

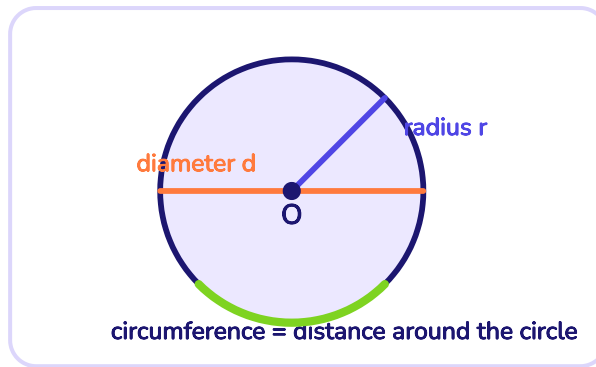
Circles, Area, Surface Area and Volume: math lesson, Grade 7 – download the PDF

A bike wheel, a pizza, a tent, a pyramid-shaped gift box, a swimming pool: all of these need a measurement you can calculate. How far does the wheel roll in one turn? How much cheese covers the pizza? How much fabric makes the tent? How much water fills the pool? In this chapter you will use a small set of formulas, plus careful thinking, to measure **lengths, areas, surface areas and volumes** in the real world.

1. Parts of a circle

D Circle, radius, diameter, circumference

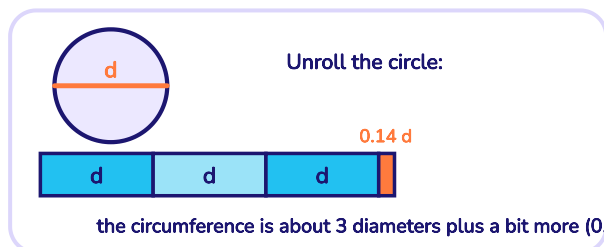
A **circle** is the set of all points at the same distance from a fixed point called the **center**. The **radius** r is the distance from the center to the circle. The **diameter** d is a segment through the center with both ends on the circle, so $d = 2r$. The **circumference** C is the distance around the circle.



The radius is always half of the diameter, and the diameter is always twice the radius. Before you use any formula, decide whether you were given the radius or the diameter. This one small step prevents most mistakes.

2. Pi and the circumference

If you measure the distance around any circle and divide it by the diameter, you always get the same number, a little more than 3. That number is called **pi**, written π . It cannot be written exactly as a fraction or as a finite decimal, so we use an approximation: $\pi \approx 3.14$ or $\pi \approx \frac{22}{7}$. Your calculator has a π key that is more accurate.



P Circumference formula

$$C = \pi d \quad \text{or} \quad C = 2\pi r$$

E**Example 1: a trampoline**

A round trampoline has a diameter of 14 ft. How long is the safety rope that goes once around its edge? Use $\pi \approx 3.14$.

The diameter is given, so $C = \pi d \approx 3.14 \times 14 = 43.96$.

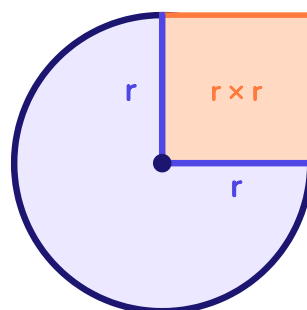
The rope must be about **43.96 ft** long.

!**Zyro's tip**

On my planet we say: "a bit more than three diameters wraps once around." Use this to check your answer. If you get a circumference smaller than 3 times the diameter, something went wrong.

3. The area of a circle

Area measures the flat space inside a shape, in square units. Look at the square built on one radius, whose area is $r \times r = r^2$. The circle covers about **3.14** of these squares, which gives the formula.



The circle covers about 3.14 squares of side r

$$A = \pi \times r \times r = \pi r^2$$



Area of a circle

$$A = \pi r^2$$

The radius is squared first, then multiplied by π .



Example 2: a sandbox

A circular sandbox has a diameter of 18 ft. What is its area? Use $\pi \approx 3.14$.

The radius is half the diameter: $r = 18 \div 2 = 9$ ft.

$$A = \pi r^2 \approx 3.14 \times 9^2 = 3.14 \times 81 = 254.34.$$

The area is about **254.34 ft²**.

