

## 9.CONSTRUCTION OF TRIANGLES

### 9.0 Introduction

You will learn how to construct triangles in this chapter. You do not need all the six elements i.e. the three angles and three sides of a triangle to construct a triangle. A triangle can be drawn if you know the elements that are required for two triangles to be congruent. Thus, a triangle can be drawn in any of the situations given below i.e., if we know the-

- (i) Three sides of the triangle.
- (ii) Two sides and the angle included between them.
- (iii) Two angles and the side included between them
- (iv) Hypotenuse and one adjacent side of a right-angled triangle.

A triangle can also be drawn if two of its sides and a non-included angle are given. However, it is important to remember that this condition is not sufficient to make two triangles, congruent.

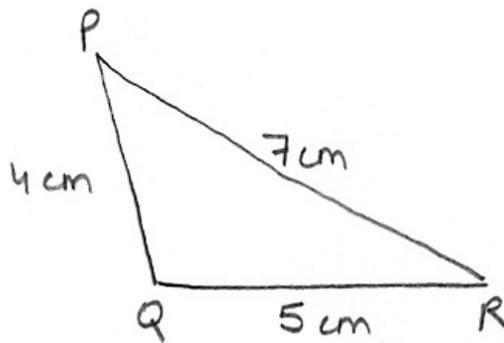
Let us learn to construct triangles in each of the above cases.

### 9.1 Construction of a triangle when measurements of the three sides are given

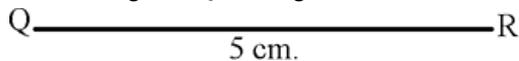
In the construction of any geometrical figure, drawing a rough sketch first, helps in indentifying the sides. So we should first draw a rough sketch of the triangle we want to construct and label it with the given measurements.

**Example 1:** Construct a  $\triangle PQR$  with sides  $PQ = 4$  cm,  $QR = 5$  cm and  $RP = 7$  cm.

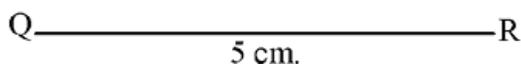
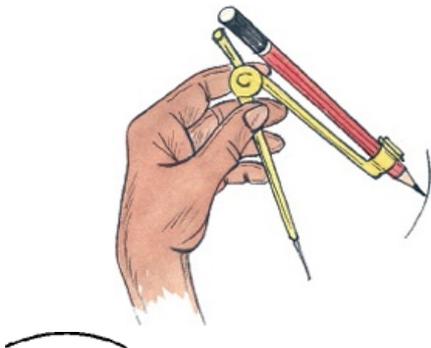
**STEP 1 :** Draw a rough sketch of the triangle and label it with the given measurements.



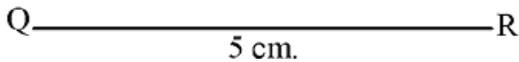
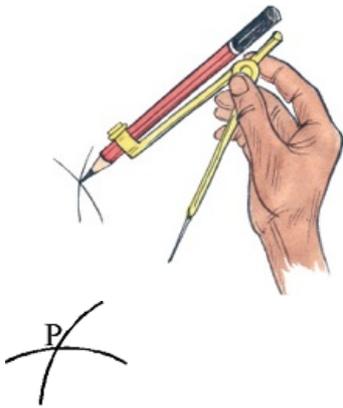
**STEP 2 :** Draw a line segment QR of length 5 cm.



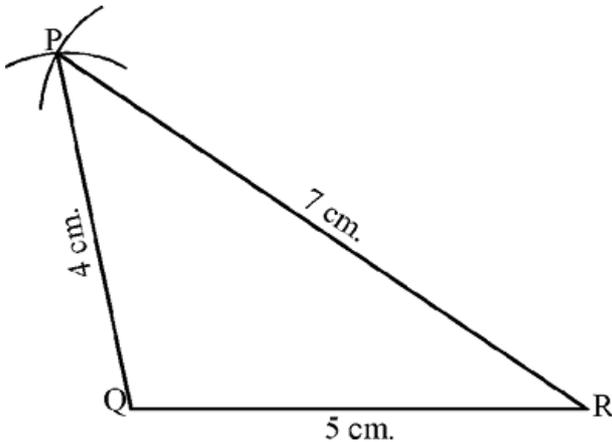
**STEP 3 :** With centre Q, draw an arc of radius 4 cm.



