Space Exploration

Summary

Students will learn about volume and measuring volume.

Materials

For each group:

- 14 oz. (approximate) clear plastic cup
- 32 oz. water bottle, as a water source
- Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- 8 plastic vials (similar to plastic pill bottles)— 4 small and 4 large
- Cloth or paper towels
- Centimeter cube or a 1-ml measuring spoon

Part I

For each group:

- 100-ml beaker
- 32 oz. water bottle, as a water source
- Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- 1-liter container (a 1- liter beaker or a 32 oz. bottle with metric markings)
- Cloth or paper towels
- Empty 2-liter plastic soda bottle

Part II

For each group:

- 50-ml graduated cylinder
- 50-ml syringe (optional)
- 14 oz. (approximate) clear plastic cup
- 32 oz. water bottle, as a water source
- Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- Cloth or paper towels

Part III

For each group:

- Set of various small containers for measuring capacity (e.g., portion cup, film canister, a variety of plastic cups, cans, etc.)
- Empty 12 oz. soda can
- 32 oz. water bottle, as a water source
- Plastic basin for flood control (a clear plastic shoe box or small cat litter box)

For the class:

- Cloth or paper towels

Resources

Book

- *FOSS Measurement*
  , by Lawrence Hall of Science, UCB, (available at http://www.deltaeducation.com/fossgallery.aspx?subID=&menuID=2); Item #WX542-2005, ISBN 0-87504-766-1

Background for Teachers

Volume

can be described as the space occupied by something. Matter occupies space, whether it is solid, liquid, or gas. The standard metric unit for measuring volume is the *liter*. One liter is made up of 1000 *milliliters*. One milliliter is equivalent to a cubic centimeter. The symbol ml is used to represent milliliters. Because liquids conform to the shape of the container in which they are placed, it is fairly easy to measure their volume using containers with milliliter markings. Three useful tools are a graduated cylinder (tall narrow tube with milliliter markings), a beaker (a relatively wider cup with markings on the side and a spout on the rim), and a syringe (basically a graduated cylinder with a plunger stem in one end and a small funnel-like spout at the other end).

Intended Learning Outcomes

4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Instructional Procedures

Invitation to Learn

Hold up an empty 14 oz. clear plastic cup and have students measure how much water the cup can hold when it is completely full. The unit for measuring that they will use is a small plastic vial.

- Demonstrate how to do this by pouring water from a water bottle into the small plastic vial until the vial is completely full. Do all pouring over the basin to catch any spills.
- Pour the contents of the vial into the cup and repeat until the clear plastic cup is completely full. Keep track of exactly how many "vials" it takes to fill the plastic cup completely.
- One person from each group picks up a basin, an empty plastic cup, and a bottle of water. Distribute one vial to each group, giving half the groups a larger vial and half the groups a smaller vial.
- After students complete the measuring, have one person from each group report the number of "vials" it took to fill the cup completely full.
- Write their reports on the board. It should be apparent that there are two differing sets of results. Point out the discrepancies and ask the students to explain (two different sizes of vials were used). Help students understand the need for a common unit of measurement.
- Hold up a cubic centimeter cube or a 1-ml spoon to show the standard unit of the *milliliter*.
- Students pour the water from the cup back into the water bottle. Pour any "floods" back into the water bottle and use cloth or paper towels to dry any spills on the table.

Instructional Procedures

Part I

- Introduce a 100-ml beaker and explain its usefulness in measuring amounts of water in a container. When the beaker is filled to the 100-ml line it holds exactly 100 milliliters.
- One student from each group picks up a bottle of water and a basin with a 100-ml beaker. Each group carefully fills their beaker to the 100-ml line.
- One person from each group pours their 100-ml of water into the 1-liter container at the front of the class. As each student pours in their water, have the class count by 100's out loud. Do not tell them that it is a 1-liter container yet.
- Have some groups refill their beaker until exactly ten portions have been placed in the container. There are now 1,000 milliliters of water in the container. This new unit of measure is a *liter*.
- Lead a discussion with the class about their experience with liters. Most will refer to a 2-liter bottle of soda.
- Pour the liter of water you have collected into the empty soda bottle. Refill the liter and add it to

the soda bottle to fill it to the level where it is as full as it would be in the grocery store.
Discuss connections. Students clean up and return materials.

