

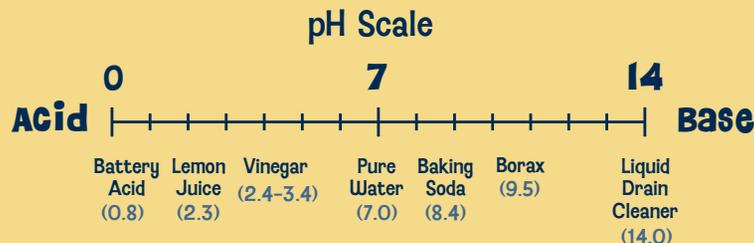
# Operation ESPIONAGE

Kids test for the best way to make invisible ink reveal itself. They discover that mixing a base (invisible ink made from baking soda) and an acid (fruit juice) can create a chemical reaction. In this case, the chemical reaction causes a change in color, making the invisible message appear.

## Prepare Ahead

Familiarize yourself with the activity, which happens in three stages:

1. Writing messages with invisible ink
  2. Having a group discussion about acids, bases, and chemical reactions while the messages dry
  3. Testing out different ways to reveal the message
- Set up tables for the first stage. Each kid needs a cup with a tsp. of baking soda, a spoon, a couple of cotton swabs, and a piece of paper. Place paper towels and a bowl of water in the center of each table.
  - Prepare and set aside materials for the third stage. Each table will need: three bowls filled halfway, one each with grape juice, grape juice concentrate, and cranberry juice; one bowl filled halfway with water plus a few drops of red and blue food coloring (so it looks like juice). Label the bowls with sticky notes. Also set up a bowl filled with cotton balls, and an empty bowl for the used cotton balls.



Indicates how acidic or basic a substance is

## Lead the Activity

- 1 **Introduce Ruff's challenge.** (5 minutes) Hand out the activity sheets. Tell kids they'll be making invisible ink and writing secret messages with it. Later, they'll make their hidden messages appear!
- 2 **write with invisible ink.** (15 minutes) Have kids follow the directions for writing with invisible ink (steps 2 and 3 on the activity sheet). When they've finished, have them leave their papers to dry, which will take about 10 minutes.
- 3 **Discuss acids and bases.** (5 minutes) Tell kids that to make their messages appear, it helps to know a little chemistry. Draw the pH scale (left) on chart paper. Explain that *acids* and *bases* are common chemicals, and give a few examples. (*Citrus juices and vinegar are acids; baking soda, borax, soaps, and other cleaners are bases.*)

The pH scale indicates how acidic or basic a substance is: the scale goes from 0 (most acidic) to 14 (most basic). Acids and bases are chemical opposites, and when they are combined, a chemical reaction can occur. Some signs of a chemical reaction include foaming, fizzing, or a change in color. Tell kids to watch for a chemical reaction as they try to reveal the invisible message.

## Materials

- Activity sheet for each kid
- 1 box of baking soda (1 tsp. per kid)
- Water
- Juices: cranberry and purple grape juices; grape juice concentrate
- Sticky notes to label juices
- Bowls (see "Prepare Ahead")
- Red and blue food coloring
- Measuring spoons
- Plastic spoons (1 per kid)
- Cotton swabs (2 per kid)
- Cotton balls (6 per kid)
- Cups (1 per kid)
- Paper (1 sheet per kid)
- 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

- 4 Make Predictions.** (5 minutes) Ask kids:
- Looking at the pH scale, is baking soda a base or an acid? (*A base*)
  - If you wanted to create a chemical reaction with the baking soda, what would you combine it with, a base or an acid? (*Its opposite, an acid*)
  - Of the four liquids you're going to use to reveal your messages (grape juice, grape juice concentrate, cranberry juice, and colored water), which one do you think will work best? Why? (*Record predictions on chart paper.*)
  - What kind of chemical reaction do you think you'll see? Some choices are: foaming, fizzing, or a change in color.

- 5 Set up materials for revealing the invisible ink.** (2 minutes) Prepare tables for the third stage, as outlined in "Prepare Ahead."

- 6 Test the different liquids and make observations.** (15 minutes) Have kids follow step 4 on the activity sheet. Make sure they use a different liquid on each section of their paper, as well as fresh cotton balls. Have them pat the liquids sparingly over each section so their paper stays as dry as possible. If time permits, have kids create additional secret messages, trade them with others, and then reveal them.

- 7 Discuss what happened.** (10 minutes)
- Ask kids what worked best to reveal the secret message. (*Grape juice concentrate*)
  - Is this what they predicted? (*Answers will vary.*)
  - Did any of the other liquids work? (*A faint message appeared with the grape juice.*)
  - What kind of chemical reaction did they see? (*A change in color. The grape juice concentrate turned a bluish-green color.*)
  - Why do you think the grape juice concentrate might have worked better than the other juices? (*Answers will vary. Kids may say it has something to do with being a concentrate, which is correct.*) Tell kids that grape juice contains a pigment, which gives it its color. The acid–base reaction between the baking soda and grape juice caused a color change, and the amount of pigment in the grape juice influenced how dark the message became. Because grape juice concentrate has more pigment in it than grape juice does, it produces a darker, more visible message.

- 8 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 does a pH scale show? (*How acidic or basic a substance is*)
  - Is baking soda a base or an acid? (*A base*)
  - What about the juice? (*An acid*)
  - When you mix a base and an acid together, what can happen? (*A chemical reaction*)
  - What kind of chemical reaction occurred here? (*A color change*)

