

# Learning IGCSE Mathematics with Pictures

by Victor Liao

## #4 **Ratio** vs. **Rate**

$$\frac{20 \text{ in.}}{3 \text{ ft.}} = \frac{20 \text{ in.}}{36 \text{ in.}} = \frac{5}{9}$$

A comparison of two whole numbers in the **same units**.

Always written as **two numbers**.

$$\frac{3}{2} \quad 4:9 \quad 15 \text{ to } 1$$

**Never write** the **units**.  
**Reduce** to simplify.

$$\frac{300 \text{ mi.}}{5 \text{ hr.}} = 60 \text{ mi./hr.}$$

A comparison of a number to one in **different units**.

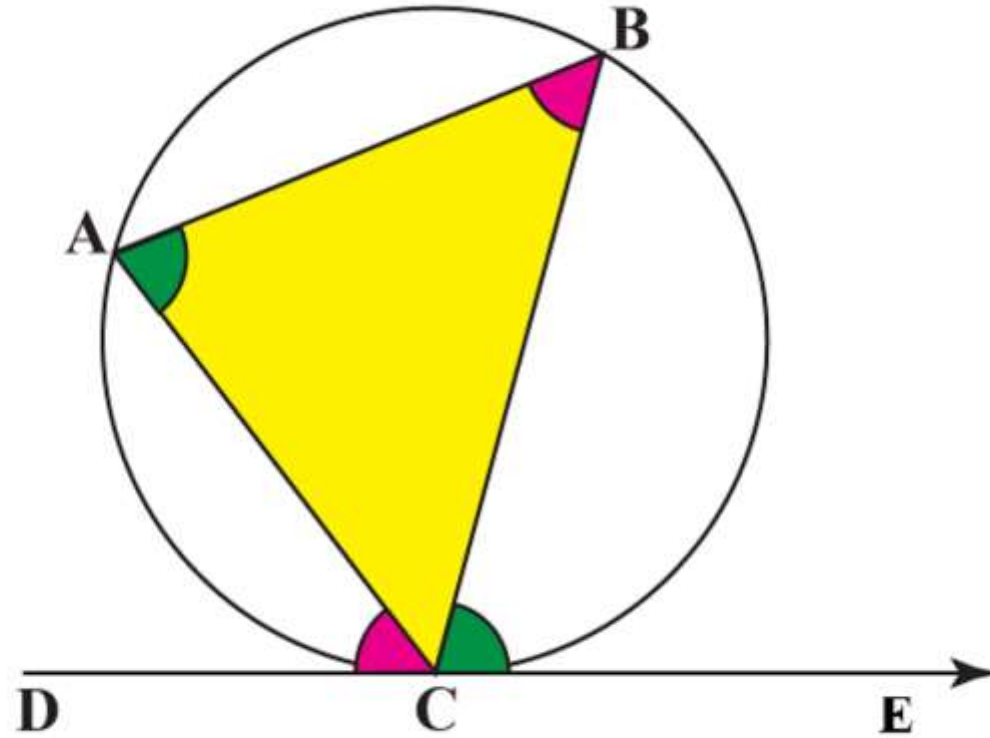
Always written as a **single number** on a per unit basis.

**30.7 words/min.**

**3 children/family**

**Always write** the **units**.  
**Divide** to simplify.

<b>Sequence</b>	<b>Series</b>
A sequence is defined as a group of numbers or objects that follow a specific pattern.	A series is defined as the sum of elements of the sequence.
The order of elements is important in the sequence.	The order of elements is not important in the series.
Finite Sequence: 10, 9, 8, 7	Finite Series: $10 + 9 + 8 + 7$
Infinite Sequence: 10, 9, 8, 7, ....	Infinite Series: $10 + 9 + 8 + 7 + \dots$



The alternate segment theorem states that **the angle between a tangent and a chord at their point of contact is equal to the angle in the alternate segment.**

**Example 01** Find the Mean, Median, Mode, and Range of the data set:

Goals Scored Over the Last 7 Games

1 3 4 6 6 7 8

**mean** **5**  
average

**mode** **6**  
most common

**median** **6**  
middle

**range** **7**  
largest - smallest

# Quadrilateral

A quadrilateral is a shape (polygon) with 4 sides (edges), 4 corners (vertices) and 4 interior angles.



**Square**

4 equal sides, 4 right angles



**Rectangle**

4 right angles



**Rhombus**

4 equal sides



**Kite**

2 pairs of adjacent sides of equal length



**Parallelogram**

2 pairs of parallel sides



**Trapezoid**

1 pair of parallel sides

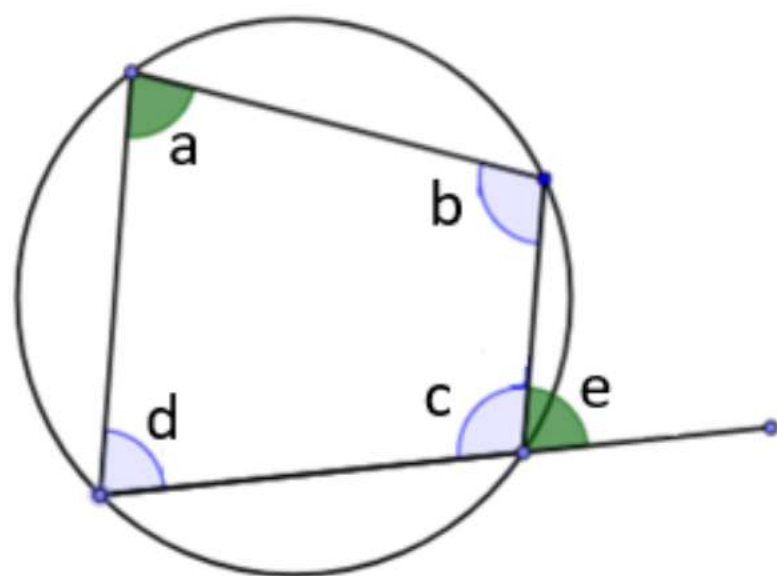


**Irregular Quadrilateral or Trapezium**

no pairs of parallel sides

## Cyclic Quadrilateral

A cyclic quadrilateral has all its vertices on the circumference of the circle.



Opposite angles add up to  $180^\circ$

$$\angle a + \angle c = 180^\circ$$

$$\angle b + \angle d = 180^\circ$$

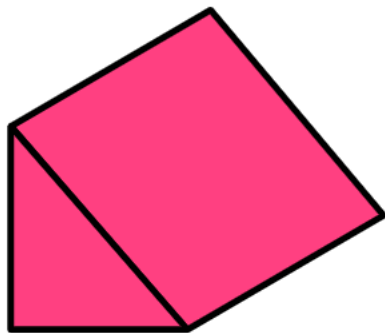
Exterior angle is equal to the interior opposite angle

$$\angle a = \angle e$$

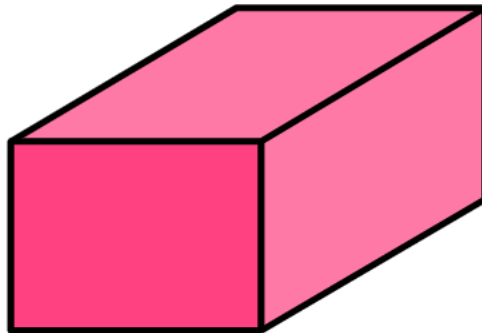
# What is a prism shape?

