Chemistry at the crime scene

Contents

Guidance notes

This 'forensic day' activity should take approximately four to five hours to complete in full. It was initially created for 11–14 year-old learners but can be adapted to suit other age groups.

Download the PowerPoint presentation, technician notes, student workbook and station instruction sheets that accompany this resource at rsc.li/3cjwcx9.

The activity requires learners to analyse several items of evidence collected at a fictional, local crime scene. The resources, produced by Liverpool John Moores University (LJMU), can be adapted to reflect a scene local to the users.

The technician notes list the evidence that needs to be provided for each pair of learners, along with the reagents and equipment needed for the tests.

Read our health & safety guidance, available from rsc.li/3IAmFA0, and carry out a risk assessment before running any live practical. Use the specific safety notes for the practicals included in this workshop to guide you.

The safety equipment suggested is in line with CLEAPSS requirements. For non-hazardous substances, wearing lab coats can help to protect clothes. The safety rules might be different where you live so it is worth checking local and school guidance.

Station 4 involves the use of animal blood. Make learners aware of this before they start the practical and give them the option to avoid handling the clothing at that station. Any learners who do not wish to handle the clothing could collect the observations gathered from another group. This presents a good opportunity to discuss with the learners how forensic teams work with each other and the police to gather evidence when trying to solve crimes.

Acknowledgements

This resource was originally developed by Liverpool John Moores University to support outreach work delivered as part of the Chemistry for All project.

To find out more about the project, and get more resources to help widen participation, visit our Outreach resources hub: rsc.li/3CJX7M3

If the use of animal blood is not a suitable option, an alternative 'blood mixture' may be prepared using corn syrup, water, red food colouring and catalase (from liver, potato or horseradish), or an inorganic catalyst (such as manganese dioxide, potassium iodide, copper nitrate or ferric oxide).

Use the PowerPoint to introduce the background to the crime that has been committed and the two suspects arrested on suspicion of the crime.

Arrange the activity using six stations, one for each section of evidence collected, for learners to circulate around. Laminating the station instruction sheets means that only one of these is needed at each station.

The student workbook leads learners through the forensic analysis of the evidence presented at each station, encouraging them to record their observations and conclusions at each station. Learners should make a conclusion as to which of the suspects is guilty of the crime and how they can use their evidence to support this conclusion. The glossary sheet included in the student workbook may be useful for any learners who are unsure about some of the terminology used. Use the key terms quiz at the end of the workbook to assess learners' recall of some of the techniques used.

Learners should demonstrate precautions such as those that a crime scene investigator would take to avoid contamination of the evidence. This includes wearing safety glasses, gloves and a buttoned-up lab coat, when appropriate, and filling in an evidence continuity label on each evidence bag.

Learning objective

By the end of this session, learners should be able to:

- Analyse observations to reach a conclusion.

Career links

Ask learners to reflect on the career of a forensic scientist and the skills and knowledge needed for this in relation to their own interests.

Forensic scientist

Introduce learners to the skills used in the career of forensic scientists with **slide 3** of the PowerPoint. Meet Joni, a forensic scientist, whose role involves investigating biological samples and evidence seized by the police for the presence of controlled drugs or a possible cause of death. Her video job profile is available at rsc.li/42bLYQa.

Advanced apprentice, occupation drug testing laboratory

Slide 6 of the PowerPoint introduces learners to the option of an apprenticeship in forensics. Jamie, an apprentice at an occupation drug testing laboratory, works alongside scientists to deliver a service to support the criminal justice system. Find out more at rsc.li/42fo3zh.

Forensic toxicologist

Using **slide 13**, watch Calum's video job profile (also available at rsc.li/42ciCBd). He is a forensic toxicologist and helps to ensure public safety through the toxicological testing of everyday items such as food, cosmetics, electronics, medicines and textiles to make sure they are safe to use and consume.

After going through the final answers on **slides 16–19** of the PowerPoint, you could discuss other careers in forensic science that make use of some of the skills the learners have practised during this activity.

Assistant analyst, drug control centre

Use **slide 20** to introduce learners to Nicola, an assistant analyst at a drug control centre. She used chemical analysis techniques and instruments to test for the presences of drugs and banned substances in the body fluids of athletes during the London 2012 Olympic Games. Her job profile is also available from rsc.li/408Uuh3.

Evidence analysis stations

Station 1: screwdriver cast

The cast of marks made around the lock of the victim's back door (**EV1**) showed that someone used a screwdriver to break in.

