14

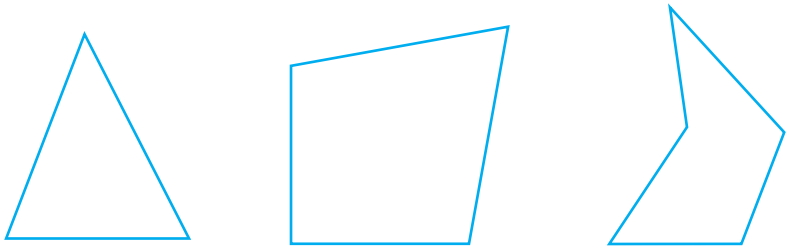
Rectilinear plane figures
(Part I)

By studying this lesson you will be able to

- identify what a polygon is and
- identify convex polygons, concave polygons and regular polygons.

14.1 Polygons

Consider each of the following plane figures.

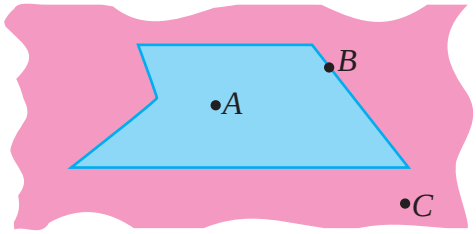


The above figures are all bounded by straight line segments. Furthermore, the straight line segments do not intersect each other in these plane figures, and only two straight line segments meet at each vertex point. Such plane figures are called **polygons**.

A closed plane figure bounded by three or more straight line segments is called a **polygon**.

Each of the line segments by which a given polygon is bounded is called a **side** of the polygon and each of the points at which two of these sides meet is called a **vertex** of the polygon.

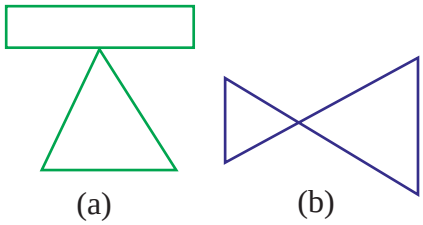
The region bounded by the straight line segments of a polygon (shaded blue) is called the interior region of the polygon, and the region outside (shaded pink) is called the exterior region of the polygon.



A is a point in the interior region of the polygon,
B is a point on the polygon and
C is a point in the exterior region of the polygon.

An angle in the interior region of a given polygon, between two sides which meet at a vertex is called an **angle** of the polygon.

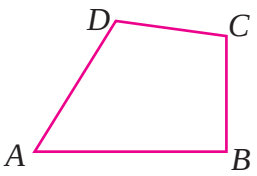
Figure (a) shown here has three straight lines which meet at a particular point. Figure (b) has two straight lines which intersect at a point. Therefore, these plane figures are **not polygons**.


(a) (b)

A polygon should have at least three sides. Polygons with three sides are **triangles**. Polygons with 4 sides are **quadrilaterals**, polygons with 5 sides are **pentagons** and polygons with 6 sides are **hexagons**.


Triangle Quadrilateral Pentagon Hexagon

The vertices of a polygon are named using capital letters of the English alphabet. Then the polygon itself, the sides and the angles of the polygon can be named by using these letters.



- In the above given quadrilateral, the vertices have been named *A*, *B*, *C* and *D*. The quadrilateral is called *ABCD*.
- The sides of quadrilateral *ABCD* are *AB*, *BC*, *CD* and *DA*. In the same way, the sides can also be named *BA*, *CB*, *DC* and *AD*.
- The angles of quadrilateral *ABCD* are $A\hat{B}C$, $B\hat{C}D$, $C\hat{D}A$ and $D\hat{A}B$. In the same way, the angles can also be named $C\hat{B}A$, $D\hat{C}B$, $A\hat{D}C$ and $B\hat{A}D$. In a polygon, the number of sides and the number of angles are both equal to the number of vertices.

Exercise 14.1

(1) The way a polygon is named, based on the number of sides it has, is given in the following table.

Number of sides	Name of polygon	Number of angles	Number of vertices
3	Triangle		
4	Quadrilateral		
5	Pentagon		
6	Hexagon		
7	Heptagon		
8	Octagon		
9	Nonagon		
10	Decagon		

(i) Copy the table and complete the columns named "number of angles" and "number of vertices".

