Crime Scene Investigation Workshop

**LEARNING GOALS:** After the completion of this workshop, students will understand:

Provide students with an understanding of how CSI uses:

1. Locard’s Exchange Principle
2. Chain of custody
3. Chromatography

**CONCEIVE – What do I wish to accomplish through this project?**

This stage involves guiding students in defining the goals of the project, then helping them develop conceptual, technical and action plans to meet those goals while considering the technology, knowledge, and skills that apply. This guidance is provided in the form of Essential Questions that use student’s preconceptions, and misperceptions then move them toward a deeper and more realistic understanding of the process and skills needed to complete the project.

**ESSENTIAL QUESTIONS:**

1. What is the “science” used in Crime Scene Investigation?
2. How does the real experience differ from what is shown on TV?
3. Who is the CSI team?
   a. What roles/jobs/expertise does each member provide?
   b. How is the information communicated to keep each team member up to date?

**NOTES:** Attachment 1 includes a handout that explains beginning principles in CSI

**DESIGN – How will I accomplish the project?**

This stage focuses on creating the plans, drawings and algorithms that describe the product, process or system that will be implemented.

**Chemistry Lab Break-In**

The Scene: A TA for a chemistry lab was found this morning unconscious and the chemistry lab was torn up. The TA has been taken to the hospital and three witnesses and potential suspects have been asked to stay for questioning while a CSI team arrives to inspect the crime scene.

Your job is to determine who the person responsible for knocking out the TA and damaging the chemistry lab is.

Students should identify the following items will provide clues as to who was with the TA:

- Fingerprints
- Pens (will use chromatography to determine suspects)
- Method of knocking unconscious (pizza box with rocks, poisoned coffee, or chloroform)
- Witness/Suspect Accounts

Copyright University of Colorado Colorado Springs, 2011. For permission to use these materials, contact the Director at the Center for STEM Education, (719) 255-3595. Curriculum format design adapted from CDIO developed by MIT.
Students will then use chromatography to identify the pen that was used to sign the sign-in sheet and place the witness at the crime scene.

- (5 min) **[Outside of Crime Scene / Entrance to Crime Scene]** Brief introduction of the scenario followed by separating the students into 4 groups.
- (5 min) Pass out clipboards / tri-folds / handouts and go over brief explanation of the students’ roles and objectives
- (40 min) First group is allowed 10 mins ‘in’ the crime scene; other groups may interview 3 witnesses (‘out’ of the crime scene); after 10 mins, rotate so that the next group may go ‘in’ to the crime scene and the other groups may interview a different witness
- (10 min) **[Inside Crime Scene / Gathered around Crime Scene]** Debriefing for Crime Scene
- (5 min) **[Chemistry Lab]** Chromatography Introduction (See Attachment 2 on Paper Chromatography)
- (15 min) Chromatography exercise
- (10 min) Final Debriefing for Chromatography and overall CSI workshop

**NOTE: In Attachment 3 is included a different scenario used in our Fall 2010 Girls in STEM event. In Attachment 4 are the lab instructions for Lipstick Chromatography.**

**IMPLEMENT - From an idea to a product!**

This stage refers to the transformation of the design into a product. It includes hardware, manufacturing, software coding, testing and validation.

**What students know coming into CSI:**
- Break in at one of the school’s chemistry labs.
- A TA was found unconscious at the scene this morning, and the crime scene has been cordoned off.

**In this CSI workshop:**
- Groups will be given 10 minutes to walk through and collect fingerprints and to observe and document evidence they locate in the crime scene from the inside.
- They must also interview 3 witnesses and determine which, if any, are suspects.
- They will then analyze those suspects’ pens (or more accurately, their pens’ ink) using chromatography to determine which matches the ink used on the sign-in sheet.

