LESSON PLAN: You Do the Math

Description
In this math-based lesson, learners will explore ways to calculate volume in regular objects and practice how to measure and calculate the volume of irregular/novel/real world objects.

Grade Levels
3-9

Duration
55 minutes

Tech Tip
Data Collection

The Tech Challenge Connections
This lesson can help Tech Challenge teams build skills that aid in crafting their solutions:

- Measuring regular and irregular objects and making calculations. Tech Challenge.
- Teams will need to include area and volume calculations in their journal for their expanded devices.

Objectives
Students will:

- Calculate the volume of different objects.
- Practice estimating the volume of irregular objects.

Standards Connections

- *6.EE.2.c* Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations).
- *7.EE.3* Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.
- *8.G.9* Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
- *G.GMD.3* Use volume formulas for cylinders, pyramids, cones and spheres to solve problems.

Grade Level Modifications
Younger learners will need additional support. They may also need additional class discussion on defining volume. Provide step-by-step assistance when using formulas.

Materials
• A set of four different-sized regular objects in a variety of shapes (e.g., cubes, cones, rectangular prisms, spheres) for each group. Note: It is recommended that each group has identical objects, especially with younger learners. This will make it easier to compare results. • Irregular objects (e.g., small toys, small rocks or pebbles, large objects in the room) • Calculator (one per group) • Rulers and flexible tape measures • Pencil • You Do the Math Worksheet (one per person or group) • Scrap paper • Pipe cleaners **For optional displacement activity** • Graduated cylinders 1000 ml • Water (2 liters per group) • Dump tub for water (if no sink in room) • Towel
Test Area
• Collect materials. • Set up groups of 2-4. • On the whiteboard, draw sketches of the objects being used in the lesson (e.g., a cube, sphere, etc.)

Lesson (55 minutes)

1. Introduce the objects (5 minutes)
    a. Choose four standard three-dimensional objects for students to measure and compare (cube, sphere, rectangular prism, and cone). Have them examine the different objects and discuss what they notice about their similarities and differences.
    b. Suggested wording— *What do you notice about the objects? How are they alike? What are some differences between them?*
    c. *Today we are going to explore one characteristic of these objects: volume.*
2. Calculating volume of regular objects (40 minutes)
    a. Introduce/review the concept of volume. Example—Volume is how much space an object takes up. Hold up a ball. *Imagine the amount of air contained inside this ball, the amount of stuff inside would be the volume. We measure volume in cm3 or ml. What are some possible ways we might measure the volume of our objects?*
    b. Using the sketches of the chosen objects on the board, discuss/demonstrate the different ways to measure volume depending on which object they are using. See: You Do the Math Worksheet for the volume formulas for regular objects. As you refer to the formulas, discuss what each part of the formula is measuring.
    c. If using spheres, write the formula for the volume of a sphere on the white board. ($V=\frac{4}{3} \prod r^3$).
        i. Explain radius (the distance from the center of the sphere to any point on the outer surface).
        ii. Explain pi in simple terms (it is the ratio of the circumference of the circle to the diameter, and is approximately 3.14).
    d. Demonstrate how to measure the radius of the ball.
        i. Wrap the pipe cleaner once around the center of the ball (circumference) and remove the ball. The pipe cleaner will hold its circular shape when the ball is removed.

   ii. Place the pipe cleaner down on the grid paper and trace the inside of the circle. Using a ruler, measure the diameter of the circle (straight across the center) and divide that number by 2 to find the radius.
   iii. Walk them through how to plug the radius into the formula for volume. See: You Do the Math Worksheet.
e. Have learners measure and calculate the volume for the remaining regular objects.
f. Have students share out their answers and note why there might be variations in the answers.

3. Introduce how to measure and calculate the volume of an irregular object.
   a. Reduce the object into a few shapes for which you have formulas.
   b. Measure and calculate for each individual shape and add them up (e.g., a couch can be reduced to four rectangular prisms. See: You Do the Math Worksheet).
      i. Students measure each rectangle, calculate the volume and add those to get an estimate of the volume of the couch.
4. Have students select and measure irregular objects.
5. On the You Do the Math Worksheet, have them sketch their irregular object, note the measurements, then calculate the volume.
6. Share out for irregular objects (10 minutes)
   a. Have learners share their methods for calculating the volume of their irregular objects.
   b. If they measured the same irregular objects, have them share calculations and observations.
      i. What are some reasons why the numbers might be a little different? (Human error, rounding, estimating, calculation errors).
      ii. How can we be more accurate?
      iii. Optional: If you measured irregular items that fit in the graduated cylinder, you can measure their volume using the water displacement method.

Extensions and Resources

Video on volume: https://www.youtube.com/watch?v=IbkU_VhImww
Online volume calculator for several different three dimensional shapes:
https://www.gigacalculator.com/calculators/volume-calculator.php

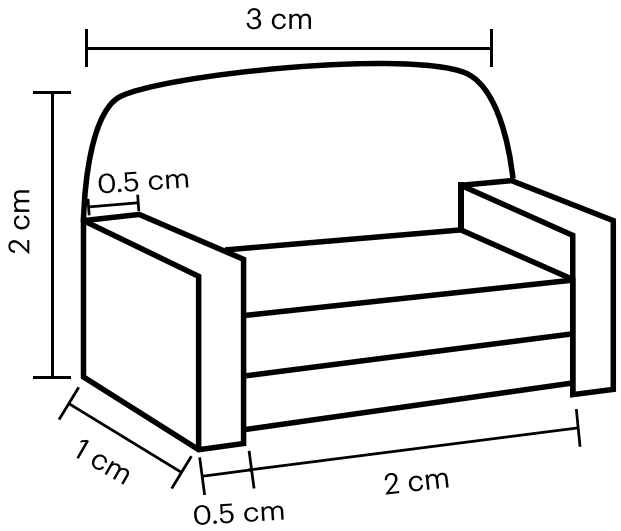
- Have students verify their volume calculations using the water displacement method for measuring volume.
  - Fill the graduated cylinder half-way with water.
  - Record the original water level.
  - Carefully drop the object in. If it floats, use a pencil tip to push it down just below the water level.
  - Record the new water level and subtract. The difference is equal to the volume of the object (ex. 1 ml=1 cm^3).

Name/Team_____

Volume of regular three-dimensional objects

Object	Equation	Measurements	Calculation
Cube	V = l x w x h		
Sphere	$V = \frac{4}{3} \prod r^3$		
Rectangular Prism	V = l x w x h		
Cone	$V = \frac{1}{3} \prod r^2 h$		

Volume of an Irregular Object

Sketch with Measurements	Calculations
Ex. Toy Sofa  	Back V= 3 cm X 0.5 cm x 2 cm = 3 cm^3 Middle V = 3 cm x 2 cm x 1 cm = 6 cm^3 Side a V = 1 cm x 1 cm x 2 cm = 2 cm^3 Side b V = 1 cm x 1 cm x 2 cm = 2 cm^3 Total V = 3 cm^3 + 6 cm^3 + 2 cm^3 + 2 cm^3= 13 cm^3