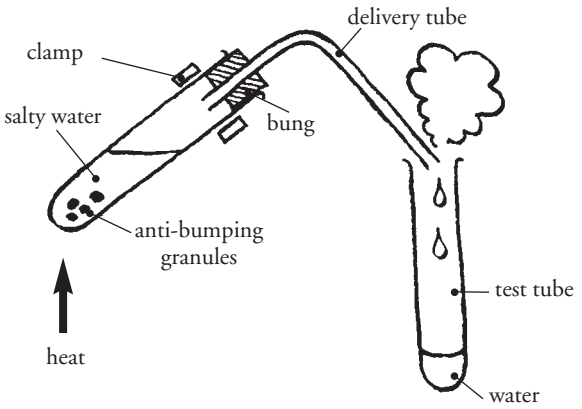
▶ Draw a graph to show how high the float is in different strengths of water.

▶ Now use your graph to work out how much salt there is in a mystery solution!

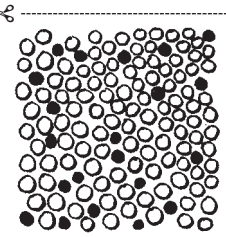
Pure Particles

Paula and Narinder have been working out how to get pure water by evaporation. This is their report:

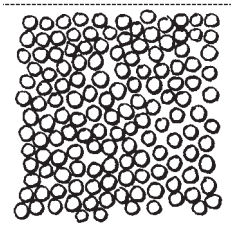
First we dissolved some rock salt in water. Then we filtered the mixture. We took some of the clear water and put it in a boiling tube. We added a delivery tube. Next we heated the tube very carefully until the water boiled. We put a test tube at the end of the delivery tube. After a few minutes we collected some pure water, but some of the steam escaped.



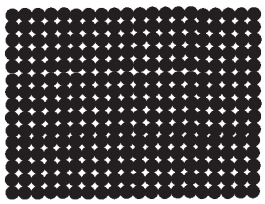
Their teacher asked Paula and Narinder to try and explain what was happening to the particles of salt and water. They drew pictures of the particles and wrote about them.



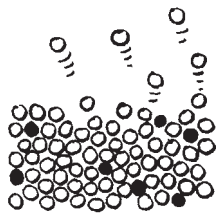
The particles of water move faster and faster until some of them escape. The ones that escape become a gas called water vapour. The salt particles cannot escape.



The particles of water are quite close together because water is a liquid. The particles of salt are held closely together because salt is a solid.



When the salt starts to dissolve, particles break off and mix with the water particles.



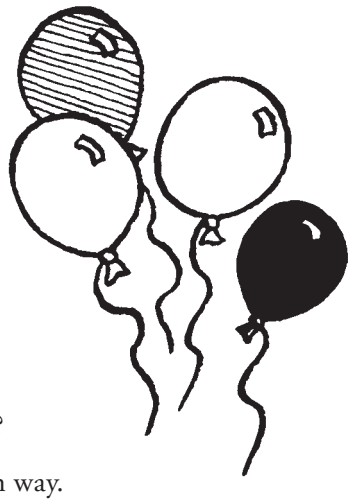
The particles of water are close together and free to move past each other. It is a pure liquid.

▶ Work with a partner. Cut out the drawings and explanations.

▶ Discuss the order that the drawings and explanations should go in. Arrange the cards in the right order and stick them into your notebook.

▶ When Paula and Narinder had finished the experiment, there was some salt on the sides of the boiling tube. Draw the arrangement of particles and write an explanation for this.

Gases Overview



Before watching the programme

What are your ideas about:

- how the particles of a gas behave?
- how the properties of a gas can be explained?

How might you research your ideas?

After watching the programme

What evidence do you have to support the following scientific ideas?

a The particles of a gas have energy. They move around in a random way.

b Gas pressure is caused by particles pushing against the walls of their container.

c Gases move from a region of high pressure to one of low pressure.

d Gas particles have mass and can be weighed.

e Gas can easily be compressed.

f Gases spread out naturally. (This is called 'diffusion'.)

