

## UNIT 3: RENTERS BEWARE

**truTV**

# ***Forensics in the Classroom***

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

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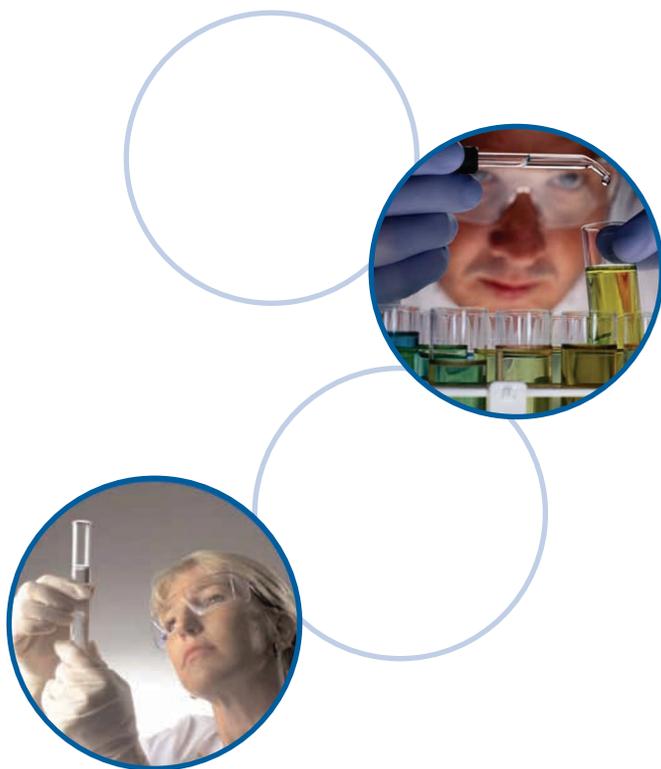
## WARNING and SAFETY PRECAUTIONS

*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 with 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 of 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 keep dangerous spills away
- ¥ Heat-resistant plastic gloves, chemical-resistant vinyl gloves
- ¥ Shatter-resistant plastic containers for acids
- ¥ Child-resistant plastic safety caps for 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 3 Teacher Overview: Renters Beware

### Level of Difficulty: Advanced

#### UNIT DESCRIPTION:

After being introduced to the mystery and the information at hand, students will perform three separate lab activities to analyze evidence found at the scene. Students will perform a Kastle-Meyer, color test to indicate the presence of blood, a flame test to identify the liquid poison found at the scene, and fingerprint identification to place one of the story's characters at the scene. Then, based on their findings, students will compose a Crime Lab Report to summarize their conclusions and solve the mystery. After completing their reports, students will be provided with the story epilogue to confirm their findings.

#### IN ADDITION TO THIS TEACHER OVERVIEW, UNIT 3 INCLUDES:

##### Lesson 1: Mystery Introduction and Kastle-Meyer Color Test

- ✂ Forensics Terms and FAQ Sheet handout (optional)
- ✂ Mystery Synopsis handout
- ✂ Kastle-Meyer Color Test handout

##### Lesson 2: Flame Test

- ✂ Flame Test activity sheet
- ✂ Evidence Sheet: Metals Research handout

##### Lesson 3: Fingerprint Identification Test

- ✂ Fingerprint Identification handout
- ✂ Crime Lab Report
- ✂ Unit 3 Epilogue



#### DESIRED OUTCOMES:

After completing the unit, students should:

- ✂ Understand and perform scientific inquiry
- ✂ Understand the Bohr model and quantum structure of the atom
- ✂ Understand catalytic processes
- ✂ Analyze and synthesize several pieces of data from which to draw conclusions

#### NATIONAL STANDARDS ADDRESSED:

After completing the unit, students should understand:

- ✂ The structure of the atom
- ✂ Chemical reactions
- ✂ Interactions of matter and energy

**IMPORTANT TERMS:**

**Bohr model of the atom** — also referred to as the planetary model of the atom; first to suggest quantization of electrons energies, saying that electrons orbit the nucleus at fixed distances and with fixed energies, and that any transfer between orbits requires the absorption of energy (if rising to a higher orbit) or the release of energy (if falling to a lower orbit)

**Catalyst** — a substance that is added to a reaction to increase its rate; a catalyst is reformed at the end of the reaction sequence; and thus is not consumed by the reaction

**Heme** — the active, iron-containing part of the hemoglobin molecule

**Orbitals** — regions of the atom where electrons are located, according to Schrödinger's wave equation

**Oxidation** — the loss of electrons from an atom during a chemical reaction

**Reduction** — the gain of electrons by an atom during a chemical reaction

**Photon** — a particle of light, with the energy of a particular photon being proportional to the frequency of the associated light wave

**MYSTERY SYNOPSIS:**

The main character of this plot is a curious teenager named Gerald who lives in a high-rise apartment building in New York City. He is in the basement of the building one day and notices that a usually locked door is slightly ajar. He checks it out and finds a crude, makeshift chemistry laboratory, complete with a vial of unidentified liquid, lab instruments, broken glass, what appears to be a bloody rag, and a list of information about metal compounds that can be used as poisons. He tells his mother about it, and given the nature of today's environment with concerns about terrorist activities, they decide that the police should be notified. The police come over to check it out and are immediately suspicious when they see the broken glass, a research list, and the rag. All six people who have access to the room's key deny knowledge of the lab.

In order to find out who set up the lab and if it is indeed being used for dangerous or illegal purposes, students must use the following forensic techniques:

1. Kastle-Meyer color test on the rag sample to indicate if the stain on it could be blood
2. Flame tests to determine the contents of the vial
3. Fingerprint identification to identify those who have been handling the lab equipment

Please note that students will perform the labs in sequence. A typical criminal investigation, however, bases its order of examination on the time-sensitive nature of the evidence.

After determining that the residue on the rag is likely to be blood and that the liquid in the vial contains barium nitrate (which students can hypothesize could be used as a poison), further evidence from the fingerprint analysis leads student investigators to link the lab to one of the six persons of interest; the landlord. The landlord eventually admits to a plot to poison pets in the building in order to drive out certain longtime tenants who have rent-controlled apartments.

