

Forensic Science: Case of the Missing Diamond Maker

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Subject: Chemistry

Grade Level: 5-9

Standards: *Next Generation Science Standards* (www.nextgenscience.org)

5PS1-3 Make observations and measurements to identify materials based on their properties.

MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Schedule: Two 40-minute periods

CCMR Lending Library Connected Activities:



<p><u>Objectives:</u></p> <p>Learn about techniques of forensic science including: fingerprint identification, chromatography, and chemistry.</p>	<p><u>Vocabulary:</u></p> <p>Chromatography</p>
<p><u>Students Will:</u></p> <ul style="list-style-type: none"> ● Use fingerprinting, chromatography, and chemistry to gather and analyze evidence left behind at a crime scene. ● Use deductive reasoning to evaluate the evidence and determine the criminal's identity. 	<p><u>Materials:</u></p> <p>Station 1: Fingerprint Materials</p> <ul style="list-style-type: none"> ___ Magnifying Lenses ___ Clear Plastic Cups ___ Paintbrush ___ Cocoa Powder ___ Clear Tape ___ Fingerprint Guide (<i>in folder</i>) <p>Station 2: Chromatography Materials</p> <ul style="list-style-type: none"> ___ Coffee Filters or Filter Paper ___ Plastic Cups ___ Popsicle Sticks ___ Binder Clips ___ 4 Different Black Pens <p>Station 3: Fiber Analysis</p> <ul style="list-style-type: none"> ___ 6 Different Fabric Samples <p>Station 4: Smells</p> <ul style="list-style-type: none"> ___ 4 Different Perfume Samples ___ 5 Plastic Containers <p>Station 5: Spilled Liquid</p> <ul style="list-style-type: none"> ___ Clear Plastic Cups ___ pH Paper ___ Alka Seltzer ___ Juice Powder ___ Orange Juice Drink <p>Station 6: Spilled Powder</p> <ul style="list-style-type: none"> ___ Baking Soda ___ Powdered Sugar ___ Baking Powder ___ Vinegar (<i>in dropper bottle</i>) ___ Water (<i>in dropper bottle</i>)
<p style="text-align: center;">Safety</p>	<p>There are no safety concerns for this lab.</p>



Science Content for the Teacher:

Fingerprints: Fingerprints have been used for hundreds of years as an identifying characteristic of people. No two fingerprints are alike (not even in identical twins). Fingerprints can be classified according to their patterns (arches, loops, etc). Most countries have fingerprint databases where they store fingerprint images. Although fingerprints used to be examined and compared by hand, this is no longer the case. In the United States, a computer system called the Automatic Fingerprint Identification System (AFIS) searches the database looking for fingerprint matches in just minutes.

For more information see <<http://www.fingerprints.tk/>>.

Chromatography: Chromatography is the process of separating the parts of a complex mixture. In this lesson, we are separating the pigments that make up the black inks in a variety of pens. Chromatography works by passing a material through a medium in which the parts migrate at different rates, for example filter paper. Chromatography is used frequently in biochemical labs to separate proteins or chemicals. Liquids, solids and gases can all be used to separate out materials.

For more information about chromatography see

<<http://www.rpi.edu/dept/chem-eng/Biotech-Environ/CHROMO/chromintro.html>>.

Fiber Analysis: Fibers are the small pieces of materials from which textiles are composed. Fibers can be woven, knitted or pressed together to make a fabric. There are a wide variety of fibers from natural and man-made sources. Often fibers that look similar to the naked eye can be easily distinguished when magnified. Fibers can become evidence in a crime if they are left behind by the criminal.

For more information see

<<http://www.fbi.gov/hq/lab/fsc/backissu/july2000/deedric3.htm>>.

Smells: Although humans do not have the most acute sense of smell compared to other mammals, we can differentiate thousands of odors. Smell is detected by activity 4.

Powders: There are two reactions that take place in the powders portion of the activity: the reaction between baking powder and water and that between baking soda and vinegar. In each case the reaction occurs between an acid and a base, producing water and a gas, CO₂, which bubbles.

For more information on these reactions see

<<http://science.howstuffworks.com/question57.htm>>.



