SCIENCE AT WORK

# Forensic Science

REVISED EDITION

# SCIENCE AT WORK

Project Director
John Taylor

Editorial Team
Jackie Hardie
Peter Llewellyn
Colum Quinn
Keith Roberts

Language Consultant
Grahame Mitchell

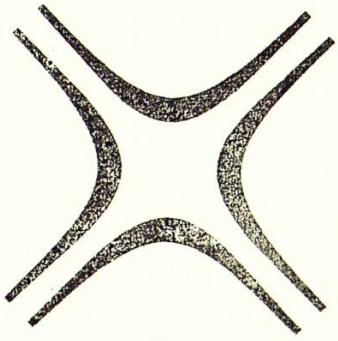
This book from an original manuscript by P. Llewellyn, P. Isaacson, J. Maloney, B. Busby, and H. Kovan.

The publishers wish to thank the Metropolitan Police Forensic Science Laboratory for their help in preparing this book, checking its accuracy and supplying many of the photographs.

This edition revised by Paul Isaacson.

## Contents





NATIONAL
STE
CENTRE



ISBN 201 14004 7

Designed, set and illustrated by Parkway Group and printed in Malta by Interprint Limited

FGH 8987654

# 1 Dusting for fingerprints

## Dusting with carbon powder

Apparatus

★ spatula ★ sheet of newspaper ★ carbon powder ★ soft brush
★ samples of: glossy paper, filter paper, black plastic, white plastic, cloth

You are going to dust for your own fingerprints using carbon powder.

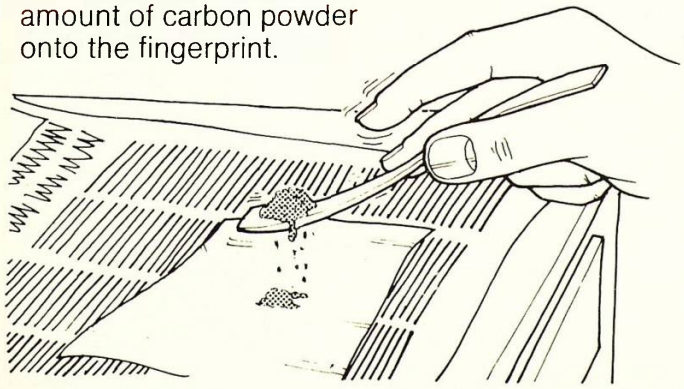
**Q1** Copy this table.

| Sample | Did you get a clear print? |
|---|---|
| | |

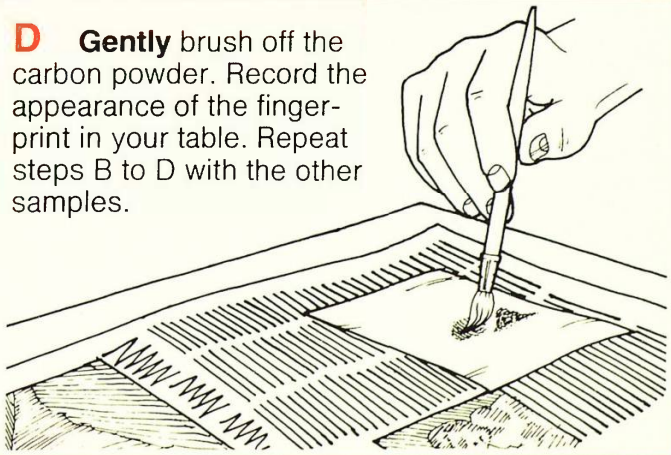
**A** Lay a sheet of newspaper on the bench.

**B** Put one of the samples on the newspaper. Press your finger on it to make a fingerprint.

**C** Sprinkle a **small** amount of carbon powder onto the fingerprint.



**D** **Gently** brush off the carbon powder. Record the appearance of the fingerprint in your table. Repeat steps B to D with the other samples.



**Q2** On which surfaces were the prints clear?

**Q3** Why wouldn't you get a clear print from a blanket?

**Q4** Why is it difficult to get a clear print from filter paper?

**Q5** On what surfaces would the police use carbon powder?

## Dusting with a white powder

Apparatus

★ spatula ★ sheet of newspaper ★ white powder ★ brush
★ samples of: glossy paper, filter paper, cloth, black plastic, white plastic

You are going to dust for your own fingerprints using a white powder.

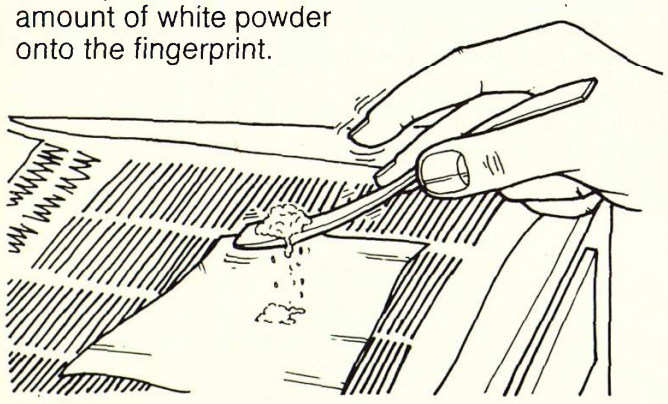
**Q6** Copy this table.

| Sample | Did you get a clear print? |
|---|---|
| | |

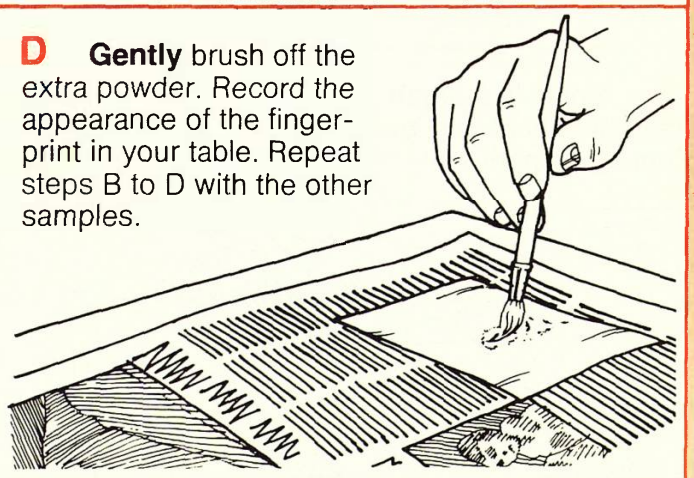
**A** Lay a sheet of newspaper on the bench.

**B** Put one of the samples on the newspaper. Press your finger on it to make a fingerprint.

**C** Sprinkle a **small** amount of white powder onto the fingerprint.



**D** **Gently** brush off the extra powder. Record the appearance of the fingerprint in your table. Repeat steps B to D with the other samples.



**Q7** On which surfaces were the fingerprints clear?

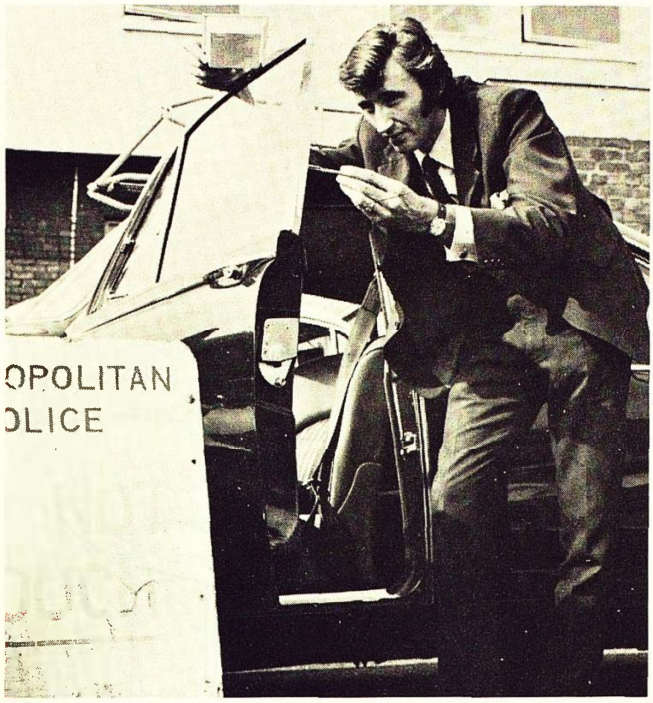
**Q8** On what kind of surfaces would the police use white powder?

**Q9** Why could salt and sugar not be used as the white powder?

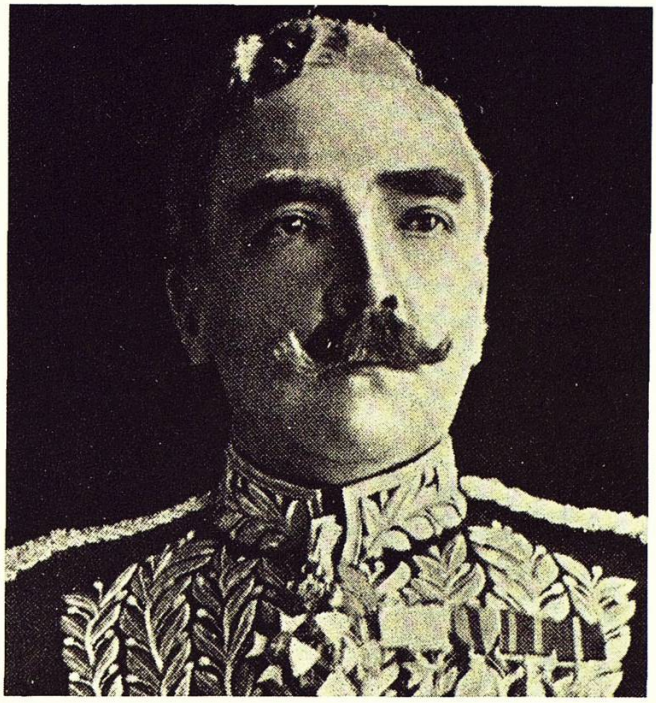
**Q10** Name any other substance which you could use to show up a fingerprint by dusting.

# Information: Fingerprints and their use in crime detection

Fingerprinting is an important method of identification. No two people have the same fingerprints. A person's fingerprints never change throughout his life. Some criminals have even tried to have their fingerprints removed by plastic surgery.

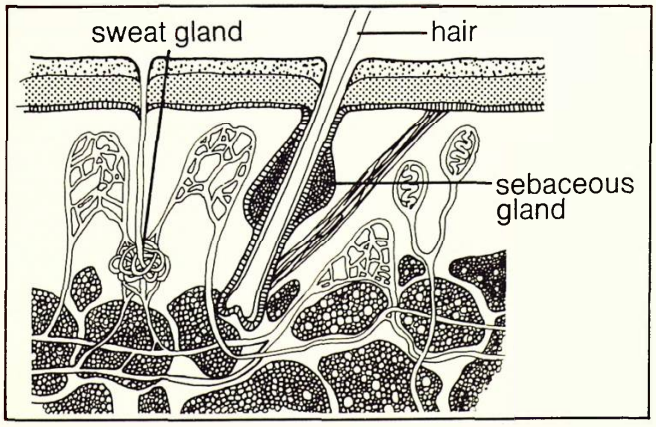



Fingerprints will show up easily on soft surfaces like plasticine. If fingers are stained with blood, ink or a dye, a clear print will be formed on most objects.



Fingerprinting was introduced in England and Wales in 1901. The system of identifying people by their fingerprints was devised by Sir Edward Henry.

## What makes fingerprints?




Below the skin there are two glands:

1. The **sweat gland** is always releasing sweat onto the surface of the skin. Sweat contains water, salt and urea.
2. The **sebaceous gland** releases oils onto the surface of the skin.

Small amounts of these substances are left on everything we touch. The fingerprint pattern can be **developed** (shown up) by special methods. Fine dark powders are used to show up fingerprints on light, smooth surfaces. Fine white powders are used to show up fingerprints on dark, smooth surfaces.

**Q11** Do identical twins have the same fingerprints?

**Q12** Name three substances contained in sweat.

# 2 Fingerprints in blood

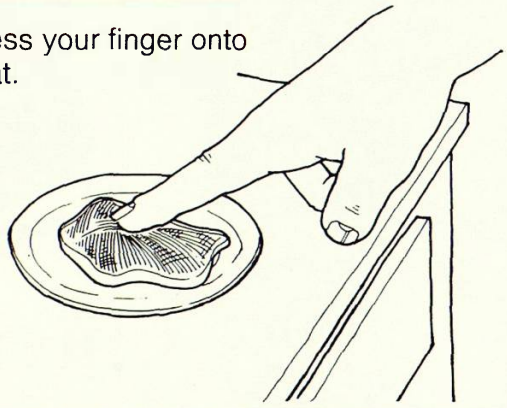
## Developing a fingerprint in blood

Apparatus

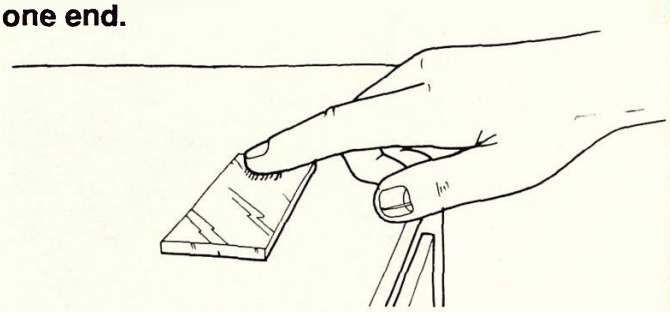
★ microscope slide ★ oven set at 100 °C ★ 3 beakers (100 cm³)
★ tweezers ★ solution A ★ solution B ★ solution C ★ hand lens
★ piece of uncooked meat ★ paper towel

You are going to develop your own fingerprint made in blood.
Do not spill solution A, B or C on your skin.
Keep the solutions away from flame.

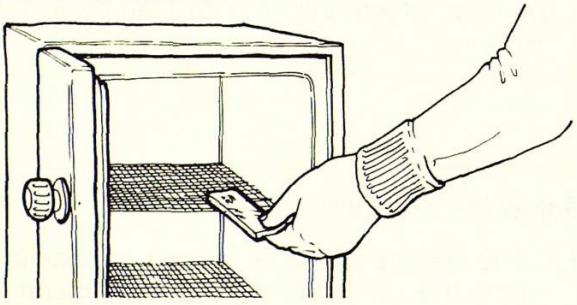
**A** Press your finger onto the meat.



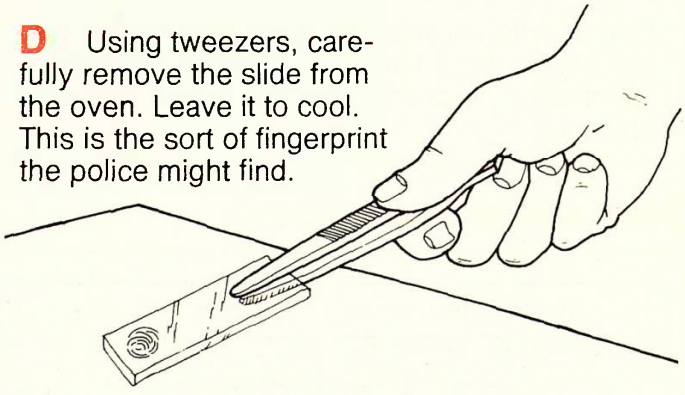
**B** Press the same finger onto a microscope slide **near one end.**



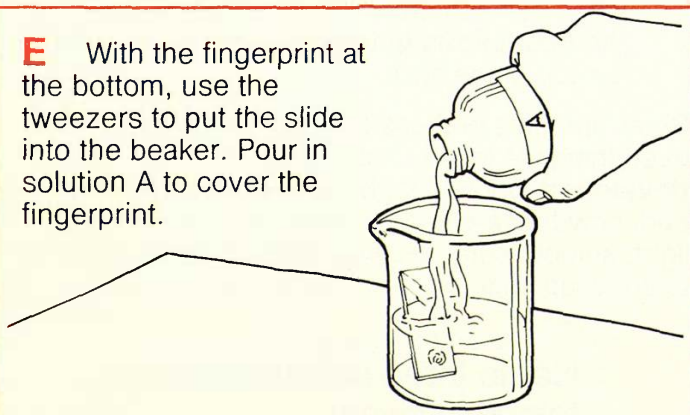
**C** Dry the fingerprint in the oven for 10 minutes.



