scdi Scottish Council for Development and Industry

Young Engineers & Science Clubs Scotland

Investigating Forensics

Teacher's Pack

Contents

Overview of Forensic Science Information

This information pack contains the following:

- Forensic science information: This gives the teacher extra information about forensic science. It can be used as the basis of an introduction to the topic.
- A set of teacher's notes on each of the following topics:
    - Analysing Ink
    - Fibre Transfer
    - Fingerprint Analysis
    - Footwear Marks
    - Tyre Tread Impressions
    - Toxicology/Screening Tests

  These give extra information about the topic as well as how to set up the experiments.
- A set of experiment sheets for the pupils.
- A set of results sheets on which the pupils can collect their results.
- Options for different cases the pupils could solve having learnt the above techniques.

The aim of this information pack is to introduce the pupils to forensic science. It is proposed that this information pack contains enough material for at least 8 weeks work as follows:

- 1: Fingerprint Analysis
- 2: Fibre Transfer
- 3: Footwear Marks
- 4: Analysing Ink
- 5: Tyre Tread Impressions
- 6: Toxicology/Screening Tests

For the last two weeks, there are a few different options. It will depend on the resources available and numbers of pupils which of these is the most practical to use:

1. Week 7 – A crime scene has been set up for the pupils to investigate. They can try to identify and collect the evidence.
   Week 8 – The pupils can test the evidence they collected on the previous week and use this to solve the case.

2. Week 7 – A crime has been committed and evidence has been collected. The pupils can test this evidence to try and identify the suspect.
   Week 8 – The pupils can hold a mock court case to present the evidence as to why they think the suspect is guilty.

3. Two different crimes have been committed and the pupils can solve one of these each week.

What is Forensic Science?

Forensic science is science relating to the law. Science is used to examine pieces of evidence which have been recovered from a crime scene. It can be used to prove or disprove claims by suspects and to convict criminals.

Forensic science is underpinned by **Locard's principle**. Dr. Edmond Locard was one of the first forensic scientists in the early 1900s and wrote that:

> "There is no such thing as clean contact between two objects. When two bodies or objects come into contact, they mutually contaminate each other with minute fragments of material…….. The microscopic debris that covers all our clothing and bodies is the mute witness, sure and faithful of all our movements and all encounters."

This is simplified to **"every contact leaves a trace".** This means that all activity causes materials to be altered in some way or another. This alteration on contact is what is studied by forensic scientists to give information about the crime and suspects. In the fibre experiment information, the differences between primary and secondary contact are mentioned.

Forensic scientists give scientific support to the police service. There are two different types:

- **Scenes of crime officer** (SOCO) - A SOCO would search the crime scene and collect the evidence at a crime scene. These are the people in the white suits that children tend to think of when forensic scientists are mentioned.
- **Laboratory forensic scientist** - A laboratory forensic scientist would work in the lab testing the evidence that had been collected by the SOCO.

There are lots of different branches of forensic science for the scientists to specialise in. These include fire investigation, firearms, documents, drugs, explosives, toxicology, trace evidence (which includes glass, fibre, and paint analysis), and mark enhancement and identification (which includes fingerprints, footwear, and tool marks).

Scientific evidence is a chain that is only as strong as its weakest link. This means great care should be taken with the evidence. All the evidence must be stored correctly (different evidence will be stored in different ways) and should be clearly and correctly labelled with:

- Case title
- Type of sample
- The location from where the sample was recovered
- The date and time of recovery
- Dated signatures of every person who has handled the item

From the moment that the piece of evidence is discovered at a crime scene until it is used as an exhibit in court, its whereabouts must be accounted for. It is very important that there are no gaps in the evidence timeline as this would mean it could have been contaminated or tampered with and it would no longer be

evidence!!! In order to prevent this, forensic laboratories operate under very strict conditions called "**quality systems**". This allows people to trust the forensic scientists' results.

These results would be written up as a document called a court report. This would be lodged with the courts and used in the trial. The forensic scientist may or may not be called as a witness.

Laboratory Conditions in the Classroom

If chemicals have been required in any of the experiments, easily available common household substances have been used, e.g. sugar, bicarbonate of soda, vinegar. This makes the tests suitable to be carried out by younger children as it prevents the need for buying in chemicals and the increased associated safety precautions. However, reasonable care should still be taken.

While it would be unreasonable to suggest, that the pupils work under the very strict "**quality system**" conditions of a forensic laboratory, there is the opportunity to:

- Encourage the pupils to be very careful with the evidence, in order to not to damage it or contaminate it.
- Ensure they are very tidy when they are working. This prevents contaminations!
- Make sure they are writing down clearly what standard/sample is which so that the results don't get mixed up!
- For the case weeks, you could package the evidence and attach case labels to it. The pupils could then come and collect the evidence from you. When they collect it, they could sign (and time and date) the label to say they have received it. When they return it, you could sign the evidence back in.

1. What is a Fingerprint?

Skin is made up of different layers. The outer layer (the epidermis) of the hands and feet will have ridges which can be classified into specific patterns. When the skin touches a surface the sweat and oils from the skin transfer onto the surface in this ridge pattern leaving a fingerprint. This is called a latent fingerprint as it is invisible to the human eye. It is possible to have a visible fingerprint if the fingers are contaminated with e.g. dirt, cosmetics, blood etc.

Why do Suspects have their Fingerprints taken by the Police?

Everyone has fingerprints as they are formed before you are born. Every person's fingerprints are different – even identical twins have different fingerprints! By looking at the different patterns on the fingerprint, they can identify the person it belongs to.

Analysing Fingerprints in Forensics

There are different patterns that can be found in a human fingerprint. The three most common ones are shown in Figure 1. 60-65% of fingerprints contain a loop, 30-35% have a whorl and 5% contain an arch. These patterns are studied in forensics. The forensic scientist would compare the suspect's samples with a database of fingerprints.

Figure 1: Common patterns in fingerprints, from left to right, the loop, the whorl, the arch and the tented arch.

There are several different ways to detect fingerprints. These include using:

- Powders (e.g. carbon black, alumina) that stick to the fingerprints
- Different light sources
- Chemicals (e.g. cyanoacrylate fuming).

The powder sticks to the fingerprint and then is lifted to be analysed. The pupils are going to lift one from a glass, but instead of the above, they will be using cocoa powder!!! An example is shown in Figure 2 below.

Figure 2: A fingerprint on a glass that has been dusted with cocoa powder.

