crime scene investigation

fighting crime
protecting communities

TOUGH-CALL.CO.UK

# Investigation pack

## TEACHERS' GUIDE

# The assignment

This gun crime forensics project has been developed to show students how science can be applied to real-life situations. Based around a crime scene scenario, it directly links school science to forensic fieldwork, allowing students to develop important practical skills and learn essential scientific terminology.

The project combines a range of practical activities with interactive resources to give students an invaluable insight into the work of the police and the effects of gun crime.

A pilot project has been carried out at Litherland High School, and was enthusiastically received by staff and pupils alike.

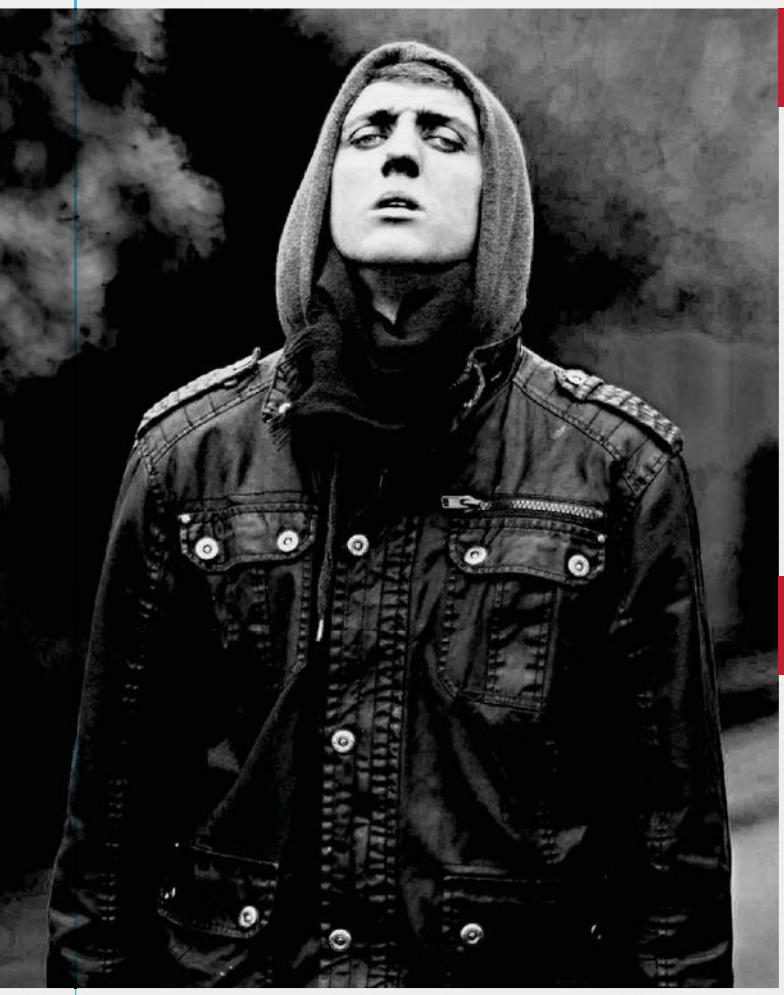
"The whole day was great. I really learned more about what forensic science is and how the scientists actually work on cases"
(Kaitlyn, age 14)

"I never knew that forensic science was so varied. I really enjoyed taking fingerprints."
(Louis, age 14)

"My favourite was the flame tests to identify the gun residue."
(Craig, age 13)

"Brilliant – I have never enjoyed a whole day at school as much as I did."
(Mark, age 14)

# The curriculum



## This flexible project has been designed so you can:

- Fit it into KS3, KS4 and BTEC programmes of study.
- Encourage cross-curricular links with citizenship and PHSE within your school.
- Adapt it to suit the individual needs of students and the resources of the school.
- Extract specific activities to complement existing schemes of work.
- Deliver the complete project at school or through departmental events such as collapsed curriculum days.

## Key curriculum learning covered in this pack includes:

- Key concepts
  - Scientific thinking
  - Applications and implications of science
- Key processes
  - Practical and enquiry skills
- Range and content
  - Energy, electricity and forces
  - Chemical and material behaviour

Visit the Teachers' Zone at **www.tough-call.co.uk/forensics** for complementary resources including videos, animated characters, experimental set-up guides and a detailed breakdown of the curriculum.

| | | | STUDENTS' PRINTED RESOURCES | TEACHERS' ZONE – RESOURCE CENTRE | |
|---|---|---|---|---|---|
| | PAGE NO. | SECTION OVERVIEW | STUDENTS' PACK REFERENCE | ANIMATION & VIDEO | SET-UP VIDEO AND OTHER RESOURCES |
| PRE-PROJECT QUESTIONNAIRE | | A questionnaire about students' perceptions of gun crime. This should be completed before students are handed their packs to avoid any priming of answers. | This can be found on page 2 of the students' pack. | – | Pre-project questionnaire can be downloaded. |
| GUN CRIME INTRODUCTION | | An introduction to gun crime. | This can be found on page 3 of the students' pack. | – | – |
| SECTION 1 INTRODUCTION | 2 | **Section 1**<br>An introduction to this Gun Crime Forensics Project. | An introduction for students is on page 4 of the students' pack. | **ANIMATION 1:** An introductory animation to be shown at the beginning of the project (after students have completed the initial questionnaire). An officer outlines the case, explaining that students will be assuming the role of forensic scientists. | – |
| SECTION 2 PHYSICS TESTS | 3 | **Section 2**<br>Introduction to the physics tests. Students apply physics-based principles to a crime scene. | A section introduction for students is on page 5 of the students' pack. | – | – |
| | 5 | **Section 2.1 – Angle of deflection**<br>Students will use the information provided to narrow the search for the missing bullet. | Introduction and a worksheet for this experiment will be available on page 6 of the student pack. | – | Set-up video X.<br>Photo reference. |
| | 6 | **Section 2.2 – Speed and distance**<br>Students compare the speed and distance of a bullet when it's travelling through air and through glycerol. | Introduction and a worksheet for this experiment will be available on page 7 of the student pack. | – | Set-up video X.<br>Photo reference. |
| | 7 | **Section 2.3 – Testing projectiles**<br>Students test the impact of bullets when they're fired at different displacements. | Introduction and a worksheet for this experiment will be available on page 8 of the student pack. | – | Set-up video X.<br>Photo reference. |
| | | | | **ANIMATION 2:** To be shown **after** the 3 physics experiments (before the chemistry experiments). This introduces the students to the next section. | |
| SECTION 3 CHEMISTRY | 8 | **Section 3 – Introduction to chemistry tests.**<br>Students perform chemistry-based tests to eliminate suspects from their enquiries. | A section introduction for students is on page 9 of the students' pack. | This animated video explains the importance of forensic analysis in eliminating suspects. Students see a gallery of suspects and are briefed on the evidence that has been found and how they're going to analyse it. | – |

