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Concept: Demonstrating spaces in matter

National Science Standards:

A	B	C	D	E	F	G

A. Background:

Matter is anything that takes up space. No two molecules of matter can occupy the same space at the same time. There are three common phases of matter: solid, liquid, and gas. Solids, liquids, and gases are made up of atoms or molecules. There is empty space between the atoms or molecules and no two atoms or molecules can occupy the same area at the same time. Solids, which have the least amount of empty space, are made up of atoms or molecules that are close together. Liquids, which have more empty space than solids, are made up of atoms or molecules that are further apart than those in solids. Gases, which have the most empty space, are made up of atoms or molecules that are further apart than those in liquids or solids.

This activity demonstrates spaces in two different solids and in one liquid. *The extension section has for ideas for demonstrating spaces in gases.*

Objective: Students will observe that there are spaces in matter. The students will also be able to measure and record their observations.

Suggested grade levels: 3-5 (See extensions for other grade levels.)

Estimated time:

- Teacher prep: 10-15 minutes
- Activity: 15-20 minutes

Materials needed (per group):

- 4 - 100 mL graduated cylinders
- water
- BBs
- rubbing alcohol
- coarse sand
- funnel
- paper and pencil
- GOGGLES

Safety/Disposal:

Caution students to avoid not to drink or breathe the rubbing alcohol and to avoid contact with skin, eyes, or mucous membranes. **Goggles required!**

Drain water off sand and BBs mixtures. Dispose of the water and alcohol down the drain if permitted in your community. Solids can be thrown away in the garbage or dried and saved for reuse.

Procedure:

1. Fill a graduated cylinder with exactly 40 mL of water.
2. Fill a second graduated cylinder with exactly 40 mL of BBs.
3. Slowly pour the 40 mL of water into the graduated cylinder of BBs.
4. Carefully record the total volume of the water and BBs.
5. Repeat steps 1-4 using 40 mL of sand instead of BBs.
6. Repeat steps 1-4 using 40 mL of rubbing alcohol instead of BBs.

Wrap-up:

- Expected results: The total volume recorded will be less than the sum of the two original amounts. This shows that there are spaces that were filled. The conclusion that there are spaces is straightforward with the sand and BBs. The observation that there are also spaces in liquids is a great starting point for a discussion of the atomic and molecular nature of matter.
 - Discuss the existence of spaces in matter. Is there space between molecules in solids? Is there space between molecules in liquids? How do you know?
 - Follow-up questions: Is there space between molecules in gases? How might we find out? (See extension.)
- d) • What to do if something unexpected happens: If a student should have an equal volume, then have them repeat the experiment, checking that their measurements are accurate. Alternatively, have all of the students report their findings to the class, then look for trends and discuss any anomalies.

Extensions:

- This is an activity dealing with spaces in gases. It requires balloons (6-9 inches in diameter), a large evaporating dish (or Styrofoam™ trays), and dry ice. Heavy gloves should be worn when handling the dry ice. (Caution students not to touch the dry ice.) Goggles should be worn!
 1. Blow up balloon and tie it. You might tie a string around the balloon to measure/show the circumference before and after.
 2. Using gloves, place dry ice in dish or tray.
 3. Place inflated balloon into the tray of dry ice.
 4. Observe and record.
 5. Remove balloon from the tray of dry ice.
 6. Observe and record.

The balloon deflates because the speed of the gas molecules has slowed; thus the pressure is reduced, which decreases the volume of the balloon. The balloon will inflate again when removed from the dry ice, because warming causes the speed of the gas molecules to increase, thus, the volume of the balloon increases.

- For other extensions, see the chapter titled “Matter” in Chemistry for Every Kid by Janice Van Cleave.

Resources/Bibliography:

This activity is based upon a presentation given at the MATR Institute by Dr. Steve Wright, University of Wisconsin- Stevens Point chemistry professor and MATR safety coordinator.

Lang, C. Marvin, Showalter, Donald L., and Shulfer, Gary J. “The Effect of Temperature,” Fun with Science. University of Wisconsin- Steven Point, 1993.

Parratore, Phil. Matter. Cypress, CA: Creative Teaching Press, Inc., 1995.

Van Cleave, Janice Pratt. Chemistry for Every Kid. New York: John Wiley & Sons, Inc., 1989.