**STEP 4 :** Since P is at a distance of 7 cm from R, draw another arc from R with radius 7 cm such that it intersects first arc at P.



**STEP 5 :** Join Q,P and P,R. The required  $\triangle PQR$  is constructed.



**Try This**

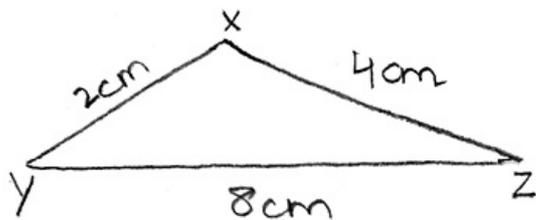
1. Construct a triangle with the same measurements given in above example, taking PQ as base. Are the triangles congruent?
2. Construct a  $\triangle PET$ ,  $PE = 4.5$  cm,  $ET = 5.4$  cm and  $TP = 6.5$  cm in your notebook. Now construct  $\triangle ABC$ ,  $AB = 5.4$  cm,  $BC = 4.5$  cm and  $CA = 6.5$  cm on a piece of paper. Cut it out and place it on the figure you have constructed in your note book. Are the triangles congruent? Write your answer using mathematical notation.

**Exercise - 1**

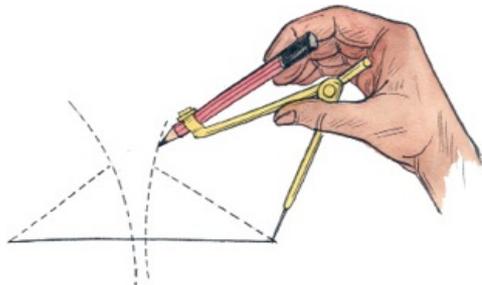
1. Construct  $\triangle ABC$  in which  $AB = 5.5$  cm,  $BC = 6.5$  cm and  $CA = 7.5$  cm.
2. Construct  $\triangle NIB$  in which  $NI = 5.6$  cm,  $IB = 6$  cm and  $BN = 6$  cm. What type of triangle is this?
3. Construct an equilateral  $\triangle APE$  with side 6.5 cm.
4. Construct a  $\triangle XYZ$  in which  $XY = 6$  cm,  $YZ = 8$  cm and  $ZX = 10$  cm. Using protractor find the angle at X. What type of triangle is this?
5. Construct  $\triangle ABC$  in which  $AB = 4$  cm,  $BC = 7$  cm and  $CA = 3$  cm. Which type of triangle is this?
6. Construct  $\triangle PEN$  with  $PE = 4$  cm,  $EN = 5$  cm and  $NP = 3$  cm. If you draw circles instead of arcs how many points of intersection do you get? How many triangles with given measurements are possible? Is this true in case of every triangle?

**Try This**

Sushanth prepared a problem: Construct  $\triangle XYZ$  in which  $XY = 2$  cm,  $YZ = 8$  cm and  $XZ = 4$  cm. He also drew the rough sketch as shown in Figure 1.



Reading the problem, Srija told Sushanth that it would not be possible to draw a triangle with the given measurements. However, Sushanth started to draw the diagram as shown in Figure 2.

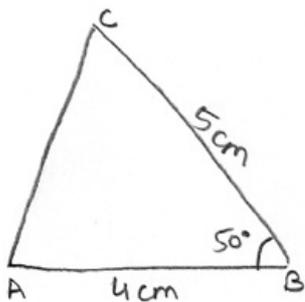


Check whether Sushanth can draw the triangle. If not why? Discuss with your friends. What property of triangles supports Srija's idea?

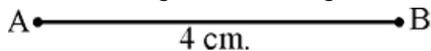
### 9.2 Construction of a triangle with two given sides and the included angle

**Example 2 :** Construct  $\triangle ABC$  in which  $AB = 4$  cm,  $BC = 5$  cm and  $\angle B = 50^\circ$ .

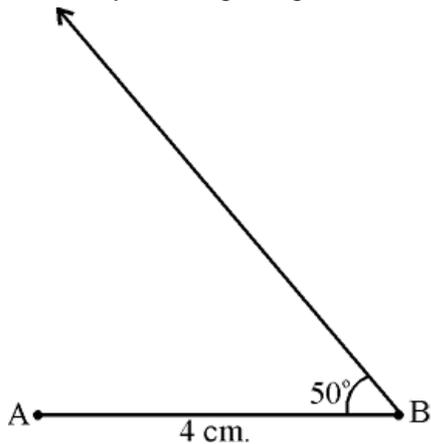
**STEP 1 :** Draw a rough sketch of a triangle and label it with the given measurements.



