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MATHEMATICS

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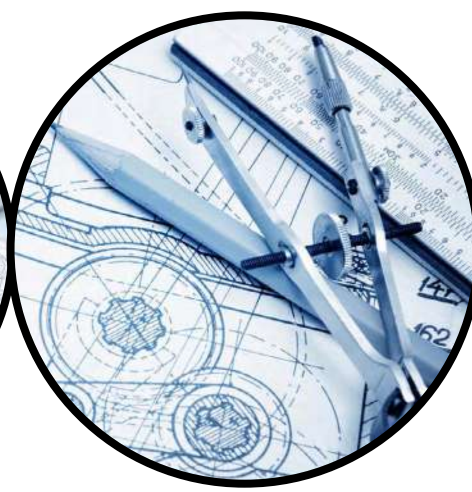

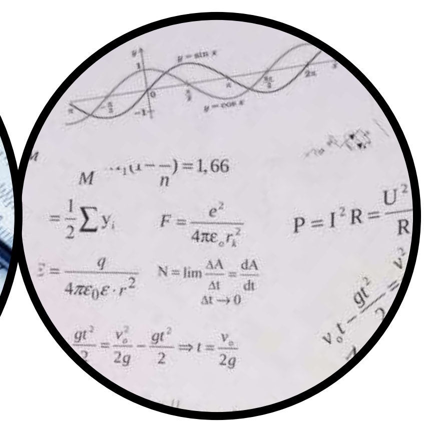

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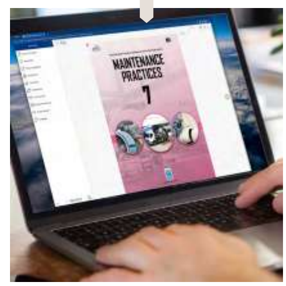

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VERSION	EFFECTIVE DATE
003	2024.06

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ISBN-13: 978-1951275952

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VERSION	EFFECTIVE DATE	DESCRIPTION OF REVISION(S)
001	2014.01	Module creation and release.
002	2017.05	Format update and appearance update.
002.1	2019.10	Added "Solving Word Problems" to end of Submodule 2.
002.2	2019.10	Format update and appearance update.
002.3	2019.10	Inclusion of Measurement Standards for clarification.
003	2024.06	Regulatory update for EASA 2023-989 compliance.

Module was reorganized based upon the EASA 2023-989 subject criteria.

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MATHEMATICS

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$$A = L \times W$$
$$A = 24 \text{ cm} \times 12 \text{ cm}$$
$$A = 288 \text{ cm}^2$$

SQUARE

A *square* is a 4-sided figure with all four sides of equal length and opposite sides that are parallel to each other. [**Figure 1-17**] All the angles contained in a square are right angles and the sum of all of the angles is 360°. A square is actually a rectangle with 4 equal sides. Therefore the area of a square is the same as that of a rectangle: Area = Length × Width or, A = L × W. However, since the sides of a square are always the same value (S), the formula for the area of a square can also be written as follows:

$$\text{Area} = \text{Side} \times \text{Side}$$
or,
$$A = S^2$$

To calculate the area of a square, determine the length of a side and perform the arithmetic in the formula.

Example:
What is the area of a square access plate whose side measures 25 centimeters?

$$A = S^2$$
$$A = 25 \text{ cm} \times 25 \text{ cm}$$
$$A = 625 \text{ cm}^2$$

TRIANGLE

A *triangle* is a three-sided figure. The sum of the three angles in a triangle is always equal to 180°. Triangles are often classified by their sides. An *equilateral* triangle has 3 sides of equal length. An *isosceles* triangle has 2 sides of equal length. A *scalene* triangle has three sides of differing length. Triangles can also be classified by their angles: An *acute* triangle has all three angles less than 90°. A *right triangle* has one right angle (a 90° angle). An *obtuse* triangle has one angle greater than 90°. Each of these types of triangles is shown in **Figure 1-18**.

