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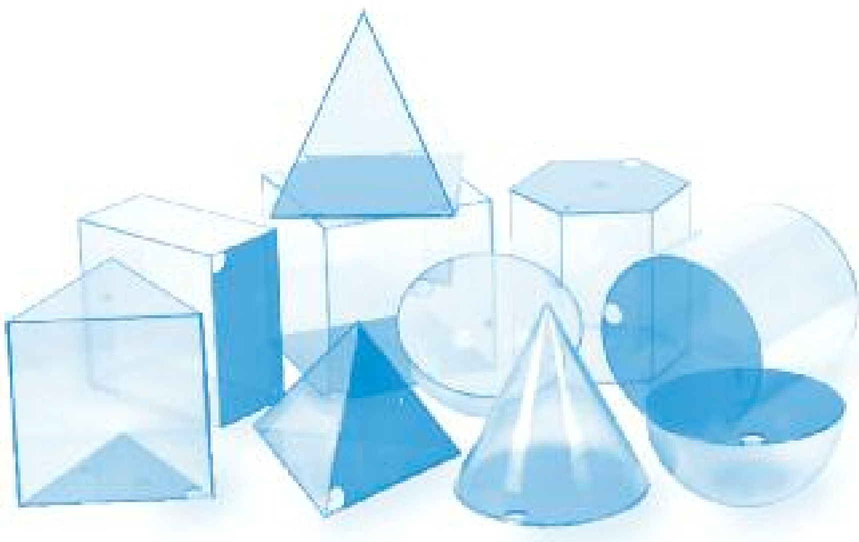
GIANT GeoSolids®

ACTIVITY GUIDE



Ages 8+

Giant Geometric Shapes Volume Table

Square Prism	$V = A \text{ of base} \times H$	$V = (s \times s) \times H$	$V = (15 \times 15) \times 15$	$V = 3375 \text{ cm}^3$
Rectangular Prism	$V = A \text{ of base} \times H$	$V = (l \times w) \times H$	$V = (15 \times 7.5) \times 15$	$V = 1687.5 \text{ cm}^3$
Hexagonal Prism	$V = A \text{ of base} \times H$	$V = (w \times \frac{\sqrt{3}}{2} \times s) \times H$	$V = (12.99 \times \frac{\sqrt{3}}{2} \times 7.5) \times 15$	$V = 2192 \text{ cm}^3$
Triangular Prism	$V = A \text{ of base} \times H$	$V = (\frac{1}{2} \times b \times h) \times H$	$V = \frac{1}{2} \times (15 \times 12.99) \times 15$	$V = 1461.4 \text{ cm}^3$
Square Pyramid	$V = \frac{1}{3} A \text{ of base} \times H$	$V = \frac{1}{3}(l \times w) \times H$	$V = \frac{1}{3}(15 \times 15) \times 15$	$V = 1125 \text{ cm}^3$
Triangular Pyramid	$V = \frac{1}{3} A \text{ of base} \times H$	$V = \frac{1}{3}(\frac{1}{2} \times b \times h) \times H$	$V = \frac{1}{3}(\frac{1}{2} \times 15 \times 12.99) \times 15$	$V = 487.12 \text{ cm}^3$
Sphere	$V = \frac{4}{3}\pi \times r^3$	$V = \frac{4}{3}\pi \times r^3$	$V = \frac{4}{3}\pi \times 7.5^3$	$V = 1767.1 \text{ cm}^3$
Cylinder	$V = A \text{ of base} \times H$	$V = (\pi \times r^2) \times H$	$V = \pi \times (7.5)^2 \times 15$	$V = 2650.7 \text{ cm}^3$
Cone	$V = \frac{1}{3} A \text{ of base} \times H$	$V = \frac{1}{3}(\pi \times r^2) \times H$	$V = \frac{1}{3} \times \pi \times (7.5)^2 \times 15$	$V = 883.6 \text{ cm}^3$
Hemisphere	$V = \frac{1}{2} \times (\frac{4}{3}\pi \times r^3)$	$V = \frac{1}{2} \times (\frac{4}{3}\pi \times r^3)$	$V = \frac{1}{2} \times (\frac{4}{3}\pi \times 7.5^3)$	$V = 883.6 \text{ cm}^3$

Introduction

The transparent *Giant GeoSolids®* set includes 10 plastic, three-dimensional shapes that allow for hands-on study of volume. These shapes can expand daily math lessons while introducing, teaching, and reviewing geometric concepts effectively. They allow students to make concrete connections between geometric shapes and their associated formulas for volume, as well as compare the volumetric relationship between each shape.