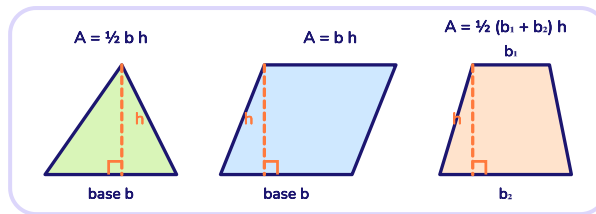


Common mistakes

(1) Using the diameter in place of the radius in πr^2 . (2) Computing $\pi \times r \times 2$ instead of $\pi \times r \times r$. (3) Mixing the two formulas: the circumference is measured in plain units (ft), the area in square units (ft²).

4. Area of triangles and quadrilaterals

In every formula below, the height h is measured at a right angle to the base, not along a slanted side.



Shape	Area formula	Remark
Rectangle	$A = \ell \times w$	length times width
Parallelogram	$A = b \times h$	h is perpendicular to the base
Triangle	$A = \frac{1}{2}bh$	half of a parallelogram
Trapezoid	$A = \frac{1}{2}(b_1 + b_2)h$	average of the parallel sides times h

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Example 3: a trapezoid

A trapezoid has parallel sides of 9 cm and 15 cm, and a height of 6 cm. Find its area.

$$A = \frac{1}{2}(9 + 15) \times 6 = \frac{1}{2} \times 24 \times 6 = 12 \times 6 = 72.$$

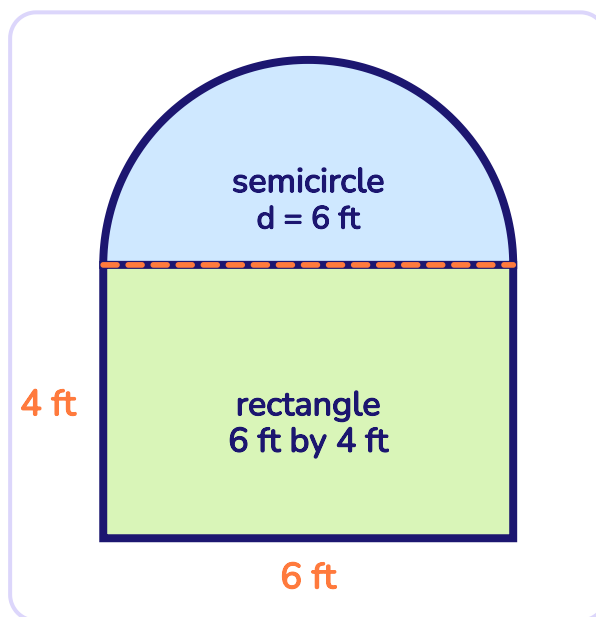
The area is **72 cm²**.

5. Area of composite figures

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Method

1. Cut the figure into simple shapes (rectangles, triangles, circles, half circles), or see it as one big shape with a piece removed.
2. Find the missing measurements, such as a radius from a diameter.
3. Compute the area of each piece.
4. Add the pieces, or subtract the removed piece.
5. Write the answer with square units.



E**Example 4: a window**

The window above is a rectangle 6 ft wide and 4 ft tall, topped by a semicircle whose diameter is the 6 ft side. Find the area of the glass.

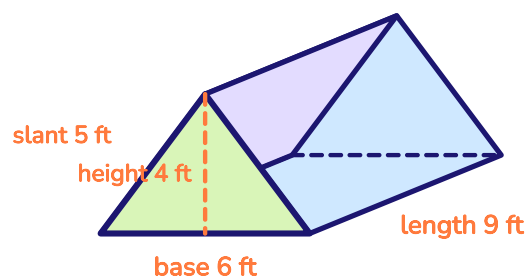
Rectangle: $6 \times 4 = 24$ ft². Semicircle: the radius is 3 ft, so its area is

$$\frac{1}{2} \times 3.14 \times 3^2 = \frac{1}{2} \times 28.26 = 14.13 \text{ ft}^2.$$

Total: $24 + 14.13 = 38.13$. The glass has an area of **38.13 ft²**.

6. Surface area of prisms and pyramids**D****Surface area**

The **surface area** of a solid is the total area of all its faces. It is measured in square units. A **prism** has two identical parallel bases joined by rectangles. A **pyramid** has one base and triangular faces that meet at a point called the apex.