The formula for the area of a triangle is:

$$\text{Area} = \tfrac{1}{2} \times (\text{Base} \times \text{Height})$$
or,
$$A = \tfrac{1}{2}\, BH$$

Example:
Find the area of the right triangle shown in **Figure 1-19**. First, substitute the known values into the area formula.

$$A = \tfrac{1}{2}(B \times H) = \tfrac{1}{2}(1.2 \text{ m} \times 750 \text{ cm})$$

Next, convert all dimensions to centimeters (or meters):

$$A = \tfrac{1}{2}(1\,200 \text{ cm} \times 750 \text{ cm})$$
or,
$$A = \tfrac{1}{2}(1.2 \text{ m} \times .75 \text{ m})$$

Now, solve the formula for the unknown value:

$$A = \tfrac{1}{2}(900\,000 \text{ cm}^2)$$
$$A = \tfrac{1}{2}(.9 \text{ m}^2)$$
$$A = 450\,000 \text{ cm}^2$$
$$A = .45 \text{ m}^2$$

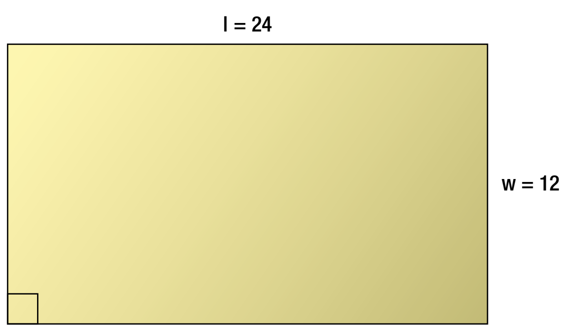


Figure 1-16. A rectangle.

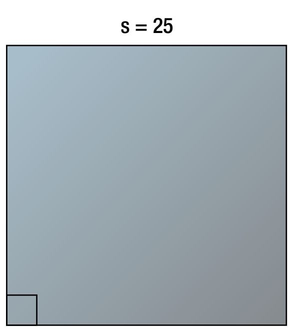


Figure 1-17. A square.

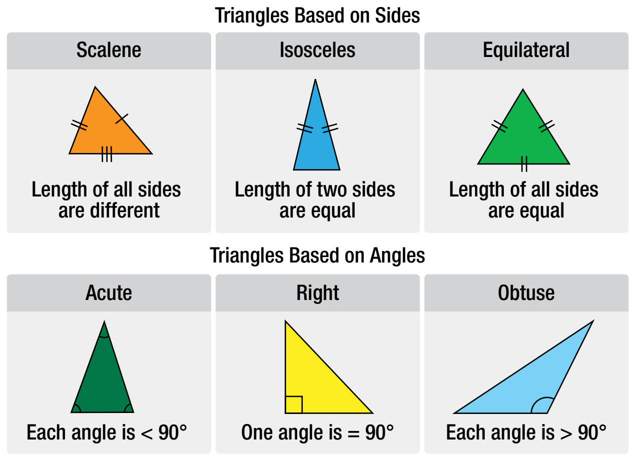


Figure 1-18. Types of triangles.

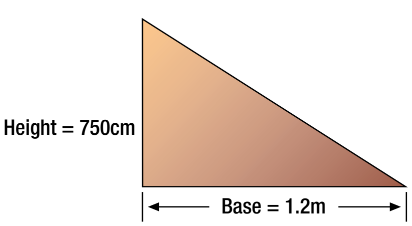


Figure 1-19. An right triangle.

PARALLELOGRAM

A *parallelogram* is a four-sided figure with two pairs of parallel sides. [**Figure 1-20**] Parallelograms do not necessarily have four right angles like rectangles. However, the sum of the angles in a parallelogram is 360°. Similar to a rectangle, the formula for the area of a parallelogram is:

$$\text{Area} = \text{Length} \times \text{Height}$$
$$A = LH$$

To find the area of a parallelogram, simply substitute values into the formula or multiply the length times the height.

TRAPEZOID

A trapezoid is a four-sided figure with one pair of parallel sides known as base_1 and base_2 and a height which is the perpendicular distance between the bases. [**Figure 1-21**] The sum of the angles in a trapezoid is 360°. The formula for the area of a trapezoid is:

$$\text{Area} = \tfrac{1}{2}\,(\text{base}_1 + \text{base}_2) \times \text{Height}$$

Example:
What is the area of the trapezoid in **Figure 1-22** whose bases are 35 centimeters and 25 centimeters, and whose height is 15 centimeters?Substitute the known values into the formula and perform the arithmetic.

$$A = \tfrac{1}{2}\,(b_1 + b_2) \times H$$
$$A = \tfrac{1}{2}\,(35\text{ cm} + 25\text{ cm}) \times 15\text{ cm}$$
$$A = \tfrac{1}{2}\,(60\text{ cm}) \times 15\text{ cm}$$
$$A = 450\text{ cm}^2$$

CIRCLE

A *circle* is a closed, curved, plane figure. [**Figure 1-23**] Every point on the circle is an equal distance from the center of the circle. The *diameter* is the distance across the circle (through the center). The *radius* is the distance from the center to the edge of the circle. The diameter is always twice the length of the radius. The *circumference* of a circle, or distance around a circle is equal to the diameter times π (3.141 6).