The police found two screwdrivers in Suspect 1's shed – one was a flathead screwdriver (**EV2**) and one was a crosshead screwdriver (**EV3**). The police also found one flathead screwdriver (**EV4**) in Suspect 2's dishwasher.

Learners should compare the screwdriver cast (**EV1**) with the photos of the suspects' screwdrivers (**EV2**, **EV3** and **EV4**). (These photos will need to be taken and printed off in advance of the lesson.)

Learners should record their observations and answers to the questions provided in their student workbooks.

Answers

Learners should match the imprint seen in the screwdriver cast (**EV1**) with the appearance of the flathead screwdriver found in Suspect 2's dishwasher (**EV4**). They should therefore link Suspect 2 to the screwdriver that was used to break open the victim's back door.

Station 2: fingerprints

Aluminium powder fingerprint lifts were taken from the victim's back door (**EV5**) and from the handle of a baseball bat (**EV6**) which was found in the garden of 20 Chestnut Road.

Provide learners with these two fingerprint lifts, along with a ten-print fingerprint card taken from Suspect 1 (**EV7**) and a ten-print fingerprint card taken from Suspect 2 (**EV8**). Make the fingerprint lifts and cards prior to the session (see technician notes).

Learners should use the magnifying glass/fingerprint magnifier to compare the aluminium fingerprint lifts and the fingerprint cards from Suspect 1 and Suspect 2. They should use the guidance in the instruction sheet and record their observations in their student workbooks.

Answer

Using their observations, learners should conclude that the fingerprints lifted from the back door (**EV5**) and from the baseball bat (**EV6**) match the prints provided by Suspect 2 (**EV8**).

Station 3: white powder

During their investigation, the forensic scientist found white powder with an unknown identity (**EV9**) on one of the kitchen surfaces in the victim's house.

When the police searched each of the suspects, they found similar bags of white powder on them. The white powder found on Suspect 1 is labelled **EV10** and the white powder found on Suspect 2 is labelled **EV11**.

In this activity, learners will use flame tests to determine whether the white powder found on either of the suspects was the same as the powder found in the victim's house.

Tell the learners the three white powders have been dissolved in water to form the solutions they are testing.

The learners will place splints that have been pre-soaked in each of the three solutions into a blue Bunsen burner flame and record the colours of the flames produced in their student workbooks.

They will compare the flame colours seen with the reference colours provided on **slide 14** of the PowerPoint to determine the identities of the metals in the solutions they test.

Answers

Solution tested	Colour of flame observed	Metal present in the solution
EV9 (made from the white powder at the victim's house)	red	lithium
EV10 (made from the white powder found on Suspect 1)	yellow/orange	sodium
EV11 (made from the white powder found on Suspect 1)	lilac/purple	potassium

From their observations, learners should observe that the white powder found at the victim's house did not match the white powder found on either of the suspects.

Use this to show learners that not all evidence will be useful in solving crimes or identifying suspects, but the police must follow the process of investigation to reach this conclusion.

Station 4: bloodstained clothing

Chemical tests are often used to detect or confirm the presence of blood.

Station 4 involves the use of animal blood. Make learners aware of this before they start the practical and give them the option to avoid handling the clothing at that station. Any learners who do not wish to handle the clothing could collect the observations gathered from another group. This presents a good opportunity to discuss with the learners how forensic teams work with each other and the police to gather evidence when trying to solve crimes.

If the use of animal blood is not a suitable option, an alternative 'blood mixture' may be prepared using corn syrup, water, red food colouring and catalase (from liver, potato or horseradish), or an inorganic catalyst (such as manganese dioxide, potassium iodide, copper nitrate or ferric oxide). The method for this can be found in the technician notes.

In this activity, learners carry out the Kastle–Meyer (KM) test on a swab taken from the baseball bat found in the garden of a house in a street near to the victim's house (**EV13**), clothing from the victim (**EV12**), clothing from Suspect 1 (**EV14**) and clothing from Suspect 2 (**EV15**).

Learners may need support with this activity as it should be completed using a fume cupboard/fume hood, if available. If a fume hood is not available, set up this station in a well-ventilated area.

Answers

By comparing the observations from the baseball bat swab (**EV13**) with the swabs taken from the three samples of clothing (**EV12**, **EV14** and **EV15**), learners should conclude that there was the same blood present on the baseball bat and on both the victim's clothing and Suspect 2's clothing.

Station 5: hair samples

In this activity, learners will be provided with three pre-mounted hair samples to examine under the microscope. One is a hair sample taken from the victim's clothing (**EV16**), one is a hair sample taken from Suspect 1 (**EV17**) and the third is a hair sample taken from Suspect 2 (**EV18**).