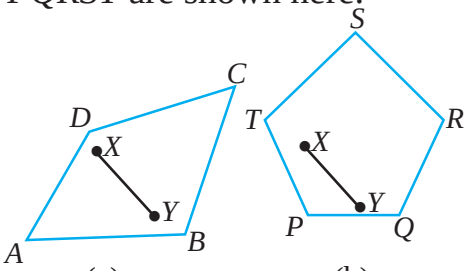
(ii) Draw a sketch of each type of polygon named in the above table. Name the vertices of each polygon you drew using capital letters of the English alphabet. Name the sides and the angles of each polygon.

(2) Cut 4 strips of paper of breadth around 5 cm. By folding each paper appropriately, make a triangle, a quadrilateral, a pentagon and a hexagon and cut each shape out. Paste these shapes in your book.

14.2 Convex polygons and Concave polygons

A quadrilateral *ABCD* and a pentagon *PQRST* are shown here.

- When joining any two points marked inside a polygon with a straight line, as shown in the figure, if the straight line, lies entirely inside the polygon, that is, it never goes outside the polygon, then that polygon is known as a **convex polygon**.

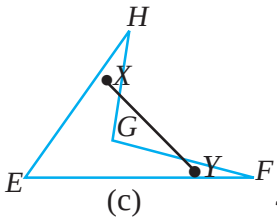


(a) (b)

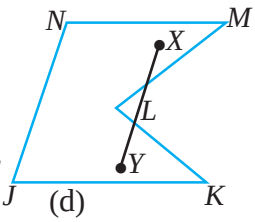
That is, the straight line joining any two points inside a convex polygon does not intersect the sides of the polygon.

A quadrilateral *EFGH* and a pentagon *JKLMN* are shown here.

- If there are two points in the interior of a polygon such that the straight line joining these two points does not lie entirely inside the polygon, then that polygon is known as a **concave polygon**.



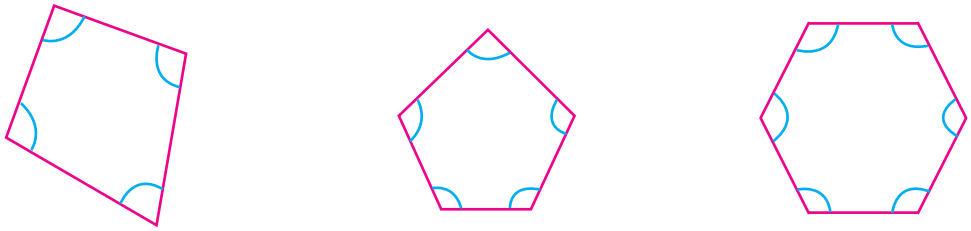
(c)



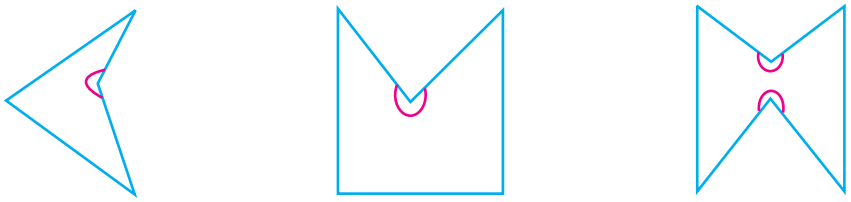
(d)

That is, in a concave polygon, there are two points inside the polygon such that the straight line which joins the two points intersects certain sides of the polygon.

No angle of a convex polygon is a reflex angle.



At least one angle of a concave polygon is a reflex angle.



- If no interior angle of a polygon is a reflex angle, then such a polygon is a convex polygon.
- If at least one interior angle of a polygon is a reflex angle, then such a polygon is a concave polygon.

Exercise 14.2

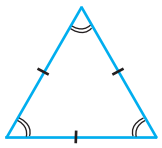
(1) Draw a concave polygon with 1 reflex angle, with 2 reflex angles and with 3 reflex angles. Name each polygon based on the number of sides.

(2) State two facts that distinguish a triangle from the other polygons.

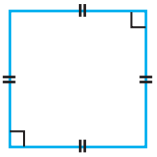
14.3 Regular polygons

A polygon with all sides equal in length and all angles equal in magnitude is called a **regular polygon.**

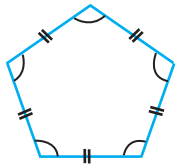
- A triangle with all three sides equal in length and all three angles equal in magnitude is a **regular triangle** or an **equilateral triangle**.