CONTINUED...

| | | | STUDENTS' PRINTED RESOURCES | TEACHERS' ZONE – RESOURCE CENTRE | |
|---|---|---|---|---|---|
| | PAGE NO. | SECTION OVERVIEW | SUPPORTING MATERIALS & STUDENTS' PACK | ANIMATION & VIDEO | EXPERIMENT SET-UP: VIDEO & PHOTO |
| SECTION 3 CHEMISTRY (CONTINUED) | 10 | **Section 3.1 – Flame testing** Students will test and identify different compounds. They will then use the compound table to identify elements. | An introduction and worksheet are on page 10 of the students' pack. | – | Set-up video X. Photo reference. |
| | 11 | A **compound table** is provided for students, to help them identify and eliminate suspects. | Compound table is available in the students' pack page 11. | – | – |
| | 12 | **Section 3.2 – Fingerprinting** Students conduct some fingerprint tests. | An introduction and worksheet are on page 12 of the students' pack. | – | Set-up video X. Photo reference. |
| | 13 | **Section 3.3 – pH soil testing** Students conduct a pH test on soil samples to help match the soil type to soil samples found on the eight suspects' shoes. | An introduction and worksheet are on page 13 of the students' pack. | – | Set-up video X. Photo reference. |
| | 14 | **Section 3.4 – Microscopic analysis of fibre** Students conduct a microscopic analysis of a number of different fibre types to find a match with fibres found on suspects' clothes. | An introduction and worksheet are on page 14 of the students' pack. | – | Set-up video X. Photo reference. |
| SECTION 4 PRESENTING THE EVIDENCE | 15 | **Section 4 – Presenting evidence** Students see how all the evidence they've collected can help build a case and secure a conviction. | Introduction section 4 is available for students on page 15 of the students' pack. | – | – |
| | 16 | **Section 4.1 – Physics section summary** Students evaluate their findings and present them in a report format. Teachers can ask students to stand up and formally present their report in a court room scenario. | Worksheets for this write-up will be available on pages 16–20 of the students' pack. | **ANIMATION 3:** To be shown at the beginning of section 4.1. Students will be given an overview of the section and asked to present their evidence as if they were reporting to a senior officer or giving evidence at a trial. | – |
| | 4 | **Section 4.2 – Chemistry section summary** Students evaluate their findings and present them in a report format. | Worksheets for this write up will be available on pages 21–25 of the students' pack. | **ANIMATION 4:** To be shown at the beginning of section 3.2. This will introduce the final part of the project. Pupils will be asked to present their evidence to the jury. | |
| | 9 | **Section 3.1 – Suspects** Students are given a list of possible suspects and are asked to eliminate them one by one from the enquiry by carrying out a series of tests. | An introduction and instructions for students' are on page 26 of the student's pack. | **ANIMATION 5:** To be shown after the courtroom video at the very end of the project, where the full set of videos will be shown to explain the whole story. | – |
| POST-PROJECT QUESTIONNAIRE | 17 | This questionnaire is designed to find out if students' perceptions about gun crime have changed. | This can be found on page 28 of the students' pack. | – | Post-project questionnaire. |

**SHOW ANIMATION 1 BEFORE STUDENTS BEGIN THIS SECTION**

# Physics tests

Ask students to complete the CSI survey at the very beginning of the project. Then show animation 1, where Chief Inspector Lewis will introduce the assignment and explain what they are required to do.

Once students have watched animation 1, which incorporates a video of a shooting incident, they will apply some of the principles they learn in Physics to help them understand a real-life crime scene.

They will conduct a series of ballistics tests about aerodynamics, projectiles and angles of deflection to identify the speed the bullet was travelling when it went through the victim's leg. This information will help students narrow down the police search for the missing bullet

## Key Curriculum Subjects

**Attainment target 4: Energy, forces and space**

**Level 4**

Students describe energy and forces, recognising how forensic scientists use ballistics to support or refute scientific ideas as part of a legal process.

**Level 5**

Students draw on abstract ideas to describe how energy and forces are applied in the study of ballistics.

**Level 6**

Students describe processes and phenomena related to students take account of a number of factors in their explanations of processes and phenomena. They apply knowledge to refine the search for a bullet at a fictitious crime scene.

**Level 7**

Students describe a wide range of processes and phenomena. Using abstract ideas where appropriate, students explain the application and implications of science within the field of forensic science.

**Level 8**

Students interpret, evaluate and synthesise data from a range of sources, showing an understanding of the relationship between evidence and scientific ideas that underpin the work of forensic scientists.

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# Angle of deflection

Students are told that Dean was shot in the leg, and that the bullet hit him at an angle of between 35 and 45 degrees. They will have to perform an experiment, using their knowledge of angles of deflection, to try and determine where the bullet could have deflected when it went through Dean's leg.