Try to think of more ways to test whether these ideas make sense.

Now try these

Here are some more questions about GASES for you to discuss and investigate.

1 Why is carbon dioxide used in fire extinguishers?

2 Why do some people think that when you fill a balloon with air it gets lighter?

3 Which rides at a fun-fair might use compressed air?

4 How could you turn hydrogen gas into a liquid?

5 What would happen if you tried to squash air, instead of carbon dioxide, into lemonade? Would it still be fizzy?

6 Why would it be dangerous if air got into the braking system of a car?

7 Do all gases diffuse at the same rate?

Do you have any questions about GASES that you want to discuss or investigate?

Key Words

particles	flammable	inflate	shape	carbon dioxide
mass	pressure	hydrogen	compress	helium
diffusion				

Gas Works

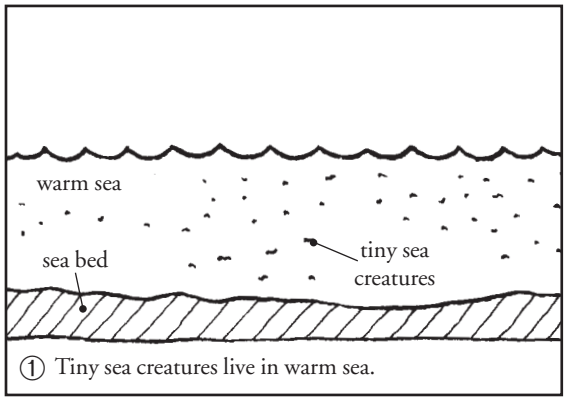
Many homes in Britain use natural gas as a fuel. Natural gas consists mainly of methane. Today it comes from gas fields under the North Sea.

The gas was formed hundreds of millions of years ago when much of Europe was covered by warm, shallow seas. Microscopic sea creatures died and fell to the sea bed, forming thick layers. Later, they were covered by layers of sand and mud which was carried into the seas by rivers. As these layers got thicker they hardened into rock. The pressure on the layers of organic matter below caused them to change chemically, turning into gas and oil.

The gas and oil seeped upwards until they were stopped by layers of non-porous rock. There they remained until people discovered and tapped them.

1 Draw a cartoon strip with five pictures to show how natural gas was formed. The first picture has been done for you.

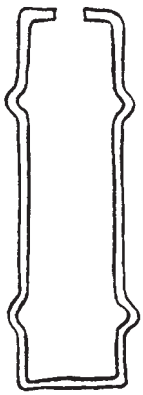
Sometimes the gas was not trapped underground, and escaped to the surface. Over 2300 years ago, people in the central Chinese province of Sichuan noticed that this gas could be burned. They dug into the ground to collect it and transported in to towns through bamboo tubes lined with tar. The gas was used for lighting streets and homes. It was even used as a portable fuel supply. Bamboo tubes filled with methane were used as torches by travellers at night. A text by Chang Qu describes how this was done in 347 BC.



① Tiny sea creatures live in warm sea.

2 Why were the bamboo tubes lined with tar?

3 Copy this cross section of a bamboo torch and draw in some gas particles to show how they are arranged and how they move.



4 Some travellers felt that methane torches were too dangerous. What do you think were the risks of using them?

Some questions to research:

5 When did natural gas become an important fuel in Britain?

6 What would have been the most important fuel in Britain in 350 BC?

7 The Chinese are said to have had a Golden Age of Scientific Discovery between 400 and 300 BC. What were their other discoveries and inventions?

