Whodunit?

Activity 5

Is Grandma Ruffman guilty or innocent? It all depends on the identity of the mystery substance found on her apron. In this activity, kids help solve a crime. In the process, they observe different kinds of chemical reactions and record data like a scientist.

Prepare Ahead

- Fill cups with 1 tsp. of baking powder, enough so that each pair of kids will have 3 cups. Do the same with the flour and baking soda (for a total of 9 cups per pair). Label cups "BP," "F," and "soda," and organize in groups by type.
- Then fill a fourth group of cups with 1 tsp. of baking powder and label "?" This is the mystery substance. Set aside for later.
- Set up work tables: each table should have bowls of grape juice, vinegar, and iodine, with a pipette for each, and paper towels. Keep the cups with powders on a separate table(s); kids will gather the cups and set them up with their partner.
- Make a larger version of the data table (below) on a separate sheet of paper and photocopy for each pair of kids. Allow plenty of space for kids' notes.
- Have kids work in pairs. Distribute an activity sheet, data table, and pencil to each pair.

	Baking Powder	Flour	Baking Soda	Mystery Substance
Grape Juice				
Vinegar				
Iodine				

Lead the Activity

1. **Introduce Ruff's challenge.** (10 minutes) Tell kids they're going to help solve a crime using chemistry. Read the story on the front of the activity sheet. Their challenge is to prove whether Grandma Ruffman is guilty or innocent. First, kids will test a number of white powders with different liquids and look for signs of a chemical reaction. Then they'll test the "mystery substance" found on Grandma's apron with the same liquids, and compare the results to the powders they've already tested. If the mystery substance is baking soda (the ingredient used to bake Scruff Ruffman's cake), then she's guilty. But if it's not, she's innocent!

2. **Set up work stations** (10 minutes) as explained in step 2 of the activity sheet. Tell kids that being well organized and setting up an experiment systematically is part of being a scientist. This helps the scientist test, observe, and record results accurately.

3. **Test, observe, and record.** (15 minutes) Have kids test the liquids and powders (as explained in steps 3, 4, and 5 of the activity sheet). Make sure they use a different pipette for each liquid. Encourage them to observe reactions very closely.
   - Is there a lot or a little fizzing? Is there a change in color, or is the liquid exactly the same color? (*Kids can have difficulty identifying the color of iodine—it looks*

Materials

- Activity sheet for each pair of kids
- Data tables (see "Prepare Ahead")
- Pencils for each pair of kids
- Sticky notes for labels
- Paper cups (12 per pair of kids)
- 1-lb. box of baking soda (3 tsp. per pair of kids)
- 1-lb package of flour (3 tsp. per pair of kids)
- 2 10-oz. or 1 16-oz. container of baking powder (6 tsp. per pair of kids)
- Measuring spoons
- 1 quart purple grape juice
- 1 bottle white vinegar
- 2 fl. ounces iodine (from a pharmacy)
- 3 bowls per table
- 3 pipettes (from an online school supply site) or eyedroppers (from a pharmacy) per table
- Paper towels (1 roll per table)
- Chart paper and marker

National Science Education Standards

Grades K–4
Science as Inquiry: abilities necessary to do scientific inquiry; understanding about scientific inquiry

Physical Science: properties of objects and materials

Grades 5–8
Science as Inquiry: abilities necessary to do scientific inquiry

Physical Science: properties and changes of properties in matter

black in a bottle or bowl, when in fact it's reddish brown. Place a drop of iodine on a paper towel and ask them to observe the color.)

- Sometimes there's no noticeable chemical reaction. What happened instead? *(Sometimes liquid is absorbed into powder; sometimes it doesn't mix easily.)*

4 Discuss what happened. (10 minutes) Gather the group and draw the data table on your chart paper. Fill out the chart together using kids' observations. Then tell them that they will now test the mystery substance and record their observations (steps 6 and 7 on the activity sheet). Finally, they'll compare the results to the original three powders and see if they can identify the mystery substance, which is one of the powders they've already tested.