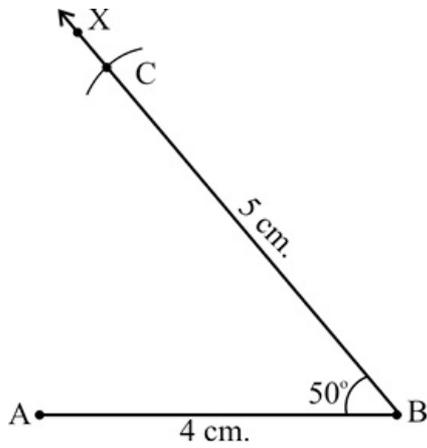
**STEP 2 :** Draw a line segment  $AB$  of length 4 cm.



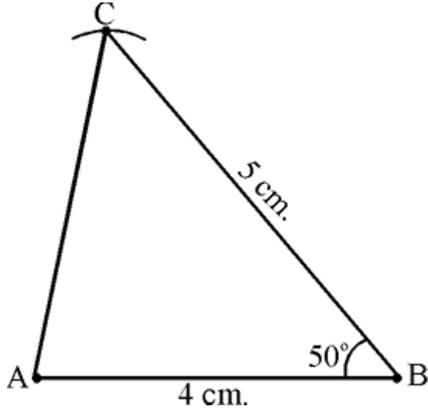
**STEP 3 :** Draw a ray  $\overrightarrow{BX}$  making an angle  $50^\circ$  with  $AB$ .



**STEP 4 :** Draw an arc of radius 5 cm from B, which cuts  $\overrightarrow{BX}$  at C.



**STEP 5 :** Join C, A to get the required  $\triangle ABC$ .



**Exercise - 2**

1. Draw  $\triangle CAR$  in which  $CA = 8$  cm,  $\angle A = 60^\circ$  and  $AR = 8$  cm. Measure  $CR$ ,  $\angle R$  and  $\angle C$ . What kind of triangle is this?
2. Construct  $\triangle ABC$  in which  $AB = 5$  cm,  $\angle B = 45^\circ$  and  $BC = 6$  cm.
3. Construct  $\triangle PQR$  such that  $\angle R = 100^\circ$ ,  $QR = RP = 5.4$  cm.
4. Construct  $\triangle TEN$  such that  $TE = 3$  cm,  $\angle E = 90^\circ$  and  $NE = 4$  cm.

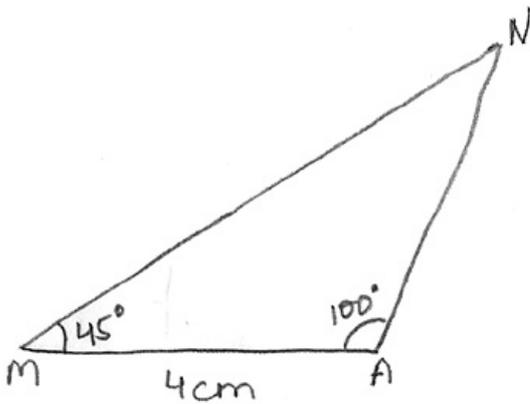
**Try This**

Take two sides and an angle of your choice. Construct a triangle. Is it possible to construct two triangles as said above?

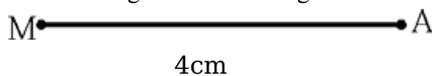
**9.3 Construction of a triangle when two angles and the side between the angles is given**

**Example 3 :** Construct  $\triangle MAN$  with  $MA = 4$  cm,  $\angle M = 45^\circ$  and  $\angle A = 100^\circ$ .

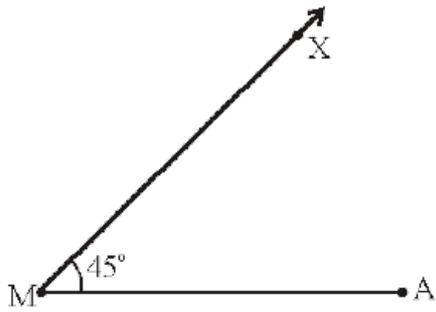
**STEP 1 :** Draw rough sketch of a triangle and label it with the given measurements.



