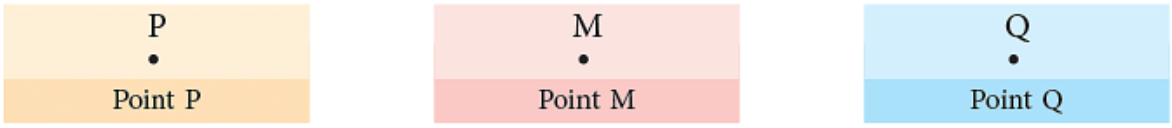
Geometry

Basic Geometrical Terms

1. Point

A dot (.) represents a point.
It represents an exact location in a **plane or space**.

It has no length and breadth. We represent a point with a capital letter, as shown below.



2. Line Segment

Mark two points on a sheet of paper and name them as A and B.

Join these points using a ruler. The figure so obtained is called a line segment. A line segment has two endpoints. It is named by the endpoints, as line segment AB or $\overline{AB}$.

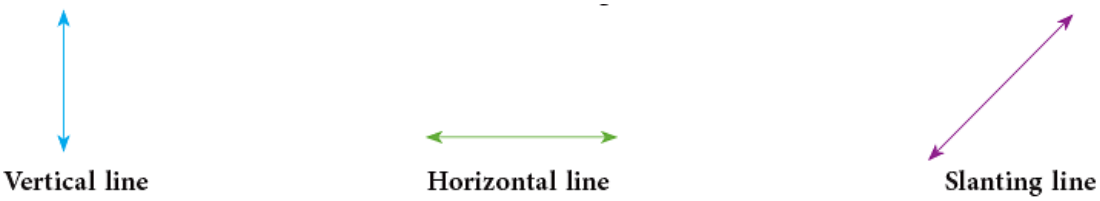
3. Line

A line segment extended on both the sides without an end is called a **line.**

A line has no endpoints. A line is denoted by taking any two points on it. For example, consider the line .

To name this line, we mark any two points on it, say, A and B. Then, it is named as $\overleftrightarrow{AB}$ (line AB) and represented, as shown alongside.

Generally, we use the word line for a straight line. Straight line can be vertical, horizontal or slanting.

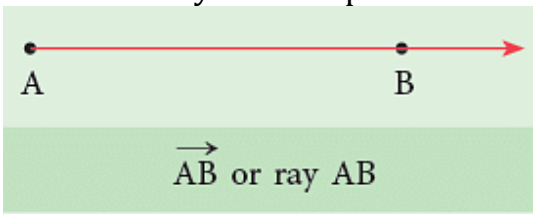


4. Ray

A **ray** is a straight path that has one endpoint and goes on and on in one direction.

This ray begins at point A and goes through point B.

It does not stop at point B. We name the given ray as $\overrightarrow{AB}$ (ray AB), where the first letter is always the endpoint.



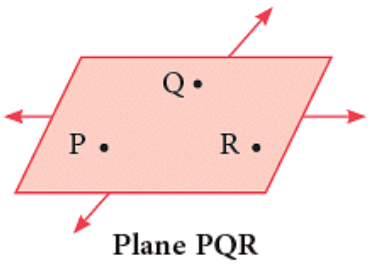
The symbol → shows that a ray has a fixed endpoint and extends forever in the other direction.

The rays of light from a torch and the rays of sun are the most common examples of a ray.

5. Plane

A **plane** is a flat surface.

In mathematics, a plane means one that goes on and on, in all directions without an end. We usually work with just a part of a plane. Points and lines lie on a plane. A plane can be named by using any three points on it. The given figure shows plane PQR. The order of the points does not matter.



Some representations of a plane surface from your everyday life are:

Screen of a flat TV

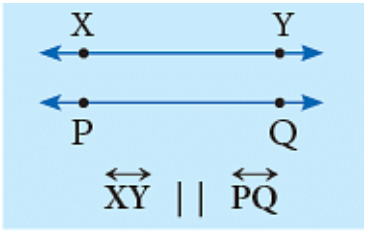
Surface of a blackboard

Surface of a book

Types of Lines

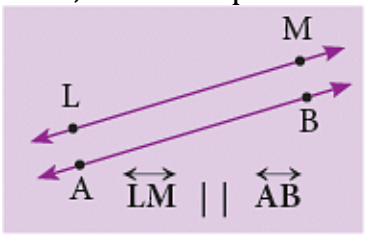
1. Parallel lines

The lines on the same plane that never meet, no matter how far they are extended, are called **parallel lines**.

