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Overview

This Delta Science Module introduces students to the techniques scientists use to study unknown substances, a process called *chemical analysis.*

In Activity 1, students learn to describe and identify ordinary objects based on their properties. First, they describe the physical characteristics of classroom objects. Then they attempt to identify objects described by others. Finally, teams challenge one another to differentiate between similar objects based on their property descriptions. From this, students conclude that the best descriptions are those that are detailed and that focus on features peculiar to the object.

In Activity 2, students are presented with six unidentified white substances (baking soda, citric acid, cornstarch, plaster of paris, salt, and sugar) and challenged to differentiate between them using their senses of sight, smell, hearing, and touch.

In Activity 3, students use Pocketscopes, a kind of hand-held microscope, to make more detailed observations of the substances. They discover that three of the substances have a crystalline structure, and three are powders.

Students learn the names of the six substances in Activity 4 after comparing them to six identified substances.

In Activity 5, students observe how each substance interacts with water. By noting differences in the way each substance responds to water, students conclude that water tests can be used to differentiate between the substances.

In Activity 6, students observe what happens when vinegar is added to each substance. They discover that vinegar fizzes when combined with baking soda—evidence of a chemical reaction. From this, students conclude that vinegar can be used as an indicator for baking soda.

In Activity 7, students observe what happens when iodine is added to each substance. They learn that iodine turns blue-black in the presence of starch. They note that other common materials, such as paper, also turn blue-black, indicating there is starch in them as well.

In Activity 8, students test each substance with bromthymol blue (BTB), a pH indicator. Students are introduced to the concept of acids and bases, learn about the pH scale, and determine the relative pH of the six substances.

Students begin Activity 9 by heating each substance over a candle and observing its response: Some melt, some burn, and some appear not to change at all. Students conclude that heat, too, can be used to help them distinguish between the substances.

Students are challenged to identify four mystery mixtures in Activity 10. They test the mixtures, which are made from two or three of the substances, and compare their results with those obtained in previous activities. Students then use deductive reasoning to infer the ingredients in each mixture.

Activity 11 introduces students to three new substances: baking powder, confectioners' sugar, and flour. Students predict how these substances will respond to the same tests. They discover that two of these substances are actually mixtures, and the third, flour, is a relative of cornstarch derived from wheat.

Finally, in Activity 12, students create their own mixtures from any three of the nine substances, then challenge their classmates to identify the ingredients in their mixture.

Materials List

Qty		Description
1	c	aluminum foil
1	c	†baking powder, 10 oz
1	c	†baking soda, 1 lb
4		bottles, dropper, p/8
3	c	BTB solution, 2 oz
16	c	candles
1	c	chart, Which Is Which?
1	c	citric acid, 2 lb
16		clothespins
1		Color Sheet
1	c	†cornstarch, 1 lb
3	c	cups, paper, soufflé, p/250
120		cups, plastic, 1-oz
8		cups, plastic, 9-oz
1	c	dots, adhesive, blue, p/96
1	c	dots, adhesive, green, p/96
1	c	dots, adhesive, orange, p/96
1	c	dots, adhesive, red, p/96
1	c	dots, adhesive, white, p/96
1	c	dots, adhesive, yellow, p/96
1	c	†flour, baking, 2 lb
40	c	index cards
2	c	iodine, 2 oz
18		jars, with lids
3	c	labels, p/100
8		magnifiers
16		pans, aluminum
1	c	paper, construction, black, p/50
1	c	†plaster of paris, 2 lb

Qty		Description
16		Pocketscopes™
1	c	†salt, 26 oz
1		slides, depression, p/40
18		spoons, plastic
1	c	sticks, stirring, p/8
1	c	†sugar, confectioners', 1 lb
1	c	†sugar, granulated, 5 lb
2	c	toothpicks, flat, p/750
8		trays, plastic
1	c	vinegar, 16 oz
1		teacher's guide

Teacher provided items

8		cans, metal, small
8		crayons
8		markers, felt-tip
8		matches, books
–		newspaper
–		paper towels
16		paper, plain
8		pencils
8		pens, ball-point
1		ruler, metric
32		safety goggles
8		scissors
–		tape, transparent
–		water, distilled
–		water, tap

† = in separate box
c = consumable item

Activity 3
A Closer Look

Objectives

Students use Pocketscopes to observe detailed differences in the structure of the mystery substances.

