86 The scene of the crime

Description

Many people, adults and children alike, are fascinated by how crimes are solved using forensic science. On the television, many detective programmes include an element of forensic work and many students watch programmes such as *CSI*. New GCSE Applied Science courses have a greater link to science in everyday life and cite forensic science as an example. This day course gives students a greater insight into the work of both a forensic scientist and a scenes of crime officer (SOCO).

The word forensic comes from the Latin word forum, the area where Romans used to hold their law court sessions. So basically, forensic science means using science to help the law.

Fingerprints

People have known about fingerprints since the 17th century and in the 19th century they knew there were different patterns. In 1858, fingerprints were used to pay retired Bengali soldiers in India who couldn't sign their name. They had to have their fingerprint on their paybook and then put it on the receipt when paid, so that the two could be compared.

Several scientists worked on the idea of putting fingerprints to good use and Sir Francis Galton wrote a book about them in 1892. This book was read by Edward Henry, Inspector General of the Bengal Police, who met Galton and together they developed the ideas further. In 1898, Henry published a book called *The Classification and Uses of Fingerprints*. In 1902, Henry was put in charge of Scotland Yard's new fingerprint branch and, in that year, a burglar called Henry Jackson was the first criminal convicted by fingerprinting when he left his thumbprint on the paintwork of a house he entered.

Discuss with the students why it is not only criminals who have their fingerprints taken. Sometimes people have their fingerprints taken to eliminate them from an enquiry, for example the home owner of a house that has been broken into.

Explain how fingerprints are left on everything we touch. Below the skin there are two glands. The sweat gland releases sweat (water, salt and urea) on to the surface of the skin and the sebaceous gland releases oils. Whenever someone touches something they leave behind small amounts of these substances, which show the patterns of ridges on your fingers. These fingerprints often cannot be seen and are referred to as latent prints. A SOCO has a number of techniques that can be used to make the print show up. The print has then been developed.

On a blank ten-print form (Resource 1 on page 231), students use an ink pad to take their own fingerprints. They will need to be shown how to take their

Enrichment areas

- Applied science
- Chemical detection
- Biology
- Chemistry

Resources

Taking fingerprints

blank ten-print forms;
ink pad;
magnifying lens.

Developing fingerprints

dusting powder;
soft brushes;
lifting tape;
Cobex;
selection of different surfaces eg cloth;
paper;
plastic.

Plaster cast

plastic container;
stirring implement;
water;
strip of card (approx. 50cm x 3cm);
paper clip;
Plaster of Paris;
spoon.

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Resources *continued*

Which tool?

piece of wood with a tool mark impression;
plasticine;
selection of different tools.

Sulphur/graphite cast

plasticine;
coin;
tin lid;
sand bath;
tongs;
Bunsen burner;
spatula;
tripod;
gauze;
sulphur powder;
carbon powder.

Comparing inks under different light

paper;
'magic pen';
microscopes;
UV lamp;
IR lamp.

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fingerprints correctly. For the individual fingers at the top of the form students should roll their finger across the ink pad and then roll the inked finger on to the correct space in one direction only. They should not roll the finger back again, otherwise the print will smudge. If they press too lightly the print will be too faint and if they press too hard the print will smudge. Therefore, they should practise first on scrap paper before using the ten-print form. At the bottom of the form they press the four fingers of both their hands simultaneously on to the correct spaces (without rolling) and then repeat with the two thumbs. They then try to work out what type of print they have. Loops can be subdivided into ulna or radial (named after the bones in the forearm). This depends on which way the loop opens. If the opening of the loop is towards the little finger this is called an ulna loop, because the ulna bone is the one on the outside of the arm. If the opening of the loop is towards the thumb it is a radial loop because the radius is the bone on the inside of the arm.

When a crime has been committed, fingerprint experts are usually the first people sent to the scene of the crime. They have to look for fingerprints first before anything else is disturbed. Some fingerprints are fairly easy for the fingerprint expert to find. The criminal may have put their finger into something soft such as putty, wet paint or wax, or they may have had something on their fingers, such as oil, paint, blood or ink, which would have left a print. If the SOCO finds one of these types of print they are carefully photographed.