## The Task

Students investigate the impact of a bullet when it hits the body at different angles. This will help narrow down the search for the missing bullet later on in the project. To do this, they will first fire a ball bearing against a hard, smooth surface (similar to the density of bone) at 35, 40 and 45 degrees.

This will help them work out the angle at which the bullet could have deflected when it went through Dean's leg.

**EQUIPMENT LIST**

- Pistol (as per example in set-up video X)
- Appropriately sized ball bearings (11mm used)
- Wooden surface to fire at
- Large laminated A3 protractor
- Strips of plasticine stuck along one half of the protractor to measure angle of deflection

**Please see experiment set-up video X to see how the equipment is used.**

| ANGLE OF INCIDENCE | ANGLE OF DEFLECTION | | | |
|---|---|---|---|---|
| | TEST 1 | TEST 2 | TEST 3 | AVERAGE $\frac{T1+T2+T3}{3}$ |
| $35^0$ | | | | |
| $40^0$ | | | | |
| $45^0$ | | | | |

**Task 1 – Fire the ball bearing at 35 degrees**

Fire a ball bearing at a smooth, hard surface from an angle of 35 degrees and measure the angle of deflection. Repeat this three times to make sure your data is reliable.

**Task 2 – Fire the ball bearing at 40 degrees**

Repeat step 1 at an angle of 40 degrees.

**Task 3 – Fire the ball bearing at 45 degrees**

Repeat step 1 from an angle of 45 degrees.

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# Speed and distance

This experiment will also help students narrow the search for the missing bullet.

We know that the bullet was deflected when it hit the bone in Dean's leg and slowed down as it passed through the tissue.

This experiment will demonstrate how a bullet slows down when it passes through a dense medium such as human muscle.

**EQUIPMENT LIST**

- 2 x large cylinders
- Glycerol solution (to simulate human muscle)
- Ball bearing (to imitate a bullet)
- Stop watch

**Please see experiment set-up video X to see how the equipment is used.**

| | TIME 1 (S) | TIME 2 (S) | TIME 3 (S) | AVERAGE TIME $\frac{T1+T2+T3}{3}$ | DISTANCE (m) | SPEED (cm/s) $\frac{\text{DISTANCE}}{\text{AVERAGE TIME}}$ |
|---|---|---|---|---|---|---|
| BULLET TRAVELLING THROUGH AIR | | | | | 1 METRE | |
| BULLET TRAVELLING THROUGH GLYCEROL | | | | | 1 METRE | |

## The Task

Students will measure the change in speed of a ball bearing travelling through air compared to when it travels through a dense object such as human muscle. They will use a ball bearing to imitate a bullet and glycerol to simulate human muscle.

**Task 1 – Collect experimental data as the ball bearing travels through air**

Drop a ball bearing down a 1.25 acrylic metre tube filled with air and use a stop clock to time how long it takes the ball bearing to travel 1 metre. Repeat this three times to make sure your data is reliable.

**Task 2 – Collect experimental data as the ball bearing travels through glycerol**

Repeat the process using a 1.25 acrylic metre tube filled with glycerol.

**Task 3 – Calculate average times**

Calculate the average time that the ball bearing takes to travel 1 metre through both air and glycerol.

**Task 4 – Calculate the average speeds**

Calculate the average speed of the ball bearing as it travels through both air and glycerol. You can use this equation:

$$\text{SPEED} = \frac{\text{DISTANCE}}{\text{AVERAGE TIME}}$$

Visit the Teachers' Zone at **www.tough-call.co.uk/forensics** for complimentary resources including videos, animated characters, experimental set-up guides and a detailed breakdown of the curriculum.

# Measuring impact

In this experiment, students will learn how speed is an important factor affecting the impact of a bullet when it hits its target.

## The Task

Students will use a piece of apparatus (see set-up video 2) to fire a ball bearing at plasticine from different elastic displacements. This will help demonstrate the effects of speed on the impact of a bullet. They will repeat the experiment three times to ensure their results are accurate.

| ELASTIC DISPLACEMENT | WIDTH OF IMPACT | | | |
|---|---|---|---|---|
| | TEST 1 | TEST 2 | TEST 3 | AVERAGE $\frac{T1+T2+T3}{3}$ |
| 5cm | | | | |
| 10cm | | | | |
| 15cm | | | | |

**EQUIPMENT LIST**

- Pistols (as per example in set-up video 2)
- Appropriately sized ball bearing (11mm used)
- Strips of plasticine for students to fire at
- Clear plastic rules to measure the impact diameter

**Please see experiment set-up video X to see how the equipment is used.**

**Task 1** – Perform the experiment three times at each distance, making sure conditions are the same for each experiment.

**Task 2** – Record the results in the table.

Visit the Teachers' Zone at **www.tough-call.co.uk/forensics** for complimentary resources including videos, animated characters, experimental set-up guides and a detailed breakdown of the curriculum.

**SHOW ANIMATION 2 BEFORE STUDENTS BEGIN THIS SECTION**

# Chemistry tests

## Eliminating suspects through forensic chemistry experiments.

Students will watch animation 2 where Chief Inspector Lewis will introduce the forensic chemistry experiments. They are told that Crime Scene Investigators have collected evidence at the scene and that they will act as forensic scientists to try and link that evidence to a list of suspects. Students will carry out experiments on compounds, fibres and soil samples that were found on the suspects' clothes. They will use the results of these experiments in section 3 to find out who fired the gun.


## Key Curriculum Subjects

**Attainment target 3: Materials, their properties and the Earth**

**Level 4**

Students describe phenomena related to materials and their properties, recognising that evidence can support or refute scientific ideas as part of a legal process.

**Level 5**

They draw on abstract ideas to describe how materials are applied in the study of forensic evidence.

**Level 6**

Students take account of a number of factors in their explanations of processes and phenomena. They apply knowledge to eliminate suspects from a fictitious enquiry and describe the evidence that they've used.