**What students will be told in CSI phase?**
- “Training CSIs, you have just walked into an already secured crime scene: your objective as a CSI trainee is to recognize, preserve, collect, interpret, and reconstruct all the relevant physical evidence at the crime scene.”
- Pay close attention to the evidence collected by each group. You will need to know these key items for reconstruction. You MUST include them in your scene details.
- Handouts describe three important objectives of crime scene investigation.

*Copyright University of Colorado Colorado Springs, 2011. For permission to use these materials, contact the Director at the Center for STEM Education, (719) 255-3595. Curriculum format design adapted from CDIO developed by MIT.*
- How to secure a crime scene
- Chain of custody
- Locard Exchange Principle

- Due to the break-in at the chemistry lab, it is necessary to find out what happened.
- Each student in a group will pick a responsibility:
  1. **Interview the witness** – student will take the lead on interviewing the witness and paying close attention to, and documenting, the information given.
  2. **Documentation of scene** – student will document the scene paying particular attention to items which should be later seized for evidence. They will also document fingerprints and where they were retrieved.
  3. **Sketch of scene** – student will draw a diagram of the crime scene, noting where different pieces of evidence were located.
  4. **List evidence** – student will identify at least one significant piece of evidence and document the chain of custody to the Lead CSI.

- Emphasis on importance of these roles:
  - Securing the scene
    - Nothing can be changed at the crime scene. Police tape must surround the entire area.
    - Authorized personnel must be extremely careful when handling anything.
  - Legalities
    - We ensure proper scene security because if defense attorney can show there was evidence tampering, then the guilty person can be set free.
    - Matter of safety.
  - Recording the scene
    - The Crime Scene must be secured and protected.
    - Ways to record a crime scene: draw a sketch of the area and take notes.
  - Sketching the scene
    - It is the initial drawing made by the forensic sketcher at the scene. It is a rough outline with rough measurements of the scene.
  - Taking notes
    - ALL aspects of the scene must be recorded. A detailed description of the scene as well as all the physical evidence is necessary.
    - Time, by whom, and how all the evidence listed was packaged and shipped must be noted.
  - Looking for clues
    - Physical evidence is most important aspect of crime scene.

**Roles:**

*Reporter / Nosy bystander:* This is a random individual (such as another teacher, a parent chaperone, etc.) trying to get information about what occurred. This person should (ideally) be removed from the crime scene to prevent them from trampling it or contaminating evidence.

*Lead CSI:* This is the subject-matter expert and lead CSI on the team. They appraise the trainee CSIs of their duties and answer any DIRECT questions about the scene. They will also accept the transfer of evidence if it is properly documented.

*TA:* This person is the TA who was found unconscious. He or she is now in the hospital awaiting recovery. He or she doesn’t remember the person’s face but remembers that they signed the sign-in sheet with their own pen.
Witness/Suspect #1: This person is failing the chemistry class. He or she might be able to pass the class with a 100% on the exam. This person showed up early for the test today and seems apprehensive about taking the test and getting it over with. He or she has a part-time job delivering pizzas.

Witness/Suspect #2: This witness is another TA in the chemistry department. This witness works in another chemistry lab handling the chemicals, like chloroform, and isn’t allowed to work in the lab that the crime scene is in because his/her boyfriend/girlfriend is in that class. His/her boyfriend/girlfriend is failing the class.

Witness/Suspect #3: This suspect is a friend of the victim. He or she works at a coffee shop nearby. His or her little brother is taking the class and is failing.