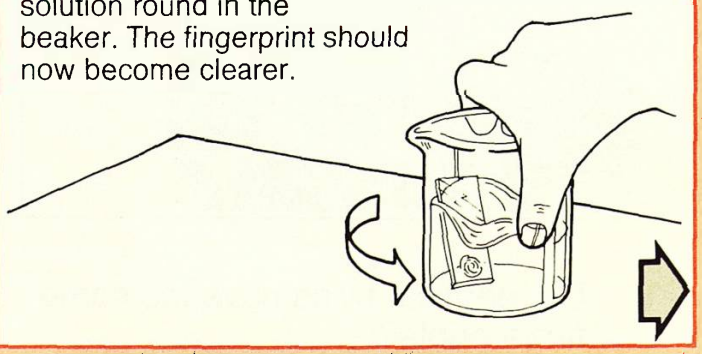
**D** Using tweezers, carefully remove the slide from the oven. Leave it to cool. This is the sort of fingerprint the police might find.



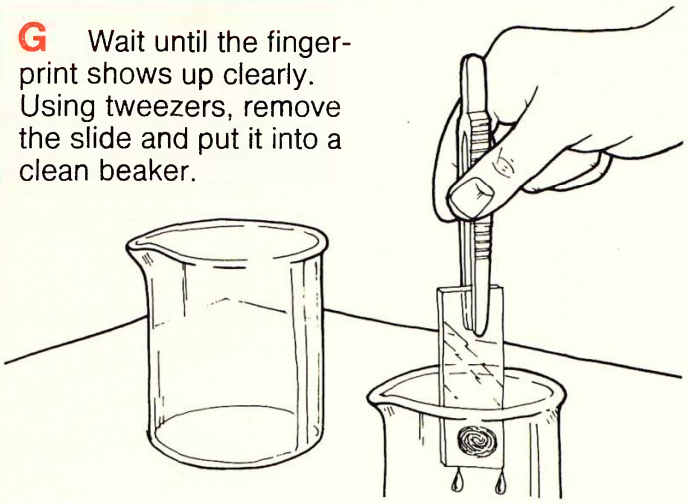
**E** With the fingerprint at the bottom, use the tweezers to put the slide into the beaker. Pour in solution A to cover the fingerprint.



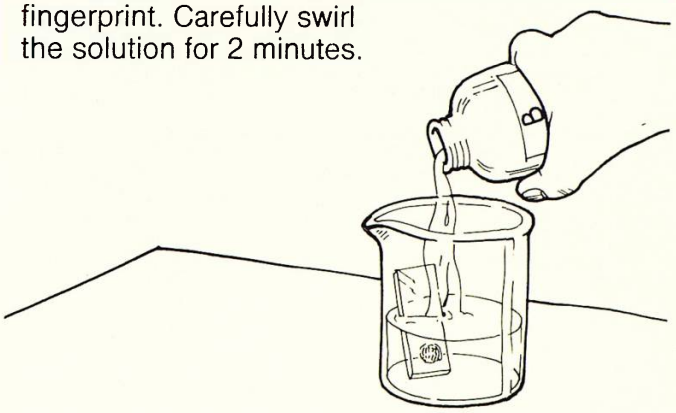
**F** Gently swirl the solution round in the beaker. The fingerprint should now become clearer.



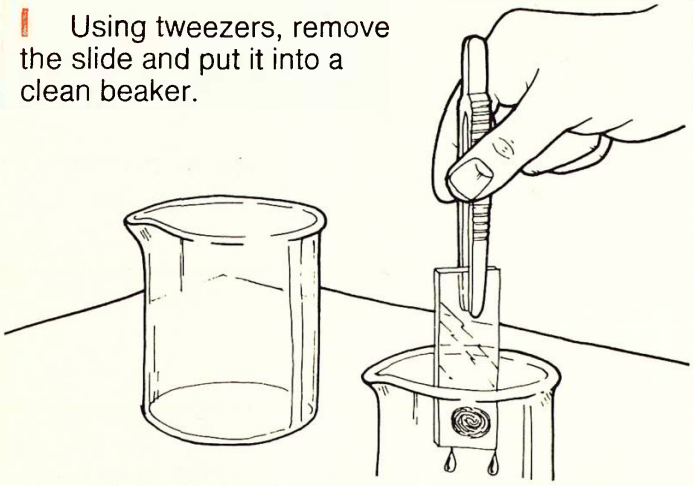
**G** Wait until the fingerprint shows up clearly. Using tweezers, remove the slide and put it into a clean beaker.



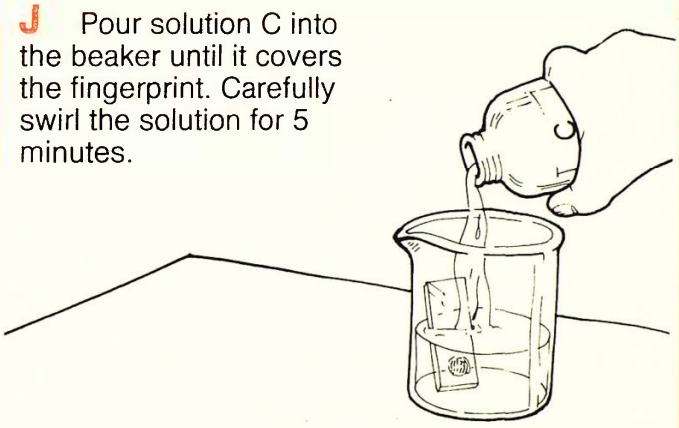
**H** Pour solution B into the beaker so it covers the fingerprint. Carefully swirl the solution for 2 minutes.



**I** Using tweezers, remove the slide and put it into a clean beaker.

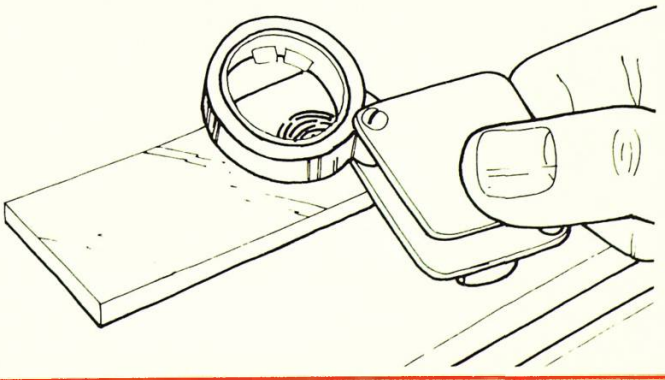


**J** Pour solution C into the beaker until it covers the fingerprint. Carefully swirl the solution for 5 minutes.



**K** Rinse the slide under the tap and pat dry with a paper towel. **Do not rub.**

**L** Use a hand lens to look at the fingerprint. Keep your fingerprint for future use.

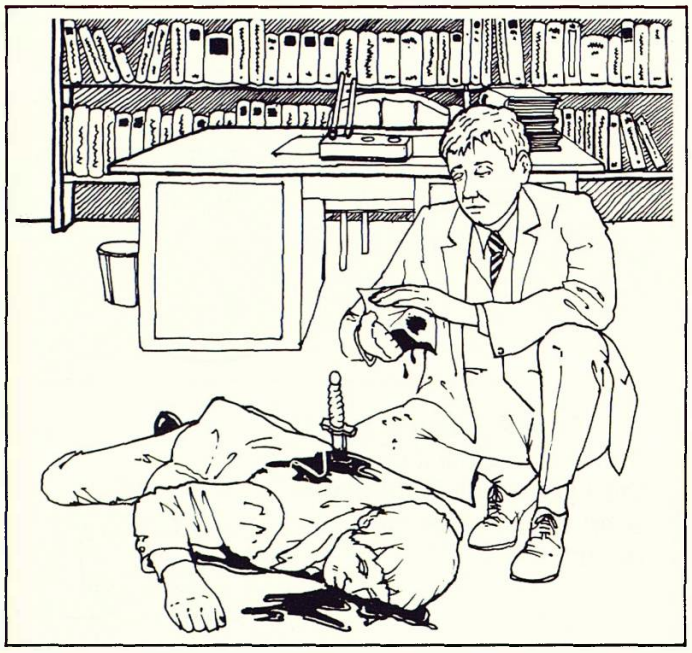


**Q1** How clear was the fingerprint in step D?

**Q2** Did swirling the different solutions over the fingerprint improve it?

**Q3** Make a drawing of your fingerprint.

# Information: Fingerprints in blood



A criminal who has wiped the blood from his hands can leave very faint prints on the things he touches. Although these are too faint to see, they can be made clearer by using special chemicals. This method can be used on almost any material. After the fingerprint has been developed, it is photographed. All fingerprints are recorded as photographs.

The solutions used to make the blood prints clearer have the following chemicals in them:

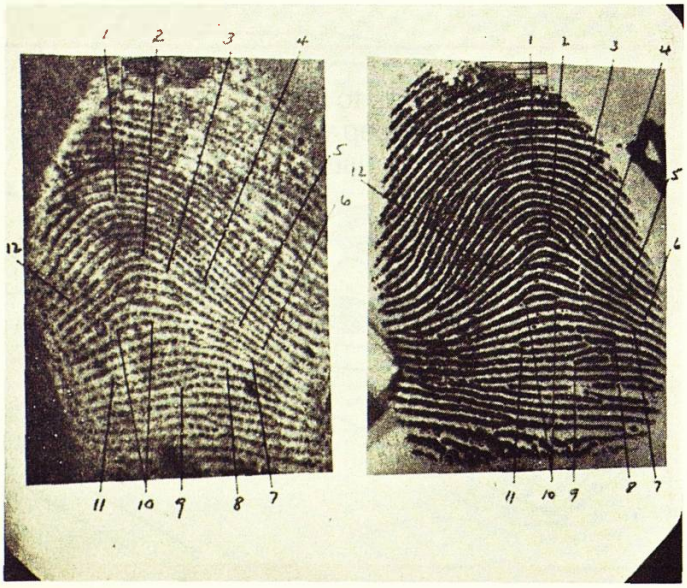
Solution A: acetic acid, naphthalene black (a dye) and methanol.

Solution B: acetic acid and methanol.

Solution C: acetic acid and water.

Since all contain an acid, they must be handled with care. Solutions A and B are also inflammable.

## Using fingerprints as evidence



Fingerprints from the scene of a crime must be matched with a set already on file. If a suspect has never been convicted of a crime before, there will be no record of his fingerprints for comparison. This is why the police "fingerprint" a suspect when he is taken in for questioning. If his fingerprints match those from the crime at 16 points or more, they can be used as evidence in court.

These fingerprints have 12 points in common – not enough to be used in court.

**Q4** How do the police make a lasting record of a fingerprint?

**Q5** How many points in common do fingerprints need to be used in court?

# 3 Fingerprints on difficult surfaces

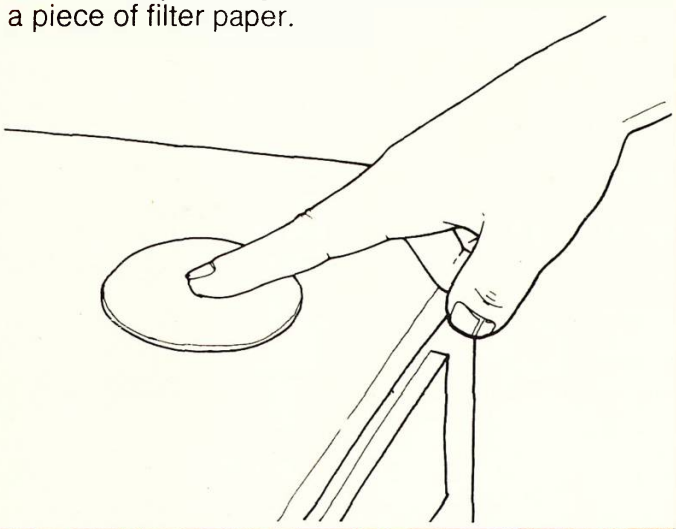
## Developing a fingerprint on a rough surface

Apparatus

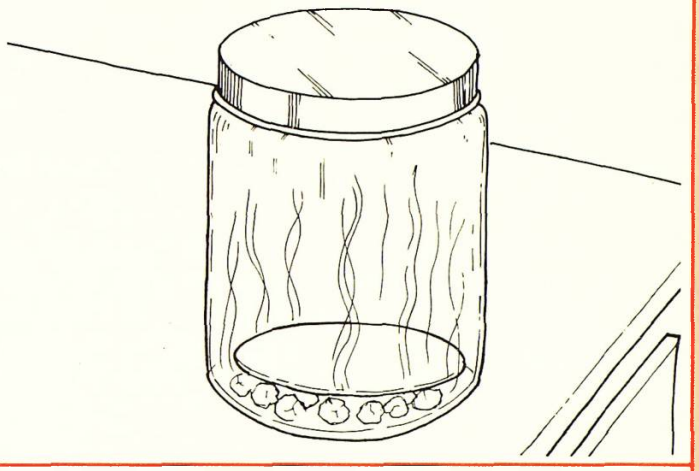
★ screw top jar containing iodine crystals ★ filter paper ★ tweezers
★ clear tape

You are going to develop your own fingerprint made on rough paper.

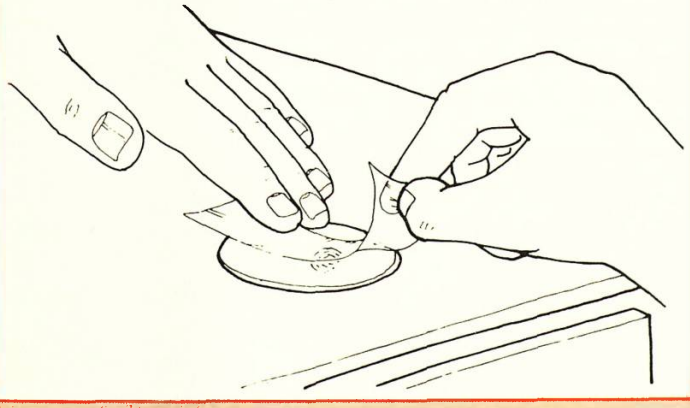
**A** Press your finger on to a piece of filter paper.



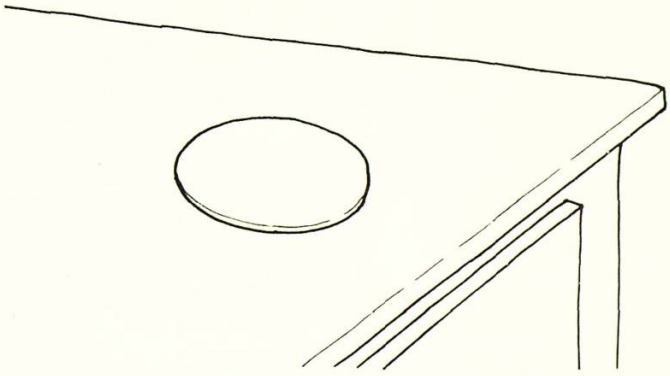
**B** Put the filter paper into the jar of iodine crystals and screw the top on.



**C** When you can see the fingerprint clearly, remove the paper using tweezers. Cover the fingerprint on both sides with clear tape.



**D** Repeat the activity with another filter paper. **This time do not cover the fingerprint with tape.** Leave it on the bench.