**Level 7**

Using abstract ideas where appropriate, students explain the application and implications of science within the field of forensic science.

**Level 8**

Students interpret, evaluate and synthesise data from a range of sources, showing an understanding of the relationship between evidence and scientific ideas that underpin the work of forensic scientists.

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# Flame testing different compounds

Students are told that eight suspects have been arrested and that forensic scientists have found different substances on their clothes. Their task is to find out if any of those substances are found in gunpowder, and therefore may link some of these suspects to the crime scene.

## The Task

Students will carry out flame tests on four substances to find out which one contains the same elements as gunpowder (potassium chloride, lead or equivalent). This will help them identify who may have fired the gun in section 3 of the project.

| | COMPOUND A | COMPOUND B | COMPOUND C | COMPOUND D |
|---|---|---|---|---|
| COLOUR OF FLAME | YELLOW | RED | LILAC | BLUE/GREEN |
| NAME OF COMPOUND | SODIUM CHLORIDE | CALCIUM CARBONATE | POTASSIUM CHLORIDE, LEAD OR EQUIVALENT | COPPER SULPHATE |
| WHAT IS THIS COMPOUND CLOSELY ASSOCIATED WITH IN EVERYDAY LIFE? | • WINDOWS FOR ANALYTICAL INSTRUMENTS<br>• DE-ICING<br>• FOOD AND COOKING | • BUILDING<br>• OPTICAL APPLICATIONS<br>• PAPER, PLASTICS, PAINTS AND COATINGS | • MEDICINE<br>• FOOD PROCESSING<br>• FERTILISERS<br>• BULLET MANUFACTURE | • PESTICIDE<br>• FUNGICIDE<br>• HERBICIDE |

**Task 1** – Perform the flame test on each of the compounds.

**Task 2** – Use the table on the next page to identify what the compound is.

**Task 3** – Write down what types of things this compound is often found in.

Visit the Teachers' Zone at **www.tough-call.co.uk/forensics** for complimentary resources including videos, animated characters, experimental set-up guides and a detailed breakdown of the curriculum.

### EQUIPMENT LIST

- Compounds A, B, C, D as listed above
- Bunsen burners
- Heatproof mats
- Flame loop
- Glass beaker of 2m hydrochloric acid or alternative for cleaning and rinsing
- Beaker of water (between samples)
- Acid

**Please see experiment set-up video X to see how the equipment is used.**

# Compound properties

| COMPOUND | PROPERTIES | FLAME COLOUR | USES |
|---|---|---|---|
| **SODIUM CHLORIDE** | • Has a cubic crystalline structure<br>• Is clear when pure, although may also appear white, grey or brownish, depending upon purity<br>• Is soluble in water<br>• Is slightly soluble in other liquids<br>• Is odourless<br>• Has a characteristic taste<br>• Molten sodium chloride is an electrical conductor | Yellow | • Windows for analytical instruments<br>• De-icing<br>• Food and cooking<br>• High power lasers<br>• To produce chlorine and sodium<br>• Historically it has been used as a form of currency |
| **CALCIUM CARBONATE** | • Produces $CO_2$ when in contact with acids<br>• Crystals are usually white or transparent<br>• Crystals can cause double refraction of light ionic | Red | • Building<br>• Optical applications<br>• Paper, plastics, paints and coatings<br>• Antacids |
| **POTASSIUM CHLORIDE** | • Has a cubic crystalline structure<br>• It will precipitate insoluble chloride salts when added to a solution of an appropriate metal ion | Lilac | • Medicine<br>• Food processing<br>• Fertilisers<br>• Lethal injections |
| **LEAD CHLORIDE** | • White solid poorly soluble in water<br>• Occurs naturally in the form of the mineral cotunnite<br>• It is colorless, white, yellow, or green toxic | Blue/white | • Production of glass<br>• Bullet manufacture |
| **COPPER SULPHATE** | • Reacts with more reactive metals than copper | Blue/green | • Pesticide<br>• Fungicide<br>• Herbicide<br>• Test blood for iron and anaemia |

# Fingerprinting

Students learn that fingerprints are unique to one person. They are told that if officers can match fingerprints at the scene of a crime to an individual, it can help lead to a prosecution.

## The Task

Students will familiarise themselves with the three types of fingerprints; arches, loops and whorls. The teacher will demonstrate how students can lift their own set of fingerprints to see what type they have.

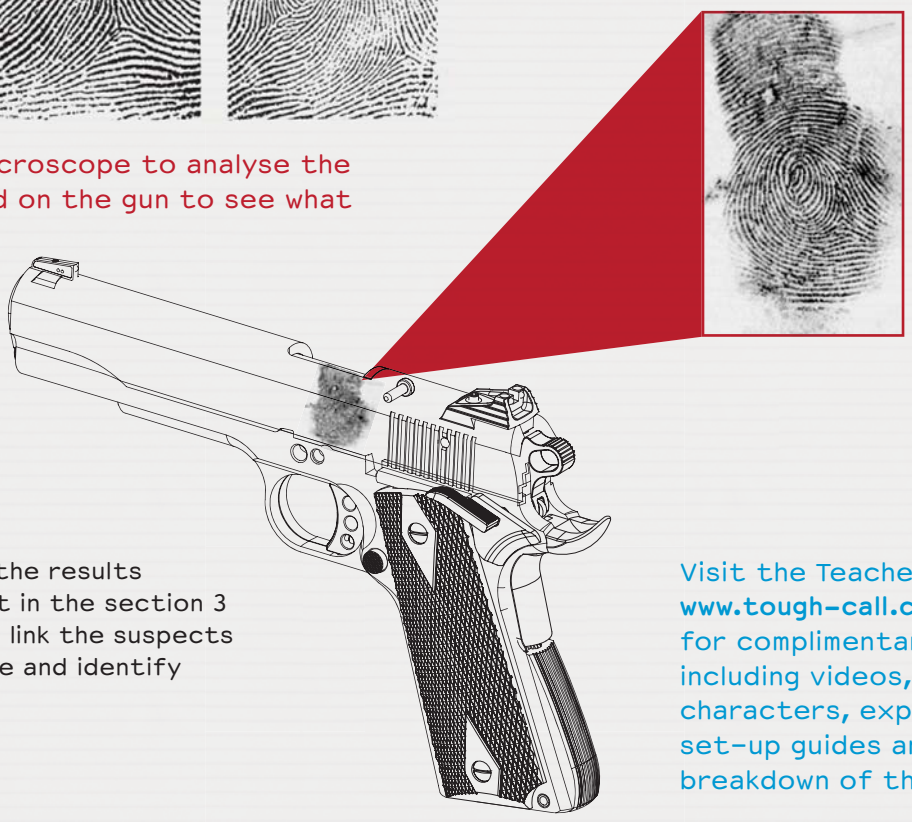
In the second part of the experiment, students will use a microscope to analyse fingerprints that police have found on the gun. They will use the results of this experiment in Section 3 to eliminate people from the investigation.