What can you take away?
- Securing a crime scene alleviates foot traffic, assists with reconstruction and prevents evidence contamination.
- Documenting the chain of custody ensures that evidence is monitored and recorded accurately and can be used in court.
- The Locard Exchange Principle (LEP) is an important theory in the forensic science discipline because it shows that even the most “careful” criminal will leave a trace. This is extremely helpful to investigators because the evidence can tell a story.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair with Shoe Print</td>
<td>Can be used to identify a suspect and place that individual at the crime scene</td>
</tr>
<tr>
<td>Sign-in/Guest log</td>
<td>Can be used to identify the pen that was used to sign a name and place that pen at the crime scene</td>
</tr>
<tr>
<td>Fingerprint</td>
<td>Can be used to identify a suspect and place that individual at crime scene</td>
</tr>
<tr>
<td>Pizza Box</td>
<td>Can be used to place Witness #1 at the crime scene</td>
</tr>
<tr>
<td>Chloroform Test Tube</td>
<td>Can be used to place Witness #2 at the crime scene</td>
</tr>
<tr>
<td>Broken Coffee Mug</td>
<td>Can be used to place Witness #3 at the crime scene</td>
</tr>
<tr>
<td>Fingerprint on folder labeled “Final Exams”</td>
<td>Can be used to identify a suspect and place that individual at the folder</td>
</tr>
<tr>
<td>Post-it Note</td>
<td>Can be used to infer that a signature signed in black cannot have come from the pens on this desk</td>
</tr>
<tr>
<td>“Rules of the Lab”</td>
<td>Can be used to infer that anyone entering the chemistry lab must sign in</td>
</tr>
<tr>
<td>Scattered Papers</td>
<td>Can be used to infer that someone was searching for some papers</td>
</tr>
</tbody>
</table>

OPERATE – Does it work the way I planned?

This stage uses the built product, process or system to satisfy the intended goal.

Debriefing Questions (Crime Scene):

Copyright University of Colorado Colorado Springs, 2011. For permission to use these materials, contact the Director at the Center for STEM Education, (719) 255-3595. Curriculum format design adapted from CDIO developed by MIT.
1. Were you able to apply the principles (Locard, chain of custody, securing crime scene) that you learned to your crime scene?
2. What did you notice about the crime scene? What were key findings or pieces of evidence?
3. Based on what you found, what do you think happened? Who are your suspects?

Debriefing Questions (Overall CSI Workshop):

1. Who did it?
2. How do you know / can you prove it?
3. What did you learn from this workshop?

RESOURCES NEEDED – What equipment and supplies do I need?

Supplies Needed:

1. “Rules of the Lab” sheet
2. At least four clipboards (more is better)
3. Brightly colored post-it note
4. Chair with shoe-print (use dusty shoe)
5. Coffee mug (broken)
6. Coffee mug (intact)
7. Collectible Fingerprints (see creation guide)
8. Crime Scene tape / Caution tape
9. Empty test tube, labeled “chloroform”
10. Filing cabinet
11. Folder labeled “Final Exams”
12. Non-exam homework papers, slides, and other miscellaneous “teacher’s desk papers”
13. Pizza box with rocks
14. Several blue pens
15. Sign-in Sheet
16. Teacher’s Desk
17. Three different brands of black pens (Four sets; 12 pens total); one permanent black pen, 2 black water soluble pens
18. Paper coffee filters
19. Container full of water
20. Several sheets of paper
21. Small glasses or plastic containers
22. Isopropyl rubbing alcohol
23. Pencils

Copyright University of Colorado Colorado Springs, 2011. For permission to use these materials, contact the Director at the Center for STEM Education, (719) 255-3595. Curriculum format design adapted from CDIO developed by MIT.
24. Tape
25. Scissors
26. Stapler

SET-UP

1. First, prepare the collectible fingerprints from your victim and three witnesses/suspects and choose which one of them you want to be the guilty suspect. Have non-witnesses fill out and sign the sign-in sheet with their natural signatures using various blue pens from the materials. Have the guilty suspect sign the sign-in sheet with one of the three brands of black pens. Have him keep that pen and have the other two suspects use each of the other brands.

NOTE: Which witness is “guilty” should change between each 90-minute workshop so that the students don’t know who is guilty based on cross-talk between workshops or during lunch.

