truTV

Forensics in the Classroom

Developed as part of a continuing educational partnership with the **American Academy of Forensic Sciences**

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truTV
NOT REALITY. ACTUALITY.™

WARNING and SAFETY PRECAUTIONS

Working with your students on these projects gives you an excellent opportunity to instill in them good work practices, in particular the practice of dealing safely and efficiently with chemicals and other materials that may be potentially hazardous and/or expensive. It is important to comply with the warnings and safety instructions concerning the use of your materials, as well as any laws regarding the disposal of the materials. For safety and to avoid waste, you should inform your students of these warnings, instructions, and laws and the reasons behind them. The goal is to educate the students without creating or enhancing any unreasonable fears.

Safety is an important part of any laboratory exercise. Plastic safety products, as illustrated below, can help protect your students as they conduct chemistry experiments such as those described in the FIC units. To find out more about plastics, log on to the American Plastics Council at http://www.americanplasticscouncil.org.

Plastic safety devices, if used properly, can help save kids from injuries.

- *Safety eye goggles*
- *Splatter-proof face shields*
- *Plastic apron to prevent harm from dangerous spills*
- *Heat-resistant plastic gloves, chemical-resistant vinyl gloves*
- *Shatter-resistant plastic containers for acids*
- *Child-resistant plastic safety caps for use in storing dangerous substances*
- *Plastic film for spill-resistant laboratory beaker sealing*
- *Plastic tubs immune to harsh solvents for appropriate disposal*
- *Emergency plastic face mask and eyewash bowl*
- *Flame-retardant countertops made with plastic composite*

Unit 1 Teacher Overview: The Celebration

Level of Difficulty: Simple

UNIT DESCRIPTION:

This unit is designed to combine an introduction to forensic science with two simple investigative lab activities. After reviewing the forensics FAQ Sheet and a list of possible forensic tests, students will solve a mystery using a Gunshot Residue (GSR) Detection Test, Bullet Type Determination Test, and eyewitness testimony. Based on their findings, students will then compose an Investigative Report, in which they must detail their evidence and conclusions. After completion of the reports, the story s epilogue is revealed.

IN ADDITION TO THIS TEACHER OVERVIEW, UNIT 1 INCLUDES:

Lesson 1: Introduction to Forensics and the Mystery

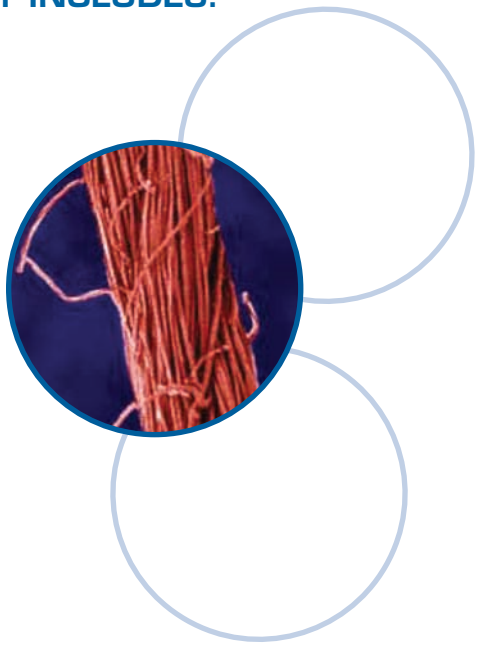
- *Forensics Terms and FAQ Sheet handout*
- *Mystery Synopsis handout*
- *Forensic Tests handout*

Lesson 2: Gunshot Residue Test

- *Gunshot Residue Test activity sheet*

Lesson 3: Bullet Type Determination

- *Bullet Type Determination activity sheet*
- *Investigative Report*
- *Unit 1 Epilogue*



DESIRED OUTCOMES:

After completing the unit, students should:

- *Understand and perform scientific inquiry*
- *Understand the process of experimental design*
- *Analyze and synthesize several pieces of data to draw conclusions*

NATIONAL STANDARDS ADDRESSED:

After completing the unit, students should understand:

- *Structure and properties of matter*
- *Chemical reactions*
- *Interactions of energy and matter*

IMPORTANT TERMS:

Negative control: *a standard for comparison that will present a negative result.*

Positive control: *a standard for comparison that will present a positive result.*

Saturated solution: *a solution that cannot dissolve more solute. Usually made by placing more solute in the solvent than can be dissolved. Some crystals of solute will remain undissolved on the bottom of the flask.*

MYSTERY SYNOPSIS:

An outdoor celebration is taking place immediately following a city s home team victory in a championship football game. During the excessive celebration outside a restaurant, various people fire a couple of shots up into the air. Although no one is injured, police are called to the scene and several people are taken downtown for questioning. One of the bullets rips through the canvas awning of Manzetti's Fine Italian Restaurant. Mr. Manzetti is steaming mad, and he wants the police to find out who fired the bullet and who is going to pay for damage to his property. A few eyewitnesses provide their accounts of what happened. One witness is Mr. Manzetti s son Frankie, who was in the doorway of the restaurant at the time. Another is Vince, a man who was outside in the crowd. Students are challenged with determining which of those taken into custody actually fired a weapon (a few have weapons in their possession), as well as the validity of each eyewitness account.Is the younger Manzetti unbiased? Which of the two eyewitnesses could really see the suspects? The hole left in the awning canvas allows students to perform a particle examination to determine the type of residue left by the bullet. They will identify which of the characters fired a gun and then match the awning bullet type to the gun registered to the guilty party.

MATERIALS NEEDED:

Reproducibles

1. *Forensics Terms and FAQ Sheet*
2. *Mystery Synopsis that includes statements from witnesses and suspect information*
3. *Forensic Tests sheet*
4. *Gunshot Residue Test activity sheet, including guidance on what data to record and how to do so*
5. *Bullet Type Determination activity sheet, including guidance on what data to record and how to do so*
6. *Investigative Report handout detailing what information needs to be provided to conclude the investigation*
7. *Unit 1 Epilogue*

Lab Equipment and Chemicals

Gunshot Residue Test — Lesson 2:

- *Filter paper (standard, 75—125 mm diam.)*
- *Concentrated sulfuric acid*
- *Diphenylamine*
- *Sodium nitrate (or any other nitrate compound)*
- *Watch glasses or spot plates*
- *Dropper bottles*
- *Safety equipment*

Bullet Type Test — Lesson 3:

- *Filter paper*
- *Rhodizonic acid disodium salt (also known as sodium rhodizonate)*
- *Solution of 15% acetic acid*
- *Lead nitrate (or another water-soluble lead compound)*
- *Copper nitrate (or another water-soluble copper compound)*
- *25 ml beakers*
- *Droppers*

ORDER OF ACTIVITIES:

1. *Introduction to Forensics and the Mystery Synopsis*
2. *Gunshot Residue Test*
3. *Bullet Type Analysis*
4. *Investigative Report*

You can present students with the story s epilogue upon successful completion of all activities, or hold a classroom discussion to share various theories and the mystery conclusion.

