Name: Date:

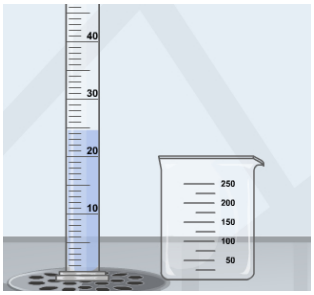
Student Exploration: Measuring Volume

Vocabulary: cubic centimeter, diameter, graduated cylinder, meniscus, milliliter, pipette, radius, rectangular prism, sphere, volume, water displacement

Prior Knowledge Question (Do this BEFORE using the Gizmo.)
Albert plays football. His sister Juliana plays volleyball. While walking home from practice one day, Albert and Juliana argue about which is bigger, a football or volleyball.

How would you measure and compare the sizes of the two balls?

Gizmo Warm-up
When scientists talk about how big something is, they are really talking about its **volume**, or the amount of space it takes up. The *Measuring Volume* Gizmo allows you to measure the volumes of liquids and solids using a variety of tools.



To begin, remove the **50-mL graduated cylinder** from the cabinet and place it below the faucet. To turn on the faucet, drag the slider next to the faucet up. Fill the cylinder about halfway, as shown.

1. Place the **magnifier** over the waterline. Draw a sketch of what you see in the area at right. Label the large tick marks on your sketch.

   What volume is represented by each small tick mark?

2. What is the shape of the waterline?

   This curved shape is called the **meniscus**. Always read the volume at the bottom of the meniscus.

3. What is the volume of water in the graduated cylinder?

Activity A: **Volume of liquids**	Get the Gizmo ready: • Drag all objects to the cabinet. • Move the **25-mL graduated cylinder**, the **250-mL beaker**, and the **2-mL pipette** to the counter.	

Introduction: **Graduated cylinders** are precise tools for measuring volume. Most graduated cylinders are marked in **milliliters**. There are 1,000 milliliters in 1 liter (about two cups).

Goal: Fill a graduated cylinder with a given amount of water.

1. Prepare: Place the **250-mL beaker** below the faucet and fill it with water. (Move the faucet handle up to pour faster.) You will use the beaker as a source of water in your experiments.

2. Measure: To pour water from the beaker to the graduated cylinder, move the beaker over the graduated cylinder. Add about 15 mL of water to the graduated cylinder (does not have to be exact).
   Place the **magnifier** over the waterline, and sketch what you see in the space at right. Label the large tick marks on your sketch.

   A. How many medium tick marks lie between two labeled tick marks?

   B. How much volume does each medium tick mark represent?

   C. How much volume does each small tick mark represent?

   D. Estimate the water volume in the graduated cylinder to the nearest 0.1 mL. (Remember to read from the bottom of the curved meniscus.)

3. Measure: Scientists use **pipettes**, also known as eyedroppers, to add or remove small amounts of water. To fill the **pipette**, place its tip in the beaker water and click the black bulb once.
   To release a small amount of water, place the pipette above the graduated cylinder and click the bulb. Do this until the graduated cylinder contains exactly 17.5 mL of water. (Remember to read the volume at the *bottom* of the meniscus.)
   Practice: Use the Gizmo to complete each of the following challenges.

A. Fill the **25-mL graduated cylinder** with 11.5 mL of water.

B. Fill the **100-mL graduated cylinder** with 76.0 mL of water.

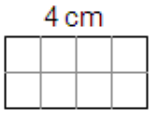
C. Fill the **50-mL graduated cylinder** with 38.5 mL of water.

Activity B: **Regular solids**	Get the Gizmo ready: • Select the **Free Exploration** mode. • Return all items to the cabinet. • Drag the **block** and the **ruler** to the counter. • You will need a calculator for this activity.	

Introduction: The volumes of regular solids, such as spheres (balls) and **rectangular prisms** (blocks), can be determined by measuring their dimensions. The volume of a solid is usually expressed in **cubic centimeters** (cm^3). One cubic centimeter is exactly the same volume as 1 milliliter.

Goal: Measure and calculate the volume of a rectangular prism and a sphere.

1. Measure: Just as the area of a rectangle is the product of its length and wid a rectangular prism is equal to the product of its length, width, and height. Ir place the **ruler** over the **block**.



   A. What are the length, width, and height of the block?

   Length:
   Width:
   Height:

   B. What is the volume of the block?

2. Measure: Return the **block** to the cabinet and drag out the large **sphere**. The volume of a sphere is calculated using the following formula:

$$V_{Sphere} = 4\pi r^3 / 3$$

   The symbol π represents the number pi, which is about 3.14. The letter r stands for the **radius** of the sphere, which is the distance from the center of a sphere to its surface. The radius is exactly half of the **diameter**, which is the distance across the sphere. (The diameter is also equal to the length, width, and height of the sphere.)

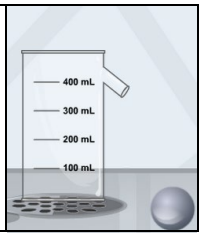
   A. Place the ruler over the sphere. What is the diameter of the sphere?

   B. What is the radius of the sphere?

C. What is the volume of the sphere?

3. Measure: Return the large **sphere** to the cabinet and drag out the small **marble**. Use the ruler and your calculator to find the volume of the marble. Show your work.

   Volume of the marble:

Activity C: **Water displacement**	Get the Gizmo ready: • Select **Free Exploration**. • Return all objects to the cabinet. • Drag the large **sphere**, the **overflow cup**, the **250-mL beaker**, the **50-mL graduated cylinder**, and the **magnifier** to the counter.	

Introduction: Have you ever climbed into a tub and seen the water rise? The amount the water rises is related to your size—the bigger you are, the more the water will rise. This method, called **water displacement**, can be used to measure volume.

Goal: Use water displacement to measure the volume of an object.

1. Get the Gizmo ready: Place the **overflow cup** under the faucet. Fill it until water starts to flow out of the spout. Place the **250-mL beaker** next to the overflow cup so that the spout of the overflow cup is over the beaker. (If necessary, empty the beaker into the sink.)

2. Measure: Place the **sphere** into the overflow cup, causing water to pour into the beaker. Empty the beaker into the **50-mL graduated cylinder**. Place the **magnifier** over the waterline.

   A. What is the volume of water in the graduated cylinder?

   B. Recall that you used the ruler and the volume of a sphere equation to find the volume of the sphere in activity B. What is the volume of the sphere?

   (Recall that 1 cm^3 is the same volume as 1 mL.)

3. Explain: Why does the water volume in the graduated cylinder match the sphere's volume?

4. Practice: Using what you have learned, find the volume of the **rock**. (Hint: For a more precise measurement, use the **25-mL graduated cylinder**.)

   What is the volume of the rock?

   Describe how you found the rock's volume: