Student workbook

Chemistry at the crime scene

Name: _____

Date: _____

Investigation team: _____

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

Contents

Learning objective and background

By the end of this session, you will be able to:

- Analyse observations to reach a conclusion.

In this session, you will be using some of the same skills that forensic scientists use to discover which of the two suspects is the most likely to have committed the murder of Mr A Deal on 20 March 2017.

Working in pairs or small groups, you will work your way around the six evidence stations. You will analyse the evidence at each station and keep notes of your observations in this Student workbook.

Once you have visited all six evidence stations, you will draw together your observations to make conclusions about what happened and who was responsible.

Career link

Forensic scientist

Forensic scientists, such as Joni, analyse a range of different types of evidence at crime scenes to help the criminal justice system in the prosecution of criminals or defence of suspected criminals. Watch Joni's video job profile on **slide 3** or at rsc.li/42bLYQa.

Safety

As you will be completing your investigations in the same way as forensic scientists do, you must wear goggles, gloves and a buttoned-up lab coat, where appropriate, to avoid contaminating any of the evidence. Take note of any hazard symbols and risks too.

Station 1: screwdriver cast

Evidence

- **EV1** Screwdriver cast taken from the victim's back door
- **EV2** Photo of flathead screwdriver taken from Suspect 1's shed
- **EV3** Photo of crosshead screwdriver taken from Suspect 1's shed
- **EV4** Photo of flathead screwdriver taken from Suspect 2's dishwasher

Safety

No risks.

To do

1. Take the evidence into your custody and fill in the chain of custody/continuity on the evidence bags. Open the evidence bag.
2. Follow the instructions on the laminated sheet at station 1.
3. Record all observations and findings in the table below. Sketch the screwdriver cast markings and screwdrivers. Include measurements and any specific markings.
4. Once analysis is complete, seal the evidence back into the evidence bags using evidence tape.

Evidence	Observations
EV1 Screwdriver cast taken from the victim's back door	
EV2 Photo of flathead screwdriver taken from Suspect 1's shed	

Evidence	Observations
EV3 Photo of crosshead screwdriver taken from Suspect 1's shed	
EV4 Photo of flathead screwdriver taken from Suspect 2's dishwasher	

To answer

(a) Which screwdriver may have been used to open the door?

(b) What is your evidence for this?

(c) Does this provide enough information to conclude who committed the crime? Explain your answer.

Station 2: fingerprints

Evidence

- **EV5** Aluminium powder fingerprint lift taken from the victim's back door
- **EV6** Aluminium powder fingerprint lift taken from the handle of the baseball bat found in the garden of a house in the street near to the victim's house
- **EV7** Ten-print fingerprint card from Suspect 1
- **EV8** Ten-print fingerprint card from Suspect 2

Safety

Aluminium powder is flammable so keep it away from flames.

To do

1. Take the evidence into your custody and fill in the chain of custody/continuity on the evidence bags. Open the evidence bag.
2. Follow the instructions on the laminated sheet at station 2.
3. Record all observations and findings in the table below.
4. Once analysis is complete, seal the evidence back into the evidence bags using evidence tape.

Evidence	Pattern – level 1	Detail – level 2
EV5 Fingerprints taken from the victim's back door		
EV6 Fingerprints taken from the handle of the baseball bat		

Evidence	Pattern – level 1	Detail – level 2
EV7 Ten-print fingerprint card from Suspect 1		
EV8 Ten-print fingerprint card from Suspect 2		

To answer

(a) Can you match the print to either of the suspects?

(b) Which finger does the print come from?

(c) Is your evidence *conclusive*? Explain your answer.

Station 3: white powder

A flame test shows the characteristic colour of a metal salt. It is used to find the identity of an unknown metal or metal ion.

The heat of a flame excites the electrons of the metal ions. The ions emit visible light. Different metals give different colours to the flame.

During their investigation, the forensic scientists found a bag of unidentified white powder on one of the kitchen surfaces in the victim's house (EV9), which they suspect may contain lithium.

The police found similar bags of white powder on Suspect 1 (EV10) and Suspect 2 (EV11).

Each of the metal powders has been dissolved in water to produce a solution.

You will conduct flame tests on these solutions to identify the metal present in the white powder found in the victim's house and on each of the two suspects.

Career link

Forensic scientist apprentice

Jamie works alongside scientists at drug testing laboratories to analyse and identify powders to provide evidence to support the criminal justice system when prosecuting or defending suspects. Find out more about his job at rsc.li/42fo3zh.

Evidence

- **EV9** Solution containing the white powder from the victim's house dissolved in water
- **EV10** Solution containing the white powder found on Suspect 1 dissolved in water
- **EV11** Solution containing the white powder found on Suspect 2 dissolved in water

Safety

Wear eye protection and a buttoned-up lab coat, if instructed, to protect your clothes.

Make sure that the Bunsen burner is on the yellow flame when it is not in use.

To do

1. Follow the instructions on the laminated sheet at station 3.
2. Record all observations and findings in the table below.

Evidence	Flame colour produced
EV9 White powder taken from the victim's house	
EV10 White powder found on Suspect 1	
EV11 White powder found on Suspect 2	

To answer

(a) What metals were present in substances **EV9**, **EV10** and **EV11**?

i. **EV9** _____

ii. **EV10** _____

iii. **EV11** _____

(b) Was the powder obtained from the victim's house the same as that found on either Suspect 1 or Suspect 2? Explain your answer.

_____

_____

_____

_____

(c) Can you use these findings to make a conclusion about the identity of the suspect who committed the crime? Explain your answer.