ADDITIONAL RESOURCES FOR TEACHERS:

http://faculty.ncwc.edu/toconnor/425/425lect06.htm
An excellent educational resource written as a lecture for North Carolina Wesleyan College.

http://www.suite101.com/article.cfm/forensic_science_mystery_writer/80785
http://www.suite101.com/article.cfm/11537/82964
Contains articles written for mystery writers who want to know about detecting gunshot residue.

http://www.firearmsid.com
Contains forensic firearms identification information.

http://www.aafs.org
The Resource/Forensics section provides additional links to forensic publications and organizations.

LESSON 1:
INTRODUCTION TO FORENSICS AND THE MYSTERY

OBJECTIVE:

Students will review the Forensics Terms and FAQ Sheet about forensic science. After being introduced to the story and the facts of the mystery, they will decide which forensic tests would be useful to perform.

MATERIALS NEEDED:

Reproducibles

- *Forensics Terms and FAQ Sheet*
- *Mystery Synopsis that includes statements from witnesses and suspect information*
- *Forensic Tests sheet*

Equipment and chemicals

None

TIME REQUIRED:

- *Teacher Prep Time: 30 minutes*
- *Class Time: 45 minutes, depending on amount of class discussion desired*

LESSON DESCRIPTION:

In this lesson, students will be introduced to forensic science and learn about various investigative techniques and evidence examination activities used by investigators. They will then read about the mystery and discuss the information available to them. To begin the evidence analysis, they will discuss the different forensic tests that are available and decide which ones are likely to yield significant results relevant to the case.

BACKGROUND INFORMATION:

Before beginning this lesson, you should be acquainted with the history of forensics and types of tests that can be performed. Be prepared for lots of questions from the students about a variety of forensics-related topics, as they will be curious about certain techniques that they have seen on TV. They may have many misconceptions that need to be corrected.

LESSON STEPS:

1. *Begin by activating students prior knowledge of forensics. Many of them will have seen recent TV shows that use forensics as the central theme. Ask them to write a definition of forensics in their notebooks before you start the discussion, so that everyone gets a chance to answer before an especially interested and knowledgeable person provides the definition.*

2. *Hand out the Forensics Terms and FAQ Sheet. Explain to students that in this unit they will get to perform some of the tests described. It will spark students interest when they realize that they get to be part of solving a mystery.*

3. *Distribute the Mystery Synopsis. Read it aloud or silently, and then discuss the scenario to ensure that all students understand the story. You may find it helpful to make a transparency of the crime scene so that you can point to the diagram to elucidate the event. Lead students to decide that the most significant pieces of evidence will be gunshot residue and the bullet hole in the canvas awning.*

4. *As a class, discuss the first problem for investigators: Is Mr. Manzetti s son a reliable witness? This is a good opportunity to discuss the value (or lack of value) of eyewitness testimony.*

5. *Distribute and discuss the list of forensic tests. Guide the discussion to the two that students will perform, the Gunshot Residue test and the type of bullet determination. You may find it helpful to break the class into small groups prior to this discussion. In a large class, several voices may dominate the conversation. If a student suggests a test that is not on the list, discuss why that test may or may not be useful.*

ACADEMIC EXTENSIONS/MODIFICATIONS:

To abridge this unit, you can assign students to read the Forensics Terms and FAQ Sheet handouts for homework. Then, combine Lesson 1 and Lesson 2 into one class period by beginning the lesson with a brief discussion of forensics followed by the mystery introduction and first lab.

STUDENT HANDOUT

FORENSICS TERMS AND FAQ SHEET

Q: What is forensic science, and how can it aid in criminal investigations?

A: Forensic science isn t limited to just criminal investigations. It is essentially the application of science to law in events subject to criminal or civil litigation. More commonly, though, it is applied to the investigation of criminal activity. The term "forensic science" covers a number of different technical fields, including (but not limited to) physics, chemistry, biology, engineering, psychology, and medicine. Forensic scientists might study the path a bullet took, DNA evidence found at a crime scene, or the mental and emotional state of a suspect. Investigators turn to forensic scientists to discover additional evidence that requires specialized training to analyze and interpret.

Q: How long have investigators been using forensic science?

A: Forensic science has been around for nearly 900 years. The first recorded application of medical knowledge to the solution of a crime was in the year 1248. The first known use of a forensic chemical analysis was in 1836, when James Marsh, a Scottish chemist, detected arsenic poisoning in connection with a criminal investigation. Techniques involving blood typing have been used since 1900, when Karl Landsteiner discovered human blood types. Developed only within the past 20 years, DNA tests are now commonplace and are revolutionizing the field.

Q: What are some types of evidence that investigators look for?

A: A few clues that investigators look for are:

- *Fingerprints, palm prints, and footprints*
- *Shoeprints*
- *Fibers from clothes*
- *Blood spatters*
- *DNA samples (can be from hair, skin cells, blood, semen, saliva)*
- *Residue from accelerants (compounds used to speed up fires set by arsonists)*
- *Gunshot residue on hands and clothing*
- *Bullet casin (such as marks left on a bullet by a gun when fired)*
- *Insect and mold growth in a body as well as body temperature (to determine time of death)*
- *Bullet residues around bullet holes*
- *Patterns of gunshot residue spray (can determine the distance the shooter was from the victim)*
- *Gunpowder burns*

STUDENT HANDOUT

Q: Why are fingerprints important?

A: If you look at the palms of your hands and soles of your feet, you will see a maze of lines in your skin that curve, break apart, and join back together. The places where skin ridges break apart and join together are unique for every person. This unique pattern allows forensic investigators to trace a print found at the scene of the crime back to a specific person. Even identical twins have different fingerprints!

Though one of the older forms of investigative techniques, fingerprint identification is not without some controversy. One recent court ruling declared that fingerprint examination and identification did not qualify as a science, in part because an examiner subjectively decides if two sets of prints match. There is no uniform set of requirements used by all analysts to determine a positive match, so critics argue that fingerprint identification should not be considered scientific evidence. It is important to note, however, that other court challenges to the science of fingerprint identification have been rejected.

Q: How long after a crime can DNA evidence be collected?

A: DNA is a wonderfully stable molecule. Researchers have been able to recover usable DNA from Egyptian mummies thousands of years old. Each individual strand of DNA is made with strong, unreactive bonds. The strands of DNA twist around each other to form the well-known double helix, concealing weaker hydrogen bonds in the middle of the molecule. There are so many billions of hydrogen bonds that even though one is not strong by itself, the cumulative effect is strong enough to keep DNA intact.

Q: How is the scientific method reflected in a criminal investigation?

A: The scientific method involves many steps: researching a problem, hypothesizing an answer, testing out the answer, and if the answer is wrong starting the process over again. Investigators of a crime follow this same process by taking a general survey of the crime scene, hypothesizing who might have committed the crime based on the evidence present, and testing the evidence that they find to see if it implicates a suspect. The process continues until a theory can be proved with evidence. One pitfall that investigators try to avoid (but don t always succeed in avoiding) is forming conclusions too early in an investigation. By concentrating too soon on a particular theory or suspect, investigators can neglect or even miss evidence that is not part of their working theory.

Q: Are some forensic tests, by their nature, NOT conclusive?

