SCIENCE AT WORK

Pollution

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SCIENCE AT WORK

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Contents

NATIONAL SCIENCE CENTRE

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1 Dirty water

Particles in water

Apparatus

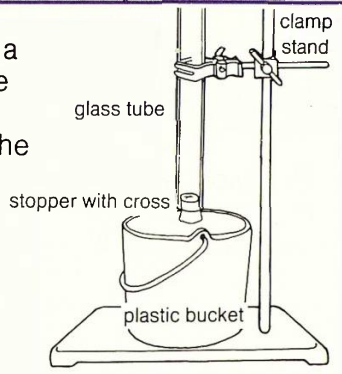
★ water samples in numbered containers ★ long glass tube
★ stopper with cross ★ clamp stand with boss head
★ 100 cm³ measuring cylinder ★ 2 funnels ★ beaker ★ filter papers
★ ruler ★ bucket

You are going to find out what makes water look dirty.

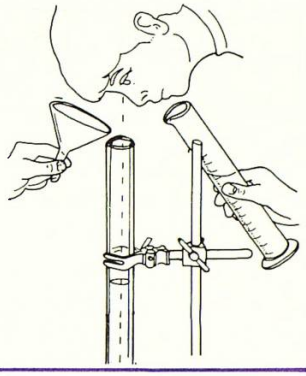
Q1 Copy this table.

Number of water Sample	Source of water	Height of water in glass tube (cm)	Appearance of filter paper

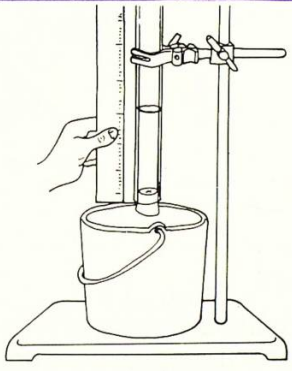
A Push a stopper (with a cross drawn on it) into the bottom of a glass tube. Set up the apparatus on the floor, as shown.



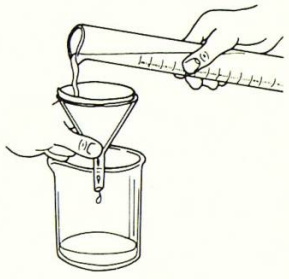
B Pour 5 cm³ of water sample 1 into the tube. Look down the tube to see if you can see the cross on the stopper. Repeat this step until you cannot see the cross, or the water reaches the top of the tube.



C Measure the height of the water in the tube. Record the height in your table. Pour the water back into the container it came from.



D Pour 10 cm³ of water sample 1 through a filter paper in a funnel into a beaker. Remove the filter paper. Record its appearance in your table.



E Repeat steps B to D for each water sample.

Q2 Could the cross be seen through a full tube of any of the water samples?

Q3 The shorter the column of water when the cross disappeared, the dirtier the water. Which water sample was dirtiest?

Q4 Look at the filter paper for the dirtiest water sample. What makes the water dirty?

Q5 Which water sample was cleanest?

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Bacteria in water

Apparatus

★ 5 water samples in numbered containers ★ 6 numbered petri dishes with agar jelly
★ 6 numbered screw-topped bottles of broth ★ inoculating loop ★ 5 droppers
★ Bunsen burner ★ heatproof mat ★ sticky tape ★ disinfectant
★ bench swabs

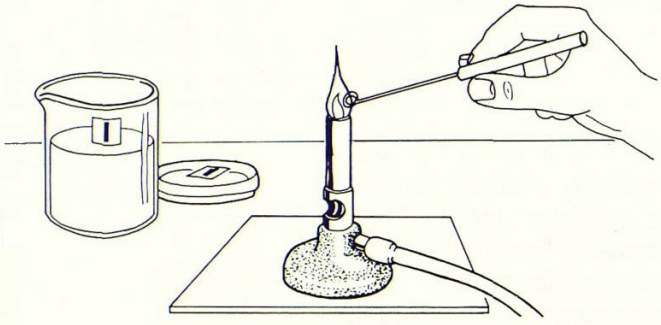
You are going to find out if any water samples contain bacteria.

All benches must be swabbed before and after the experiment.
Your teacher will tell you what other sterile procedures you should follow.

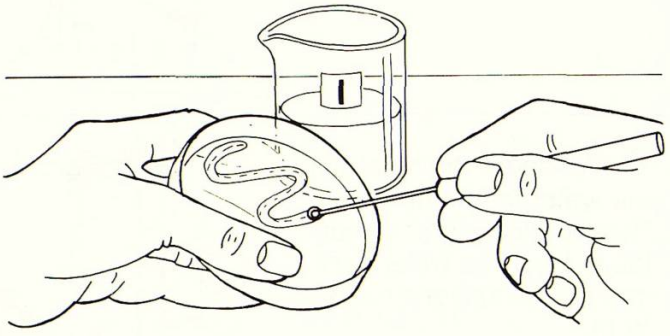
Q6 Copy this table.

Number of water sample	Source of water	Appearance of agar jelly after ____ days	Colour of broth after ____ days

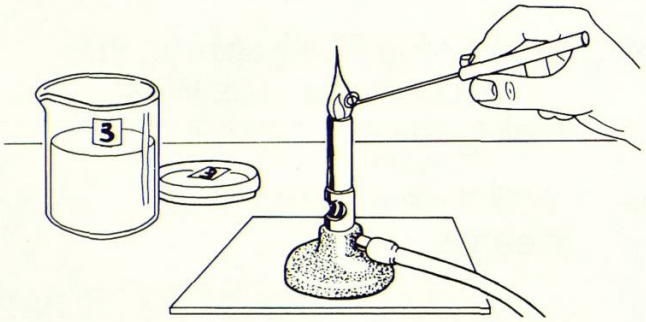
A Swab the bench. Hold an inoculating loop in the flame of a Bunsen burner to sterilise it.



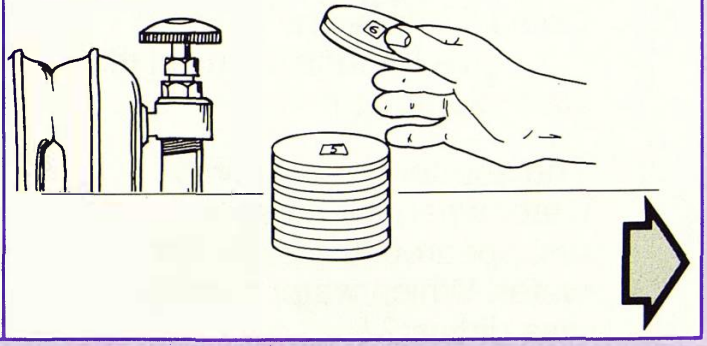
B Dip the loop in water sample 1. Streak the loop on the jelly in petri dish 1. Put the lid on the petri dish. Seal it with clear tape.



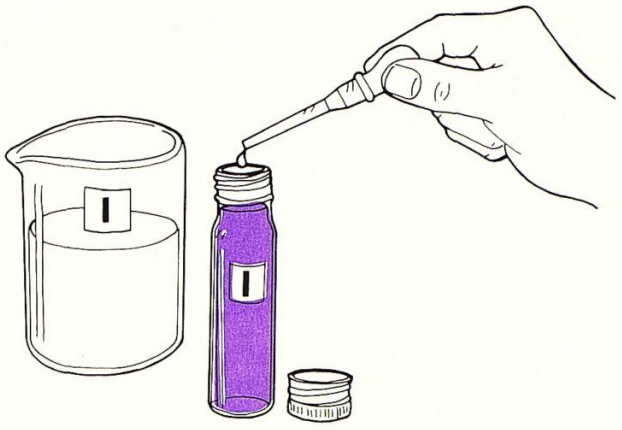
C Repeat steps A and B with each water sample. Each time, use the petri dish with the same number as the water sample.



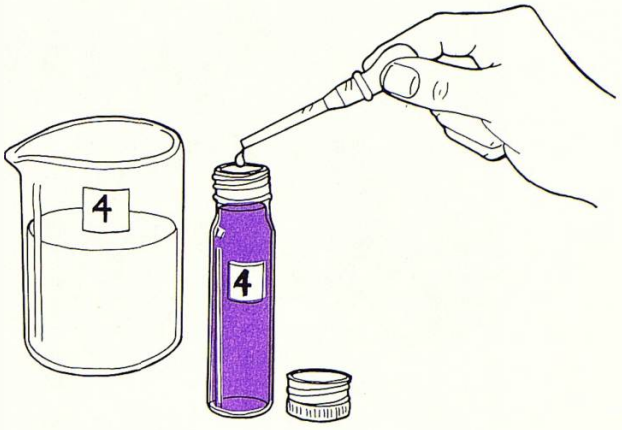
D Store all the dishes (including No. 6—the one you have not used) upside-down in a warm place. Leave them until next lesson. Now go on to step E.



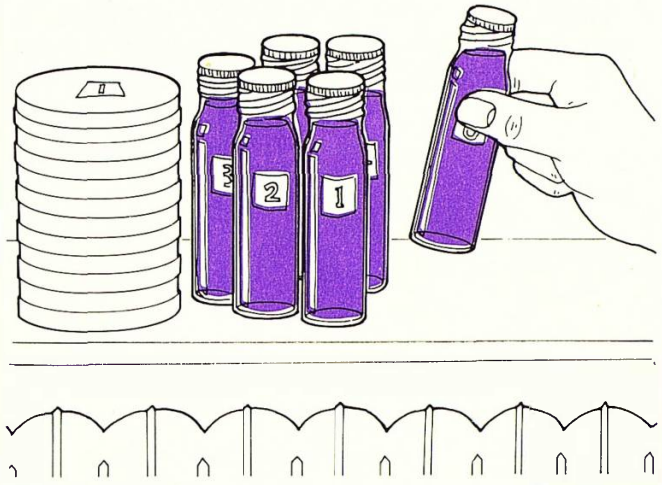
E Add 1 dropper full of water sample 1 to the broth in bottle 1. Screw on the lid. Shake the bottle.



F Using a clean dropper each time, repeat step E with each water sample. Each time, use the bottle with the same number as the sample.



G Store ail the bottles (including No. 6—the one you have not used) in a warm place until next lesson. Swab the bench.



Next lesson:

H Do not take off the lids of the petri dishes and bottles. Look at the samples. In your table, record what you see. Ask your teacher to throw away the dishes and bottles. Swab the bench.

Q7 Why are the petri dishes sealed?

Q8 Why are the petri dishes stored upside-down?

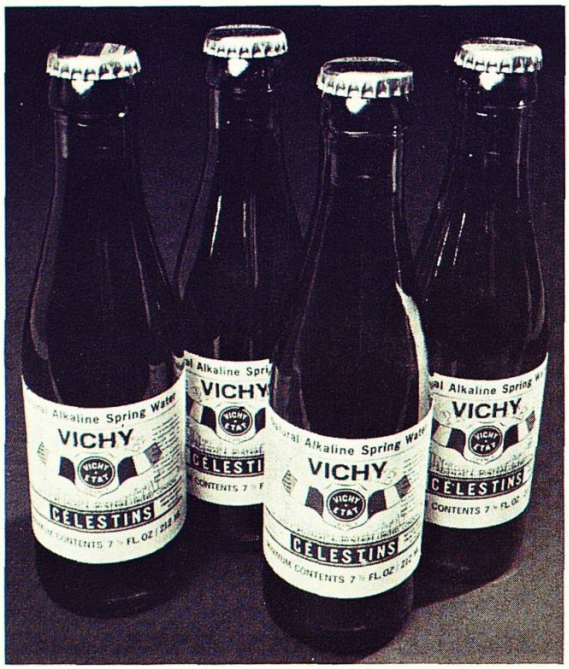
Q9 Some bacteria (called coliforms) grow on agar and form pink "blobs". Which water samples contained coliform bacteria?

Q10 Coliform bacteria turn purple broth yellow. In which of the bottles did the broth turn yellow?

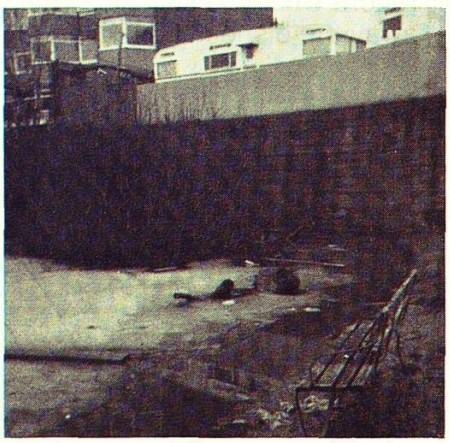
Q11 Does tap water contain any bacteria?

Q12 Why must you leave one petri dish and one bottle unused?

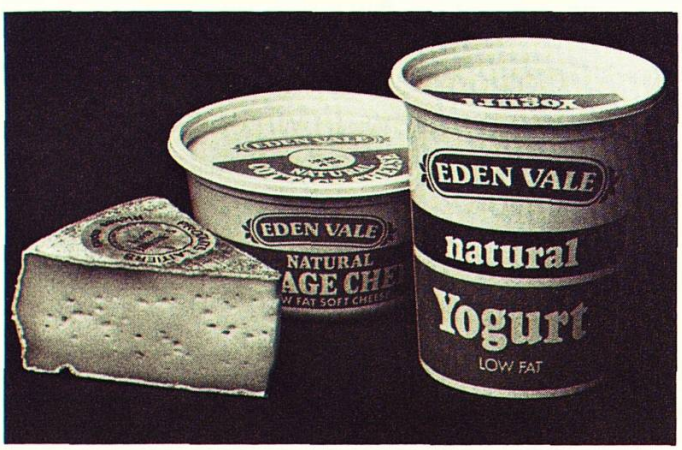
Information: Useful and harmful bacteria



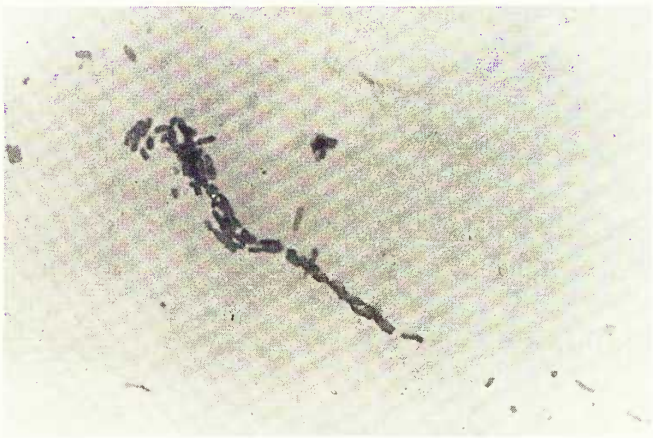
Most drinking water has small amounts of dissolved mineral salts in it. These are substances such as magnesium chloride. These minerals give water its taste. Some people buy "spring water". This has a lot of mineral salts which make the water tasty.