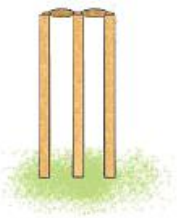


They are always the same distance apart. The symbol '||' is used to show "**is parallel to**".

Here, line XY is parallel to line PQ and line LM || line AB.



The following are some of the representations of parallel lines in everyday life:



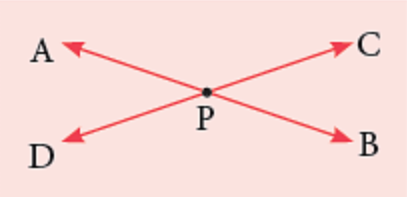
Stumps of a wicket

Two rails of a railway track

Zebra crossing

2. Intersecting lines

The lines that cross each other at a point are called **intersecting lines.**

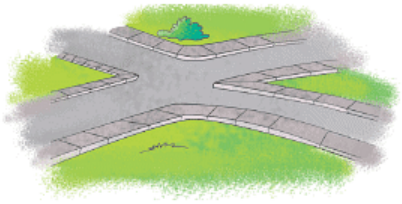


In the figure given alongside, $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ intersect at point P.

The following are some examples of the intersecting lines or line segments:

The letter X

Spokes of a bicycle wheel



A crossing where two roads meet and cross each other.

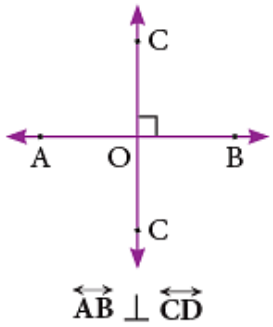
3.

Perpendicular lines

When two intersecting lines meet to form **right angles,** they are called **perpendicular lines.**

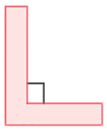
They are indicated by the symbol '⌝' (a square corner) in the diagrams.

Line AB is perpendicular to line CD and is written in short as $\overleftrightarrow{AB} \perp \overleftrightarrow{CD}$.



$\overleftrightarrow{AB} \perp \overleftrightarrow{CD}$

The letter 'L' is an example of perpendicular line segments. ' ⊥ ' is the symbol for "**is perpendicular to**".



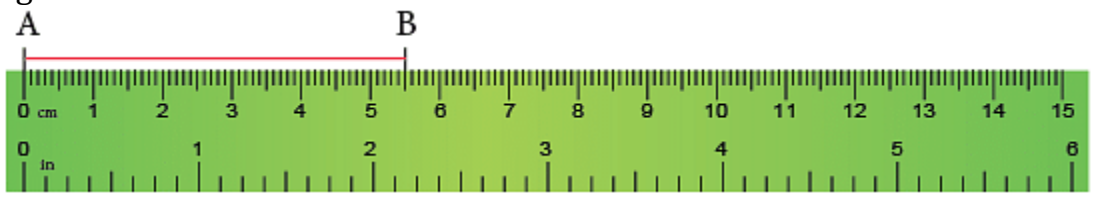
The letter L

Measuring a Line Segment

To Measure the Length of a Line Segment using a Ruler

Let us measure the line segment AB shown below. We follow the steps given below.

Step 1: Place the ruler along the line segment AB.
The zero (0) mark of the ruler should coincide with one end, point A of the line segment.

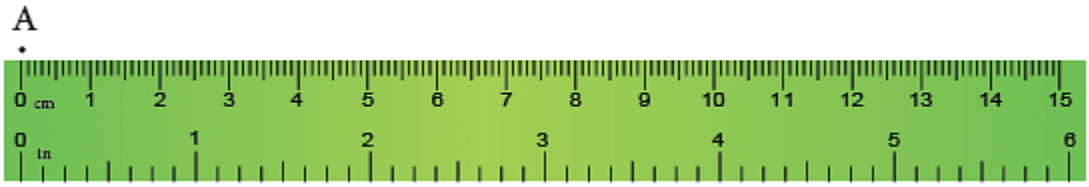


Step 2: Read the mark on the ruler at the other end of the line segment, i.e., point B. Here, point B is at 5.5 cm mark of the ruler. So, the length of the line segment AB is 5.5 cm.