The Experiment

Overview:	In this experiment, the pupils will take their own fingerprints and lift a print from a glass. They will identify the common patterns found in fingerprints.
Aims:	1. To look at your own fingerprints to try and identify the patterns. 2. To lift a print from a glass.
Apparatus:	Non-permanent inkpad (water soluble)

	Water for washing hands Cocoa powder Small paint brush Tape A glass Paper A magnifying glass 1 experiment sheet per group A copy of the results sheet for each pupil
Method:	**Taking your own fingerprints:** A. Roll a finger from left to right on the inkpad. B. Transfer the fingerprint to the table below by placing the left hand side of the finger in the correct box on the paper and rolling your finger to the right. C. Make sure you then lift your finger straight off the paper to prevent smudging. D. Wash the ink off your finger. E. Repeat this for each finger and thumb on both hands. F. Looking at the fingerprints with the magnifying glass and comparing with the pattern sheets, try to identify the patterns on your fingerprints. Record your results in the tables
	Left Hand

Thumb/Finger	Pinkie	Ring	Middle	Pointer	Thumb
Fingerprint					
What patterns can you see?					

Right Hand

	Thumb	Pointer	Middle	Ring	Pinkie
Fingerprint					
What patterns can you see?					

Lifting a fingerprint:

In a real crime scene, the fingerprints would be lifted using different powders and chemicals. The powder sticks to the fingerprint and then is lifted to be analysed.

You are still going to lift a fingerprint, but instead you will be using cocoa powder!!!

1. Press your finger onto a clean, dry glass. Remember which finger you used! You should be able to see it but perhaps not make out the detail.
2. Dust the fingerprint with cocoa powder and then lightly brush off any excess.
3. Place the sticky side of the tape onto the dusted fingerprint and then lift it off and stick it onto the box below .
4. Get a friend to look at this fingerprint with a magnifying glass and compare this fingerprint with the tables to identify which fingerprint it is.
5. Swap over and try to identify their lifted fingerprint!

Dusted Fingerprint

2. Fibres

Fibres and hairs are one of the most common forms of evidence found as they are continuously shed. There are lots of different types of fibres and hair:

- **Natural** – from plants – e.g. cotton, jute; from animals – e.g. silk, wool
- **Man-made** – e.g. viscose, nylon, polyester.

Fibre Transfer

There are two different ways that fibres can be transferred:

- **Primary Transfer** – e.g. if someone sits on a chair, they will leave fibres from their clothes on the chair
- **Secondary Transfer** – e.g. after they leave, if someone else were to sit on the same chair, fibres from the first person's clothes would transfer from the chair to the second person.

However, all fibres transferred are fairly loose and so 90-95% would be lost within 24 hours

Analysing Fibres in Forensics

Items can be sampled for fibres using adhesive tape lifts. Fibre analysis is a complex area of forensics; examples include examining the fibres using different types of microscopy and dye analysis using chromatography.

The Experiment

Overview	In this experiment, the pupils will be carrying out a tapelift to collect any fibres that are stuck to an item of clothing and then look at the fibres
Aims:	To lift fibres from an item of clothing using tapelifts and then look at these fibres with a microscope
Apparatus:	Items of clothing (Note 1) Large sheet of white paper Clear tape Plastic sheets, e.g. acetates of a polypocket Microscope (Note 2) Ruler

	Access to computers 1 experiment sheet per group A copy of the results sheet for each pupil
	Note 1: The items of clothing should be old and worn (sometimes charity shops will have old ones that cannot be sold due to them being too worn/ripped) and have a mixture of fibres (e.g. loose threads, fluff) on it. They should be stored in a bag so the fibres do not come off.
	Note 2: To look at the fibres, it is best to use a microscope due to the increased magnification. If this is not available a magnifying glass can be used but less detail will be observed. If neither is available it is still worthwhile that the pupils have used tapelifts to collect fibres. In every case it would be worthwhile for the pupils to have a look on the internet at some magnified fibres (e.g. compare cotton, wool and nylon)
Method:	1. Place the item of clothing onto the large sheet of white paper. 2. Cut a 10 cm of tape and while holding it at the ends, starting at the top left lightly touch the tape to the cloth so any loose fibres will stick to the tape. Keep applying and lifting the tape all the way along the cloth. 3. Press the tape onto the plastic sheet. 4. Take another 10 cm of tape and repeat on another part of the clothing. Repeat until all the item of clothing has had tape on it. 5. Look at the tapelifts with the microscope or magnifying glass. Record your results. 6. Examine the item of clothing for any wear and tear, e.g. rips, missing buttons, broken zips etc. If you find anything, record this with your tapelift results.

3. Footwear Marks

When people walk they leave footwear marks because they distort the surface they are walking on. They generate static electricity which can lead to transfer of materials from the surface onto the shoe and vice-versa. There are several different types of marks:

- **2-dimensional** – the footwear mark is on a flat surface
- **3-dimensional** – the footwear leaves an impression e.g. on soil or snow

In this experiment, the pupils will be looking at 3-dimensional footwear marks like those shown in Figure 3.

Figure 3: Examples of 3-dimensional footwear marks. Note the square toe and heel on the first (left hand side), the random triangular pattern on the second, a wavy pattern on the third and a regular triangular pattern on the fourth. On examining these actual footwear marks, the name of the manufacturer can be clearly seen on the second and last footwear prints, as well as the size on the second footwear print.

Footwear marks can give the investigators lots of information about the suspect such as shoe size - by measuring the length and width of the mark (although this will not be 100% accurate)

- Estimations for the size of the suspect can also sometimes be made. This would depend on the condition of the soil and the depth of the footwear mark.
- The type of footwear – by comparison to a database
- How the suspect got to and from the crime scene – route, plus information about how they were walking/running by measuring the distance between the footwear marks.
- How many people were at the crime scene

Even if the type of footwear is identified, more evidence will be required to definitely confirm the footwear marks are from the suspect's shoes. However, as people walk differently, the shoes will wear differently. If signs of defects or wear that match the suspect's shoes are found on the footwear mark then this would be very strong evidence that the suspect has been at the crime scene.