Most shapes in this set are variations of a **prism** or a **pyramid,** both of which are **polyhedrons.** Polyhedrons are solid figures with flat sides, or **faces.** Faces may meet at a point, called a **vertex,** or at a line, called an **edge.** A **prism** has two congruent bases; the remaining faces are rectangles. A **pyramid** has one base and the remaining faces are triangles.

Three shapes in this set have curved faces rather than flat ones: the **cylinder, cone,** and **sphere.** Technically, they are not polyhedrons. Even so, a **cylinder** can be thought of as a circular prism: a figure with congruent circular bases and a single, rectangular face. A **cone** can be thought of as a pyramid with a circular base and a face that is a wedge. A **sphere** is a unique shape with no parallel to prisms or pyramids.

At the outset, learning formulas for the volume of more than a dozen geometric shapes may seem daunting to your students. However, formulas become much easier to remember when students recognize that only the method for calculating the area of a base changes from formula to formula; the other variables of a polyhedron are calculated the same way, regardless of shape.

Getting Started with Transparent Geometric Shapes

Allow students to become familiar with the manipulatives before beginning directed activities. You may want to explore prisms and pyramids on separate days. Encourage students to handle, observe, and discuss the shapes. Ask them to write down their observations as they make the following comparisons: How are the shapes similar? (With the exception of the sphere, all shapes have the same height. They are all three-dimensional. They all have empty spaces inside them.) How are they different? (Some have flat sides, some have curved sides. Some are box-shaped, some are round, and some are triangle-shaped.) Where have students seen these shapes in the world around them? (Great Pyramids of Egypt, traffic pylons, film canisters, soccer balls, pieces of chalk, boxes, lipstick tubes, and so on.)

Introduce and identify the following terms: **face**, **edge**, **vertex** or **corner**, and **base**. Mention to students that the base of each shape can be identified by its color.

Ask students how they might organize the shapes into categories based on their features. Write students' answers on the board. Then, define **pyramids** and **prisms**. Hold up an example of a prism and a pyramid for the class. Encourage students to organize the shapes again based on this information. Discuss and explain the cylinder, sphere, and cone as exceptions.

Geometric Shape	Number of Bases	Shape of Base(s)	Number of Faces	Number of Edges	Number of Vertices
Square Prism					
Rectangular Prism					
Hexagonal Prism					
Triangular Prism					
Square Pyramid					
Triangular Pyramid					
Sphere					
Hemisphere					
Cylinder					
Cone					

Work with students to create a table like this one to record their observations:

Show students a cardboard box. Ask if the box is a prism or a pyramid. (Prism.) Have a student volunteer identify the box's bases, faces, edges, and vertices. Have another student do the same for an oatmeal container. You may need to cut the container to make identification easier.

This would be a good time for your students to make constructions of the various models. You can construct models using toothpicks and gum drops, straws and yarn, or even pipe cleaners. As you go through formulas, encourage students to refer to their models to visualize why the formulas work.

Introducing Volume

Volume, or the capacity of an object, is sometimes confused with surface area. At first glance, the formulas for finding each appear somewhat similar. A helpful way to compare the two is to explain surface area is the amount of room on the *outside* of a shape, and volume is the amount of space *inside* a shape. Discuss the importance of measuring volume, giving such examples as knowing how much water a pool will hold, how much air fills a SCUBA tank, or how much cement fits in a cement mixer. Ask students for other examples.

Students will benefit from practice with building, measuring, and filling containers to understand volume. Each shape has openings in the base and can be filled with water, sand, rice, or other materials. By filling one shape and pouring its contents into another shape, students can explore volume relationships between shapes. If you intend to have students perform exact measurements using a graduated cylinder, be sure they are comfortable reading the bottom edge of the water level, or **meniscus.**

Note: The bottoms of each shape are not removable.

Challenge students to estimate the volume of each shape and place them in order from largest to smallest volume. You may want to allow students to fill their shapes to make more accurate estimations. As you introduce the formulas for finding the volume of each shape, encourage students to refer to the shapes for reference. You may wish to distribute copies of the table on page 2 for reference.

Once you have finished your discussion, students can mathematically calculate the volume of each shape to confirm the accuracy of their initial guesses about volume.