Drawing a Line Segment

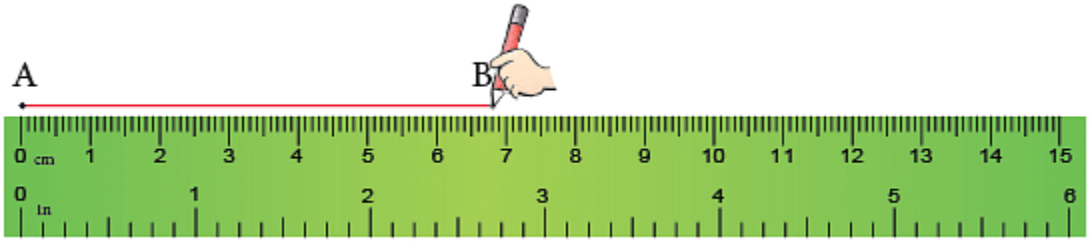
To draw a line segment of a given length, say 6.8 cm, we take the following steps.

Step 1: Take a sheet of paper and mark a point, say A, on it with a sharpened pencil.



Step 2: Place the ruler with its zero (0) mark at point A, as shown.

Step 3: Put your pencil at point A and move the pencil 8 small divisions after 6. This gives a line segment AB of length 6.8 cm.

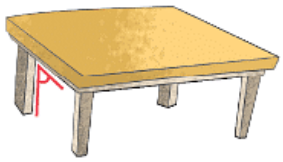


Angle

An **angle** is a figure formed by two rays meeting at a common endpoint

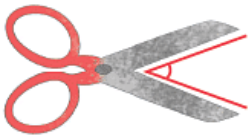
The common endpoint is called the **vertex** of the angle and the two rays are called the **arms** of the angle.

Looking at these pictures, you can form some idea of an angle:



Angle formed by tabletop and its legs

Angle formed by hour and minute hand of a clock



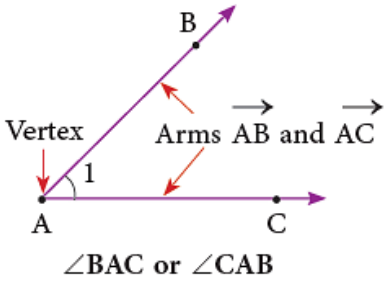
Angle formed by the edges of the scissors

The **symbol** for the word angle is '∠'.

Naming an Angle

You can name an angle in three ways:

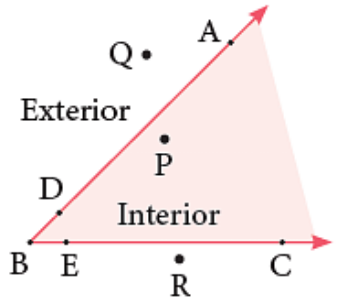
1. Using a three-letter name in the order: A point on one ray, vertex and a point on the other ray as ∠BAC or ∠CAB.
2. Using only one letter name, that is the vertex, ∠A. (This can be used when there is only one angle with this vertex.)
3. Writing a number or a small letter of the alphabet within the rays of the angle and naming the angle using this number.
   For example, ∠1.



∠BAC or ∠CAB

Interior and Exterior of an Angle

The inside of an angle, that is, the region between the rays, is called the interior of the angle. Point P is in the **interior** of ∠ABC.



Points A, B, C, D and E are on the arms (also called sides) of the angle. The points of the plane that do not lie on the arms or in the interior of the angle lie to the **exterior** of the angle. The points Q and R are to the exterior of ∠ABC.