**Q1** What colour is the gas inside the jar?

**Q2** What colour does the fingerprint become inside the jar?

**Q3** What happened to the uncovered fingerprint in step D?

**Q4** On which surfaces might the police use this method?

## Developing a fingerprint on a sticky surface

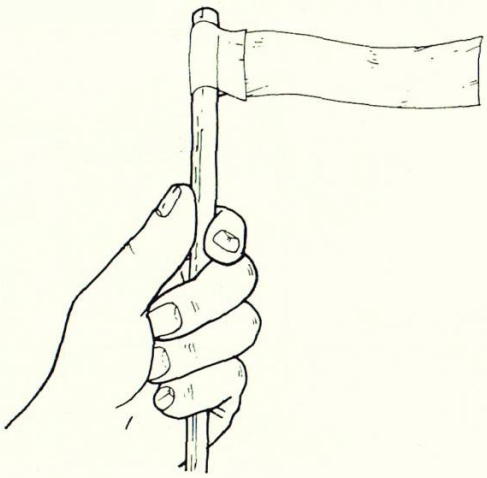
Apparatus

★ sticky tape ★ gentian violet ★ 250 cm³ beaker ★ tweezers
★ glass rod ★ scissors

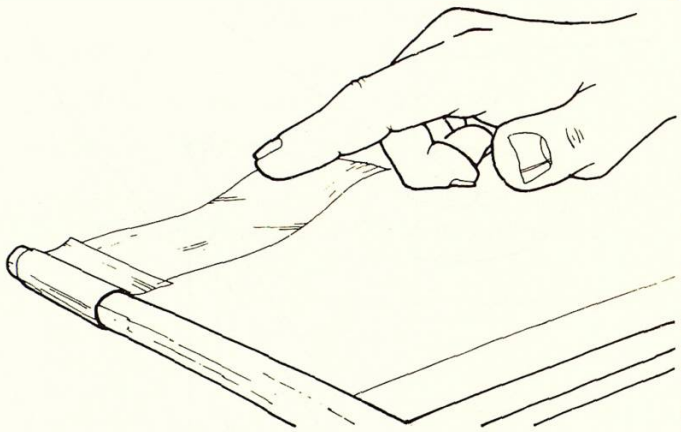
You are going to develop your own fingerprint on sticky tape.

Take care not to spill gentian violet on yourself.

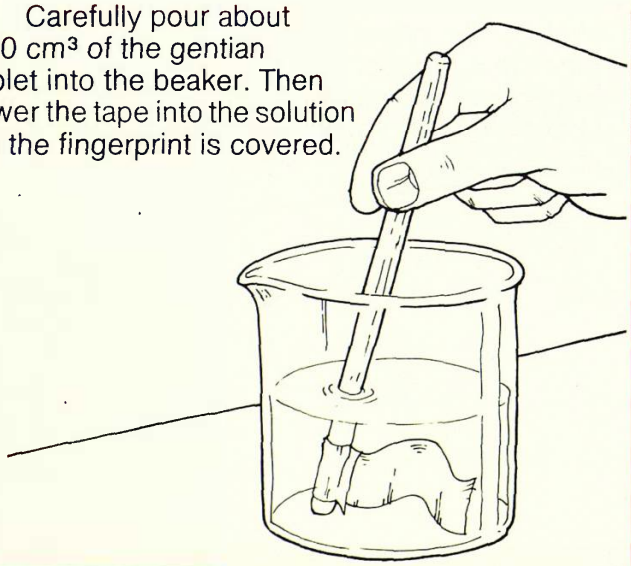
**A** Cut a piece of sticky tape. Stick it to the glass rod as shown.



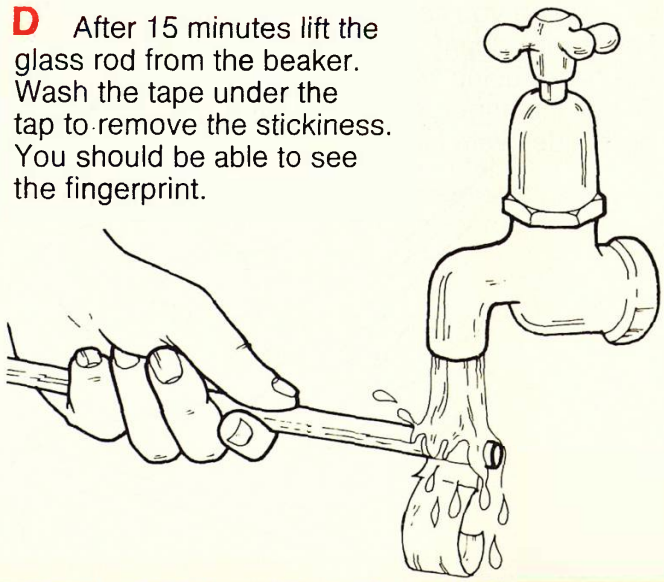
**B** Press your finger onto the sticky side of the tape near the end.



**C** Carefully pour about 100 cm³ of the gentian violet into the beaker. Then lower the tape into the solution so the fingerprint is covered.



**D** After 15 minutes lift the glass rod from the beaker. Wash the tape under the tap to remove the stickiness. You should be able to see the fingerprint.



**Q5** What colour is the fingerprint now?

**Q6** Name some objects on which the police might find sticky fingerprints.

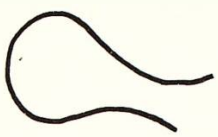
**Q7** Why wouldn't you use carbon powder to develop a print on sticky tape?

## Information: Sorting fingerprints

Fingerprints are sorted into 3 main groups so that they can be stored and matched quickly. The 3 groups are arches, loops and whorls.

**Arch**

**Loop**



**Whorl**

A fingerprint may have several of these patterns joined together to form what is known as a **composite** print.

A fingerprint expert needs special training, because within each of these 3 groups, there are many tiny variations.

Iodine crystals are used to show up fingerprints on rough, absorbent surfaces. These crystals give off iodine vapour which dissolves in the tiny drops of oil in the fingerprint. The fingerprint then shows up more clearly. Gentian violet, mixed with phenol and alchohol, can be used to show up fingerprints on sticky surfaces like tape. The phenol, which is an acid, takes away the stickiness and the fingerprint is stained a deep purple colour by the gentian violet.

**Q8** What are the three main groups of fingerprints?

**Q9** Look at the blood print you made in chapter 2. Which group of fingerprints does it fit into?

**Q10** What type of fingerprint has all three patterns joined together?

**Q11** What job does the phenol do in developing fingerprints?

# 4 Shoeprints

## Looking at shoeprints

Apparatus

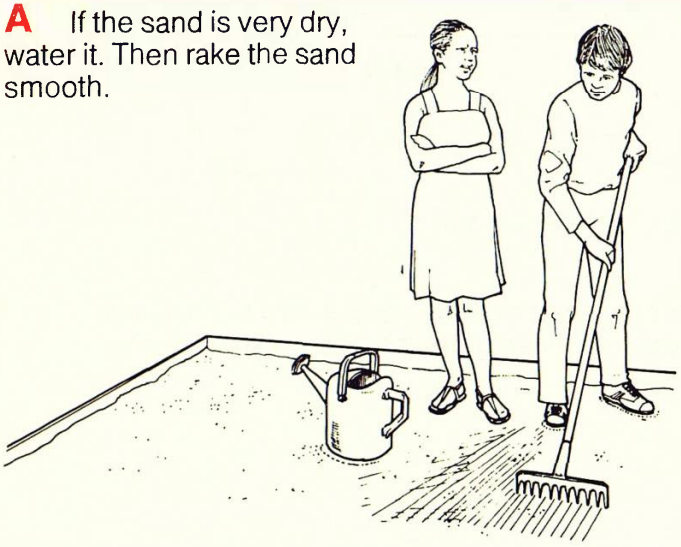
★ sandpit ★ watering can ★ rake ★ metre rule ★ heavy rucksack

You are going to look at differences in shoeprints.

**Q1** Copy this table.

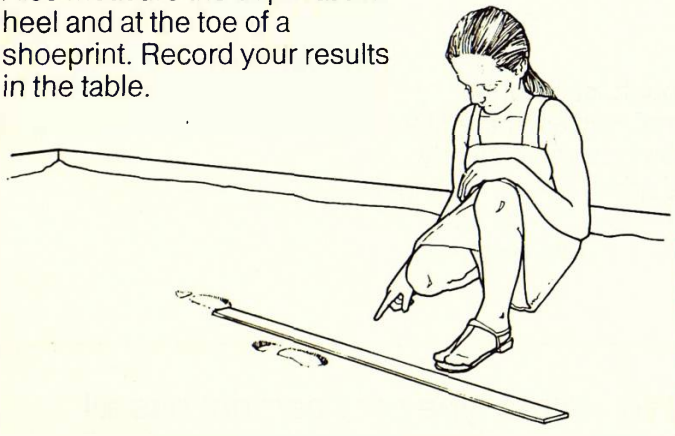
| How print was made | Length of stride (cm) | Depth of heel (cm) | Depth at toe (cm) |
|---|---|---|---|
| | | | |

**A** If the sand is very dry, water it. Then rake the sand smooth.

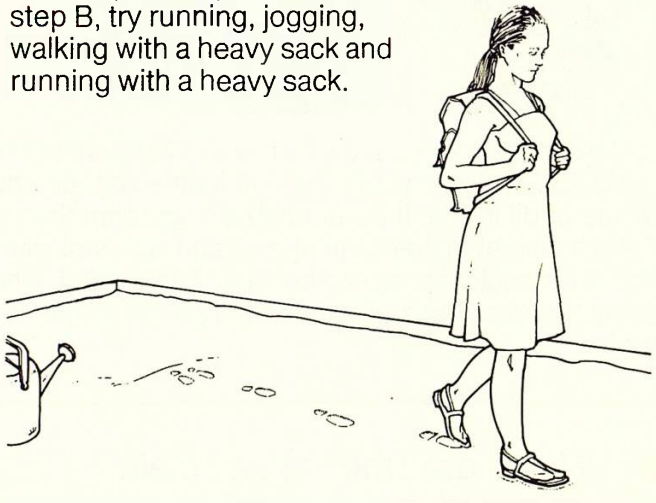


**B** Walk slowly across the smooth sand.

**C** Measure the distance beween the first 2 shoeprints. Also measure the depth at the heel and at the toe of a shoeprint. Record your results in the table.



**D** Repeat steps A to C. In step B, try running, jogging, walking with a heavy sack and running with a heavy sack.



**Q2** When did you get the longest stride?

**Q3** When did you get the deepest heel print?

**Q4** When did you get the deepest toeprint?

**Q5** What difference did the heavy sack make?

# 5 Making casts

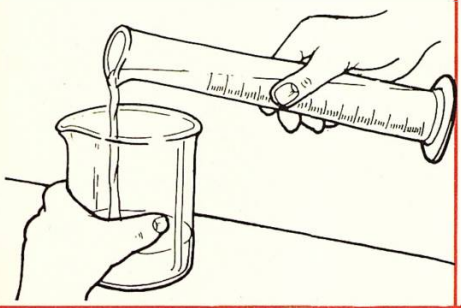
## Making a plaster cast

Apparatus

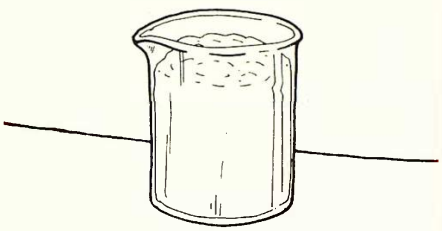
★ plastic beaker ★ water ★ plaster of Paris ★ tray of soil ★ paperclip
★ glass beaker ★ plastic stirrer ★ strip of card (30 cm x 5 cm)
★ measuring cylinder ★ brush

You are going to make a plaster cast of your shoeprint in soil.

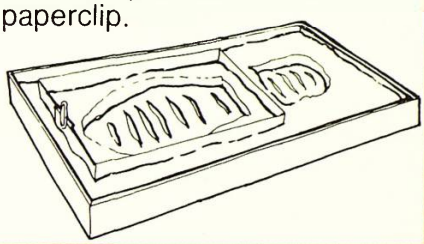
**A** Put about 70 $cm^3$ of water into the plastic beaker.



**B** Fill the **dry** glass beaker with plaster of Paris.

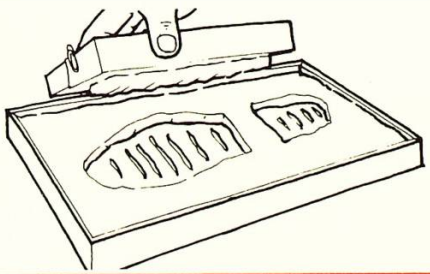


**C** Make a shoeprint in the tray of soil. Make a mould around **part** of the shoeprint with a strip of card and a paperclip.

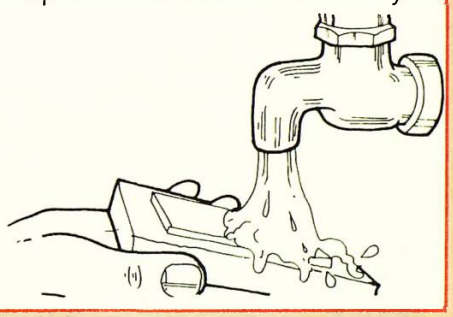


**D** Pour the plaster into the water and stir well until you have a thick, smooth cream. Pour it into the mould quickly.

**E** Let the plaster set. This will take about 48 hours. Next lesson: Lift off the cast.



**F** Rinse your cast under the tap. Brush it clean if necessary.



**Q1** Make a drawing of your plaster cast.

**Q2** Why is it important to wash the plaster cast before examining it?

**Q3** What effect would air bubbles in the plaster have on the cast?

**Q4** Which of the following would give you a **good** plaster cast?

a bicycle tyre print
b shoeprint in snow
c scratches on a stone floor
d tractor tyre print
e shoeprint in earth
f car tyre prints
g marks on a bench top
h scratches on a bullet
i dog's footprint in earth

**Q5** Write down some everyday uses of plaster of Paris.

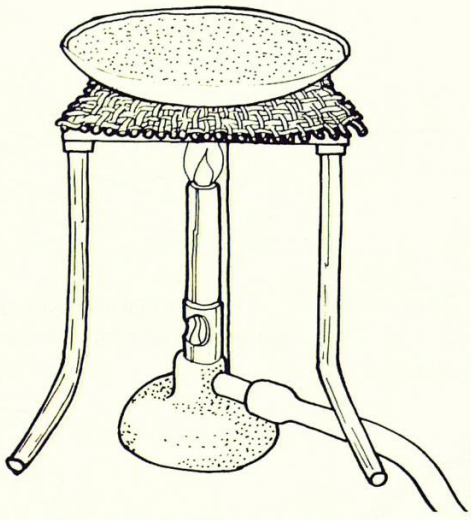
# Making a cast of scratches in metal

Apparatus

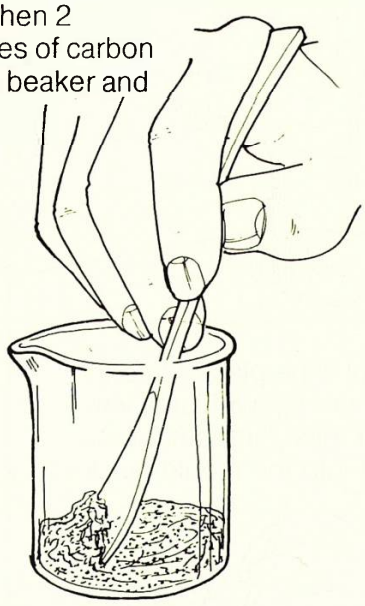
★ small beaker ★ stirring rod ★ sulphur ★ sand bath ★ plasticine
★ spatula ★ Bunsen burner ★ tongs ★ carbon powder
★ scratched metal ★ gauze ★ tripod

You are going to make a cast of scratches in metal.