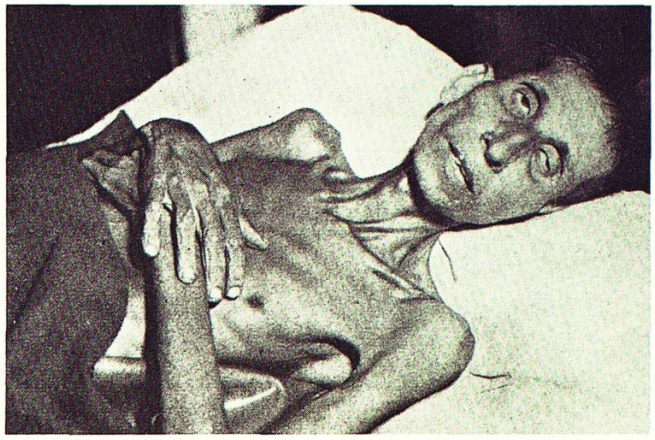
Polluted water can be dirty, smelly and have a nasty taste. It can contain bacteria. These may be harmful and cause disease.



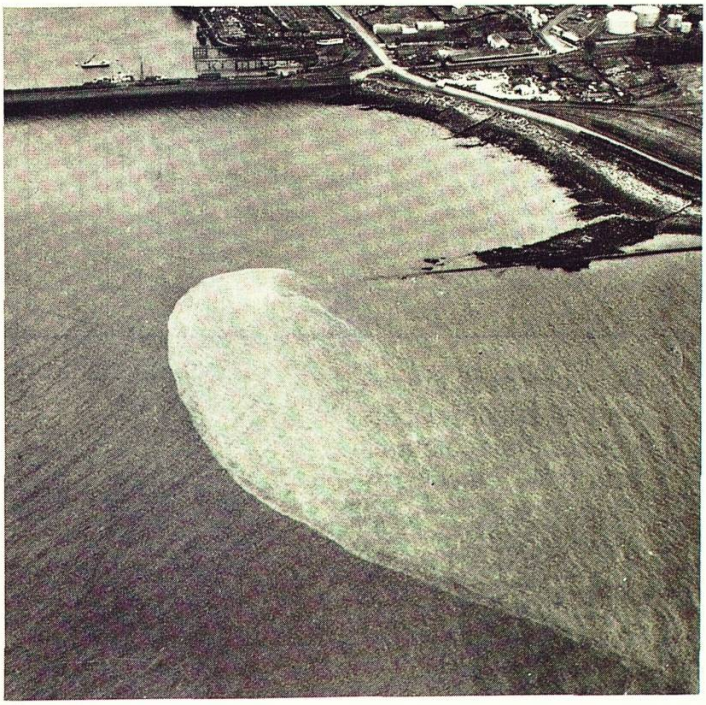
Some bacteria are useful to humans. They feed on dead animals and plants which helps to rot them. Some bacteria are used to **extract** (get out) *metals from ores. Some are used to make* food such as cheese and yogurt.



Human waste contains millions of bacteria. Most are usually harmless. The main type is **Escherichia coli,** shown in the photo. This is found in the healthy gut of every human. Scientists test water for **E. coli** (**a coliform**). If these bacteria are in the water, it means that more harmful bacteria may be present.



Harmful bacteria cause disease. Among the diseases that are carried in water are cholera, typhoid and dysentery. The picture shows someone suffering from cholera.



If human waste is passed into water that is used for drinking, cholera, typhoid or dysentery could break out. The photo shows untreated sewage being pumped into the sea. If you swam in this sea, you could become ill.

Q13 How do humans make use of bacteria?

Q14 Why do scientists test water for coliform bacteria?

Q15 Name one disease that can be carried in dirty water.

Q16 Why do you think there are still outbreaks of cholera in parts of Europe?

2 Chemicals in water

Testing for hydrogen sulphide

Apparatus

★ 6 water samples in numbered containers ★ screw-topped jar with holes in lid
★ Alka-Seltzer tablets ★ lead ethanoate paper ★ fume cupboard

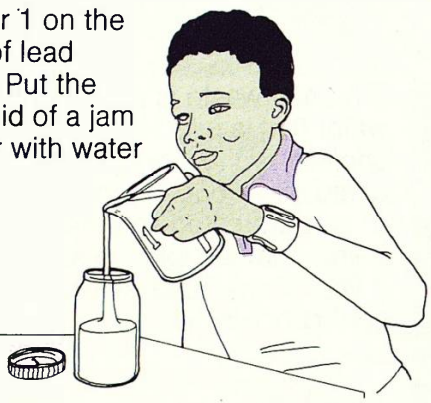
You are going to find out if there is any hydrogen sulphide in different samples of water. Putting an Alka-Seltzer tablet in the water helps "lift out" hydrogen sulphide.

This experiment must be done in a fume cupboard. Wash your hands after using the lead ethanoate paper.

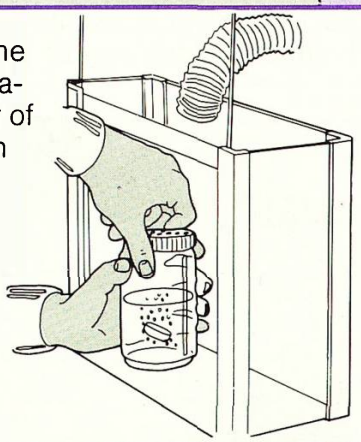
Q1 Copy this table.

Number of water sample	Source of water	Colour of dried lead ethanoate paper

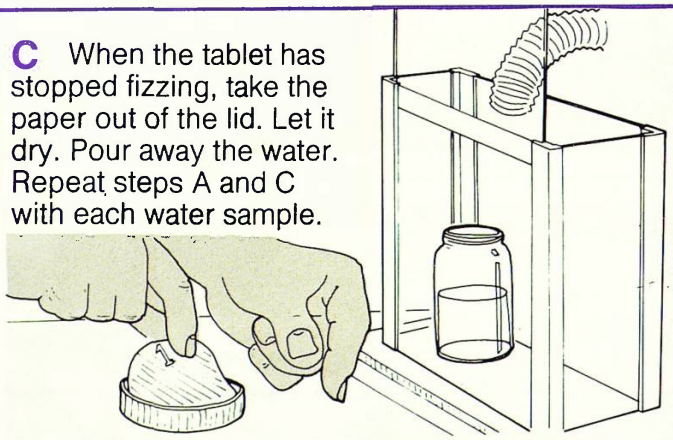
A Write number 1 on the edge of a piece of lead ethanoate paper. Put the paper inside the lid of a jam jar. Half fill the jar with water sample 1.



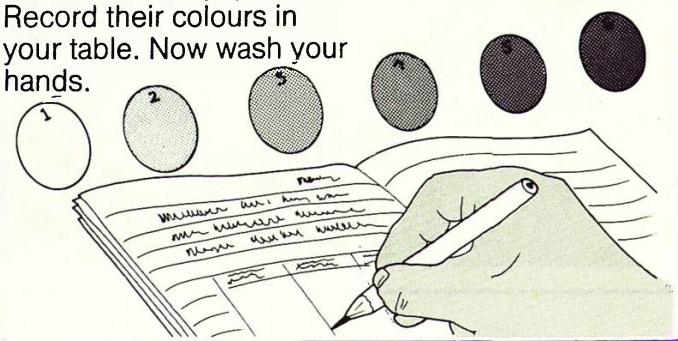
B Put the jar in a fume cupboard. Put one Alka-Seltzer tablet in the jar of water. Screw the lid on quickly.



C When the tablet has stopped fizzing, take the paper out of the lid. Let it dry. Pour away the water. Repeat steps A and C with each water sample.



D Look at all the dried lead ethanoate papers. Record their colours in your table. Now wash your hands.



Q2 When hydrogen sulphide is in the air, lead ethanoate paper turns black. Which water samples gave off hydrogen sulphide gas?

Q3 Hydrogen sulphide comes from water containing bacteria and plant and animal waste. Which water sample contained most waste?

Testing for lead

Apparatus

★ 4 water samples in numbered containers ★ potassium chromate solution
★ 4 test tubes ★ test tube rack ★ four 1 cm³ syringes ★ dropper
★ wax pencil

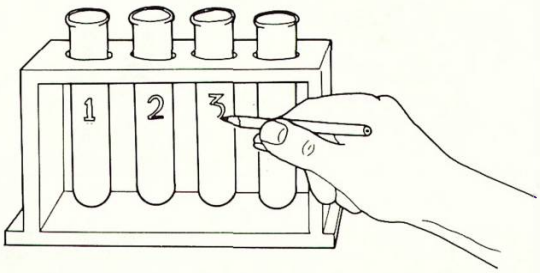
You are going to find out if there is any lead in different samples of water.

Wash your hands after using potassium chromate.

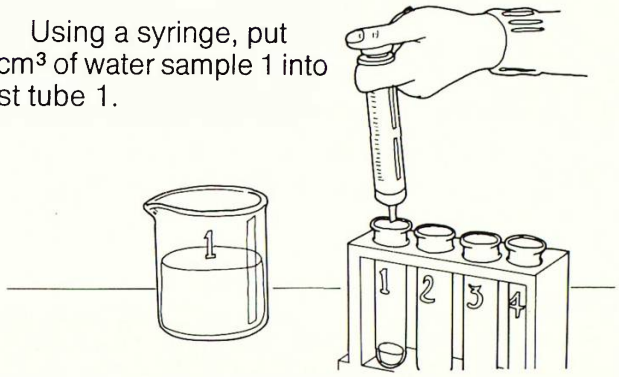
Q4 Copy this table.

Number of water sample	Source of water	Appearance of water when potassium chromate has been added

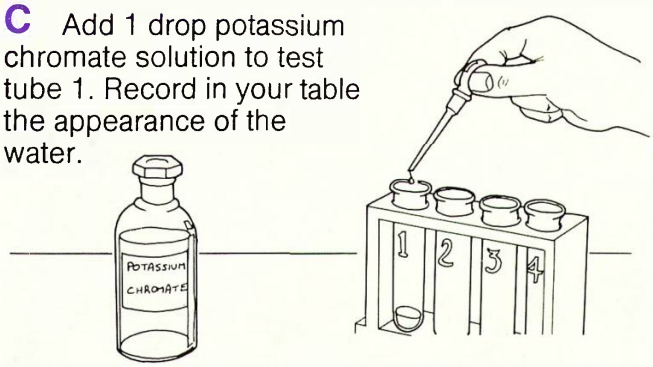
A Number the test tubes 1 to 4 with a wax pencil.



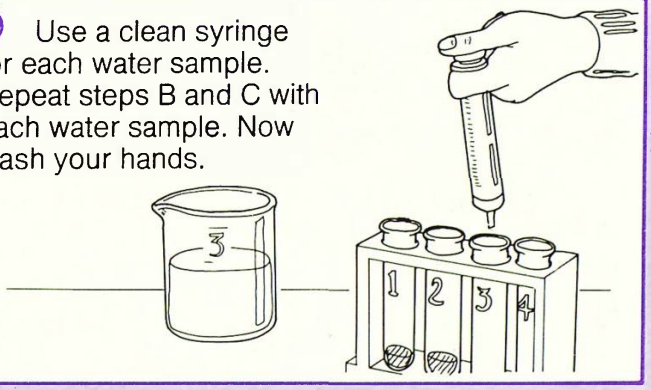
B Using a syringe, put 1 cm³ of water sample 1 into test tube 1.



C Add 1 drop potassium chromate solution to test tube 1. Record in your table the appearance of the water.



D Use a clean syringe for each water sample. Repeat steps B and C with each water sample. Now wash your hands.



Q5 When lead is present in water, potassium chromate forms a yellow solid. Which of your water samples contained lead?

Q6 Where did the water that contained lead come from?

Q7 Lead compounds are poisonous. Why do you think lead water pipes are no longer used in houses?

Information: Waste water

Every day we use a lot of water. We use it to drink and wash. Industry uses water in making the things we need.

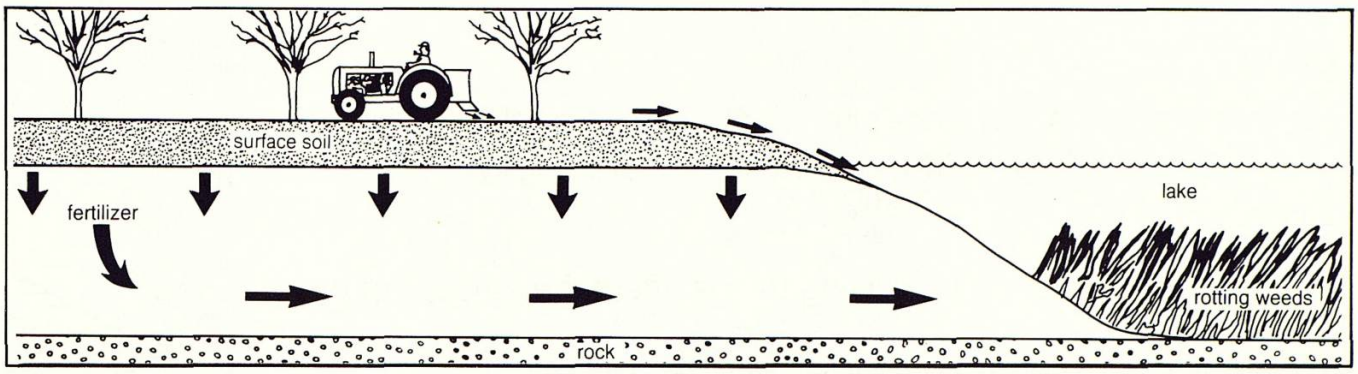
It takes 350 litres of water to make 1 litre of beer.

It takes 190 litres of water to make the paper for 1 newspaper.

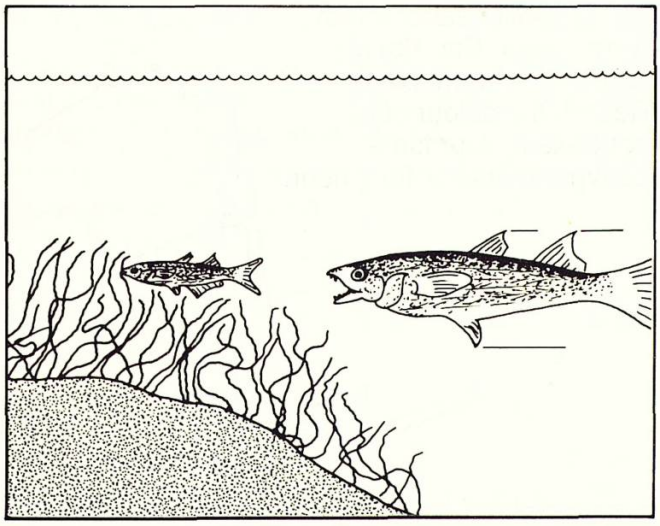
It takes 190 000 litres of water to make a tyre and 450 000 litres to make a family car.