Open and Closed Shapes

1. Open Shapes

The shapes which do not begin and end at the same point are called **open shapes.**

Look at the following open shapes:

2. Closed Shapes

The shapes which begin and end at the same point are called **closed shapes.**

Observe the following closed shapes:

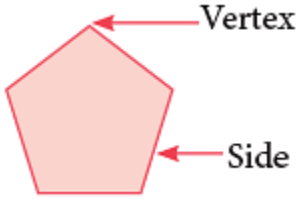
(i) Simple Closed Figures

Look at the following figures:

Which of the figures given above could you draw by starting at some point, never lifting your pencil from the paper and end at the starting point?
Obviously, **A, B, C, D, G** and **H**. Such figures are called **closed figures.**
Out of these, which figures can you draw without having the figure crossed itself?
Ans: A, B, D, G and **H**. Such figures are called **simple closed figures.**

Polygon

A closed figure such as the one shown at the right is a special kind of plane figure called a **polygon.** It is made up of more than two **line segments**.



The line segments that form a polygon are called the **sides** of the polygon. The intersection of two sides is called a **vertex** of the polygon.

Naming a Polygon

The name of a polygon depends on the number of sides it has. Some examples of polygons are given below.

Triangle	Quadrilateral	Pentagon	Hexagon	Octagon
3 sides	4 sides	5 sides	6 sides	8 sides

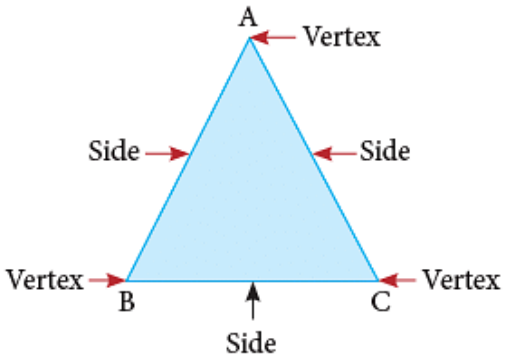
Triangle

A **triangle** is a polygon formed by three line segments as its sides.

The point of the intersection of two sides is called the **vertex** (plural: vertices).

Naming a Triangle

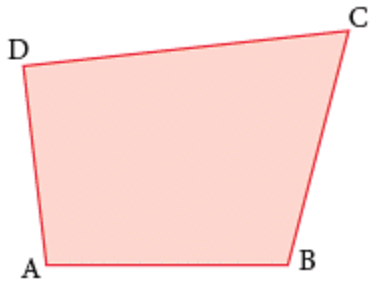
A triangle is named by naming its vertices.
Thus, to name a triangle whose vertices are A, B and C, we say “triangle ABC” and denote it as ΔABC.
Δ is the symbol of a triangle. Other names for ΔABC are ΔACB, ΔBAC, ΔBCA, ΔCAB, ΔCBA.



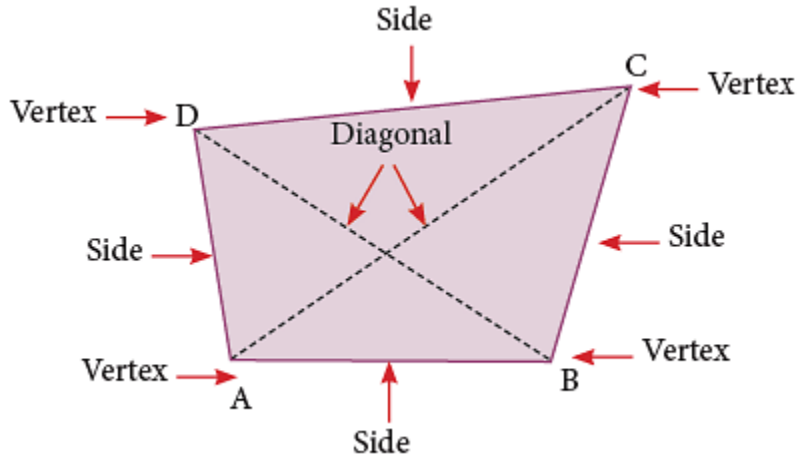
Thus, the order of vertices does not matter while naming a triangle.
AB or BA, BC or CB, CA or AC are the three sides of triangle ABC.
∠ABC, ∠BCA and ∠CAB are the three angles of the triangle ABC.