The students

- use a Pocketscope to examine the mystery substances more closely
- learn the difference between powders and crystals
- differentiate between the substances based on the structure of their particles

Schedule

About 40 minutes

Vocabulary

crystal
particle
powder

Materials

For each student

1	Activity Sheet 3
1 pair	*safety goggles

For each team of four

1	*Color Sheet
6	*cups, plastic, 1-oz, color-coded
2	Pocketscopes™
2	slides, depression
6	toothpicks, flat
1	tray, plastic

For the class

2 jars	*baking soda (blue dot)
2 jars	*citric acid (green dot)
2 jars	*cornstarch (orange dot)
1	cup, plastic, 1-oz
1 roll	*paper towels
2 jars	*plaster of paris (red dot)
2 jars	*salt (white dot)
12	*spoons, plastic, color-coded
2 jars	*sugar (yellow dot)
	*tape, transparent
1	toothpick, flat

*provided by the teacher or from a previous activity

Preparation

1. Make a copy of Activity Sheet 3 for each student.
2. Set up two distribution stations and place one set of six color-coded jars and spoons at each station.
3. You will need a pair of safety goggles, a toothpick, a 1-oz cup containing a very small amount of cornstarch, a depression slide, a Pocketscope, and a sheet of white paper for a class demonstration.
4. Each student will need a pair of safety goggles. Each team of four will need a tray, a Color Sheet, six color-coded cups, six toothpicks, two depression slides, two Pocketscopes, two sheets of white paper, three small pieces of transparent tape, several paper towels, and access to the substances at either distribution station.

Background Information

In this activity, students use Pocketscopes to examine the structure of the *particles* that make up each of the six substances. They discover that three of the substances are in crystalline form—composed of *crystals*—and three are in *powder* form.

A crystal is a transparent solid that has a regularly repeating internal arrangement of atoms or ions, resulting in a particular structure and shape.

Of the crystals in this activity, the salt is the most regular in shape, appearing as tiny cubes of various sizes. The sugar and the citric acid are also composed of crystals, but are more irregular in shape, possibly because the conditions under which they form cause them to form imperfectly.

The baking soda, plaster of paris, and cornstarch are not crystalline in form but are powders. A powder is a substance composed of finely ground or pulverized loose solid particles.

Name _____ Activity Sheet 3

A Closer Look

Examine each substance with a Pocketscope. Then draw and describe it in the chart below.

Substance (color code)	What do the particles of this substance look like when viewed with the Pocketscope?
blue	
green	
orange	
red	
white	
yellow	

Teaching Suggestions

1

Distribute a copy of Activity Sheet 3 and a pair of safety goggles to each student. To each team of four distribute a tray, a Color Sheet, six color-coded cups, six toothpicks, two depression slides, two Pocketscopes, and several paper towels.

Have students collect samples of each of the six substances from either distribution station.

Demonstrate how to use a Pocketscope to examine the cornstarch, baking soda, and plaster of paris.

Additional Information

1

Students need only a very small amount of each substance for this activity. Remind them to use the color-coded spoons to avoid cross-contaminating the substances.

2

Put on a pair of safety goggles. Use a toothpick to place a very small amount of cornstarch in the well of a depression slide. Carefully insert the slide under the clips of the Pocketscope. Place your eye near the lens, point the Pocketscope toward the light, and slowly squeeze the frame together until the image is in focus.

Next, demonstrate how to use the Pocketscope to examine the salt, sugar, and citric acid by dropping a few salt grains on to the adhesive side of a small piece of transparent tape and placing the tape over the viewing hole of the Pocketscope. Hold the Pocketscope up to the light as before.