Written as a formula:

$$\text{Circumference} = \pi \times d$$
$$\text{or,}$$
$$C = 2\,\pi \times r$$

The formula for finding the area of a circle is:

$$\text{Area} = \pi \times \text{radius}^2$$
$$\text{or,}$$
$$A = \pi\, r^2$$

Example:
The bore, or "inside diameter," of a certain aircraft engine cylinder is 12 centimeters. Find the area of the cross section of the cylinder. First, substitute the known values into the formula:

$$A = \pi\, r^2 = 3.141\,6 \times (\tfrac{12}{2}\text{ cm})^2$$

Note that the diameter is given but since the diameter is always twice the radius, dividing the diameter by 2 gives the dimension of the radius (6 cm). Now perform the arithmetic:

$$A = 3.141\,6 \times 36\text{ cm}^2$$
$$A = 113.097\,6\text{ cm}^2$$

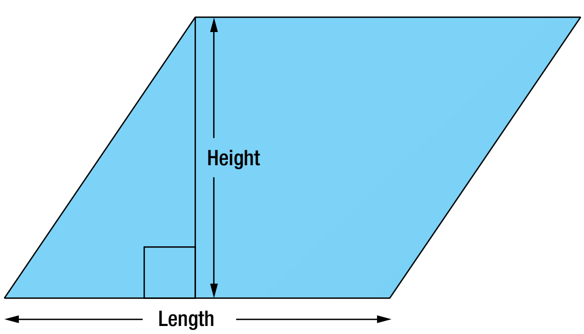


Figure 1-20. A Parallelogram.

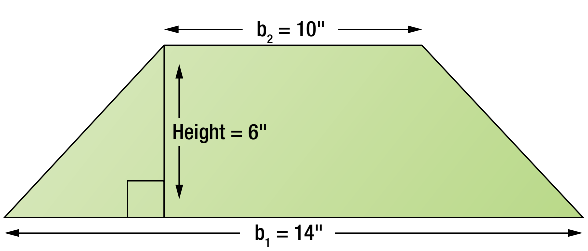


Figure 1-21. A trapezoid has 1 set of parallel sides known as base1 and base2 and a height which is the perpendicular distance between the bases.

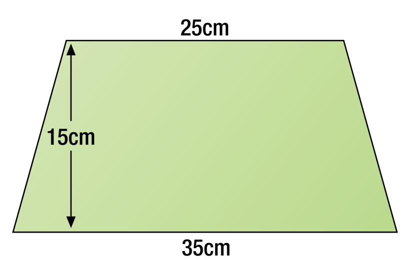


Figure 1-22. A trapezoid with dimensions.

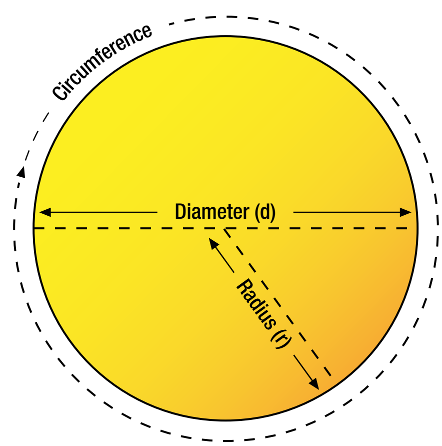


Figure 1-23. A circle.