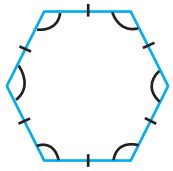
- A quadrilateral with all four sides equal in length and all four angles equal in magnitude is a **regular quadrilateral** or a **square**.



- A pentagon with all five sides equal in length and all five angles equal in magnitude is a **regular pentagon**.

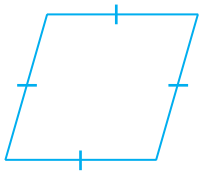


- A hexagon with all six sides equal in length and all six angles equal in magnitude is a **regular hexagon**.



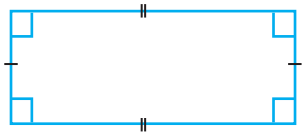
There are polygons with all sides equal in length, which are not regular polygons.

For example, in a rhombus, all four sides are equal in length, but all four angles are not equal in magnitude. Therefore a **rhombus is not a regular polygon.**



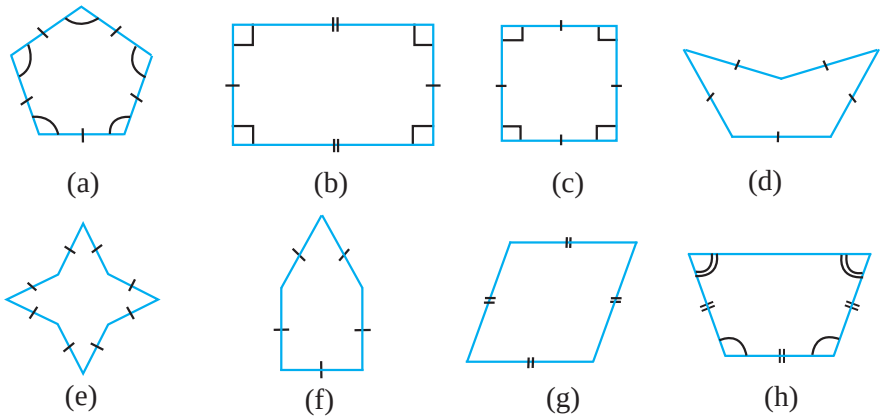
There are polygons with all angles equal in magnitude, which are not regular polygons.

For example, in a rectangle, all four angles are equal in magnitude but all four sides need not be equal in length. Therefore, a **rectangle is not a regular polygon**.



Exercise 14.3

(1) Use the data in the below given polygons to complete the table.



(a) (b) (c) (d)

(e) (f) (g) (h)

Figure	Convex / Concave	Is it regular?	If it is not regular, the reason
a b c d e f g h			

(2) Create various polygons by folding a piece of paper of length 50 cm and breadth 5 cm. Using a pen, draw straight lines along the folds. Name the polygons you obtain.

Summary

- A closed rectilinear plane figure consisting of three or more straight line segments is a polygon.
- No interior angle of a convex polygon is a reflex angle.
- At least one interior angle of a concave polygon is a reflex angle.
- A polygon with all sides equal in length and all angles equal in magnitude is called a regular polygon.

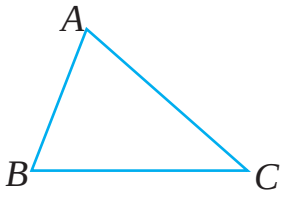
14 Rectilinear plane figures (Part II)

By studying this lesson you will be able to

- identify acute angled triangles, right angled triangles and obtuse angled triangles, and
- identify equilateral triangles, isosceles triangles and scalene triangles.

14.4 Triangles

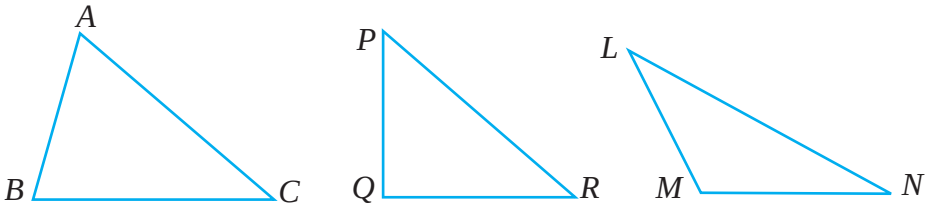
You have learnt that a polygon consisting of three straight line segments is a triangle. There are three angles and three sides in a triangle. These are called the elements of the triangle.