Learners will record their observations in their student workbooks and should be able to use these observations to match the hair sample taken from the victim with that taken from one of the suspects.

Depending on time and interest, this can be made more or less challenging. For example, to reduce the challenge, the hairs used should be obviously different in colour and texture, or, to increase the challenge, the hairs used could be of similar colour but have different textures or pattern of scales.

Answer

Learners should be able to use their observations to match the hair sample found on the victim (**EV16**) with that taken from Suspect 2 (**EV18**).

Station 6: fibre samples

In this activity, provide the learners with three sets of fibres to examine under the microscope. One set is from the victim's clothing (**EV19**), one set is from Suspect 1's clothing (**EV20**) and the third set is from the Suspect 2's clothing (**EV21**).

Learners will record their observations in their student workbooks and compare the three sets of fibres with each other, along with photographs of reference fibres, to try to identify the types of fibres present and match the fibres found on the victim to those in the clothing of one of the suspects.

The station instruction sheet provides an overview of three types of fibres and their identifiable features. Learners can use this sheet to identify the type of fibre present.

Answer

The fibres found on the victim's clothing (**EV19**) should match those taken from Suspect 2's clothing (**EV21**).

Drawing conclusions

In the conclusions section of the student workbook, the learners should analyse their observations from each of the six evidence stations to reach a conclusion about which of the two suspects is more likely to have committed the crime.

Learners fill in their overall conclusions in the summary case sheet page of their student workbooks.

You could stage a case meeting, giving one learner from each pair the role of 'expert' in one type of test.

Run the key terms quiz with each pair of learners completing a single sheet and competing with other pairs.

Answers

The conclusions from each of the six stations should lead learners to the conclusion that Suspect 2 is more likely to have committed the crime than Suspect 1.

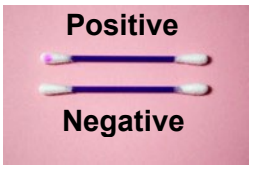
The cause of death was blunt force trauma to the head using the baseball bat found in the garden of a nearby property.

Glossary

Learners are provided with this list of key words at the back of their student workbooks.

Analyse	to study or examine something carefully in a methodical way
Autopsy	an examination and dissection of a dead body to determine cause of death
Comparable	two or more samples that can be likened to each other
Cortex	the outer layer of a hair or fibre
Cuticle	the root of the hair
Dissection	cutting to separate into pieces
Erode	to gradually destroy or wear away over time
Follicle	a tiny hole in the skin from which a hair grows
Forensic pathologist	a scientist who uses medical knowledge for legal purposes
Forensic scientist	a scientist who uses scientific evidence for legal purposes
Fume hood	a contained area which ventilates and removes hazardous or toxic fumes, vapours or dust
Irregularity	a feature that is different to the norm
Kastle–Meyer test	a test used to confirm the presence of haemoglobin in the identification of blood
Luminol	a chemical that glows blue in the presence of certain chemicals including haemoglobin in the blood
Microscopic	an object that is very small and can be seen only through a microscope
Mortuary	a room in which dead bodies are kept for examination until they are buried or cremated
Mounting medium	a mounting medium holds the sample in place between the coverslip and the slide
Perpetrator	a person who commits a crime
Solvent	a liquid that can dissolve other substances
Tamper	to interfere with and change evidence
Trauma	physical injury

Key terms quiz answers

Evidence bag	 © Daniela Staerk/Shutterstock	a paper or plastic bag containing evidence from a crime scene; the bag labels the item and details the chain of custody
Kastle–Meyer test		a small, flat, rectangular piece of glass on which specimens can be mounted for microscopic study
Hair cuticle	 © Bruno Rodrigues B Silva/Shutterstock	a hard layer of overlapping cells which forms the outermost part of a hair shaft
Corrosive	 © Douglas Sacha/Getty Images	a ceramic or plastic tile with 12 cavities or ‘wells’, used for low volume reactions involving a colour change
Pipette	 © Peter Sobolev/Shutterstock	the warning sign used for a substance with the power to cause irreversible damage or destroy another substance by contact
Microscope slide	 © Rost9/Shutterstock	a glass or plastic tube with a suction bulb, used for the transfer of small volumes of liquids
Spotting tile	 © CI Photos/Shutterstock	a chemical test, commonly used by forensic crime labs in the chemical identification of blood; a pink swab shows a positive result