

CONSUMER MATHEMATICS 5 MEASUREMENT, CONSTRUCTION AND BUILDING TRADES CALCULATIONS

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III. VOLUME COMPUTATIONS AND APPLICATIONS

SECTION OBJECTIVES

Read these objectives. When you have completed this section, you will be able:

7. To identify solid geometric figures.
8. To compute volumes of liquids and solids given appropriate dimensions.
9. To estimate building materials requirements based on volume.

Once you have obtained mastery of area computations, you will find that determining the measurement of three-dimensional geometric figures is fairly straightforward. When you speak about quantitative measuring of three-dimensional figures, you are concerned with measuring volume or capacity and surface area. Add the formulas in this section to your list.

SOLID FIGURES WITH PLANE BOUNDARIES

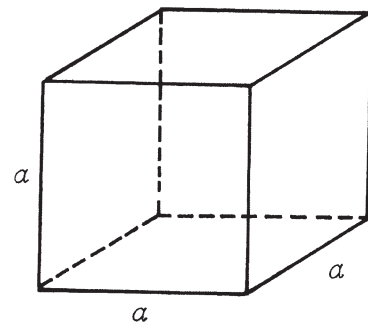
This section will cover figures with plane boundaries. The cube, pyramid, and rectangular solid are included.

DEFINITION

A *cube* is a solid with six equal, square faces.

Volume of a cube: $V = a^3$, where a is the length of any side of a square face.

Total surface area of a cube: $A = 6a^2$.

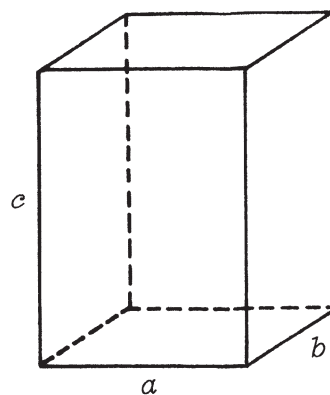


DEFINITION

A *rectangular solid* is a solid with three pairs of opposite, parallel faces.

Volume of a rectangular solid: $V = abc$,
where a , b , and c are the lengths of the
sides.

Total surface area of a rectangle solid:
 $A = 2(ab + ac + bc)$.

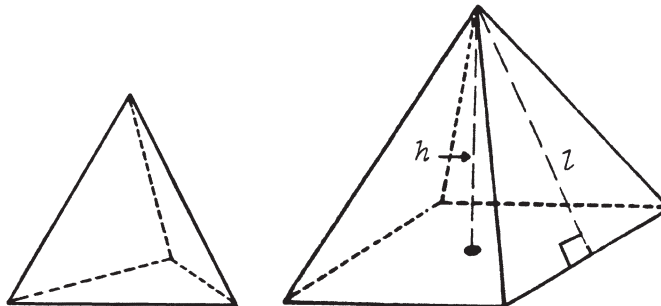


DEFINITION

A *pyramid* is a solid having triangular sides meeting in a point. If the base of the pyramid is a triangle, it is a special kind of pyramid called a *tetrahedron*. A pyramid may also have a base composed of a square, rectangle, or quadrilateral.

Volume of a pyramid:
 $V = \frac{1}{3}(\text{area of base}) \times (\text{altitude})$.
 $V = \frac{1}{3} Bh$

Lateral area of a pyramid (the area of all sides, excluding the base):
 $A = \frac{1}{2}(\text{perimeter of base}) \times (\text{slant height})$.
 $A = \frac{1}{2} pl$



Model 1: A cube measures 6 cm along
one of its sides. What is its total
surface area?

$$A = 6a^2 = 6(6)^2.$$

$$A = 216 \text{ cm}^2.$$

Model 2: A rectangular solid has sides
measuring 5 metres, 7 metres, and
9 metres. What is its volume?

$$V = abc = 5 \times 7 \times 9.$$

$$V = 315 \text{ m}^3.$$

Compute the following volumes and areas. Use your tables.

- 3.1 A square based pyramid has a base measuring 4 in. on each side and an altitude of 6 in. What is its volume?

- 3.2 A rectangular solid has sides of 4 cm, 6 cm, and 8 cm. What is its total surface area? Remember there are six surfaces.

- 3.3 A cube has a total surface area of 96 in.² What is the length of its sides?

- 3.4 A pyramid has a slant height of 10 metres. The base is a square with a one-side length of 5 metres. What is its lateral area?

- 3.5 A rectangular solid has sides of 15 in., 12 in., and 9 in. What is its volume?