## MATERIALS NEEDED:

### Reproducibles

1. *Forensics Terms and FAQ Sheet (unnecessary if students have already used it in a previous unit)*
2. *Mystery Synopsis*
3. *Kastle-Meyer Color Test activity sheet — includes guidance for the students' observations and information about the reaction on which the test relies*
4. *Metals Research handout — a piece of evidence found at the scene that includes information on where eight different metals can be commonly found and their possible biological effects*
5. *Flame Test activity sheet — includes guidance for the students' observations and questions about the structure of the atom and the behavior of electrons*
6. *Fingerprint Identification handout — includes the print gathered from the scene as well as the prints from three of the persons of interest, as well as information about fingerprint analysis and how fingerprints are formed*
7. *Crime Lab Report that students will use to summarize their conclusions of the criminal's identity and plan*
8. *Unit 3 Epilogue*

### Equipment and Chemicals

*Kastle-Meyer Color Test — Lesson 1:*

- ¥ *ethanol (95%) or distilled water*
- ¥ *Kastle-Meyer reagent\**
  - phenolphthalein\*\**
  - potassium hydroxide*
  - absolute ethanol (100%)*
  - zinc dust*
- ¥ *hydrogen peroxide (3%)*
- ¥ *sample of animal blood (can be obtained from a butcher)*  
*OR beef or calf liver (both contain high blood content) homogenized in a blender*
- ¥ *filter paper (cotton swabs may be used instead, if necessary)*
- ¥ *latex/vinyl gloves*
- ¥ *chemical splash goggles*
- ¥ *droppers*
- ¥ *biohazard or other disposable bag*



\* Premixed Kastle-Meyer reagent may be purchased from Antec, Inc.:

1-800-448-2954 or 1-502-636-5176

\*\* Phenolphthalin may be purchased online from Sigma:

<http://www.sigmaaldrich.com> or 1-800-325-3010; Product number P8903

#### Flame Test — Lesson 2:

¥ 0.5 M solutions of barium nitrate, silver nitrate, lithium nitrate, potassium nitrate, aluminum nitrate, lead (II) nitrate, copper (II) nitrate, nickel (II) nitrate

¥ Bunsen burners

¥ strikers

¥ 50-ml beakers

¥ wire loops

¥ safety equipment: chemical splash goggles, lab aprons

#### ORDER OF ACTIVITIES:

1. Mystery Introduction and Kastle-Meyer color test
2. Flame test
3. Fingerprint identification
4. Crime lab report

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

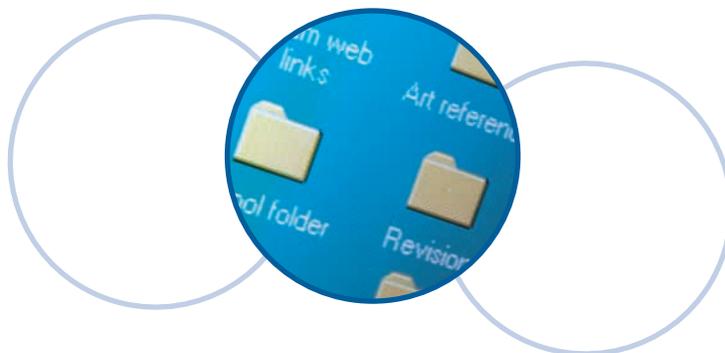
#### ADDITIONAL RESOURCES FOR TEACHERS:

<http://www.thegateway.org/>

A search for forensics or criminology will produce articles of interest.

<http://www.aafs.org>

The Resource/Forensics section provides links to forensic publications and organizations.



## LESSON 1: MYSTERY INTRODUCTION AND KASTLE-MEYER COLOR TEST

### OBJECTIVE:

*Students will review the Forensics Terms and FAQ Sheet about forensic science. (Not necessary if they have already done so in another unit.) Students will be introduced to the story and will use the Kastle-Meyer color test to analyze what appears to be blood on a rag found at the scene.*

### MATERIALS NEEDED:

#### Reproducibles

- ¥ *Forensics Terms and FAQ Sheet (optional)*
- ¥ *Mystery Synopsis and Character List*
- ¥ *Kastle-Meyer Color Test activity sheet — includes guidance for student observations and information about the reaction on which the test relies*

#### Equipment and Chemicals

- ¥ *ethanol (95%) or distilled water*
- ¥ *Kastle-Meyer reagent\**
  - phenolphthalein\*\**
  - potassium hydroxide*
  - absolute ethanol (100%)*
  - zinc dust*
- ¥ *hydrogen peroxide (3%)*
- ¥ *sample of animal blood (can be obtained from a butcher)*  
*OR beef or calf liver (both contain high blood content) homogenized in a blender*
- ¥ *filter paper (cotton swabs may be used instead, if necessary)*
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### TIME REQUIRED:

- ¥ *Teacher Prep Time: 105—120 minutes*
- ¥ *Class Time: one class period (45 minutes)*

## LESSON DESCRIPTION:

*In this lesson, students will be introduced to the mystery and the information available to them. As part of the evidence analysis to determine if a crime has been committed or was being planned, students will first use a Kastle-Meyer color test to examine residue on both a rag and a napkin found at the scene, searching for the presence of blood.*

## BACKGROUND INFORMATION:

*Before beginning this lesson, familiarize your students with the vocabulary terms. It is essential that you clarify these terms with your students, as they are used throughout the unit. It is also important to familiarize yourself with the list of forensic techniques so that you can answer any questions about why certain techniques are or are not applicable to this unit.*

## LESSON STEPS:

### Lab Preparation

*Prior to class, treat one set of filter paper samples with a 2(blood): 1(water) mixture. Label this set Unknown from rag. Treat an additional set of samples with very thin smears of ketchup or barbeque sauce, which mimic blood in appearance when dry. Label this set "Unknown from napkin." Prepare another set of paper samples with an undiluted blood sample and label it "Positive control." Leave another set of paper samples untreated and label it "Negative control." Each student should receive one sample from each set.*

- 1. As a class or in groups, read the Mystery Synopsis handout and discuss preliminary explanations for what Gerald found. Also, have students identify which forensic techniques might be useful in this situation. In particular, students should note the evidence from the scene that will be useful the stained rag and napkin, possible fingerprints, the identity of the solution in the flask, and the sheet of paper listing the eight metals. (Note: The Mystery Synopsis reproducible indicates that investigators are trying to obtain a set of prints, so any examination of fingerprints will have to wait until a set of prints becomes available.) Lead the students to the decision that the rag and the napkin should be tested for the presence of blood.*
- 2. Distribute the Kastle-Meyer Color Test reproducible. Familiarize students with the procedure and the purpose of testing a positive control (the sample that was known to contain blood) and a negative control (the sample that was known not to contain blood). Caution students about safety concerns associated with the lab. Specifically, students should wear clean gloves to prevent the contamination of the wipe and the rag they are given, and they should wear chemical splash goggles to avoid eye irritation that may be caused by hydrogen peroxide.*
- 3. Using the procedures listed on the activity sheet, have your students perform the lab. Note that if students observe a pink color change prior to adding the hydrogen peroxide, then other chemical oxidants that may produce a false positive may be present on the samples.*

- 4 Give students time to summarize their findings.
- 5 As a class, discuss the oxidation reaction that students observed.
- 6 Discuss with the students what their results suggest, namely that the presumed presence of blood on the rag, in combination with the broken glass, strongly indicates that the person operating the homemade laboratory had an accident of some sort. Since the sample from the napkin registers a negative result, students will likely hypothesize that the person used the napkin while eating something with ketchup or barbeque sauce. Lead students to conclude that the person they are looking for will likely have a cut somewhere on his/her body. Remind students, however, that the Kastle-Meyer test is a presumptive test. Reinforce the limitations of a presumptive test by having students define the term and indicate why the Kastle-Meyer test is presumptive. Finally, ask students to suggest what test they might use next to confirm the presence of blood.