A **prism shape** is a polyhedron (a 3D shape made from polygons) with a constant cross section through one dimension. A prism shape has two congruent faces (identical ends).

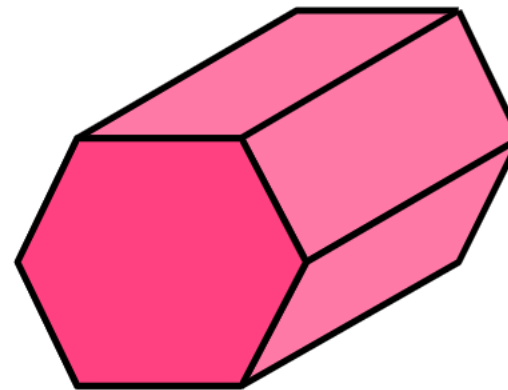
For example, below are three different types of prisms:



**Triangular  
Prism**



**Rectangular Prism  
(Cuboid)**



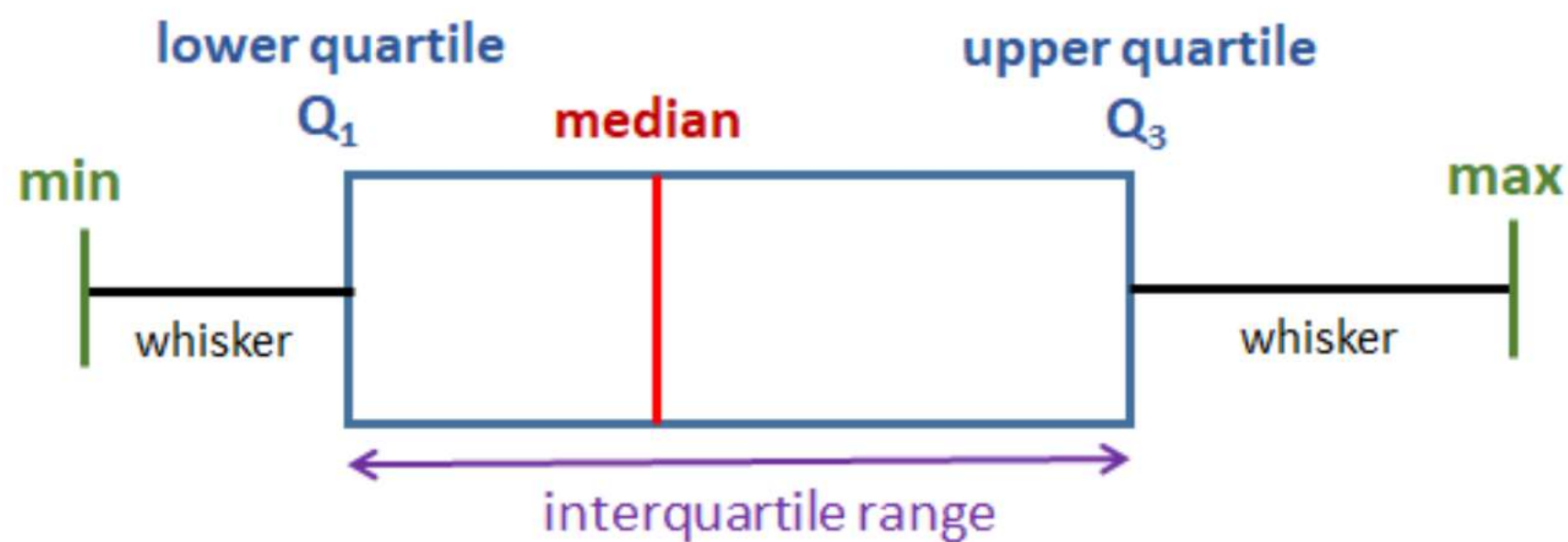
**Hexagonal  
Prism**

The name of the prism is represented by the shape of its cross section.

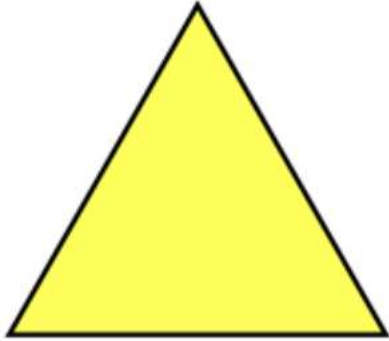


## Box and Whisker Plot

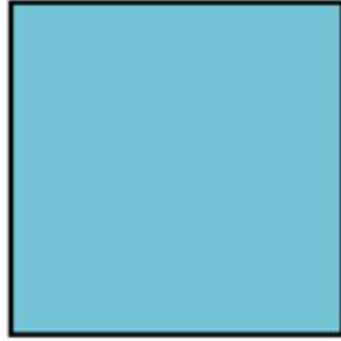
A box and whisker plot (also called a box plot) shows the five-number summary of a set of data: **minimum**, **lower quartile**, **median**, **upper quartile**, and **maximum**.