Most fingerprints found at the scene of a crime are latent prints. This means that they are not visible. The SOCO has to develop them. One way is to dust for prints. This involves using a soft brush and aluminium powder. The brush is charged with the aluminium powder and then the print is very gently wiped with the brush until the fingerprint shows up. Brushing too hard will destroy the print. The SOCO will brush the dusting powder over places where prints are most likely to be found, such as door handles, drawers, window catches and stair rails. The dust is trapped by the lines of sticky, oily sweat left behind by the fingers and so the fingerprint will show up. Once the print has been developed the fingerprint is photographed and then it is lifted from the surface, using a type of sellotape. The tape is then mounted on to a piece of Cobex (a type of plastic) to be taken back to the laboratory for closer examination.

Students press the end of their finger on to different surfaces and then sprinkle a little of the dusting power over the area. Using the brush, they gently dust the powder away and note how well the print develops. Once they have discovered that dusting for prints works best on hard, smooth surfaces, they can try making/finding prints around the room. If a good print develops, a

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piece of lifting tape could be placed over the print to try to lift it, and it can then be put on a piece of Cobex. Proper fingerprint brushes, lifting tape and Cobex can be purchased from forensic suppliers, but, as an alternative, use a soft paint brush or blusher brush, clear sticky tape and OHP acetate. A good alternative to aluminium powder is talcum powder.

Impressions

When a criminal forces their way into a building or car, they will often leave marks or impressions behind on doors or window frames made by the tools that were used. Scientists are able to learn a lot from these marks. By making a cast of the tool marks, they can later be matched to the tool if it is found. Other impressions could have been made by shoes or tyre. Again scientists make a cast of the print, so that it can later be compared.

The choice of material to make a copy of the impression will depend on the size of the impression and where it is found.

Plaster of Paris is a very good material for making casts. The mixture starts off as a liquid, so it can be poured over the print. As it begins to set it expands and so fills every crack. Once set it is easy to remove the cast and store it until it is needed. The main disadvantage of using plaster of Paris is that it doesn't set very well on wet ground. SOCOs usually use plaster of Paris for shoeprints and tyre prints. They will take a photograph first, with measurements in case the cast doesn't come out properly. If the ground is wet, SOCOs often spray the impression first with a substance called shellac, which helps to stop the impression from breaking up when the plaster is poured in.

Get students to find a shoeprint or tyre-print in earth or sand outside (or make their own). They should make a quick sketch of the print first, adding information regarding measurements of length and width. Students should use the strip of card and a paper clip to make a mould around the print. Using about 70cm^3 of water in the plastic container, the students add plaster of Paris powder a bit at a time, stirring continuously until it is the consistency of thick, smooth cream. They pour this into the mould quickly and leave it to set. Ideally the cast should be left to set for several hours, but it should be ready in two. Once set, the cast can be lifted out of the mould and washed under a running tap, after brushing off any sand or soil.

If the students have made a cast of a shoeprint, they can make deductions about who made the print – size of shoe, weight of person, type of shoe etc. They could carry out further investigations into the types of print that are left when people are: standing; walking; running; carrying a load etc.

If the students have access to a bike, they could investigate how the pattern of

Resources *continued*

Chromatography

piece of chromatography paper or filter paper;

beaker;

paper clip;

wooden splint;

pencil;

water;

felt pens or ink;

piece of paper with 'seventy' written on it;

dropping pipettes.

Looking at human hair

microscope;

blank microscope slides.

Looking at different types of hair

microscope;

prepared slides of hair from different parts of the body and also animal fur.

Looking at fibres

microscope;

blank microscope slides;

sellotape;

prepared slides of different types of fibres;

fabric samples.

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86 The scene of the crime *cont.*

Resources *continued*

Testing for cations

known solids containing:
- aluminium
- ammonium
- calcium
- copper (II)
- iron (II)
- iron (III)
- lead
- sodium
- potassium and zinc;

dilute sodium hydroxide solution;

dilute ammonium hydroxide solution;

nichrome wire (flame test rods);

concentrated hydrochloric acid;

watch glass;

test tubes;

distilled water;

dropping pipettes.

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tread changes at different speeds and whether it is possible from the pattern to work out the direction the bike was travelling in.

They could also make a plaster of Paris impression of a bite mark in an apple.