### ACADEMIC EXTENSIONS/MODIFICATIONS:

- ✧ When blood is found at a crime scene, a common forensic technique used is DNA analysis, to compare the DNA in the sample to the DNA of any known suspects. This analysis relies heavily upon biological techniques such as polymerase chain reaction (PCR) and gel electrophoresis. You may want to discuss with your students these techniques, as well as the steps involved in DNA analysis. Students may have heard about these techniques on TV or the news, and may ask you about them.
- ✧ You can use this lab activity to reinforce safety lessons, such as how to handle glassware and what to do if it gets broken.
- ✧ Extend your discussion of presumptive tests and how false positives may result. Ask students to explain what ramifications this might have in a court case. How would a good defense attorney use the possibility of a false positive to cast doubt on this aspect of the investigation? What tests should be done to follow up a presumptive test?
- ✧ During the Kastle-Meyer lab, students can perform an additional test in which they analyze a piece of filter paper treated with a chemical oxidant, such as permanganate or ground potato water, to observe a false positive result. Or, as another example of how a false positive can affect the outcome of a case, share with your students the story of a mistaken prosecution, found at <http://www.crimelibrary.com/forensics/serology/6.htm>.



**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 the 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 spatter*
- ¥ DNA samples (can be from hair, skin cells, blood, semen, saliva)*
- ¥ Residue from accelerants (compounds used to speed up fires set by arson)*
- ¥ Gunshot residue on hands and clothing*
- ¥ Bullet casings*
- ¥ Tool marks (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*
- ¥ Pattern of gunshot residue spray (can determine the distance between the shooter and the victim)*
- ¥ Gunpowder burns*

**STUDENT HANDOUT****Q: Why are fingerprints important?**

*A: If you look at the palm side of your hands and feet, you will see a maze of lines in your skin curving, breaking apart, and joining 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 a set 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 of strong, nonreactive 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 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 (to indicate the presence of blood) and certain gunshot residue tests, are presumptive, meaning 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.*

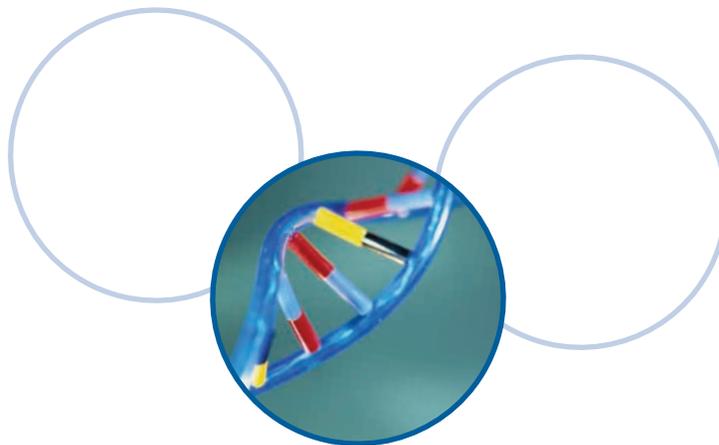
**STUDENT HANDOUT**

**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 between 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 in place. 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 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.*



**STUDENT HANDOUT****FORENSICS TERMS**

**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 bloodstains 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.*

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**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.*

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**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 3 Mystery Synopsis: Renters Beware****THE SETUP:**

*I'm going down to the basement to, uh, check on the laundry,* Gerald yelled to his mother as he walked out of their apartment.

*Thanks!* his mother answered, thinking her 16-year-old son was simply helping out with household chores. What he really wanted was an excuse to prowl around the basement of their building.

Ever since Gerald and his family moved to New York City, he had helped out with the laundry a lot. The washing machines and dryers were in the basement, and the basement was where he might find. . . well, he could find anything. Gerald didn't expect to find suitcases of cash that some crook had stashed in the bowels of the building, but he thought he'd at least see a rat—one of those New York rats that's so big it says, *Here, kitty, kitty.*

He'd been doing the laundry and looking around for over a month now but still hadn't found anything very exciting. A couple of times he had walked in on some other tenants flirting in the laundry room, like maybe they had a regular rendezvous in the basement. Another time he saw a guy pounding and kicking a washing machine. He didn't seem embarrassed when Gerald appeared—he just said, *For what we pay in rent, we shouldn't have to worry about busted equipment! Rent, it figures.* His mom was already stressing a little bit about the rent. Too bad she didn't have the deal that some of the older tenants had—it had something to do with rent control.

Whatever. Gerald still thought it would be cool to find a suitcase of cash hidden in one of the storage rooms or whatever those other rooms were down there. Maybe the reward money would cover a month's rent.

When he rounded the basement corner, something caught his eye. A door that always drew his attention but was never unlocked was open! It was barely cracked, but it was open. He almost didn't know what to do. He felt an adrenaline rush and got shaky hands—this could be his big break. After loads and loads of laundry he had finally arrived at the moment he'd been waiting for, but he hesitated. His mind began to trick him by telling him all the reasons why he shouldn't open the door.

Instead he ignored those thoughts, took a deep breath, and slowly pushed open the door. Gerald was ready for anything but prepared for nothing. He exhaled when he realized that nobody was in the room. It wasn't empty, though. He peeked around. A single light bulb revealed a maze of water pipes on the wall and some sort of makeshift chemistry lab in the middle of the room.

He saw a lot of flasks and beakers with tubes connecting them, and burners and other things that he recognized from his chemistry class. But what really caught his eye was the broken flask. It was broken off about halfway down the neck, and its contents were slowly dripping onto the floor. It appeared to be the only flask containing any liquid. He could see that there was a sheet of paper next to the flask. Even more curious, there was also what appeared to be a bloody rag on the floor a few feet away, and what looked like a napkin with blood on it on the countertop.

