

How is the Mystery Substance Like Interstellar Dust? page 1

Grades 3-5

National Science Education Standards (K-8)

- Content Standard A: Science as Inquiry
Abilities necessary to do scientific inquiry;
understanding about scientific inquiry.
- Content Standard B: Physical Science
Properties of objects and materials.
Properties and changes in properties of matter.

Materials

Instant oatmeal variety pack (including dried fruit)

Sealable plastic bags

White butcher paper (36 inches wide)

Materials for the sample strips:

- Samples of the major instant oatmeal ingredients (salt, sugar, cinnamon, oatmeal, and dried fruit).
- Samples of ingredients NOT in instant oatmeal (flour, cornmeal, M&Ms, dry cereal variety pack, etc.)
- 2-inch wide, clear plastic tape.

Tools

For each group:

Tweezers, magnifying glass, wire-mesh strainer (coarse), watercolor fine brush, transparent metric ruler showing millimeters, one large sheet of butcher paper.

Clear plastic tape (students may want to tape down small amounts of their ingredients for further study and labeling).

Rationale

This hands-on investigation of instant oatmeal models how scientists determine the composition and properties of interstellar dust (dust between and among stars) using the Spitzer Space Telescope. Students break apart the sample into its components, and test them against known samples to determine the ingredients. Astronomers cannot visit interstellar dust clouds, but they can observe them with the Spitzer Space Telescope. From these observations, and comparison to the known properties of gas and dust, astronomers can determine the recipe for interstellar dust clouds to better understand some of the ingredients that go into forming stars and planetary systems.

Preparation

Oatmeal bag

The oatmeal variety pack should include many different flavors, such as apple, peach, strawberry, blueberry, plain, maple, and brown sugar. Prepare a sealed plastic bag of instant oatmeal for each group of students, and number the bags. Make a list for your own reference that matches the bag number with the contents.

Sample strips

The sample strip contains small amounts of each ingredient with a label sandwiched together between two strips of 2-inch wide clear tape. Each strip takes 10 to 20 minutes to prepare. These strips allow students to compare their unknown ingredients with known samples without tasting.

Making the sample strip:

Salt	Sugar	Cinnamon	Oats

This example shows only four ingredients. Your strip may have up to seven samples.

1. Lay out a strip of tape sticky side up.
2. For each ingredient, attach the label, then sprinkle ingredients onto the sticky side of the tape.
3. Lay a second strip of tape sticky side down on top of the sample to seal the labels and ingredients into a “sandwich.”

Classroom

Arrange desks and tables so that students can work in groups of three to five. Lay out large butcher paper sheets (at least 3 x 3 feet) at each lab station. In the Explore and Explain phases of their investigation, students will mark up the paper and sort the oatmeal ingredients — the larger the paper, the more freedom students have to sort and describe the ingredients. The paper also serves to minimize the mess.

Materials

Lay out materials at each lab station, or set them up in a central location for students (one per group) to collect. Keep the sample strips aside for use in the Explore phase.

Background

Review “About the Spitzer Space Telescope” on the back of this poster and the article “Dust in the Universe” which accompanies this poster in the September 2004 issue of *Science and Children*.

Engage

Before students collect materials and bags, ask them what they know about dust in space. They may have seen TV shows, read a book, viewed information on the Internet, or studied in class about space dust. Tell them that some astronomers are interested in space dust, and are studying it with a new space telescope, the Spitzer Space Telescope. Hold up one of the plastic bags and ask what students think is inside. Most students will guess that it contains oatmeal. Remind them of laboratory safety, especially not to taste unknown substances even though some may be quite confident the bags contain oatmeal. Help students formulate driving questions for their investigation and

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show them the tools they can use. Relate students' questions to astronomers' questions about dust in space: What is the dust made of? What size is the dust? Use the table on the "Resources" page as a prompt.