SOLID FIGURES WITH CURVED BOUNDARIES

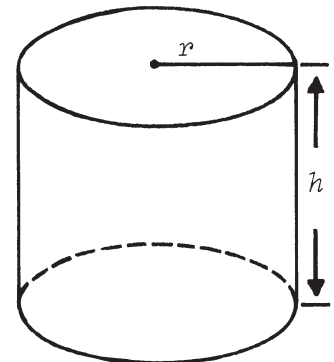
The cylinder, sphere, and cone are figures with curved boundaries. This section will present measurements of these figures. Add these formulas to your list.

DEFINITION

A *cylinder* is a solid bounded by two equal, parallel circles and a curved surface formed by moving a straight line of fixed length so that its ends always lie on the two parallel circles.

Volume of a cylinder: $V = (\text{area of base}) \times (\text{altitude});$
 $V = \pi r^2 h.$

Lateral area of cylinder: $A = (\text{perimeter of right section}) \times (\text{lateral edge}); A = 2\pi rh = \pi dh.$

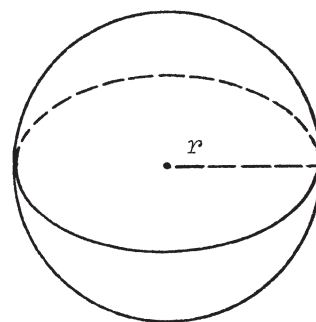


DEFINITION

A *sphere* is a round geometrical body whose surface is equally distant from the center at all points.

Volume of a sphere: $V = \frac{4}{3}\pi r^3 = \frac{1}{6}\pi d^3$.

Surface area of a sphere: $A = 4\pi r^2$.



DEFINITION

A *cone* is a solid with a flat, round base that tapers evenly to a point at the top.

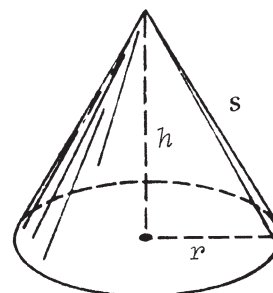
Volume of a cone (where r = radius of the base, and h = altitude):

$$V = \frac{1}{3} (\text{area of base}) \times (\text{altitude}).$$

$$V = \frac{1}{3}\pi r^2 h$$

Lateral surface area of a cone

(where s = lateral height): πrs



Model 1: Find the volume of a sphere with a diameter measuring 16 cm.

$$V = \frac{4}{3}\pi r^3 = \frac{1}{6}\pi d^3$$

$$V = \frac{1}{6}\pi (16)^3 = 2,143.57 \text{ cm}^3.$$

Model 2: Find the lateral area of a right cylinder that has a circular base with a radius of 3 cm and whose altitude is 10 cm.

A = perimeter of right section \times lateral edge.

$$A = 2\pi(3)(10) = 188.6 \text{ cm}^2.$$

Model 3: Find the amount of paint contained in a can measuring 6 in. across the bottom (diameter) and 8.5 in. high (answer in litres).

$$V = \pi r^2 h = \pi 3^2 \times 8.5.$$

$$V = 240.4 \text{ in.}^3$$

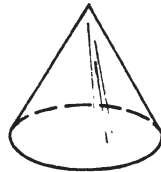
But $1 \text{ in.}^3 = 0.0164 \text{ litre}.$

Therefore, $(240.4) \times (0.0164) = 3.94 \text{ litres}.$

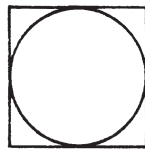
Model 4: You are to paint the surface area of a traffic control cone measuring 12 inches high and 9 inches across the bottom, which is attached to a square base measuring 9 inches on a side. How much surface area will you need to paint?

Two different area problems are involved:

1. lateral area of cone with $r = 4.5''$ and $h = 12''$;



2. area of square $9''$ on a side, less the area of the inscribed circle with radius of 4.5 inches.



$$\begin{aligned} A \text{ (cone)} &= \pi r \sqrt{r^2 + h^2} = \pi 4.5 \sqrt{4.5^2 + 12^2} \\ &= \pi 4.5 \sqrt{164.25} = \pi 4.5 (12.82) \\ &= 181.32 \text{ in.}^2 \end{aligned}$$

$$A \text{ of square} - A \text{ of circle} = 9^2 - \pi(4.5)^2 = 17.35 \text{ in.}^2$$

$$\begin{aligned} \text{Surface area of traffic cone} &= 181.32 + 17.35 \\ &= 198.7 \text{ in.}^2 \end{aligned}$$