

Assignment Discovery Online Curriculum

Lesson title:

The Case of Similar Substances

Grade level:

6-8

Subject Area:

Chemistry, Forensic Science

Duration:

Two class periods

Objectives:

Students will do the following:

1. Learn how science is used to help solve mysteries and crimes
2. Become familiar with two chemical tests that can be used to identify unknown substances
3. Draw deductions based upon observations and the results of two scientific experiments

Materials:

- Baking soda and cornstarch (1 measured cup of each should suffice)
- Water and vinegar
- Paper cups (six for each pair of students)
- Teaspoons (one for each pair of students)
- Coffee stirrers or toothpicks
- Paper towels
- Internet access (optional but very helpful)

Procedures:

1. Tell students that they have been asked to help the local crime-fighting unit solve a fictional mystery. Here's what happened:

The chef at a prize-winning restaurant found his kitchen ransacked. He was furious, especially because he had been preparing for a big banquet. In fact, he had been working so frantically that he had spilled flour and baking soda all over the counter. As soon as the chef reported the crime, the police got right on the job. They have narrowed the search to two suspects.

One suspect is the local caterer, a man who is competitive with the chef. He was known to be baking a cake for the banquet to try to steer some attention away from the chef. The second suspect is the woman who owns the banquet hall. Even though she hired the chef, she has never really liked him for reasons no one really knows.

The police have collected important evidence: samples of different white substances found throughout each suspect's house. Police officers think that whoever committed this crime tracked the substance home. For this reason, police want to determine what the substances are and deduce whether they might have come from the chef's kitchen. They have labeled the substance at the caterer's house "substance 1" and the substance at the banquet hall owner's house "substance 2."

2. Tell students that they will help figure out what each substance is by performing tests to identify the substances. Have students work in pairs to conduct the tests. You will need to prepare for the lesson as follows:

- Do not reveal to the class that substance 1 is baking soda and substance 2 is cornstarch. Before class, fill one cup with baking soda and another cup with cornstarch. Label the baking soda "substance 1" and the cornstarch "substance 2."
 - Put in a prominent place two paper cups for each pair of students, a jug of water, vinegar, measuring cups, and coffee stirrers or toothpicks.
3. Have one person from each pair come to the table, measure 2 tablespoons of each substance, and put them in separate paper cups. Then tell students to take a few moments to observe both substances. Suggest that they note the color of the substances, the textures, and the odors. (When smelling an unknown substance, students should move their hands over the top of the container to create a diluted but distinguishable odor.) Make sure that students do not taste the substances. After observing the substances, students can record their findings on a chart such as this one:

Substance	Color	Texture	Odor
Substance 1			
Substance 2			

4. After students have completed their charts, tell them to mix each substance with water. Have one student from each pair measure 2-1/2 tablespoons of water to pour into a small cup. Then tell students to put 2 tablespoons of substance 1 into the water. Have students stir the mixture with a coffee stirrer or a toothpick.

Have students repeat the steps for the second substance. Then have them record their findings on a chart such as this one:

Substance	What Happens When Mixed with Water
Substance 1	
Substance 2	

(Substance 1 (baking soda) dissolves in water; the liquid turns white, but there are no particles in the water. Substance 2 (cornstarch) does not dissolve in water; the liquid is thick, white, and cloudy.)

5. Explain to students that this test reveals physical properties of the substances. In this case, physical properties refer to what happens when the two substances are mixed together; the basic composition of each has not been changed. Tell students that the next test will reveal chemical properties of the two substances. The basic composition of one substance will change when it is mixed with another material. An example of this occurs when iron comes into contact with oxygen and a new substance—rust—forms. Rusting is a chemical property of iron. For the next test, explain that students will mix vinegar with the unknown substances to reveal something about their chemical composition.

6. Have students follow these steps:

- Measure 2-1/2 tablespoons of vinegar into a small paper cup.
- Add 2 tablespoons of substance 1 to the cup.
- Stir the mixture.
- Repeat these steps for substance 2.

After students have completed the test for both substances, have them record their findings on a chart such as this one:

Substance	What Happens When Mixed with Vinegar
Substance 1	
Substance 2	

(Substance 1 (baking soda) fizzes and bubbles while dissolving in vinegar. Substance 2 (cornstarch) does not dissolve; the liquid becomes cloudy.)

7 After students have completed both tests, tell the class to examine two tables: “Physical Properties of Three Materials” and “Chemical Properties of Three Materials.” Using the tables and their own test results, students should be able to determine the identity of each substance. Print out the following tables or put them on an overhead projector.