Quadrilateral

A **quadrilateral** is a polygon formed by four line segments as its sides.



Quadrilateral
In the given figure, A, B, C and D are the vertices of a quadrilateral. We can name the given quadrilateral as quadrilateral ABCD, BCDA, CDAB, DABC, BADC, ADCB, DCBA and CBAD. AB, BC, CD and DA are the four **sides** of the quadrilateral ABCD.
The two sides, like AB and BC, which have a common vertex B, are called **adjacent sides.** The other pairs of adjacent sides are AB, AD; AD, DC and DC, BC.
AB and CD are **opposite sides**. The other pair of opposite sides is AD and BC.
A line segment joining two non-consecutive vertices is called a **diagonal.** AC and BD are the two diagonals of the quadrilateral ABCD.



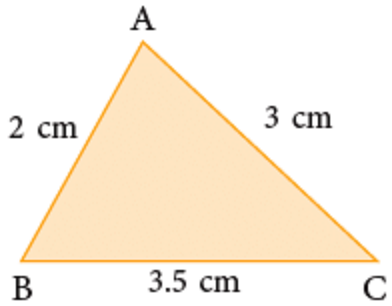
∠A, ∠B, ∠C and ∠D are the four angles of the quadrilateral ABCD.

Special Triangles

Some triangles are given special names in regard to their angles and sides.

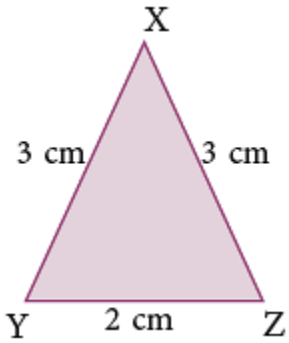
Scalene Triangle

A triangle that has no two sides equal is called a **scalene triangle.**



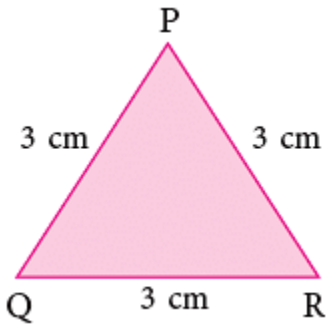
Scalene triangle
ΔABC is a scalene triangle.

Isosceles Triangle
A triangle that has two equal sides is called an **isosceles triangle.**



Isosceles triangle
ΔXYZ is an isosceles triangle.

Equilateral Triangle
A triangle in which all three sides are equal is called an **equilateral triangle.**

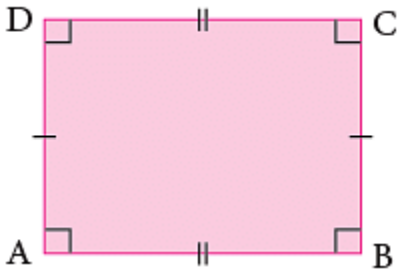


Equilateral triangle
ΔPQR is an equilateral triangle.

Special Quadrilaterals
Quadrilaterals whose opposite sides are **parallel** and are often used have been given special names.

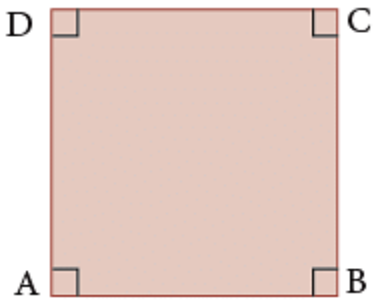
Parallelogram
A quadrilateral that has both the pairs of opposite sides, parallel is called a **parallelogram**.

Parallelogram**Rectangle**
A parallelogram whose opposite sides are equal and all four angles are right angles is called a rectangle, i.e., AB || DC, AD || BC;
AB = DC, AD = BC and ∠A = ∠B = ∠B = ∠D = 90°.



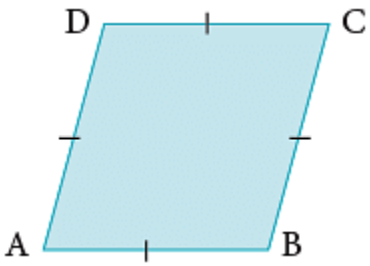
Rectangle

Square
A square is parallelogram in which all angles are right angle and all sides are equal, i.e., AB || DC, AD || BC; AB = BC = CD = DA and ∠A = ∠B = ∠C = ∠D = 90°.



