

Teacher Guide: Mystery Powder Analysis



Learning Objectives

Students will...

- Use a variety of tests to determine the properties and composition of five known substances (baking powder, baking soda, cornstarch, gelatin, and salt).
- Use the same tests to identify unknown substances.
- Use the same tests to determine the composition of unknown mixtures of two or three known substances.



Vocabulary

Biuret test, iodine test, litmus test, vinegar test



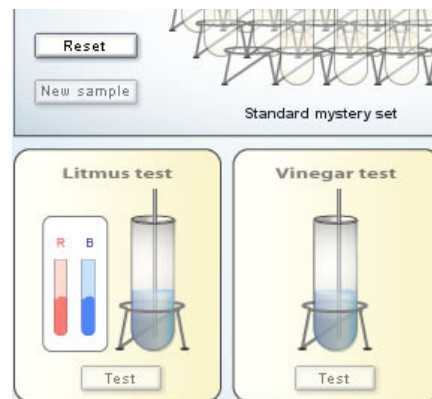
Lesson Overview

When a crime occurs, a group of police detectives called *crime scene investigators* (CSIs) go over every inch of the crime scene, gathering evidence and taking pictures. Later the evidence is processed in a *forensics laboratory*. Anything from fingerprints to a mysterious powder found on a suspect's shoe could prove crucial in solving the crime.

In the *Mystery Powder Analysis Gizmo™*, students use four tests to determine the composition of various mystery powders. Some powders contain only one ingredient, while others are mixtures of several ingredients.

The Student Exploration sheet contains two activities:

- Activity A – Students use four tests to determine the properties of baking powder, baking soda, cornstarch, gelatin, and salt.
- Activity B – Students use the same tests to identify mystery powders.



Two of the tests available in the Mystery Powder Analysis Gizmo



Suggested Lesson Sequence

1. Pre-Gizmo activity (🕒 20 – 40 minutes)

All four of the tests shown in the Gizmo are easy to do in the classroom. Bring in the five mystery powders: baking powder, baking soda, cornstarch, powdered gelatin, and salt. You can use litmus paper or any pH paper for pH. For the Biuret test you will need Biuret solution, available from science supply companies. (CAUTION: Biuret solution should not be swallowed or allowed to contact the skin or eyes. Follow all safety information.) Common vinegar can be used, and iodine solution is available in any drugstore.

Salt is identified by its coarse texture and lack of reactivity to any solution. Baking soda has a basic pH and bubbles in vinegar. Iodine solution turns dark purple when mixed with a starch such as cornstarch. Biuret solution turns purple in the presence of a protein such as gelatin. Baking powder is a mixture of baking soda, cornstarch, and a powdered acid. Baking powder turns iodine purple, has a neutral pH, and bubbles in any liquid.

2. **Prior to using the Gizmo** (🕒 10 – 15 minutes)

Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.

3. **Gizmo activities** (🕒 15 – 20 minutes per activity)

Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (🕒 15 – 30 minutes)

As students are working or just after they are done, discuss the following questions:

- What test result indicates the presence of baking soda?
- What test result indicates the presence of cornstarch?
- What test result indicates the presence of gelatin?
- What test results indicate the presence of salt?
- What combination of test results indicates the presence of baking powder?
- What three ingredients are present in baking powder? How do you know?
- What are some other tests that could be used to identify mystery powders?

5. **Follow-up activity: Crime scene investigators** (🕒 variable)

Set up a “crime scene” and have teams of students play the roles of crime scene investigators and forensic scientists to solve the mystery. Students can collect evidence (fingerprints, hair, fibers, footprints, mystery powders, handwriting, etc.) at the “crime scene,” and then compare the evidence to samples collected from a variety of “suspects.” Students can examine fibers under a microscope, make plaster casts of footprints or tire prints, use chromatography to compare ink, and use chemical tests such as the ones shown in the *Mystery Powder Analysis* Gizmo to identify powders.

Kits for this popular activity are widely available, or you can use your imagination to create your own scene. See the **Selected Web Resources** on page 3 of this document for more ideas.



Scientific Background

The four tests shown in the *Mystery Powder Analysis* Gizmo are based on the chemical properties of five known substances: baking powder, baking soda, cornstarch, gelatin, and salt.

The first indicator of the properties of a substance is its appearance. Gelatin and salt both have a coarse texture, with visible grains. Baking powder, baking soda, and cornstarch all have a fine texture, meaning that the individual grains are too small to see with the naked eye.

Litmus powder is extracted from a variety of lichens found in northern Africa, Madagascar, Norway, and California. Litmus is a pH indicator. Blue litmus paper turns red in acidic conditions, and red litmus paper turns blue in alkaline (basic) conditions. If no color change is observed, the

test solution is neutral. Baking soda is alkaline, gelatin is acidic, and the other substances (baking powder, cornstarch, and salt) are neutral.

Vinegar contains an acid (acetic acid) that reacts with baking soda (NaHCO_3), a carbonate, to produce carbon dioxide. The reaction can be observed as bubbling (effervescence). Baking powder, which contains baking soda, cornstarch and an acid salt, also effervesces when added to a liquid.

The Biuret test uses Biuret solution, a mixture of sodium hydroxide (NaOH) and copper (II) sulfate (CuSO_4). When Biuret solution is exposed to protein, its color changes from blue to violet. In the *Mystery Powder Analysis* Gizmo, only gelatin will show a positive test for protein.

The iodine test indicates the presence of starch. Part of a starch molecule forms a helical, or spiral, structure. Iodine molecules gather within these spirals, resulting in a dark blue-violet color. Cornstarch—and baking powder, which contains cornstarch—will show a positive result for starch.

Baking powder is a mixture of baking soda, cornstarch and an acid salt such as cream of tartar. When added to water, the baking soda and acid react to form bubbles of carbon dioxide. The resulting solution is neutral. Because it contains cornstarch, baking powder also reacts with iodine.

In the *Mystery Powder Analysis* Gizmo, there is a standard set of 15 unknown powders. The tubes in the front row (1-5) all contain one substance. The tubes in the second row (6-10) all contain two substances, and the tubes in the third row (11-15) all contain three substances. Once the **New sample** button is clicked, the number of substances in each tube stays the same, but the substances are randomized. Two new substances are also used in these sets:

- *Talc* is neutral and does not react with vinegar, Biuret solution, or iodine solution. It is distinguished from salt by its fine texture.
- *Detergent* is alkaline and does not react with vinegar, Biuret solution, or iodine solution.

To get back to the standard mystery set, hit **Refresh** or **Restart** on your web browser.



Selected Web Resources

Baking powder: <http://chemistry.about.com/cs/foodchemistry/f/blbaking.htm>

Gelatin: <http://www.madehow.com/Volume-5/Gelatin.html>

Mystery powder labs: <http://www.lnhs.org/hayhurst/ips/mysterypowder.htm>,

<http://www.uen.org/Lessonplan/preview.cgi?LPid=2176>

Crime scene lesson plans: <http://www.accessexcellence.org/AE/AEPC/WWC/1993/who.php>,

http://www.pbs.org/wnet/secrets/previous_seasons/lessons/lp_gangland.html,

<http://www.teachersfirst.com/lessons/forensics/finger-lesn.html>,

<http://www.indiana.edu/~ensiweb/lessons/crime.html>,

http://www.crimescene.com/store/index.php?main_page=product_info&products_id=263

Related Gizmos:

Identifying Nutrients: <http://www.explorellearning.com/gizmo/id?452>

DNA Fingerprint Analysis: <http://www.explorellearning.com/gizmo/id?406>