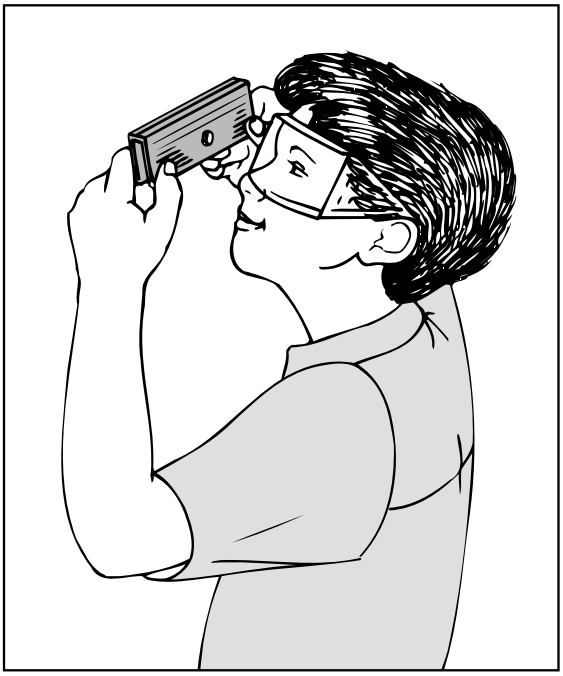

Figure 3-1. Using a Pocketscope to view a powder.

Tell students to put on their safety goggles and begin examining the substances with the Pocketscopes. Tell them to wipe their slides clean with a paper towel after each use and to record their observations on Activity Sheet 3.

Circulate and help students focus the Pocketscopes.

They should use a fresh piece of tape for each crystal they examine as well.

3

After students have had an opportunity to examine all six substances under a Pocketscope, have them place their materials on the tray and set it aside. Ask, **Do the substances all look alike?**

Students should have noted that the substances do not all look alike.

Write the word *particle* on the board. Tell students that a particle is a tiny piece of something. Ask, **How are the particles of these substances different from one another?**

Some of the substances look like dust, even under magnification, while others look like tiny crystals of different shapes.

Write the word *crystal* on the board. Tell students that a crystal is a solid form of a substance in which the atoms are arranged in repeating patterns. Because of this, crystals often have a distinctive shape characterized by regular, repeating surfaces. A substance composed of crystals is said to be crystalline in form.

Ask, **Which of the substances could we call crystals?**

The green-dot (citric acid), white-dot (salt), and yellow-dot (sugar) substances are composed of crystals.

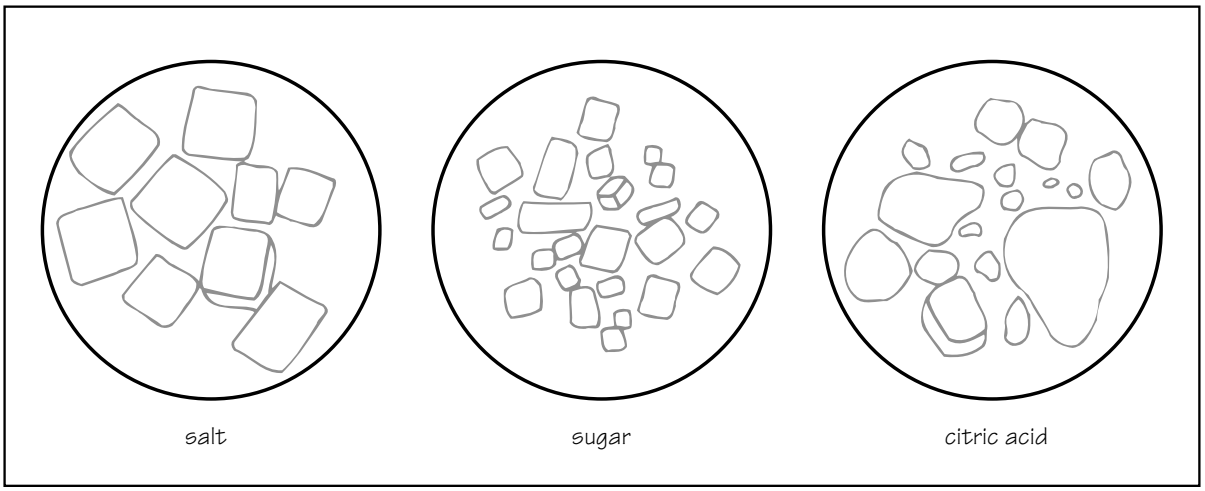

Figure 3-2. Crystals of salt, sugar, and citric acid.

Write the word *powder* on the board and explain that a powder is a substance that has been ground or pulverized into finely dispersed, loose, solid particles. The particles in a powder are not crystalline in form.