2. Crime Scene Setup:

Choose a location that has a desk near the entrance (think receptionist style) and set up the filing cabinet near it. The desk should have a sign-in sheet, the pizza box filled with rocks, and a knocked-over (intact) coffee mug with several blue pens partially fallen out of it. The coffee mug should have a brightly colored post-it note attached to it, but facing down (so the students have to move the coffee mug to read it) that reads: “Note to self: purchase more black pens. I’m all out!” Somewhere nearby, or hanging from the front of the desk, prominently display the “Rules of the Lab” sheet.

Behind the desk, move the chair with the dusty shoe print near the filing cabinet. Below the desk, place the broken coffee mug and then in a somewhat difficult (or not immediately visible) location, place the empty test tube labeled “chloroform”. Scatter the miscellaneous papers in logical places, such as the desk drawers, filing cabinet drawers, and on the floor (but leave the broken coffee mug visible to prevent anyone from cutting their hand searching the papers). Make them look like someone was going through them very quickly to find something and didn’t bother putting them back.

Place the empty folder labeled “Final Exams” somewhere to correspond with the guilty suspect (in the filing cabinet, on top of the filing cabinet, or in the teacher’s desk drawer for example). Place several of the guilty suspect’s collectible fingerprints in this folder.

Use a set of collectible fingerprints for everyone else and place them in areas around the room as red herrings. Some should correspond to the pizza box, some to the coffee mug, some to the test tube, and so forth.

Cordon off the area, leaving enough room on the outside for the CSI team to navigate the scene.
3. Collectible Fingerprints Guide:

You will want to make several copies of these. First, have the three witnesses and the victim use a black dry-erase marker and mark their thumb and index finger (these will be the easiest to read). Then use tape to “peel off” an impression of their fingerprint. Stick the tape to a piece of paper above the corresponding person’s name, and then do the same for the other fingerprints.

You will want to make several copies of these. At least eight copies of the master paper containing everyone’s fingerprints, PER 90-minute workshop. FOUR are for cutting out and taping around the crime scene to be “collected”; partial cut-outs are okay and encouraged to make it harder. FOUR are for handouts to the groups before they begin interviewing witnesses and examining the crime scene.

4. Chromatography Introduction:

Test the black pens of the three witnesses. You want to use one black permanent pen and two different brand water soluble black pens. Chromatography is an analytical chemistry technique used for separating and identifying mixtures by separating them into the chemicals from which they were made. We are using the paper chromatography method to test the three witness’s pens and match the pens to the sign in sheets.

---

<table>
<thead>
<tr>
<th>Colorado State Standards - High School</th>
<th>21st Century Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical Science</td>
<td></td>
</tr>
<tr>
<td>2. Matter has definite structure that</td>
<td>Students can:</td>
</tr>
<tr>
<td>determines characteristic physical and</td>
<td>b. Gather, analyze</td>
</tr>
<tr>
<td>chemical properties</td>
<td>and interpret data</td>
</tr>
<tr>
<td>3. Matter can change form through</td>
<td>on chemical and</td>
</tr>
<tr>
<td>chemical or nuclear reactions</td>
<td>physical properties</td>
</tr>
<tr>
<td>abiding by the laws of</td>
<td>of elements such as</td>
</tr>
<tr>
<td>conservation of mass and energy</td>
<td>density, melting</td>
</tr>
<tr>
<td>4. Atoms bond in different ways to</td>
<td>point, boiling point,</td>
</tr>
<tr>
<td>form molecules and compounds that</td>
<td>and conductivity</td>
</tr>
<tr>
<td>have definite properties</td>
<td></td>
</tr>
<tr>
<td>5. Energy exists in many forms such</td>
<td></td>
</tr>
<tr>
<td>as mechanical, chemical, electrical,</td>
<td></td>
</tr>
<tr>
<td>radiant, thermal, and nuclear, that</td>
<td></td>
</tr>
<tr>
<td>can be quantified and experimentally</td>
<td></td>
</tr>
<tr>
<td>determined</td>
<td></td>
</tr>
<tr>
<td>2. Life Science</td>
<td>Students can:</td>
</tr>
<tr>
<td>6. Cells, tissues, organs, and organ</td>
<td>a. Analyze and</td>
</tr>
<tr>
<td>systems maintain relatively stable</td>
<td>interpret data that</td>
</tr>
<tr>
<td>internal</td>
<td>genes</td>
</tr>
</tbody>
</table>