8 Before natural gas was used in Britain, a gas called 'town gas' was used. How was this made?

Airship Enterprise

Aa

Use these words to fill in the gaps in the passage below.

diffuse	mass
lighter	heavier
helium	flammable
pressure	particles

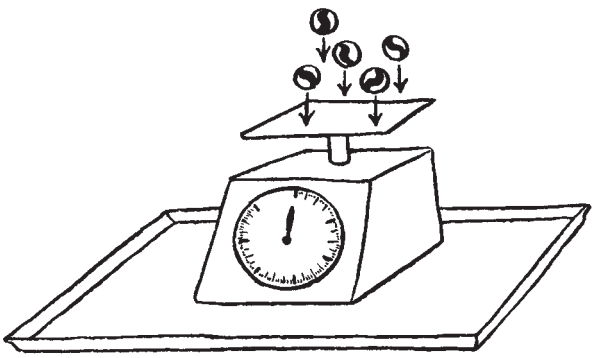
Modern airships are filled with ..... gas. An inflated airship is ..... than an empty airship because all gases have ..... The airship keeps its shape because the gas ..... push the skin outwards. The push of a gas on the walls of its container is called ..... Helium is chosen because it is ..... than air and is not ..... Airships have to be constantly replenished with gas. This is because the gas can ..... out through the skin.

▶ Why is this gas called 'helium'? (A dictionary might help here.)

▶ The picture above is called a 'calligram'. It uses a word to make a picture that represents the meaning of the word. Try and make calligrams for the following words:

mass	diffuse	pressure	flammable

Feeling the Pressure?



You can show how gas particles cause pressure on the walls of their container by using kitchen scales.

▶ Take the pan off the scales.

▶ Stand the scales on a tray.

▶ Pour some particles (such as marbles) onto the scales at an even rate.

The pressure from the particles shows up as a reading on the scales.

▶ What do you think the size of this reading (the pressure) depends on? You could try and investigate:

- **the size of the particles**
- **the height from which you pour the particles**
- **the rate at which you pour the particles**

Fuels Overview

Before watching the programme

What are your ideas about:

- what makes a good fuel?
- what happens when a fuel burns?
- how burning fuels can affect the environment?

How might you test your ideas?

After watching the programme

What evidence do you have to support the following scientific ideas?

a A fuel is a chemical that reacts with oxygen to release energy.

b Different fuels are chosen for different jobs. The choice of fuel depends on how much energy it provides, how easy it is to store and transport, and its effect on the environment.

c Coal, gas and oil are fossil fuels. Coal has taken millions of years to form from the wood of ancient forests.

d When fuels burn they form carbon dioxide gas. This gas contributes to global warming.

e Fossil fuels are non-renewable sources of energy. To make them last longer we need to control how much we use and look for alternative energy sources.

Try to think of more ways to test whether these ideas make sense.

Now try these

Here are more questions about FUELS for you to discuss and investigate.

1 What type of fuel is used to heat your school? What does it cost?

2 Think of some ways to cut down the amount of fuel you use at home.

3 Is food a fuel? How much energy do you get from different foods?

4 Find out about the fuels used in your community. How have they changed over time?

5 How much carbon dioxide do different fuels produce?

Do you have any questions about FUELS that you want to discuss or investigate?

Key Words

fuel	carbon dioxide	control	fossil fuel	non-renewable
global warming	environment	energy		

Fuel Around the World

People use different kinds of fuel in different countries. Tanzania is a country in eastern tropical Africa. Most people in Tanzania are involved in farming. Here is a report on the kinds of fuel used in Tanzania:

Almost everyone who lives in Tanzania uses firewood or charcoal for cooking. A family needs about 3 kg of wood a day. Children walk up to 10 km a day to collect firewood. Many families cut branches from trees in nearby forests. About 48% of the country is forested, but about 3% of the country is being cleared of forest every 10 years. Charcoal and paraffin can be bought in the market but they are very expensive. In some parts of the country sugar cane is grown. The waste sugar cane is called *bagasse*. It can be used as a fuel. At home families cook on wood or charcoal stoves. These stoves waste about 80% of the energy in the fuel.

Fuel	Energy (kJ/kg)
coal	15360
crude oil	45264
petrol	48265
natural gas	32340
hardwood	20004
softwood	20930
charcoal	30238
bagasse	20934
peat	20930

Energy Consumption Per Person Per Year (MJ)	Tanzania	UK
solid fuel	0	45250
liquid fuel	1040	61720
gas	0	42470
hydroelectric	80	0
nuclear	0	17160
wood and biomass	12920	70
total	14084	171250

These tables give more information about the fuels used. Your task is to prepare a presentation comparing the use of fuels in Tanzania and the UK. First you will need to do some research.