Wherever there is a town or factory, water is used and waste is produced. The waste is pumped into rivers. Water that contains waste is called **effluent.** In many parts of the world this effluent is checked by scientists. The photo shows effluent from a carbon black factory.

Sometimes, things go wrong. In Japan, the effluent from a plastics factory contained a lot of mercury. The effluent was pumped into the sea at a place called Minamata Bay. The local people caught the fish in this bay and those who ate the fish were poisoned by the mercury. The photo shows nail disease caused by mercury poisoning.



Farmers use **fertilizers** to make their crops grow well. If too much fertilizer is put on the land, it can pass from the soil to rivers and lakes. The fertilizer may make water plants grow. When these die bacteria rot them. This uses oxygen. There may not be enough oxygen to rot all the plants. Then the water goes bad and begins to smell. Fish and other creatures often cannot live in it.



Pesticides are used to stop insects and other pests eating our food crops. Pesticides can also pass into rivers and so into water plants. Animals eat the plants. These animals are then eaten by others.

In this way, pesticides are passed on. Small amounts of pesticides have been found in the muscles and eggs of birds, such as the osprey. Pesticides cause eggshells to break and so reduce bird populations.

Q8 What is **effluent?**

Q9 Why must effluent be tested?

Q10 What happened at Minamata Bay?

Q11 Why do farmers use fertilizers?

Q12 What might happen if a farmer used too much fertilizer on his land?

Q13 Why do farmers use pesticides?

Q14 How do pesticides get into the bodies of birds such as the osprey?

3 Living things in water

Using up oxygen

Apparatus

★ sugar solution ★ methylene blue ★ 5 g dried yeast ★ warm water
★ three 250 cm³ beakers ★ wax pencil ★ measuring cylinder ★ dropper
★ 2 glass rods

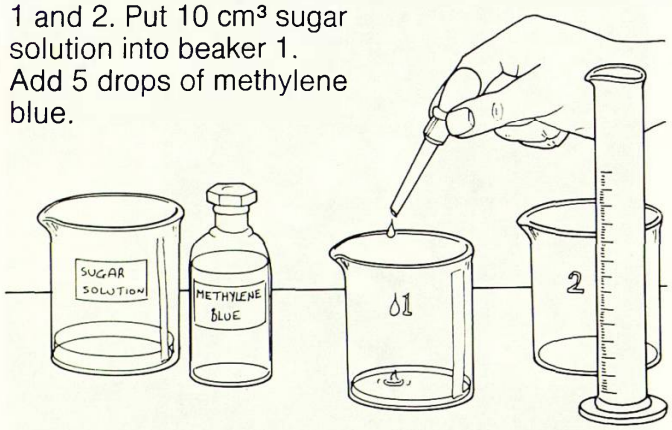
You are going to find out how living things affect the amount of oxygen in water.

Methylene blue is blue when oxygen is present. It is colourless if there is no oxygen.

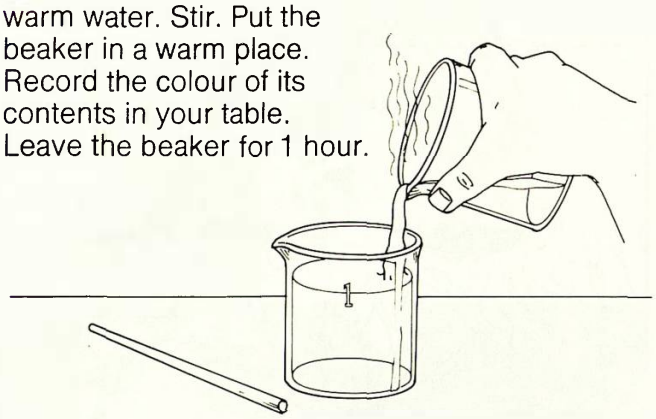
Q1 Copy this table.

Beaker number	Contents of beaker	Colour of contents at start	Colour of contents after 1 hour

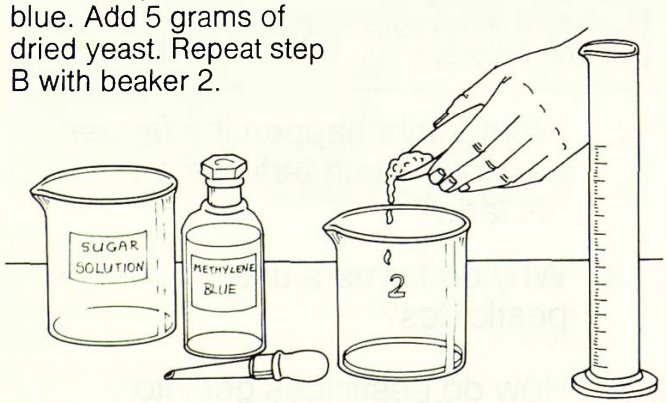
A Number two beakers 1 and 2. Put 10 cm³ sugar solution into beaker 1. Add 5 drops of methylene blue.



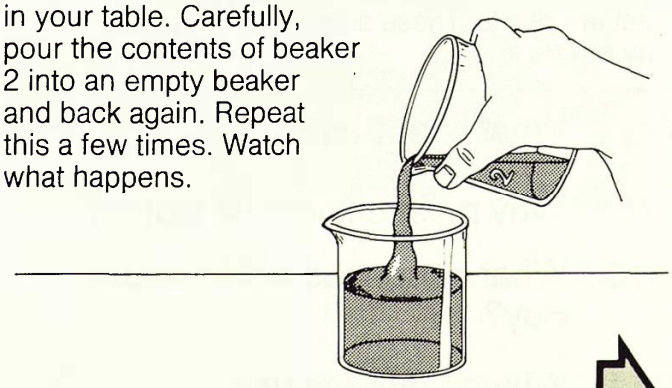
B Now fill beaker 1 with warm water. Stir. Put the beaker in a warm place. Record the colour of its contents in your table. Leave the beaker for 1 hour.



C Put 10 cm³ sugar solution into beaker 2. Add 5 drops of methylene blue. Add 5 grams of dried yeast. Repeat step B with beaker 2.



D **After 1 hour,** look at the contents of beakers 1 and 2. Record their colours in your table. Carefully, pour the contents of beaker 2 into an empty beaker and back again. Repeat this a few times. Watch what happens.



Q2 What happened to the oxygen in beaker 1?

Q3 What happened to the oxygen in beaker 2?

Q4 Yeast is alive. It uses sugar and oxygen to get energy. What do you think happened in beaker 2?

Q5 What happened when the contents of beaker 2 were poured into the empty beaker?

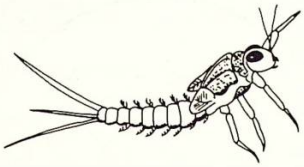
Q6 Why do you think this happened?

Information: Animals as indicators

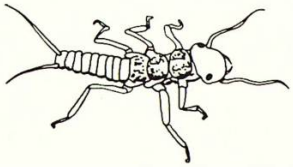
In clean water there are many water creatures. In dirty water there are fewer animals and not so many different types. This is because some are killed by chemicals and some by lack of oxygen in the dirty water.

Some animals can live in water which has little oxygen. Looking at the animals which live in water helps to show if the water is polluted. These animals are called **indicator animals.**

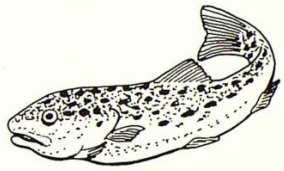
These animals are found in clean water:



mayfly nymph
actual size 6 mm

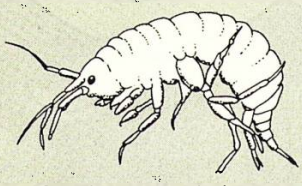


stone fly nymph
actual size 14 mm

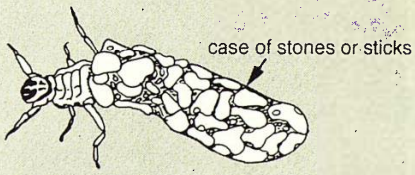


salmon trout
actual size 40 cm

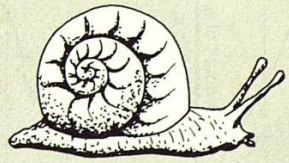
These animals are found in slightly polluted water:



freshwater shrimp
actual size 4 mm

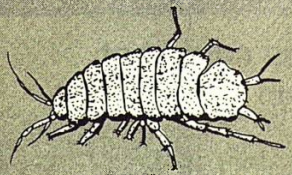


caddis fly larva
actual size 10 mm

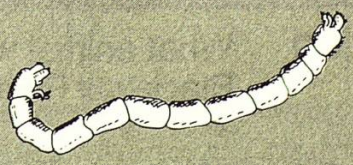


snail
actual size 20 mm

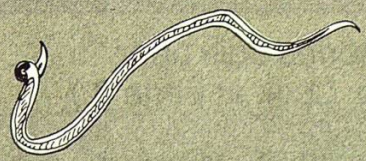
These animals are found in very dirty water:



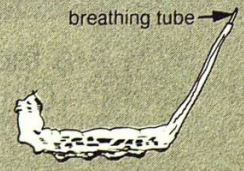
water louse
actual size 12 mm



blood worm
actual size 16 mm



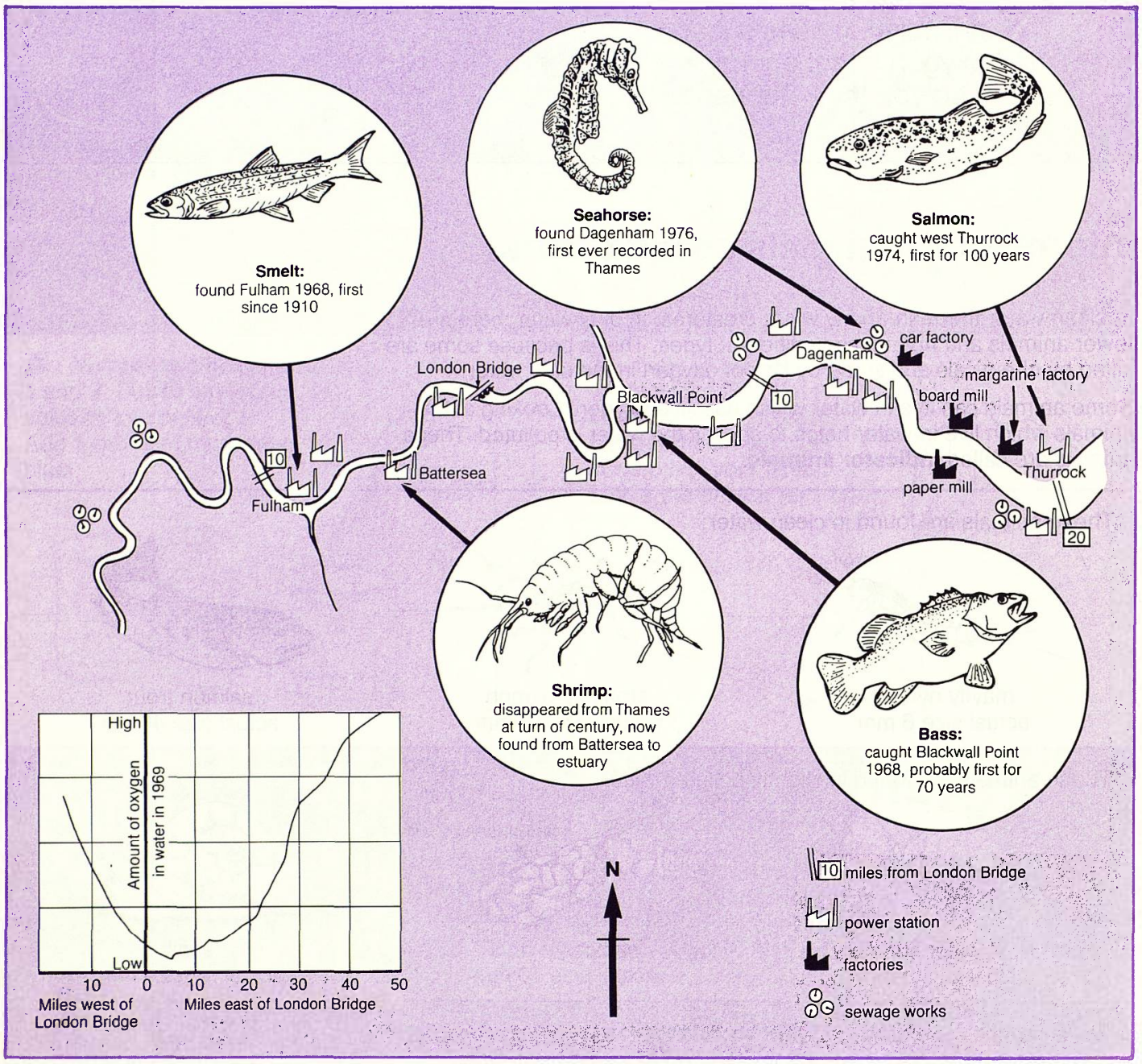
sludge worm
actual size 48 mm



rat-tailed maggot
actual size 10 mm

Information: The River Thames

Efforts are now being made to keep rivers clean. Less than 20 years ago, the River Thames was dead. There were no animals in the river. At some times the water contained no oxygen at all. The river stank. Now it is clean. The river water is alive with fish and other animals.



Q7 Why are factories built near rivers? (Clue: Look at page 8.)

Q8 Was the amount of oxygen in the River Thames at London Bridge high or low in 1969?

Q9 What animal was caught at Blackwall Point in 1968?

Q10 When was a seahorse first found in the River Thames?