PHYSICAL PROPERTIES OF THREE MATERIALS

Substance	What Happens When Mixed with Water
Sugar	Dissolves; liquid is clear
Baking soda	Dissolves; liquid is clear
Cornstarch	Does not dissolve; liquid is milky

CHEMICAL PROPERTIES OF THREE MATERIALS

Substance	What Happens When Mixed with Vinegar
Sugar	Dissolves
Baking soda	Dissolves; makes fizzing and bubbling sounds
Cornstarch	Does not dissolve; liquid is cloudy

8. Ask students whether they can identify each substance. Using their own observations and both tests, students should deduce that substance 1 is baking soda and substance 2 is cornstarch. With this information, ask students who ransacked the chef's kitchen. (*The local caterer. He had a motive: he wanted to outshine the chef. Also, the police said the chef had spilled flour and baking soda, so the person who ransacked the kitchen would have tracked either one of those substances into his or her own house. Signs of baking soda were found in the caterer's home, while cornstarch was found in the banquet hall owner's house. It is not exactly clear why the banquet hall owner was using cornstarch, but one theory is that she mixes it with baby powder and puts it on after taking a bath. Even though the caterer had baking soda in his kitchen, too, the fact that it was found throughout the house, even at the front door, indicates that he tracked it in after ransacking the chef's kitchen. The presence of baking soda in his house is strong evidence that the caterer most likely committed the crime.*)

Discussion Questions:

1. Were you able to deduce what the substances were and who ransacked the chef's kitchen? If so, what evidence did you find the most compelling? Would you have been able to make an educated deduction without performing the two tests?
2. How do you think police detectives use chemical tests to help them solve crimes? Try to give at least two examples. *They analyze residue from gunpowder and determine a suspect's blood type from a small sample of blood.*
3. Based on what you learned about how liquids and solids interact, what do you think performing that tests used in this lesson with any solid or liquid would tell you about the properties of the substance? Do you think such a test is a good way to identify a substance?

Evaluation:

Use the following three-point rubric to evaluate how well students follow directions, complete both tests accurately, make thorough notes, and figure out what the substances were and who committed the crime:

Three points: exhibited above-average ability to follow directions; demonstrated proficiency in completing both tests accurately; took clear and thorough notes; figured out what the substances were and who committed the crime.

Two points: exhibited on-grade ability to follow directions; completed both tests but made a couple of mistakes in conducting them; took some notes; figured out what the substances but were not able to determine who committed the crime.

One point: had difficulty following directions; completed one test but made several mistakes in conducting it; took only a few notes; could not solve either mystery.

Extension:

Arson Dogs

Although chemical tests are an important tool of forensic science, sometimes information can be gathered using alternative methods. It should be no surprise that “man's best friend” can also be a best friend in solving some crimes, especially those related to arson, or purposely setting a fire. Arson detectives often turn to trained dogs to help them detect chemical compounds that can indicate foul play in the destruction of property by fire. Have students find out how dogs are trained for this job and how they continue to be important in this type of crime solving. Tell students to think about the following questions as they do their research:

- ❑ Which breeds of dogs are trained?
- ❑ What does the training involve?
- ❑ What specific tasks do arson dogs perform?
- ❑ How do the dogs help in the investigative process?

After students have gained a general understanding of the skills and duties of arson dogs, have them present to the class specific stories of arson dogs that have played pivotal roles in solving crimes.

The following Web sites provide useful information:

Working Dogs

<<http://www.workingdogs.com/doc0130.htm> >

Canine Academy

<<http://www.k9-academy.com/arson.htm>>

Canine Accelerant Searches

<<http://www.execpc.com/~fireinv/canine.htm>>

Suggested Reading:

Crime & Detection (Eyewitness Books)

Brian Lane. Dorling Kindersley, 1998.

Using its familiar style of color photographs and short paragraphs, this entry in the Eyewitness series provides a solid introduction to the subject of detective work. With examples of crimes from ages past up to the present, this book presents many of the techniques used to solve crimes, such as examining the crime scene, using chemical analysis, testing DNA samples, and looking for fingerprints. In addition, it covers the history of the police force and the evolution of the detective.

Solving a Crime (Expert Guide)

Peter Mellett. Heinemann Library, 1999.

The theft of a Toltec mask from a museum puts the reader on the trail of a thief, observing police and legal activities and security measures such as gathering and analyzing clues, questioning witnesses and suspects, arresting a suspect, and conducting a trial. Illustrations carry the story along. A short glossary and bibliography wrap things up.

Vocabulary:

chemical property

Definition: A characteristic of a substance whereby its composition changes as a result of interaction with another substance.

Context: Burning wood breaks apart, revealing a **chemical property** of wood.

chemistry

Definition: A science that focuses on the structure and properties of substances and the changes they undergo.

Context: Detectives use **chemistry** in much of their work, such as analyzing residue from guns and determining the blood type of samples at crime scenes.

observe

Definition: To watch carefully, especially with attention to details or behavior, for the purpose of arriving at a judgment or uncovering information about an object, a person, or a place.

Context: In science class, to **observe** means more than just looking; it encompasses paying careful attention to a given object or situation in order to draw a conclusion.

physical property

Definition: A characteristic of a substance whereby its composition is not changed as a result of interaction with another substance.

Context: When sugar and water are mixed together, both substances retain their physical structures; this is a **physical property** of both substances.

Academic Standards:

This lesson adheres to the National Science Education Standards for students in grades 5-8:

1. Physical Science
2. Science as Inquiry

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