Part II

Explain that everything takes up space. The amount of space occupied by something is its *volume*. Your body takes up space and an orange takes up space. If we measure the amount of space these things occupy, we are measuring volume. Liquids are easy to measure because you can pour them into measuring container, like a beaker.

Fill a 14 oz. clear plastic cup approximately half full of water. The water is occupying space that we are going to measure in milliliters. The lines on a beaker do not allow for as precise of a measurement as you would like, so you are going to use narrower containers.

Show students a syringe and a graduated cylinder. (If you do not have syringes, graduated cylinders will suffice.) Demonstrate the use of a syringe by using the plunger to push out all of the air. Submerge the tip of the syringe into the cup of water and pull up the plunger until it stops at the pin.

The syringe is now completely full and holds exactly fifty milliliters. You may want to demonstrate accidentally pulling large air bubbles into the syringe. Tell them that if they are to be accurate and ensure that there are no air bubbles. If it happens, have them push out the air and water and try again. Also explain that the syringe is not a toy. Students are not to squirt water for any other purpose than directed.

Once you have successfully withdrawn 50-ml of water, expel it into the water bottle and have students keep track of how much you have removed.

Draw out a second unit of 50-ml. As you expel it into the water bottle, students note that the second unit makes 100 total milliliters. At this point there is less than 50 remaining milliliters, so we must use the graduated cylinder to continue measuring.

Pour the remaining water into the graduated cylinder. Demonstrate how to read the graduated cylinder, similar to reading a thermometer.

Add the amount of water in the cylinder to the 100-ml you have already drawn out. The combined total is the total volume of water that was in the cup.

Have one student from each group pick up a bottle of water, a basin, a 14 oz. clear plastic cup, a syringe, and a 50-ml graduated cylinder.

Observe students as they take turns measuring volumes. There will not be a common result since the amount of water in the cup will vary by group. The important concept is the process of using the tools.

After practicing, students return all of the water to the water bottle, return the equipment, and dry off any splashes on the table.

Part III

Show students sets of a variety of containers. Explain that their task is to fill the containers completely full and measure the volume of water in each container.

Students create a data table in their journal that has a column for the object, a column for an estimated volume, and a column for the measured volume.

Students evaluate the containers one at a time, estimating the volume of the container and recording their estimate.

Have them fill the container to capacity, measure the volume, and record the measured volume.

Monitor students as they work on this project in groups.

After students have completed five or six different estimates and measurements, have them measure the capacity of an empty soda can. Point out that the label indicates the volume of soda is 355-ml. Ask them to confirm the full volume of the can.

Help students work through the problem of the syringe not fitting into the opening of the can. Model how to fill the can, pour the contents into a larger cup, and then measure the volume.

Students will discover that the can holds about 375-ml. Discuss why this is different from the indicated volume of soda.
As a follow up, students create a bar graph showing the various full volumes of each container.

Extensions

Students write a letter addressed to the customer service department of the soda company asking them to explain the discrepancy between the advertised volume and their measured volume. Students who have already determined the need for air space may write a response letter to such inquiries.
Students line up the various containers in order of capacity.
Students research other units of volume measurement, their origins, and uses.

Family Connections

Make a list of various containers of liquid food. Next to each item, students record the number of milliliters of liquid food advertised on the label of the container. Students may also measure liquid in containers and compare actual volume to listed volume.

Assessment Plan

Create an assessment cup from a 9 oz. clear plastic cup. Measure and mark three lines on the side of the cup labeled A, B, and C. Make one cup for each student or group of students. Students fill the cup to the A level, then measure and record the volume. Students repeat the process for the B level and the C level. Determine the accuracy of their measuring skills by checking to see if their volumes are correct within an allowable margin of error.
As students work on projects involving volume, move around the classroom observing. Invite individual students to demonstrate the process of determining volume. Correct and modify as needed.

Bibliography

Research Basis

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