Preparation:

Note: These preparations are designed to implicate Malcolm, but evidence can be rearranged to implicate a different suspect as needed.

Fingerprints Materials:

- Suspect fingerprints and evidence handouts
- Magnifying glasses
- Crystal clear plastic cups
- Small paintbrush
- Cocoa powder
- Clear tape
- Fingerprint Guide

Chromatography Materials:

- Filter paper cut into 1x3 inch strips
- Small tub of water
- Wooden dowels
- Binder clips
- 4 Different black pens labeled A, B, C, D
- Prepare an “evidence” strip using pen C, place it in a plastic bag labeled “evidence”

Fiber Analysis

- Six different fabrics cut into 2-inch squares (use fabrics of similar color schemes but different materials and different manufacture such as woven, knitted, pressed).
- Put each square into a different bag and label one for each character (Maria, Randy, Sandra, Malcolm, Dr. Evil, and Dr. Squeeze). Take a piece of fiber from Dr. Evil and Dr. Squeeze and place them in bags labeled Evidence 1 and Evidence 2 respectively.
 - Magnifying lenses

Smells

- Cut strips of filter paper and spray each with a different perfume. Close each and seal in a film canister. Label canisters with names of the suspects. In the evidence canister, place a piece of filter paper scented with Sandra’s perfume.



Spilled Liquid

- 4 Plastic cups labeled orange juice, water, alka seltzer, and juice powder with the respective liquid inside
- Make a solution of juice powder and place some in the evidence container.
- pH paper
- Paper towels

Spilled Powder

- Black construction paper
- Spoons
- Dropper bottle of water
- Dropper bottle of vinegar
- Powdered sugar
- Baking soda
- Baking powder

Classroom Procedure:

Day 1

Engage (Time: 10 mins)

- Ask the class what they know about forensic science, fingerprinting, and chromatography. Go through the Power Point presentation and discuss these concepts.
- Describe the crime and tell students they are needed to help police solve it. (Note: stop at slide 13).

Explore (Time: 30 mins)

- Describe the basics of each station, especially explain how chromatography works.
- Divide the class into six equal groups and let them work together as detective teams to solve the crime. Each team will start at a different station and rotate clockwise through the stations in 8-10 minute intervals. See Supplemental Information for station instructions.



Day 2

Explore (Time: 25 mins)

- Let the students finish visiting the stations and prepare their *Evaluating the Evidence* worksheets.

Explain (Time: 15 mins)

- Have each group present who they think the criminal is; they should use evidence from the stations to support their answers.
- After all groups have gone, show the last few Power Point slides to reveal the solution to the crime.

Resources:

"STEM-Works - Forensics Activities." *STEM-Works - Forensics Activities*. Web. 13 Feb. 2017.
<http://stem-works.com/subjects/3-forensics/activities>

"Kids Ahead - Subjects - Forensics." *Kids Ahead - Subjects - Forensics*. Web. 13 Feb. 2017.
<http://kidsahead.com/subjects/3-forensics>



Assessment:

The following rubric can be used to assess students during each part of the activity. The term “expectations” here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

- 1= exceeds expectations
- 2= meets expectations consistently
- 3= meets expectations occasionally
- 4= not meeting expectations

	Engage	Explore	Explain
1	Shows leadership in the discussion and offers creative ideas reflecting a good understanding of forensics.	Completes work accurately while providing an explanation for what is observed. Works well with partners.	Provides an in-depth explanation of findings, makes excellent use of evidence from the crime. Fills out worksheet clearly.
2	Participates in the brainstorm and shows an understanding of forensics.	Completes work accurately. Works well with partners.	Provides clear explanation of findings, uses evidence from the crime well. Fills out worksheet clearly.
3	Contributes to the brainstorm, but shows little understanding of forensics.	Makes some mistakes with the procedure, gets along with partners.	Provides a limited explanation of findings, uses some evidence. Fills out some of the worksheet.
4	Does not participate in brainstorm. Shows no understanding of forensics.	Does little to complete the procedure. Does not work well with group.	Is not clear in explanation of findings, does not use evidence from crime. Does not fill out worksheet.