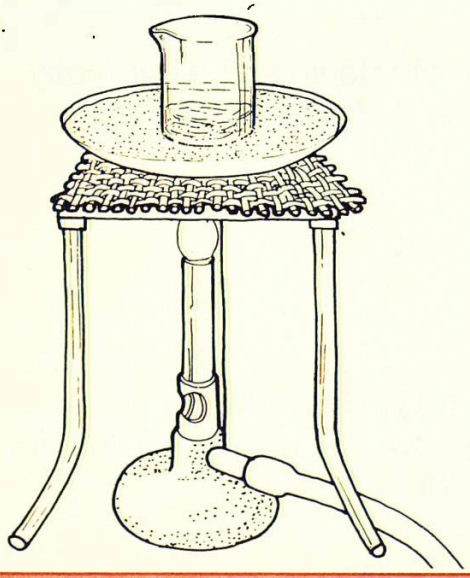
**A** Heat up a full sand bath.



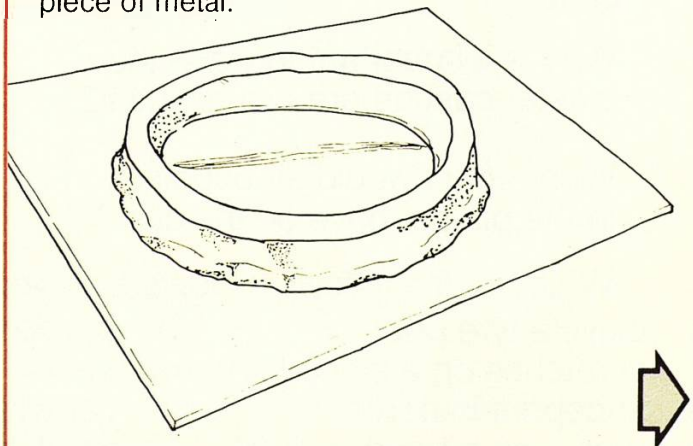
**B** Put 8 spatula measures of sulphur and then 2 spatula measures of carbon powder into the beaker and stir thoroughly.



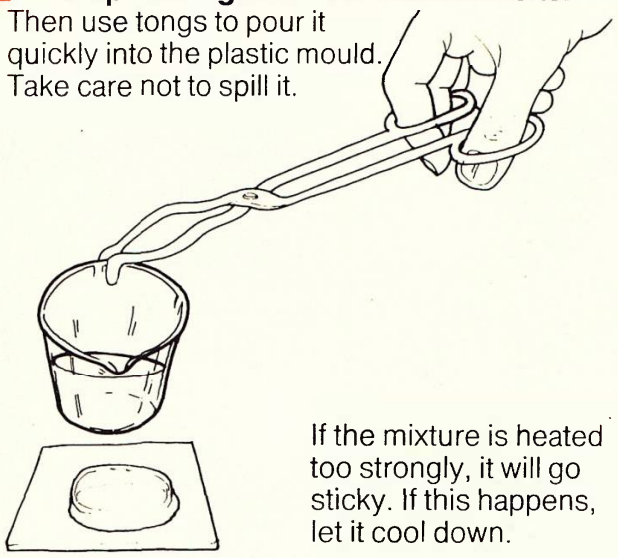
**C** Put the beaker into the sand bath and continue heating.



**D** Meanwhile, roll the plasticine into a strip. Make the strip into a ring about the size of a 2p piece. Put this around a scratch on a piece of metal.

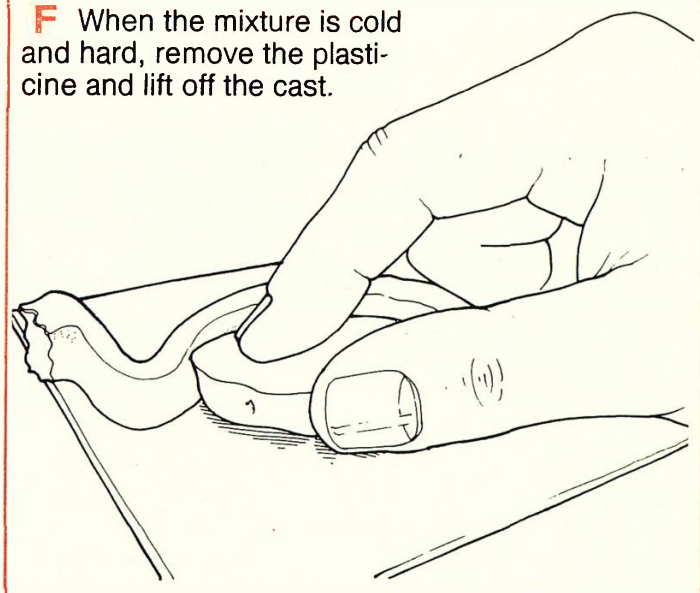


**E** **Stop heating when the mixture melts.** Then use tongs to pour it quickly into the plastic mould. Take care not to spill it.



If the mixture is heated too strongly, it will go sticky. If this happens, let it cool down.

**F** When the mixture is cold and hard, remove the plasticine and lift off the cast.



**Q6** Does the cast you have made look like the sulphur and carbon powder you have made it from?

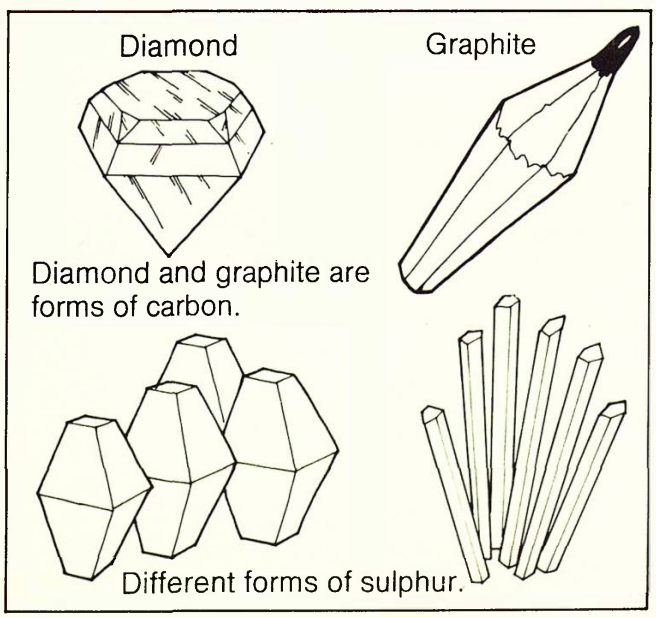
**Q7** Has it made a good copy of the scratches on the metal?

**Q8** Look at the sides of the cast. What else has it made a copy off?

**Q9** Would the cast chip easily?

## Information: Casts

### Sulphur/graphite casts



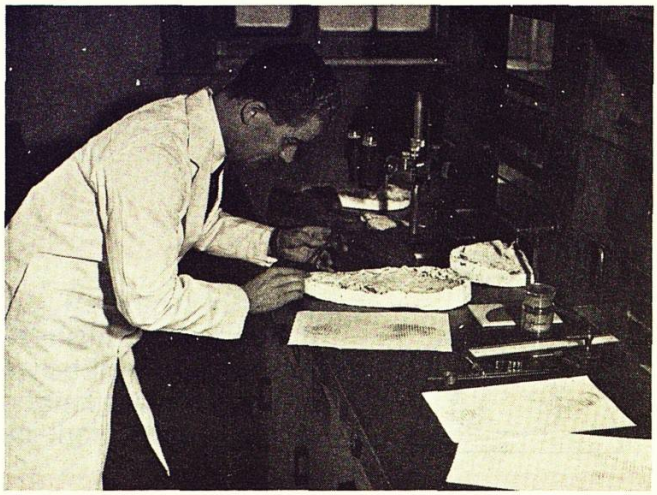

Sometimes police need to make casts of scratches on metal. Their casts are made from a mixture of graphite and sulphur. Sulphur is a yellow solid which is found in various forms. Graphite is a black solid which is used in pencils. It is a form of carbon, as is carbon powder.

A mixture of sulphur and graphite melts easily and solidifies quickly to make very detailed casts. This mixture can be used for taking casts in very wet ground, and even snow. The cast will set on a wet surface where plaster of Paris will not work.

# Making casts

## Plaster casts

Marks such as shoeprints are often left at the scene of a crime. These can give important clues to the police. A shoeprint, if kept unspoiled, can be matched with the suspect's shoeprint and used as evidence against him.
A shoeprint on the ground will soon get spoiled so forensic scientists make a cast of it.



The scientist does this by pouring a liquid on to the shoeprint. The liquid dries hard and, when lifted away, shows the pattern of the shoeprint on it. This cast can easily be stored until the police need it. The substance often used for making a cast is plaster of Paris. When mixed with water it sets quickly to a white solid. It also expands on setting and so fills every crack and gives a good impression.

**Q10** **Copy this table.**

| Plaster of Paris | | Sulphur/Carbon Powder | |
|---|---|---|---|
| Advantages | Disadvantages | Advantages | Disadvantages |
| | | | |

List in your table the advantages and disadvantages of using plaster of Paris or sulphur/carbon powder for making casts.

**Q11** Why are sulphur and carbon powder used to make casts on wet surfaces, rather than plaster of Paris?

**Q12** Why do the police need to take plaster casts of shoeprints?

# 6 Comparing soil samples

## Appearance of soil samples

Apparatus

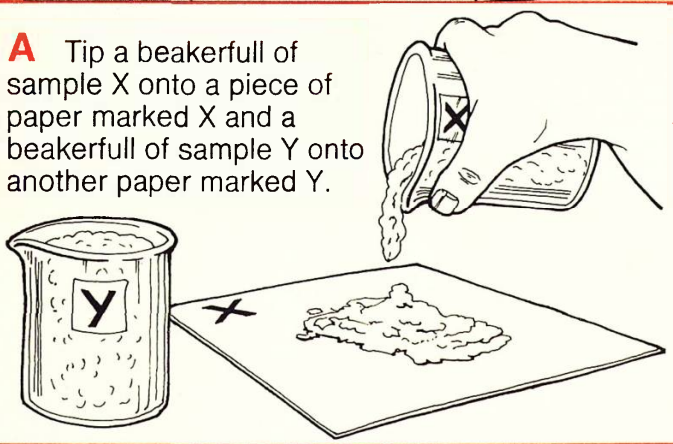
★ 2 beakers ★ soil sample X ★ soil sample Y ★ 2 large pieces of paper
★ hand lens

You are going to look for differences in the appearance of soil samples X and Y.

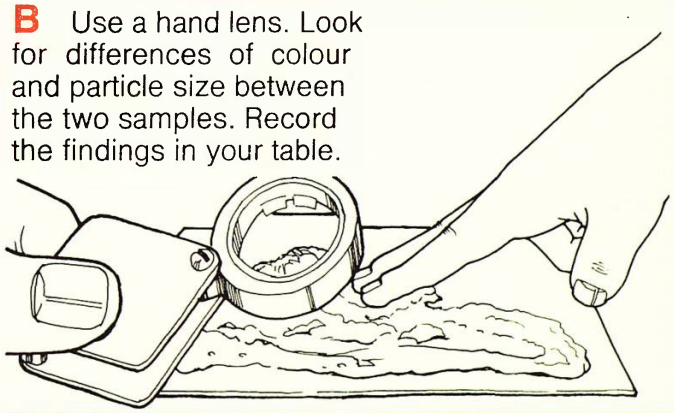
**Q1** Copy this table.

| Observation | Soil X | Soil Y |
|---|---|---|
| Colour | | |
| Particle size | | |
| Animals found | | |
| Plants found | | |
| Dampness | | |

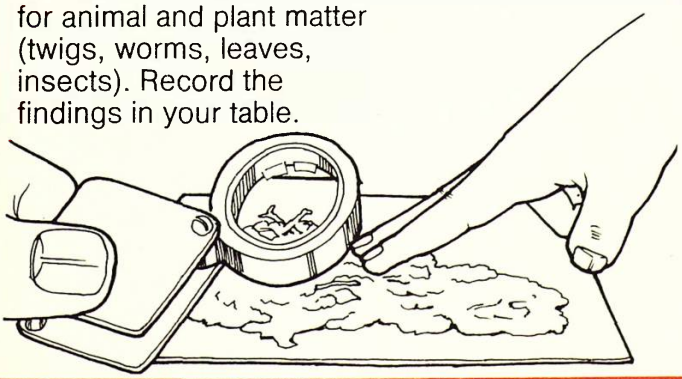
**A** Tip a beakerful of sample X onto a piece of paper marked X and a beakerful of sample Y onto another paper marked Y.



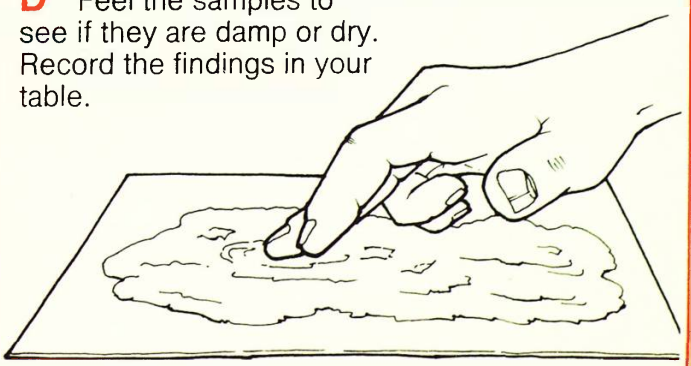

**B** Use a hand lens. Look for differences of colour and particle size between the two samples. Record the findings in your table.



**C** Use a hand lens. Look for animal and plant matter (twigs, worms, leaves, insects). Record the findings in your table.



**D** Feel the samples to see if they are damp or dry. Record the findings in your table.



**Q2** Do you think the samples X and Y came from the same place? Give reasons for your answer.

# Acidity of soil samples

Apparatus

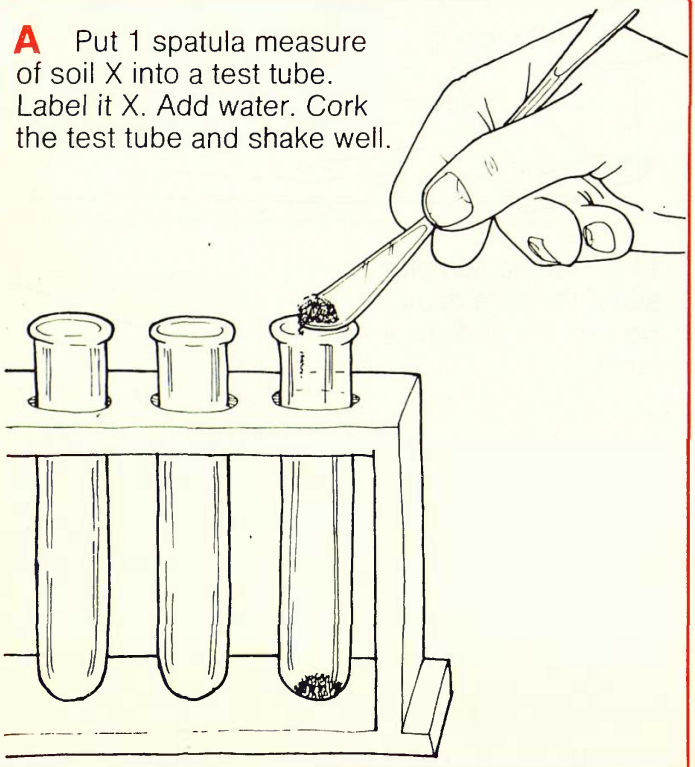
★ universal indicator paper ★ soil samples X and Y ★ clamp stand
★ 2 corks ★ spatula ★ filter paper ★ alkaline solution ★ labels X and Y
★ 5 test tubes ★ filter funnel ★ acid solution ★ test tube rack

You are going to test the acidity of soil samples X and Y.