4 Cleaning water

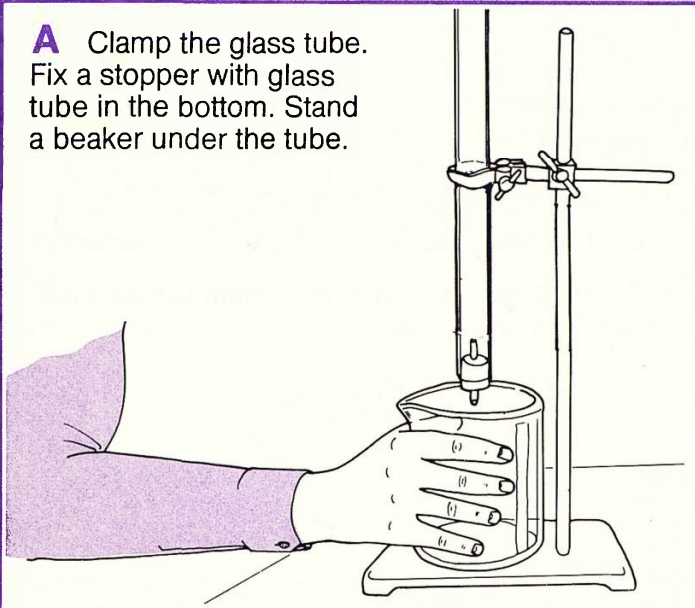
Removing particles (1)

Apparatus

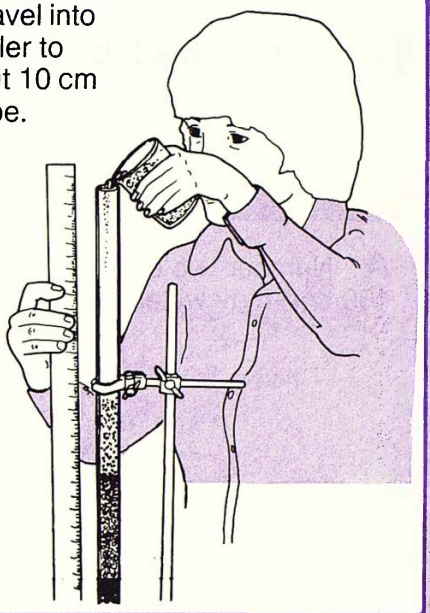
★ sand ★ fine gravel ★ muddy water ★ long glass tube
★ clamp stand with boss head ★ plastic funnel ★ stopper with glass tube
★ 250 cm³ beaker ★ ruler ★ measuring cylinder

You are going to try cleaning water with sand and gravel.

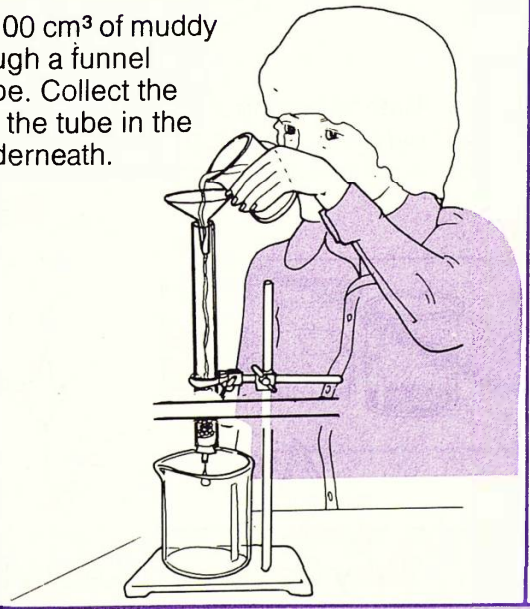
A Clamp the glass tube. Fix a stopper with glass tube in the bottom. Stand a beaker under the tube.



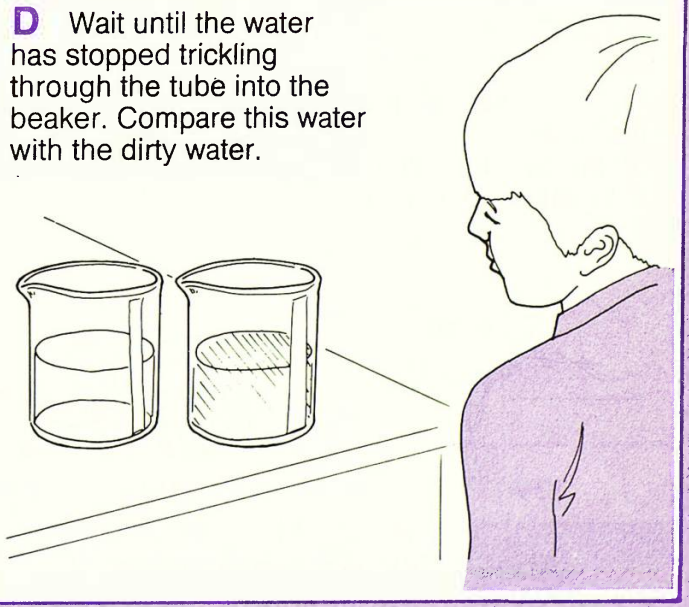
B Put 5 cm of gravel into the tube. (Use a ruler to measure.) Then put 10 cm of sand into the tube.



C Pour 100 cm³ of muddy water through a funnel into the tube. Collect the water from the tube in the beaker underneath.



D Wait until the water has stopped trickling through the tube into the beaker. Compare this water with the dirty water.



Q1 What happened to the water as it passed through the tube of sand and gravel?

Q2 Why do you think the sand is put in the tube on top of the gravel?

Removing particles (2)

Apparatus

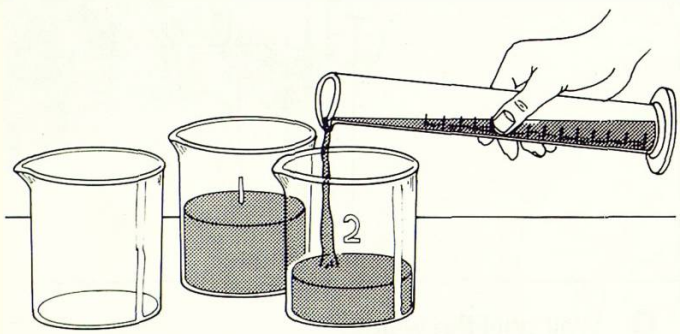
★ beaker of dirty water ★ aluminium sulphate ★ three 250 cm³ beakers
★ measuring cylinder ★ filter funnel ★ filter paper ★ spatula ★ stirrer
★ wax pencil ★ stop clock

You are going to try cleaning water with chemicals.

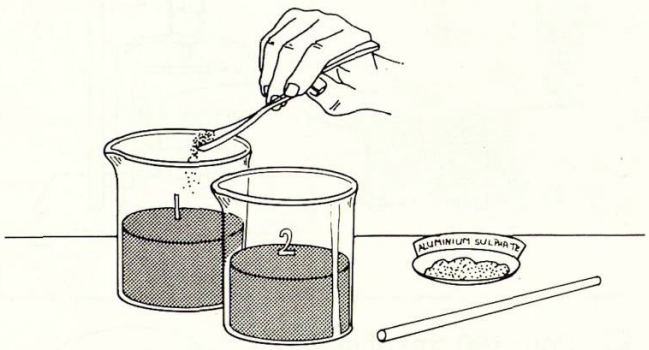
Q3 Copy this table.

Beaker number	Treatment given to water	Appearance of water after treatment

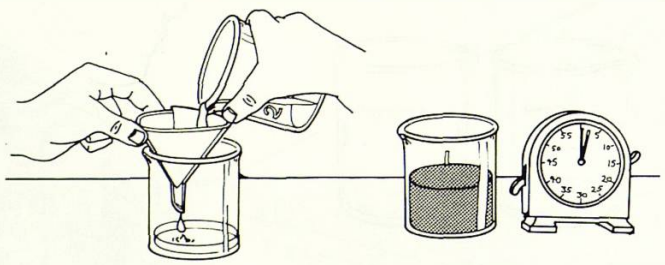
A Number two empty beakers 1 and 2. Put 100 cm³ dirty water into beakers 1 and 2.



B Put 5 spatulas full of aluminium sulphate into beakers 1 and 2. Stir.



C Fit a filter paper into a funnel. Filter the water from beaker 2 into a third beaker. Leave beaker 1 on the bench for 30 minutes. Fill in the first 2 columns of your table.



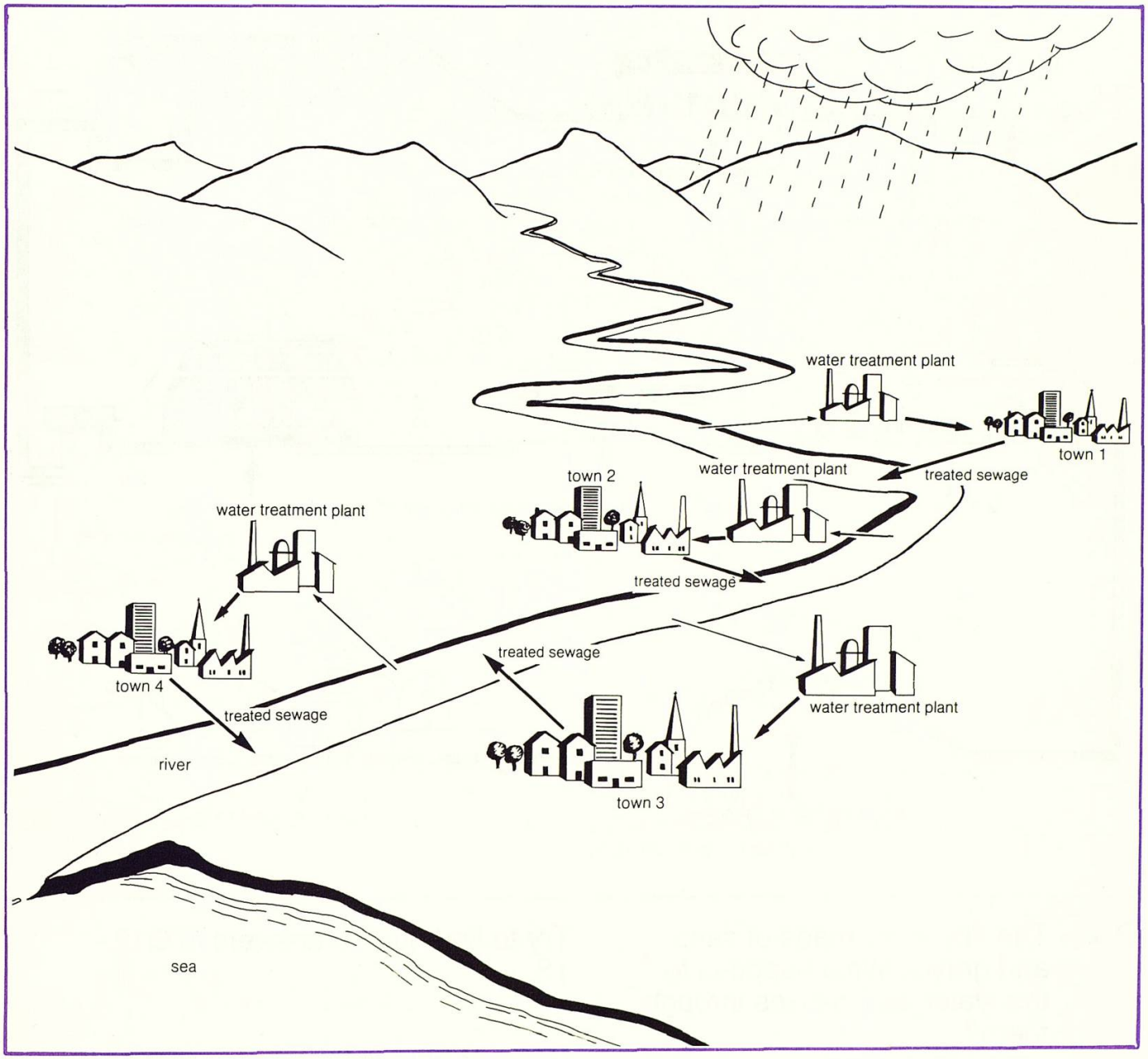
D After half an hour, stand the beakers together. Compare their appearance with the dirty water you left untreated. Record the results in your table.

Q4 About 100 years ago, **alum** (aluminium sulphate) was put into pond water to clean it for drinking. Was this a good way of cleaning water?

Q5 Why were you asked to filter one water sample and not the other?

Information: Supplying clean water

The map shows four towns sited near a river. All the towns get their water from the river. The river carries away their waste water. The sewage or effluent must be treated before it goes into the river.



Q6 Why do you think water is taken from the river **above** each town?

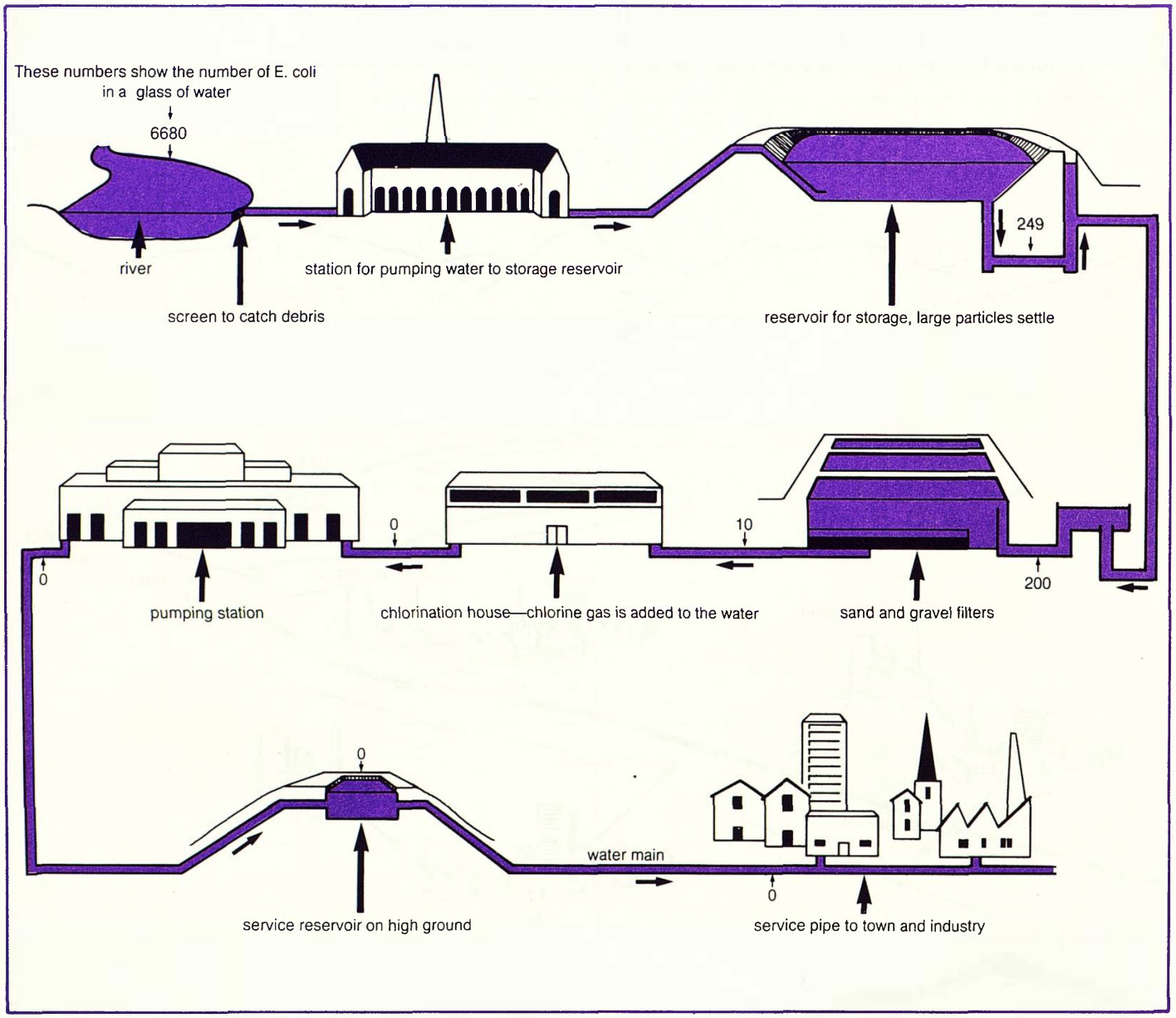
Q7 Why do you think treated sewage effluent is put in the river **below** each town?