Copyright University of Colorado Colorado Springs, 2011. For permission to use these materials, contact the Director at the Center for STEM Education, (719) 255-3595. Curriculum format design adapted from CDIO developed by MIT.
environments, even in the face of changing external environments

7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins

**Inquiry Questions:**
2. Why are human offspring not genetic clones of their parents or siblings?

<table>
<thead>
<tr>
<th>Colorado State Standards – Eighth Grade</th>
<th>21st Century Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Physical Science</strong></td>
<td><strong>3. Distinguish between physical and chemical changes, noting that mass is conserved during any change</strong></td>
</tr>
<tr>
<td>Students can:</td>
<td>a. Identify the distinguishing characteristics between a chemical and a physical change</td>
</tr>
<tr>
<td></td>
<td>b. Gather, analyze, and interpret data on physical and chemical change</td>
</tr>
<tr>
<td><strong>Inquiry Questions:</strong></td>
<td>1. What evidence can indicate whether a change is physical or chemical?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Colorado State Standards – Seventh Grade</th>
<th>21st Century Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Physical Science</strong></td>
<td><strong>1. Mixtures of substances can be separated based on their properties such as solubility, boiling points, magnetic properties, and densities</strong></td>
</tr>
<tr>
<td>Students can:</td>
<td>a. Identify properties of substances in a mixture that could be used to separate those substances from each other</td>
</tr>
<tr>
<td><strong>Nature of Science:</strong></td>
<td>3. Share experimental data, and respectfully discuss inconsistent results</td>
</tr>
<tr>
<td><strong>Inquiry Questions:</strong></td>
<td>1. How does each body system contribute to supporting the life of the organism?</td>
</tr>
<tr>
<td></td>
<td>2. How do organs and organ systems in the human body interact to perform specific Functions?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Colorado State Standards- Sixth Grade</th>
<th>21st Century Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Physical Science</strong></td>
<td><strong>1. All matter is made of atoms, which are far too small to see directly through a light microscope. Elements have unique atoms and thus, unique properties. Atoms themselves are made of even smaller particles</strong></td>
</tr>
<tr>
<td>Students can:</td>
<td>a. Identify evidence that suggests there is a fundamental building block of matter</td>
</tr>
<tr>
<td></td>
<td>b. Distinguish between changes in temperature and changes of state using the particle model of matter</td>
</tr>
<tr>
<td><strong>Inquiry Questions:</strong></td>
<td>1. In the world of science what makes something a building block?</td>
</tr>
<tr>
<td></td>
<td>2. Why do substances behave</td>
</tr>
<tr>
<td>solid, liquid, and gas states can be explained differently? 3. What determines whether matter is in the form of a solid, liquid, or gas?</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

**Relevance and Application:**
1. Different arrangements of atoms provide different properties.
2. Solids, liquids, and gasses all have unique properties that make them useful in different situations.
**Forensic Science: Crime Scene Investigation**

- Forensic science refers to the application of science to legal issues.

- Crime scenes cannot be managed without a series of investigators whose use of specialized techniques and procedures lead to the apprehension of suspects and convictions.

- Characteristics of crime science investigation include: how to secure a crime scene, chain of custody, and Locard exchange principle.

**Center for STEM Education**

The Center for STEM Education at UCCS works with parents, educators and industry to inspire and encourage students in their decisions related to careers in Science, Technology, Engineering and Math (STEM).