A: Yes, not all tests performed by forensic investigators are conclusive. Some tests, such as those using luminol and phenolphthalein (used to indicate the presence of blood) and certain gunshot residue (GSR) tests, are presumptive, meaning that they do not indicate absolute proof for what the investigator is testing. When investigators use presumptive tests, which are often quick, easy, and sensitive ways to initially screen evidence from a crime scene, they must then follow up with conclusive tests that provide concrete results.

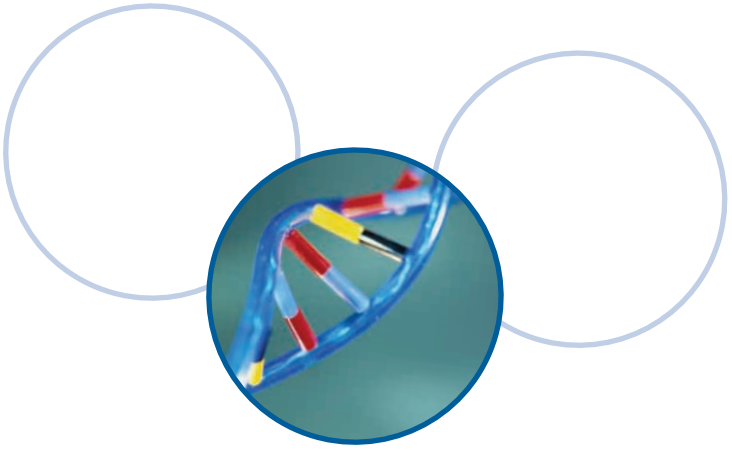
STUDENT HANDOUT

Q: What is the difference between a "suspect" and a "person of interest"?

A: Sometimes investigators designate people as suspects, and sometimes they refer to them as persons of interest. However, there is no published definition that distinguishes the the two. Generally speaking, investigators consider someone a suspect once he/she becomes an official focus of an investigation. Initial evidence or circumstances make it clear that the person is a likely perpetrator of a crime. Further, once someone is deemed a suspect, police must follow certain rules for interrogation. For example, police must advise a suspect of his/her Miranda rights, and if a suspect requests a lawyer, the police must stop questioning until a lawyer is present. If someone is simply a person of interest, however, police can do some initial probing for information without such restrictions. If the investigation is to probe more deeply into someone s background and possible connection to a crime, the judicial system then insists that the police consider that person a suspect.

Q: What changes are occurring in the field of forensic science?

A: Experts believe that forensic science will continue to evolve and provide new and exciting ways to help solve crimes. One current focus of the field is to scrutinize closely its many analytic techniques in order to strengthen their use in investigations, mainly by eliminating as many potential errors as possible. For example, by comparing cases from all over the world that involve similar uses of handwriting analysis or ballistics tests, investigators can establish improved practices from these many experiences. Many in the community of forensic science hope to improve on the techniques already in place by establishing standards and using careful error analysis.



Autopsy: *the internal and external examination of a body after death. An autopsy is performed to confirm or determine the cause of death and to establish other predeath conditions, such as the type of food last consumed and the time it was consumed.*

Ballistics: *the study of the motion of bullets and their examination for distinctive characteristics after being fired. Examiners can use this evidence to match bullets or bullet fragments to specific weapons.*

Blood Spatter: *the pattern of blood that has struck a surface. This pattern can provide vital information about the source of the blood. Blood spatter can help determine the size and type of wound, the direction and speed with which the perpetrator and/or victim was moving, and the type of weapon used to create the blood spill.*

Bloodstain Interpretation: *the interpretation of size, shape, orientation, and distribution of blood-stains on various surfaces. Information about the event can be derived from the proper interpretation of the stains.*

Bullet Track: *the path of a bullet or projectile as it passes through matter, such as a body or a wall.*

Caliber: *the diameter of the bore of a rifled firearm, usually expressed in hundredths of an inch or in millimeters. For example, a Colt 45 has a bore of .45 inches.*

Catalyst: *a substance that accelerates a chemical reaction but is not itself permanently changed by the reaction.*

Composite Drawing: *a sketch of a suspect produced from eyewitness descriptions of one or more persons.*

Criminology: *the study of criminal activity and how it is dealt with by the law.*

DNA: *deoxyribonucleic acid. Occurring in the form of double-helix strands, DNA contains genetic code. In each individual among the higher organisms, identical DNA occurs in the nucleus of every cell and serves to define that individual s characteristics. In addition to the portions of the DNA that encode the proteins making up all the individuals of a species, there are portions of junk DNA unique to each individual within the species. Often, an individual s DNA appears in the blood and other body fluids. This provides a powerful technique for uniquely identifying the person or animal who left traces of such fluids at a crime scene. Indeed, this is the best method presently known for such identification.*

DNA Electrophoresis: *the technique by which DNA fragments are placed in a gel and charged with electricity. An applied electric field then separates the fragments by size, as part of the process of creating a genetic profile.*

STUDENT HANDOUT

DNA Profiling: *the process of identifying DNA patterns or types. In forensic science this testing is used to indicate parentage or to exclude or include individuals as possible sources of fluid stains (blood, saliva, semen) and other biological evidence (bones, hair, teeth).*

Evidence: *anything that has been used, left, removed, altered, or contaminated during the commission of a crime or other event under investigation.*

Fingerprint: *the unique patterns created by skin ridges found on the palm sides of fingers and thumbs.*

Forensic Science: *the application of science to law.*

Gas Chromatograph: *a forensic tool used to identify the chemical makeup of substances used in the commission of crimes. The questioned substance is burned at high temperatures. The temperature at which this material becomes gas is then charted to determine its makeup.*

Gene: *a unit of inheritance consisting of a sequence of DNA that determines a particular characteristic in an organism.*

Hemoglobin: *a red blood cell protein responsible for transporting oxygen in the bloodstream. Also provides the red coloring of blood.*

Latent Fingerprint: *a fingerprint made by deposits of oils and/or perspiration, not usually visible to the human eye. Various technologies, including lasers, can be used to identify latent prints.*

Lie Detector: *also known as a polygraph. A machine that charts how respiration and other bodily functions change as questions are asked of the person being tested. An attempt to knowingly provide false answers can cause changes in bodily functions. Lie detector tests are usually not admissible in court because many scientists and others consider the results to be unscientific and inconsistent.*

Luminol: *a chemical that is capable of detecting bloodstains diluted up to 10,000 times. Luminol is used to identify blood that has been removed from a given area. It is an invaluable tool for investigators at altered crime scenes.*

Physical Evidence: *any object that can help explain an event under investigation. For example, physical evidence can establish that a crime has been committed, and sometimes it can provide a link between a crime and its victim or between a crime and its perpetrator.*

Point-by-Point Analysis: *when comparing a known object to one that needs to be identified, analysts will break down photos of each into small portions and compare the respective similarities within those portions.*

Ridge Characteristics: *ridge endings, bifurcations, enclosures, and other ridge details, which must match in two fingerprints for their common origin to be established.*

STUDENT HANDOUT

Serology: *a technology dealing with the properties and actions of serums in blood; also known as blood analysis.*

Super Glue Fuming: *technique used to develop latent fingerprints on non-porous surfaces. A chemical in the glue reacts with and adheres to the finger oils, and then exposes latent prints.*

Toxicology: *the study of poisons and drugs and their effect on human and animal populations.*

Trace Evidence: *material deposited at a crime or accident scene that can only be detected through a deliberate processing procedure. An individual entering any environment will deposit traces of his or her presence, and this material can be used as evidence. Common types of trace evidence are hairs and clothing fibers.*

Trajectory: *the path of a projectile.*

STUDENT HANDOUT

Unit 1 Mystery Synopsis: The Celebration

THE SETUP:

"WHOOOOO HOOOOO!"
"Yeah! That s right!"
"Yeeeeeeah!"
"Bring it on, Wildcats, and we ll win again!"