Q8 How many times is this river water used as it passes from the mountains to the sea?

Q9 Where does the water in the mountain stream come from?

Cleaning water

The water from rivers must be cleaned before it is used. Water is cleaned at the water works.



Q10 The filters are made of sand and gravel. What happens to the water as it passes through them?

Q11 Chlorine gas kills bacteria. Why is water chlorinated after filtering?

Q12 What happens to the numbers of bacteria in the water between the river and the town?

Try to find out the answers to Q13 – 15.

Q13 Where is the service reservoir for your school?

Q14 Where is your local water treatment works?

Q15 From which river does your storage reservoir get its water?

5 Oil and water

Getting rid of oil

Apparatus

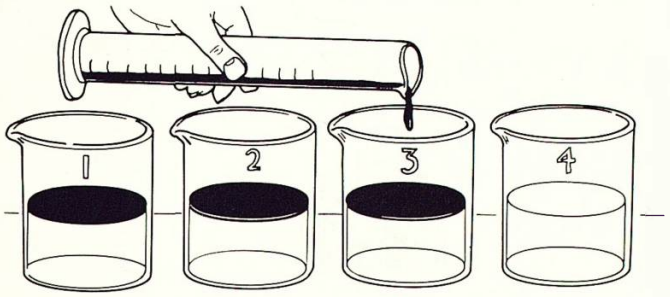
★ salt water ★ crude oil ★ detergent ★ polystyrene ★ sawdust
★ plaster of Paris ★ four 250 cm³ beakers ★ two 10 cm³ measuring cylinders
★ wax pencil ★ stop clock

You are going to use different substances to try to get rid of oil floating on water.

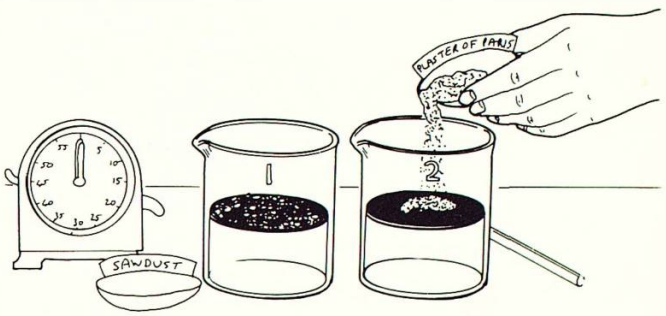
Q1 Copy this table.

Beaker number	Treatment of oil on water	What happened to the oil after:	
		5 minutes	1 day

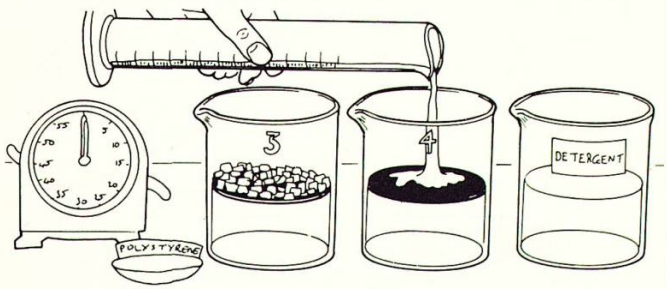
A Number the beakers 1 to 4. Half fill each beaker with salt water. Pour 4 cm³ of crude oil into each beaker.



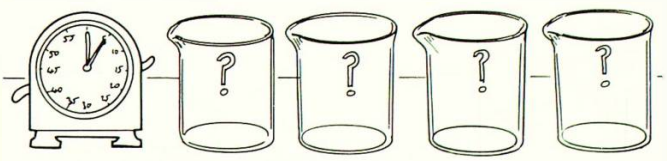
B Sprinkle sawdust into beaker 1. Sprinkle plaster of Paris into beaker 2. Stir gently.



C Sprinkle polystyrene into beaker 3. Pour 10 cm³ of detergent into beaker 4. Stir gently. Leave all the beakers on the bench for 5 minutes.



D After 5 minutes, look at all the beakers. Record in your table what happened to the oil in each. Leave the beakers for one day. Then record in your table what happened to the oil.



Q2 Did the oil sink in any of the beakers?

Q3 Did any of the methods spread the oil through the water?

Q4 Would sawdust be any use in cleaning oil from a stretch of water?

Cleaning oily feathers

Apparatus

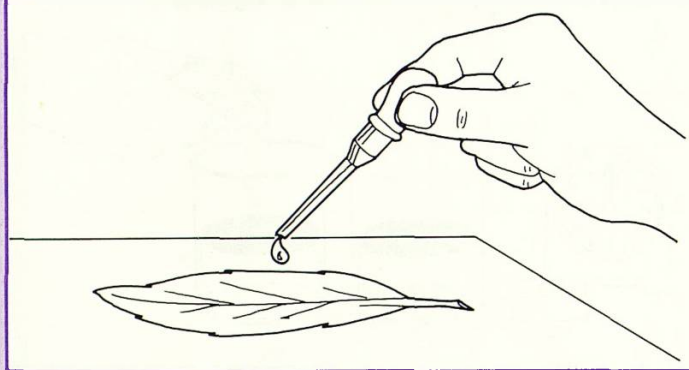
★ 2 feathers ★ crude oil ★ detergent ★ white tile ★ dropper
★ cotton wool

You are going to find out how oil damages birds' feathers.

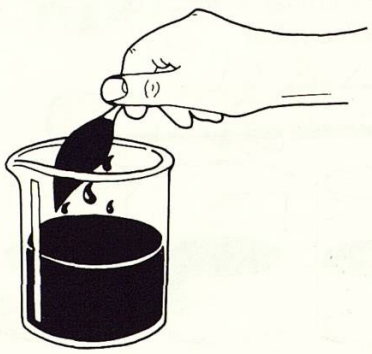
Q5 Copy this table.

Type of feather	Shape of water drop
Normal feather	
Oiled and cleaned feather	

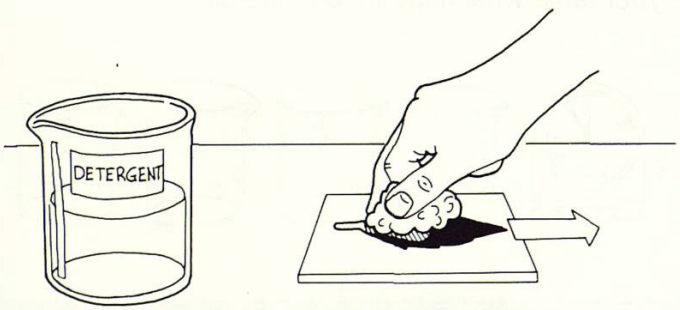
A Put one drop of water on a feather. Draw the shape of the water drop in your table.



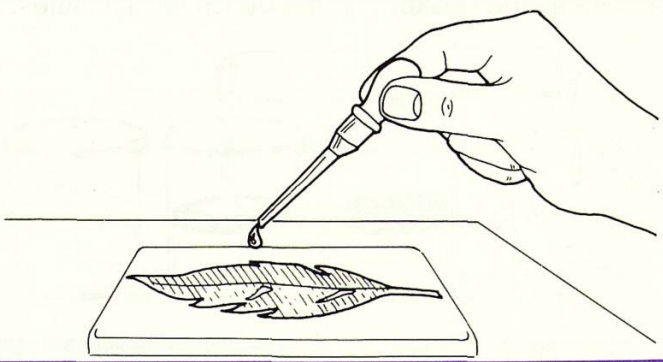
B Dip another feather in crude oil. Hold it over the beaker to drain. Put the feather on a tile.



C Clean the feather with cotton wool soaked in detergent. Stroke the feather from the **quill** to the tip with the cotton wool.



D Put one drop of water on the cleaned feather. Draw the shape of the drop in your table.

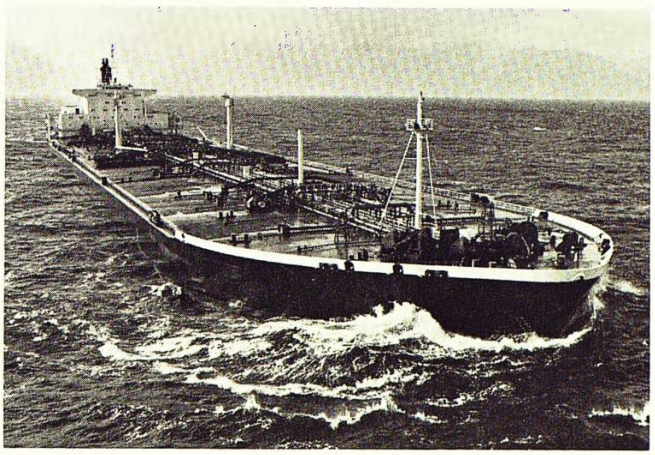


Q6 Was there any difference in the shape of the 2 water drops?

Q7 If a drop is "flat" the water must have gone into the feather. What would happen if a "cleaned" bird was put back into water?

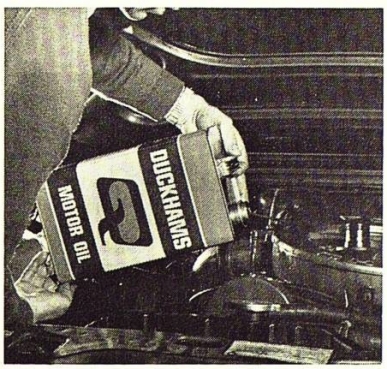
Information: Oil pollution

Oil is needed by many countries. Some countries have oil wells under the sea. Oil is transported from the countries that produce it by oil tanker.



Accidents to tankers and wells means that most oil pollution happens at sea. In 1978, a giant oil tanker, the Amoco Cadiz, went aground off the coast of France. The oil from the tanker damaged French beaches.

Oil harms sea birds. It makes their feathers stick together. This means the birds cannot keep warm. Even cleaned birds can die. They have lost their natural oils that keep water out. Sometimes, they swallow oil. Detergents can be used to break up oil slicks. These often harm animals, such as sea anemones.



Sometimes oil gets into the rivers from which we take our drinking water. The water must then be specially treated, which is very expensive. For this reason, oil from cars must never be put down drains.

Q8 Where does most oil pollution happen?

Q9 How does oil pollution kill sea birds?

Q10 Which country's beaches were damaged by oil from the Amoco Cadiz?

Q11 Name one of the dis-advantages of using detergent to clear oil slicks.

Q12 What do you think you should do with dirty oil from cars?

6 Dirty air

Collecting dust particles

Apparatus

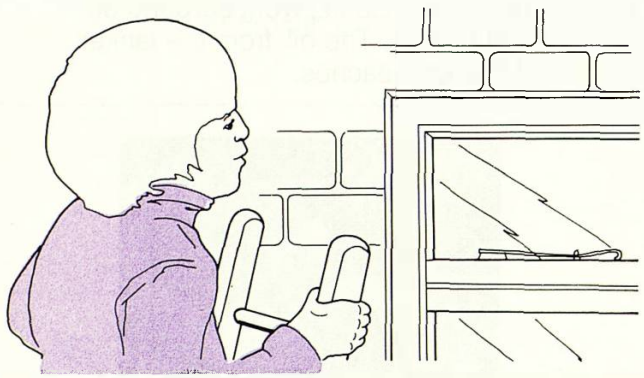
★ petroleum jelly ★ 3 microscope slides ★ wax pencil ★ plasticine
★ waterproof tape ★ microscope ★ bench lamp

You are going to find out if dust particles can be collected from air.

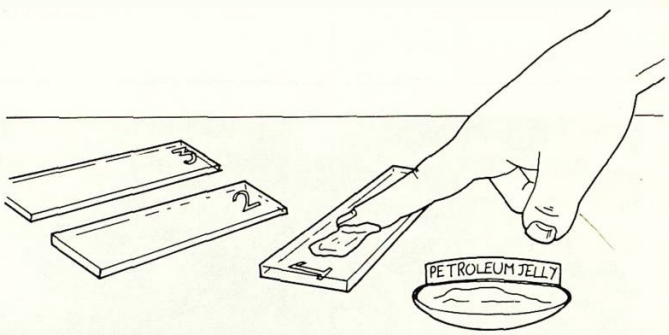
Q1 Copy this table.

Slide number	Position of slide	Appearance of slide after _____ days

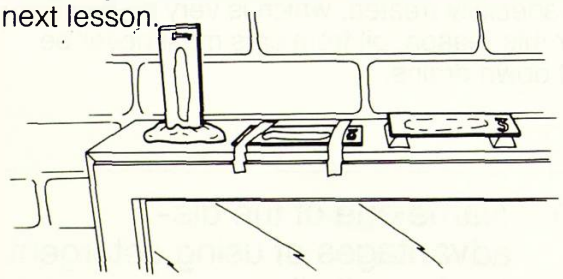
A Find a place outside where your experiment can be left and not damaged.



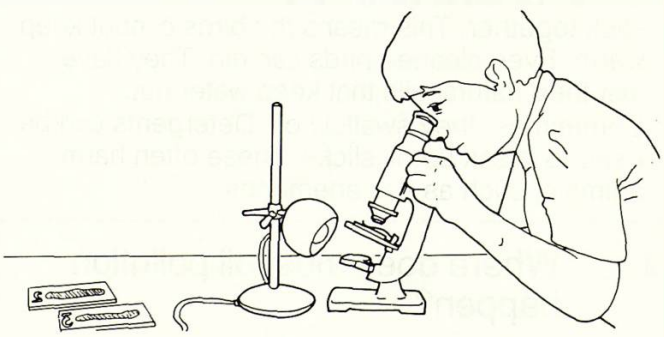
B Number the slides 1, 2 and 3 on one side. On the other side of each slide spread a very thin layer of petroleum jelly.