*For More Information: www.uccs.edu/~pipes 719-255-5124*

The Partnership in Innovative Preparation for Educators and Students (PIPES) exists to inspire and ignite parents, educators and students to pursue the excitement of real life problem-solving in science, technology, engineering, and math.
How to secure a crime scene

- Establish boundaries of the crime scene.
- Mark perimeters with crime scene tape or barriers.
- Remove unnecessary individuals from the scene. Gather witnesses, if any.
- Determine if there is any evidence present. If so, LOG it carefully.
- Record conditions of the area and anything that affects it.
- After all documentation is complete, crime scene can be released.

Chain of custody

- Requires that from the moment the evidence is collected, every transfer of evidence from person to person be documented and that it be provable that nobody else could have accessed that evidence.

1. Keep the number of people involved in collecting and handling samples and data to a minimum.
2. Only allow people associated with the project to handle samples and data.
3. Always document the transfer of samples and data from one person to another on chain-of-custody forms.
4. Always accompany samples and data with their chain-of-custody forms.

Locard exchange principle

- Every contact leaves a trace.
- Exchange usually refers to trace evidence such as a footprint or fingerprint, hair, blood, clothing fibers, paint, etc.
Paper Chromatography

Chromatography is a method for analyzing complex mixtures (such as ink) by separating them into the chemicals from which they are made. Chromatography is used to separate and identify all sorts of substances in police work. Drugs from narcotics to aspirin can be identified in urine and blood samples, often with the aid of chromatography.

Materials

- Paper coffee filters
- One black permanent pen
- Black water soluble pens
- Container full of water
- Several sheets of paper
- Small glasses or plastic containers
- Isopropyl rubbing alcohol*
- Pencils
- Tape
- Scissors
- Stapler

*Read and obey warnings on rubbing alcohol label.

Note: in addition we found you need 6-500 ml beakers, 6 evaporating dishes, 6 graduated cylinders, gloves and goggles for each student.
Instructions

Part I - Separating Black Ink
1. Cut several coffee filters into long strips, one strip per pen.
2. Fold the end of each strip over then staple it to form a loop.
3. Place a dot of ink near the bottom of each strip. Use a pencil to identify which strip belongs to which pen.

4. Poke a pencil through one of the loops you just made. Use the pencil to suspend the strip in a small glass or container.
5. Carefully add water to the glass until it reaches the bottom of the paper strip just below the ink dot. Be sure the ink stays above the water and the paper stays in the water.
6. Allow the water to soak up the strip and watch what happens to the ink drop.
7. If the ink you are testing does not spread out, re-test it using rubbing alcohol.
8. Repeat this process for each strip and compare your results.
9. Let the strips dry and tape them on a sheet of paper as a record of the different pen types.
Part 2- Secret Note Challenge
1. Turn your back while someone uses one of the pens you just tested to write a secret note on a piece of coffee filter.
2. Cut out several individual letters from the note.
3. Staple each letter to the bottom of a strip of coffee filter.
4. Conduct the chromatography experiment above to determine which pen was used to write the secret note.

(Watch how the ink spreads up the paper. Compare it to your known samples of ink.)

What’s Happening

Because molecules in ink and other mixtures have different characteristics (such as size and solubility), they travel at different speeds when pulled along a piece of paper by a solvent (in this case, water). For example, black ink contains several colors. When the water flows through a word written in black, the molecules of each one of the colors behave differently, resulting in a sort of “rainbow” effect.

Many common inks are water soluble and spread apart into the component dyes using water as a solvent. If the ink you are testing does not spread out using water, it may be “permanent” ink. In such cases, you will have to use a different solvent such as rubbing alcohol.
**Role 1: Witness Interview Information**
Witnesses must be interviewed and the information they provide must be documented. **PAY CLOSE ATTENTION** and write down important information!

Witness #1

Witness #2

Witness #3
**Role 2: Crime Scene Documentation Information**
Crime scenes must be thoroughly documented for reconstruction. Inspect your crime scene and record critical information. **Pay attention** to the points identified in the parenthesis.