The atmosphere around Vince was electric. It seemed as if everyone was screaming as loud as they could. Even he was getting into it. "We rock!" he called out, adding to the chaotic mix of sounds.

For early January, it was a warm night, and people packed the streets. It seemed as if every fan who was at the game was out celebrating the team s come-from-behind victory. Plus, Mr. Manzetti s Fine Italian Restaurant had guaranteed a free pasta feast for all comers if the home team won. The way Vince saw it, since everyone was already out celebrating, they all decided to show up and dig in.

Most of the shouting outside the restaurant was simply ongoing celebration, but occasionally tempers flared among people in line. Vince and his friends from college, Anna and Marcus, suspected that some fans had been "celebrating" too much.

After they had been waiting in the restaurant line for nearly 30 minutes, two gunshots suddenly went off, briefly silencing the crowd. At first, some people didn t seem to know what had happened, but as soon as people figured out what they had heard, they started running in every direction, trying to find a place any place to duck for cover.

Police officers who were out patrolling the streets arrived quickly and calmed things down. They asked if anyone was hurt. They also instructed everyone to stay in the area. Nobody seemed to be injured. Once things settled down, people immediately began to speculate about what had happened. It was obvious that there was a lot of confusion. Many seemed to think that what they had heard were simply big firecrackers. Others were sure they d heard gunshots. Vince even heard someone suggest that it was an upset fan of the losing team.

Vince tried to remember exactly what he had seen. At the time of the shots he had instinctively turned toward the nearby cracking sounds, and he was pretty sure that he saw a couple of guys holding weapons up in the air. It looked to him aas if they were just shooting in the air, but he hadn t wanted to take any chances, so he d scrambled for cover along with everyone else. Vince suddenly realized that in all the chaos he had gotten separated from Anna and Marcus.

Without too much difficulty he found Anna under one of the tables. Marcus had jumped into a trashcan to hide. When Vince found him, he was covered in marinara sauce. The lasagna all over his head and face made it obvious that Marcus had escaped harm but not embarrassment.

STUDENT HANDOUT

"Nice look, Marcus," Vince said laughing.

After helping Marcus out of the trashcan, Vince wondered if he should talk to the cops, since he might have seen the guys who fired the shots. Vince wasn t sure, though, if he should get involved especially since he might be mistaken about who did it.

"Dude, you gotta talk to them," Anna said. "If you saw it, you could be on TV!" Vince was unconvinced, but after looking at Marcus, he realized that he did not want to go back to campus in the same car as "Marinara" Marcus, so he said he d see them tomorrow and went to talk to the police.

As the police were calming the crowd and speaking to witnesses, Mr. Manzetti barreled out of his restaurant with his son in tow. "He saw it! He saw it all! Frankie can point em all out! Every one of em!" Frankie didn t say a word. His father didn t really give him a chance. "Look at this mess! Everything was going great. Now everything is ruined!"

A couple of officers approached to try and to calm Mr. Manzetti, but he continued to complain loudly, barely giving his son the chance to speak. By the time Frankie Manzetti was finally able to report some of what he had seen, Vince had approached another officer to tell her his story that he saw a group of five guys, probably in their late 20s or early 30s, hanging out together in the area where he thought the shots went off. She politely asked Vince to stay with her and wait for a detective, who pulled up a few minutes later.

"Vince, is it? I m Detective Fuentes, and I m hoping that you can help us get to the bottom of what happened. Officer Gaddy tells me you saw the guys who did it. So, did they all have guns?"

"No," Vince replied, " and I m not exactly sure which ones did. But I think that one of the guys the big one fired his gun. Sorry, but I just don t know about the others. It all happened so fast.

Detective Fuentes kept asking questions, hoping that at least one of them might trigger something in Vince s memory. "How many shots did you hear? Were the shots fired BANG BANG one right after the other or was there a pause between them?" Vince tried to recall exactly what he had seen and heard, but all he could say for certain was that there were only two shots.

Next, Detective Fuentes moved on to question Frankie Manzetti about what he had seen. With his dad standing over him, Frankie told Detective Fuentes that he saw a bunch of guys, all shooting their guns together up in the air. Frankie s account was somewhat similar to Vince s. "Yeah, there were, like, four or five guys something like that."

"Where were you when the shooting took place?" asked the detective.

Mr. Manzetti jumped into the conversation, screaming again. "What?! You think Frankie might ve done this?! You think he s a suspect?!"

STUDENT HANDOUT

"No. No, sir," Detective Fuentes said, trying to reassure Mr. Manzetti (and trying not to laugh). "We just want an idea of where Frankie was when the shots were fired, in order to get a sense of his perspective. Besides, right now, we would only consider someone a person of interest, not a suspect. We re just trying to find out what happened."

Mr. Manzetti didn t respond. "Oh," said Frankie, a little relieved. "I was in charge of the door, trying to keep order. You know how people get crazy whenever there s free food. I don t know, there was just something about that group. I could tell that they looked suspicious. Plus, that guy Wally comes in here all the time he s got a really bad temper. And he always tells me that I gotta lay off the breadsticks. He definitely shot a gun. I m really good at knowing who s bad and who s good. So I kept my eye on em, watching em like a vulture, you know what I mean?"

"It s a hawk, Frankie. A hawk," his father said, shaking his head.

"So how many of them fired guns?" Detective Fuentes inquired.

"I . . . don t know. All of em? No, wait. Most of em."

"Are you sure about that?" Detective Fuentes asked, wondering if Vince might have been mistaken. "We have witnesses who say that there were only two shots."

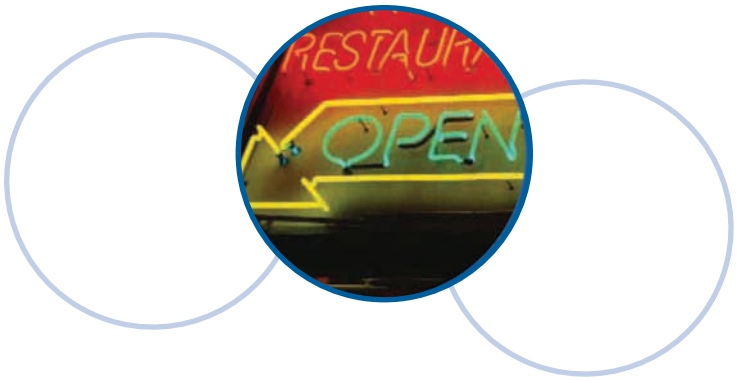
"Oh, yeah." Frankie acted like it was all coming back to him. "There were just, like, two shots. So I guess only two of em did."

"And were you inside the door or outside the door when the shots were fired?" the detective asked.

"I was inside. But I mean I was outside too, because I had the door half open checking people as they came in. I saw what happened!" Frankie declared.