As with shoeprints and tyre-prints, impressions made by tools are first photographed and then a cast taken. One way is to press a pad of quick-setting plastic on to the mark, which, when peeled away, leaves a copy of the impression.

For an impression with very fine details, a sulphur/graphite cast can be made.

Give students a piece of wood that has been marked by a tool. They are to use the plasticine to get an impression and then try to match it with a selection of tools to work out which one made the mark.

Show students how to make a sulphur/graphite cast. This activity can only be done in a laboratory with good ventilation. Provided the students take care, there is no danger, but if the sulphur powder is allowed to catch fire then sulphur dioxide fumes will be produced, so it might be better to do it as a demonstration. A cast can be made of a scratch on a piece of metal, but if the students make a cast of a coin, they will be able to see why this method is good for showing fine detail. Place a sand bath on top of a tripod and gauze, and pre-heat using a Bunsen burner. Roll the plasticine into a strip and use this to make a mould around the coin. On the tin lid mix together two spatula measures of carbon powder and eight of sulphur powder. Put the tin lid on to the sand bath and continue to heat gently. When the mixture has melted, use the tongs to pick up the tin lid and pour the mixture on to the coin in the plasticine mould. The cast will set quickly and can then be lifted from the coin.

Forgery

Forgery covers a range of different aspects, for instance forging a signature, altering/adding words to a legal document, ransom notes or printing bank notes. Documents fall into three categories – handwritten, typewritten and printed.

Typewritten documents can be almost as distinctive and individual as handwriting. In time, typewriter keys become worn, bent and damaged. If a document specialist is given a typewritten note and a selection of typewriters, he or she will be able to say which typewriter was used to produce the note.

These days typewriters are not used as much. Many people have computers and it is more difficult to compare the prints from printers. The scientists can, however, decide whether the printer used was, say, a laser printer or a dot-matrix and therefore if a suspect is caught, they can compare the print with the type of printer the suspect has.

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A scientist working in the documents section at a forensic laboratory will have a number of techniques available to try to determine whether a document has been forged.

Cheques may be forged by replacing words or numbers with others, or by adding extra words and numbers to the ones already there, for example 'seven' can be changed to 'seventy'. This type of forgery can be detected by showing that different inks have been used for different parts of the cheque. There are two main ways of doing this:

1. Observing the cheque under different light conditions. Inks will look different when viewed under normal light, UV light or even IR light. This technique can also be used to read words that have been crossed out or erased. By adjusting the light conditions, the ink can be made transparent, allowing any erased words or numbers to show up.
2. Chromatography. Inks are made of a mixture of dyes; two black pens may not necessarily be made from the same dyes and chromatography is a method of separating an ink into the individual dyes it is made from.

Students write their name on a piece of paper using the magic pen and then use the eraser to erase half of it. They then observe the words under a) a low-power microscope and b) a UV lamp.

Students then write their name using one black pen to write their first name and a different one for their surname. The two words can then be observed under both UV and IR light.

The inks can then be further tested by chromatography. On a piece of chromatography or filter paper, students draw a horizontal line in pencil about 2cm up from the bottom edge. They then make some ink blobs using two or three different black inks. The paper is suspended in a beaker containing about 1cm depth of water. The paper is hung from the wooden splint using a paper clip. It should be left until the water has nearly soaked up to the top of the paper. Explain how chromatography works and also other similar techniques such as thin layer chromatography and gas chromatography.

Students can then be given a piece of paper (filter or blotting paper is best) with 'seventy' written on it, where the 'seven' has been written with one black pen and the 'ty' with another. By dripping water on to the ink they can decide if the word is a forgery or not. It is worth stressing that although, if there are two different inks, a forgery is indicated, it cannot be categorically said that if the inks are the same that it is not a forgery.

Resources *continued*

Testing for anions

known solids containing
- bromide
- carbonate
- chloride
- iodide
- nitrate
- sulphate;

dilute hydrochloric acid;

silver nitrate solution;

dilute nitric acid;

concentrated sulphuric acid;

barium chloride solution;

dilute hydrochloric acid;

iron (II) chloride;

dilute sodium hydroxide solution;

aluminium powder;

spatula;

distilled water;

dropping pipettes;

test tubes.

Chemical analysis investigation

samples A, B, C, D and E;

all chemicals used in testing for cations and testing for anions activities.