5 Reveal the mystery! (10 minutes) Together, fill out the last column of the data table on the chart paper.

- Ask kids what the mystery substance is. *(Baking powder)*
- How did they reach their conclusions? *(We compared the reactions of the mystery substance to the reactions of the other powders we tested. The mystery substance reacted the same way the baking powder did.)*
- Does this mean that Grandma Ruffman is innocent or guilty? *(She's innocent! The cake at the crime scene was made with baking soda, but the substance on Grandma Ruffman's apron was baking powder.)*

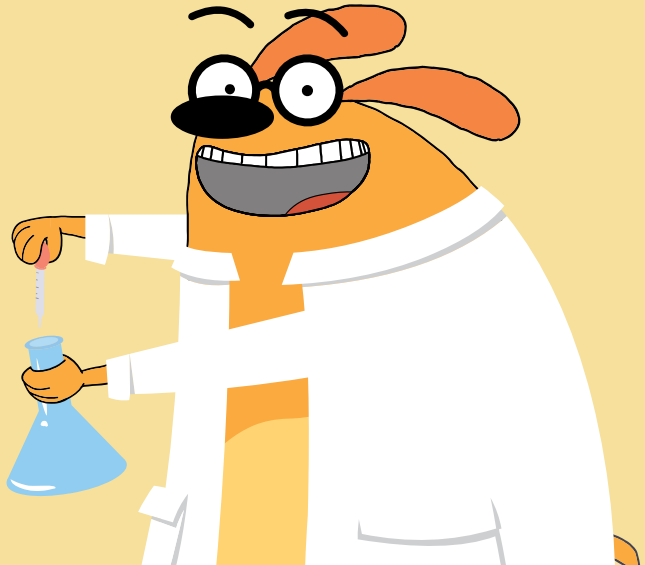
6 Award points. (5 minutes) Time to rack up some points! Review the activity's key ideas by asking the following questions, worth 50 points each:

- What was the mystery substance? *(Baking powder)*
- How did you know? *(The mystery substance had chemical reactions just like the baking powder.)*
- What were some of the different signs of chemical reactions you noticed when you tested the powders? *(Foaming or fizzing; change in color)*
- Were there some combinations that didn't have any reaction? *(Flour didn't show a reaction with vinegar or grape juice; baking soda didn't show a reaction with iodine.)*
- Science involves testing, making observations, recording information, and drawing conclusions. Did you do any of these steps today? *(We tested the liquids and powders, we observed their reactions, and we recorded the information on our data tables. By comparing the data, we could draw conclusions and figure out the mystery substance.)*

Answer key

	Baking Powder	Flour	Baking Soda
Grape Juice	LOTS of fizzing; turns purplish green	No reaction; they don't mix	Fizzing; turns greenish-grey
Vinegar	Fizzing	No reaction	Fizzing
Iodine	Foams a little; turns a dark color	Turns very black	No reaction; soaks into the powder

Note: Baking powder and baking soda have similar (though not identical) reactions to vinegar and grape juice, but very different responses to iodine: baking powder foams and changes color, but baking soda produces no reaction.



Safety Tips

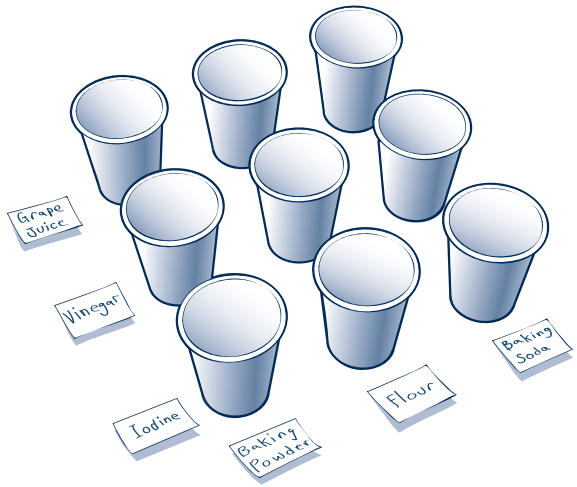
Keep all substances away from eyes and mouth. Iodine and grape juice will stain clothing.