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Gerald didn't really know what to make of it, but he had a hunch about why the door was usually locked. Somebody didn't want other people in there fiddling around; Someone clearly wanted to keep the place secret. It looked like maybe someone had left in a hurry. Did whoever it was hear him coming down the stairs? He really wanted to check it out, but he had watched enough TV to know that you don't disturb the evidence. Still, he smiled at the thought of blowing the cover off a terrorist plot.

He left the room and the laundry and went upstairs to tell his mom what he'd found. He debated keeping it to himself, but something about the way that whole scene looked just wasn't right. His mom agreed, and together they called the police.

**PEOPLE OF INTEREST:**

In this day and age, anything that may be remotely connected to terrorism takes a high priority, so the police arrived immediately. The lead investigator, Detective Glover, interviewed Gerald about how he had stumbled upon the scene. So you saw that the door was unlocked, and you opened it?

Yes, ma'am. Gerald knew that now was the time to be very polite.

It's normally locked then, I take it? The detective didn't seem to suspect Gerald of any part in it, but he was taking no chances.

Yes, ma'am, he repeated. I come down here a lot to do the laundry for my mom. And ever since we moved here, I've always kinda wondered what was on the other side of that door, but it was always locked, so I never, you know, knew what it was.

Detective Glover asked him how long they'd lived there and whether he'd ever noticed anything suspicious. One question in particular surprised him. Gerald, what do you think is in there? the detective asked, motioning in the direction of the dimly lit room.

I don't know. My mom and I were afraid it might be connected to terrorism. That's why we called. Then Detective Glover surprised him again. She touched his shoulder reassuringly and thanked him for calling. As the detective turned away, one of the other investigators approached her and said something in a low voice. Gerald overheard the word *poison*, which really got his mind racing.

After interviewing Gerald, other tenants, and people who worked in the building, Detective Glover had a short list of people she deemed persons of interest. At that point in the investigation there was no hard evidence associating anyone with the lab, so there were no official suspects. However, since there were no signs of forced entry, the investigation centered on the six people who had access to the key that could unlock the door to the room. Mysteriously, the key was missing from the maintenance room rack where keys to all of the different utility rooms were kept. Interviews with each of the six people didn't reveal much, since all of them denied knowledge of the chemistry lab and the missing key.

**STUDENT HANDOUT**

Here are some notes that Detective Glover compiled on each of the persons of interest:



**Dave Lowry, building superintendent** — *Dave Lowry is an outgoing, older man. He is in charge of maintenance for two adjacent apartment buildings, and though he is not required to do any of the actual work himself, he frequently does. He has a large cut on his hand that he claims is from replacing a tenant's window the previous day.*



**Elizabeth Green, secondary superintendent** — *Elizabeth Green tends to keep to herself. Quiet but extremely reliable and superb with tools, she is usually the person who handles the difficult maintenance jobs. She has numerous small cuts on her hands and has an explanation for most of them. None of the cuts seem big enough to have bled very much, if at all. One tenant claims to always hear Elizabeth grumbling under her breath and swears she once kicked his cat. She also has a widely known phobia of dogs.*



**Harold Manning, plumber** — *Harold is pretty well known to most of the tenants, and most of them like him. He has worked there for 20 years. He is also a part-owner of the building, having been paid with owner's shares in the building when they couldn't afford to pay him cash about six years ago. As with most plumbers, his hands and arms are pretty banged up.*



**Jeff Knight, majority owner** — *Jeff is not well-liked by several of the older tenants, who claim that he has tried to break their leases. Their maintenance problems always seem to be the last ones fixed. Newer tenants seem indifferent to Jeff. He claims that the gash across his palm is the result of a recently broken air conditioning unit, which he returned early from a vacation to fix.*



**Derrick Jensen, custodian** — *Derrick doesn't really like the tenants, and they are pleasant to him only because they feel they have to be. In general, he thinks that the people who live there are unnecessarily dirty, intentionally leaving him messes to clean up. They think that he is too grumpy but treat him nicely because he does clean up a lot of messes. He has no obvious injuries. Derrick used to be a custodian at a local high school.*



**Kirsten Knight, co-owner** — *Kirsten isn't very well-known. She is married to Jeff Knight and is also part-owner of the building. Because she is a radiologist, she reportedly does nothing in the day-to-day operations of the building. She has access to the key, however. The tenants who live in the room directly below the Knights have said that the two of them argue frequently.*

**STUDENT HANDOUT****THE EVIDENCE:**

*The pieces of evidence collected at the scene confirm that Gerald was very observant. Since no one claims any knowledge or ownership of the lab, investigators have the following to go on: a rag and a napkin that may have blood on them (which could indicate that more than one person is involved if both test positive for blood and each sample contains a separate blood type); an unidentified liquid; and a sheet of printed paper that lists suspicious information about certain metal compounds. As the investigation begins, detectives are still trying to find a fingerprint anywhere in the lab.*

**YOUR TASK:**

*Based on the information available at the scene, you must conduct a series of forensic experiments to help investigators determine the user and the purpose of the lab.*



**STUDENT HANDOUT****LESSON 1:  
MYSTERY INTRODUCTION AND KASTLE-MEYER COLOR TEST****OBJECTIVE:**

The Kastle-Meyer color test is commonly used to presumptively indicate whether blood is present on an object. It is fast and easy to use, making it an ideal test to use at a crime scene or on samples taken from a crime scene. The test relies upon the heme, the iron-containing portion of a red blood cell, to catalyze the oxidation of phenolphthalein (also known as Kastle-Meyer reagent). Phenolphthalein is normally clear and colorless, but in the presence of blood and hydrogen peroxide, it becomes pink. If results of a Kastle-Meyer color test suggest the presence of blood, investigators then know that further analysis of the residue may provide additional useful information.

The disadvantage of the Kastle-Meyer color test is that it is presumptive, not conclusive. If any chemical and plant oxidants from sources other than blood are present, the test can produce a false positive result. In this experiment, however, you will minimize false positive results by adding the hydrogen peroxide catalyst last. Other chemical oxidants that may be present will usually produce a pink color before the hydrogen peroxide catalyst is added.

The reaction that you will test for is described below:

**Heme iron + phenolphthalein (clear) + hydrogen peroxide → oxidized phenolphthalein (pink)  
+ water**

*(Heme is a catalyst and is unchanged. Hydrogen peroxide is reduced to water.)*

**SAFETY PRECAUTIONS:**

Given the materials you will be working with for this test, safety goggles and latex gloves must be worn.

**PROCEDURE:**

1. In order to determine that there are no other chemical oxidants present, first test the clean filter paper sample (Negative control).
2. Apply one drop of ethanol or distilled water to the sample.
3. Apply one drop of Kastle-Meyer reagent to the same area on the sample and observe any color change. If there is a color change, record it in the chart provided. If not, record that no change occurred.
4. Apply one drop of 3% hydrogen peroxide to the sample area. Observe and record any color change. (Because there are no chemical oxidants present on the sample, you should observe and record no color changes.)