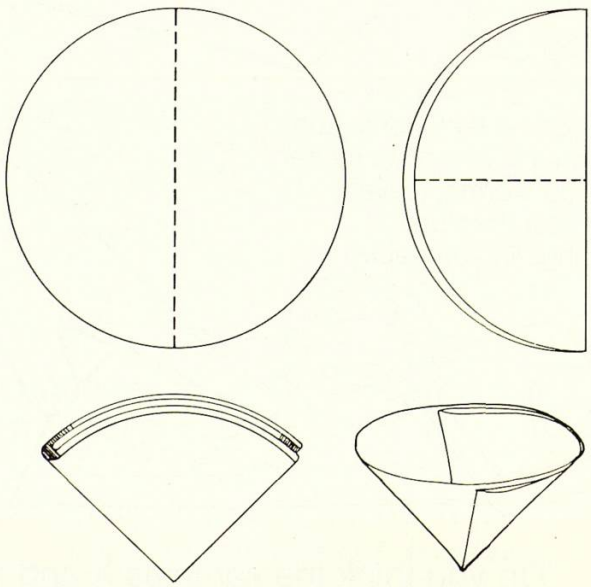
**Q3** Copy this table.

| Sample | Colour of indicator paper | Is sample alkaline, acid or neutral? |
|---|---|---|
| Soil X | | |
| Soil Y | | |
| Water | | |
| Acid solution | | |
| Alkaline solution | | |

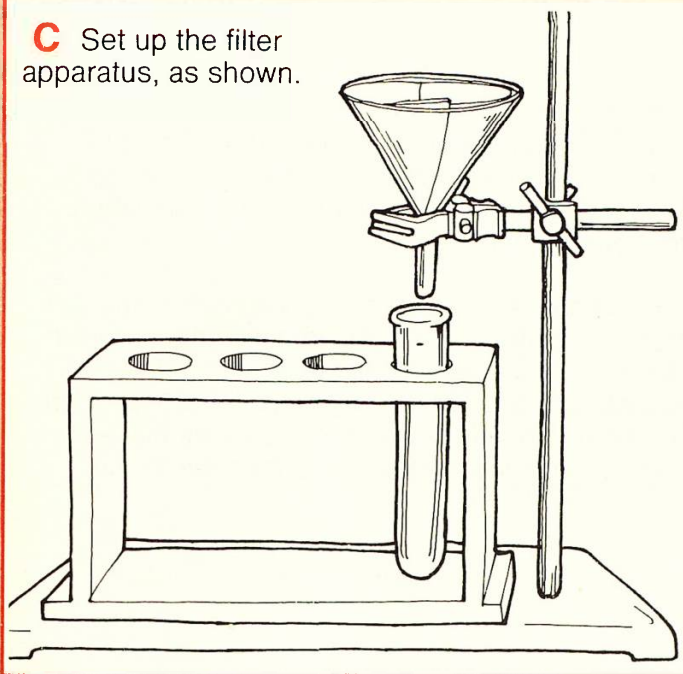
**A** Put 1 spatula measure of soil X into a test tube. Label it X. Add water. Cork the test tube and shake well.



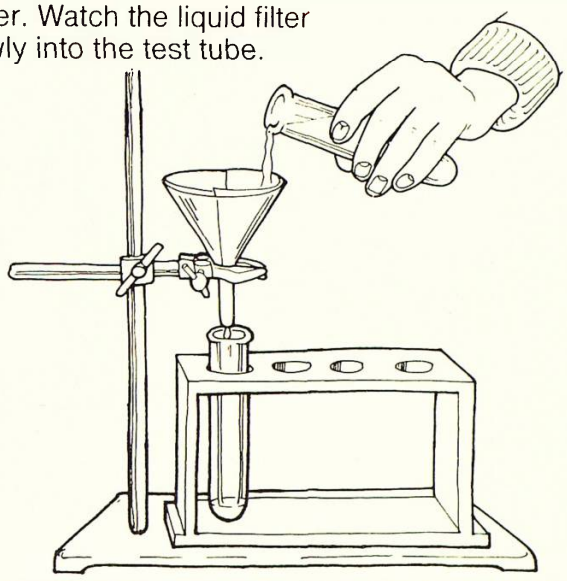
**B** Fold a filter paper into quarters. Open it out to form a cone.



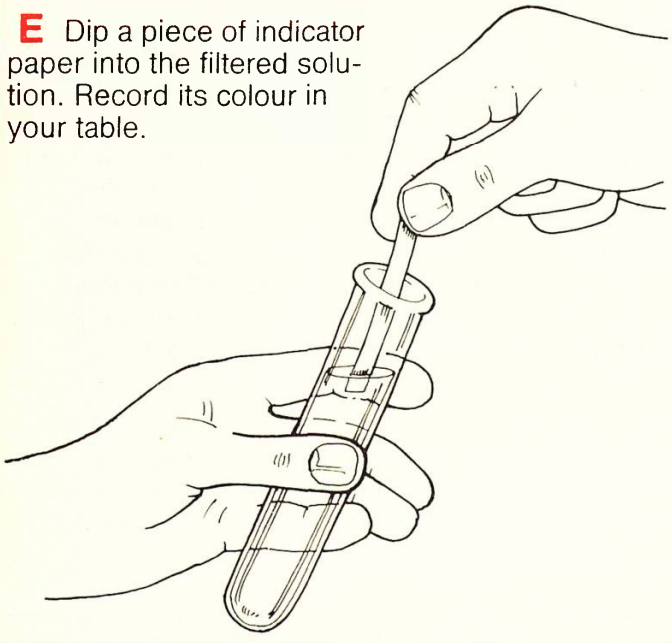
**C** Set up the filter apparatus, as shown.



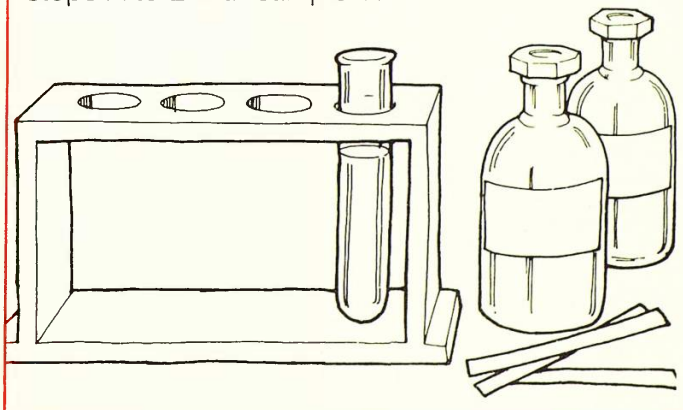
**D** Pour the contents of test tube X into the filter paper. Watch the liquid filter slowly into the test tube.



**E** Dip a piece of indicator paper into the filtered solution. Record its colour in your table.



**F** Dip a clean piece of indicator paper into dilute acid, another piece into dilute alkali and yet another into water. Record your results in the table. Repeat steps A to E with sample Y.



**Q4** What colour does universal indicator paper turn in **acid** solution?

**Q5** What colour does universal indicator paper turn in **alkaline** solution?

**Q6** Why do you find out the acidity of water?

**Q7** What colour does universal indicator paper turn in a **neutral** solution?

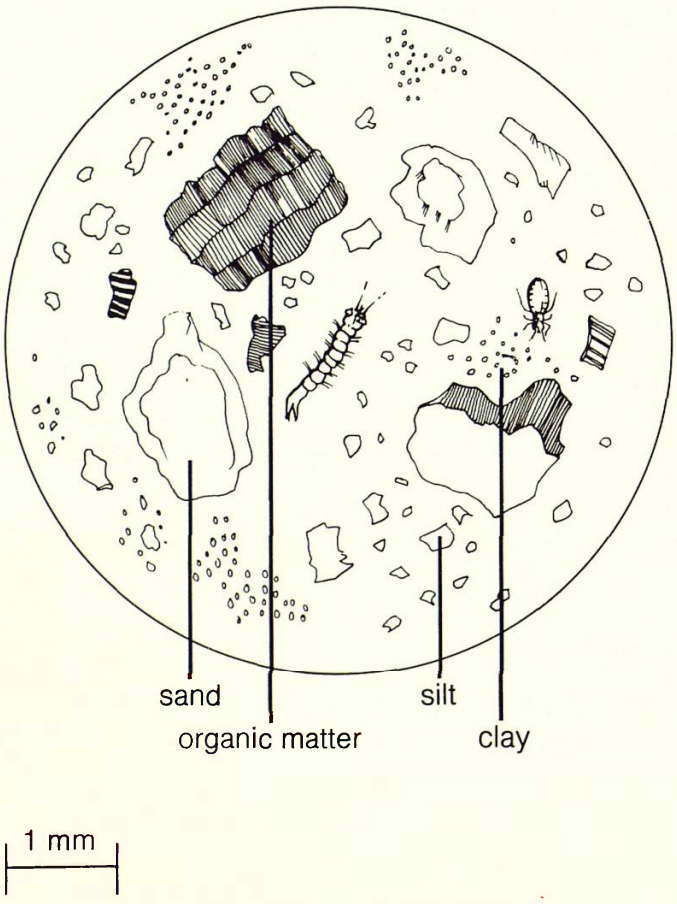
**Q8** Do the soils have the same acidity?

## Information: Identifying soils

Traces of soil are often found at the scene of a crime. A small sample on a person's shoe can be used by a forensic scientist to find out where that person has been.

If someone is attacked on a country path, the soil from the path can be compared with the soil from the shoe of a suspect. However, comparing samples of soil can be very difficult because there are often big differences between soils that are found only a few metres away from each other.

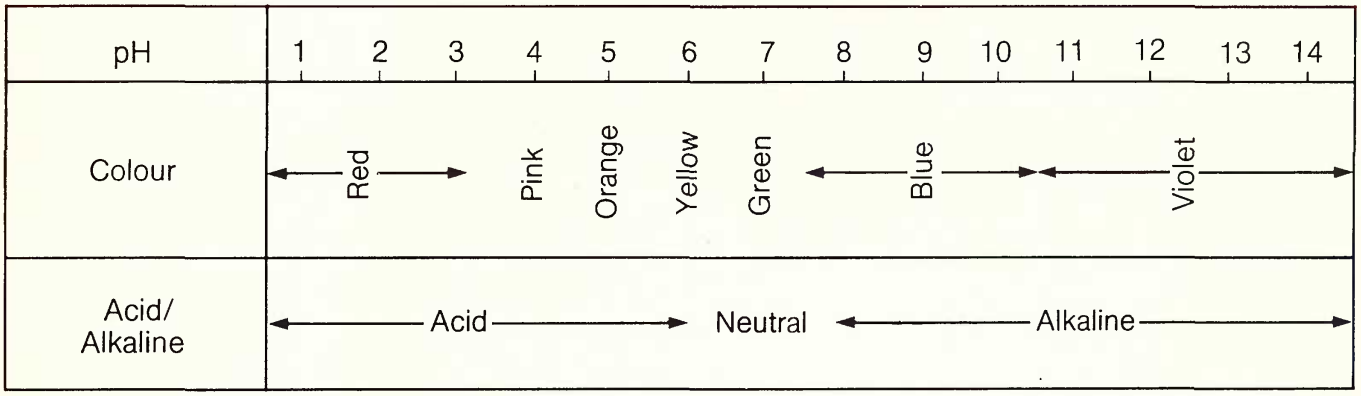
## Soil content




Soil is made of very small bits of rock with dead and rotting plants and animals in it. The rock particles are made of chemical substances.
A simple way to identify a soil is to look at the colour of it. This will tell you something about the chemicals in it. The colour of a soil sample is one piece of evidence used by the police.

| Soil colour | Substances present |
|---|---|
| white or light grey | silica or lime |
| black, dark brown or very dark grey | rotted plants or animals (humus) |
| yellow, brown or red | iron compounds |

## Acidity of soil (pH)




Some parts of a soil may dissolve in water to make the water **acid.** Some parts may dissolve to make the water **alkaline.** The **acidity** of the soil can be measured with **universal indicator** which changes colour depending on the acidity. Each colour is given a number, to make a scale of acidity called the pH scale.

When you use universal indicator, look up the colour on the chart to get the pH number:

pH less than 7 means acid

pH exactly 7 means neutral

pH more than 7 means alkali

In this way, the acidity of two soils can be measured and compared with each other.

**Q9** Why might a forensic scientist need to compare soil samples?

**Q10** What does the colour of soil tell us about its content?

# 7 Heating and burning soils

## Comparing the amount of water in soils

Apparatus

★ 2 evaporating dishes ★ Bunsen burner ★ gauze ★ balance
★ sand bath ★ heatproof mat ★ tongs ★ tripod ★ soil samples X and Y

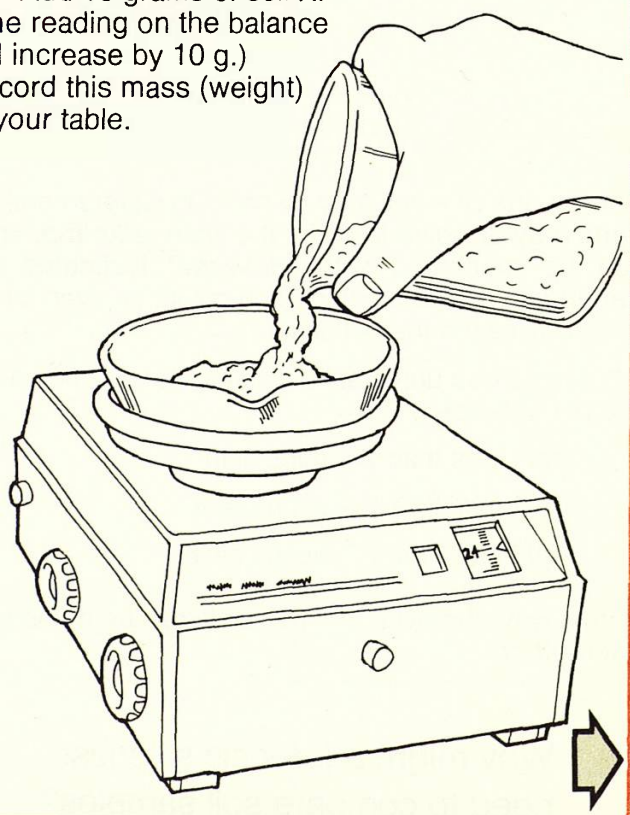
You are going to find the amount of water in soil samples X and Y.

**Q1** Copy this table.

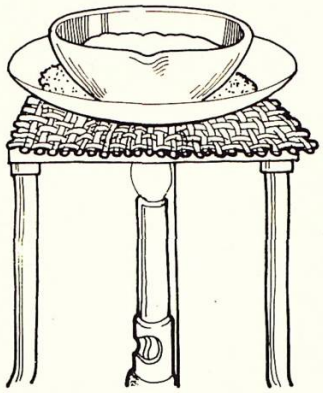
| Observation | X | Y |
|---|---|---|
| Colour of soil before heating | | |
| Colour of soil after heating | | |
| Mass (weight) of dish and damp soil (g) | | |
| Mass (weight) of dish and heated soil (g) | | |
| Mass (weight) of water lost (g) | | |

**A** Record the colour of soil X in your table.
Weigh an empty evaporating dish.

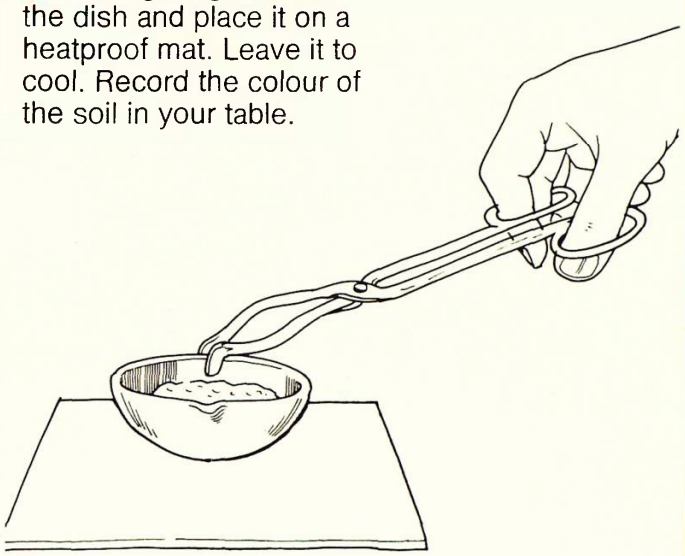
**B** Add 10 grams of soil X. (The reading on the balance will increase by 10 g.)
Record this mass (weight) in your table.