Whodunit?

Today's challenge is to solve the case of the mystery substance—the secret is in the science!

1 Get what you need.
• Data table • Pencil • 3 cups, each with 1 tsp. of baking powder • 3 cups, each with 1 tsp. of flour • 3 cups, each with 1 tsp. of baking soda • 3 cups, each with 1 tsp. of the "mystery substance" • Purple grape juice • White vinegar • Iodine • 3 pipettes or eyedroppers • Paper towels • Sticky notes (to use as labels)

2 Set up your work station. Make labels for each powder and liquid listed on the illustration below and arrange in a grid. Get 3 cups of each powder (9 in total), and line them up under their labels. (Your cups with the mystery substance come later!)



3 Test, observe, and record. Put 5 to 10 drops of grape juice in one cup of baking powder. What happens? Record your observations on the data table (below). Now try the grape juice on the other two powders, recording your observations each time.

4 What's happening? In some cases, a chemical reaction will occur. Signs of this include foaming, fizzing, or a change in color. But sometimes no chemical reaction can be seen. Can you tell the difference?

5 Repeat steps 3 and 4 until you've tested all the liquids with all the powders and have written your observations in the data table. Use a new pipette with each liquid.

6 Test the mystery substance! Get 3 cups of the mystery substance and line them up next to the grape juice, vinegar, and iodine. Test and record your observations. (Hint: the mystery substance is one of the powders you already tested!)

	Baking Powder	Flour	Baking Soda	Mystery Substance
Grape Juice				
Vinegar				
Iodine				

Chew on This!

In this activity, you performed an experiment and analyzed data like a scientist does. A chemical will react in the same way every time, as long as the conditions are the same. You set up the experiment so that each powder was tested in exactly the same way. Then you observed the chemical reactions closely and recorded your data. When you drew conclusions about what the mystery substance was, your conclusions were supported by scientific evidence.

7 Compare data and draw conclusions.
Did your observations about the mystery substance match any of the powders you tested? By comparing your data, can you figure out what the mystery substance is? Explain your reasons. Did you prove Grandma Ruffman's innocence?

Cool Science Jobs!

Did you like figuring out the mystery substance? Then you might love one of these jobs.

Forensic Scientist

Imagine a job where you help put criminals behind bars or free innocent people! That's what forensic scientists do. They work in crime labs, analyzing evidence from the scene of a crime. A forensic scientist might test blood, DNA, gunshot residue, fingerprints, hair or fibers, poisons, mysterious stains, and other clues.

Food Scientist

Think of your favorite candy or ice cream. You can thank a food scientist for making it so delicious! It takes the right chemical know-how to make foods that stay fresh and taste good. But being a food scientist isn't just about dessert! They also develop healthy food to help relieve hunger and malnutrition around the world.

PBS KIDS GO!

Watch the related FETCH! episode, "The People vs. Grandma Ruffman," on PBS KIDS GO! (check local listings) or visit the FETCH! Web site at pbskidsgo.org/fetch.

FETCH! is produced by WGBH Boston. Major funding for FETCH! is provided by the National Science Foundation and public television viewers. Corporate funding is provided by Greendog®. This FETCH! material is based upon work supported by the National Science Foundation under Grant No. 0714741. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Fold

FETCH!

Whodunit?

Help! Grandma Ruffman's been arrested! Detectives say she baked a cake with a metal file in it so that my notorious brother Scruff Ruffman could use it to break out of jail! But sweet old Grandma would never turn to a life of crime! The cake in question was made with baking soda, and they found something that looks like baking soda on her apron. Quick! Head to the crime lab and test it. Can you prove she's innocent?