**EQUIPMENT**
- Glassware
- Hand lens
- Sticky tape
- Ink pad
- Example of fingerprinting powder (extra fine aluminium powder)

**Please see experiment set-up video X to see how the equipment is used.**

**Task 1** – Analyse your own set of fingerprints to see what type you have.


**Task 2** – Use a microscope to analyse the fingerprint found on the gun to see what type it is.



Students will use the results of this experiment in the section 3 of the project to link the suspects to the crime scene and identify the shooter.

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# Testing the pH of soil

Merseyside Police found a gun buried in a field, a mile away from where Dean was shot. They believe it belonged to the shooter. Students are asked to work out if any of soil samples found on the suspects clothes match the soil the gun was buried in.

## The Task

The soil that the gun was buried in was very acidic. Students will carry out an experiment to work out which of the three soil samples found on the suspects' shoes is neutral, alkaline or acid. Once they have found which is the acidic one, they can eliminate more suspects to the crime.

| | SOIL SAMPLE A | SOIL SAMPLE B | SOIL SAMPLE C |
|---|---|---|---|
| pH VALUE | | | |
| ACIDITY | NEUTRAL | ACID | ALKALINE/BASIC |

**EQUIPMENT LIST**

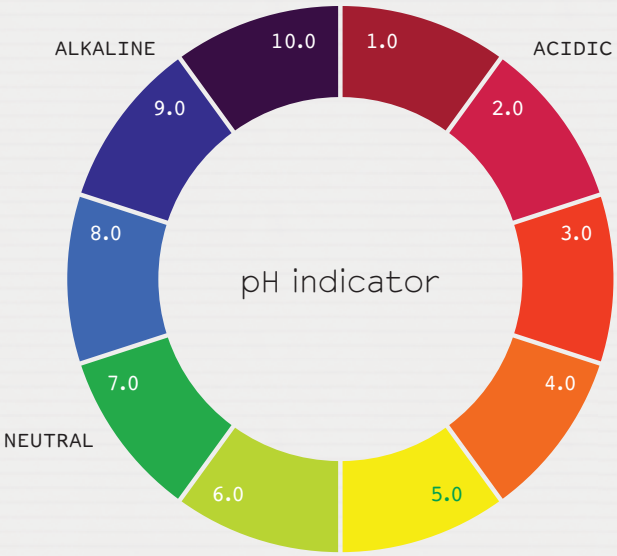
- Soil samples A, B and C as listed above
- Boiling tubes
- Bungs
- Universal indicator solution and card, or pH meters to test soil samples
- Barium sulphate to flocculate
- Spatulas
- Wash bottles

**Please see experiment set-up video X to see how the equipment is used.**

**Task 1** – Use the pH meter to test the soil samples found on the suspects' shoes.

**Task 2** – Record your results in the table.

Students will use the results of this experiment in the section 3 of the project to link the suspects to the crime scene and identify the shooter.




Visit the Teachers' Zone at **www.tough-call.co.uk/forensics** for complimentary resources including videos, animated characters, experimental set-up guides and a detailed breakdown of the curriculum.

# Microscopic analysis of fibres

Students discover that the gun that police think was used in the shooting was found buried in a field, wrapped in a red polyester scarf. They will analyse the fibres found on the suspects' clothes to see if they can find a match to the fibres from the scarf.

## The Task

Students will analyse four different red fibres found on the suspects' clothes. They will analyse the fibres to determine what they are (cotton, polyester, wool or fake hair) to establish if one of them is the same as the fibres found on the gun.

| | FIBRE A | FIBRE B | FIBRE C | FIBRE D |
|---|---|---|---|---|
| DESCRIPTION | | | | |
| SKETCH | | | | |
| FIBRE TYPE | COTTON | POLYESTER | WOOL | FAKE HAIR |

**EQUIPMENT LIST**
- Microscopes
- Microscope slides
- Fibres A, B, C and D as listed above

**Please see experiment set-up video X to see how the equipment is used.**

**Task 1** – Analyse the four red fibres A, B, C, D to determine what they are. Write a brief description of the fibre and draw a sketch of what it looks like under a microscope.

Students will use the results of this experiment in the section three of the project to link the suspects to the crime scene and identify the shooter.

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# Presenting the evidence

## Building a case and securing a conviction.

The final task for students is to present the results from their forensic science investigation to the Senior Investigating Officer, and then to a judge and jury in court. But before they do this, they need to do some further analysis on the results from their physics and chemistry experiments, to ensure their evidence is valid and reliable.

They will speak to Chief Inspector Lewis at the beginning of section 3.1, and then Judge Aston at the beginning of section 3.2, who will provide them with instructions.

To get students even more involved, you could choose to conduct section 3.3 in a courtroom style scenario.