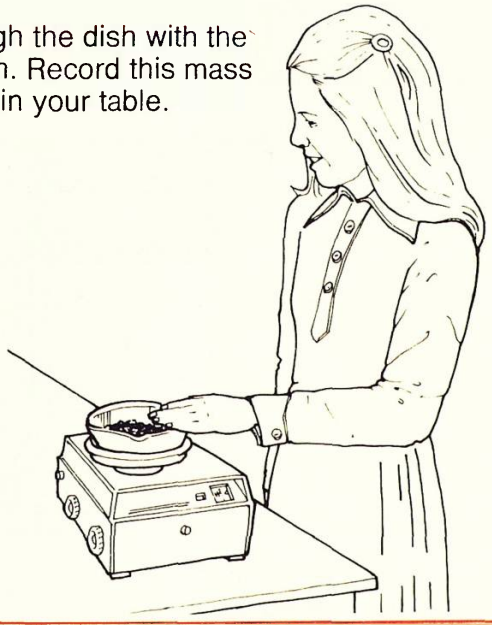
**C** Put the dish on the sand bath and heat over a low flame for 20 minutes. Do not let the soil burn.



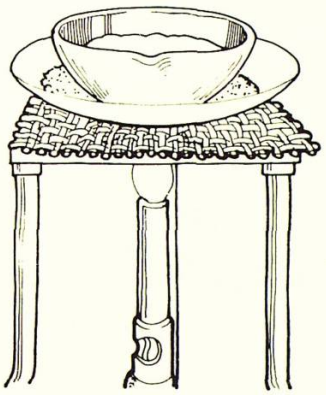
**D** Using tongs, remove the dish and place it on a heatproof mat. Leave it to cool. Record the colour of the soil in your table.



**E** Weigh the dish with the soil again. Record this mass (weight) in your table.



**F** Repeat steps A to E with soil sample Y.



**Q2** What did you see coming from the soils while they were being heated?

**Q3** Which soil has the largest particles?

**Q5** How many grams of water did soil X lose?

**Q6** How many grams of water did soil Y lose?

**Q4** Work out the percentage (%) of water in the two soil samples, using the equation:

$$\text{percentage of water} = \frac{\text{difference in weight} \times 100}{\text{weight of soil before heating (10 g)}}$$

## Burning soils

Apparatus

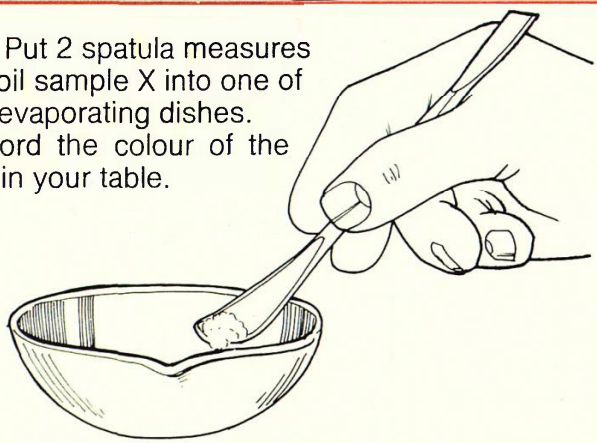
★ gauze ★ soils samples X and Y ★ heatproof mat ★ Bunsen burner
★ 2 evaporating dishes ★ tongs ★ spatula ★ tripod

You are going to find the differences between soil samples X and Y by burning them.

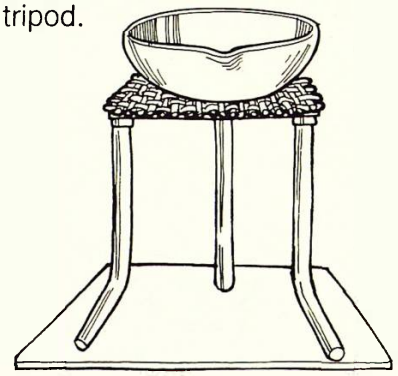
**Q7** Copy this table.

| | Colour before burning | Colour after burning |
|---|---|---|
| Soil sample X | | |
| Soil sample Y | | |

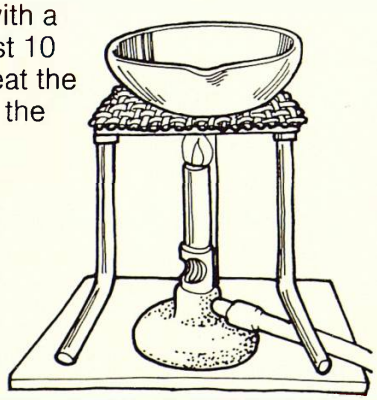
**A** Put 2 spatula measures of soil sample X into one of the evaporating dishes. Record the colour of the soil in your table.



**B** Put the dish onto the gauze on the tripod.



**C** Heat the dish with a high flame for at least 10 minutes. At times heat the soil from above with the Bunsen.

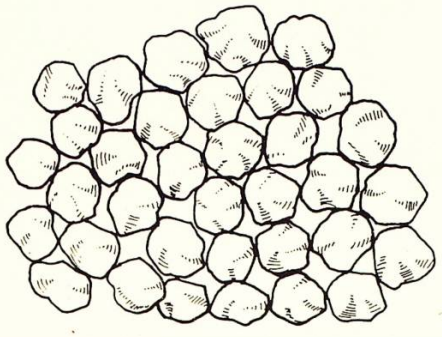


**D** Using tongs, remove the dish and leave to cool. Record in your table the colour of the soil. Repeat steps A to D with soil sample Y.

**Q8** Write down anything else that happened to the soils while being heated.

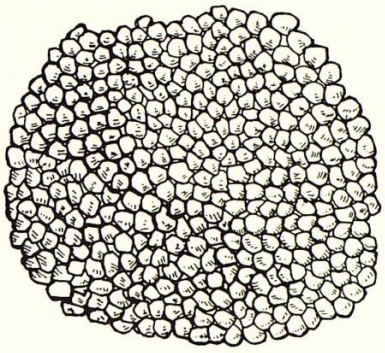
# Information: Drying and burning soils

## Drying soil



Particles of sandy soil
(diameter 0.2 mm)

If the particles of rock in the soil are large then rainwater runs straight through the soil. Even after heavy rain, the soil will be dry. We call this type of soil, **sandy** soil.



Particles of clay soil
(diameter 0.0002 mm)

If the particles of rock are small, then water cannot get through so easily. The soil is wet and sticky except in very dry weather. We call this type of soil, **clay** soil.

Usually, sandy soils are dry and clay soils are wet. A forensic scientist can dry a sample of soil to see how much water is in it. This is one way to compare different soil samples.

## Burning soil

A black soil has rotted plants and animals in it. Almost all soils have some. This is **organic matter** and when it has completely rotted, it is called **humus.** It is the humus in the soil that provides food for plants.

If we heat soil strongly, all the organic matter is burned away, and we can see whether the rock particles are **silica** coloured or **iron** coloured.

If all the tests made on the two soil samples give the same results, then the two soils **probably** came from the same place.

**Q9** If the soil is heated with a high flame, what part of it is burnt away?

**Q10** What is humus?

**Q11** Why is humus an important ingredient of soil?

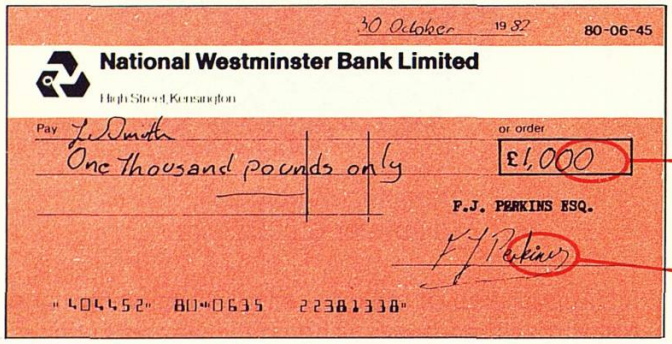
# 8 Forgery

## Using chromatography to show up a forged cheque

Apparatus

★ ink samples X and Y ★ filter paper ★ dropper ★ scissors
★ beaker of water

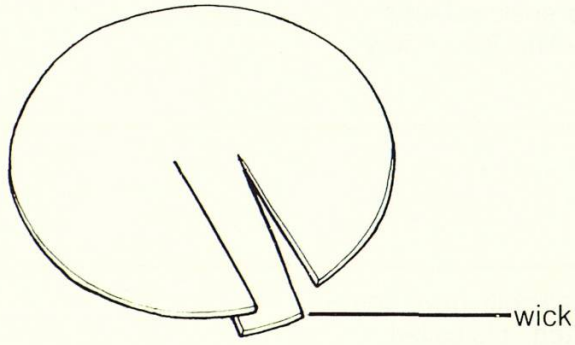
You are going to compare the inks from two parts of a cheque.



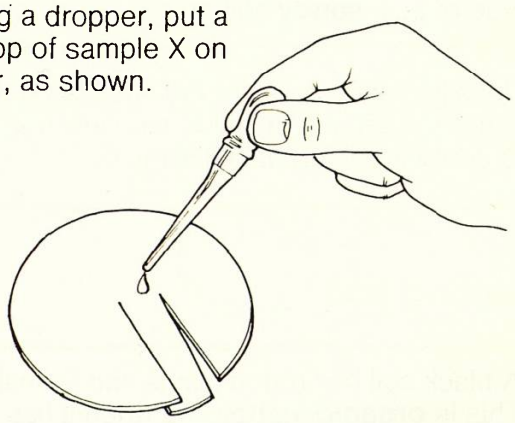

Sample X taken from here

Sample Y taken from here

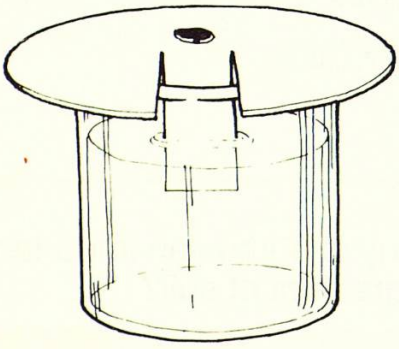
**A** Cut a piece of filter paper, as shown.



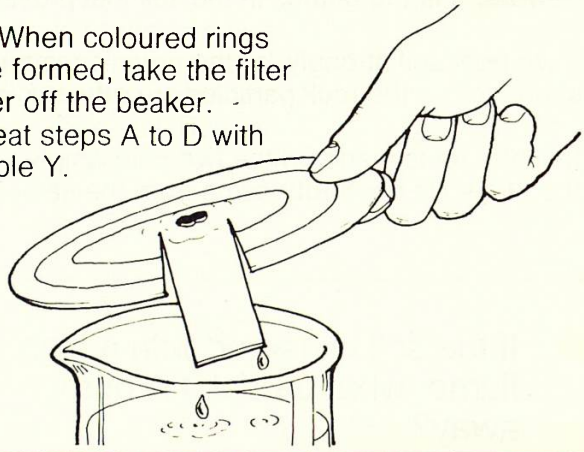

**B** Using a dropper, put a **small** drop of sample X on the paper, as shown.



**C** Put the "wick" into a beaker of water, as shown.



**D** When coloured rings have formed, take the filter paper off the beaker. Repeat steps A to D with sample Y.



**Q1** Were the coloured rings the same for samples X and Y?

**Q2** Do you think the cheque had been forged?

# Using UV light to show up a forged cheque

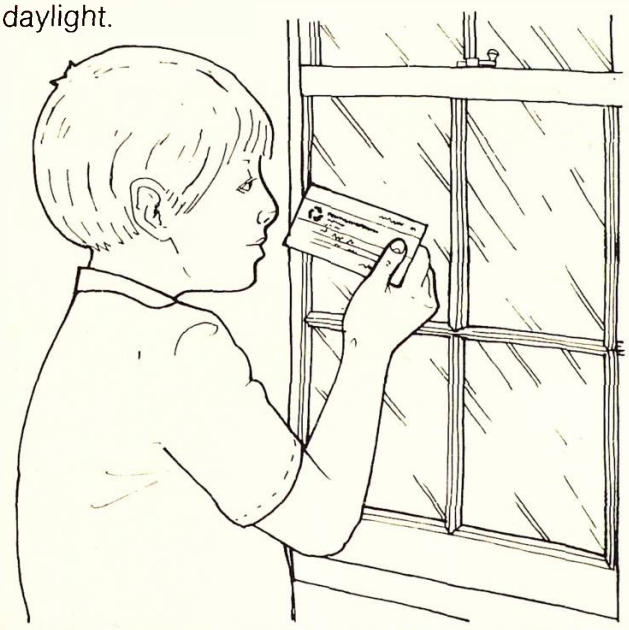
Apparatus

★ UV light in a case ★ forged cheque

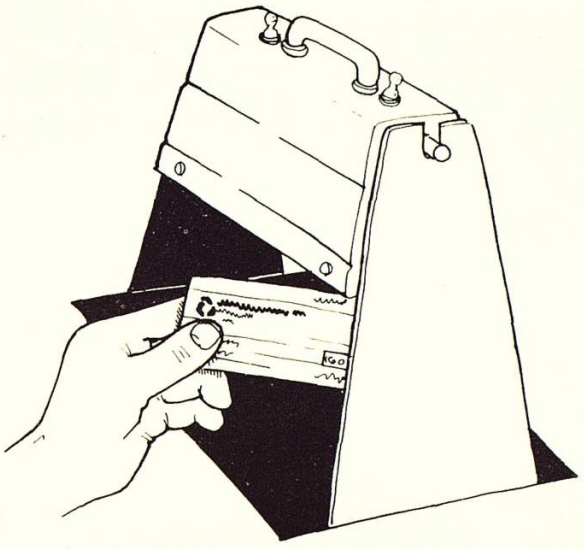
You are going to see how UV light can show up a forgery.

Never look directly at UV light.

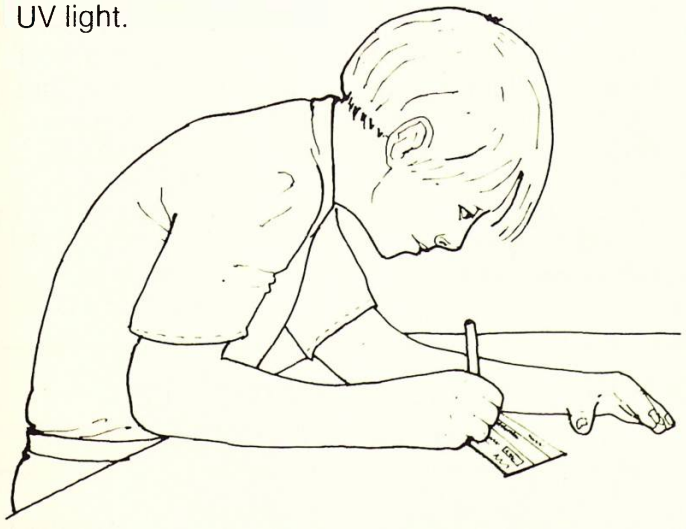
**A** Look at the cheque in daylight.



**B** Look at the cheque under UV light.



**C** Draw circles around the areas that are forged which showed up under UV light.



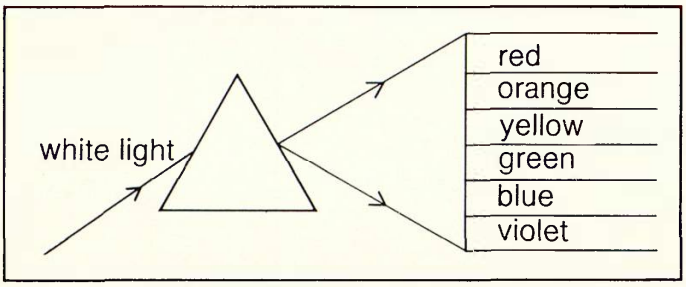
**Q3** What changes have been made on the cheque?