Square

Rhombus
A rhombus is a parallelogram in which all four sides are equal i.e., AB || DC, AD || BC and AB = BC = CD = DA.



Rhombus

You will find many things around you which have the shape of a rectangle:
Each page of your notebook is a rectangle.


Page of a notebook

Squares are also very commonly used.
Many floor tiles have the shape of a square.


Floor Tiles

A chessboard has squares on it.


Chessboard

Properties of a Parallelogram

Draw any parallelogram as PQRS.

Measure its sides.

Now, complete the following table.

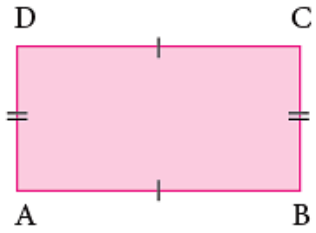
Sides	PQ	QR	RS	SP
Measurement	_____ cm	_____ cm	_____ cm	_____ cm
Angle	∠PQR	∠QRS	∠RSP	∠SPQ
	_____°	_____°	_____°	_____°

Do you observe that

1. the opposite sides of a parallelogram are equal?

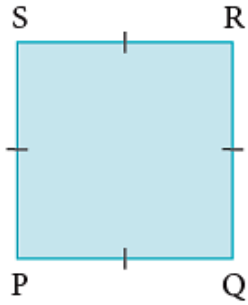
2. the opposite angles of a parallelogram are equal?

Since a **rectangle is a parallelogram,** therefore, **the opposite sides of a rectangle are equal.**



Thus, in the rectangle ABCD shown here, AB is parallel to DC and AD is parallel to BC.

Also, AB = DC and AD = BC.



A **square**, also being a **parallelogram**, has all the properties of a parallelogram.
Also, in square PQRS,

(a) PQ = QR = RS = SP

(b) PQ is parallel to SR and PS is parallel to QR

Circle

Look at the following objects.

Which shape do all of the above objects remind you of?
All these objects are in the shape of a circle.
A **circle** is a simple closed curve.

Tips: A circle is not a polygon as it is not made up of straight lines.

Drawing a Circle

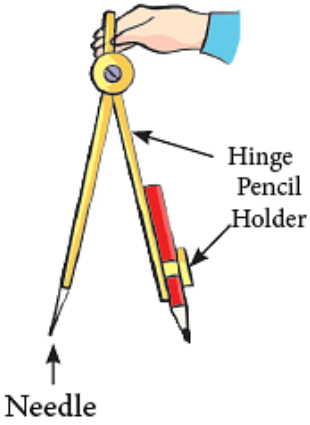
We can draw a circle using any one of these methods.

Method

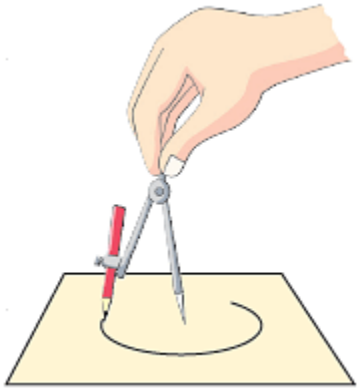
1. Take any circular object such as a coin, bottle cap, bangle, etc., and trace its outline. You will get the shape of a circle.
2. Take a piece of thread and tie a pencil to one end of the thread. Fix the other end of the thread to the paper with a pin. Hold the thread tightly and rotate the pencil. The shape you get will be a circle.
3. Using compasses which has a metal-pointed edge at A circle is not a polygon as it is not made up of straight lines. one end and a pencil holder on the other end.

To draw a circle using compasses:

Step 1: Fix the pencil to the compasses tightly. Adjust the pencil such that the needle and the pencil edge are at the same level.



Step 2: Fix the needle of the compasses on the sheet of paper.



Step 3: Stretch the other arm of the compasses which is holding the pencil.

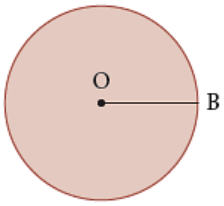
Step 4: Move the pencil around to draw a circle.