**STUDENT HANDOUT**

5. Repeat steps 2—4 on the Positive control paper sample containing a known spot of blood. You should observe and record a pink color after adding the hydrogen peroxide.
6. Repeat steps 2—4 on each of the Unknown filter paper samples. One has been wiped on the spots from the rag found in the basement, while the other has been wiped on the spots from the napkin found in the basement. Observe and record any color changes in the appropriate rows.
7. When finished, clean up your lab area by disposing of the stained filter papers in the biohazard or other bag supplied by your teacher.

**OBSERVATIONS:**

Enter the results of each test in the chart below. Make sure that you record precise descriptions of the color(s) that appear, and note when no color changes result.

	Standard Litmus Paper Test	pH Indicator Paper Test
Negative control		
Positive control		
Unknown from rag		
Unknown from napkin		

**DATA ANALYSIS:**

Based on your recorded observations, answer the following questions:

1. Did the wipes from any of the Unknown samples taken from the scene test presumptively positive for blood?

**STUDENT HANDOUT**

- 2 *Describe what you presume to be on the rag and what you presume to be on the napkin. Explain why you've reached these presumptions.*
  
  
  
  
  
  
  
  
  
  
- 3 *What was the purpose of performing the test on a known spot of blood and on clean filter paper?*
  
  
  
  
  
  
  
  
  
  
- 4 *Why is this test not conclusive with respect to the presence of blood?*

**CONCLUSION:**

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

**STUDENT HANDOUT****LESSON 2: FLAME TEST****OBJECTIVE:**

*Students will use a flame test to correctly identify the solution contained in a vial found at the scene.*

**MATERIALS NEEDED:****Reproducibles**

- ✂ *Metals Research information sheet found at the crime scene*
- ✂ *Flame Test activity sheet includes guidance for the students' observations and questions about the structure of the atom and the behavior of electrons*

**Equipment and Chemicals**

- ✂ *0.5 M solutions of barium nitrate, silver nitrate, lithium nitrate, potassium nitrate, aluminum nitrate, lead (II) nitrate, copper (II) nitrate, nickel (II) nitrate*
- ✂ *Bunsen burners*
- ✂ *strikers*
- ✂ *50-ml beakers*
- ✂ *flame test loops*
- ✂ *safety equipment: chemical splash goggles, lab aprons*

**TIME REQUIRED:**

- ✂ *Teacher Prep Time: 45 minutes (if the solutions are already made)—2 hours (including mixing of the solutions)*
- ✂ *Class Time: 45 minutes*

**LESSON DESCRIPTION:**

*Police are immediately suspicious when they find a printed list of what appears to be research on various metals, all of which can be used as poisons when mixed in the right combinations and strengths. In order to determine whether the unidentified liquid in the broken vial contains any of the metals listed, students must perform a flame test and compare results from the unknown against results from the set of chemicals listed.*

**BACKGROUND INFORMATION:**

*Before beginning this lesson, review with your class the Bohr model of the atom, which, though a breakthrough in 1913, is now primarily a heuristic model for describing the fact that electrons in atoms can only occupy specific energy levels. (An analogy may be made to the quantized heights allowed for a ball located on any level of a set of stairs.) Review the concept that the restriction in energy levels occurs in molecules as well, as atomic and molecular electrons absorb a fixed amount of energy when going from a lower to a higher level, and emit a fixed amount of energy when going*

**STUDENT HANDOUT**

from a higher to a lower level. Emphasize that this emitted energy is normally in the form of a light particle, known as a photon. A specific color is associated with the energy of each transition.

In this activity, students add energy in the form of heat to a metal-containing solution. This causes electrons in some of the metal atoms to jump to higher orbitals. At any given time, some of these excited electrons are falling back into lower-energy orbitals, giving off the energy difference in the form of photons as they fall. These photons add color to the flame being used to heat the solution, the color being unique to the type of metal atom emitting the photons. Thus, the color of the light reveals the type of the atoms being heated.

**LESSON STEPS:****Lab Preparation**

1. Prepare for the lab by making the solutions. You will need about 25–50 ml of each solution, depending on your class size. Create two sets of the barium nitrate solution, labeling one set as the unknown liquid. Set up 10 stations throughout the room (one for each solution and the unknown, plus one station for testing the clean flame test loop). Students will rotate through the stations during the lab.
2. Each lab station will need a Bunsen burner, a striker, one of the solutions, a flame test loop labeled with its solution, and a paper towel for the loop to rest on to prevent contamination. It may be useful to mount the burner at a 45° angle on a ring stand, using a ring stand clamp, to prevent contamination.

**Note:** Flame test loops can often be borrowed from your school's biology teacher. If they are not available, you can substitute crystals of the compounds above and have students wet a cotton swab, touch it to a crystal, and place the crystal in the flame. This isn't ideal as it burns more compound, the cotton swabs burn fairly readily and have to be replaced, and the crystals tend to pop as the moisture inside them boils away. Plus, this is a bit more dangerous, tends to waste the chemicals, and increases contamination. Crystals can also get inside the Bunsen burner barrel and provide a recurrent contaminant. If you are using cotton swabs, be sure to mount the burners on ring stands at a 45° angle.

**Lab Execution**

1. Begin class by recapping the findings from the previous lab and discussing what pieces of evidence remain to be examined. Ask students to brainstorm ways in which the liquid in the vial could be identified. Then present students with the research sheet on various metals that was found in the lab. Explain that the premise of the flame tests is to determine if the liquid in the vial contains any of the compounds on the suspicious list.

- 2 Review with students the procedure for each flame test and the safety precautions that must be followed. Students should record the color for each known solution and then test the unknown solution in an attempt to match the unknown's flame color with that of one of the known solutions. Emphasize the importance of correct and precise observations of the flame colors.
- 3 Instruct students to perform the lab using the procedures listed on the activity sheet.
- 4 Give students time to summarize their findings.

*Note: If class time is limited, assign the data analysis questions as homework.*

- 5 As a class, discuss sources of error that the lab might have. For example, both a cotton swab and a flame test loop will affect the color of the flame itself. Discuss how any sources of error may have affected their results. Brainstorm with them ideas about how to eliminate this source of error.
- 6 For homework, instruct students to research the following:
  - ✧ Why would barium be useful to someone trying to poison others?
  - ✧ How would someone obtain barium?
  - ✧ Where is barium commonly found?