When he finished speaking with Frankie, Detective Fuentes then questioned a few other people in the crowd to try to corroborate Vince s and Frankie s accounts.

In the meantime, the crime scene investigators were busy. No bullets could be found, but they did find a small hole in the awning outside Mr. Manzetti s restaurant. The hole appeared to have been made by a bullet. When Mr. Manzetti heard that his awning had been damaged, he started shouting again, demanding that the police figure out who had fired the bullet so he would know who to sue.



STUDENT HANDOUT

THE SUSPECTS

After the interviews, the police decided that they had enough to hold the five men who Frankie and Vince both thought were members of the group that had been responsible for shooting guns. All five denied being involved. Police quickly discovered that all five had criminal records, including one who had a warrant out for his arrest. The five men were:

Jay Nofsinger — *Jay was the big guy who Vince had pointed out to investigators. He denied everything, but he did have a handgun on him. The handgun contained lead bullets with copper full-metal jackets. He claimed that he carried a gun because he worked a third-shift job at the meat-packing plant and needed it for protection when he walked to his car in the parking lot. Jay had a prior conviction for theft.*

Rafe Wood — *Rafe appeared to be the guy who all the others looked down on. Apparently he had no job and just hung around all the time. He claimed not to have shot a gun. He had a Glock on him, but said that it belonged to Reuel. Bullets in the gun were made of lead with brass jackets. Rafe s trouble with the law included several misdemeanor offenses.*

Reuel Sprinkle — *Reuel said that he didn t really like the other guys because they carried their guns everywhere, which he disapproved of. After a bit of interrogation, he admitted that he and Jay were friends and worked the third shift together. As investigators began to expose holes in his story, Reuel also revealed that he d forced Rafe to take his gun after the shootings, but he insisted that he hadn t fired it. He just didn t want to be suspected as one of the shooters. Police learned that Reuel s gun was unregistered and that he had previously pled guilty before to carrying an unregistered firearm.*

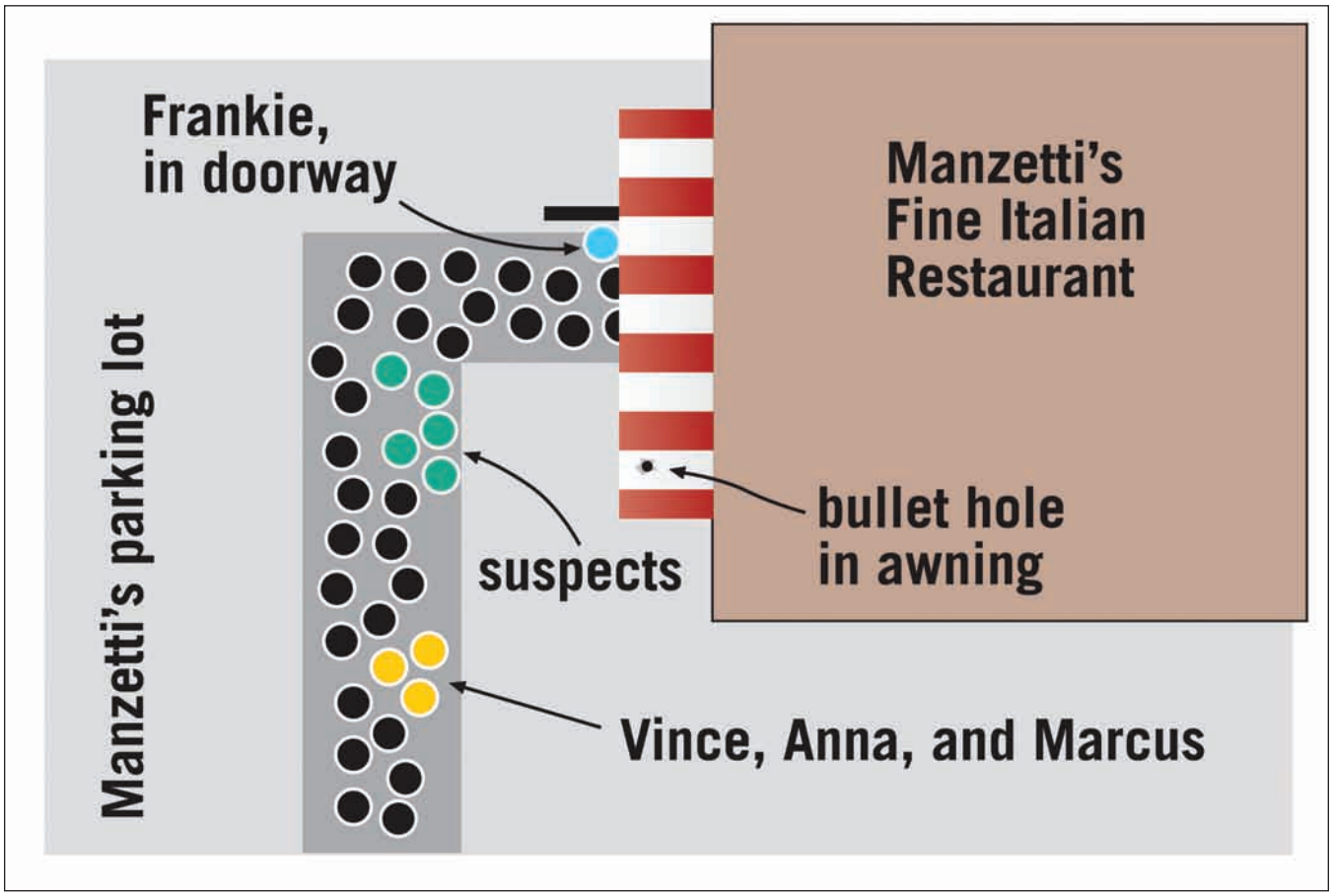
Simon Harger – *Simon was cool and collected with the police, not saying any more than he had to. His record showed that he had three prior convictions, all for firearms violations. Simon maintained that he would never fire a gun with a crowd around. True to form, though, he was carrying a gun containing round-nosed lead bullets. Like Jay, he said he carried it for protection, but unlike Jay, Simon worked part-time delivering pizzas.*

Wally Taylor — *Wally didn t have a gun on him and said he didn t normally hang out with the other guys. He said that he had recently met Simon through Simon s brother, with whom he worked at a landscaping company. He told police that as soon as the shooting started, he freaked out and tried to run away. He also claimed, however, that he didn t have a clue who had a gun or who fired a gun. When police learned from their records that Wally had an arrest warrant out for failure to appear in court, they had a hunch why Wally "freaked out" and tried to run away.*

STUDENT HANDOUT

CRIME SCENE DIAGRAM

Detective Fuentes hand-sketched the following diagram, based on information he obtained from eyewitnesses and by surveying the scene in the parking lot. Circles represent individuals standing in line to enter the restaurant. Note that the diagram is not to scale, but merely provides a graphic representation of the scene.



YOUR TASK

Based on the information given from some uncertain eyewitness accounts, the people who were taken into custody, and the little bit of evidence collected at the crime scene, you must decide which forensic tests to conduct. Ultimately, you should build a case for who fired the gun with the bullet that damaged Mr. Manzetti s awning.