The Experiment	
Overview:	In this experiment, the pupils will be looking at and making 3-dimensional footwear marks
Aims:	To measure and sketch footwear marks
Apparatus:	A seed tray of soil with a footwear mark in it. Other seed trays of soil to allow the pupils to make their own footwear marks Ruler Pencils Magnifying glass 1 experiment sheet per group A copy of the results sheet for each pupil
Method:	1. You will be provided with a footwear mark in a tray of soil. Without disturbing the soil measure length, width (at narrowest and widest points) and depth of the footwear mark. Record your results. 2. Look at the footwear mark to identify any patterns. Sketch the result. 3. Look closer at the footwear mark (you may wish to use a magnifying glass) to see if you can see any signs of defects or wear on the footwear. If these are present, then this makes the evidence stronger that the suspect shoe is the exact one you found at the crime scene. 4. Record your results. 5. Collect a fresh tray of soil. Put this on the floor and carefully stand in it with one shoe. Carefully step back out. Clean your shoe with a paper towel. 6. Measure and sketch your footwear mark as above and record your results

4. The Chemistry of Ink

Ink is made up of several different components, including different dyes and pigments as well as compounds to keep the ink soluble and to stop it drying out. The colour you get when you write with a pen depends on the dyes or the mixtures of the dyes. There are many different kinds of dyes that are all similar in colour. Also, a pen ink can look black, but it can actually be made up of different colours of dye. The colours in Figure 4 are all from black pens!

Figure 4: Colours found in black pens after carrying out paper chromatography on the ink.

By trying to compare the components of different inks, you can identify a brand of ink. This can be carried out using chromatography.

Chromatography

What is Chromatography?

Chromatography is a way of separating mixtures into the different components. The name chromatography comes from the Greek word for colour ('chromato') as it was first used to describe separation of coloured substances – but it is not limited to just coloured substances.

There are many different types of chromatography: paper chromatography, thin layer chromatography, column chromatography, liquid chromatography and gas chromatography. The simplest of these is paper chromatography

Paper Chromatography

In this experiment, you will be using paper chromatography. This is where the sample is put on some paper (the stationary phase) and then the bottom of the paper is put into a liquid (the mobile phase). A photo of this is shown in Figure 5 on the next page.

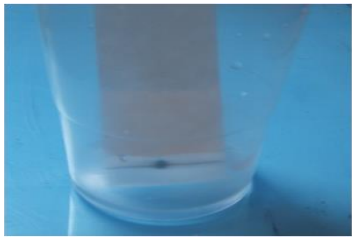


Figure 5: Photo of paper chromatography set up with the paper in the water. Note that the sample spot is above the level of the water.

The liquid will move up the paper. As it does so, the sample components will also move up the paper, but the different components will move at different rates. This depends on how much the components in the mixture are attracted to the mobile phase (liquid) and the stationary phase:

- If the component prefers the stationary phase rather than the mobile phase, the substance will move very slowly up the paper.
- If the component prefers the mobile phase rather than the stationary phase, the substance will move very fast up the paper.

Analysing Ink in Forensics

When documents or notes are suspected of being potentially fraudulent, the document would be called a "questioned document". An example of this could be a cheque with someone having altered the figures or name! To analyse the document, samples of the ink would be taken from the "real" part of the document and the "suspected fraudulent" part of the document. These would be analysed using chromatography to see whether the whole document was written with the same ink or not.

Or, there may be a document that they want to have more information about, for example, a written note. This ink could be analysed by chromatography. The results could then be compared with a database of inks to identify what ink was used.

The Experiment

Overview:	In this experiment, the pupils will be carrying out paper chromatography on the inks from various pens and comparing these to the ink used in a written note.
Aims:	To compare ink samples from various pens with a written note.
Apparatus:	Written note (see note 1) Scissors Pens from suspects (see note 2) Strips of filter paper or blotting paper or coffee filter (at least 2 cm wide and ideally about 10 cm long) Beaker or plastic cup Watch glass or circle of card Water Paperclips Pencils Ruler Coloured pencils 1 experiment sheet per group

	A copy of the results sheet for each pupil **Note 1**: The note should be written on whatever paper you are using (filter paper, blotting paper or coffee filter). It should be one line about 1 cm down the paper. Ideally, there should be about 9 cm of paper below this. By doing this, it makes it easier for analysis as the ink does not need to be extracted before analysis. Once you have shown the note to the class, cut strips about 2 cm wide, with writing at the top/bottom of it. **Note 2**: Water is being used as the mobile phase in this experiment. This means the majority of the ink should be water soluble so that the components separate. Ordinary non-permanent writing pens are usually water soluble. As a comparison, one permanent marker can be used. (This will remain as a dot at the bottom of the paper.) Try the experiment first before the pupils, to check the pen inks you have chosen give different results.
Method:	**Setting up the chromatography tank:** 1. Add some water to a level of about 0.5 cm to the beaker (or plastic cup) and put the watch glass (or circle of card) over it. **Analysing the note:** 1. Collect the piece of the note. 2. Put the strip of paper in the chromatography tank – making sure that the ink is not in the water, only the bottom of the note with no ink on it (see Figure 5). You might want to paperclip the note to the side of the beaker/cup to stop it falling into the water. 3. Watch the water rise up the paper and when this is about 1-2 cm from the top. Take the paper out of the water and draw a line, in pencil on it, to show how far the water travelled. 4. Leave this to dry. 5. Sketch the results onto your record sheet. **Analysing the reference sample ink:** You now need to do similar experiments with the ink from each suspect's pen in turn. 1. You will need to draw a line in pencil, about 1 cm from the bottom of the paper.

2. Then draw a dot from one of the pens in the middle of this line (see Figure 6).

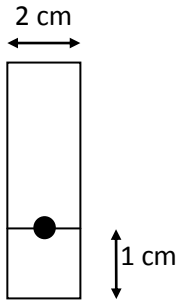


Figure 6: Diagram of the chromatography paper, with a sample spot on the pencil line.

3. Put the strip of paper into the chromatography tank – again making sure that the ink is not in the water.
4. Watch the water rise up the paper and take it out when this is about 1-2 cm from the top, marking in pencil how far the water travelled.
5. Try and leave all the samples for about the same amount of time so the water travels about the same distance up each paper. This makes it easier to compare them.
6. Leave this to dry.
7. Sketch the results onto your record sheet.

Compare the note and reference samples:

Compare all the reference samples with the note. Can you tell which one was used to write the note?

5. Tyre Tread Impressions

Tyre tread impressions (Figure 7) can be used to identify the type of tyre on a vehicle by comparison with a database of known tyre treads.

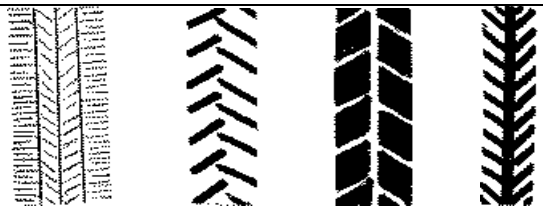


Figure 7: Tyre tread impressions (not to scale). These are from (from left to right) a car, a tractor, a toy car and a bicycle!!!