**Q4** In what other ways could a cheque be forged?

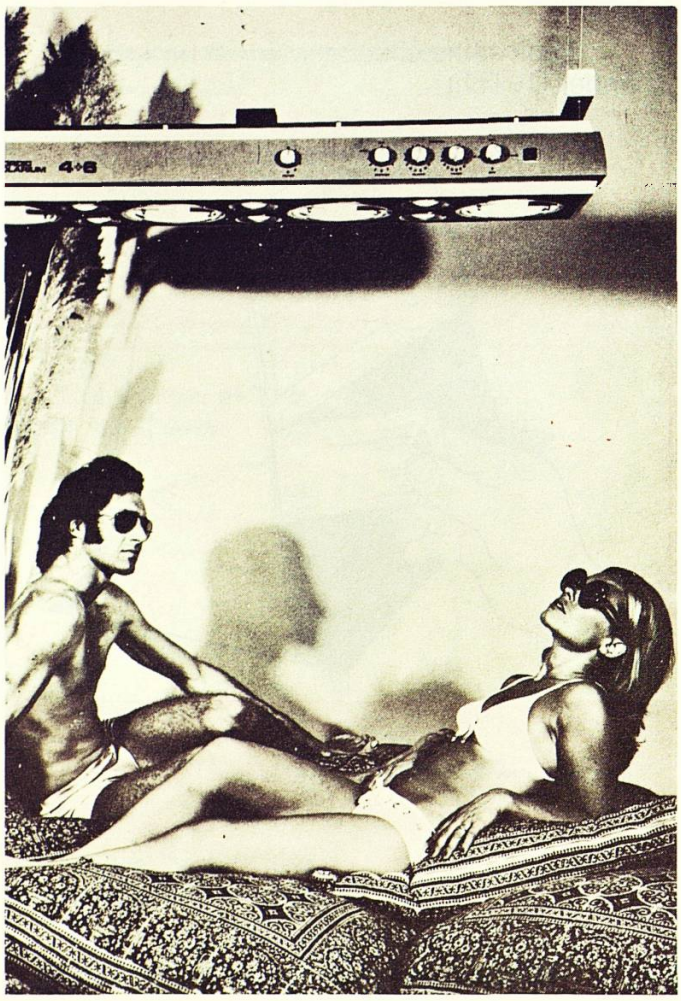
**Q5** How could you write a cheque so as to make forgery difficult?

**Q6** What other documents might a forger try to change?

## Information: Ultraviolet light




The light that we see as white light is made up of many colours. These colours make up the **spectrum** and they are the colours of the rainbow. A spectrum can be made by shining white light through a prism.



There are other parts of the spectrum on both sides of these colours that we cannot see. The area beyond red is the **infrared** region. Infrared rays are used in heat lamps and high-speed ovens.
The area beyond violet is the **ultraviolet** region. These rays have a lot of energy and can hurt your eyes badly if you look at them. There are ultraviolet rays in sunlight. These rays tan the skin so they are used in sunray lamps, as in the photo. Too much ultraviolet light causes sunburn.

When a substance gives out light (usually a bluish or greenish light) under ultraviolet rays, it is said to be **fluorescent.** Many soap powders contain special dyes which give a fluorescent effect to make clothes look "whiter than white".

**Q7** How are ultraviolet rays useful to us?

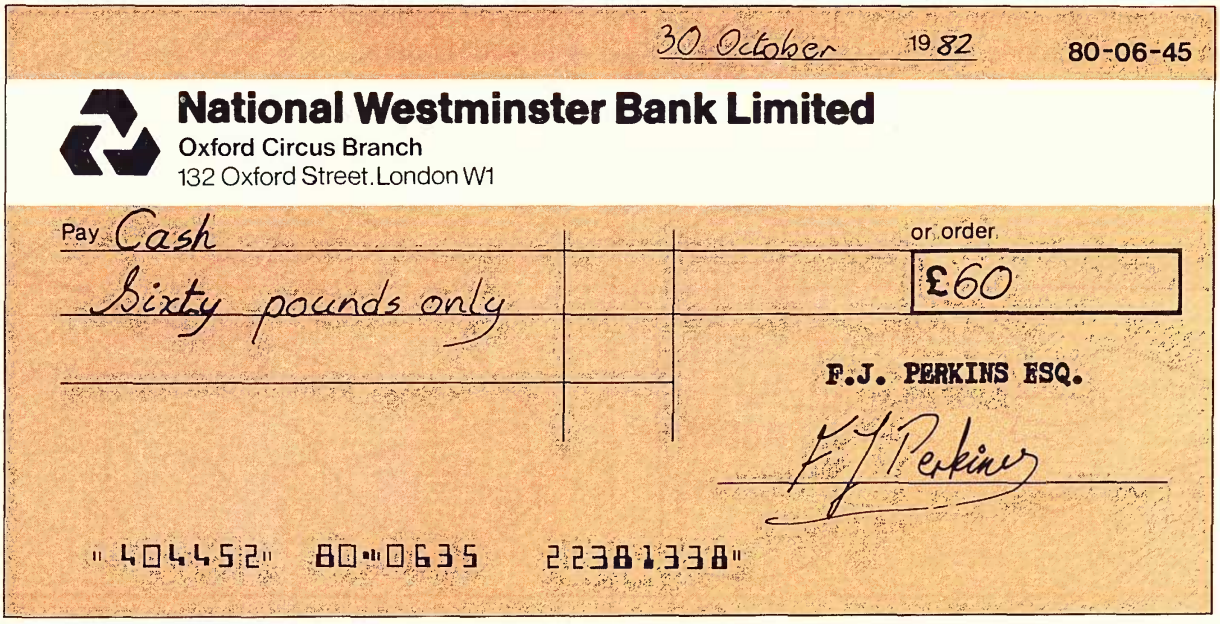
**Q8** What does **fluorescent** mean?

**Q9** Why are fluorescent dyes put into certain soap powders?

# Information: Forgery

When someone writes a signature which is not their own, or alters a figure or some words (on a cheque, for example), he is a forger. If forging is done skillfully, the help of a forensic scientist is needed to prove it.

Cheques may be forged by blotting out words or numbers and replacing them with others, or by adding extra words and numbers to the ones already there, eg **six** can be changed to **sixty.** This type of forgery can easily be detected by showing that different inks have been used for different parts of the cheque. There are two main ways of doing this:


30 October 1982 80-06-45

National Westminster Bank Limited
Oxford Circus Branch
132 Oxford Street. London W1

Pay Cash or order
Sixty pounds only £60

F.J. PERKINS ESQ.

F J Perkins

"404452" 80-06-35 22381338"

1. Using UV light. Only some inks will shine in UV light. Other inks, which appear to be the same colour, may show up as different colours.

2. Chromatography. Inks are made of a mixture of dyes. If these dyes are separated, it can be seen which colours the ink is made from. Two inks which look the same colour may be made up of different coloured dyes. Chromatography is a method of separating the dyes.

**Q10** What are the two different methods of identifying inks?

# Forgery on metal

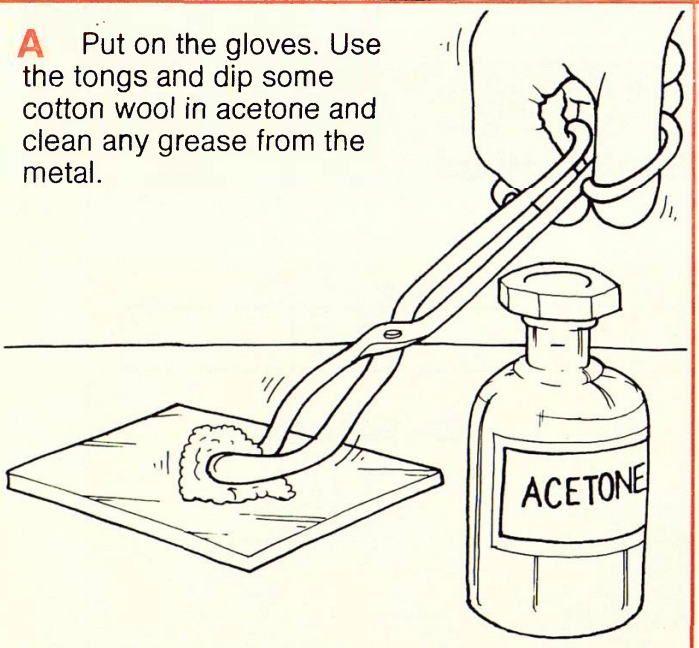
Apparatus

★ sample of forged metal ★ cotton wool ★ gloves ★ 250 $cm^3$ beaker
★ Bunsen burner ★ dilute ammonia ★ nitric acid ★ tongs
★ Fry's reagent

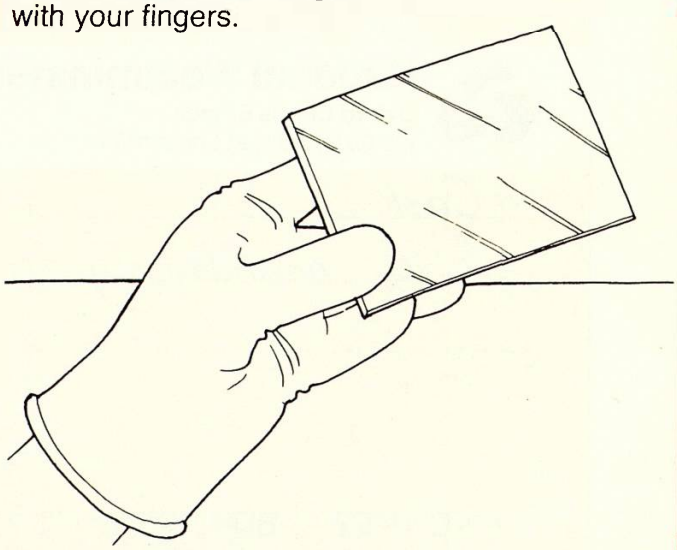
You are going to find the forgery on a piece of metal.

Throughout this experiment, wear gloves and hold cotton wool with ongs at all times.

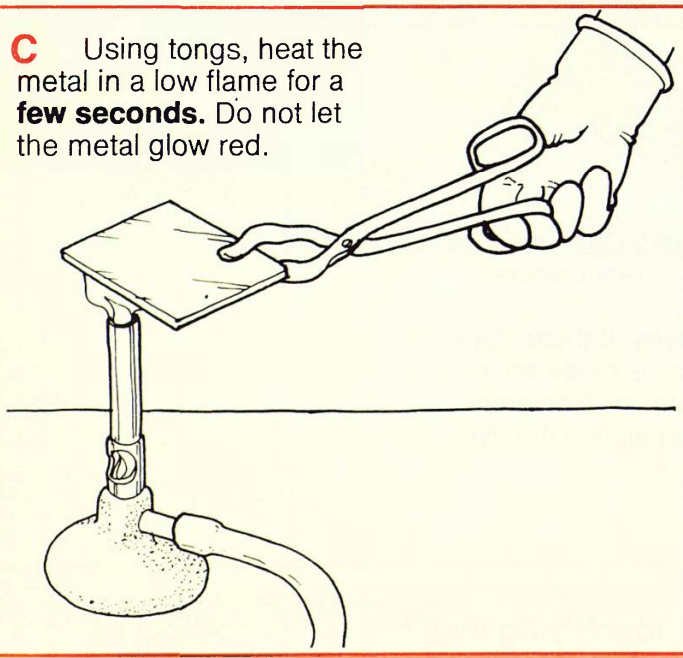
**A** Put on the gloves. Use the tongs and dip some cotton wool in acetone and clean any grease from the metal.



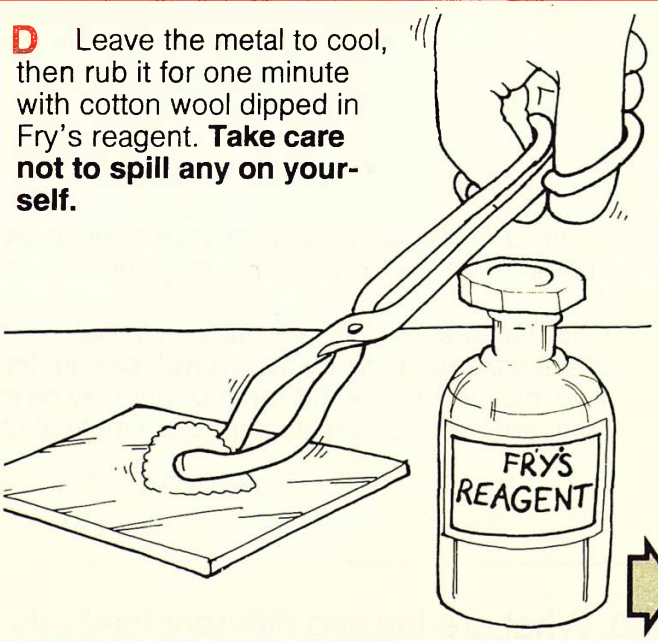

**B** When the metal is clean, do not touch it again with your fingers.



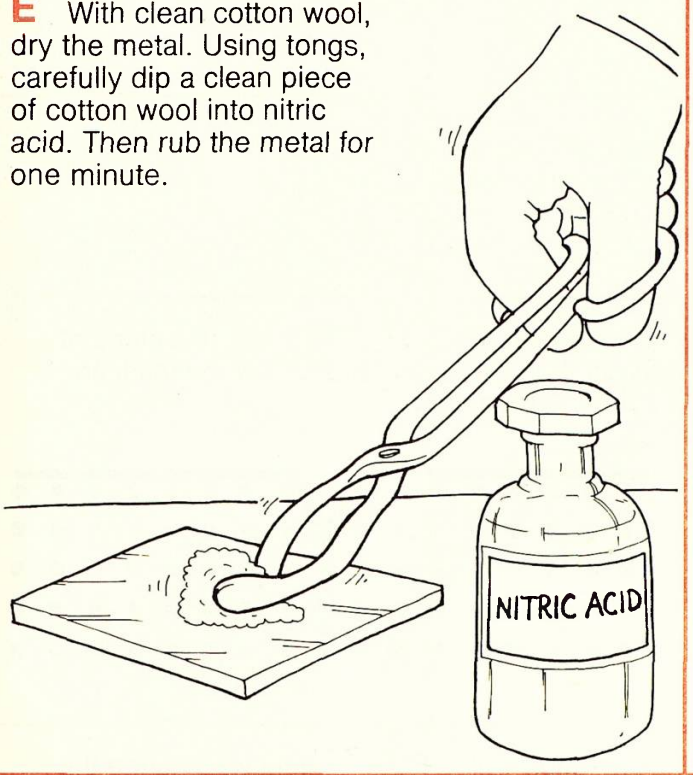
**C** Using tongs, heat the metal in a low flame for a **few seconds.** Do not let the metal glow red.