Parts of a Circle

- **Centre**
  In the figure given alongside, O is the point where we put the metal end of the compasses to draw a circle. O is called the **centre** of the circle.

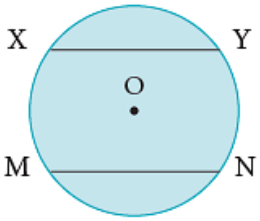
- We name the circle with its centre.

- **Radius**
  The line segment joining the centre of the circle to any point on the circle is called the **radius** of the circle.



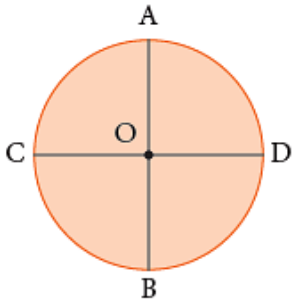
- In the figure, line segment OB is the radius of the circle.

- **Chord**
  The line segment joining any two points on a circle is called a **chord.**



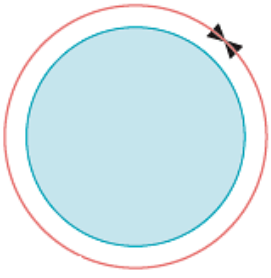
  In the figure, XY and MN are the chords of the circle.

- **Diameter**
  A chord that passes through the centre is called a **diameter** of the circle.



  Here, AB and CD are the diameters of the circle O.

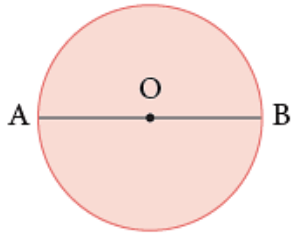
- **Circumference**
  The length of the boundary of a circle is called its **circumference**.



Relation between Radius and Diameter of a Circle

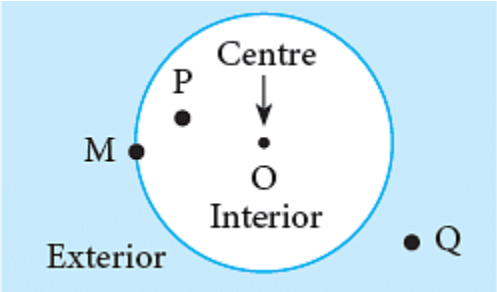
In the given figure, AB is the diameter of the circle. AO and OB are the two radii of the circle.

Measure OA, OB and AB. OA = ___ cm, OB = ___ cm, AB = __ cm
You will find that AB = 2OA or 2OB = 2 × radius



i.e., $\text{diameter} = 2 \times \text{radius}$ or $\text{radius} = \frac{1}{2} \times \text{diameter}.$

Interior and Exterior of a circle

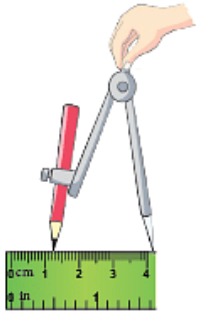


- The points O and P are in the **interior** of the circle.
- The point M is **on** the circle.
- The point Q lies to the **exterior** of the circle.

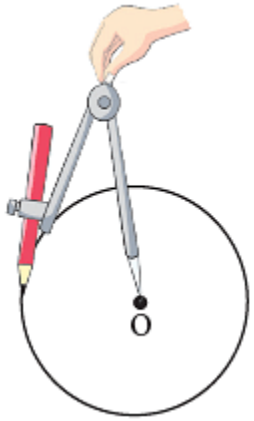
To Draw a Circle of Given Radius

You must use a pair of compasses to draw neat and accurate circles. Suppose, you have to draw a circle of radius 3 cm. You can do so by following these steps.

Step 1: With the help of your ruler, open the arms of your compasses to 3 cm length.



Step 2: Mark any point O on a piece of paper.



Step 3: Place the steel end of the compasses on the dot marked O. Hold the head of the instrument between the thumb and the forefinger such that the pencil end of the compasses may touch the paper. Now, turn it completely round so that the pencil end traces a circle. You will get a circle of radius 3 cm, with centre O.