



Is it really full?

Subject Area(s): Earth and Space, Measurement

Activity Title: Is it really full? (Measuring Volume and Capacity with Porous)

Grade Level: 5 (4-5)

Activity Dependency

Time Required: 45 minutes

Group Size: 2

Expendable Cost per Group: US\$0 - \$1 (earth materials can be collected from outdoors)

Summary:

Students will measure volume and capacity, with materials used by civil and environmental engineers for water filtration. Students will graph their findings and determine the relationship between grain size and porosity.

Engineering Connection:

Environmental engineers use different materials to filter water based on the size of the pores they provide. Larger materials like gravel are used to let water move through quickly and to retain large objects. Smaller materials like sand are used in a similar way to trap large and small particles. Engineers also use membranes (i.e. fabrics) to trap very small particles like bacteria and viruses. Another application of these materials is storage of water before it can be infiltrated (absorbed) in to the ground. All of these applications require the knowledge of both volume and capacity.

Keywords:

Filtration, sieve, pore, membrane, mass, granular, capacity, volume, water treatment

Educational Standards:

- Science: PA - 3.2.7A, 3.2.7B
- Math: PA -2.2C, 2.3A, 2.5E, 2.11E

Pre-Requisite Knowledge”

Student should be familiar with the concept of volume before the lesson.

Students should be familiar with liquid capacity, commonly used volumes and conversion between different units like, ounces, cups, liters, pints, and gallons.

Learning Objectives:

After this lesson, students should be able to:

- Understand the difference between volume and capacity
- Measure liquid volumes
- Understand what a flow rate is
- Graph results of their experiments
- Understand the concept of porous materials.
- Explain how engineers use porous and granular materials.

Materials List:

Each group needs:

two containers with known volumes

a measuring container with volumes indicated (a measuring cup and a graduated cylinders)

To share with the entire class:

4 gallons of water.

rocks, gravel, stones and coarse sand

Introduction / Motivation:

[Hold up a glass of water that is $\frac{3}{4}$ filled. Ask the students if they know or could figure out the volume of the glass. Then ask the students to recall what capacity means. Ask the students if the glass is filled to capacity. Show the students a glass filled to the same level with rocks. Ask the students if the same volume is full. They will probably say yes. Then demonstrate that water can be added to the glass to fill the pores.]

Pore space is important to environmental engineers because we can use the pores to trap particles and filter water. We can also use pores to store water underground. [Show the attached Powerpoint presentation.]

Vocabulary / Definitions:

Word	Definition
filtration	Passing liquid through a material to remove solids.
sieve	an instrument with a meshed bottom, used for separating coarse from fine parts of loose matter, for straining liquids, etc.,
pore	A space in rock, soil, or unconsolidated sediment that is not occupied by mineral matter and that allows the passage or absorption of fluids
granular	Composed or appearing to be composed of granules or grains

Procedure:

Background

[Show the attached Powerpoint presentation]

Before the Activity

1. Divide students into groups of four; have them break off into pairs to do the investigation
2. Give each group a volume of each of the four granular materials; each pair will work with two materials; the group will share the data for graphing

With the Students

Part 1

1. Have students fill a container with the granular material.
2. Have students estimate the volume that the material fills.
3. Have students pour water into the container to fill the pore spaces. Pour the water slowly allowing it to fill the spaces and push the air out of the way. Tapping the container might be required.
4. Determine how much water it takes to fill the pore spaces.
5. Have students subtract to determine the volume of the rocks.
6. In their science journal, have the students list volume of the container, the volume of the granular material, and the volume of the water in two different units (i.e. ounces and milliliters)

Part 2

7. Graph the entire classes results – volume of pores (volume of water added) vs. the pore size (very large, large, medium, small) on graph paper.
8. Determine the relationship.

Attachments:

is it really full_activity_introduction.ppt

Investigating Questions:

1. If you can fill the container with granular material to a certain volume, is the container full? What if I gave you water to add?
2. What is the difference between volume and capacity?
3. How much water can you fill between the pores of the rocks, stones, gravel and sand?
4. Which material stores more water? (This is the one with the larger capacity.)

Assessment:

Pre-Activity Assessment

Title: Make sure the students understand how to use graduated cylinders and measuring cups. Give some volumetric measurements and have them convert them to another unit.

Activity Embedded Assessment

Title: Have the students calculate the porosity of the materials based on the equation: $\text{porosity} = \frac{\text{volume of pores}}{\text{total volume}}$. Explain to the students that the volume of the pores is the same as the water added to the granular materials if there is no air left in the spaces. Ask the student to convert the volumetric measurements to a number of different units. Ask the students which units are most appropriate for the amount of water being measured.

Post-Activity Assessment

Title: Have the students graph the results and explain the relationship between grain size and porosity. Ask the students how they would arrange the materials in layers to use as a water filter if they wanted to remove the larger particles first.

Activity Scaling:

1. For upper grades – design your own filter to clean dirty water provided by the teacher. Determine which materials should go first. Add a competition to see which group has the cleanest water. Introduce concepts of pressure loss measured by reduced flow rates.

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