*Students should keep notes of their findings as a source for their Crime Lab Report.*

### ACADEMIC EXTENSIONS/MODIFICATIONS:

- ✧ To abridge the activity, you can reduce the number of solutions to be tested.
- ✧ Have the students research the biological effects of barium as a poison and compare the effects to those of the other heavy metals. Since barium poisoning is relatively similar to lead and mercury poisoning, this can be a good lesson on periodicity. What other chemicals might emit the same color as barium?
- ✧ Many students have difficulty grasping the Bohr and quantum theories of atomic structure. To modify the lesson for these students, you may want to answer some of the questions in small groups. Check in on each small group to monitor students' levels of understanding.



**STUDENT HANDOUT****LESSON 2: FLAME TEST ACTIVITY****INTRODUCTION:**

*The flame test is a quick way to identify elements (usually metals) contained in a compound. Flame tests have been around for centuries, yet some understanding of the nature of the atom is necessary to understand the underlying process. In 1913, Nils Bohr devised the base model of the atom. His model was then refined by the quantum theory of Erwin Schrödinger and Werner Heisenberg in the 1920s.*

*In a flame test procedure, a small sample of the compound to be tested is placed in a well-tuned Bunsen burner flame. The heat from the flame excites the electrons in the atoms, raising them to higher energy levels. As electrons fall from the higher energy levels to lower levels, they emit the energy difference as photons (light particles). The photons emitted are of a specific energy for each element; thus, the light associated with them is of a unique color.*

*In this experiment, you will record and compare the unique colors of the eight metals listed on the information sheet found in the lab against the color of the unknown liquid in the vial. What you find may help you determine the purpose of the liquid itself.*

**SAFETY:**

*The amount of poison generated by this experiment is negligible; however, goggles must be worn whenever you use Bunsen burners.*

**PROCEDURE:**

- 1. In the data table provided, write the names of the metals to be tested in the left column: lithium, aluminum, potassium, nickel, copper, silver, barium, lead, and the unknown. Record your observations in the right column as you move around to each station. One row is included for clean flame test loop and one row is for the unknown.*
- 2. Place the flame test loop into the solution to be tested. (The order of station testing does not matter, but be sure to follow the procedure at each station, including the clean loop station.)*
- 3. Heat the solution to be tested in the flame test loop by holding the loop in the flame. Observe and record the color that results. It is important to be exact in your description of the color. You may want to repeat the test.*
- 4. After you are done, allow the flame test loop to cool in the air, then place it back on the paper towel it came from. Do not cool the loop with water or by touching it with your hands, as that will contaminate it.*
- 5. Repeat steps 2–4 at each station. You may repeat any tests if you feel you need to do so to make an accurate match with the unknown liquid.*

**STUDENT HANDOUT****DATA TABLE**

Metal	Observations (color, etc.)
clean loop	
unknown	

**DATA ANALYSIS:**

1. According to your observations, what is the identity of the unknown liquid? How sure are you of your identification?
2. What was the purpose of observing the clean flame test loop's color in the flame? How might this affect other colors observed?
3. What was the major source of error in this experiment?
4. According to Bohr's model of the atom, why does each element produce a distinctive color?

**CONCLUSION:**

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

**STUDENT HANDOUT**

**Lithium** — Lithium is a necessary part of neurological function. Persons deficient in lithium often exhibit bipolar disorders of varying degrees, and supplements of lithium are commonly used to treat these disorders. Lithium chloride can be a part of lethal injections administered during executions as it disrupts the nervous system, preventing proper lung and heart functioning. Lithium is most commonly used in batteries and in psychiatric settings.

**Aluminum** — Aluminum is found in many applications and is not toxic in low quantities. Because it is strong but lightweight, it is often used in soft drink cans, car engines and chassis, airplane frames, and cookware. If exposure is both heavy and prolonged, aluminum can cause stuttering, seizures, comas, bone disorders, liver damage, and blood clots that can result in strokes and heart attacks. Aluminum can be found in many industrial settings.

**Potassium** — Like lithium, potassium plays a vital role in brain function. A person deficient in potassium can suffer from seizures and other neurological defects. However, in large quantities it can be toxic. For example, potassium chloride can be a major component in lethal injections, stopping the heart and breathing and generally preventing the brain from communicating with the rest of the body.

**Nickel** — Some evidence suggests that nickel is necessary for life in trace amounts. Its toxic effects vary with the oxidation state and the compound it is contained in when ingested. In very high doses it can cause nausea, abdominal cramps, diarrhea, headache, and shortness of breath. In a case in which a toddler ingested 15 g (an almost absurdly high dose) of a nickel compound, it caused death by cardiac arrest. Nickel is sometimes used in refineries.

**Copper** — Copper is an essential element for life. Among its many roles in the body, it helps carry oxygen in the blood, is in the active site of many enzymes, plays a role in neurotransmission, and is necessary for the synthesis of adrenaline. If levels of copper get too high, negative effects include liver damage, personality changes, nausea, psychosis, and anemia. Causes of elevated copper levels include medications, environmental factors, and smoking. Copper is commonly used in electrical industries.

**Silver** — Though generally harmless, in cases of heavy and prolonged exposure silver can cause liver disease, convulsions, paralysis, and kidney disease. Silver is widely used in photographic industries.

**Barium** — Barium is found in most soils and foods at very low levels. When ingested in high levels, barium causes convulsions, hallucinations, nausea, cramps, and paralysis. It is toxic in every water-soluble form. A toxic dose of barium chloride is slightly less than 1g.

**Lead** — Lead has effects similar to those of barium and mercury, causing vomiting, convulsions, cramps, and paralysis. Lead used to be used in pipes and paint, and can gradually leach into the water supply, slowly poisoning people. As with all heavy metals, prolonged exposure is harmful.

## LESSON 3: FINGERPRINT IDENTIFICATION

### OBJECTIVE:

*Students will perform a fingerprint analysis to match a partial fingerprint found in the basement lab with the fingerprints of one of the persons of interest. Students will then conclude their investigation with a Crime Lab Report.*

### MATERIALS NEEDED:

#### Reproducibles

- ✂ *Fingerprint Identification sheet showing the partial print gathered from the scene as well as the prints from three of the persons of interest*
- ✂ *Detail of what information needs to be included in the Crime Lab Report that will summarize student conclusions of the lab's owner and his or her plan*

#### Equipment and Chemicals

- ✂ *None*

### TIME REQUIRED:

- ✂ *Teacher Prep Time: 15–30 minutes*
- ✂ *Class Time: 45 minutes*

### LESSON DESCRIPTION:

*Through a careful examination of the evidence found in the lab, investigators were able to lift one partial fingerprint from the broken vial. After reviewing the basic concepts associated with fingerprinting, students will examine the print found at the scene and compare it to fingerprints of three people for a possible match. Students will then use the findings from each of their labs to write up a conclusive Crime Lab Report. In their report students must explain which individual they believe is the user of the lab and which pieces of evidence support their conclusion.*