Confirming that a tread is from a specific tyre requires the identity of an individual characteristic. These can be caused by defects (e.g. from gravel or nails) and uneven wear of the tyre (e.g. from unbalanced tyres, bad wheel alignment or heavy braking). If these are identified then this would be very strong evidence that the car had been at the scene.

The Experiment

Overview:	In this experiment, the pupils will be comparing tyre treads. To prevent complicated logistics of using real tyres, toy cars are being used.
Aims:	To allow the students to compare tyre treads of several toy cars looking for identifying marks
Apparatus:	Several small toy car tyres (all labelled) A suspect tyre tread (Note 1) Non-permanent ink pad (water soluble) Paper towels (wet and dry) Access to computers 1 experiment sheet per group A copy of the results sheet for each pupil **Note 1**: Before the club starts, you should ink one of the tyres and provide this to the students as the suspect tyre tread. This can either be shown on an overhead/PowerPoint or as paper copies.

Method:	1. For each of the reference car tyres, roll one of the tyres in the ink. 2. Roll the inked tyre onto the results sheet from one side to the other, keeping a firm pressure on the tyre. Remember to keep a note of which tyre tread belongs to which tyre. 3. Clean the ink off the tyre with a damp paper towel and then dry the tyre with a paper towel. 4. Try to describe and draw each of the patterns. Note any defects or wear patterns. 5. Compare the reference tyre tracks with the given suspect tyre track. Can you identify which tyre it came from? Would you say whether it came from this make and model of tyre? Or, do you have enough identifying features to say that you think it is from this exact tyre? If you have time, you can also look on the internet at some car tyre treads

6. Toxicology

Toxicology is the study of poisons. A poison is a substance that is harmful to a living organism. There are lots of different poisons including metals, drugs, gases and medicines. In fact, Paracelsus (a famous physician) is quoted as having said "All substances are poisonous. There is none that is not a poison. The right dose differentiates a poison from a remedy."

People can obviously die from poisons but there can also be other symptoms. These can include diarrhoea, vomiting, thirst, cyanosis (blue lips), loss of hair and weight, convulsions. As different poisons accumulate in different parts of the body, many samples can be taken for testing. For example, samples would be taken of hair and liver for testing to see if there was metal poisoning.

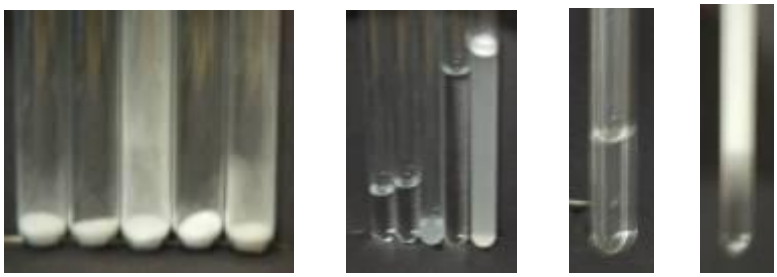
Analysing Poisons in Forensics

When testing for poisons it is common to carry out screening tests. These might involve testing the samples with chemicals to give colour changes. These are presumptive tests that establish either:

- The sample is definitely not a certain substance, or
- The sample could be a substance.

If these tests indicate that the sample could be a particular substance then further testing can be carried out. These would be more complex tests that would confirm the identity of the sample.

The Experiment	
Overview:	In this experiment, the pupils will be carrying out tests trying to replicate the nature of screening tests using readily available common household substances. This makes the tests suitable to be carried out by younger children as it prevents the need for buying in chemicals and the increased associated safety precautions. If you do have access to chemicals, you may wish to supplement the following with other tests, for example, the starch test. If this is the case, a COSHH form would have to be completed.
Aims:	To compare an unknown white powder with a range of standards
Apparatus:	Salt Sugar Icing Sugar Bicarbonate of soda Baking powder 6 containers with labels Standard 1, Standard 2, Standard 3, Standard 4, Standard 5, Unknown Sample (see Notes 1-3) Vinegar (see Note 1) Water Test tubes (7 per group) or if not available, small containers or plastic cups Spatulas for transferring the powders to the test tubes. Marker pen for labelling the test tubes 1 experiment sheet per group A copy of the results sheet for each pupil **Note 1**: The pupils should not know the identity of the standards – only the teacher should. The vinegar should be labelled Test Reagent. **Note 2**: The unknown sample can be chosen by the club leader, or different groups can have different unknowns. (There is only a very slight difference between the

	salt and sugar test.) **Note 3**: Photos of specimen results are shown in Figure 8 .  **Figure 8:** From left to right: A. Photograph of all the standards (left to right, salt, sugar, icing sugar, bicarbonate of soda, baking powder) B. After the solubility test C. After the vinegar reaction – no reaction (as expected for salt, sugar and icing sugar) D: After the vinegar reaction – rapid fizzing reaction for bicarbonate of soda. (Baking powder may fizz slightly).
Method:	**Visual Comparison:** 1. Taking each of the standards and samples in turn, look closely at each of the samples and record any important features in the table. Important features might include, e.g. colour, type (crystals or powder – if you are not sure what they look like see the photo in Figure 9 below).  **Figure 9**: A photo of crystals (on the left) and powder (on the right). 2. Compare the results of the standards and unknowns. Can you make any conclusions based on these tests? **Solubility:** 1. Label the test tubes Standard 1, Standard 2, Standard 3, Standard 4, Standard 5 and Unknown Sample.

2. Put a small spatula of the correct powder into the labelled tube. Try to put about the same amount of powder in each.
3. Slowly add water to each test tube, stopping once the powder has dissolved.
4. Compare the results of the standards. Did they all dissolve? Are they all clear? Which standard needed most water to dissolve? Which was least? Record the results in the table.
5. Compare the results of the standards with the unknowns. Can you make any conclusions based on these tests?
6. Empty out and wash the test tubes.

Reaction with the Test Reagent:

1. As before, label the test tubes Standard 1, Standard 2, Standard 3, Standard 4, Standard 5 and Unknown Sample.
2. Put a small spatula of the correct powder into the labelled tube. Try to put about the same amount of powder in each.
3. Add a small volume of water to each test tube (about 5 mL).
4. Making sure that there is lots of space in the test tube (to allow space in case it fizzes up); add 2 mL of the Test Reagent to each test tube.
5. If the solution fizzes, record the result in the table. If there is no fizzing, record the result as “no reaction”.

Identify the Unknown Powder

1. Look at all the results in the results table. There should now be only one standard that has all the same results as the Unknown Sample.