▶ Find a map showing the positions of Tanzania and the UK. Prepare a fact file for each country. This should include:

- the capital city
- the name of the leader of the government
- the population
- the average earnings
- the types of crop grown
- the types of industry

▶ Use your fact file and the information on this sheet to prepare your presentation. You should include any graphs and charts that might be relevant.

These questions might help you organise your presentation:

- What are the main differences in the kinds of fuel used in Tanzania and the UK?
- What are the main differences in lifestyle between Tanzania and the UK?
- Why do we use more energy in the UK than in Tanzania?
- Which kinds of fuel are high-energy and which are low-energy?
- Why are wood and charcoal not used as fuels in the UK?
- Why do we use much more liquid fuel in the UK?
- Which country's fuel usage is doing more damage to the environment?
- How could this damage be reduced?

Designer Fuel

In this activity you are going to work in groups of five or more to think about what makes a good fuel.

▶ First divide into five Home Groups: Coal, Oil, Gas, Wood and Biomass, and Charcoal. Decide what you know about your fuel – how easy it is to find and use, how safe it is, how much energy it gives, and so on.

▶ Then form new Expert Groups. Send at least one person from each Home Group to each Expert Group: Energy, Environment, Resources, Availability, and Burning. Each Expert Group will have some information to discuss.

▶ Now return to your original Home Groups and discuss each person's findings from their Expert Group. Summarise the advantages and disadvantages of your fuel.

▶ Finally, choose a spokesperson to present your conclusions to the other Home Groups.

Information for Expert Groups

Coal

Energy	15 kJ/kg.
Environment	Contributes to acid rain and global warming. Must be mined.
Resources	Should last until about 2150.
Availability	Mining expensive. Difficult to move.
Burning	Burns well as powder but not as lumps. Produces acidic gases.

Oil

Energy	45 kJ/kg.
Environment	Contributes to global warming and acid rain. Risk of oil spills.
Resources	Should last until about 2100.
Availability	Drilling expensive. Found in harsh environments. Highly flammable.
Burning	Burns well when refined. Produces acidic gases.

Gas

Energy	32 kJ/kg.
Environment	Contributes to global warming. Pipelines must be constructed.
Resources	Should last until about 2100.
Availability	Drilling expensive. Found in harsh environments. Explosive.
Burning	Burns easily. Can produce carbon monoxide.

Wood and Biomass

Energy	21 kJ/kg.
Environment	Contributes to global warming and deforestation.
Resources	Renewable but limited by space.
Availability	Large amounts of land needed. Difficult to transport.
Burning	Burns well when dry. Can produce smoke.

Charcoal

Energy	30 kJ/kg.
Environment	Contributes to global warming and deforestation. Manufacture produces smoke.
Resources	Renewable but limited by space.
Availability	Large amounts of land needed. Easier to transport than wood.
Burning	Burns easily with little smoke.

Elements Overview

Before watching the programme

What are your ideas about:

- what an element is?
- what makes something a metal?
- what makes something a non-metal?

How might you test your ideas?

After watching the programme

What evidence do you have to support the following scientific ideas?

a Everything is made up of elements.

b Elements are either metals or non-metals.

c Metals and non-metals have different properties.

d Elements are the simplest forms of chemical substance.

e Elements react with one another to form compounds.

Try to think of more ways to test whether these ideas make sense.

Now try these

Here are some more questions about ELEMENTS for you to discuss and investigate.

1 What names of chemicals do you know? Which of these are elements?

2 What are the most common elements in the Earth's crust?

3 Which elements are liquid and which are gaseous?

4 Which are the most important elements?

5 How many elements are there?

6 Which elements are in your body?

Do you have any questions about ELEMENTS that you want to discuss or investigate?

