

MATHEMATICS • CLASS 9

CHAPTER 6

Measuring Space

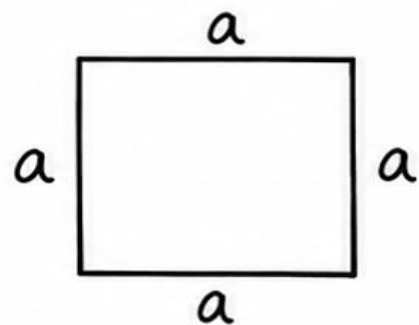
Perimeter and Area

CHAPTER NOTES

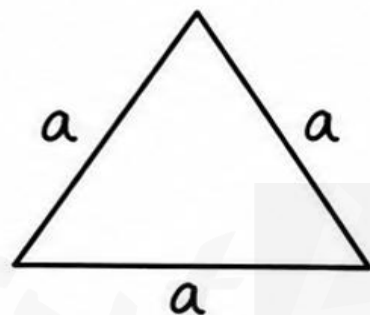


PERIMETER AND SCALING

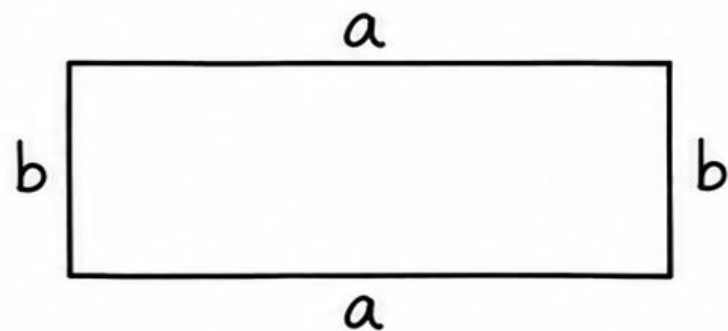
Perimeter is the total length around the boundary of a closed shape.
Measure it in units of length, such as cm or m, not square units.



$$\text{Square: } P = 4a$$
$$\frac{P}{a} = 4$$



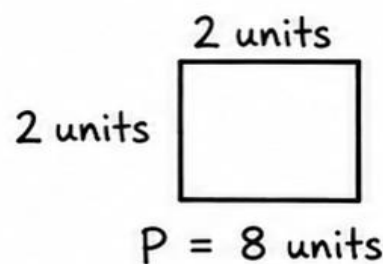
$$\text{Equilateral triangle: } P = 3a$$
$$\frac{P}{a} = 3$$



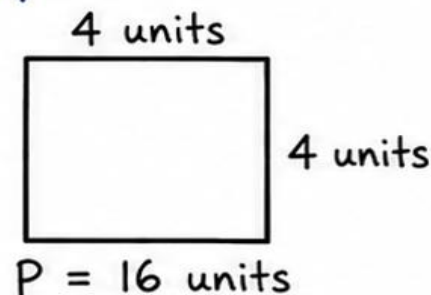
$$\text{Rectangle: } P = 2(a + b)$$

A square is a special rectangle with $b = a$.

Scaling: If every length is multiplied by k , the perimeter is also multiplied by k .

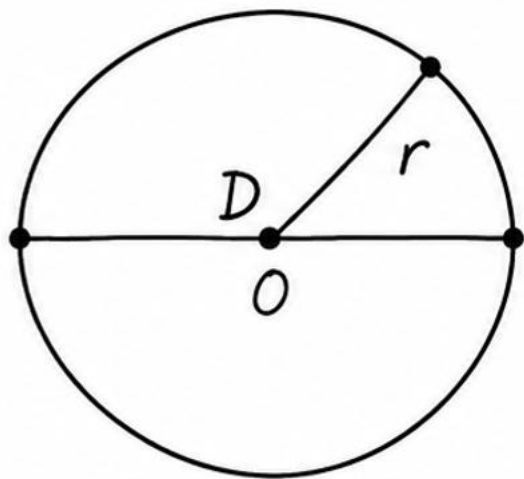


scale factor 2 →



CIRCUMFERENCE AND PI

- A circle's perimeter is its circumference. The circumference-to-diameter ratio is the same for every circle.