C Take the slides outside. Fix them in place with tape and plasticine. Stand slide 1 upright. Lay slide 2 flat, jelly side up. Lay slide 3 flat, jelly side down on plasticine wedges. Fill in the first two columns of your table. Leave the slides until the next lesson.



D **Next lesson.** Collect the slides. Hold them at their edges. Look at each slide under a microscope. Record in your table what you see.



Q2 Were there any grains or particles on the slides? If so, on which slides?

Q3 Where do you think the particles have come from?

Q4 On which slide had most particles collected?

Testing leaves for grime

Apparatus

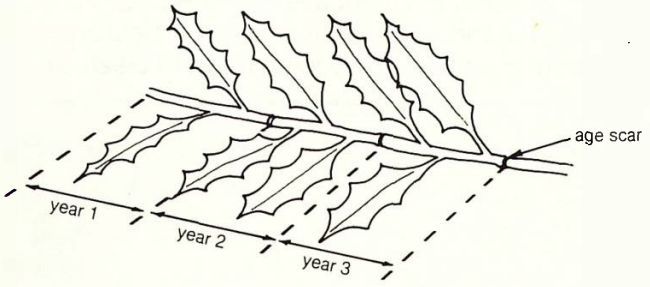
★ twig of holly ★ scissors ★ clear sticky tape ★ 3 dishes ★ wax pencil

You are going to find out how much grime builds up on holly leaves over a period of 3 years.

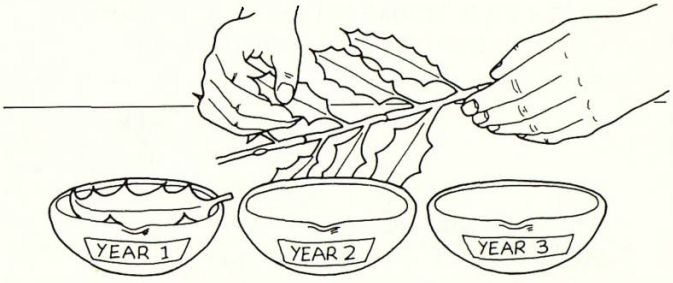
Q5 Copy this table.

Age of leaf (years)	Sticky tape from leaf

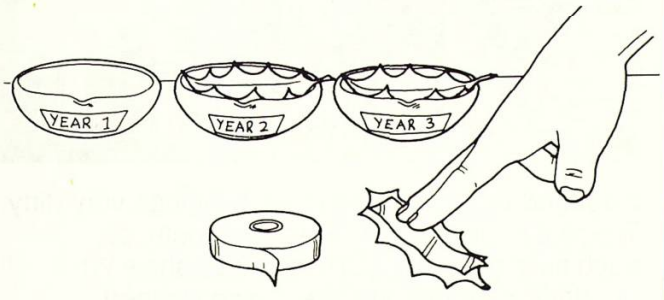
A Find the year scars on your holly twig. These scars go round the twig, as shown.



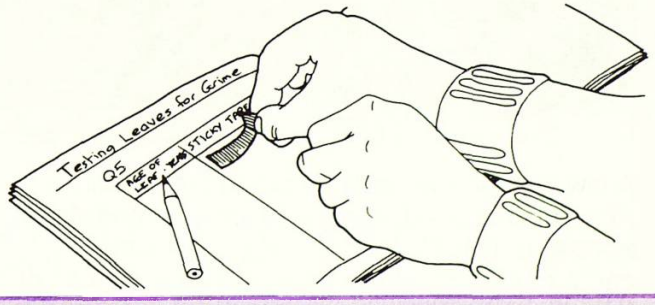
B Label 3 dishes, year 1, year 2 and year 3. Take one leaf of each year from the twig and put it in the correct dish.



C Press a piece of sticky tape across the shiny side of a one-year-old leaf.



D Peel off the sticky tape and stick it in your table. Repeat steps C and D with the 2 and 3 year old leaves.



Q6 Which holly leaf made the dirtiest smear on the sticky tape?

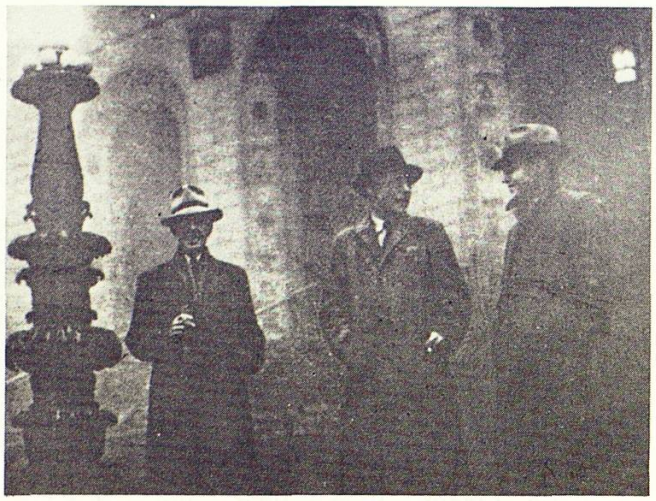
Q7 Where do you think the grime has come from?

Q8 Which was the cleanest holly leaf?

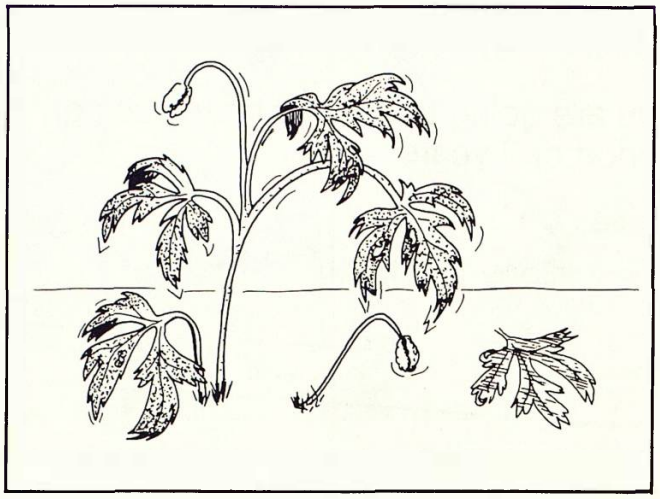
Q9 Why did you use leaves from an evergreen tree for this experiment?

Q10 What is the advantage of being able to tell the age of holly leaves?

Information: Clean air



Burning coal produces smoke. Coal was the main fuel used in homes until the 1950s. When there is a lot of smoke in the air it is difficult to see. The air can be dangerous to breathe.



Plants need light to make food. Animals need plants for food. If a plant's leaves are covered in soot, light cannot reach them easily. The plant cannot make as much food as it can in clean air.

A law was passed in 1956 called the Clean Air Act. This means that in some areas (**smokeless zones**) only fuels that do not give off smoke can be used. Electricity, gas and special kinds of "coal" are used for heating.

Soot and dust in the air make buildings very dirty. These can be cleaned by special methods, such as sand blasting. The pictures show Whitehall in London, before and after being cleaned.

Q11 What was the main domestic fuel used until the 1950s?

Q12 Why do plants need light?

Q13 What is a **smokeless zone?**

Q14 Name one fuel that does not produce smoke when used for heating.

Q15 Have any buildings near your school been cleaned? Which ones are they?

7 Analysing smoke

Cigarette smoke

Apparatus

★ 1 cigarette ★ bottle of universal indicator ★ glass wool ★ 2 U tubes
★ T tube ★ 2 rubber stoppers ★ 4 lengths of rubber tubing
★ two 100 cm³ conical flasks ★ stopper with 2 bent glass tubes ★ filter pump
★ glass rod ★ plasticine ★ matches ★ rubber gloves ★ heatproof mat
★ stop clock

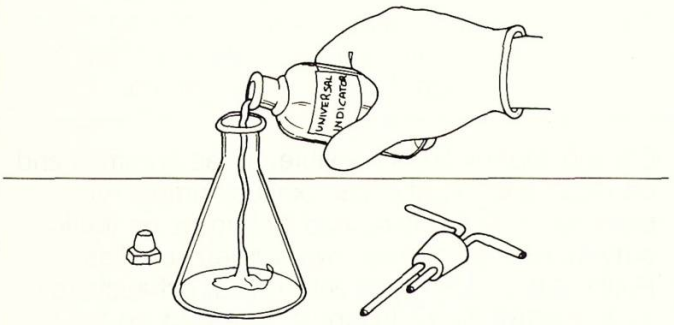
You are going to find out if cigarette smoke contains harmful chemicals. Universal indicator tests the acidity of the smoke.

Rubber gloves must be worn.

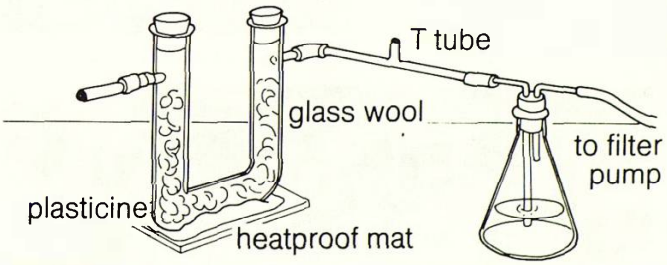
Q1 Copy this table.

Substance tested	Appearance of glass wool	Colour of indicator
Cigarette smoke		
Air		

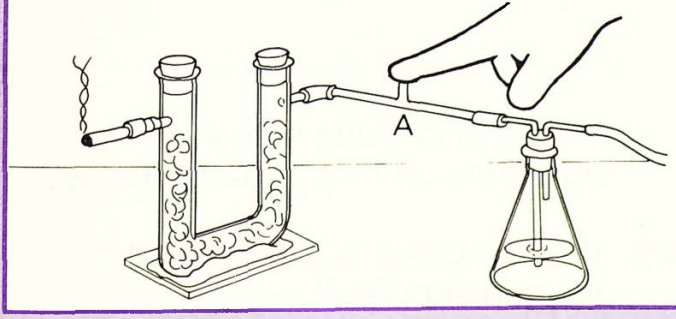
A Put on rubber gloves. Put some universal indicator in a flask. Push a stopper with bent glass tubes into the neck of the flask.



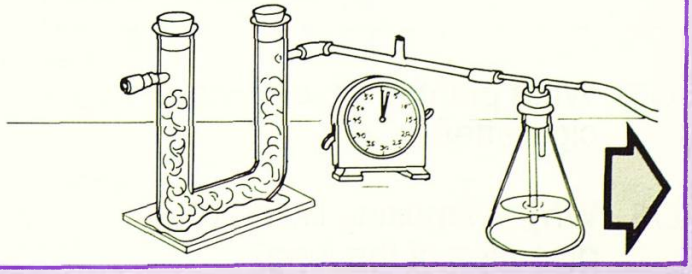
B Use a glass rod to pack glass wool loosely into a U tube. Then set up the apparatus, as shown. Fix a cigarette into the rubber tube. Turn on the pump.



C Light the cigarette. Put a finger over A. Lift the finger now and again. When the cigarette stops burning, switch off the pump. Record in your table the appearance of the glass wool and the indicator.



D Use a second flask of indicator and U tube of glass wool. Repeat the experiment without a cigarette. Let the pump run for 15 minutes. Then record in your table the appearance of the glass wool and indicator.



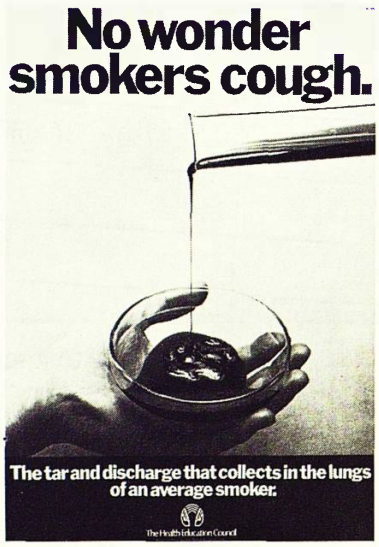
Analysing smoke

Q2 Why did you repeat the experiment without a cigarette?

Q3 Why did you have to lift your finger on and off the U tube when you used the cigarette?

Q4 What does the colour of the indicator tell you about cigarette smoke?

Information: Breathing in fumes



When smoke is **inhaled** (breathed in), it goes down the wind-pipe into the lungs.
Tobacco smoke is a mixture of gases and tiny droplets of tar. Over 1000 different substances have been found in the smoke of a tobacco plant. The chemicals can be divided into 4 groups. These are: nicotine; carbon monoxide; chemicals that cause cancer; chemicals that irritate the breathing tubes. Many of these substances damage your health.

Carbon monoxide is invisible. It has no smell and no taste. It is found in car exhaust fumes. Air pollution in Tokyo is so bad that police on traffic duty have to carry their own oxygen supplies. Police carry out daily checks on car exhausts to try to control the pollution. People who work where there is a little carbon monoxide may become sleepy and get headaches. If there is a lot, they may even die.

Q5 What plant is used to make cigarettes?

Q6 Why is smoking linked with diseases of the lung?

Q7 What gas is found both in cigarettes and car exhaust fumes?

Q8 Why do police in Tokyo need oxygen supplies?

8 Chemicals in air

Sulphur dioxide and plants

Apparatus

★ 2 containers of maize seedlings ★ 2 containers of barley seedlings
★ sodium metabisulphite solution ★ 4 polythene bags ★ 4 elastic bands
★ 4 labels ★ 4 watch glasses ★ cotton wool ★ tongs ★ stop clock

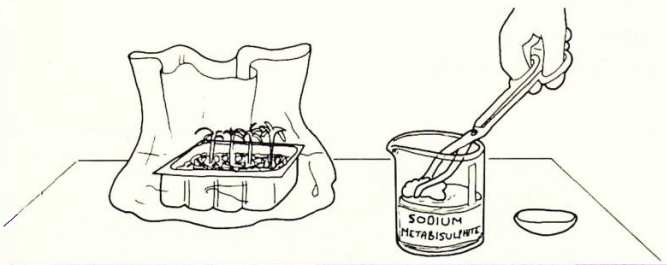
You are going to find out how sulphur dioxide affects plants. Sodium metabisulphite solution gives off sulphur dioxide.

Rubber gloves must be worn.