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86 The scene of the crime *cont.*

Resources *continued*

Testing a stain for blood

filter paper;

phenolphthalein indicator;

dropping pipettes;

hydrogen peroxide solution;

selection of materials with different stains (blood can be taken from a piece of meat).

Analysing blood patterns

dropping pipettes;

artificial blood;

metre ruler;

small ruler;

large pieces of paper.

Hair and fibres

Hair is constantly being lost from our bodies, and the clothes we wear leave behind fibres. Criminals often leave behind hairs or fibres without realising.

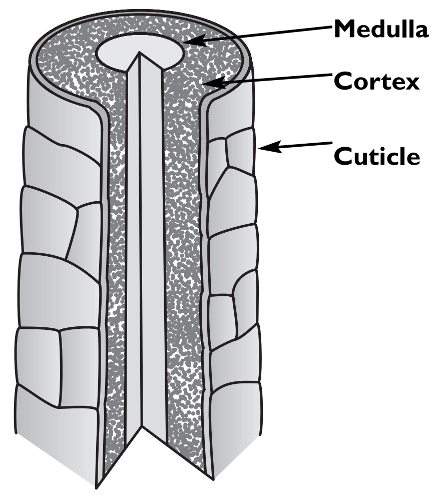
It is quite easy to see the difference between animal hair and human hair using a microscope. Most often the lab will be asked to confirm whether the hair recovered from the scene of a crime matches that of the suspect. For this a comparison microscope is used. This type of microscope allows the forensic scientist to examine both hairs together. If the hair roots are examined, it is possible to tell whether the hair was pulled out or just fell out.

Human hair is categorised according to where it comes from on the body and is divided into six types:

- Head
- Eyebrows and eyelashes
- Beard
- Axillary (underarm)
- Body
- Pubic

The hair, from different parts of the body have different characteristics and these can be seen under a microscope.

Under a powerful microscope hair can be seen to consist of three layers. The medulla is the central core. In most human head hair, there is no medulla or it is fragmented. The cortex contains granules of pigment which give our hair its colour and the cuticle is the outer sheath of overlapping scales.



Students make up a slide using one hair from their head and then use a microscope to look at each other's hair. They should start with low magnification and then increase the magnification (although it may be difficult to get the higher magnification into focus). Ask them to look for differences, particularly whether there are differences with different colours and with hair from different ethnic origins. Students should then look at some prepared slides of hair from different parts of the body, such as head, arm, leg, beard and also animal fur. They should try to identify differences – beard hair for example is triangular. Can they tell the difference between human and animal hair?

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Like hair, fibres are among the most common evidence that can be transferred between two people in close contact. A range of techniques can be used to identify and compare fibres. A compound microscope is always used first and often this is enough to say whether two fibres match. Other techniques used include chromatography to match dyes and spectrophotometry to match type of fibre. This last method involves shining white light through fibres. Some dyes in the fibres absorb some of the wavelengths in the light more than others. The intensity of the different wavelengths of light that get through the fibres can be analysed.

Fibres can be divided into two main classes – natural and man-made. In turn, natural fibres can be classified as having animal (eg wool), vegetable (eg cotton) or mineral (eg asbestos) origin.

Students look at the various types of fibre on prepared slides, seeing if they can identify differences. They should again start with low magnification and then increase the magnification. They can also look at small pieces of different fabric, so they can see how the fabric has been woven. Finally they can use clear sticky tape to lift fibres from their own clothing. By looking at the fibres, is it possible to tell which clothing it came from?

Chemical analysis

Chemical analysis is carried out in the toxicology department, which is often the busiest in the forensic chemistry laboratory. It includes analysing for illegal drugs and poisons.

These days, laboratories have sophisticated equipment, such as mass spectrometers and gas chromatography, which can be used to analyse a minute amount of a substance.

There are two types of chemical analysis, qualitative analysis, in which the substances are identified, and quantitative analysis, where the relative masses or concentrations of the substances are found.

There are many simple experiments that can be carried out where students can identify unknown substances. Most simple substances, for example sodium chloride or potassium nitrate, are made up of two parts. The first part (sodium/potassium) is called the cation and the second part (chloride/nitrate) is the anion. Resource 2 on page 232 shows tests that can be used to identify the cation and anion in unknown substances containing:

cations – aluminium, ammonium, calcium, copper, iron, lead, sodium, potassium, zinc

anions – bromide, carbonate, chloride, iodide, nitrate, sulphate.