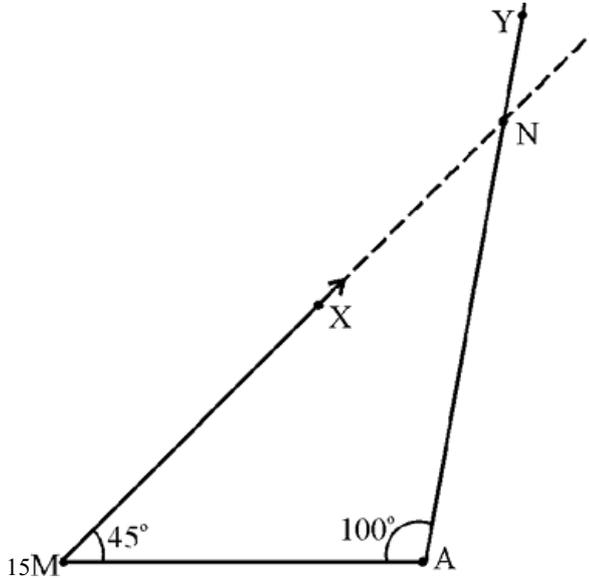
**STEP 2 :** Draw line segment MA of length 4 cm.



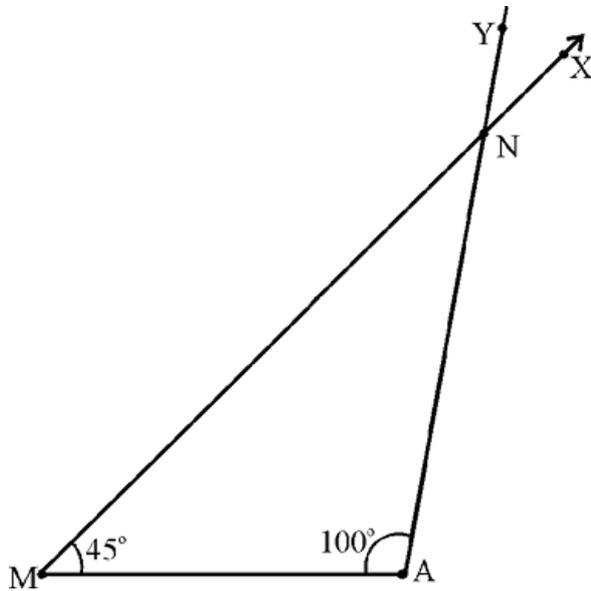
**STEP 3 :** Draw a ray  $\overline{MX}$ , making an angle  $45^\circ$  at M.



**STEP 4 :** Draw a ray  $\overline{AY}$ , making an angle  $100^\circ$  at A.  
 Extend the ray  $\overline{MX}$  if necessary to intersect ray  $\overline{AY}$ .



**STEP 5 :** Mark the intersecting point of the two rays as N. You have the required  $\triangle MAN$



**Try This**

Construct a triangle with angles  $105^\circ$  and  $95^\circ$  and a side of length of your choice. Could you construct the triangle? Discuss and justify.

**Exercise - 3**

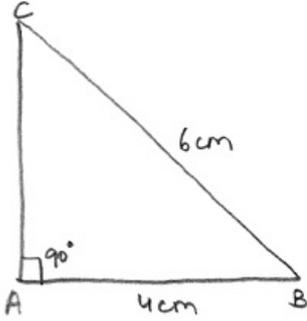
1. Construct  $\triangle NET$  with measurement  $NE = 6.4$  cm,  $\angle N = 50^\circ$  and  $\angle E = 100^\circ$ .
2. Construct  $\triangle PQR$  such that  $QR = 6$  cm,  $\angle Q = \angle R = 60^\circ$ . Measure the other two sides of the triangle and name the triangle.
3. Construct  $\triangle RUN$  in which  $RN = 5$ cm,  $\angle R = \angle N = 45^\circ$ . Measure the other angle and other sides. Name the triangle.

**9.4 Construction of right-angled triangle when the hypotenuse and a side are given.**

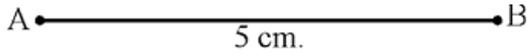
**Example 4 :** Construct  $\triangle ABC$ , right-angled at A, and  $BC = 6$  cm;  $AB = 5$  cm.