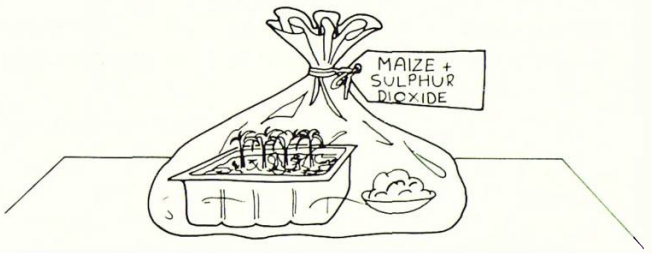
Q1 Copy this table.

Appearance of seedlings	Maize + sulphur dioxide	Maize + damp air	Barley + sulphur dioxide	Barley + damp air
At start				
After ½ hour				
Next lesson				

A Put on rubber gloves. Put 1 container of maize seedlings into a polythene bag. Using tongs, soak a wad of cotton wool in sodium metabisulphite. Put the cotton wool on a watch glass.

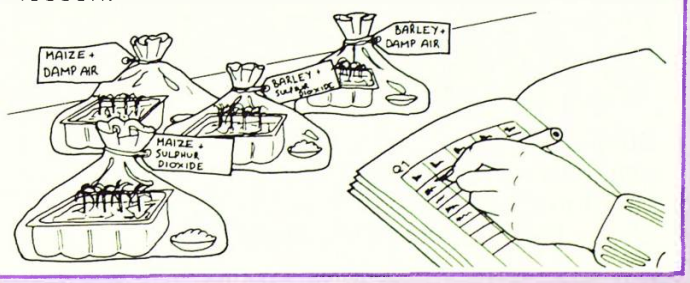


B Using tongs, put the watch glass, with cotton wool, into the polythene bag. Close the bag with an elastic band. Label the bag **maize + sulphur dioxide.**



C Repeat steps A and B. Use water instead of sodium metabisulphite. Then repeat steps A, B and C with barley seedlings instead of maize seedlings.

D Record the appearance of the seedlings in your table. Record their appearance again after half an hour and then at the beginning of the next lesson.



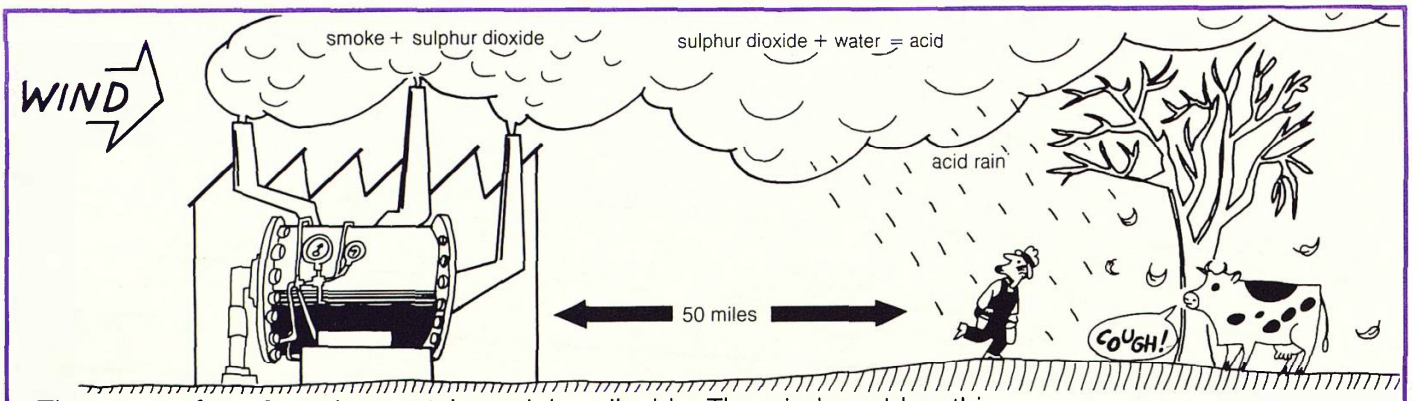
Q2 How did sulphur dioxide affect the maize seedlings?

Q3 How did sulphur dioxide affect the barley seedlings?

Q4 Which plant is sensitive to sulphur dioxide?

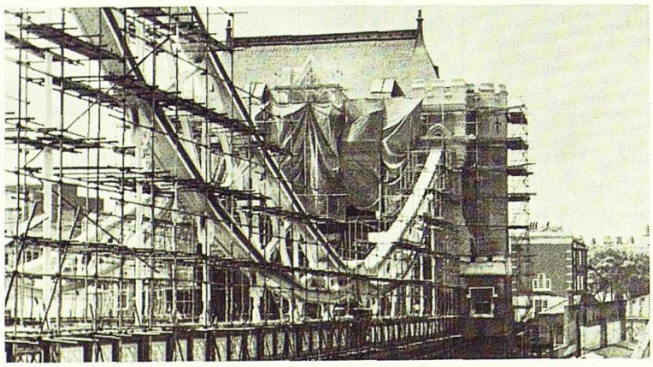
Q5 Why were you asked to repeat each experiment using water instead of sodium metabisulphite?

Information: Damage by sulphur dioxide



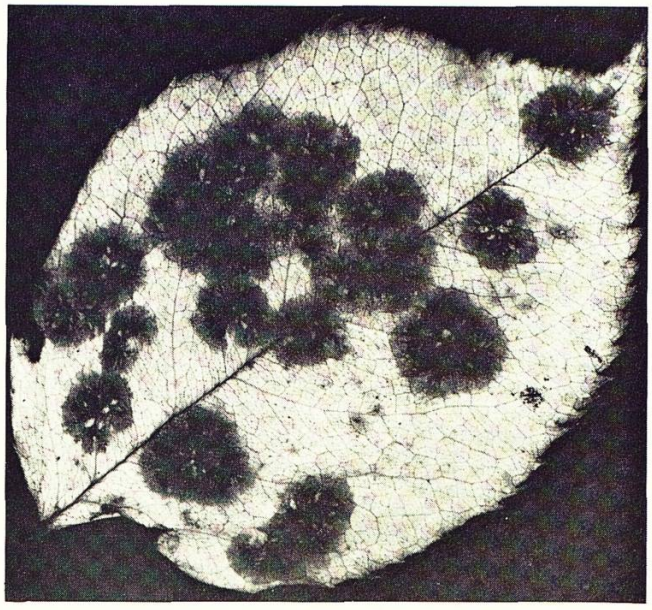
The smoke from factories contains sulphur dioxide. The wind can blow this smoke a long way. The gas dissolves in water and forms an acid. This means that "acid" rain can fall on land many miles from the factory.

One day in 1948, the town of Donora in North America was covered in **smog.** There were many factories near the town. The factory chimneys produced smoke containing sulphur dioxide. There was so much sulphur dioxide in the foggy air that 6000 people became ill. They suffered from runny eyes, coughs and sore throats. After 3 days, 20 people had died. 4000 people who suffered from bronchitis and similar illnesses died when London had a bad smog in 1952. There are different types of smog. For example, Los Angeles suffers from smog caused by the chemicals from car exhaust fumes.

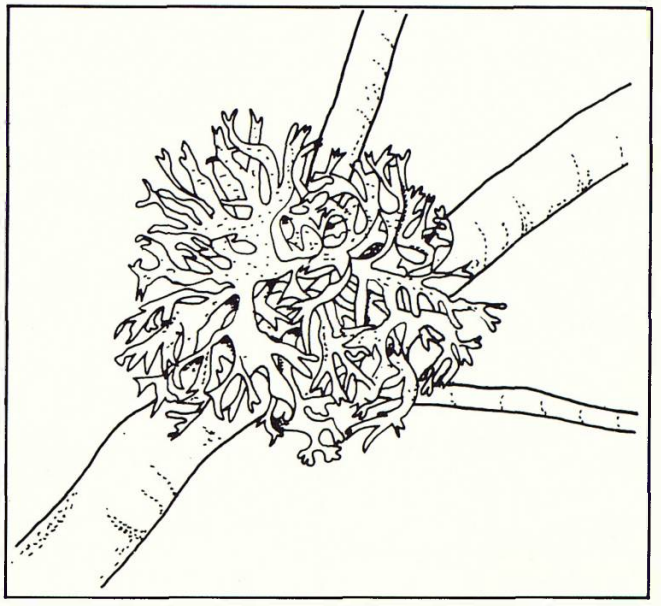


Sulphur dioxide in the air can damage building materials. It **corrodes** (eats into) metals. Metal structures must be protected. A layer of paint or plastic helps to protect the metal.

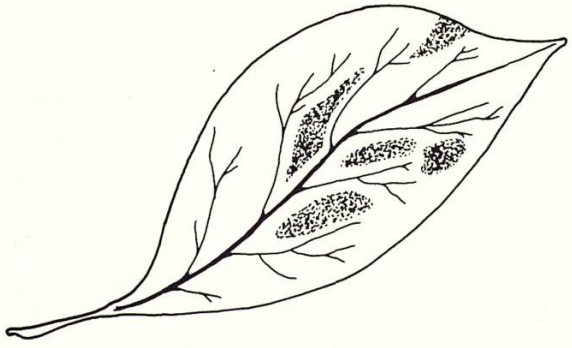
Many old buildings are made of **limestone.** Limestone is slowly dissolved by acid rain. Statues have been damaged in this way, like the one in the picture.



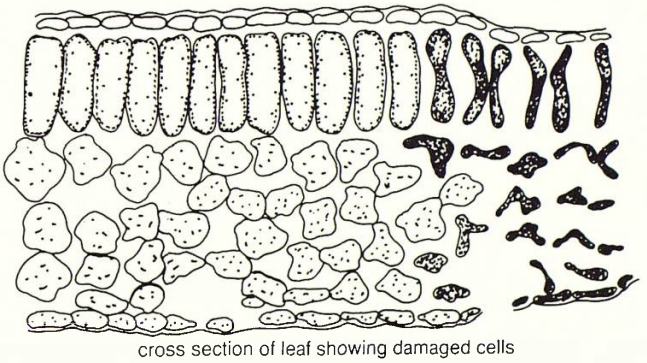
Some plants are sensitive to sulphur dioxide in the air. **Black spot** is a fungus that attacks roses. The fungus can live in clean air, but not in air that contains sulphur dioxide. If roses are not affected by black spot, it is a clue that sulphur dioxide may be in the air.



Lichens are plants that are sensitive to the amount of sulphur dioxide in the air. Shrubby lichens are found **only** where the air is very clean.



leaf damaged by sulphur dioxide



cross section of leaf showing damaged cells

Sulphur dioxide can damage the cells that make up the leaves of plants. This stops the plants making food. Experts have worked out that several million dollars worth of crops are damaged in this way each year along the east coast of North America.

Q6 Why can the people of Norway complain that smoke from factories in Germany poisons their air?

Q7 How can sulphur dioxide damage buildings?

Q8 What effect does sulphur dioxide have on humans?

Q9 How can black spot fungus and lichens be used as indicator plants?

9 Sound

Measuring sound

Apparatus

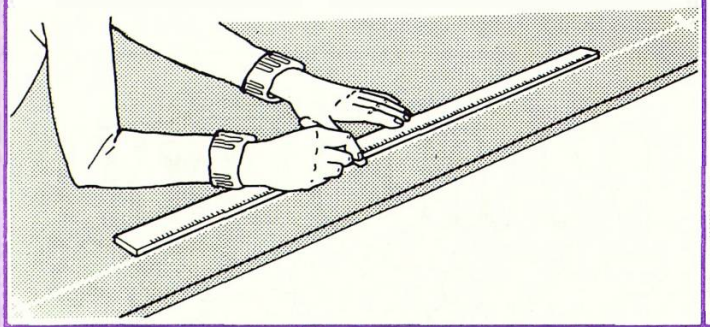
★ metre rule ★ chalk ★ sound meter ★ stop clock ★ football rattle
★ baby's rattle ★ toy drum ★ alarm clock ★ whistle ★ bicycle bell
★ food mixer ★ record player and record

Sound is measured in **decibels.** You are going to measure the **intensity** of some sounds. Work with a partner.

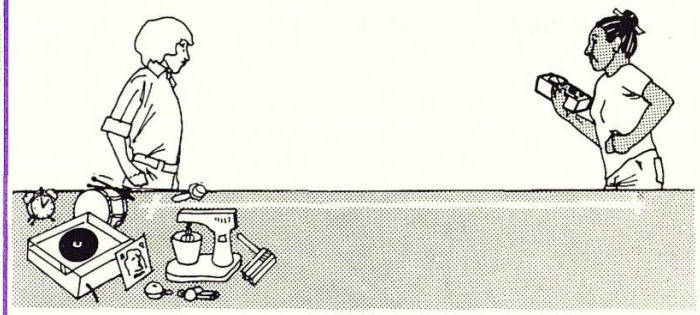
Q1 Copy this table.

Object used to make sound	Reading on sound meter 2m from object

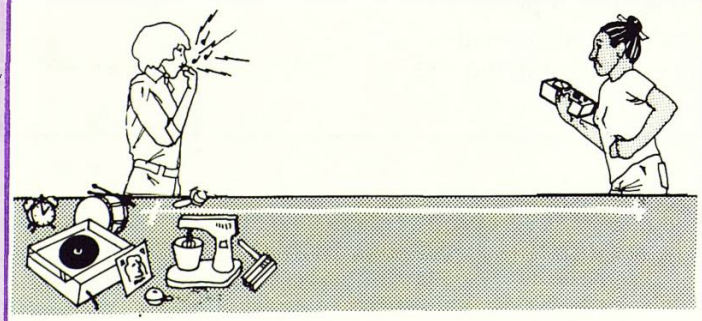
A Make a chalk mark on the bench or floor. Make another mark 2 metres from the first. Draw a straight line between the marks.



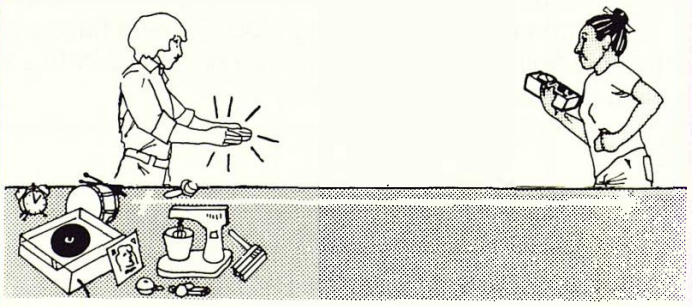
B Stand at one end of the chalk line with a sound meter. Ask your partner to stand at the other end with all the objects to be tested.



C Ask your partner to make a sound with one of the objects for 15 seconds. Record in your table the reading on the sound meter. Repeat this step with each object.