Further reading and websites

http://home.earthlink.net/~thekeither/Forensic/forsone.htm

www.pathguy.com/TimeDead.htm

The Encyclopedia of Forensic Science, Brian Lane, Headline Book Publishing Ltd (ISBN 978-0747239048)

The Modern Sherlock Holmes, Judy Williams, Broadcast Books (ISBN 978-0951562932)

Traces of Guilt, Hugh Miller, BBC Books (ISBN 978-0563369646)

86 The scene of the crime *cont.*

Show students how to carry out tests on cations and anions so that they can produce a crib sheet for what happens to each substance. They can then be given some unknown chemicals to analyse.

Blood

If a burglar cuts his or her hand while breaking into a house, he or she will probably leave traces of blood. At the scene of most violent murders, there is often a lot of blood. Blood can give the forensic scientist a lot of evidence.

Any smear that looks like blood has to be analysed first to check that it is blood. The usual method for this is the Kastle-Meyer test. This test works because blood contains a chemical called peroxidase. When hydrogen peroxide is added to blood, the peroxidase causes oxygen to be released from the blood. This oxygen will cause phenolphthalein indicator to turn pink. It will only work in the presence of blood. Students who watch television programmes like *CSI* will have noticed this test being done on blood smears.

(To investigate this, students wipe a piece of filter paper on to different stains provided and add a few drops of hydrogen peroxide solution to each. They then add a few drops of phenolphthalein indicator. If the indicator turns a pink colour, then the stain is blood.)

The stain is then analysed to check whether it is human blood. Once it has been established that it is human, it can be analysed to find out which blood group it belongs to. There are four main groups of blood. About half the British population has group O blood, with about 42% being group A, 8% group B and 3% group AB. Blood also contains other chemicals that can be analysed. When a suspect is arrested a blood sample will be taken and analysed to see if it matches traces of blood found at the scene of the crime.

In violent struggles where someone is wounded the blood can be sprayed all over the place and a forensic scientist will analyse the pattern of the blood spatter and the angles of drips to try to piece together what may have happened.

As well as drops or splashes, blood can form other patterns, for instance if a major artery is severed, the pumping heart will cause the blood to spurt out, often quite a long way. Spurts have been known to hit the ceiling. A pool of blood could be formed when a person who is bleeding heavily stays in one place for a while. A wounded person can leave smears of blood as they move, on walls and furniture etc. If a bloody corpse is moved from the scene of the killing by dragging, a smeared trail may be left. Blood often ends up on walls, especially if someone is hit with a blunt instrument so that their blood spurts out.

Some artificial blood can be made by mixing water and cornflour with some red food colouring. Students use the ruler to drip one drop of artificial blood vertically from different heights and to look at the shape and size of the spatter pattern. They can then

86 The scene of the crime *cont.*

stick a piece of paper on a wall and squirt artificial blood at the paper from different angles. Can they tell which direction the spurts came from by looking at the patterns made by the splashes?

Pathology

In cases of suspicious death, a forensic pathologist is called to the scene. The body is not moved until the pathologist has examined it. The job of the pathologist at the scene of a death is to:

a) examine the position and condition of the body

b) examine the environment and local conditions.

In examining the position and condition of the body, the pathologist will take the temperature of the body (see further information on estimation of time since death). They will also look at a number of other changes to the body that occur after death (post mortem).

Hypostasis

This is most easily seen between one and three hours after death and happens to the body when blood circulation stops. Gravity then acts upon the blood and it is pulled down to the lowest areas of the body that it can get to. When the blood 'pools', the skin becomes redder. The pattern of hypostasis depends on the position of the body after death. Where the body is pressed against something hypostasis will be prevented from forming. For instance, if the deceased body is lying on its back, the shoulders, buttocks and calves are likely to be touching the ground or other surface. Hypostasis cannot form here, so these areas will remain white. A pathologist will look for signs of hypostasis. If the marks are not consistent with the position that the body is found in, this is a good indication that the body has been moved after death.