_____

_____

_____

_____

Station 4: bloodstained clothing

- **EV12** Victim's clothing thought to be bloodstained
- **EV13** Paper swab of red substance taken from the edge of the baseball bat found in the garden of a house in the street near to the victim's house
- **EV14** Suspect 1's clothing thought to be bloodstained
- **EV15** Suspect 2's clothing thought to be bloodstained

Safety

Wear safety googles and take care not to spill the solutions as both Kastle–Meyer test solution and hydrogen peroxide are irritating to the eyes. Kastle–Meyer test solution is also corrosive and can cause irritation to the skin.

To do

1. Take the evidence into your custody and fill in the chain of custody/continuity on the evidence bags. Open the evidence bag.
2. Follow the instructions on the laminated sheet at station 4.
3. Record all observations and findings in the table below.
4. Once analysis is complete, seal the evidence back into the evidence bags using evidence tape.

Blood swab taken from …	Is it blood?
EV12 Victim's clothing	
EV13 Baseball bat swab	
EV14 Suspect 1's clothing	
EV15 Suspect 2's clothing	

To answer

(a) Is the red substance on the baseball bat blood? How did you know?

(b) Did the victim or either of the suspects have blood on their clothing? How did you know?

(c) What are your conclusions? How do you know?

Career link

Forensic toxicologist

Watch Calum's video job profile on **slide 13** (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.

Station 5: hair samples

Evidence

- **EV16** Hairs collected from victim's clothing
- **EV17** Hair taken from Suspect 1's clothing
- **EV18** Hair taken from Suspect 2's clothing

To do

1. Take the evidence into your custody and fill in the chain of custody/continuity on the evidence bags. Open the evidence bag.
2. Follow the instructions on the laminated sheet at station 5.
3. Record all observations and sketches in the table below.
4. Once analysis is complete, seal the evidence back into the evidence bags using evidence tape.

Evidence	Observations
EV16 Hair taken from victim's clothing	
EV17 Hair taken from Suspect 1's clothing	
EV18 Hair taken from Suspect 2's clothing	

To answer

(a) Did the hair on the victim come from Suspect 1 or Suspect 2?

_____

(b) What features of the hair helped you to make any match?

_____

_____

_____

_____

Station 6: fibre samples

Evidence

- **EV19** Fibres collected from victim's clothing
- **EV20** Fibres collected from Suspect 1's clothing
- **EV21** Fibres collected from Suspect 2's clothing

To do

1. Take the evidence into your custody and fill in the chain of custody/continuity on the evidence bags. Open the evidence bag.
2. Follow the instructions on the laminated sheet at station 5.
3. Record all observations and sketches in the table below.
4. Once analysis is complete, seal the evidence back into the evidence bags using evidence tape.

Evidence	Observations
EV19 Fibres taken from victim's clothing	
EV20 Fibres taken from Suspect 1's clothing	
EV21 Fibres taken from Suspect 2's clothing	

To answer

(a) Did the fibres on the victim come from Suspect 1 or Suspect 2?

(b) What features of the fibres helped you to make any match?

Conclusions

Now you are going to analyse your evidence and draw some conclusions about who is the more likely of the two suspects to have committed the crime and what the circumstances surrounding the crime were.

Use your findings from each of the six evidence stations to complete the following table.

Evidence	Conclusions
EV1 Screwdriver cast	Which screwdriver matches that used in the cast?
EV5 Fingerprints taken from the victim's back door	Which of the two suspects' fingerprints match those taken from the victim's back door?
EV6 Fingerprints taken from the handle of the baseball bat	Which of the two suspect's fingerprints match those taken from the baseball bat?
EV9 White powder taken from the victim's house	Does the white powder match that found on either suspect?
EV12 Victim's clothing	Is blood present on the victim's clothing?
EV13 Baseball bat handle	Is blood present on the baseball bat?
EV14 Suspect 1's clothing	Is blood present on Suspect 1's clothing?
EV15 Suspect 2's clothing	Is blood present on Suspect 2's clothing?
EV16 Hairs from victim's clothing	Whose hair was found on the victim's clothing?
EV17 Hair from Suspect 1	Do the hairs on Suspect 1 match **EV16**?

Evidence	Conclusions
EV18 Hair from Suspect 2	Do the hairs on Suspect 2 match **EV16**?
EV19 Fibres from the victim's clothing	What type of fibres were found on the victim's clothing?
EV20 Fibres from clothing of Suspect 1	What type of fibres were found on Suspect 1's clothing? Did they match **EV19**?
EV21 Fibres from clothing of Suspect 2	What type of fibres were found on Suspect 2's clothing? Did they match **EV19**?

Career link

Assistant analyst, drug control centre

Nicola is 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 on **slide 20** and available from rsc.li/408Uuh3.

Case summary sheet

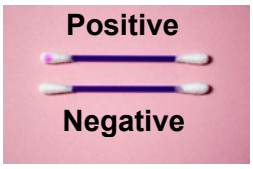
Using your analysis of the evidence, summarise your conclusions in the table below.

Reflect on any notes you made, and feel are relevant, from your investigation.

Who, in your opinion, is more likely to be responsible for the murder of Mr A Deal? *How do you know?* *Can you justify your answer?*	
How was Mr A Deal murdered? *How do you know?* *Can you justify your answer?*	
What was the motive of the killer? *Can you think of any reason the suspect might have murdered Mr A Deal?* *Do you have enough information to decide?*	

Key terms quiz

Draw lines to match each of the key terms in the first column below to its corresponding picture in the second column and definition in the third column. One has been done for you.

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

Glossary

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