D Ask your partner to make sounds with parts of his body (clapping, whistling, etc.). Record in your table the readings on the sound meter.



Q2 Which sound gave the highest reading on the sound meter?

Q3 Which sound gave the lowest reading on the sound meter?

Stopping sound

Apparatus

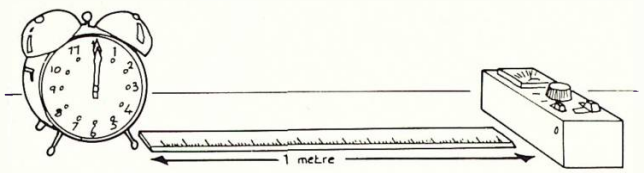
★ metre rule ★ alarm clock ★ sound meter
★ boxes made from cardboard, cork, perspex, carpet underlay, polystyrene and insulating board
★ flat pieces of the same materials

You are going to see how effective different materials are at stopping sound.

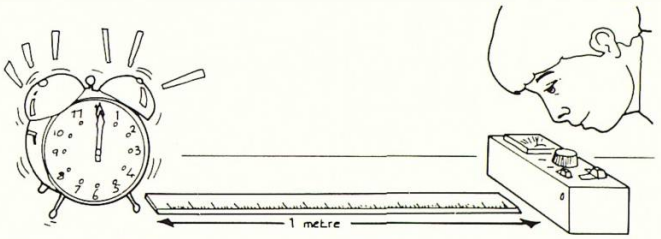
Q4 Copy this table.

Sound meter reading of clock alone = _____ dB			
Name of material	Box over clock (✓)	Material under clock (✓)	Sound meter reading

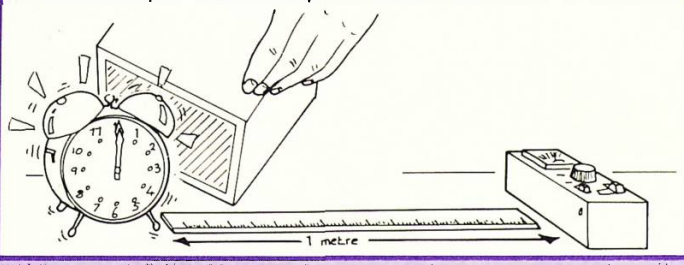
A Put a metre rule on the bench. Put a fully wound alarm clock at one end of the ruler. Put a sound meter at the other end.



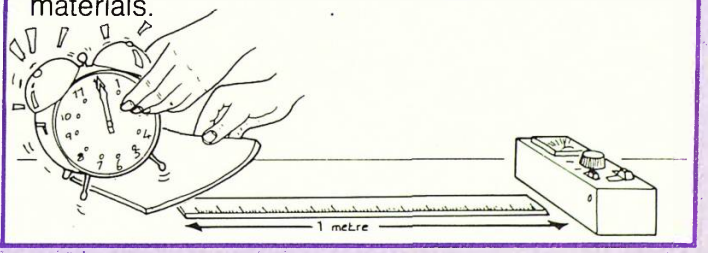
B Set the alarm clock to ring. Measure the sound on the sound meter. Record the reading in your table.



C Put a cork box over the ringing alarm clock. Measure the sound. Record the reading in your table. Repeat this step with the other boxes.



D Put a piece of cork under the ringing alarm clock. Measure the sound. Record the reading in your table. Repeat this step with the other flat materials.



When the alarm clock rings noise travels through the air and through the bench.

Q5 Did covering the clock with boxes change the sound meter reading?

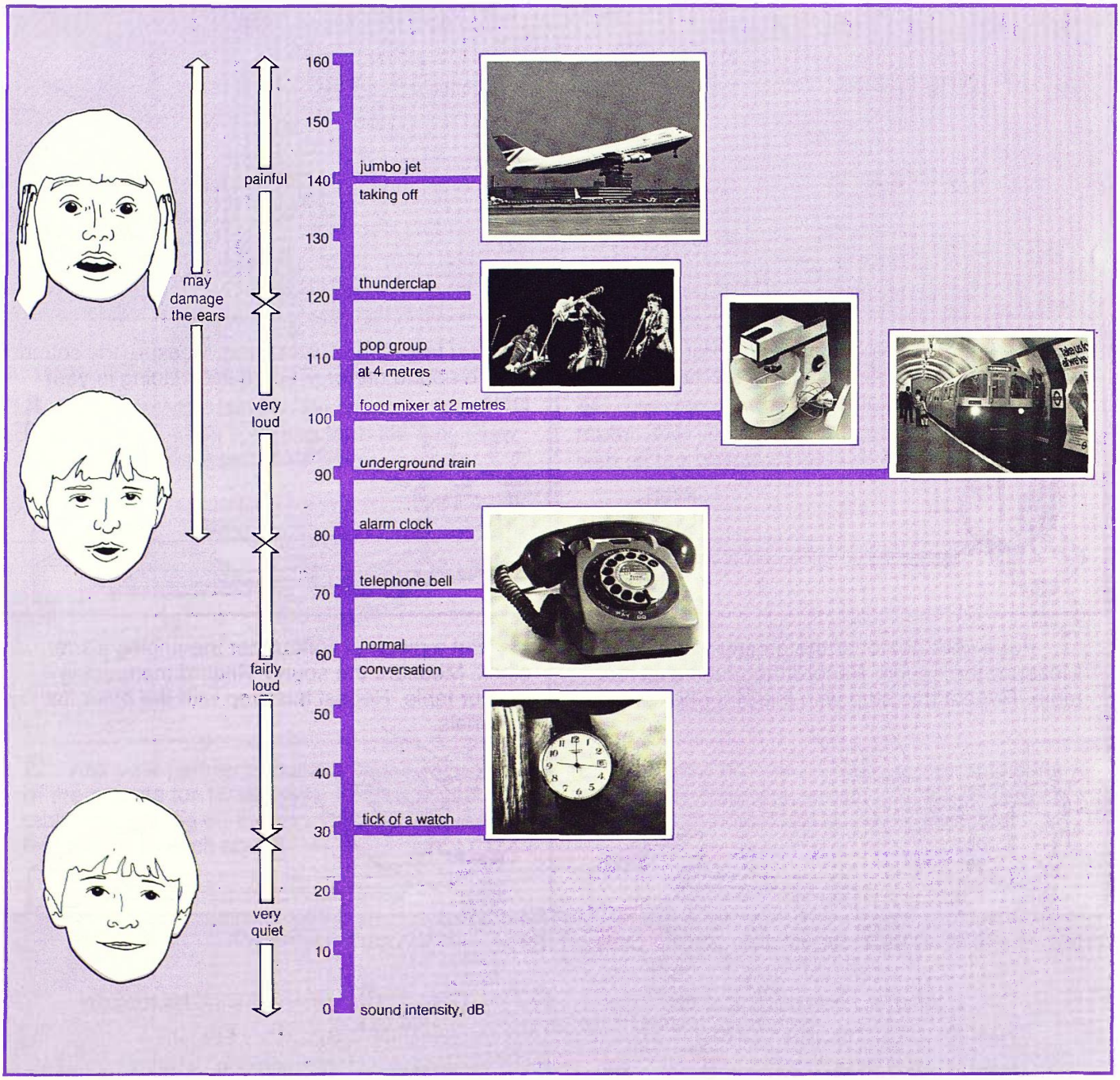
Q6 Which box cover gave the lowest reading? (This material **absorbs** sound best.)

Q7 Did putting materials between the clock and the bench change the meter reading?

Q8 Which material under the clock gave the lowest reading? (This material **dampens** sound best.)

Information: Sound measurement

Sound levels are recorded in decibels, dB. The quietest sound that people with good hearing can hear is tall grass moving in a breeze. This has a sound level of 0 dB. The noise of a jet aircraft taking off is 100 000 000 000 000 (10^{14}) times as **intense** (loud). That is 140 dB.

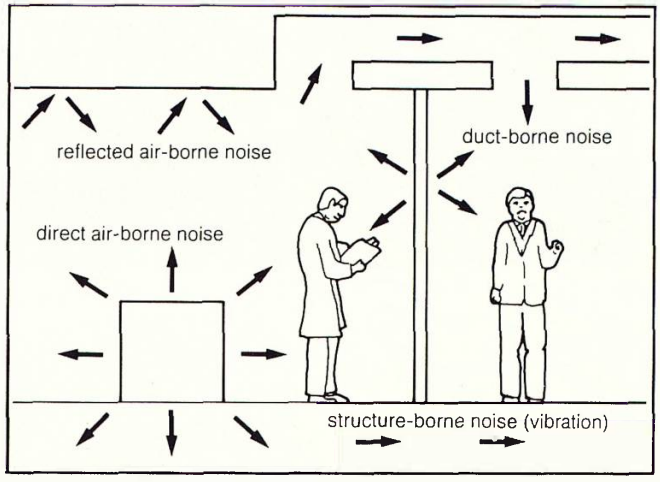


Q9 Where do you think these sounds would fit on the dB scale?

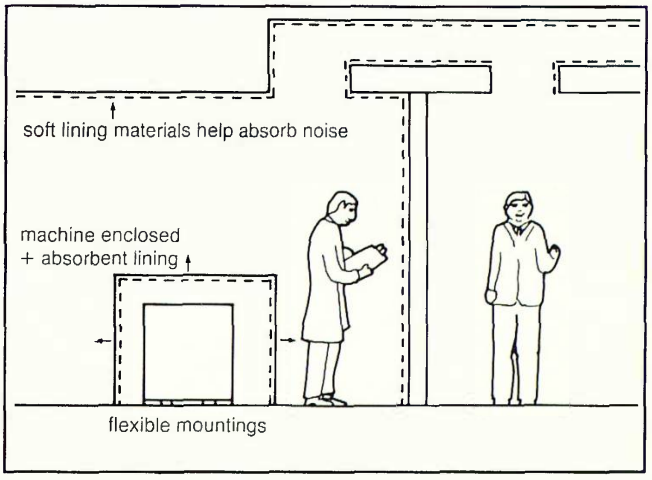
a) fire siren
b) heavy lorry
c) light traffic noise

Information: Noise

Noise means different things to different people. To some people, pop music is noise. To others the noise a racing car makes is "music". To a scientist, noise is unwanted sound.

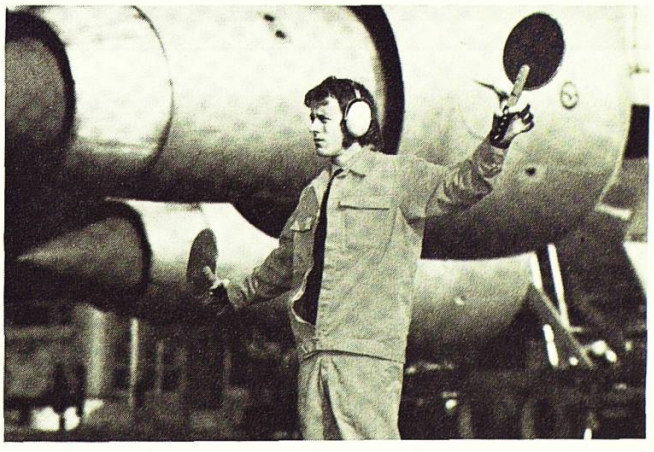


Noise can be controlled by **absorption** and **damping.** Noisy machines can be surrounded by absorbent materials. Machines can be **mounted** to dampen noise. Noisy parts can be replaced.



Sound bounces off hard, smooth surfaces. Soft materials in a room help to cut down the amount of noise. The drawings show the same room before and after noise control treatment.

Noise in factories can be controlled. Noisy machines could be restricted to certain times of the day. This means that not all the noisy machines are used at the same time.



People who work where sound is intense may damage their hearing. Ear protectors should be worn where noise cannot be controlled. The photo shows a man wearing ear defenders on an airport runway.

Q10 What is noise?

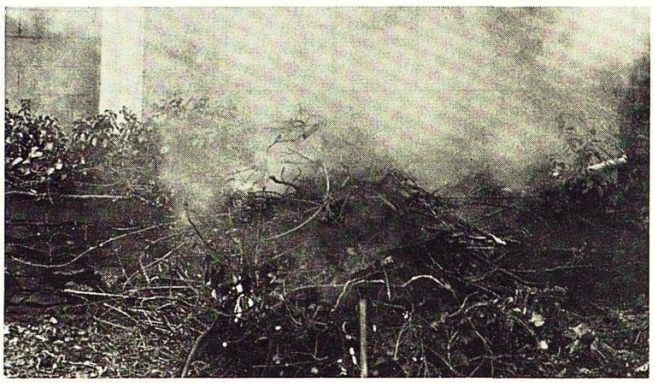
Q11 What could you do to cut down the noise in a house?

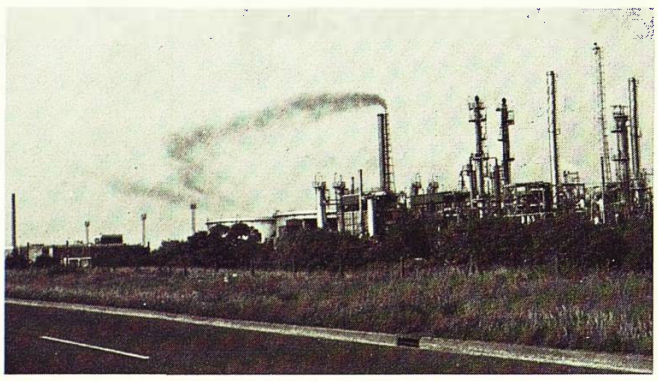
Q12 What could you do to cut down the noise in a factory?

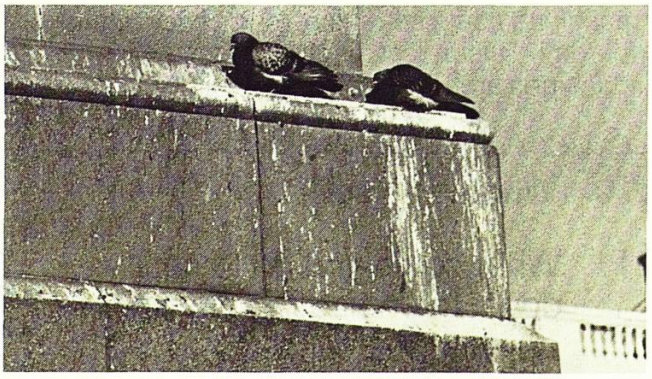
Q13 Make a list of people who should wear ear protectors at work.

10 Pollution check

These pictures are of everyday scenes. Which show pollution? How might this pollution be avoided? Which kinds of pollution shown here can you find in your neighbourhood?







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Pollution
Environment

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