Rigor mortis

When a person dies, their muscles initially relax and the body becomes limp and flaccid. After a while the muscles begin to stiffen. Although rigor begins to set in all over the body at the same time, it is first apparent in the smaller muscles such as the face, fingers and toes. After about 36 hours the stiffening begins to wear off as the muscles break down. The smaller muscles will decompose more quickly and so the effect of rigor disappears in the same order as it is formed.

Rigor mortis can be used as an aid to establishing the time since death and as a general 'spot check', the following can be applied:

- If the body is warm and flaccid, it has been dead less than three hours.
- If the body is warm and stiff, it has been dead for between three and eight hours.
- If the body is cold and stiff, it has been dead for between eight and 36 hours.
- If the body is cold and flaccid, it has been dead more than 36 hours.

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This should only be taken as a general rule. There are many factors that can change the timing of the onset of rigor mortis. For instance, if a person dies after a violent struggle, the heat energy that they have generated will help rigor to begin more quickly. Also, a person who dies in extreme terror may become stiff more quickly.

Decomposition

Once a human body has died, the process of decomposition starts. This is greatly affected by conditions in the environment such as temperature and dampness. The amount and type of decomposition can differ from one body to another.

Discuss with students what changes they think could happen to a body after it dies. Explain why hypostasis is so important in determining whether a body has been moved.

One of the first questions that an investigating police officer asks the pathologist is when the victim died. The answer to this cannot be given exactly as a number of factors have to be taken into account, but the pathologist is usually able to give a range, for instance between four and six hours ago.

Discuss with students what they think will affect how quickly a body will cool down.

The best means of estimating time since death is measuring body temperature, although again there are factors that affect how quickly a body cools after death:

- Size of body – a thin person will cool more quickly than a fat one. A child will cool more quickly than an adult.
- Posture – a curled up body will lose heat more slowly than one that is stretched out.
- Clothing – a naked body will lose heat more quickly than a covered one.
- External temperature – a body found outside will cool more quickly than one found indoors.
- Bleeding – a person who has died from severe loss of blood will cool more quickly.

A pathologist will use a method of estimating time since death called a Henssge's nomogram. The internal temperature of the body is taken and so is the temperature of the air in which the body is found (called the ambient temperature). By plotting these values on a chart and also taking into account body type, dry or wet clothing, still or moving air etc, an estimate can be arrived at.

The website www.pathguy.com/TimeDead.htm has a program where students can put in the different values and it will work out time since death. They could be given different scenarios to find out time since death, for instance a young boy weighing 30kg was found at 8.00am wearing only thin pyjamas. He was face down in a wet ditch. The water was not flowing. The internal body temperature was 23°C and the air temperature was 14°C.

86 The scene of the crime *cont.*

Going further

There are many education text books available that give further activities to supplement the ones given, on topics such as:

- developing fingerprints on absorbent or sticky surfaces
- developing ear prints
- handwriting analysis
- odontology
- qualitative analysis using titration
- soil analysis
- glass analysis
- paint analysis
- ballistics.

Students could be set a crime to do the forensic analysis for. One way is to give them all the evidence that was found at the scene of the crime. In a separate part of the room is evidence from the main suspects. They have to try to match the evidence to one (or more) of the suspects.

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Student's Notes

The scene of the crime

The word *forensic* comes from the Latin word *forum*, the area where Romans used to hold their law court sessions. So basically, forensic science means using science to help the law.

Modern forensic science owes much to the work of Edmund Locard (1877-1966), who was assistant to the Professor of Forensic Medicine at Lyons University before establishing the Police Laboratory in France in 1910. Locard identified the basic principle of forensic science that is known as the Theory of Exchange. This means that a criminal is likely to leave some trace of himself at the scene of crime and also take something from the scene of crime away with him. For example, if someone drives their car into a lamp-post, paint from the car would be left on the lamp-post and paint from the lamp-post would be left on the car. If the two types of paint can be matched then scientists would have enough evidence to say it is likely that it was this car that hit the lamp-post.

Scenes of crime officers (SOCOs) are people whose job it is to find clues at the scene of a crime. Even before they start collecting clues, the scene will be photographed from several different angles. SOCOs have to put a special paper suit on over their clothes so that they don't drop anything from their own clothes that could contaminate the evidence. SOCOs start from the outside and work their way to the middle of the room.