Results:

Standard/Sample	Visual	Solubility	Reaction with Test Reagent
Standard 1			
Standard 2			
Standard 3			
Standard 4			
Standard 5			
Unknown Sample			

	From the visual comparison I can say Unknown Sample is not: _____ _____ The Unknown Sample could be: _____ _____ From the solubility experiment I can say Unknown Sample is not: _____ _____ The Unknown Sample could be: _____ _____ From the reaction with the test reagent I can say Unknown Sample is not: _____ _____ The Unknown Sample could be _____ _____ **Conclusions:** The Unknown Sample is likely to be Standard_____. Further tests would have to be carried out to definitely confirm the results before this was taken to court.

7. Mock Cases

Care should be taken that the age of the children is taken into account when setting up the mock cases for the children to solve. There is a balance between trying to find a case to solve that is complex enough to keep their attention and interest, without scaring them. This is especially important if the crime scene is within the school grounds as the primary children will associate this as a "safe place" and you do not want them to think otherwise.

For these cases you might want to wear gloves so you do not contaminate the evidence. For health and safety, NON-latex gloves should be used.

At the end of the pupils' results worksheets, there is a case form with space for details of the case and a specimen table for the pupils to use to record their results. A new table should be used for each piece of evidence/test carried out. There is also a sheet of blank tables, so lots of time is not spent drawing tables and the pupils can get on with solving the case. Depending on how complex the case is, depends on how many of these extra worksheets are required.

Some options for cases

CASE STUDY 1

"Julie was off school yesterday. When she came back, she handed the absence note to her teacher, Miss Kemp. However, Miss Kemp didn't think Julie's Mum had written the note as the writing seemed to be too childish and she thought the note would be more detailed. The note only said "Dear Teacher, Julie was off sick yesterday. From Mrs Morris". Miss Kemp thought it must be one of the other children and then started to investigate."

Apparatus/setting up experiments:

See ink analysis experiment

Magnifying glass for comparing the handwriting

Evidence:

The note

Reference samples:

The pupil's pens

Sample writing from each pupil

CASE STUDY 2

Mrs Smith was working hard trying to finish her report cards. She was so busy; she worked all through her breaks and lunch hour, apart from making herself a coffee (black, three sugars). She didn't even stop for a biscuit! However, later that afternoon she ran out of the classroom in an awful rush. She was feeling really sick and spent the next hour in the staff toilets... Mrs Smith felt so bad she thought she better go home. Before she went, she went to collect the report cards so she could finish them later, but they had disappeared... The next day, some shredded paper was found in the playground, but they were covered in some kind of white powder."

Apparatus/setting up experiments:

See all the previous experiments.

The white powder should be bicarbonate of soda.

Evidence:

Coffee (Is this just ordinary coffee? Are there any fingerprints on the jar other that Mrs Smith's?)

Mug (Are there any fingerprints on the mug other that Mrs Smith's?)

Teaspoon (Are there any fingerprints on the teaspoon other that Mrs Smith's?)

Sugar bowl and contents (Is it sugar? Are there any fingerprints on the sugar bowl other that Mrs Smith's?)

Small table cloth from staff room (Check for fibres)

Shredded paper (Are these the report cards? Test the ink to see if these were written with Mrs Smith's pen.)

Footprint and bicycle tread near to the shredded paper

Reference samples:

Shoe prints from pupils

Fingerprints from pupils

Coffee

Sugar

Mrs Smith's pen

CASE STUDY 3

"When Mr Brown the janitor came into school today he found that the classroom door was lying open. He reported this to the head teacher who told Mr Brown to lock the door until the teacher, ADD IN TEACHER'S NAME arrived and then they could see if everything was ok. When ADD IN TEACHER'S NAME arrived, the door was opened and they found that HIS/HER mobile phone had been taken. HE/SHE knew that you had been studying forensics and so they sealed the room for you to carry out an investigation."

Apparatus/setting up experiments:

See any previous relevant experiments.

You also may want the pupils to sketch the classroom as the crime scene.

Depending on the room, other evidence can be planted, or perhaps certain objects can be moved from their usual locations.

Also, if the room is near an outside door, you may wish to have them search the entrance too, or perhaps if on the ground floor you could leave a window open and check the area outside the window to see if you can see any footwear marks.

Evidence:

Mobile phone case with fingerprint on it

Dusty footwear marks on the floor leading into the room (plus, out of the room or outside a window if on ground floor)

Handprint on the door

Fingerprints on the door handle (plus possibly on the window)

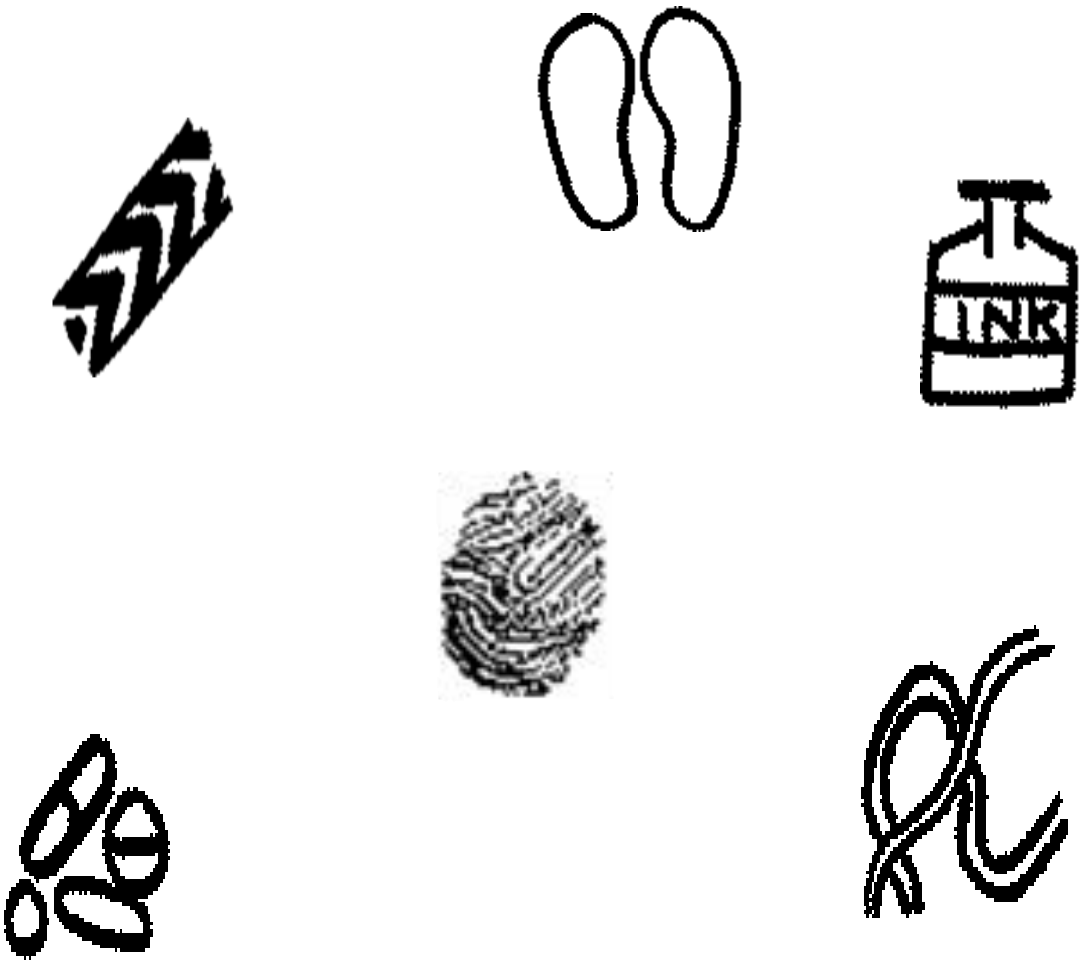
Depending on the room, other evidence can be planted, or perhaps the locations of certain objects can be moved.