A video then reveals the correct suspect and the full story behind the shooting. Judge Aston thanks students for their efforts, stressing how important valid and accurate evidence were in securing a conviction.

## Key Curriculum Subjects

**Attainment target 1: How science works**

**Level 4**

Students record their observations, comparisons and measurements using tables and bar charts, then communicate their conclusions using appropriate scientific language as if they were in a court of law.

**Level 5**

Students interpret numerical data and draw conclusions, then communicate them using scientific conventions and terminology as if they were in a court of law.

**Level 7**

Students make systematic observations and measurements with precision, using a range of apparatus. They then communicate effectively, using symbols and flow diagrams as if they were in a court of law.

**Level 8**

Students analyse data and begin to explain anomalies, showing awareness of a range of views and evaluating evidence critically as if they were in a court of law.

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SHOW ANIMATION 3 BEFORE STUDENTS BEGIN THIS SECTION

# Presenting evidence from your physics tests...

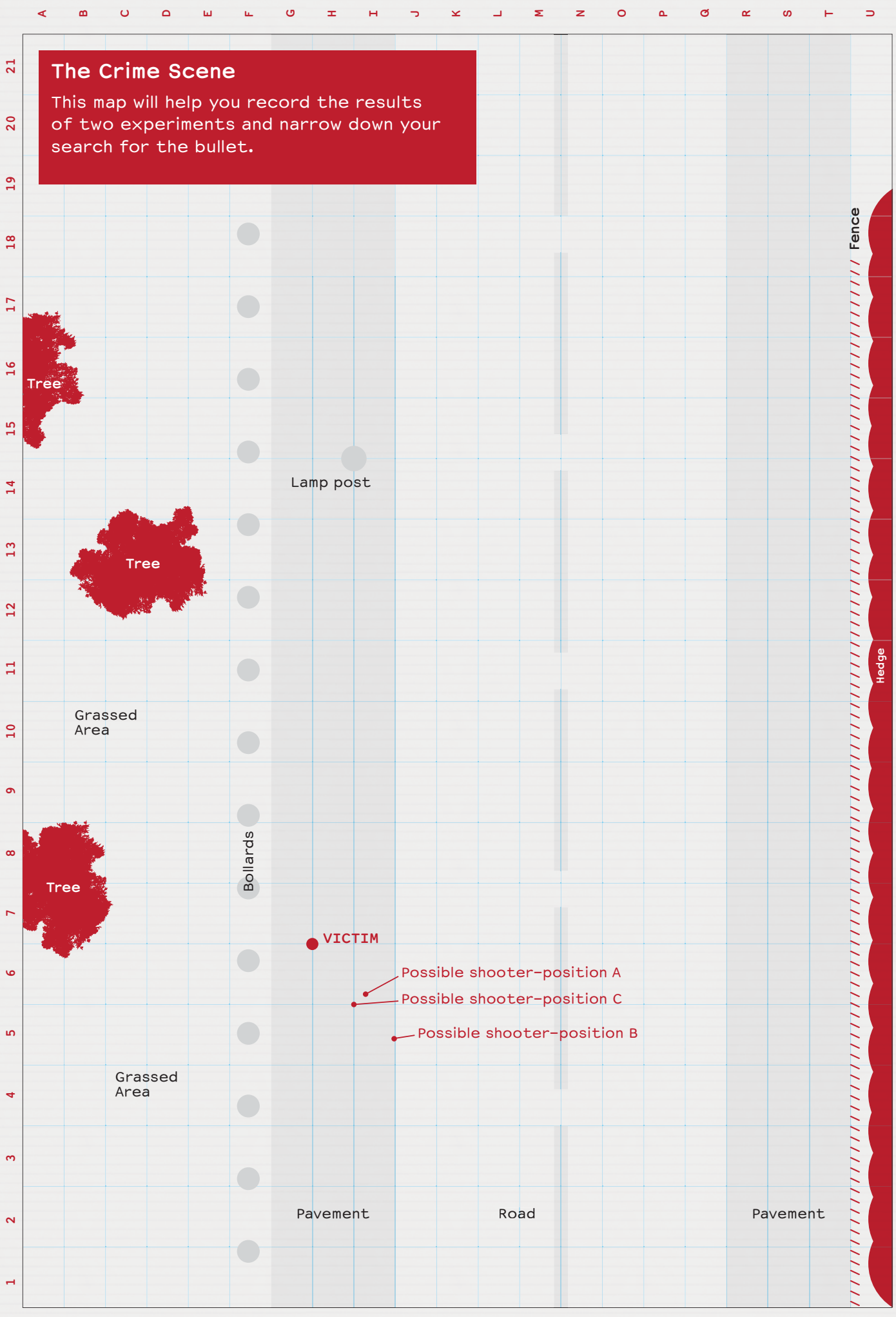
to narrow the search for the bullet

In this section, students will perform some further calculations and analysis on their physics experiments, to try and narrow down the search for the missing bullet. Students are told that police need this to prove that it's from the gun that they have found.

## Review of Section 1.1 – Angle of deflection

Witnesses have come forward and given police three possible positions from where Dean was shot (these positions are marked on the crime scene map on the next page).

Using a pair of compasses and the results from section 1.1, students will draw the average angles of deflection at 35, 40 and 45 degrees onto the crime scene map. This will help to narrow down where the bullet could have gone when it passed through Dean's leg.