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LESSON 1: FORENSIC TESTS

Before the police begin searching for evidence in this case, they need to know what kinds of evidence will be useful to the investigation. It is important that you decide what types of tests you will run so that investigators do not waste their time looking for evidence that might not exist and that you can t use. Following is a list of tests that might be useful in this case. Talk with your fellow investigators about the following tests and decide which ones are worth pursuing.

Ballistics: *Ballistics is the study of the motion of a bullet, as well as the examination of a bullet s distinct characteristics once it has been fired. Forensic investigators can track the path of a bullet and determine the exact location it came from. And because each gun leaves distinctive marks upon fired bullets, investigators can match bullets with the gun they are fired from. Being able to do this, however, is dependent on having a bullet that is in fairly good condition; if a bullet strikes concrete, bone, or some other similarly hard material, it can become deformed and damaged to the extent that markings are not visible and a match cannot be made.*

Blood Spatter: *This refers to the pattern of blood on a surface. By studying the pattern of blood, investigators can deduce information about the crime. For example, they can determine the type of weapon used to cause the injury that produced the blood, as well as information about the perpetrator and the victim, even if the victim is not found at the crime scene.*

Bullet Type: *Using small traces of metal left by a speeding bullet as it passes through a wall, body, or other object, an investigator can determine what type of bullet was fired. Bullets can be lead, lead with a copper coating, or brass/steel or copper full-metal jacketed, to name a few types. This test will determine, for example, whether, a bullet that passed through a wooden wall was made of just lead or lead and copper. Bullets from a suspect s gun can then be analyzed to determine if they are made of the same metal.*

DNA Profiling: *This technique relies upon biological traces found at a crime scene to create a genetic profile of the perpetrator. Hair, bodily fluids, or a small piece of skin can be a source of DNA. If a suspect s DNA matches the DNA found at the scene of the crime, it can indicate that he or she was involved in the crime.*

Fingerprints: *Each person has unique fingerprints. A fingerprint is the pattern of skin ridges on a per-son s finger pads. Prints can be hard to find at a crime scene, in part because they can be wiped off of surfaces quite easily. If a perpetrator is not careful or is in a hurry, however, fingerprints will often be left at the scene of the crime. Investigators also look for handprints and footprints.*

Gunshot Residue (GSR): *Gunshot residue results whenever a gun is fired. When a shot is fired the gunpowder combusts, turning from a solid into a gas. Not all the gunpowder will fully combust, however, and very small pieces of partially combusted gunpowder will be ejected out of the barrel and sides of the gun. These small particles land on the clothing and skin of the person firing the gun. GSR tests are excellent for determining whether someone has recently fired a gun. However, a GSR test can produce a false positive result (if it detects nitrate that is present that is not gunshot residue) or a false negative result (if the person being tested washed his or her hands and clothing after firing the weapon).*

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LESSON 2: GUNSHOT RESIDUE TEST

OBJECTIVE:

Students will determine which person taken into custody most likely fired a gun at the crime scene by performing a test for the presence of nitrate on the clothing and hands of all those taken into custody.

MATERIALS NEEDED:

Reproducibles

- *Gunshot Residue Test activity sheet, including guidance on what data to record and how to do so*

Equipment and Chemicals

Gunshot Residue test:

- *Filter paper (standard, 75—125 mm diam.)*
- *Concentrated sulfuric acid*
- *Diphenylamine*
- *Sodium nitrate (or any other nitrate compound)*
- *Watch glasses or spot plates*
- *Dropper bottles*

TIME REQUIRED:

- *Teacher Prep Time: 45 minutes*
- *Class Time: 30 minutes*

LESSON DESCRIPTION:

Students will perform a laboratory procedure involving a reaction between diphenylamine (DPA) and nitrate to detect the presence of gunpowder residue (nitrates) on wipes from the clothing and hands of five people taken into custody.

BACKGROUND INFORMATION:

Gunshot Residue tests are presumptive tests used in forensic investigations. A GSR test can lead to a false positive result since nitrates are relatively common compounds and can be present on clothing and skin for a number of reasons. On the other hand, if a person were to wash his or her hands and clothes prior to testing, this could lead to a false negative result. For these reasons, the test is not a definitive one. These are important points to emphasize to your students.

STUDENT HANDOUT

For more information on GSR tests, consult:
http://faculty.ncwc.edu/toconnor/425/425lect06.htm
This site is written as a lecture for North Carolina Wesleyan College, and you will need to scroll down to find specific information on gunpowder residue.

LESSON STEPS:

Lab Preparation

Each student or lab station will need the following:

- *At least 20 drops of diphenylamine solution*
- *One sample each of clean, untreated filter paper and treated filter paper*
- *One wipe from each of the five people taken into custody*
- *A platform for the filter paper to rest on*
- *Safety gloves and goggles*

1. *Prepare the diphenylamine solution: Dissolve 1 g of diphenylamine in 100 ml of sulfuric acid. Each group will use about 20 drops of solution during the course of the investigation. Fill the dropper bottles with the diphenylamine test solution.*

2. *Prepare a solution of a known nitrate compound such as sodium nitrate. A 0.1 M solution is sufficient. You will need enough solution to prepare a positive control for each lab group. Treat one set of filter paper samples with 20 drops each of solution and label the set "Treated with nitrates." Leave one set of filter paper untreated and label it "Clean filter paper."*

3. *Prepare a "wipe" from each person taken into custody. The wipe is a piece of filter paper with either gunshot residue applied to it (if you want to be very realistic), the sodium nitrate applied to it, or no treatment. Place some dirt and fibers on the filter paper as well to make it look as if it has been wiped across fabric and skin. Three of the wipes those from Jay, Simon, and Wally should be treated with GSR or sodium nitrate and should yield positive results. The other two wipes should yield negative results and can just be filter paper with dirt and such added to make them visually indistinguishable from the other wipes. Label each set of wipes with the name of the person from whom it was obtained.*

4. *Because the diphenylamine is dissolved in concentrated sulfuric acid, provide a "platform" for the filter paper being tested to rest on, such as a watch glass or a ceramic spot plate.*

5. *Caution your students about the concentrated sulfuric acid solution. A single drop of the solution will cause a chemical burn virtually on contact. Students should wear gloves and splash-proof goggles.*

STUDENT HANDOUT

Lab Execution

Instruct students to perform the lab. Monitor their observations to ensure that they are recording sufficient information. They should observe three positive results for residue, one of which is a false positive (Wally). Students should reach this conclusion based on information about his occupation provided in the Suspect List and the fact that he was not carrying a gun. They may also need some help with the concepts of negative and positive controls. Be sure they understand why these are important.

ACADEMIC EXTENSIONS/MODIFICATIONS:

- *As homework, students can write a short essay on why the results of this test are not definitive. Have them play the role of a defense attorney and submit an essay as a motion to dismiss the evidence or as a court argument against the evidence. Half the class could argue against the evidence, while the other half could argue to keep it.*

- *Have the students research additional GSR tests. A common type of GSR test is called a Griess test. Performing an Internet search for either "gunshot residue test" or "Griess test" should provide plenty of information.*

- *To abridge this activity, test wipes from only three of the five people taken into custody, including Jay and Simon.*

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LESSON 2: GUNSHOT RESIDUE TEST

INTRODUCTION:

Any time a gun is fired, a useful tool for investigators is a test for gunshot residue (GSR). Gunshot residue found on clothing or skin can indicate that a person has recently fired a gun. However, GSR tests can be ineffective if the person washes his or her hands and clothes before being tested or works in an environment containing the same types of chemical compounds that the test detects. GSR tests are merely presumptive, so any positive test results must be followed up by a confirmative test.