**STEP 1 :** Draw a rough sketch of right-angled triangle and label it with given information.

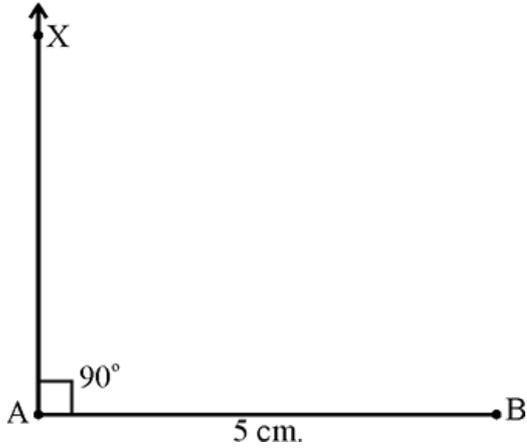
Note: side opposite to the right angle is called hypotenuse.



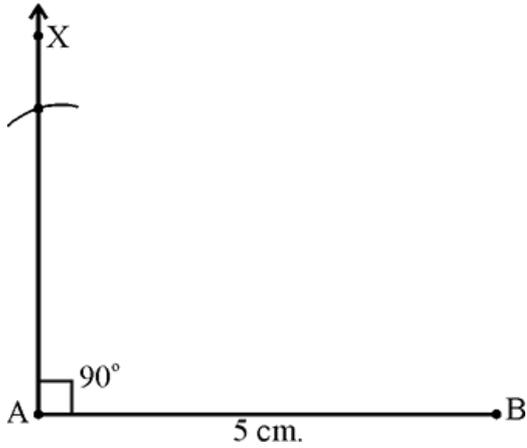
**STEP 2 :** Draw a line segment  $AB$  of length  $5$  cm.



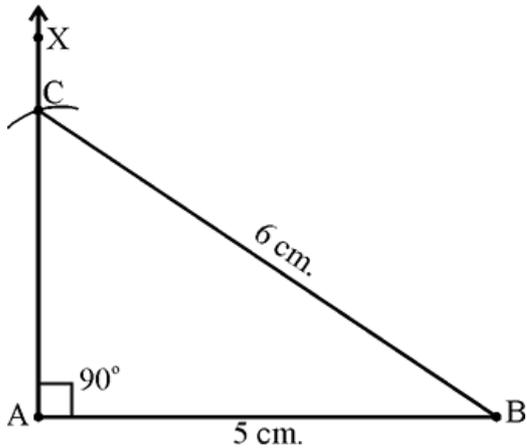
**STEP 3 :** Construct a ray  $\overline{AX}$  perpendicular to  $AB$  at  $A$ .



**STEP 4 :** Draw an arc from  $B$  with radius  $6$  cm to intersect  $\overline{AX}$  at ' $C$ '.



**STEP 5 :** Join  $B, C$  to get the required  $\triangle ABC$ .



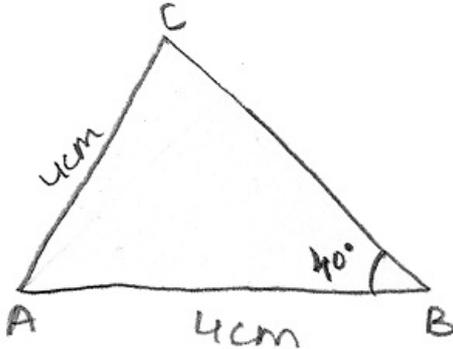
#### Exercise - 4

1. Construct a right-angled  $\triangle ABC$  such that  $\angle B = 90^\circ$ ,  $AB = 8$  cm and  $AC = 10$  cm.
2. Construct a  $\triangle PQR$ , right-angled at  $R$ , hypotenuse is 5 cm and one of its adjacent sides is 4 cm.
3. Construct an isosceles right-angled  $\triangle XYZ$  in which  $\angle Y = 90^\circ$  and the two sides are 5 cm each.

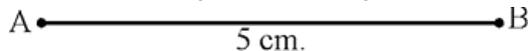
#### 9.5 Construction of triangle when two sides and the non-included angle are given

**Example 5 :** Construct  $\triangle ABC$  such that  $AB = 5$  cm,  $AC = 4$  cm,  $\angle B = 40^\circ$ .

**STEP 1 :** Draw rough sketch of  $\triangle ABC$  and label it with the given measurements.



**STEP 2 :** Draw a line segment  $AB$  of length 5 cm.



**STEP 3 :** Draw a ray  $\overline{BX}$  making an angle  $40^\circ$  at  $B$ .

**STEP 4 :** With  $A$  as centre and radius 4 cm, draw an arc to cut ray  $\overline{BX}$ .

**STEP 5 :** Mark the intersecting point as  $C$  and join  $C, A$  to get the required  $\triangle ABC$ .

Can you cut the ray  $\overline{BX}$  at any other point?