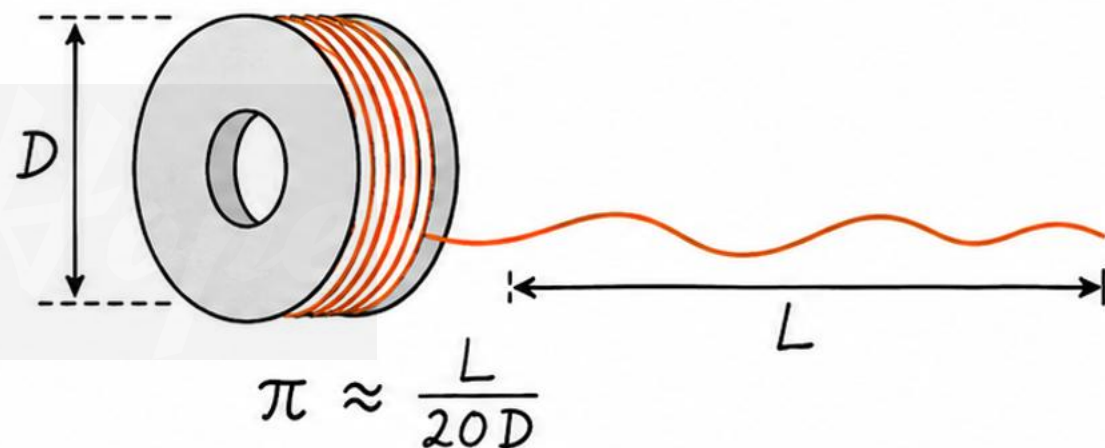


$$\pi = \frac{C}{D}$$

$$D = 2r$$

$$C = \pi D = 2\pi r$$

- To estimate the ratio, measure a reel's diameter D . Wrap very thin thread tightly around it 20 times. Unwrap and measure total length L .



- π is irrational: it cannot be written as a ratio of two integers.
- Its decimal expansion never terminates or repeats periodically.
- $\pi = 3.1415926535\dots$; $\pi \approx 3.14$; $\pi \approx \frac{22}{7}$ but $\pi \neq \frac{22}{7}$.
- The fraction $\frac{355}{113}$ is a much closer approximation.
- There is no best rational approximation: a closer one can always be found.

- C and D must use the same unit.
- π has no unit.

THE JOURNEY OF PI

Approximate values.

- Mesopotamia (c. 1900 BCE): 3.125.
- Archimedes (c. 250 BCE): polygons inside and outside a circle give bounds.
 - Hexagons: $3 < \pi < 2\sqrt{3}$.
 - With 96-sided polygons: $3 + \frac{10}{71} < \pi < 3 + \frac{1}{7}$.
- Ptolemy (c. 150 CE): $\frac{377}{120}$.
- Liu Hui developed circle-cutting methods;
Zu Chongzhi (c. 480 CE): $\frac{355}{113}$.
- Aryabhata (499 CE): $\frac{62832}{20000} = 3.1416$, explicitly approximate.
- Brahmagupta (628 CE): $\sqrt{10}$.

An exact infinite series.

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots$$

- Madhava of Sangamagrama used an infinite series to approach π .
- The equality needs infinitely many terms; a finite sum is an approximation.
- Later work by Nilakantha, Machin, Ramanujan and the Chudnovsky brothers improved computation.
- William Jones used π in 1706; Euler popularised it.
- Lambert proved π irrational in 1761.

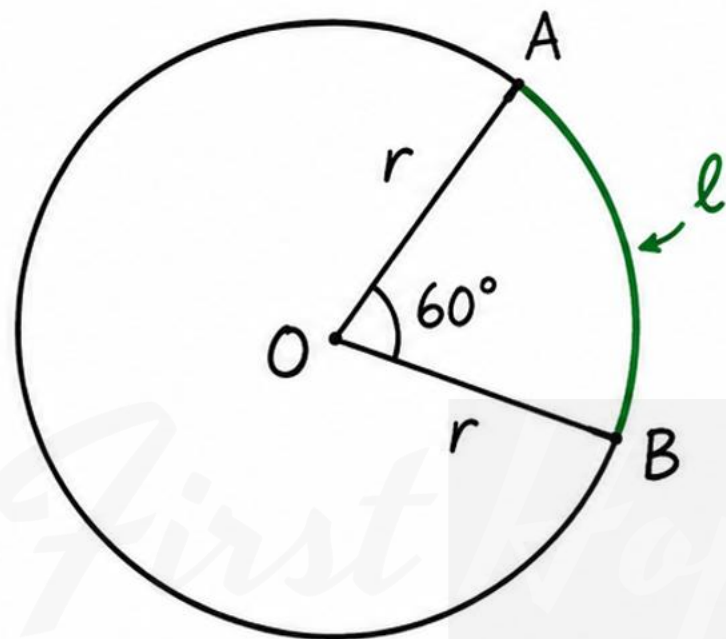
Pi Day: 14 March. | Pi Approximation Day: 22 July.

ARC LENGTH AND SECTOR BOUNDARY

Arc length is the length along part of a circle.

A central angle θ selects the fraction $\frac{\theta}{360^\circ}$ of a full turn.

$$l = \frac{\theta}{360^\circ} \times 2\pi r$$



Arc	Central angle	Arc length (l)
Full circle	360°	$2\pi r$
Semicircular arc	180°	πr
Quarter-circle arc	90°	$\frac{\pi r}{2}$

Use rotational / reflection symmetry to explain equal halves and quarters.

- Arc length is not the complete boundary of a sector.
- For $0^\circ < \theta < 360^\circ$: sector perimeter = $2r + l$.
- A semicircular region has perimeter $2r + \pi r$.
- The two straight radii must be included.
- Length answers use cm, m or other linear units.

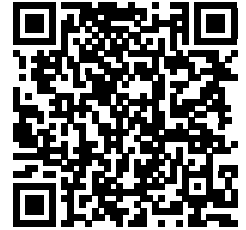


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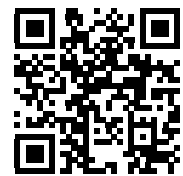


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