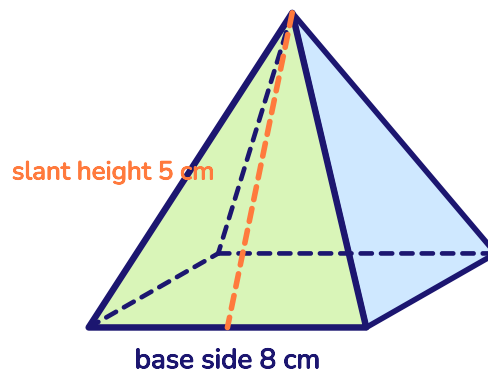
To find a surface area, imagine unfolding the solid into a flat **net**, then add up the area of every piece: **SA** = (area of the bases) + (area of the lateral faces).

E**Example 5: a triangular prism**

The bases of a prism are right triangles with legs 3 cm and 4 cm and hypotenuse 5 cm. The prism is 10 cm long. Find its surface area.

Two bases: $2 \times \frac{1}{2} \times 3 \times 4 = 12 \text{ cm}^2$. The three rectangles together form one long rectangle: perimeter of the base times length, $(3 + 4 + 5) \times 10 = 120 \text{ cm}^2$.

$SA = 12 + 120 = 132$. The surface area is **132 cm²**.

**E****Example 6: a square pyramid**

A square pyramid has a base side of 8 cm. The slant height of each triangular face, measured along the face from the apex to the middle of a base edge, is 5 cm.

Base: $8 \times 8 = 64 \text{ cm}^2$. Each triangular face: $\frac{1}{2} \times 8 \times 5 = 20 \text{ cm}^2$, and there are 4 of them, so **80 cm²**.

$SA = 64 + 80 = 144$. The surface area is **144 cm²**.



Slant height or height?

The triangles use the **slant height**, which lies on a face. The vertical height from the apex straight down to the base is different and is not used for the area of a face.

7. Volume of right prisms

Volume measures the space inside a solid in cubic units. A **right prism** has bases that sit straight above one another. If you stack layers that each look like the base, the volume is the area of one layer times the number of layers.



Volume of a right prism

$$V = B \times h$$

B is the area of the base and h is the height (the distance between the two bases).
For a rectangular prism, $V = \ell \times w \times h$.



Example 7: a wedge

The base of a right prism is a triangle with base 8 cm and height 5 cm. The prism is 7 cm tall (long). Find its volume.

Base area: $B = \frac{1}{2} \times 8 \times 5 = 20 \text{ cm}^2$. Volume: $V = 20 \times 7 = 140$.

The volume is **140 cm³**.

8. Real-world measurement problems

Word problems often hide a conversion. Keep these facts handy and notice what happens to square and cubic units.

Fact	Meaning
$1 \text{ ft} = 12 \text{ in}, 1 \text{ yd} = 3 \text{ ft}$	lengths
$1 \text{ yd}^2 = 9 \text{ ft}^2$	area: 3×3
$1 \text{ m}^2 = 10,000 \text{ cm}^2$	area: 100×100
$1 \text{ L} = 1,000 \text{ cm}^3$	capacity and volume
$1 \text{ m}^3 = 1,000 \text{ L}$	capacity and volume
$1 \text{ in} = 2.54 \text{ cm}$	U.S. and metric

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Example 8: laying a patio

A rectangular patio measures 12 ft by 15 ft. Paving costs are given per square yard. How many square yards is the patio?

Area in square feet: $12 \times 15 = 180 \text{ ft}^2$. Because $1 \text{ yd}^2 = 9 \text{ ft}^2$, the area in square yards is $180 \div 9 = 20$.

The patio covers **20 yd²**.

M**Problem-solving steps**

1. Read the question and draw a quick sketch with every given measurement.
2. Decide what is asked: a length, an area, a surface area or a volume.
3. Choose the formula and keep the units consistent.
4. Calculate, then check that the answer is reasonable.
5. Answer in a full sentence with the correct unit.

Key takeaways

- $d = 2r$. The circumference is $C = \pi d = 2\pi r$ and the area is $A = \pi r^2$, with $\pi \approx 3.14$.
- Triangle: $\frac{1}{2}bh$. Parallelogram: bh . Trapezoid: $\frac{1}{2}(b_1 + b_2)h$. The height is perpendicular to the base.
- For a composite figure, split it into simple shapes, then add pieces or subtract a removed piece.
- Surface area is the sum of the areas of all the faces. Pyramid faces use the slant height.
- The volume of a right prism is $V = Bh$, the base area times the height.
- Area is in square units, volume in cubic units. Convert units before you calculate.

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