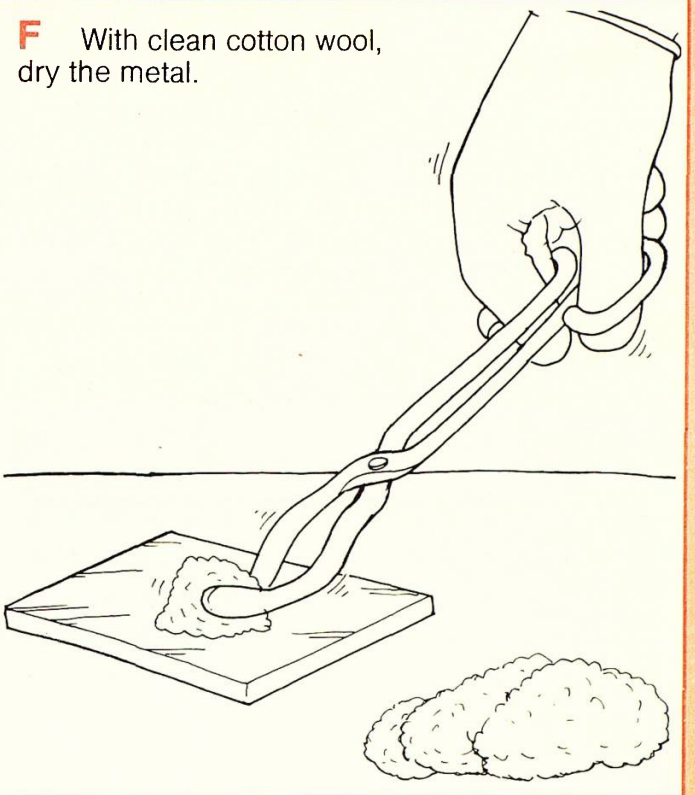
**D** Leave the metal to cool, then rub it for one minute with cotton wool dipped in Fry's reagent. **Take care not to spill any on yourself.**



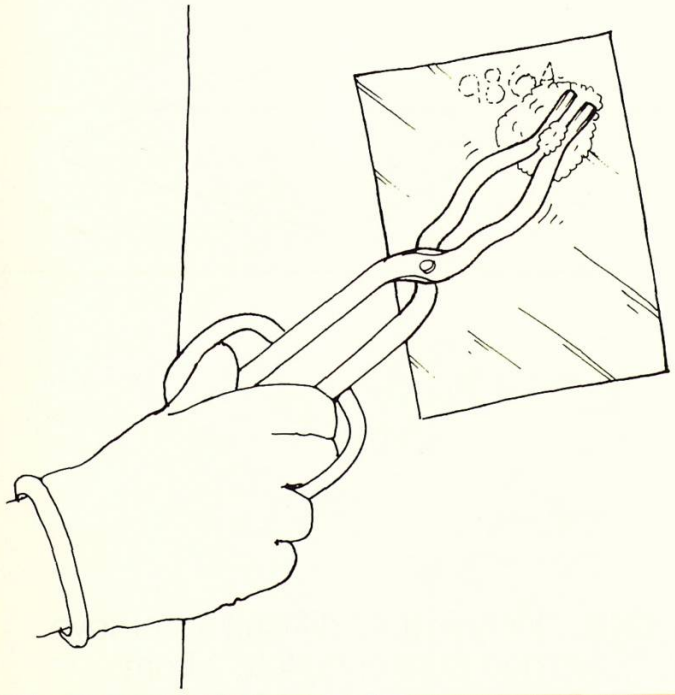
**E** With clean cotton wool, dry the metal. Using tongs, carefully dip a clean piece of cotton wool into nitric acid. Then rub the metal for one minute.



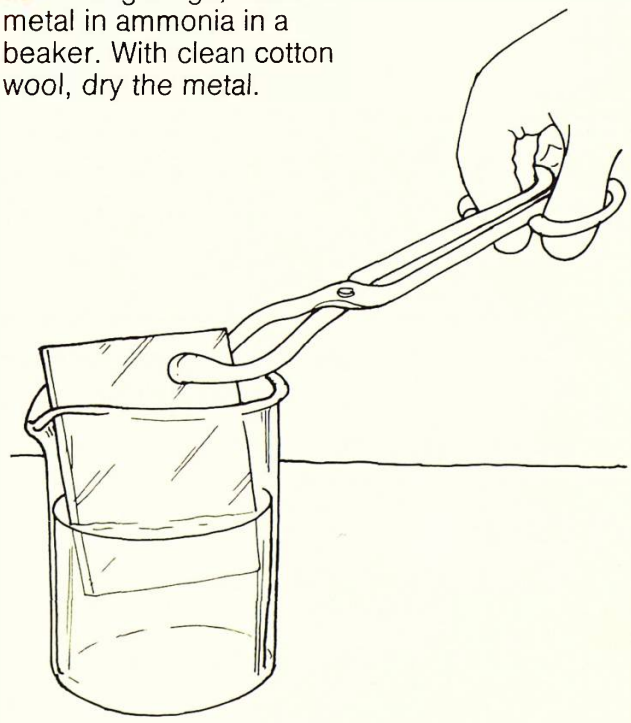

**F** With clean cotton wool, dry the metal.



**G** Repeat steps D to F until the forgery becomes clear.



**H** Using tongs, wash the metal in ammonia in a beaker. With clean cotton wool, dry the metal.



**Q11** Draw a picture of your piece of metal showing the mark(s) you have found.

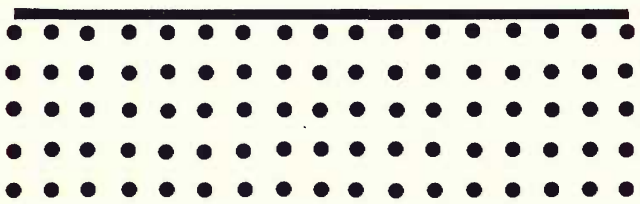
**Q12** Give some examples of forgeries where numbers might be filed off metal and replaced with new ones.

# Information: Forgery

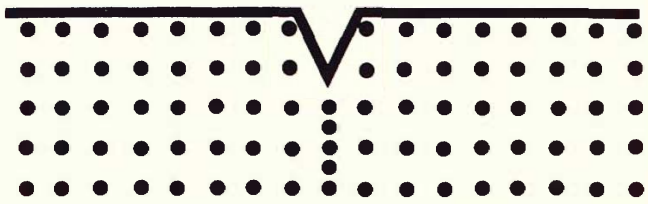
## Forgery on metal

Many stolen goods, eg cars, bikes, keys, watches, tools, guns, carry identification marks imprinted on them. Criminals try to remove these marks by filing them, in order to avoid detection. Even though these marks may no longer be visible, the forensic scientist is still able to restore them.

Metals are made of tiny particles called **atoms** that are arranged in a definite pattern.

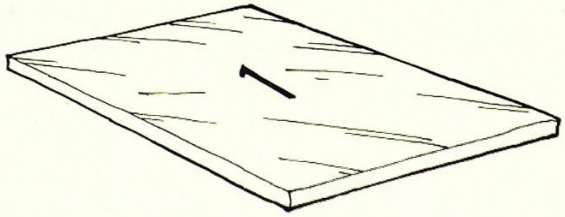


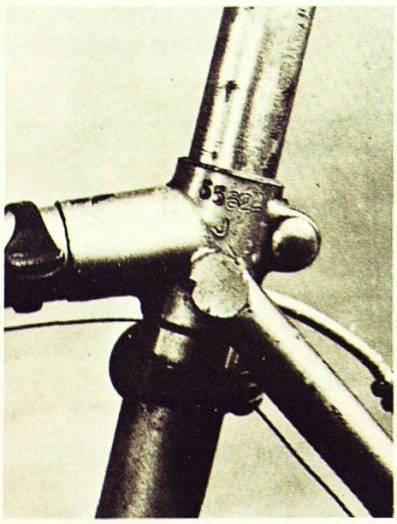
If marks are made on the surface of a piece of metal, the layers of atoms below the mark are squashed together.



If the marks are filed away, the atoms left behind are still squashed, even though you cannot see the difference.

A solution called Fry's reagent will change the colour of the parts of a piece of metal where the atoms are squashed. This then shows up the mark which was filed away.





Registration mark on a bicycle.

**Q13** Why is it so difficult to remove numbers completely from metals?

**Q14** What effect does Fry's reagent have on metal?

# 9 Bloodstains

## Testing stains

Apparatus

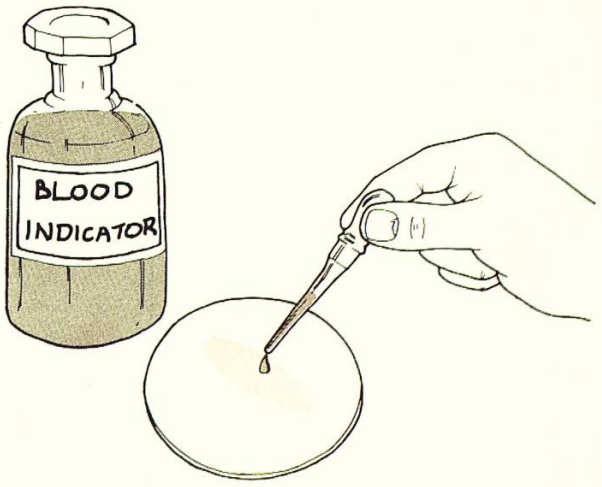
★ blood indicator ★ hydrogen peroxide ★ filter paper
★ 2 droppers ★ 2 samples of stained cloth (X and Y)

You are going to test 2 stains to see if they are bloodstains.

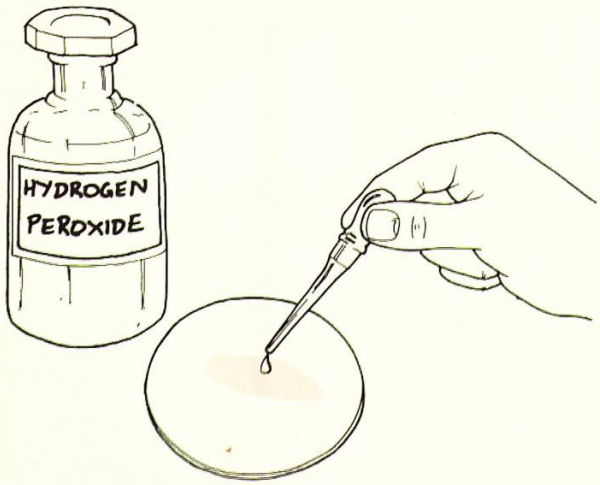
Do not spill hydrogen peroxide on your clothes.

**A** Rub stain X with a piece of filter paper.

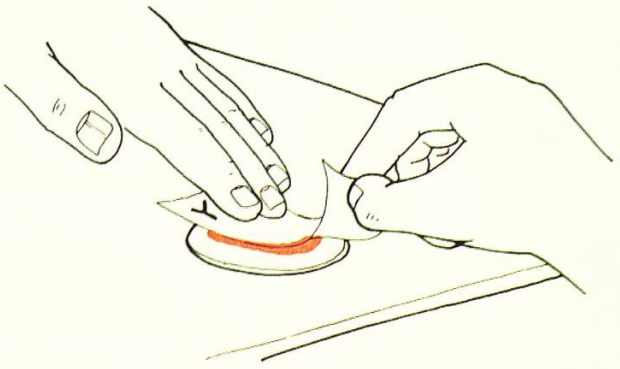
**B** Put 2 drops of blood indicator onto the filter paper.




**C** Add one drop of hydrogen peroxide.




**D** Leave for a few minutes. If the stain is blood, a pink colour will appear. Repeat steps A to D with stain Y.



**Q1** What colour were stains X and Y?

**Q2** Which sample was a bloodstain?

**Q3** Do you think this is a sensitive test?

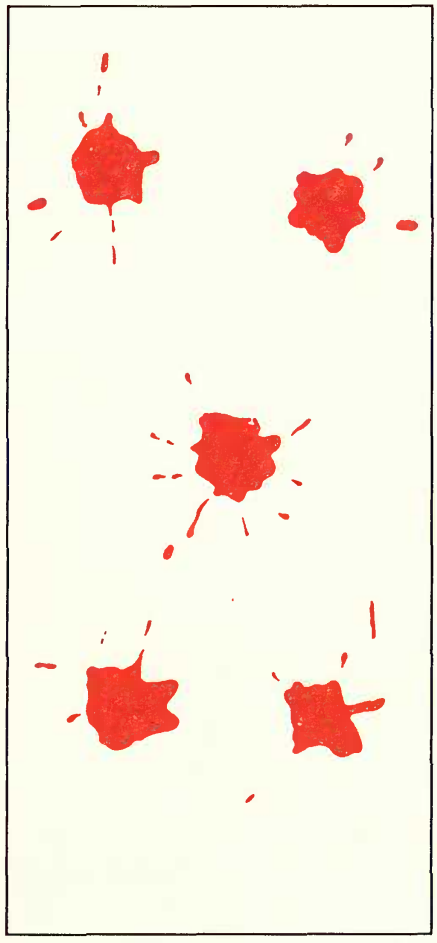
## Information: Bloodstains

Stains at the scene of a crime can provide important information. The forensic scientist tries to find out where the stains come from.

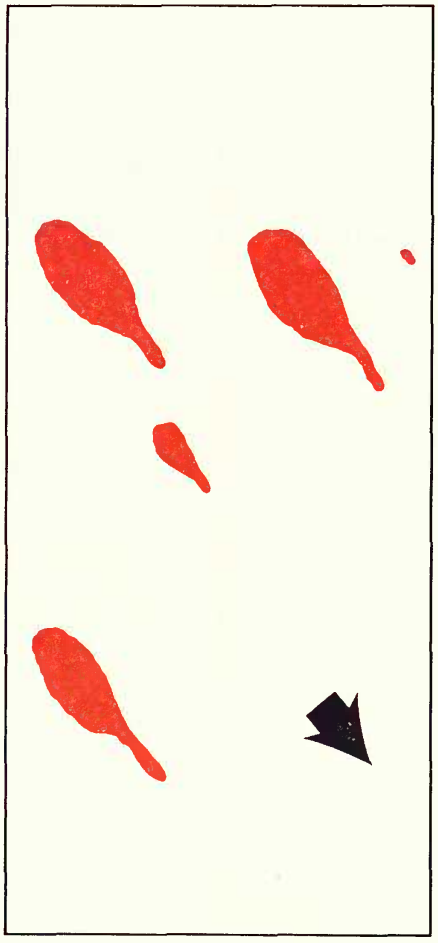
Blood indicator turns pink when oxygen is released from hydrogen peroxide. A chemical in blood releases the oxygen. This test works for both animal and human blood.

The scientist then finds out if the blood is human. There are different types of human blood. These are known as **blood groups**. The scientist can find out which group the blood is. This helps check who the blood came from.

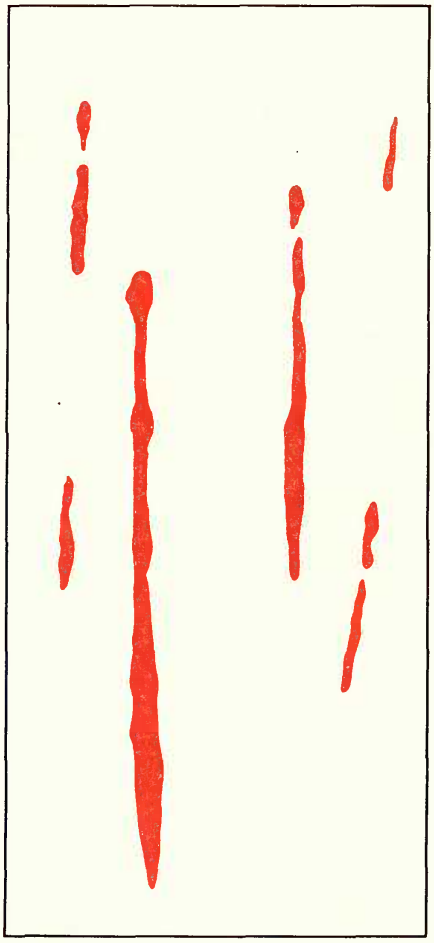
Splashes of blood can also give useful information. They can show where, and sometimes how, a crime took place.



These splashes fell straight down onto the floor.



These splashes were spurting in the direction of the arrow.



These splashes fell straight down a wall.

**Q4** What substance is released to turn blood indicator pink?

**Q5** What other tests can scientists do when they have found a bloodstain?

## Acknowledgements

*The publishers wish to thank the following for* kind permission to reproduce photographs:

Nordic Saunas Limited (sunray lamp, page 26); Commissioner of Police of the Metropolis (all other photographs).

# SCIENCE AT WORK

*Project Director*

John Taylor

The books in this series are:

Fibres and Fabrics
Electronics
Forensic Science
Photography
Gears and Gearing
Cosmetics
Body Maintenance
Pollution
Building Science
Food and Microbes
Domestic Electricity
Dyes and Dyeing
Earth Science
Science of the Motor Car
Plant Science
Energy
Flight
You and Your Mind

Addison-Wesley Publishers Limited

0 201 14004 7