Fingerprints are usually the first thing to be taken, but often if there is a body this is removed for a post-mortem first (after having been examined by a pathologist). All evidence found is packaged up separately and carefully labelled. These clues are then sent back to the forensic science laboratories to be analysed. If the SOCOs do not use the correct procedure the evidence will be rejected at the forensic science laboratory and therefore would not be allowed to be used in court.

Fingerprints

Everyone's fingers have patterns of small ridges in the skin. They are there to grip objects when held, but these patterns are also useful in crime detection because no two people have exactly the same fingerprints, even identical twins. Fingerprints do not change during a person's lifetime. There are three main types of fingerprints – arches, loops and whorls – but within each group there can be many variations. Some fingerprints combine two of these types and these are called compounds.

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Student's Notes

Below are diagrams showing the main three types.

Arch

Loop

Whorl

Statistics have shown that:

– 60% of prints are loops

– 5% of prints are arches

– 35% of prints are whorls and compounds.

- Using a ten-print form (see Resource 1 on page 231) and an ink pad take your own fingerprints and work out which pattern you have on each finger.

One technique SOCOs use is to dust for fingerprints, using a fine powder such as aluminium.

- Using a soft brush and dusting powder try to develop fingerprints on different surfaces.

Impressions

When a criminal forces their way into a building or car, they will often leave marks or impressions on doors or window frames made by the tools that were used. Scientists are able to learn a lot from these marks. By making a cast of the tool marks, they can later match them to the tool if it is found. Other impressions could have been made by shoes or tyres. Again, scientists make a cast of the print so that it can later be compared.

The choice of material to make a copy of the impression will depend on the size and location of the impression.

- Find a shoeprint or tyre-print in earth or sand outside (or make your own). Make a quick sketch of the print first, adding measurements of length and width. Use the strip of card and a paper clip to make a mould around the print. Using about 70cm^3 of water in the plastic container, add plaster of Paris powder a bit at a time, stirring continuously until it is the consistency of thick,

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Student's Notes

smooth cream. Pour this into the mould quickly and leave it to set. Ideally the cast should be left for several hours, but it should be ready in two. Once set the cast can be lifted out of the mould and washed under a running tap, after brushing off any sand or soil.

As with shoeprints and tyre-prints, impressions of marks made by tools are first photographed and then a cast taken. One way is to press a pad of quick-setting plastic on to the mark, which, when peeled away, leaves a copy of the impression.

For impressions with very fine details, a sulphur/graphite cast can be made.

- The piece of wood you have been given has a mark made by a tool. Use plasticine to make an impression of the mark and then work out which tool made it.

Forgery

Forgery covers a range of different aspects, for instance forging a signature, altering/adding words to a legal document, ransom notes or printing bank notes. Documents fall into three categories – handwritten, typewritten and printed.

Cheques may be forged by replacing words or numbers with others, or by adding extra words and numbers to the ones already there, for instance 'seven' can be changed to 'seventy'. This type of forgery can be detected by showing that different inks have been used for different parts of the cheque.

- Write your name on a piece of paper using the magic pen and then use the eraser to erase half of it. Then look at the words under a) a low-power microscope and b) a UV lamp. Can you tell whether half the name has been erased?
- Then write your name using one black pen to write your first name and a different one for your surname. The two words can then be observed under both UV and IR light. Is it possible to tell that the two inks are different?
- On a piece of chromatography or filter paper, draw a horizontal line in pencil about 2cm up from the bottom edge. Then make some ink blobs using two or three different black inks. Suspend the paper in a beaker containing about 1cm depth of water by hanging it from the wooden splint using a paper clip. The paper

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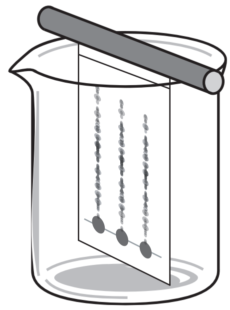
Student's Notes

should be left until the water has nearly soaked up to the top of the paper.



Hair and fibres

Hair is constantly being lost from our bodies, and the clothes we wear leave behind fibres. Criminals often leave behind hairs or fibres without realising.