Documentation of Scene (Document condition, take notes on date, time, and description. Document evidence that should be seized and document location and condition of retrieved fingerprints.)
Role 3: Crime Scene Sketch Information
Crime scenes must be thoroughly documented for reconstruction. Inspect your crime scene and record critical information. **Pay attention** to the points identified in the parenthesis.

Sketch of Scene (Ensure accurate sketch results. Sketches require a title or caption, a legend of abbreviations, symbols, numbers, or letters used. Note where different pieces of evidence, or fingerprints, were retrieved)
**Role 4: Crime Scene Documentation Information**
Crime scenes must be thoroughly documented for reconstruction. Inspect your crime scene and record critical information. **Pay attention** to the points identified in the parenthesis.

List of Evidence/Scene Search (Identify at least one significant piece of evidence to later be seized, its location and its importance, and document the chain of custody to the Lead CSI)

<table>
<thead>
<tr>
<th>Evidence To Be Collected</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The scene: romantic dinner for two gone awry

Set up: 2 wine glasses (lipstick stain and fingerprints), empty bottle of wine, take out containers with the name of the restaurant (can call for description of who the delivery man saw), flowers with a card addressed to sweetie (fingerprints do not match fingerprints on the glass), partially eaten piece of cheese (bite marks intact)

The scene: A loft on Tejon Street in Colorado Springs. Mike came home after a night of partying downtown and found his roommate (James) unconscious and bleeding at the bottom of the stairs. Mike called 911, the paramedics are transporting James to the hospital and the first officer on the scene has secured the crime scene. Officer McNichols has relayed to you that he has interviewed Mike. Mike stated that before he left for the evening he and James had a few drinks. James was very nervous and thought a few drinks might calm him down. Apparently this was James’ first date with a girl from work. James works at the Walgreens on Platte. Mike doesn’t know which girl James was having dinner with there are three girls that work with James at the pharmacy.

Your job is to determine who the last person with James was. How will you identify his date?

Students should identify the following items will provide clues as to who was with James:

Fingerprints

Lipstick (will use chromatography to determine suspects)

Bite marks

Eyewitness accounts (floral shop and delivery guy)

Students will use lipstick chromatography to identify the girl that was with James.
CHROMATOGRAPHY OF LIPSTICK
Lab CHROM 5
Adapted from the Center for Applied Research in Education

INTRODUCTION
The colors of lipstick are often due to a mixture of several pigment compounds. These pigments can be separated using paper chromatography. Porous paper serves as the stationary phase. The mobile phase carries the lipstick through the stationary phase and the lipstick separated into individual colored pigments. Depending on the type of pigment, the mobile phase will vary. Lipsticks are soluble in acetone, so acetone serves as the mobile phase. After separation, the chromatogram is completed and illustrates the different pigments that make up a particular color of lipstick.

PURPOSE
The purpose of this experiment is to discover which sample of lipstick was present at the crime scene by comparing chromatograms. The chromatogram that is most similar to the crime scene one will point to the perpetrator of the crime.

EQUIPMENT/MATERIALS
1-250 mL beaker
Assorted Lipsticks
Chromatography paper
70:30 hexane-acetone
Beral Pipet labeled HA
Ruler

SAFETY
- Always wear safety glasses and an apron in the lab
- Wash hands when lab experiment is complete.
Crime Story
Mr. Sternman was a very unpopular man who has managed to make enemies of everyone he knew. Even his own family found him to an unbearable bully who lies, cheated, and stole from his wife and grown daughter. Mr. Sternman has scheduled a meeting with his new attorney, Ms. Justice, on the afternoon that he was found dead in his apartment.