Luckily, in this scenario everyone involved in the episode was taken into custody before they could leave the scene. Since various people may have fired guns and eyewitnesses do not all agree on who fired a weapon and who didn t, the GSR test is an ideal way to eliminate those people who did not fire a gun.

A GSR test looks for traces of certain chemicals that are present in gunpowder or its combustion products. The method of testing that you will use a diphenylamine test. The DPA test detects particles of nitrate-containing compounds on clothing and skin. A color change after application of the DPA reagent indicates the presence of nitrates. Since nitrate-containing compounds are found in products as wide-ranging as fertilizers and camera film, however, the test can generate false positive results. In this activity, you will be examining pieces of filter paper that have been wiped across the clothes and hands of those taken into custody, in order to determine which suspects test positive for GSR.

PROCEDURE:

1. *In the data table, label the rows with the samples that you have to test. Two rows are already labeled for the treated and clean samples.*
2. *Your teacher will provide you with dropper bottles of diphenylamine test reagent. Be extremely careful with this reagent, as it contains concentrated sulfuric acid.*
3. *Place the sample of clean filter paper on a watch glass and add 1 or 2 drops of diphenylamine reagent directly to the filter paper. In the first row of your data table record any color change that you observe.*
4. *Place the filter paper sample that has been treated with nitrates on a watch glass and add 1 or 2 drops of diphenylamine reagent to the filter paper. In the second row of your data table record any color change that you observe.*
5. *Place the first wipe taken from one of the men in custody on a watch glass and add 1 or 2 drops of diphenylamine reagent to the filter paper. In the next row of your data table record any color change that you observe.*
6. *Repeat Step 5 with the wipes from the other four men in custody.*

STUDENT HANDOUT

DATA TABLE

Sample	Color observed
Clean sample	
Sample treated with nitrate	

ANALYSIS:

1. *Which of the wipes yielded a positive test for gunshot residue?*

2. *What was the purpose of testing the clean filter paper and the filter paper known to contain nitrates?*

3. *Does the gunshot residue evidence conflict with any of the eyewitness testimony and suspect information? How do you reconcile differences between what eyewitnesses saw and the results of this test?*

4. *Does a positive result of this gunshot residue test mean that someone definitely shot a gun? Why or why not? Does a negative result mean that someone definitely did not shoot a gun? Explain your answers.*

CONCLUSION:

Write two to three sentences summarizing the results of this test as they refer to the criminal investigation. You will refer to this summary later in the investigation.

LESSON 3: BULLET TYPE DETERMINATION

OBJECTIVE:

Students will use a sodium rhodizonate color test to determine what type of bullet damaged the awning at Mr. Manzetti s Fine Italian Restaurant.

MATERIALS NEEDED:

Reproducibles

- *Bullet Type Determination activity sheet, including guidance on what data to record and how to do so*
- *Investigative Report*
- *Unit 1 Epilogue*

Equipment and Chemicals

- *Filter paper (standard, 75—125 mm diam.)*
- *Rhodizonic acid disodium salt (also known as sodium rhodizonate)**
- *Solution of 15% acetic acid*
- *Lead nitrate (or another water-soluble lead compound)*
- *Copper nitrate (or another water-soluble copper compound)*
- *25 ml beakers*
- *Droppers*

** Rhodizonic acid disodium salt can be purchased online from the following vendors:*

- *Fisher Scientific: 800-766-7000 http://www.fishersci.com*
- *VWR International: 800-932-5000 http://www.vwrsp.com*
- *Sigma Aldrich: 800-325-8070 http://www.sigmaaldrich.com*

TIME REQUIRED:

- *Teacher Prep Time: 45 minutes*
- *Class Time: 30 minutes*

LESSON DESCRIPTION:

After determining which of the men taken into custody most likely fired a gun, students now need to figure out which one shot the bullet that damaged Mr. Manzetti s awning. Police have determined that Simon s gun uses lead bullets, while Jay s bullets are lead with a copper jacket. To discover whose bullet damaged the awning, students will test the residue around the bullet hole for traces of copper or lead. Then, based on their evidence analysis and eyewitness testimony, they will complete an Investigative Report summarizing their findings. You can share the Epilogue with students once they have completed their reports.

BACKGROUND INFORMATION:

This type of test is also used to "map" the bullet hole. A piece of filter paper is treated with acetic acid and pressed against the area surrounding and containing the bullet hole, so that the pattern of residue spray is recorded. In a true wipe, the position of the paper must be marked in relation to bullet holes, rips, and tears.

For more information on determining bullet type, consult:
http://www.firearmsid.com/A_BulletID.htm
This site provides background information on numerous ways to identify bullets.

LESSON STEPS:

Lab Preparation

Each student or lab station will need the following:

- *at least 15 drops of sodium rhodizonate solution*
- *1 sample each of clean filter paper, filter paper treated with lead nitrate, filter paper treated with copper nitrate, and the awning wipe*

1. *Prepare a saturated solution of sodium rhodizonate by placing enough into water that some sodium rhodizonate remains undissolved. Each lab group will need about 15 drops of solution. Place the solution in labeled beakers with droppers.*

2. *Prepare approximately 0.5 M solutions each of lead nitrate and copper nitrate. These will be used for the positive controls.*

3. *Treat one set of filter paper with the 15% acetic acid and the lead nitrate solution and label this set "Known lead sample." Treat a second set with the 15% acetic acid and the copper nitrate solution and label this set "Known copper sample." Treat a third set of filter paper with only the 15% acetic acid and label it "No metal sample." Treat a fourth set of filter paper with the 15% acetic acid and the copper nitrate solution and label it "Awning wipe."*

Lab Execution

1. *Caution students about the compounds on the filter paper, especially the acetic acid. Because acetic acid is so volatile and irritating to body tissues, be sure to provide plenty of ventilation.*

2. *Discuss with the students the concept of saturated versus unsaturated solutions.*

3. *Instruct students to perform the lab and be careful to record their results.*

4. *Discuss the results of the tests. Students should confirm that since the sample from the crime scene reacts in the same way as the copper nitrate treated sample, and the bullets from Jay s handgun are lead with a copper full-metal jacket, Jay is implicated as the person who shot through Mr. Manzetti s awning.*

5. *Distribute an Investigative Report to students. Instruct them to complete their report based on their results from the tests they conducted and deductive reasoning based on the information provided in the mystery synopsis. Students should explain that Wally s positive result was likely a false positive since he did not have a gun with him and because he most likely works with fertilizers in his landscaping job. You can adjust the length and specificity of the report based on your preference and your students abilities and interest.*

ACADEMIC EXTENSIONS/MODIFICATIONS:

- *Another method of identifying a bullet type in this lesson is to perform gas chromatography on the residue found around the bullet hole on the awning. This technique is often paired with mass spectromtry to analyze each sample as it comes through the gas chromatograph. Students could learn about the use of each tool and how it could be used in this setting. If they are interested, you can talk to the chemistry department at a local college or university about organizing a visit to observe their instruments.*

- *Ballistics can be used to help determine the identity of the shooter if his or her position when firing the gun is known. The shape and spread of the gunshot residue on a target can be used to infer the angle of entry of the bullet. Based on trajectory calculations, investigators can often pinpoint exactly where the bullet came from.*

STUDENT HANDOUT

LESSON 3: BULLET TYPE DETERMINATION

INTRODUCTION:

When a bullet passes through any kind of barrier, it leaves traces of metal behind. Bullets can be made of lead, lead with a copper coating, or brass/steel or copper with full-metal jacketed, to name a few types. A test to determine what type of metal trace is left behind on the barrier is useful for determining what type of bullet was fired. Once the type of bullet is known, it can be compared to the type of bullet(s) found in the gun suspected of firing the bullet.