- Make up a slide using one hair from your head and then use a microscope to look at your own hair and at each other's. Start with low magnification and then increase the magnification (although it may be difficult to get the higher magnification into focus). What differences are there? Look particularly for differences with different colours and with hair from different ethic origins.
- Now look at some prepared slides of different types of hair. Can you tell the difference between human and animal hair? What differences can you see in hair from different parts of the body?
- Look at the various types of fibre on prepared slides and see if you can identify differences. Start with low magnification and then increase the magnification. Also look at small pieces of different fabric and see how the fabric has been woven. Finally use clear sticky tape to lift fibres from your own clothing. By looking at the fibres, is it possible to tell which clothing it came from?

Chemical analysis

Chemical analysis is carried out in the toxicology department, which is often the busiest in the forensic chemistry laboratory. It includes analysing for illegal drugs and poisons.

- You will be shown how to test unknown substances to work out which chemicals they contain. Make a crib sheet of your results and then test some unknown chemicals and see if you can work out what they are.

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Blood

If a burglar cuts his or her hand while breaking into a house, he or she will probably leave traces of blood. At the scene of most violent murders, there is often a lot of blood. Blood can give the forensic scientist a lot of evidence.

- You will be provided with different stains that might be blood. Wipe a piece of filter paper on to the stain (if it is dry you will need to wet it with some distilled water) and add a few drops of hydrogen peroxide solution to the paper. Then add a few drops of phenolphthalein indicator. If the indicator turns pink, then the stain is blood.

In violent struggles where someone is wounded the blood can be sprayed all over the place and a forensic scientist will analyse the pattern of the splashes and the angles of drips to try to piece together what may have happened.

- Investigate what happens to the size and shape of a blood drop depending on the height that it falls from. Can you explain why the pattern of the splash changes depending on height? What information would this give a forensic scientist?

Pathology

In cases of suspicious death, a forensic pathologist is called to the scene. The body is not moved until the pathologist has examined it. The job of the pathologist at the scene of a death is to:

a) examine the position and condition of the body

b) examine the environment and local conditions.

One of the first questions that an investigating police officer asks the pathologist is when the victim died. The answer cannot be given exactly as a number of factors have to be taken into account, but the pathologist is usually able to give a range, for instance between four and six hours ago.

- What changes do you think will happen in a body after death?
- What factors will affect how quickly a body cools down?

86 Resource 1

Ten-print form

1. Right thumb	2. Right forefinger	3. Right middle	4. Right ring	5. Right little
6. Left thumb	7. Left forefinger	8. Left middle	9. Left ring	10. Left little

11. Left thumb	12. Right thumb
11. Left fingers	12. Right fingers

86 Resource 2

Cations		
Test	**Result**	**Conclusion**
Note colour of substance	Blue Pale green Yellow/brown	Possibly copper (II) Possibly iron (II) Possibly iron (III)
Sodium hydroxide test	White precipitate dissolves to colourless solution White precipitate (faint) which doesn't dissolve Pale blue precipitate, doesn't dissolve Grey/green precipitate, doesn't dissolve Brown precipitate, doesn't dissolve	aluminium, lead or zinc calcium copper (II) iron (II) iron (III)
Ammonium hydroxide test	White precipitate dissolves to colourless solution White precipitate, doesn't dissolve No precipitate Pale blue precipitate, dissolves to blue solution Grey/green precipitate, doesn't dissolve Brown precipitate, doesn't dissolve	zinc aluminium or lead calcium copper (II) iron (II) iron (III)
Testing for ammonium ions	Litmus paper turns blue	ammonium
Flame test	Lilac flame Orange flame Brick red flame Green/blue flame Ghostly blue flame	potassium sodium calcium copper (II) lead

Anions		
Test	**Result**	**Conclusion**
Add dilute hydrochloric acid to the solid	Fizzing	carbonate (prove gas is carbon dioxide by bubbling through limewater – turns cloudy)
Add silver nitrate solution to solution of substance	White precipitate Cream precipitate Yellow precipitate	chloride bromide iodide
Add concentrated sulphuric acid to the solid	Fuming gas Fuming gas turns orange Fuming gas turns purple	chloride bromide iodide
Add barium chloride solution to solution of substance	White precipitate	sulphate
Iron (II) chloride/conc. sulphuric acid test	Brown ring produced between the two layers	nitrate
Sodium hydroxide/ aluminium powder test.	Litmus paper turns blue	nitrate

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