### BACKGROUND INFORMATION:

*For additional background information on fingerprinting, visit the following sites:*

<http://www.fbi.gov/hq/cjisd/ident.htm>

*This is the FBI's Criminal Justice Information Services site. It contains a good overview of fingerprint identification.*

<http://www.onin.com/fp/>

*This site contains both expert-level and student-level information on latent print examination.*

<http://www.theiai.org>

*The International Association for Identification's official web site.*

**LESSON STEPS:**

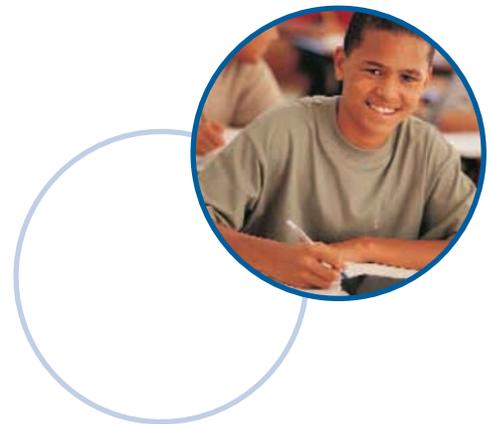
1. Begin the lesson by recapping the previous two lab activities. What pieces of evidence remain to be examined?
2. Distribute the first three pages of the Fingerprint Identification reproducible. Give students time to read it, and then discuss the information as a class.

Ask students to consider the following questions:

- ✧ What are the implications of finding fingerprints at a crime scene? In what scenarios might fingerprints not be meaningful evidence?
  - ✧ How might a person avoid leaving a fingerprint behind?
  - ✧ What are some other methods that investigators might use to determine whether a suspect had been present at a crime scene?
3. Divide students into pairs and distribute the remaining pages of the handout. Students should work in teams and follow the instructions on the sheet. By completing the instructions, students should determine that the fingerprint matches a print from Jeff Knight, the landlord of the building. (3.R.Middle is the match.)
  4. Discuss with the class the pros and cons of fingerprinting as an investigative tool. For example, does a positive identification of prints automatically prove guilt? Does the lack of a set of uniform fingerprint identification standards across the country affect the validity of fingerprint evidence in a trial?
  5. Distribute a Crime Lab Report to each student. Instruct students to compose their reports based on results of all pieces of evidence examined. Students should also use deductive reasoning to theorize possible motives for having a lab and experimenting with barium. You can adjust the length and specificity of the report to your preference and to students level and interest.
  6. Once students have reported their conclusions, give them the Epilogue to the mystery.

**ACADEMIC EXTENSIONS/MODIFICATIONS:**

- ✧ To shorten this lesson, hold a general class discussion about fingerprinting techniques. Then, using an overhead projector, let students identify and match the prints as a class.
- ✧ As an extension, obtain a simple fingerprinting kit and have students practice making and lifting prints found in the classroom.



**STUDENT HANDOUT****LESSON 3: FINGERPRINT IDENTIFICATION****INTRODUCTION:**

*Friction ridge skin identification or its more commonly recognized term, fingerprinting is the most well-known forensic technique available to crime scene investigators. Prints are examined in nearly every crime involving physical evidence, and the technique has a rich history. The first suggested use of prints to identify individuals was over 3,700 years ago, when people used fingerprints to establish their identity on Babylonian and Chinese clay tablets. And if you watch any of the many crime shows on TV today, they suggest rightly or wrongly that it is taken for granted that investigators will search for prints and criminals will try to obscure them. What exactly, then, is friction ridge skin?*

*Friction ridge skin is the pattern of ridges and valleys found on the palm sides of your hands and the bottoms of your feet. A print found at a crime scene is usually left by either body oils or amino acids found naturally in a person's skin. The oils follow the pattern of the skin's ridges and leave a copy of those ridges on many materials. Sometimes the copy is visible to the naked eye, sometimes not.*

*The major advantage that friction ridge skin identification provides in forensic science is that each person has a completely unique print. Friction ridge skin is formed while a fetus is in the womb. Genes determine the basic characteristics of the ridge patterns, but the microenvironment of the growing cells in the womb also affects how they develop. Even identical twins have subtle differences in their friction ridge skin.*

*Police will frequently dust for prints at a crime scene, meaning that they will use a very soft brush to apply a fine powder such as carbon powder and then use a piece of tape called a lifter to remove any prints illuminated by the powder. The tape is then placed on a black or white card to display the print. There are also many other methods of lifting prints, depending on the age of the print and the material it is left on.*

*To help solve crimes, detectives compare prints found at the scene of the crime to fingerprint records of suspects. Historically, fingerprint records were filed under specific class names. This system was developed as a way to categorize the growing number of prints on record. With the advent of AFIS (Automated Fingerprint Identification Systems), computers can now compare a single fingerprint to thousands upon thousands of fingerprints in a database.*



**STUDENT HANDOUT**

There are nine general classes of fingerprints, shown in the figure below:



Provided by <http://www.fingerprints.demon.nl>

**STUDENT HANDOUT**

The first task in trying to match a print is to identify the print as one of the general classes. Identification is the process of determining that an object is a member of a group with similar characteristics. Once the print has been identified as a member of a class type, police can immediately rule out any potential matches from a different class. For example, a print found at a particular crime scene may have an arch, while the suspect has a right pocket loop. It is immediately apparent that that suspect did not create the fingerprint found.

Another task in friction ridge analysis is to find out what individualizes a print. Individualization is the process of identifying what differentiates one specific print from all other prints. In the case of fingerprints, investigators need to be able to identify differences between fingerprints of the same class. Specific points in ridge patterns create this individualization. Examiners look for tiny points (minutiae) in the pattern to individualize a print. Examples of minutiae that friction ridge skin analysts look for include places where a ridge splits into two ridges (bifurcation) or where a ridge ends (ridge ending). They also look for breaks and curves in fingerprint ridges.

An important thing to keep in mind when comparing prints is that two prints may look very similar but may not be from the same person. In order to positively match prints, all minutiae points identifiable on a lifted print must also be identifiable on the print on file. The opposite is not necessarily true. While prints on official record tend to show minutiae points well, a print found at a crime scene may be incomplete. Obviously, the more elements that match, the more dependable the identification will be.