In this case, you have determined who most likely fired guns during the celebration. To further narrow the field, you will now test a wipe from the damaged canvas awning. You will compare the results of this wipe with the results of several known metal samples. From your analysis, you can determine the type of bullet that hit the awning and then deduce which weapon matches up with the bullet.

PROCEDURE:

1. *Review the data table. The first column contains the name of the sample that you are testing. Record in the second column your observations of any color changes that occur .*

2. *Obtain the filter paper labeled "No metal sample" that is wet with 15% acetic acid. Apply 3 or 4 drops of the saturated sodium rhodizonate solution to the filter paper. Record any color changes in the "No metal sample" row of your data table.*

3. *Obtain the filter paper labeled "Known lead sample" that has been treated with 15% acetic acid and a known lead sample. Apply 3 or 4 drops of the saturated sodium rhodizonate solution to the filter paper. Record any color changes in the "Known lead sample" row of your data table.*

4. *Obtain the filter paper labeled "Known copper sample" that has been treated with 15% acetic acid and a known copper sample. Apply 3 or 4 drops of the saturated sodium rhodizonate solution to the filter paper and record any color changes in the "Known copper sample" row of your data table.*

5. *Obtain the sample of filter paper labeled "Awning wipe" that has been wiped across the bullet hole in the canvas awning and treated with 15% acetic acid. Apply 3 or 4 drops of the saturated sodium rhodizonate solution to the filter paper and record any color changes in the "Awning wipe" row of your data table.*

STUDENT HANDOUT

DATA TABLE

Sample	Color observed
No metal sample	
Known lead sample	
Known copper sample	
Awning wipe sample	

ANALYSIS:

1. *Do the results of the test of the crime scene wipe match any of the results from the other samples? What type of metal trace did you find on the awning canvas from the crime scene? From the results of your test, what can you infer about the metal traces (if any) left on the awning at the crime scene?*

2. *The sodium rhodizonate solution is described as "saturated." What does that mean? How do you create a saturated solution?*

CONCLUSION:

Write two to three sentences summarizing the results of this lab as they relate to the investigation at hand. Are any of the persons taken into custody eliminated or further incriminated? You will refer to this summary later in the investigation.

STUDENT HANDOUT

INVESTIGATIVE REPORT

To conclude your investigation, you need to summarize all of your results in an investigative report. A report such as this is intended to take all the evidence you have the eyewitness testimony and the results of all tests performed to determine the identity of the guilty party. The Investigative Report is used by the district attorney s office during the prosecution of the criminal, so it needs to be as thorough as possible. Even though some of the eyewitness testimony conflicts in this case, it is still important that you report it; however, your conclusions should rely strongly upon the results of the scientific tests and physical evidence.

Questions that must be answered by this report include the following: Which eyewitness most likely could have seen what happened? Is the testimony of Mr. Manzetti s teenage son compromised? Is it usable at all? What type of bullet ripped through the canvas awning? Who fired the gun that damaged Mr. Manzetti s awning? How did you arrive at that conclusion? In the first lesson you had to decide which tests should be part of the investigation. Why did you choose to exclude certain tests? Did any of the tests provide questionable results? What aspects of the evidence do not support your conclusion, and which areas of the incident should be investigated more fully?

DATE:_____

INVESTIGATOR NAME:_____

LOG OF EVIDENCE RECEIVED:_____

_____

_____

_____

_____

CONCLUSIONS:_____

_____

_____

_____

_____

STUDENT HANDOUT

EPILOGUE: UNIT CONCLUSION

After Detective Fuentes confronted Jay with the evidence, he sat silently with his lawyer for a moment. Finally, Jay said, "Maybe gunpowder flew onto me from someone else." It sounded as much like a question as it did a statement.

"I don t think so, Jay," said the detective. "Only you and Simon had any actual gunshot residue on you. Did everybody else run home for a shower between shooting and being tested?"

Jay looked at his lawyer. She gave him a look and a nod that said he should admit only to shooting his gun, but before Jay could say anything, she turned to the detective. "I assume if Jay talks, you ll take that into consideration?"

"That all depends upon what he tells us, but yeah, we ll make sure that prosecutors take it into consideration," the detective answered coolly, wondering what Jay would say.

Again, Jay s lawyer gave him a knowing nod. "All right. I shot my gun. But I shot it in the air. The air! Straight up. I was happy. My boys just won!" Not realizing that he shouldn t say anymore, Jay went on, "No way did I shoot the awning. You saw how crazy that man was. He probably did it himself, so he could get a sucker like me to pay for it."

Knowing that they had evidence that suggested otherwise, Detective Fuentes calmly said, "Jay, the type of bullet in your gun matches the fresh residue we found on the awning. One of YOUR bullets hit that awning. Not Simon s. And certainly not Mr. Manzetti s. Yours."

Jay s eyes flared in anger. "Did Simon tell you that?! He s just trying to save himself!"

"Let s worry about you, Jay. Simon doesn t matter to you. With your record, you re looking at a Class A felony conviction at the least for firing into an occupied area during your little celebration. What should matter to you is how you ll shorten your time behind bars."

Realizing that her client was looking at some pretty serious jail time, Jay s lawyer pulled him aside to discuss how he should plea.

After finishing his paperwork on the case, Detective Fuentes called Vince to thank him for coming forward and for being so observant during the chaos. "Every single one in that group you noticed had a rap sheet," he told Vince. "One of them even had a warrant out for his arrest. Your information helped us put some repeat offenders behind bars. Thanks to you they won t be shooting off their guns again anytime soon."

As the detective spoke, Vince wondered if he should mention that he d gone back to the restaurant recently and overheard Mr. Manzetti bragging to everyone that Frankie was the hero for pointing out the guys who did it. Vince was a little hurt at hearing that. But later, he noticed that Frankie was busing tables and washing dishes. He felt sure that had been Mr. Manzetti s doing. Vince didn t have to be a rocket scientist to figure out why Frankie "the hero" was no longer working the front door.

So on second thought, Vince decided that none of it was crucial information. Detective Fuentes knew who had supplied the information that helped to nail the bad guys. That was good enough for Vince.

Satisfied, Vince thanked the detective for his kind words and quickly hung up the phone. He had to get moving. He was meeting the gang at Manzetti s for a fine Italian dinner.