Chemistry at the   
crime scene

Name: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Date: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Investigation team: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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

Note: all hazard symbol images are © Shutterstock.

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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.

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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](https://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

1. Which screwdriver may have been used to open the door?
2. What is your evidence for this?
3. 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

1. Can you match the print to either of the suspects?
2. Which finger does the print come from?
3. 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.

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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](https://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

1. What metals were present in substances **EV9**, **EV10** and **EV11**?
2. **EV9 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
3. **EV10 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
4. **EV11 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
5. Was the powder obtained from the victim’s house the same as that found on either Suspect 1 or Suspect 2? Explain your answer.
6. 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

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Evidence

* **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’sclothing 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

1. Is the red substance on the baseball bat blood? How did you know?
2. Did the victim or either of the suspects have blood on their clothing? How did you know?
3. What are your conclusions? How do you know?

A red background with white text to highlight a career link

Forensic toxicologist

Watch Calum’s video job profile on **slide 13** (also available at [rsc.li/42ciCBd](https://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

1. Did the hair on the victim come from Suspect 1 or Suspect 2?
2. 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

1. Did the fibres on the victim come from Suspect 1 or Suspect 2?
2. 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**? |

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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](https://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 |  | Two cotton buds on a pink background. The top cotton bud has a purple stain at one end and the label Positive written above it.  The lower cotton bud had no visible stain and the label Negative written below it  **Negative**  **Positive**  © 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 |  | Hazard label showing two test tubes - one pouring liquid onto a surface which is reacting and the other is pouring liquid onto a hand which is reacting |  | a small, flat, rectangular piece of glass on which specimens can be mounted for *microscopic* study |
| Hair cuticle |  | Three glass rectangular slides  © Bruno Rodrigues  B Silva/Shutterstock |  | a hard layer of overlapping cells which forms the outermost part of a hair shaft |
| Corrosive |  | Plastic bag labelled Evidence  © Douglas Sacha/Getty Images |  | a ceramic or plastic tile with 12 cavities or ‘wells’, used for low volume reactions involving a colour change |
| Pipette |  | A white tray containing six small wells or dimples  © 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 |  | Close up image of hairs  © Rost9/Shutterstock |  | a glass or plastic tube with a suction bulb, used for the transfer of small volumes of liquids |
| Spotting tile |  | Plastic tube with a bulb at one end and a hole at the other  © 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 |