Also, if the room is near an outside door, you may wish to have them search the entrance too.

Reference samples:

Fingerprints and footwear marks from the teacher and janitor to rule out any of their own fingerprints and footwear marks.

Investigating Forensics



Experiment Sheets

1. Fingerprints

In this experiment you will:

- Take your own Fingerprints
- Identify common fingerprint patterns in your fingerprints
- Lift a fingerprint from a glass

Taking your own fingerprints

1. Roll a finger from left to right on the inkpad.
2. Transfer the fingerprint to the results table by placing the left hand side of the finger in the correct box on the paper and rolling your finger to the right.
3. Make sure you then lift your finger straight off the paper to prevent smudging.
4. Wash the ink off your finger.
5. Repeat this for each finger and thumb on both hands.

Identify common fingerprint patterns in your own fingerprints

Look at the fingerprints with the magnifying glass to see if you can find any of these common fingerprint patterns (shown below). Record your results in the tables.

The Loop

The Whorl

The Arch

The Tented Arch

Lifting a fingerprint

In a real crime scene, the fingerprints would be lifted using different powders and chemicals. The powder sticks to the fingerprint and then is lifted to be analysed. You are still going to lift a fingerprint, but instead you will be using cocoa powder!!!

1. Press your finger onto a clean, dry glass. Remember which finger you used! You should be able to see it but perhaps not make out the detail.
2. Dust the fingerprint with cocoa powder and then lightly brush off any excess.
3. Place the sticky side of the tape onto the dusted fingerprint and then lift it off and stick it onto the box

below .

4. Get a friend to look at this fingerprint with a magnifying glass and compare this fingerprint with the tables to identify which fingerprint it is.
5. Swap over and try to identify their lifted fingerprint!

Fill in the questions in your results sheet.

2. Fibre Transfer

In this experiment you will…

- Collect fibres from an item of clothing using tapelifts
- Examine an item of clothing for wear and tear

Collecting fibres using tapelifts

1. Carefully place the item of clothing onto the large sheet of white paper.
2. Cut a 10 cm piece of tape and while holding it at the ends, starting at the top left lightly touch the tape to the cloth so any loose fibres will stick to the tape. Keep applying and lifting the tape all the way along the cloth.
3. Press the tape onto the plastic sheet.
4. Take another 10 cm pieceof tape and repeat on another part of the clothing. Repeat until all the item of clothing has had tape on it.
5. Look at the tapelifts with the microscope or magnifying glass. Record your results on your results sheet.

Examine the item of clothing further

1. Sketch outlines of the front and back of the item of clothing on your results sheet.
2. Examine the item of clothing for any wear and tear, e.g. rips, missing buttons, broken zips etc. If you find anything, record this on the sketches on your results sheet.

Fill in the questions in your results sheet.

3.Footwear Marks

In this experiment you will…

- Measure and sketch footwear marks
- Make your own footwear mark

Measuring and Sketching the Footwear Mark

1. You will be provided with a footwear mark in a tray of soil. Without disturbing the soil measure length, width (at narrowest and widest points) and depth of the footwear mark. Record your results on your results sheet.
2. Look at the footwear mark to identify any patterns. Sketch the footwear mark and these patterns on your results sheet.
3. Look closer at the footwear mark (you may wish to use a magnifying glass) to see if you can see any signs of defects or wear on the footwear. If these are present, record these on your results sheet.

If these defects or wear are also found on a suspect's shoe this would be strong evidence that the suspect had been at the crime scene.

Make your own Footwear Mark

1. Collect a fresh tray of soil. Put this on the floor and carefully stand in it with one shoe. Carefully step back out. Clean your shoe with a paper towel.
2. Measure and sketch your footwear mark as above and record your results on the results sheet. Compare this sketch with your own shoe. Are there any differences? Have you missed anything out?

Fill in the questions in your results sheet.

4.Ink Analysis

In this experiment you will…

- Use paper chromatography to compare ink samples with a written note.

Setting up the chromatography tank

1. Add some water to a level of about 0.5 cm to the beaker (or plastic cup) and put the watch glass (or circle of card) over it.

Analysing the note

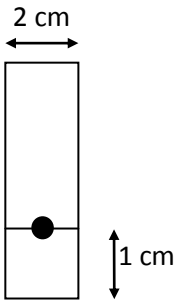
1. Collect the piece of the note.
2. Put the strip of paper in the chromatography tank (as in the photo). Make sure that the ink is not in the water, only the bottom of the note with no ink on it. You might also want to paperclip the note to the side of the beaker/cup to stop it falling into the water.

3. Watch the water rise up the paper and when this is about 1-2 cm from the top. Take the paper out of the water and draw a line, in pencil on it, to show how far the water travelled.
4. Leave this to dry.
5. Sketch the results onto your results sheet.

Analysing the reference sample ink

You now need to do similar experiments with the ink from each suspect's pen in turn.

1. You will need to draw a line in pencil, about 1 cm from the bottom of the paper.
2. Then draw a dot from one of the pens in the middle of this line, like in the diagram below.



3. Put the strip of paper into the chromatography tank – again you should make sure that the ink is not in the water and that you paperclip the paper to the side of the beaker/cup to stop it falling into the water.
4. Watch the water rise up the paper and take it out when this is about 1-2 cm from the top, marking in pencil how far the water travelled. (Try and leave all the samples for about the same amount of time so the water travels about the same distance up each paper. This makes it easier to compare them.)
5. Leave this to dry.
6. Sketch the results onto your record sheet.