Explore

Pass out or ask students to collect a set of materials and a bag for each group. As students explore and examine the contents of the bags, help them invent a strategy for sorting out and identifying the ingredients.

Sort it out

Students' main objective is to sort out the dry ingredients of instant oatmeal by their physical characteristics.

Using a wire-mesh strainer, they separate the large-size ingredients (oats, dried fruit) from the fine-size ingredients (powder, sugar, cinnamon...). To organize the ingredients, they can draw circles on the butcher paper to mark off areas for each identifiable ingredient in the instant oatmeal package. Beside the circles, they write descriptions for the physical characteristics of the material inside the circles.

Identify the ingredients

While students sort the ingredients, they will touch and smell the ingredients in order to identify them. Do not allow tasting. Let students think about how they will safely identify the ingredients. Once students sort out the ingredients by their physical characteristics, announce that you have a set of known samples (salt, sugar, cinnamon, oatmeal...) for students to examine and compare to their unknown samples.

Explain

When students finish analyzing their oatmeal samples, ask each group to explain their thinking:

- *How did you organize the ingredients?*
- *What properties did you record?*
- *What ingredients could you identify?*
- *How did you match the sample strip with the unknown samples?*

Elaborate

Help students relate their oatmeal investigation to astronomers' research using the Spitzer Space Telescope. Astronomers compare the data from the telescope with known samples. They know that objects in space are made of the same atoms as we have on Earth even though the conditions in space are different. The ingredients of the instant oatmeal

are like different kinds of dust. Dust and gas collapse under the force of gravity to form stars and planets. Astronomers observe "snapshots" of the process of dust as it forms stars and planets, then explain what happens between each snapshot.

Astronomers cannot touch or smell interstellar dust. But they can observe it with the Spitzer Space Telescope to learn about its ingredients and properties. They can observe dust "cooking" at high temperature and pressure as it coalesces into stars.

Evaluate

Since students are working in collaborative groups, this science activity is also a social skills activity. Karen Ostlund and Sheryl Mercier's book *Rising to the Challenge of the National Science Education Standards* (ISBN: 0965876810) contains excellent suggestions for assessing student social skills during collaborative learning.

Explore

(Grading rubric = 50 points)

• Sorting (25 points)

CRITERIA:

- Uses tools to separate ingredients.
- Uses tools to measure physical properties of ingredients.
- Sorts ingredients into groups based on physical properties.
- Describes ingredients using measurements and written captions.

• Identifying (25 points)

CRITERIA:

- Creates a strategy for identifying unknown ingredients.
- Compares known and unknowns using tools.
- Safely compares known and unknowns using senses (no tasting).

Explain

(Grading rubric = 50 points)

CRITERIA:

- Explains how the group decided to organize the ingredients by referring to measurements and descriptions.
- Explains the group's strategy for identifying the unknown ingredients by including logical reasons, measurements, and observations.
- Explains how the mystery substance is similar to or different from space dust.

Total: 100 points.

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Texas Essential Knowledge and Skills

Science:

§112.14. grade 3 (b)-3(C) represent the natural world using models such as volcanoes or Sun, Earth, and Moon system and identify their limitations, including size, properties, and materials.

§112.14. grade 3 (b)-4(A) collect, record, and analyze information using tools, including microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, wind vanes, rain gauges, pan balances, graduated cylinders, beakers, spring scales, hot plates, meter sticks, compasses, magnets, collecting nets, notebooks, sound recorders, and Sun, Earth, and Moon system models; timing devices, including clocks and stopwatches; and materials to support observation of habitats of organisms such as terrariums and aquariums.

§112.15. grade 4 (b)-(5)(A) measure, compare, and contrast physical properties of matter, including size, mass, volume, states (solid, liquid, gas), temperature, magnetism, and the ability to sink or float.

§112.16. grade 5 (b)-(2)(C) collect information by detailed observations and accurate measuring.

§112.16. grade 5 (b)-(2)(F) communicate valid conclusions in both written and verbal forms.