The Crime Scene
This map will help you record the results of two experiments and narrow down your search for the bullet.
A B C D E F G H I J K L M N O P Q R S T U
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Fence
Hedge
Tree
Tree
Tree
Lamp post
Grassed Area
Grassed Area
Bollards
VICTIM
Possible shooter-position A
Possible shooter-position C
Possible shooter-position B
Pavement
Road
Pavement

## Review of Section 1.2 – Speed and distance

Students know the bullet went through Dean's leg, which will have slowed it down and affected how far it travelled. In this section, students will use their results from experiment 1.2 to calculate how much the ball bearing slowed down, so that they can estimate how far the bullet may have travelled.

| | AVERAGE TIME | DISTANCE | SPEED = DISTANCE / AVERAGE TIME |
|---|---|---|---|
| BALL BEARING TRAVELLING THROUGH MUSCLE (SIMULATED BY GLYCEROL) | | 1 METRE | |
| BALL BEARING TRAVELLING THROUGH AIR | | 1 METRE | |

ESTIMATE THE DISTANCE THE BULLET MAY HAVE TRAVELLED BY WORKING OUT THE CHANGE IN SPEED OF THE BALL BEARING THROUGH AIR COMPARED TO GLYCEROL.

SPEED THROUGH GLYCEROL / SPEED THROUGH AIR X 100

_____ X 100 = %

BULLETS TRAVELLING THROUGH AIR USUALLY TRAVEL AT LEAST 100M*. USE YOUR CALCULATIONS TO ESTIMATE HOW FAR THE BULLET COULD HAVE TRAVELLED AFTER IT PASSED THROUGH DEAN'S LEG. THE FORMULA BELOW WILL HELP.

PERCENTAGE CALCULATED ABOVE X DISTANCE TRAVELLED THROUGH AIR (100M) =

*estimated for the purposes of this project

Students will use the map and their results from this section to draw the distance the bullet may have travelled when it went through Dean's leg.

| | |
|---|---|
| DISCUSS ANY PROBLEMS WITH THIS EXPERIMENT E.G. ARE THERE ANY ERRORS? DOES THIS EXPERIMENT ACCURATELY REPLICATE A BULLET PASSING THROUGH DEAN'S LEG? | |
| DISCUSS THE RELIABILITY AND ACCURACY OF THE DATA YOU RECORDED. WHAT DOES THIS MEAN FOR THIS INVESTIGATION? | |
| LIST ANY SUGGESTIONS YOU HAVE TO IMPROVE THIS EXPERIMENT TO MAKE IT MORE ACCURATELY REFLECT A BULLET PASSING THROUGH MUSCLE. | |

## Review of Section 1.3 – Measuring impact

The experiment in section 1.3 helped to demonstrate to students that speed is an important factor affecting the impact of a bullet. Students will discuss the reliability and accuracy of the experiment and any suggestions they may have to improve it.

| | |
|---|---|
| WHAT DOES THE DATA THAT YOU COLLECTED FROM YOUR EXPERIMENT TELL US ABOUT THE RELATIONSHIP BETWEEN THE MOMENTUM OF A BULLET AND THE IMPACT THAT IT MAKES? | |
| DISCUSS THE RELIABILITY AND ACCURACY OF THIS EXPERIMENT AND THE DATA YOU RECORDED. DOES THIS ACCURATELY REFLECT THE ACTION OF A BULLET TRAVELLING THROUGH MUSCLE? | |
| WHAT COULD YOU DO TO IMPROVE THE RESULTS TO MAKE THEM MORE ACCURATE? | |

# Conclusion

IN THIS SECTION, STUDENTS WILL PRESENT THE FINDINGS FROM THEIR PHYSICS EXPERIMENTS TO THE SENIOR INVESTIGATING OFFICER, TO HELP HIM NARROW DOWN THE SEARCH FOR THE MISSING BULLET.

THEY WILL PRESENT CHIEF INSPECTOR LEWIS WITH THEIR CRIME SCENE MAP AND EXPLAIN HOW THEY NARROWED DOWN AN AREA FOR HIS OFFICERS TO SEARCH.

THEY WILL SPEND SOME TIME PREPARING THEIR RESULTS TO ENSURE THEY'RE READY.

SECTION 3.2

SHOW ANIMATION 4 BEFORE STUDENTS BEGIN THIS SECTION

# Presenting evidence from your chemistry tests...

## to eliminate suspects

In this section, students will use the results from their chemistry experiments to carry out further analysis of the evidence and eliminate suspects from the enquiry. The will use the suspects list (see page 24) to help them.

## Review of Section 2.1 – Flame testing different compounds

| | |
|---|---|
| WHAT COMPOUND IS FOUND IN GUNPOWDER? | |
| WHICH OF THE SUSPECTS WERE FOUND WITH THIS ON THEIR CLOTHING?<br><br>(CIRCLE THE COMPOUND FOUND IN GUNPOWDER (A,B,C OR D) UNDER THE SUSPECTS WHO WERE FOUND WITH IT ON THEIR CLOTHING) | 1.<br>2.<br>3.<br>4.<br>5.<br>6. |
| DISCUSS THE RELIABILITY AND ACCURACY OF THIS EXPERIMENT AND THE DATA YOU RECORDED. | |

## Review of Section 2.2 – Fingerprinting

| | |
|---|---|
| WHAT TYPE OF FINGERPRINT WAS FOUND ON THE GUN? | |
| WHICH OF THE SUSPECTS HAVE THIS TYPE OF FINGERPRINT?<br><br>(CIRCLE THE FINGERPRINT TYPE UNDER ALL THE SUSPECTS WHO HAVE THE SAME TYPE) | 1.<br>2.<br>3. |
| DISCUSS THE RELIABILITY AND ACCURACY OF THIS EXPERIMENT WHEN LINKING THESE SUSPECTS TO THE CRIME SCENE. | |

## Review of Section 2.3 – Testing the pH of soil

| | |
|---|---|
| THE GUN WAS FOUND BURIED IN ACIDIC SOIL. WHICH OF THE SUSPECTS WERE FOUND WITH THIS TYPE OF SOIL ON THEIR CLOTHES?<br><br>(CIRCLE THE ACIDIC SOIL SAMPLE (A,B OR C) UNDER THE SUSPECTS WHO WERE FOUND WITH IT ON THEIR CLOTHING) | 1.<br><br>2.<br><br>3. |
| DISCUSS THE RELIABILITY AND ACCURACY OF THIS EXPERIMENT AND THE DATA YOU RECORDED. | |