These models were built using the metric system. Although they can be used with any measurement system, metric is easiest. Because of the thickness of the plastic, measurements between students might be slightly "off," depending on if they measure from the inside edges or the outside edges. If students round to the nearest centimeter, this will not be a problem.

Volume Formulas

Prism

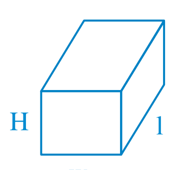
Finding the volume of a general prism is simply a matter of multiplying the area of the base times the height of the prism:

$\textbf{Volume}_{\text{general prism}} = \mathbf{A \times H}$

A = Area of the base.

H = Height of the prism.

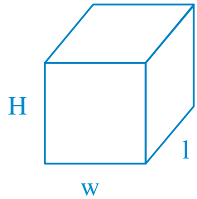
The formula for the area of the base of the prism depends upon the shape of the base.



Rectangular Prism

$\textbf{Volume}_{\text{rectangular prism}} = \mathbf{A \times H}$

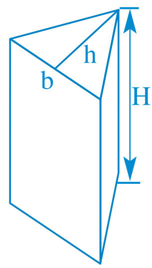
$$= (l \times w) \times H$$



Square Prism

$$\textbf{Volume}_{\text{square prism}} = A \times H$$
$$= (w \times l) \times H$$

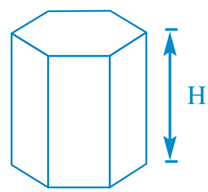
A = Area of the square base.
H = Height of the prism.
s = Length of the side.



Triangular Prism

$$\textbf{Volume}_{\text{triangular prism}} = A \times H$$
$$= (\tfrac{1}{2} b \times h) \times H$$

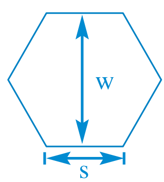
A = area of the triangle base ($\frac{1}{2}$ b × h)
h = altitude, or **height** of the triangle.
H = height of the prism.



Hexagonal Prism

$$\textbf{Volume}_{\text{hexagonal prism}} = A \times H$$
$$= (w \times \tfrac{3}{2}s) \times H$$

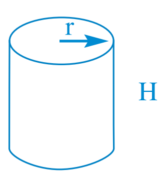
A = Area of the hexagonal base.
H = Height of the prism.



Explain that the area for a hexagon is calculated as follows:

$$A = w \times \tfrac{3}{2} s$$

w = Width of hexagon as shown.
s = Length of side.



Cylinder

$$\textbf{Volume}_{\text{cylinder}} = A \times H$$

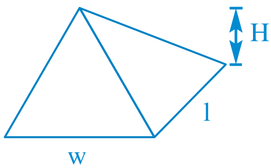
$$= (\pi r^2) \times H$$

Pyramid

Introduce the general formula for finding the volume of a pyramid.

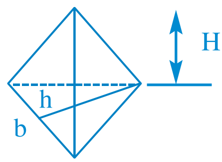
$$\text{Volume}_{pyramid} = \frac{1}{3} A \times H$$

Ask students to identify the difference between this general formula and the one for the prism. (There is one more variable: $\frac{1}{3}$.) If students remember a volume formula for a prism, it is easy to remember the volume formula for a pyramid with the same-size base and height: simply multiply by $\frac{1}{3}$. You can demonstrate this concept by pouring three filled pyramids into the corresponding prism in the Geometric Shapes set.



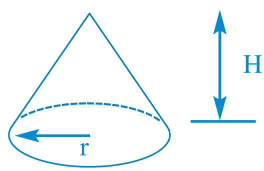
Square Pyramid

$$\text{Volume}_{square\ pyramid} = \frac{1}{3} A \times H$$
$$= \frac{1}{3} (l \times w) \times H$$



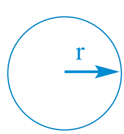
Triangular Pyramid

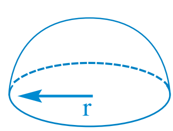
$$\text{Volume}_{triangular\ pyramid} = \frac{1}{3} A \times H$$
$$= \frac{1}{3} (\frac{1}{2} b \times h) \times H$$



Cone

$$\text{Volume}_{cone} = \frac{1}{3} A \times H$$
$$= \frac{1}{3} (\pi r^2) \times H$$





Sphere

$$\text{Volume}_{sphere} = \frac{4}{3} \pi r^3$$