After being exiled from his home a year ago, Mr. Sternman had moved into a beautiful apartment downtown. Because he was so mean, no one ever visited him. He hated house cleaning and his apartment became a shamble. One the day that his body was found, one scene in the apartment was notable because it was so unusual. The dining room table was laid out with a fresh tablecloth and silver candelabra. Two cups of coffee, two napkins, and a plate of cookies were on the table. One of the napkins contained a smear of lipstick.

In this lab, you will analyze the lipstick on the napkin and compare it with the lipstick of the only three women who were known to have visited Mr. Sternman's apartment: his wife, Mrs. Sternman; his daughter, Miss Sternman; and his attorney, Ms. Justice.

PROCEDURE
1. Obtain one 250mL beaker and a piece of pre-cut chromatography paper with lipstick from the crime scene.
2. With a pencil and rule, draw a line across the short side of the paper under the crime scene sample. At even intervals label the top of the paper with corresponding sample letters.
3. Place a dot of each lipstick sample to be tested along the bottom penciled line matching the labels on the top of the paper with the correct lipstick sample. The dots should be about 0.2 cm in diameter and dark enough to be clearly visible.
4. Using a Beral Pipet dispense approx. 6mLs of 70:30 hexane-acetone (enough to cover the bottom of the beaker) and pour it into the 250mL beaker.
5. Carefully insert the chromatography paper into the beaker, sample end down. The lipstick dots must be above the 70:30 hexane-acetone.
6. Allow the beaker to remain undisturbed for 10 minutes. Remove the chromatograph. Mark the solvent from with a pencil.
7. Measure the distance the 70:30 hexane-acetone moved in cm (the distance from the origin line to the solvent front end). Also measure the distance in cm wach component of the lipsticks moved from the origin line. Some lipsticks have only two or three components, and some have more. Enter these measurements on the Data Table.
8. Determine the Rf for each lipstick component of all lipstick samples. Enter those values on the Data table. To calculate Rf value, divide the distance traveled by each lipstick component by the distance traveled by the 70:30 hexane-acetone.

Rf=Distance traveled by one lipstick component from the origin (spotting line)
Distance the 70:30 hexane-acetone moved from the origin (spotting line)
DATA TABLE

Rf=Distance traveled by one lipstick component from the origin (column 4)
Distance the 70:30 hexane-acetone moved from the origin (column 2)

<table>
<thead>
<tr>
<th>Lipstick samples</th>
<th>Column 2</th>
<th>Colored Components</th>
<th>Column 4</th>
<th>Rf Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distance Hexane/Acetone Moved in cm</td>
<td></td>
<td>Distance Lipstick Components Moved</td>
<td></td>
</tr>
<tr>
<td>S (crime scene)</td>
<td></td>
<td>1. 2. 3. 4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (Mrs. Sternman)</td>
<td></td>
<td>1. 2. 3. 4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W (Ms. Sternman)</td>
<td></td>
<td>1. 2. 3. 4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F(Ms. Justice)</td>
<td></td>
<td>1. 2. 3. 4.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
QUESTIONS

1. In this experiment what is the purpose of the hexane/acetone?

2. Do you think water could have been used in place of the hexane/acetone? Why or Why not?

3. According to your results, who drank the coffee with Mr. Sternman before he was killed?

4. Do you think the discovery of this person’s lipstick in Mr. Sternman’s apartment is enough evidence to link that person with the crime? Why or Why not?

5. What are some other mixtures that you think can be separated by chromatography?
Chromatography of Lipstick
Teacher Notes

Lab time: 45-50 minutes

Answers to Questions:

1. In this lab, the acetone is the solvent that dissolved the lipsticks.
2. Water could not have been used. Lipsticks are designed to be insoluble in water so that they will stay on the lips.
3. The answer depends on which lipstick you used as a crime sample.
4. Answers may vary. The determination that someone was present in a location before a crime was committed does not necessarily tie that person to the crime.
5. Answers will vary, but could include inks, cosmetics, dyes, food colorings, and lubricants.