## Review of Section 2.4 – Microscopic analysis of fibres

| | |
|---|---|
| WHICH SUSPECTS WERE FOUND WITH RED POLYESTER FIBRES ON THEIR CLOTHES, AND THEREFORE COULD BE LINKED TO THE CRIME SCENE?<br><br>(CIRCLE THE POLYESTER FIBRE (A,B,C OR D) UNDER EACH OF THE SUSPECTS WHO HAD IT ON THEIR CLOTHING) | 1.<br><br>2.<br><br>3. |
| DISCUSS THE RELIABILITY AND ACCURACY OF THIS EXPERIMENT AND THE DATA YOU RECORDED. | |

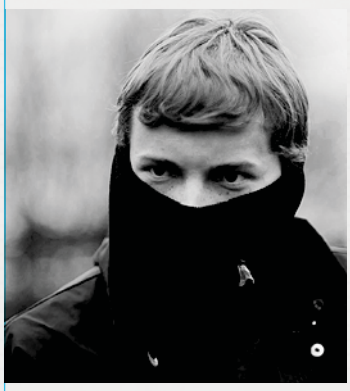
By now, students should have linked the evidence found at the scene to the list of suspects. The person who has the most evidence linked to them is their prime suspect of the shooting.

To help make the investigation more realistic and fun, you will notice a suspects section on the website where (If computer and internet access is permitted) students can play the 'suspect's game' to make sure their prime suspect is the correct person.

SECTION 3.2

# suspects

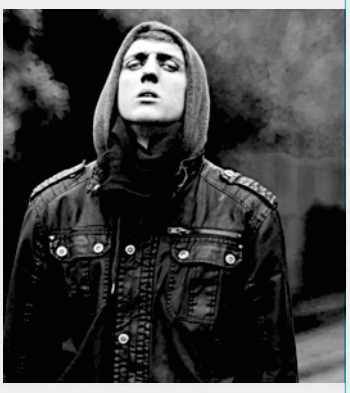
Here is a list of suspects who have been arrested because police believe they were involved in the shooting. As students link evidence gathered at the crime scene to the suspects' clothing, they should mark it on this page e.g. compound 'c' is potassium chloride which is found in gunpowder, so students should circle the letter 'c' under each of the suspects who had it on their clothing (Stephen McNally, James Taylor, Kev Dixon, Thomas Richards, Ryan Stephens and James Smith). At the end of this section, Ryan Stephens should have the most evidence linked to him and will therefore be their prime suspect.



**Stephen McNally**
Compounds found:
A C
Fibres found:
B
Soils found:
C
Fingerprint type:
ARC

**Sophie Jones**
Compounds found:
A D
Fibres found:
B D
Soils found:
B C
Fingerprint type:
WHORL

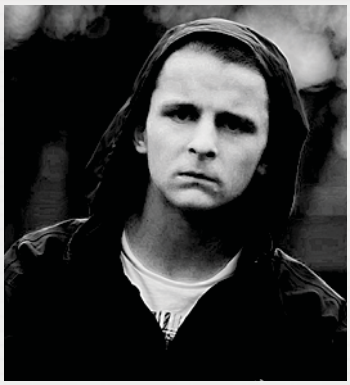
**James Taylor**
Compounds found:
A B C
Fibres found:
A C
Soils found:
A
Fingerprint type:
LOOP



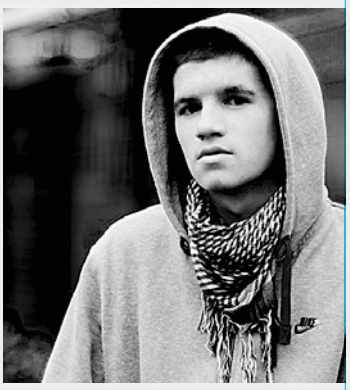
**Kev Dixon**
Compounds found:
C D
Fibres found:
A
Soils found:
A
Fingerprint type:
ARC

**Chantelle Williams**
Compounds found:
A B
Fibres found:
A B D
Soils found:
A B C
Fingerprint type:
ARC

**Thomas Richards**
Compounds found:
C
Fibres found:
A C
Soils found:
C D
Fingerprint type:
LOOP



**Ryan Stephens**
Compounds found:
C D
Fibres found:
A B D
Soils found:
A B D
Fingerprint type:
WHORL



**James Smith**
Compounds found:
A C
Fibres found:
A
Soils found:
C
Fingerprint type:
WHORL

SHOW ANIMATION 5 AFTER STUDENTS HAVE COMPLETED THIS SECTION AND FINISHED THE PROJECT

# Conclusion

BY NOW, STUDENTS SHOULD HAVE LINKED THE EVIDENCE FOUND AT THE SCENE TO THE LIST OF SUSPECTS. THE PERSON WITH THE MOST EVIDENCE FOUND ON THEIR CLOTHING IS THEIR PRIME SUSPECT TO THE SHOOTING.

IN THIS FINAL SECTION, STUDENTS WILL PRESENT THIS EVIDENCE TO JUDGE ASTON IN COURT TO HELP SECURE A CONVICTION.

THEY WILL GIVE THE JUDGE THE NAME OF THE PRIME SUSPECT AND USE THE INFORMATION IN REVIEW SECTIONS 2.1–2.4 TO JUSTIFY THEIR REASONS.

THEY WILL SPEND SOME TIME PREPARING TO ENSURE THEY'RE READY.

IN THIS FINAL SECTION, THE CLASSROOM COULD BE SET UP LIKE A COURTROOM AND STUDENTS SHOULD PRESENT THEIR EVIDENCE AS IF THEY WERE DOING SO IN COURT.

# It's a tough call walking away from gun crime.

For more information about the consequences of gun crime and where to get help visit:

**TOUGH-CALL.CO.UK**

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