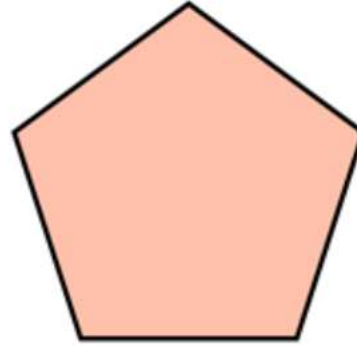
# Polygons



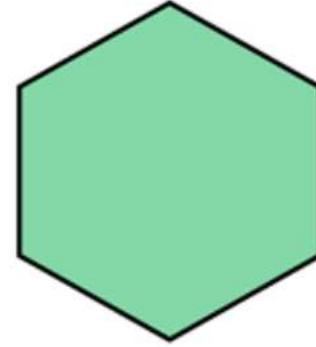
Triangle



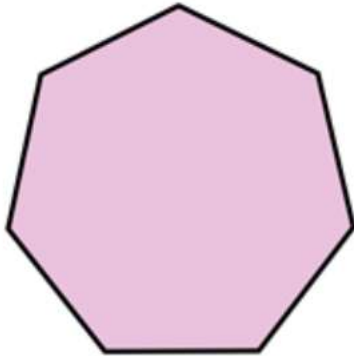
Quadrilateral



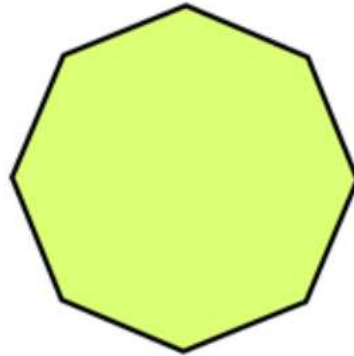
Pentagon



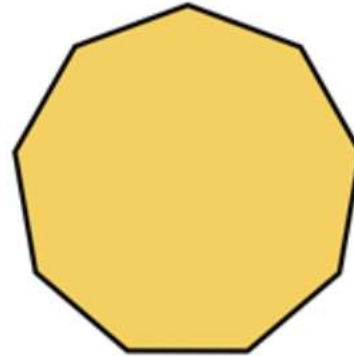
Hexagon



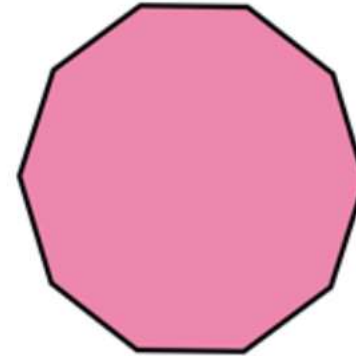
Heptagon



Octagon



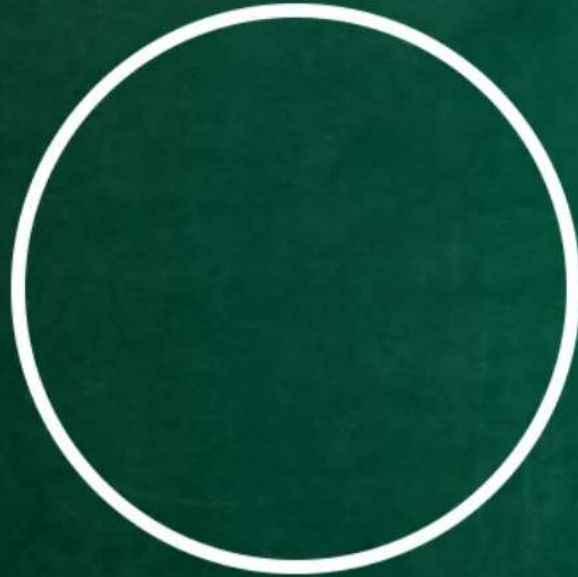
Nonagon



Decagon



# ***DIFFERENCE BETWEEN***



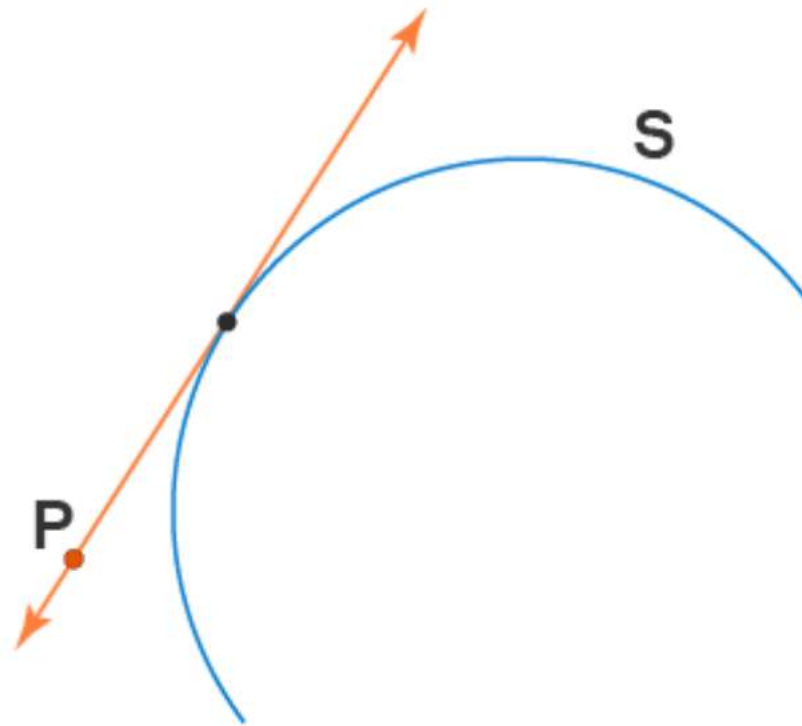
***CIRCLE***

***VS***



***SPHERE***

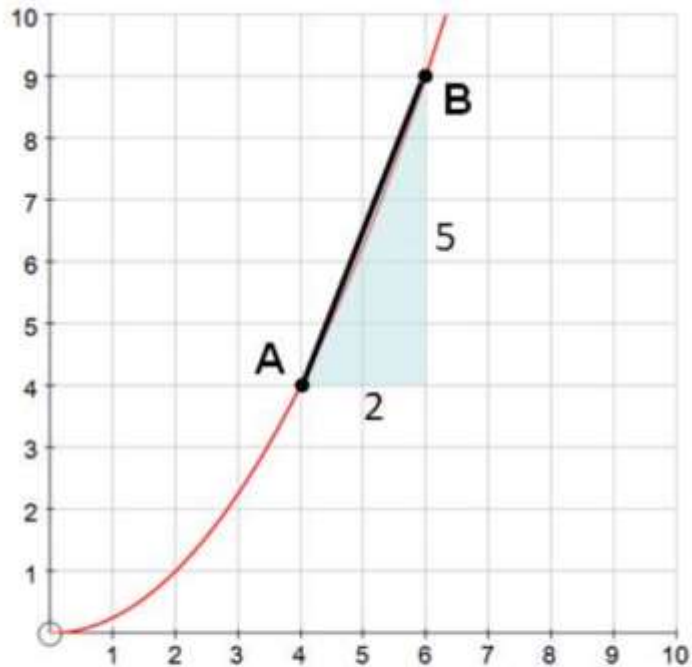
# Tangent



# Gradient of a curve

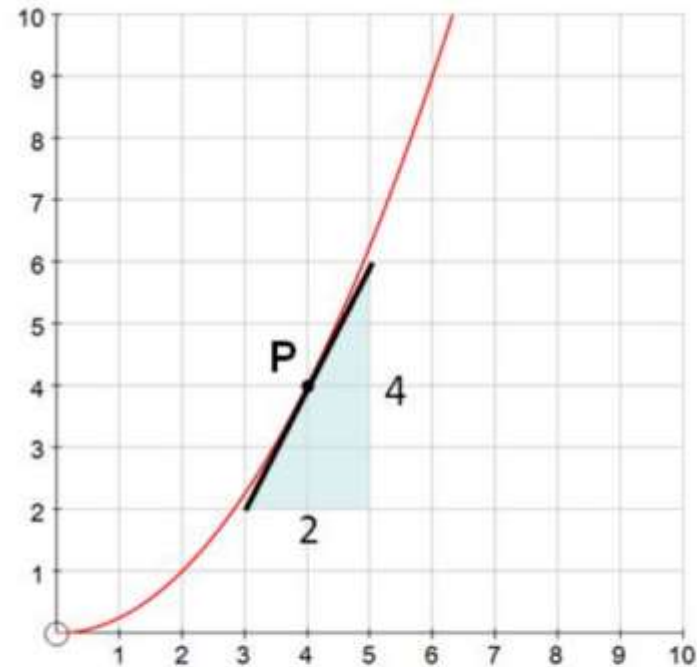
How can we measure the gradient of a curve?