AB, *BC* and *CA* are the three sides of the triangle *ABC*. Furthermore, $A\hat{B}C$, $B\hat{C}A$ and $C\hat{A}B$ are the three angles of the triangle *ABC*.

Activity 1

Step 1 - Complete the table given below by naming the sides and the angles of each of the given triangles.

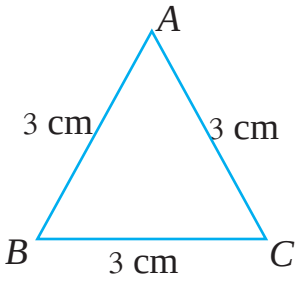


Triangle	Sides	Angles
ABC	*AB, AC, BC,*	$A\hat{B}C$, $B\hat{A}C$, $B\hat{C}A$,
PQR		
LMN		

14.5 Classification of triangles according to the length of the sides

• Equilateral triangles

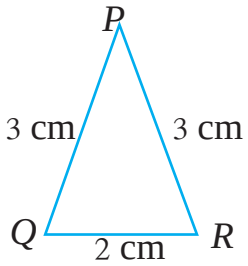
Each side of triangle *ABC* is of length 3 cm.
That is, $AB = BC = CA = 3$ cm.
All sides of triangle *ABC* are equal in length.



A triangle of which all three sides are equal in length is known as an **equilateral triangle**.

• Isosceles triangles

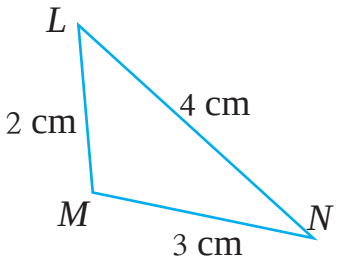
In triangle *PQR*, $PQ = PR = 3$ cm.
The other side which is *QR* is 2 cm in length. That is, *PQ* and *PR* are equal in length in triangle *PQR*.



A triangle of which two sides are equal in length is known as an **isosceles triangle.**

• Scalene triangles

In triangle *LMN*, $LM = 2$ cm,
$MN = 3$ cm and $NL = 4$ cm.
That is, all sides of triangle *LMN* are of different lengths.

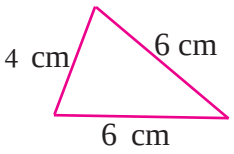


A triangle of which all three sides are unequal in length is known as a **scalene triangle.**

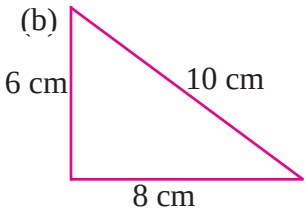
Exercise 14.4

(1) Examine the below given triangles and state whether each triangle is an equilateral triangle, an isosceles triangle or a scalene triangle.

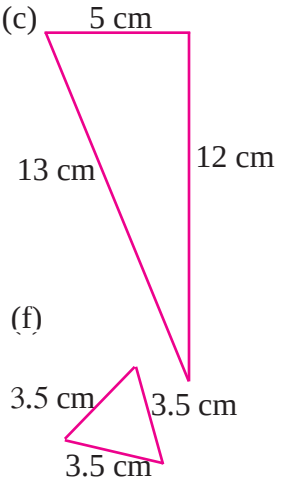
(a)



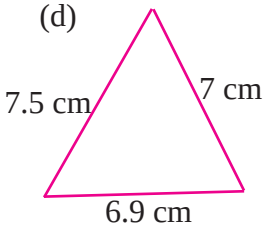
(b)



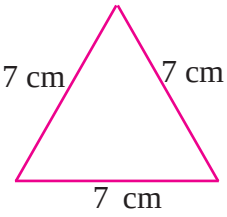
(c)



(d)

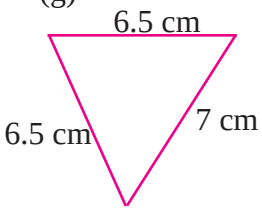


(e)

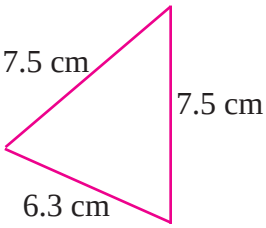


(f)

(g)



(h)

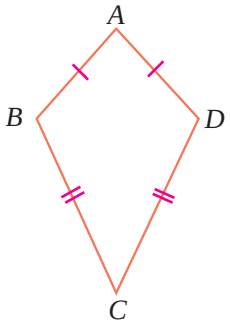


(2) Complete the table.