Compare the note and reference samples

Compare all the reference samples with the note. Can you tell which one was used to write the note?

Fill in the questions in your results sheet

4. Tyre Tread Impressions

In this experiment you will…

- Compare tyre treads of several toy cars looking for identifying marks

Making Tyre Tread Marks

1. For each of the reference car tyres, roll one of the tyres in the ink.
2. Roll the inked tyre onto the table on the results sheet from one side to the other, keeping a firm pressure on the tyre. Remember to write in the table which tyre made this tyre tread mark.
3. Clean the ink off the tyre with a damp paper towel and then dry the tyre with a paper towel.
4. Do this for all the tyres.

Describing the Tyre Treads

1. Try to describe and draw each of the patterns, e.g. zig-zag, squares, wavy, lines. Record your descriptions in the results sheet.
2. Look for any defects or wear patterns. Record these on your results sheet.

Fill in the questions in your results sheet.

If you have time, you can also look on the internet at some car tyre treads.

6.Toxicology

In this experiment you will…

- Compare an unknown sample with a range of standard compounds

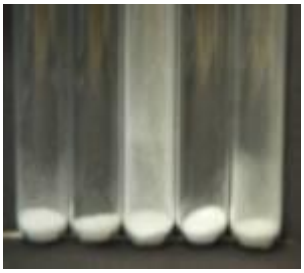
Visual Comparison

1. Taking each of the standards and samples in turn, look closely at each of the samples and record any important features in the table. Important features might include, e.g. colour, type (crystals or powder – if you are not sure what they look like see the photo below).

2. Record your results in the table in your results sheet and try to fill out the sentences about the results.

Solubility:

1. Label the test tubes Standard 1, Standard 2, Standard 3, Standard 4, Standard 5 and Unknown Sample.
2. Put a small spatula of the correct powder into the labelled tube. Try to put about the same amount of powder in each as in the picture below.



3. Slowly add water to each test tube, stopping once the powder has dissolved.
4. Compare the results of the standards. Did they all dissolve? Are they all clear? Which standard

needed most water to dissolve? Which was least?

5. Record the results in the table in your results sheet and try to fill out the sentences about the results.
6. Empty out and wash the test tubes.

Reaction with the Test Reagent

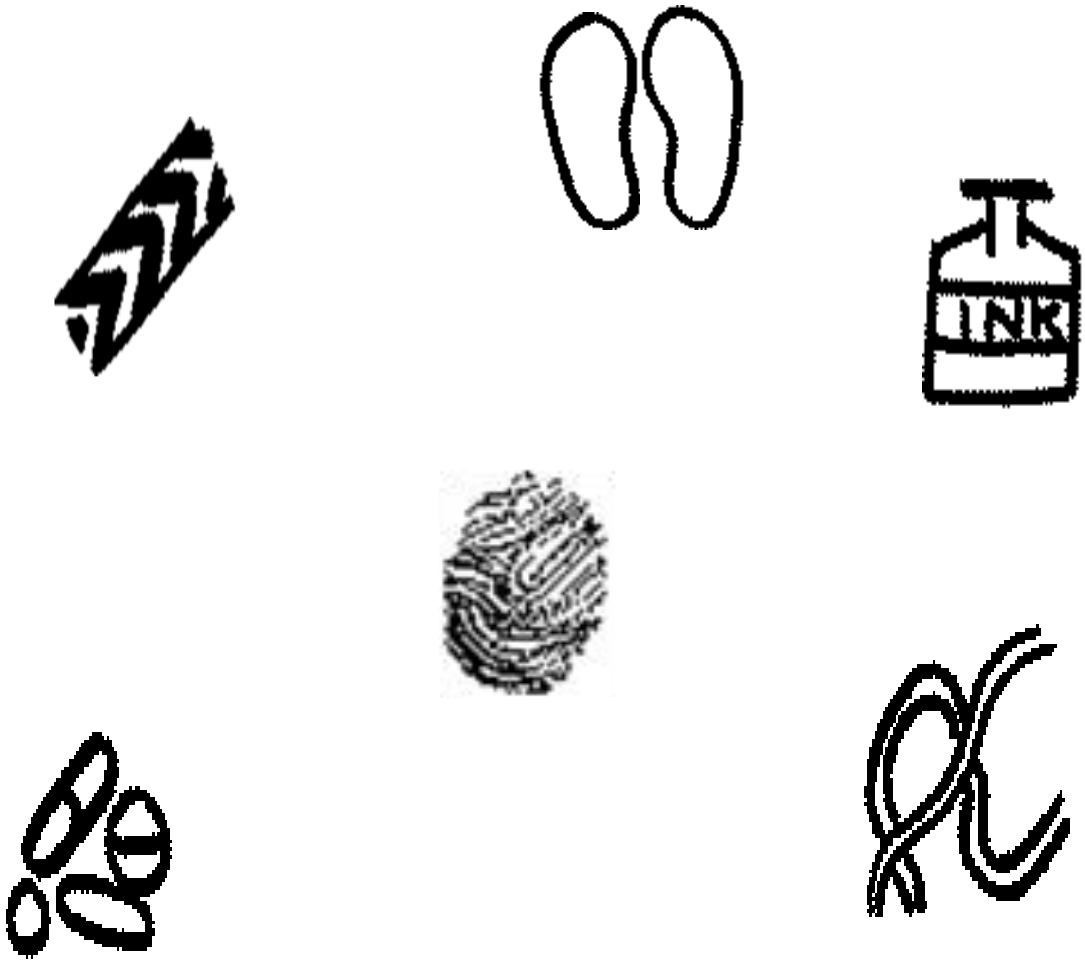
1. As before, label the test tubes Standard 1, Standard 2, Standard 3, Standard 4, Standard 5 and Unknown Sample.
2. Put a small spatula of the correct powder into the labelled tube. Try to put about the same amount of powder in each.
3. Add a small volume of water to each test tube (about 5 mL).
4. Making sure that there is lots of space in the test tube (to allow space in case it fizzes up); add 2 mL of the Test Reagent to each test tube.
5. If the solution fizzes, record the result in the table. If there is no fizzing, record the result as "no reaction". Try to fill out the sentences about the results.

Identify the Unknown Powder

1. Look at all the results in the results tables. There should now be only one standard that has all the same results as the Unknown Sample.

Fill in your conclusions on your results sheet.

Investigating Forensics



Result Sheets

1. Fingerprints

Did you know...?