We could find the **average** gradient between two points, by drawing a **line segment** between the two points



$$\text{gradient} = \frac{\text{up}}{\text{across}} = \frac{5}{2} = 2.5$$

Or estimate the **instantaneous** gradient at a point, by drawing a **tangent** to the curve at the point

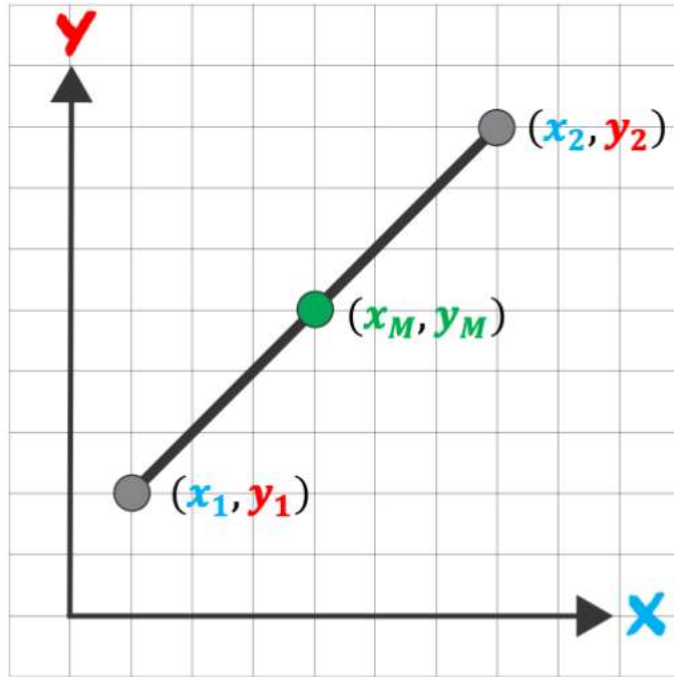


$$\text{gradient} = \frac{\text{up}}{\text{across}} \approx \frac{4}{2} = 2$$

## The Midpoint Formula

# THE MIDPOINT FORMULA

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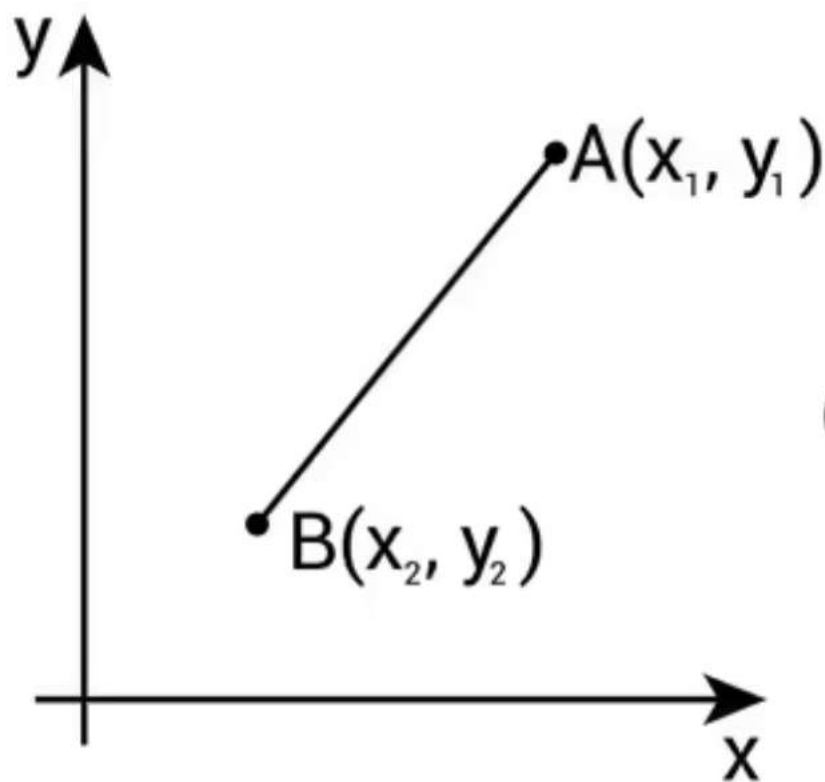


$$(x_M, y_M) = \left( \frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

### Definition:

The **midpoint** of a line segment is a point that divides or splits the line segment into two equal parts or lengths.