Length of each side of the triangle			Type of triangle based on the lengths of the sides
(cm)	(cm)	(cm)	
6	3	6	
4	4	4	
3	6	5	
5	6	8	

(3) "All equilateral triangles are isosceles triangles". Do you agree with this statement? Give reasons.

(4) A quadrilateral is shown in the figure. Name according to the lengths of the sides, the triangles that are obtained by



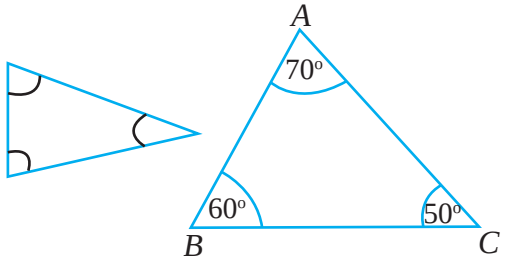
(i) joining only *AC*
(ii) joining only *BD*

(5) By folding a rectangular shaped paper, create an equilateral triangle and an isosceles triangle, cut these triangles out, and paste them in your book.

14.6 Classification of triangles according to the angles

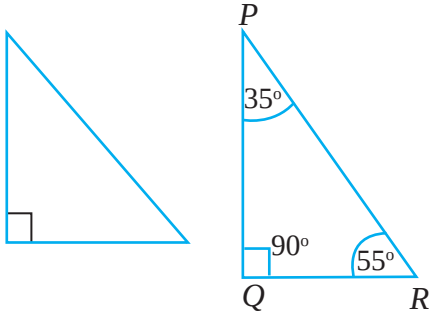
• Acute angled triangle

If all three angles of a triangle are acute angles, then the triangle is called an **acute angled triangle.**



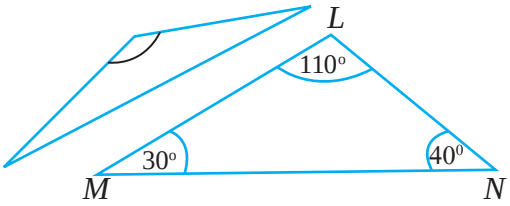
• Right angled triangle

If one angle of a triangle is a right angle, then the triangle is called a **right angled triangle**. The other two angles of a right angled triangle are acute angles.



• Obtuse angled triangle

If one angle of a triangle is an obtuse angle, then the triangle is called an **obtuse angled triangle.** The other two angles of an obtuse angled triangle are acute angles.

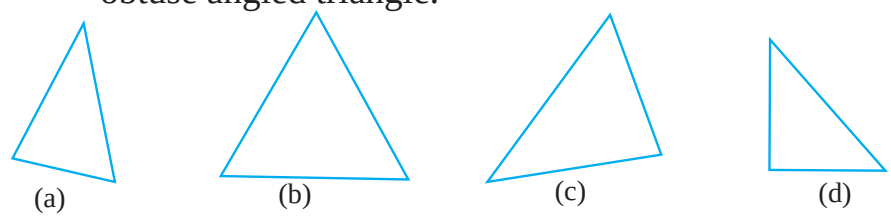


Activity 2

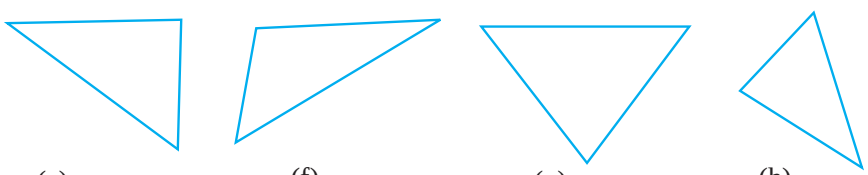
Step 1 - Obtain a right angled corner by folding a piece of paper.

Step 2 - Using the right angled corner, compare the angles of the below given triangles.

Step 3 - Accordingly, write down for each of the triangles whether it is an acute angled triangle, a right angled triangle or an obtuse angled triangle.