Key Words

element	electricity	atom	compound
reaction	property	metal	mixture
conduct			

Elements from Mars

Mars find rocks science world

THE LATEST unmanned spaceship to return from Mars has caused massive arguments in the world of science. One of its tasks was to bring back rock samples to find out if there was ever any possibility of life on Mars. This question still remains unanswered, but scientists are now investigating the possibility of the existence of a completely new element because of what they have found in one of the samples. The soft red solid was separated from the rock and found to conduct electricity and to melt when heated, although it readily reacted with the air and turned into a gas. Further tests are now being carried out to find out more about this strange new chemical.

This table shows some typical properties of metals and non-metals:

metal	non-metal
shiny	dull
solid at normal temperatures	solid, liquid or gas
high melting point	low melting point
conducts heat well	conducts heat poorly
conducts electricity	conducts electricity poorly
not brittle	brittle

1 From the information in the article, do you think that the scientists have found a new element? Explain your answer.

2 What further tests would you want to carry out to make sure that the new substance was an element?

3 If it is an element, do you think it is a metal or a non-metal? What else would you need to know to be sure? How might you find this out?

4 Is it possible or likely that there could be a completely new element on another planet?

5 Write a short script for a TV or radio news report about the new Mars 'element'. You might include an interview with an 'expert'.

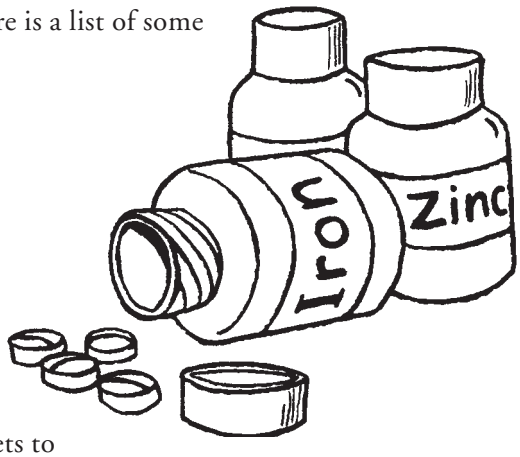
Make sure your report is geared to your audience. A report for a children's programme would need to be very different from one for the late evening news.

▶ Once your script is written, try acting it out or recording it onto tape.

Multiminerals

The human body contains many different elements. Here is a list of some of them:

calcium	oxygen
carbon	phosphorus
copper	potassium
hydrogen	sodium
iron	sulphur
magnesium	zinc



The body needs small amounts of many different elements to stay healthy. Some people take mineral tablets to supplement their diet and make sure that they get enough of these different elements. 'Multiminerals' are tablets that provide nearly all the elements the body needs. The label on the bottle gives information about the ingredients of the tablets:

MULTIMINERALS

Ingredients:
magnesium oxide, dicalcium phosphate, cellulose, potato fibre, iron sulphate, iron oxide, ascorbic acid (vitamin C), copper sulphate, zinc oxide, magnesium stearate, talc, silicon dioxide, glycerine, colouring (titanium dioxide).

To answer these questions you will probably need to use some other sources of information, such as chemistry and biology textbooks, or CD-ROMs like Bodyworks or Encarta. Make sure you write down all your sources.

1 Using a dictionary, write down a definition of the word 'element'.

2 Using the ingredients list above, try to write down all the elements contained in the tablets. Divide them into metals and non-metals.

3 Which of these elements are needed by the body, and which are added to the tablet for other reasons? Try to find out why some of the elements are needed by the body.

4 None of the elements is present as a pure element: all are in the form of compounds. Why do you think this is? Are there any elements that we take into the body in their pure form?

5 There are some chemical compounds, such as glycerine, that do not have elements in their names. Do these contain elements? Explain.

6 Chemicals that are added to food are called 'food additives'. Find out what food additives are used for. What elements do they contain?

Credits

Scientific Eye: Materials and Their Properties 2
was produced for Channel 4
by Yorkshire Television.

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