Finally, it is also important to note that fingerprint identification is not without some controversy, most of which has arisen following the U.S. Supreme Court's 1993 decision holding that scientific evidence must be scrutinized more carefully. While it is widely accepted that no two people have identical fingerprints, critics have pointed out that in the entire history of the fingerprint enterprise there has never been an objective study of the accuracy with which a partial print (as from a crime scene) can be matched to a known print. A related criticism is that there is no uniform standard for establishing that a match exists. Although some agencies require a certain number of print features to be identical before declaring a match, other large agencies have no such standard and, as a result, establish matches on a subjective basis. The thrust of the criticisms is that until these deficiencies can be remedied, fingerprint-match evidence does not qualify as admissible scientific evidence and should be excluded from court.



## STUDENT HANDOUT

### PROCEDURE:

*In this activity, you will compare the partial fingerprint below, found at the scene of the crime, to official print records of three of the story's persons of interest. As you compare, identify the class of each set of prints, and note what specifically about each set of prints does or doesn't match the print from the flask. Remember the more points of individualization you match, the more likely the positive identification.*



Partial print lifted from flask in the lab

Class of partial print: \_\_\_\_\_

Notes on partial print: \_\_\_\_\_

Identification of partial print: \_\_\_\_\_

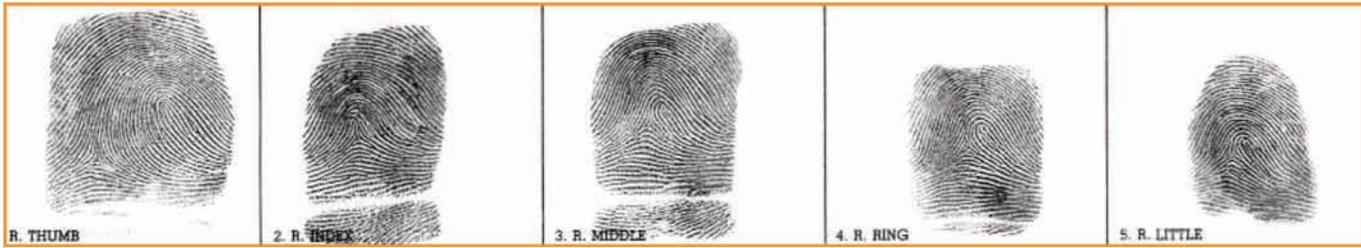
**STUDENT HANDOUT**

Name: **Derrick Jensen**



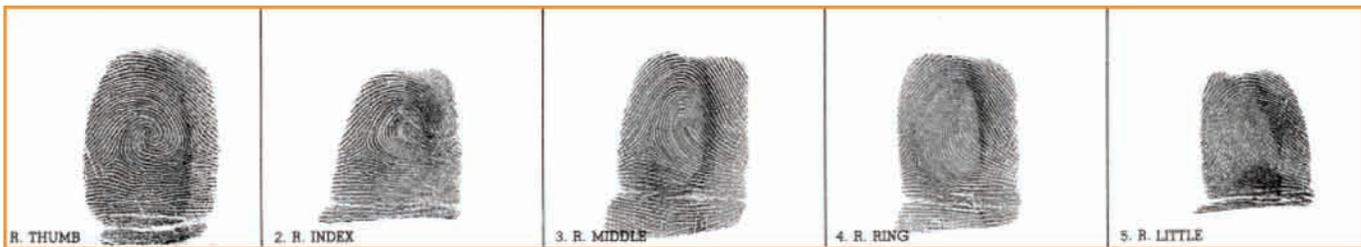
Class of prints: \_\_\_\_\_

Name: **Jeff Knight**



Class of prints: \_\_\_\_\_

Name: **Elizabeth Green**



Class of prints: \_\_\_\_\_

**STUDENT HANDOUT**

**INVESTIGATIVE REPORT**

*By now, you have uncovered many of the facts of the case. It is time to summarize your findings. The police need your evidence to corroborate their version of the crime. You need to make a case. Using the evidence that you gathered from the Kastle-Meyer color test, the flame test, and the fingerprint identification, build your case against one of the people whom investigators deemed a person of interest. Be sure to explain how each piece of evidence implicates that person. Cite specific examples, and be sure to rule out the other characters if possible.*

**DATE:** \_\_\_\_\_

**INVESTIGATOR NAME:** \_\_\_\_\_

**DEPARTMENT:** \_\_\_\_\_

**LOG OF EVIDENCE RECEIVED:** \_\_\_\_\_

**CONFIDENTIAL:** *This is an official report and is to be issued in connection with an official criminal investigation. Do not make public or reveal the contents thereof to any unauthorized person. The form for this report is found to be in compliance with NCGS 000001 and is hereby approved by the attorney general.*

**ANALYSIS OF THE SUBMITTED MATERIALS IS AS FOLLOWS:** \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**INTERPRETATION:** \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**STUDENT HANDOUT****EPILOGUE: UNIT CONCLUSION**

Upon matching a sole fingerprint to Jeff Knight and placing him at the scene, Detective Glover brought the building's majority owner back in for questioning. Under investigation, Jeff admitted that he secretly obtained the metal compound barium from his wife's office, allowing him to make the poison. DNA analysis of the blood on the rag indicates that it came from Jeff. As he heard the evidence pointing toward his guilt as well as accusations that he planned to poison tenants, he and his lawyer decided that he should confess to what he'd planned. What follows is a partial transcript of his confession:

**JEFF KNIGHT:** *It was my lab, all right. But I wasn't trying to poison people.*

**DETECTIVE GLOVER:** *Oh, yeah? Not people?*

**JK:** *No! Not people! I wanted to poison their pets.*

**DG:** *Their pets?!?*

**JK:** *Yeah. Their pets.*

**DG:** *What do you have against pets, Jeff?*

**JK:** *People are attached to their pets. If their pets started getting sick, certain people might think that the building wasn't safe to live in anymore. Then the people move away, and I can start charging rent that's a fair market price. We got people paying next to nothing! It's ridiculous! So you can see, I wasn't gonna hurt anyone. . .*

Detective Glover also learned that when Jeff cut his hand on the broken flask, he left the room in a hurry in order to tend to the bleeding. In his haste, he left the door slightly cracked, and Gerald stumbled upon it just minutes later.

Residents at the apartment complex were stunned when they learned about the investigation. Almost immediately they noticed some changes around the building. Harold took over full management, and all the rooms in the basement were cleaned out and made available for tenant storage. There was talk that Jeff could face charges ranging from reckless endangerment to criminal neglect. At the very least, the landlord would be charged with violating the city's environmental ordinances for the storage of hazardous materials. If convicted, he faced a serious jail term and a hefty fine.

Gerald was especially taken aback at the news. He never dreamed that peering into the darkened room that day would uncover such a plot. He continued his trips down to the basement, though, feeling that after that episode, not even a big New York rat would be quite as shocking.