Example:
A cockpit instrument gauge has a round face that is 3 inches in diameter. What is the area of the face of the gauge? From **Figure 1-11** for N = 3, the answer is 7.068 6 square inches. This is calculated by: If the diameter of the gauge is 3 inches, then the radius = $d/2$ = $3/2$ = 1.5 inches.

$$\text{Area} = \pi \times r^2 = 3.141\,6 \times 1.5^2 = 3.141\,6 \times 2.25$$
$$= 7.068\,6 \text{ square inches.}$$

ELLIPSE

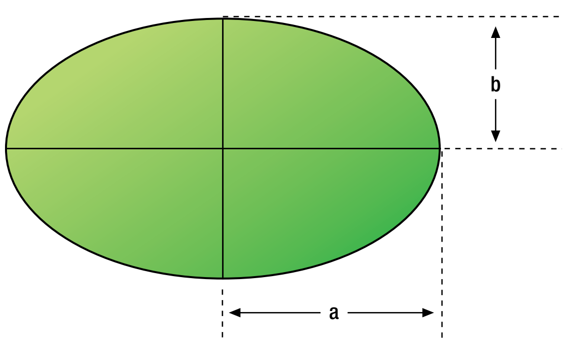
An ellipse is a closed, curved, plane figure and is commonly called an oval. [**Figure 1-24**]

In a radial engine, the articulating rods connect to the hub by pins, which travel in the pattern of an ellipse (i.e., an elliptical path). The formulas for the circumference and area of an ellipse are given in **Figure 1-24**.

WING AREA

Wing surface area is important to aircraft performance. There are many different shapes of wings. To calculate wing area exactly requires precise dimensions for the clearly defined geometric area of the wing. However, a general formula for many wing shapes that can be described using an average wing "chord" dimension is similar to the area of a rectangle. The wingspan, S, is the length of the wing from wingtip to wingtip.

The chord (C) is the average or mean width of the wing from leading edge to trailing edge as shown in **Figure 1-25**.

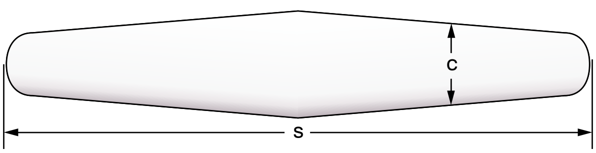


$$\text{Circumference} = C = 2\pi\sqrt{\frac{a^2 + b^2}{2}}$$

π = 3.141 6
a = Length of one of the semi-axis
b = Length of the other semi-axis

Area = $A = \pi ab$

Figure 1-24. An ellipse with formulas for calculating circumference and area.



a =Wing area, ft.^{2}
c =Average chord, ft.
s =Span, ft.

Figure 1-25. Area of an aircraft wing.

The formula for calculating wing area is:

$$\text{Area of a Wing} = \text{Wing Span} \times \text{Mean Chord}$$
$$AW = SC$$

Example:
Find the area of a tapered wing whose span is 15 meters and whose mean chord is 2 meters. As always, substitute the known values into the formula.

$$AW = SC$$
$$AW = 15 \text{ meters} \times 2 \text{ meters}$$
$$AW = 30 \text{ square meters } (30 \text{ m}^2)$$

VOLUME

Three-dimensional objects have length, width, and height. The most common three dimensional objects are *rectangular solids*, cubes, cylinders, spheres, and cones. Volume is the amount of space within an object. Volume is expressed in cubic units. Cubic centimeters are used for small spaces and cubic meters for larger spaces, however any distance measuring unit can be employed if appropriate. A summary of common three-dimensional geometric shapes and the formulas used to calculate their volumes is shown in **Figure 1-26**.

RECTANGULAR SOLIDS

A rectangular solid is any three-dimensional solid with six rectangle-shaped sides. [**Figure 1-27**]

The volume is the number of cubic units within the rectangular solid. The formula for the volume of a rectangular solid is:

$$\text{Volume} = \text{Length} \times \text{Width} \times \text{Height}$$
or,
$$V = LWH$$

Object	Volume
Rectangular Solid	LWH
Cube	S3
Cylinder	$\pi r^2 H$
Sphere	$4/3 \pi r^3$
Cone	$1/3 \pi r^2 H$

Figure 1-26. Formulas to compute volumes of common geometric three-dimensional objects.

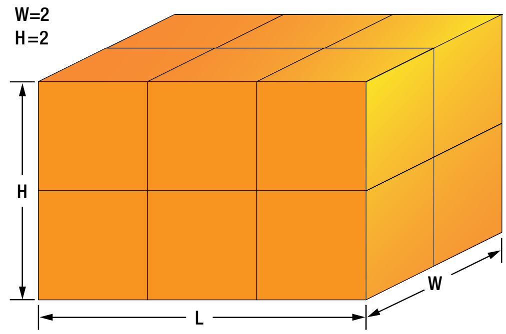


Figure 1-27. A rectangular solid.