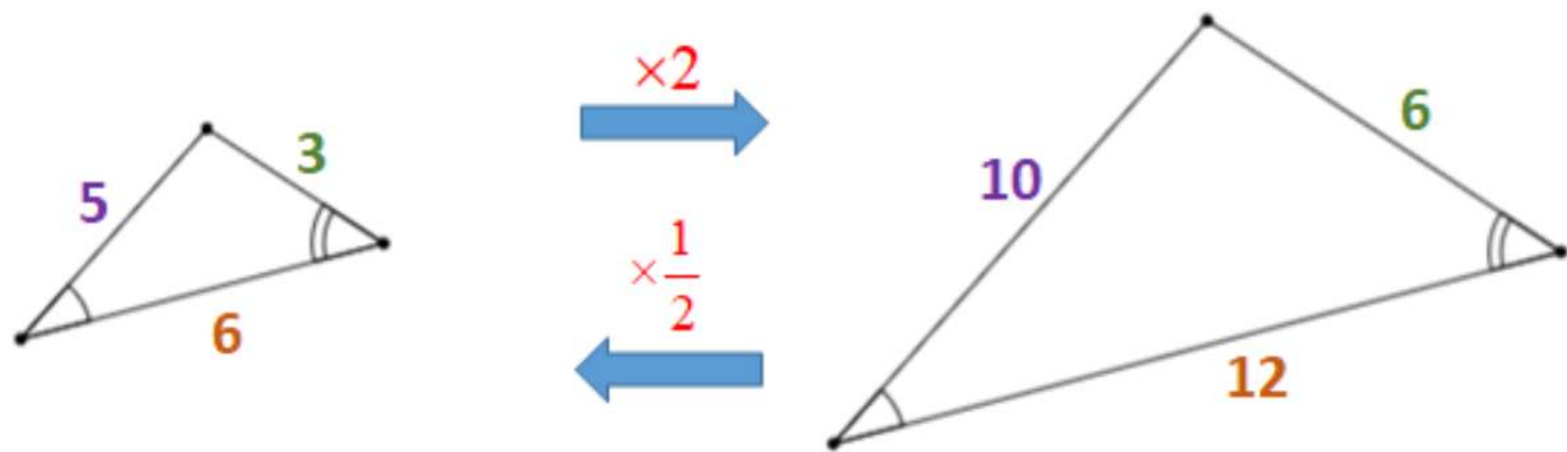
# Distance Formula



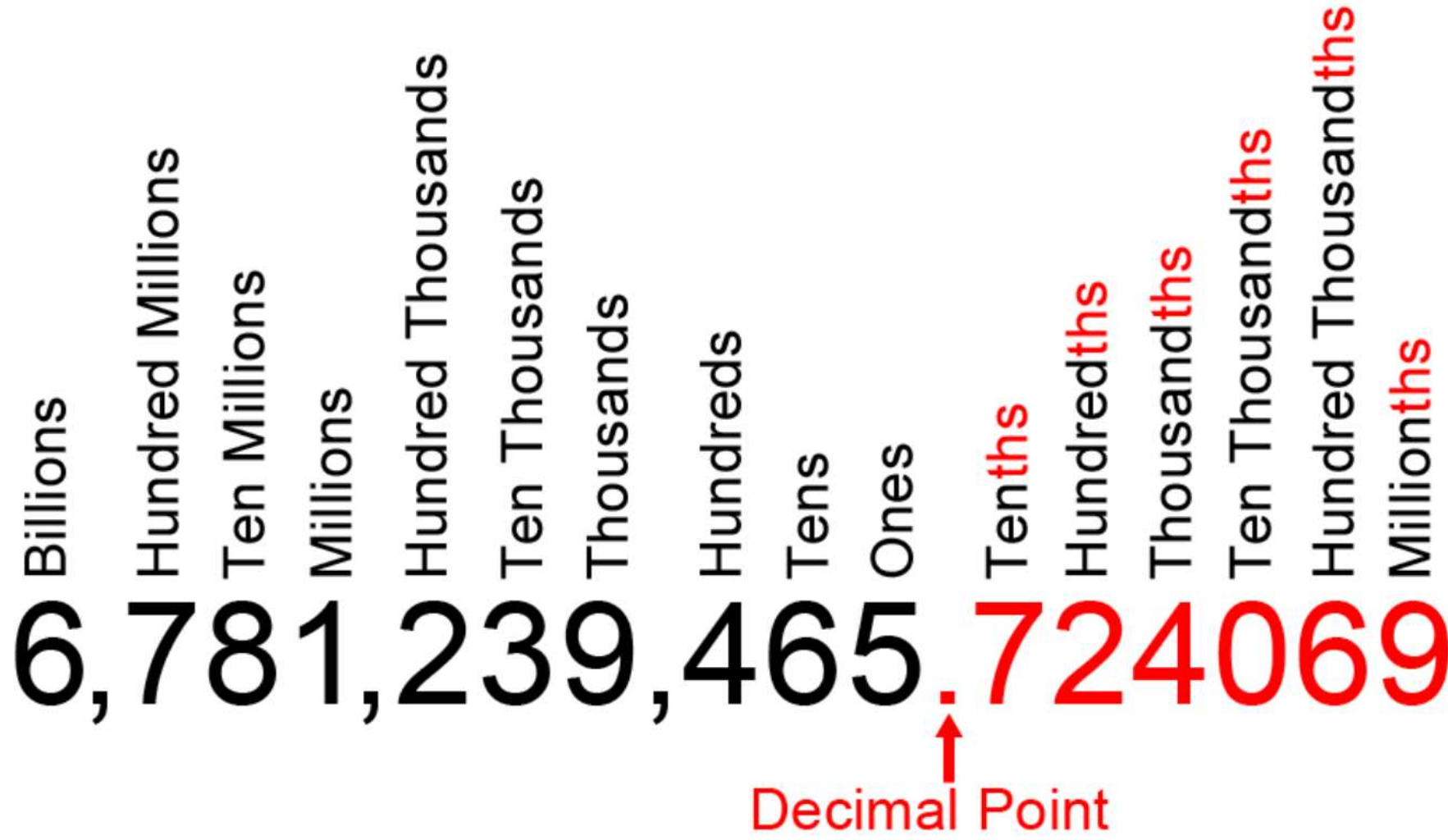
$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

## Scale Factor

A **scale factor** is the number by which all the components of an object are multiplied in order to create a proportional enlargement or reduction.