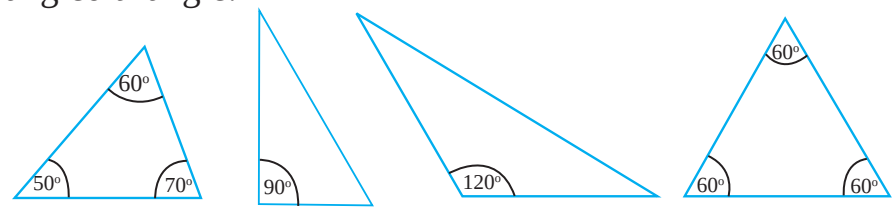
(a) (b) (c) (d)



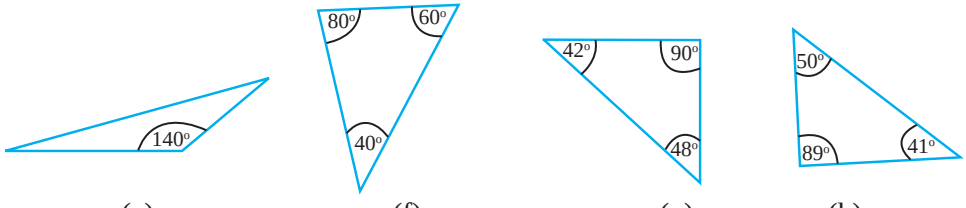
(e) (f) (g) (h)

Exercise 14.5

(1) By considering the data in the below given triangles, classify each of them as an acute angled triangle, right angled triangle or an obtuse angled triangle.

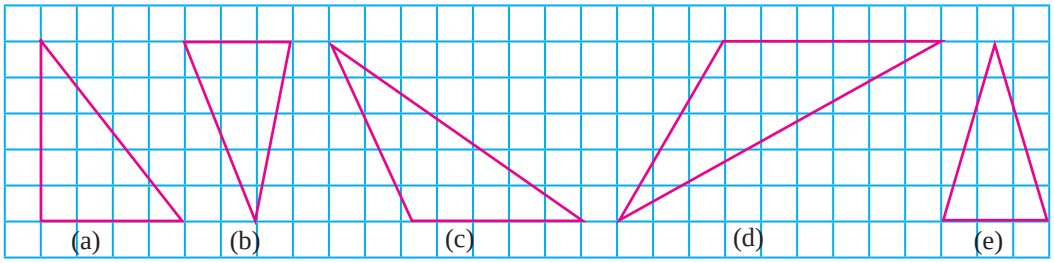


(a) (b) (c) (d)



(e) (f) (g) (h)

(2) Classify each of the triangles given below, according to its angles.



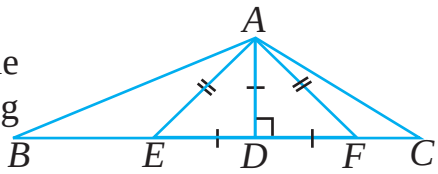
(3) Do the following by considering the given figure.

(i) Name 3 isosceles triangles.

(ii) Name 2 right angled triangles.

(iii) Name an obtuse angled triangle and a right angled triangle having *AB* as a side.

(iv) Name a scalene triangle.



(4) Do the following using the data in the figure.

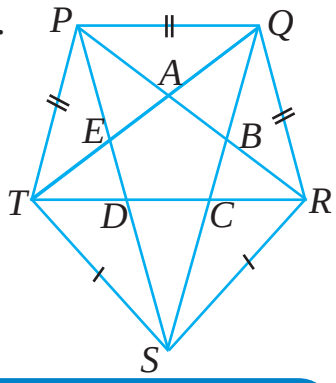
(i) Name 3 isosceles triangles.

(ii) Name 2 scalene triangles.

(iii) Name 2 convex pentagons.

(iv) Name 2 concave pentagons.

(v) Name a hexagon.



Summary

- If all three sides of a triangle are equal in length, then it is called an equilateral triangle.
- If any two sides of a triangle are equal in length, then it is called an isosceles triangle.
- If all three sides of a triangle are different in length, then it is called a scalene triangle.
- In a triangle, if all three angles are acute, then it is called an acute angled triangle.
- In a triangle, if one angle is a right angle, then it is called a right angled triangle.
- In a triangle if one angle is an obtuse angle, then it is called an obtuse angled triangle.