Example:
A rectangular baggage compartment measures 2 meters in length, 1.5 meters in width, and 1 meter in height. How many cubic meters of baggage will it hold?

Substitute the known values into the formula and perform the arithmetic.

$$V = LWH$$
$$V = 2\text{ m} \times 1.5\text{ m} \times 1\text{ m}$$
$$V = 3\text{ m3}$$
$$V = 3\text{ cubic meters}$$

CUBE

A *cube* is a solid with six square sides. [**Figure 1-28**] A cube is just a special type of rectangular solid. It has the same formula for volume as does the rectangular solid which is Volume = Length × Width × Height = L × W × H. Because all of the sides of a cube are equal, the volume formula for a cube can also be written as:

$$\text{Volume} = \text{Side} \times \text{Side} \times \text{Side}$$
or,
$$V = S^3$$

Example:
A cube-shaped carton contains a shipment of smaller boxes inside of it. Each of the smaller boxes is 10 cm × 10 cm × 10 cm. The measurement of the large carton is 30 cm × 30 cm × 30 cm. How many of the smaller boxes are in the large carton?

Substitute the known values into the formula and perform the arithmetic:

Large Box:
$V = L \times W \times H$
$V = 30\text{ cm} \times 30\text{ cm} \times 30\text{ cm}$
V = 27 000 cubic centimeters of volume in large carton

Small Box:
$V = L \times W \times H$
$V = 10\text{ cm} \times 10\text{ cm} \times 10\text{ cm}$
V = 1 000 cubic centimeters of volume in small cartons.

Therefore, since each of the smaller boxes has a volume of 1 000 cubic centimeters, the large carton will hold 27 boxes (27 000 ÷ 1 000).

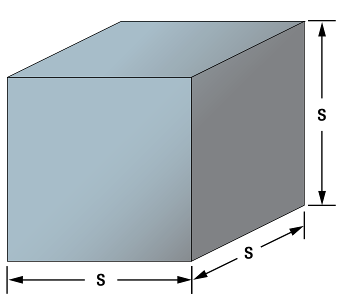


Figure 1-28. A cube.

Substitute the known values into the formula and perform the arithmetic:

Large Box:
$V = S^3$
$V = 30\text{ cm} \times 30\text{ cm} \times 30\text{ cm}$
V = 27 000 cubic centimeters of volume in large carton.

Small Box:
$V = S^3$
$V = 10\text{ cm} \times 10\text{ cm} \times 10\text{ cm}$
V = 1 000 cubic centimeters of volume in small cartons.

Therefore:, since each of the smaller boxes has a volume of 1 000 cubic centimeters, the large carton will hold 27 boxes (27 000 ÷ 1 000).

CYLINDER

A *cylinder* is a hollow or solid object with parallel sides the ends of which are identical circles. [**Figure 1-29**]

The formula for the volume of a cylinder is:

$$\text{Volume} = \pi \times \text{radius}^2 \times \text{height of the cylinder}$$
or,
$$V = \pi r^2 H$$

One of the most important applications of the volume of a cylinder is finding the *piston displacement* of a cylinder in a reciprocating engine. Piston displacement is the total volume (in cubic inches, cubic centimeters, or liters) swept by all of the pistons of a reciprocating engine as they move during one revolution of the crankshaft. The formula for piston displacement is given as:

$$\text{Piston Displacement} = \pi \times (\text{bore divided by } 2)^2 \times \text{stroke} \times (\#\text{ cylinders})$$

The bore of an engine is the inside diameter of the cylinder. The stroke of an engine is the length the piston travels inside the cylinder. [**Figure 1-30**]

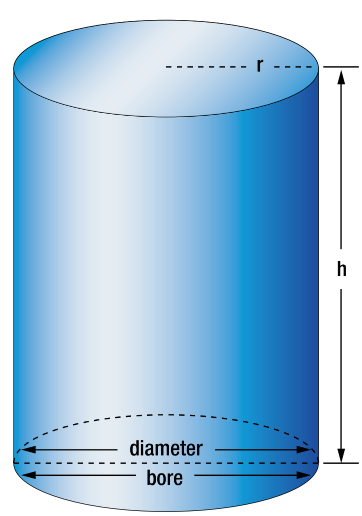


Figure 1-29. A cylinder.