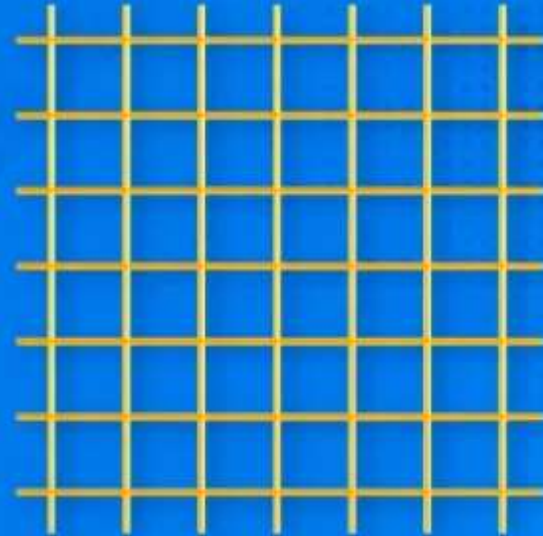




HOW TO  

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**MAKE GRID**  
Google Docs



# Circle Facts

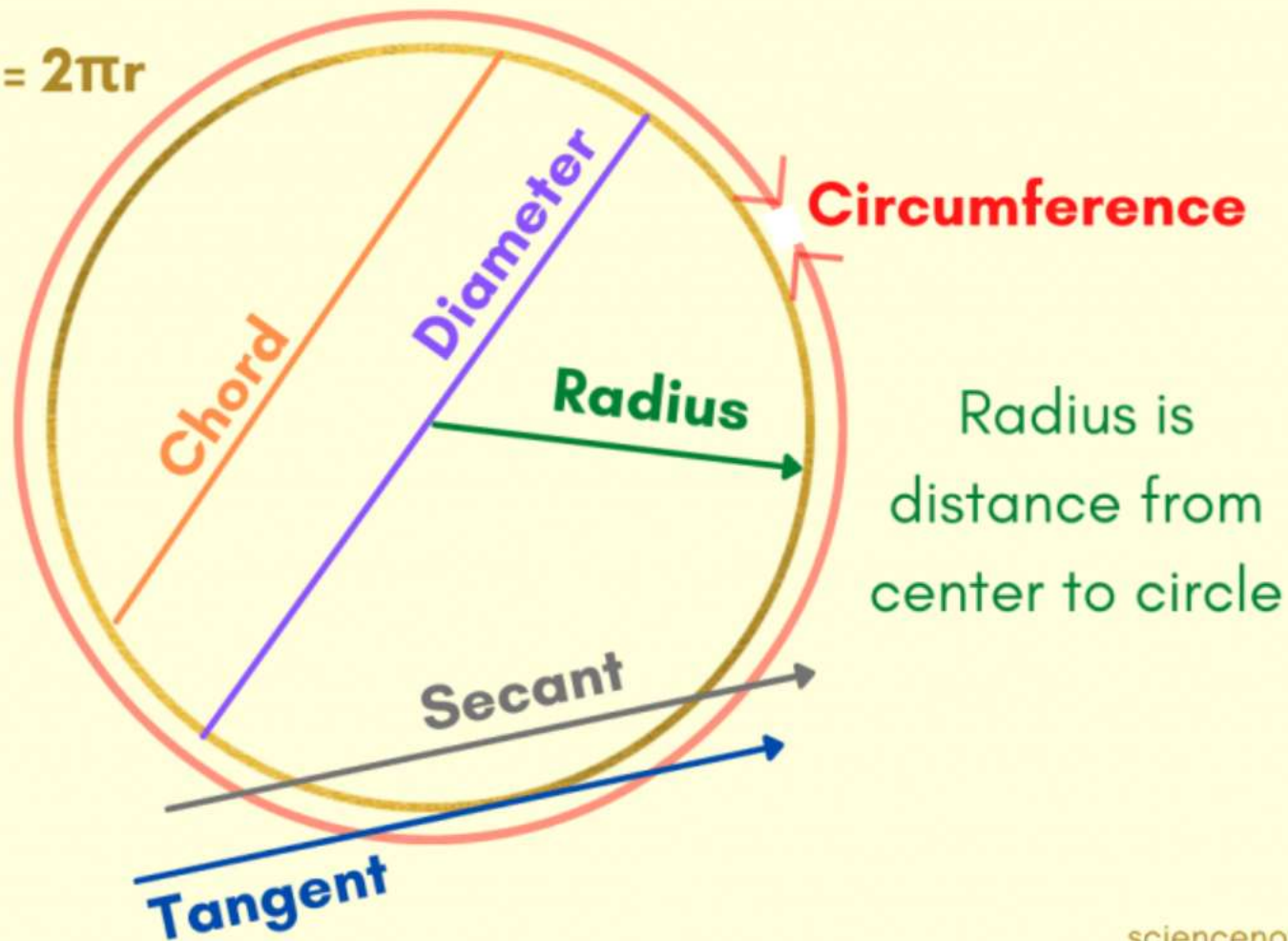
A circle is a two-dimensional shape made of points that are all the same distance from the center.

$$\text{Circumference} = 2\pi r$$

$$\text{Diameter} = 2r$$

$$\text{Area} = \pi r^2$$

Diameter is distance from one side of circle to the other, going through the center