- Everyone has fingerprints. They are formed before you are born.
- Every person's fingerprints are different – even identical twins have different fingerprints!
- By looking at the different patterns on the fingerprint, you can identify the person who it belongs to.

Follow the instructions on the experiment sheet to find out how to take your fingerprints.

Record your fingerprints in the tables.

How many of these common fingerprint patterns can you see on your fingerprints?

The Loop

The Whorl

The Arch

The Tented Arch

For each fingerprint, write in the tables what patterns you can see in the fingerprint.

Left Hand

Thumb/Finger	Pinkie	Ring	Middle	Pointer	Thumb
Fingerprint					
What patterns can you see?					

Right Hand

Thumb/Finger	Thumb	Pointer	Middle	Ring	Pinkie
Fingerprint					
What patterns can you see?					

Follow the experiment sheet to find out how to lift a fingerprint from a glass.

You might want to have a practice before taking the fingerprint to stick on this sheet.

Dusted Fingerprint

Get one of your friends to fill out the next sentence and to guess which finger you have used for the cocoa print!

_____(NAME) thinks this is my **THUMB / POINTER / MIDDLE/RING / PINKIE** finger on my

LEFT/RIGHT hand because it has _____patterns.

Are they correct? **Yes** / **No**

Which fingerprint was it? **THUMB / POINTER / MIDDLE / RING / PINKIE** Finger

RIGHT / LEFT Hand

2. Fibre Transfer

Did you know...?

- Everyone continually loses fibres from their clothes and hair every day without noticing them.
- This means fibres and hairs are one of the most common types of evidence found.

Follow the instructions on the experiment sheet to find out how to lift fibres from an item of clothing using tapelifts.

Looking at your tapelifts

Did you find any loose fibres on the tapelifts? **YES / NO**

How many? _____

Were they all the same? **YES / NO**

If they were not all the same, how many different types were there? _____

Describe the fibres, e.g. colours, lengths, types:

_____

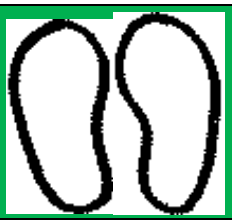
If you have looked at the fibres using a microscope or magnifying glass, draw a sketch of how they look in the space below:

Sketch an outline of the item of clothing in the boxes below:

Front of Item of Clothing	Back of Item of Clothing

Mark any wear and tear or damage on your drawings.

3.Footwear Marks



Did you know...?

- When people walk they leave footwear marks because they change the surface they are walking on.
- There are different types of footwear marks:
  - 2-dimensional – the footwear mark is on a flat surface
  - 3-dimensional – the footwear leaves an impression e.g. on soil or snow

Follow the instructions on the experiment sheet to find out how to measure and sketch the footwear marks.

Record your results in the table below:

Length/cm	
Width at widest point/cm	
Width at narrowest point/cm	
Depth/cm	

Sketch an outline of the footwear mark on the next page, using the ruler for the measurements. Then add the pattern. Are there any defects or wear? If so, mark these on your sketch.

You are now going to make and record your own footwear mark. Record your results below:

Length/cm	
Width at widest point/cm	
Width at narrowest point/cm	
Depth/cm	

Sketch your own footwear mark. Compare this sketch with your own shoe. Are there any differences? Have you missed anything out?

Sketch your own footwear mark

Compare the two Sketches

Are there any similarities?_____

Are there any differences?_____

4.Ink Analysis

Did you know...?

- Ink is made up of different dyes and pigments, e.g. all these colours were found in black ink!

- By separating these and looking at them, we can compare different inks to work out which ink was used to write a note.

Follow the instructions on the experiment sheet to find out how to compare ink samples from various pens with a written note.

What did the note say? _____

_____

Draw a sketch of how the note and the pen ink samples looked after paper chromatography

.

Which pen do you think wrote the note?_____

5. Tyre Tread Impressions

Did you know...?

- Different types of tyres leave different marks.
- By looking at these different marks, you can identify the type of tyre that made it.
- If there are any defects or wear marks, you can sometimes even identify the exact tyre!

Follow the instructions on the experiment sheet to find out how to compare tyre treads of several toy cars looking for identifying marks.

Record your results in the table below (continue on a blank sheet if required):

Tyre	Tyre Tread Marks and Descriptions
	Description:
	Description:
	Description:
	Description:

Can you identify which tyre is the suspect tyre? **YES / NO**. I think the suspect tyre is tyre _____.

Why? _____.

Would you say it was this make and model of tyre? Or, do you have enough identifying features to say that you think it is from this exact tyre? _____

6.Toxicology

Did you know...?

- Toxicology is the study of poisons.
- By testing an unknown sample and comparing the results with known standards you can identify the unknown sample.

Follow the instructions on the experiment sheet to find out how to compare an unknown white powder with a range of standards.

Describe how the different standards and unknown sample look (e.g. colour, crystals or powder, big or small crystals) and record these descriptions in the table below:

Standard/Sample	Description
Standard 1	
Standard 2	
Standard 3	
Standard 4	
Standard 5	
Unknown Sample	

From the visual comparison I can say Unknown Sample is not _____

_____.

The Unknown Sample could be _____

_____.

Carry out the solubility test and record the results (e.g. Did they all dissolve? Are they all clear? Which standard needed most water to dissolve? Which was least?) in the table below:

Standard/Sample	Description
Standard 1	
Standard 2	
Standard 3	
Standard 4	
Standard 5	
Unknown Sample	

From the solubility experiment I can say Unknown Sample is not _____

_____.

The Unknown Sample could be _____

_____.

Test the standards and unknown sample with the Test Reagent. Record what happens (e.g. no reaction, lots of fizzing, some fizzing) in the table below:

Standard/Sample	Description
Standard 1	
Standard 2	
Standard 3	
Standard 4	
Standard 5	
Unknown Sample	

From the reaction with the Test Reagent I can say Unknown Sample is not _____

_____.

The Unknown Sample could be _____

Conlcusions

Using all the results, I think the Unknown Sample is likely to be Standard____.

Further tests would have to be carried out to definitely confirm the results before this was taken to court.

7.The Case

Details of the Case:

ADD IN CASE DETAILS HERE

Use all the different forensic techniques you have learnt over the last few weeks to examine the evidence and try to solve the crime. For each piece of evidence/test carried out, record your results in a separate table.

Type of evidence/ Evidence number	
Test carried out	
Description of the results	
Conclusions	

Type of evidence/ Evidence number	
Test carried out	
Description of the results	
Conclusions	

Type of evidence/ Evidence number	
Test carried out	
Description of the results	
Conclusions	

Type of evidence/ Evidence number	
Test carried out	
Description of the results	
Conclusions	