Ask, **Which of the substances could we call powders?**

The blue-dot (baking soda), orange-dot (cornstarch), and red-dot (plaster of paris) substances are powders.

Challenge students to help you write descriptions on the board that would allow them to tell the substances apart. If there are any disagreements over what to write, have students re-examine the substances and edit the descriptions until everyone agrees. Use the students' own words for the descriptions.

For example, the blue-dot substance (baking soda) has tiny, somewhat transparent particles; the green-dot substance (citric acid) has transparent, irregularly rounded crystals of different sizes; the orange-dot (cornstarch) and red-dot (plaster of paris) substances both have very fine, dustlike particles; the white-dot substance (salt) has cube-shaped crystals all about the same size; and the yellow-dot substance (sugar) has cubic crystals (two stuck together may appear rectangular) of various sizes.

Ask, **Are there any substances that you could not tell apart in Activity 2 that you now can after examining them with a Pocketscope?**

Answers may vary, but the most likely candidates are the substances with a crystalline form, such as the green-, white-, and yellow-dot substances (citric acid, salt, and sugar).

Reinforcement

Have students draw pictures of the salt, sugar, and citric acid crystals as seen with the Pocketscope. Challenge other students to try to tell which substance is which from the pictures. Have students add to or amend their drawings until other students can tell them apart.

Cleanup

Have students discard the toothpicks and the substances in their cups. Collect the trays, Color Sheets, cups, slides, and Pocketscopes. Wipe the cups and slides clean with a paper towel, and return all materials, including the jars and spoons, to the kit. Collect the activity sheets and save them for use in later activities. Have students wash their hands.

Connections

Science Challenge

After students have grown crystals as described in the first and second Science Extensions below, suggest that they experiment with different variables in crystal-growing contests. Variables include the strength of the solution, the temperature at which the crystals are grown, and the length of time they are allowed to grow. Who can grow the largest crystal? the tiniest? the greatest number?

Science Extension

Making rock candy is an enjoyable way for youngsters to investigate crystals. Have students tie a small, clean, rust-proof nail to a heavy string, then suspend the nail in a jar filled with a supersaturated sugar solution and leave the jar where it will not be disturbed. Have students examine the sugar crystals with a magnifier and identify their shape. (cubic or rectangular) When crystal growth has stopped, let students remove and eat the rock candy.

Ask students to look through science textbooks and activity books to find other ways to grow crystals from a saturated solution of salt, sugar, or other material. For a unique method of growing sugar crystals in a gel, students can use *A+ Projects in Chemistry* by Janice VanCleave (John Wiley & Sons, 1993).

Some mineral crystals are valued as precious or semiprecious gems. Encourage students to investigate various gems. If students investigate the six basic crystal forms in Science and Math below, they may want to identify examples of gems for each form. (Examples: cubic, diamond; hexagonal, ruby; tetragonal, zircon; orthorhombic, topaz; monoclinic, jade; and triclinic, moonstone)

Science and the Arts

Let each student draw a snowflake or a simple snow scene on dark blue construction paper with a brush dipped into a saturated salt solution (3 teaspoons of salt to 0.25 cup of water). Tell students to stir the solution with the brush before making each stroke. After the papers are left to dry in direct sunlight or in an oven preheated to 150°F and then turned off, the drawings will appear in white, shiny crystals on the dark background.

Science and Math

Your more advanced students might like to find out about the six basic geometric forms in which crystals are found: cubic, hexagonal, tetragonal, orthorhombic, monoclinic, and triclinic. In addition to researching the characteristics and names of the forms, students could build three-dimensional models of them with oaktag or posterboard. Let students display their labeled models by suspending them from the classroom ceiling or from a cord stretched across the room above head level.

Science, Technology, and Society

In the early 1900s, radios had tuners that incorporated crystals. Have students research these early radios. Kits for making crystal radios are frequently available in hobby shops. Some students may want to build one and demonstrate it to the rest of the class.

Suggest that students do library research to find out about magnifying lenses and how they are made. Ask students to share their findings in oral reports or bulletin board displays. Students also might like to read about early microscopes that used a drop of water as the lens. They may be able to find directions for making such a microscope.