# What Is Volume?

**VOLUME IS THE THREE-DIMENSIONAL SPACE OCCUPIED BY A SOLID, LIQUID, OR GAS**



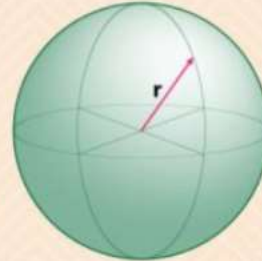
$$l \times w \times h$$



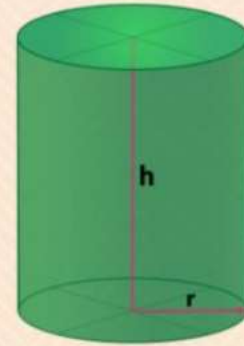
$$\frac{1}{3}\pi r^2 h$$



$$\frac{1}{3}l^2 h$$

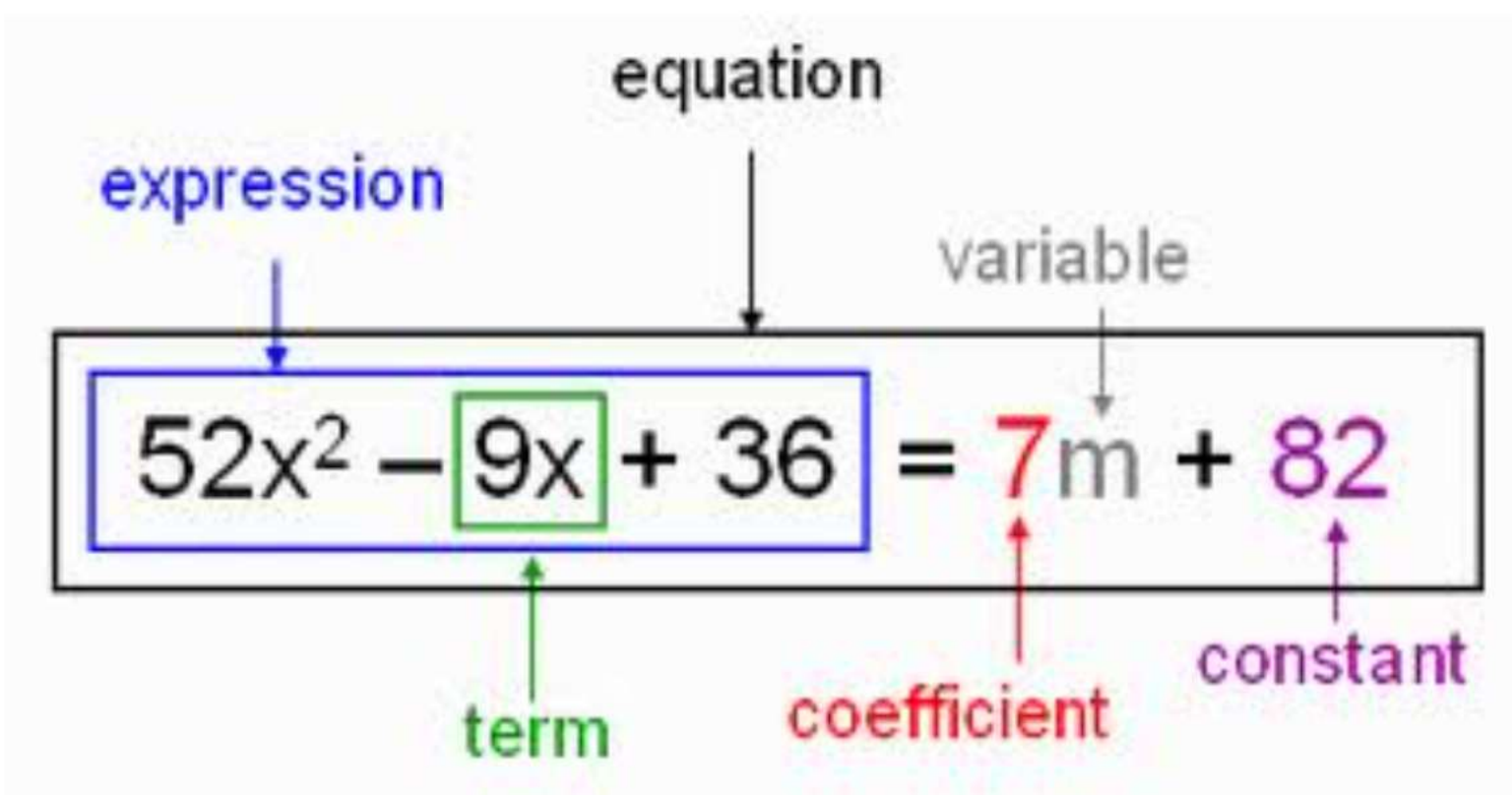


$$\frac{4}{3}\pi r^3$$



$$\pi r^2 h$$

Units include liters, cubic meters, cubic centimeters, fluid ounces, gallons, and quarts.



# Expression vs Equation



Expressions	Equations
$5y + 3$	$5y + 3 = 8$
$2xy - 5y + 3$	$2xy - 5y = 3xy$
$5 - 7 + 4 \times 2$	$5 - 7 + 4 \times 2 = 6$

## EXAMPLE OF A FRACTION

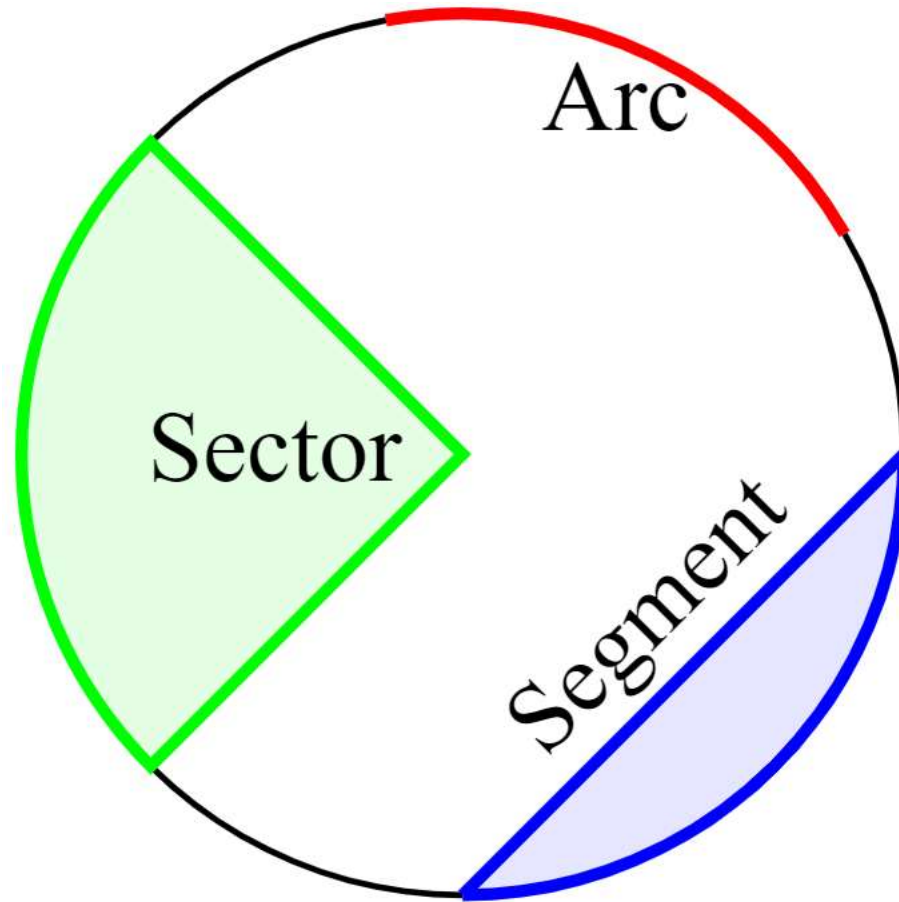
The diagram shows the fraction  $\frac{2}{3}$  with labels and arrows pointing to its components. The top number, 2, is labeled as the Numerator. The bottom number, 3, is labeled as the Denominator. The horizontal line between them is labeled as the Fractional bar.

$$\frac{2}{3}$$

Fractional bar →

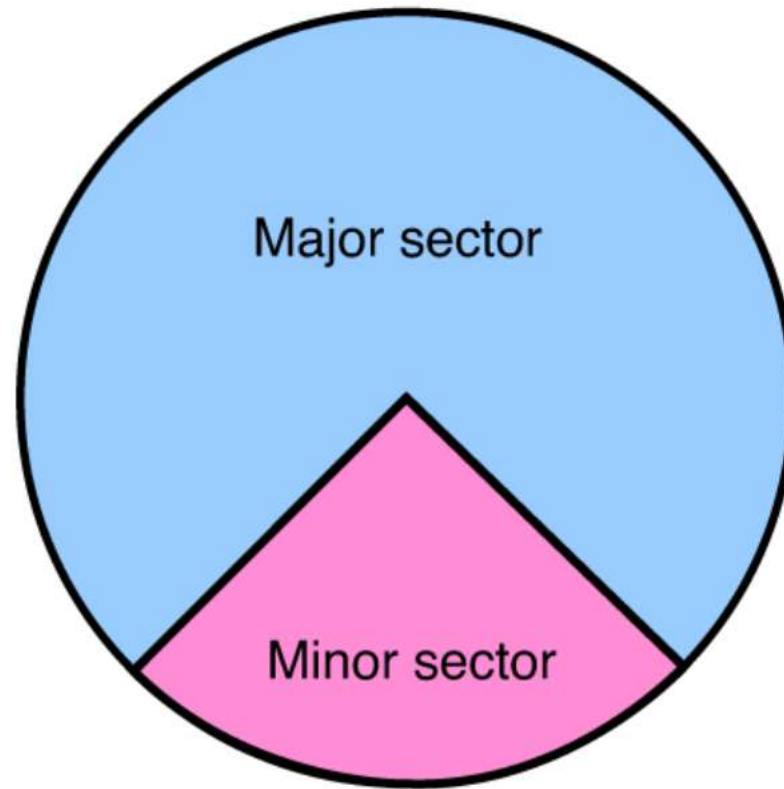
← Numerator

← Denominator



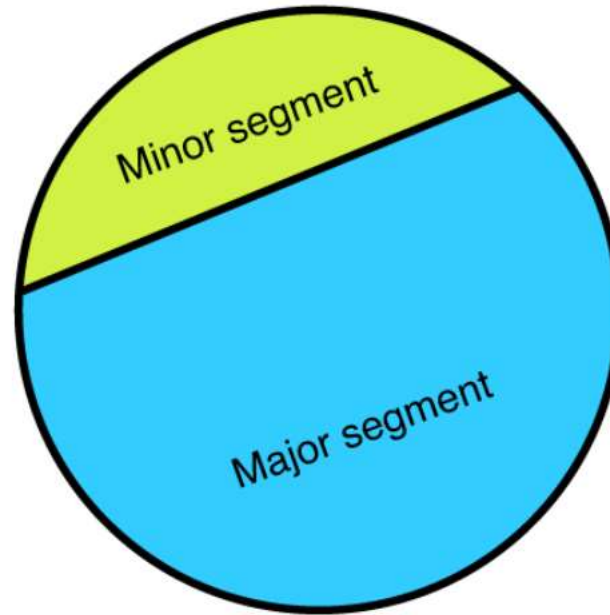


# Types of Sector

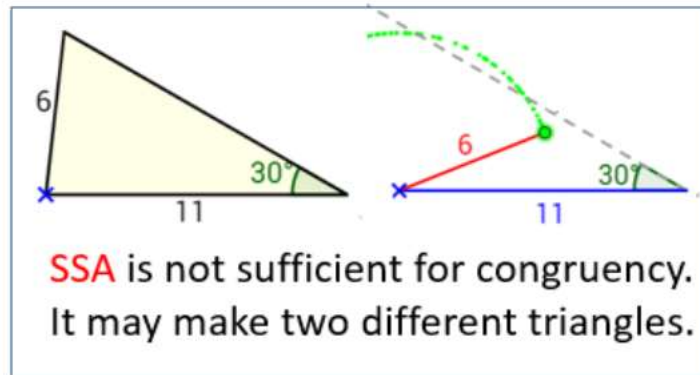
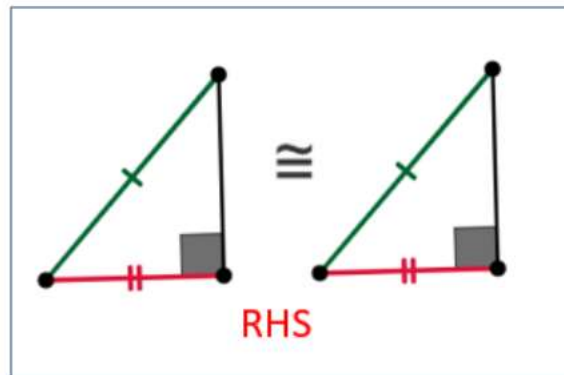
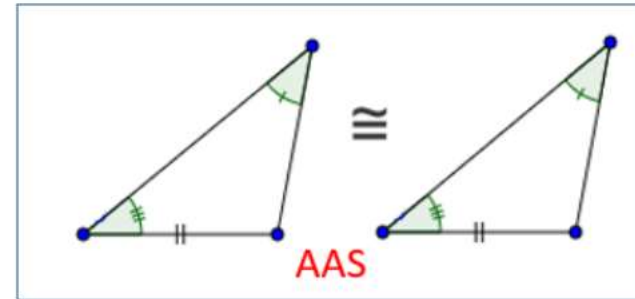
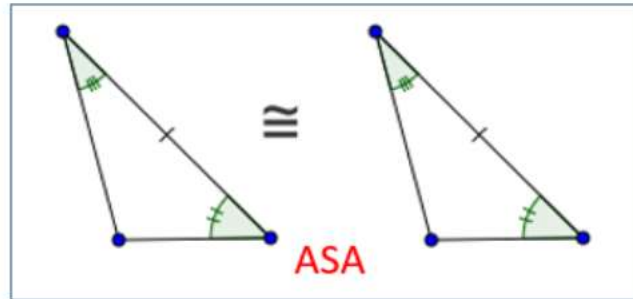
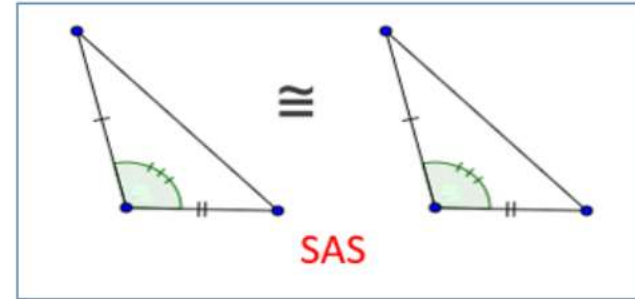
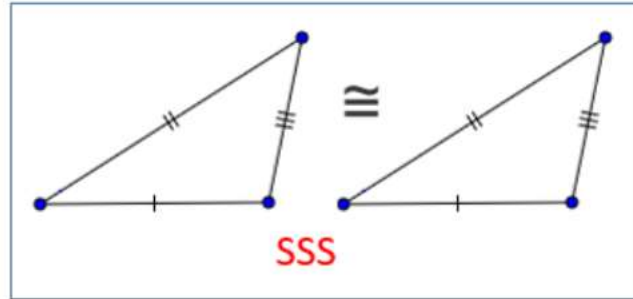


## Types of Segment in a Circle

MATH  
MONKS



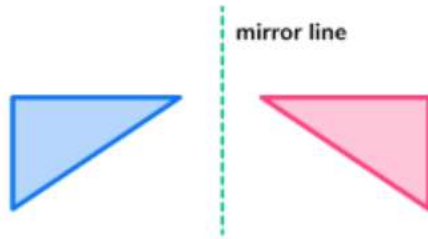
## Rules for Triangle Congruency



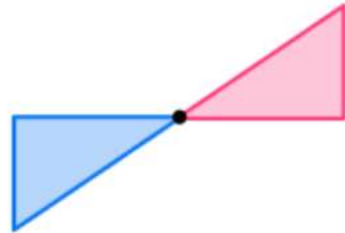
# Transformations

**Transformations** change the size and/or the position of a shape. There are **four** geometric types of transformations.

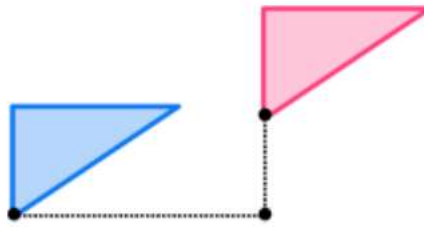
1. Reflection e.g.



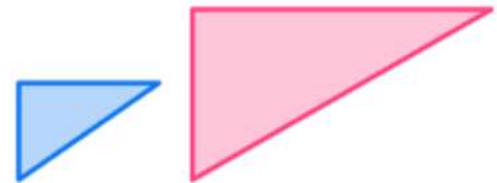
2. Rotations e.g.



3. Translation e.g.



4. Enlargement e.g.



Coordinates

$(x, y)$

Quadrants

x-y Axis