You will see that as  $\angle B$  is acute, the arc from  $A$  of radius 4 cm cuts the ray  $\overline{BX}$  twice.

Name the intersecting points as  $C, C'$ . One triangle is formed by joining the points  $C, A$ .

Another triangle is formed by joining the points  $C', A$ .

So we may have two triangles as given below:

#### Try This

Construct a triangle with two sides of length of your choice and the non-included angle as an obtuse angle. Can you draw two triangles in this solution?

#### Exercise - 5

1. Construct  $\triangle ABC$  in which  $AB = 4.5$  cm,  $AC = 4.5$  cm and  $\angle B = 50^\circ$ . Check whether you get two triangles.
2. Construct  $\triangle XYZ$  such that  $XY = 4.5$  cm,  $XZ = 3.5$  cm and  $\angle Y = 70^\circ$ . Check whether you get two triangles.
3. Construct  $\triangle ANR$  with the sides  $AN$  and  $AR$  of lengths 5 cm and 6 cm respectively and  $\angle N$  is  $100^\circ$ . Check whether you get two triangles.
4. Construct  $\triangle PQR$  in which  $QR = 5.5$  cm,  $QP = 5.5$  cm and  $\angle Q = 60^\circ$ . Measure  $RP$ . What kind of triangle is this?
5. Construct the triangles with the measurement given in the following table.

Triangle Measurements

$\triangle ABC$   $BC = 6.5$  cm,  $CA = 6.3$  cm,  $AB = 4.8$  cm.

$\triangle PQR$   $PQ = 8$  cm,  $QR = 7.5$  cm,  $\angle PQR = 85^\circ$

$\triangle XYZ$   $XY = 6.2$  cm,  $\angle Y = 130^\circ$ ,  $\angle Z = 70^\circ$

$\triangle ABC$   $AB = 4.8$  cm,  $AC = 4.8$  cm,  $\angle B = 35^\circ$

$\triangle MNP$   $\angle N = 90^\circ$ ,  $MP = 11.4$  cm.,  $MN = 7.3$  cm.

$\triangle RKS$   $RK = KS = SR = 6.6$  cm.

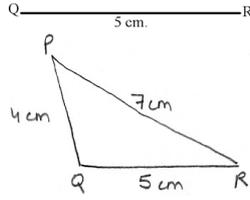
$\triangle PTR$   $\angle P = 65^\circ$ ,  $PT = PR = 5.7$  cm.

#### Looking Back

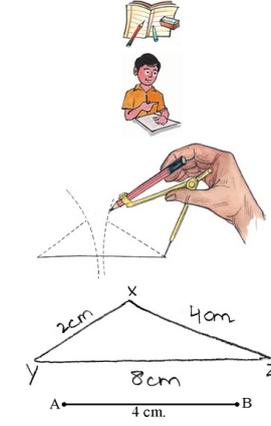
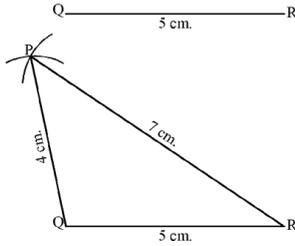
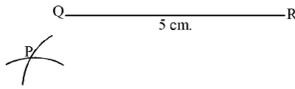
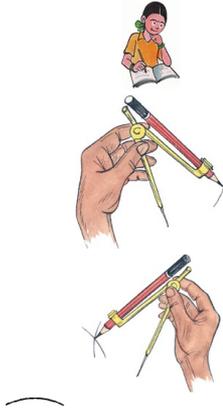
- A triangle can be constructed when.
  - (i) The three sides of the triangle are given.
  - (ii) Two sides and the angle included between them is given.
  - (iii) Two angles and their included side is given.

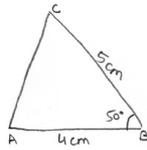
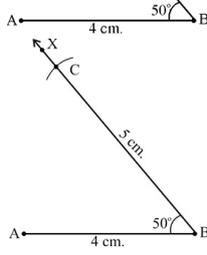
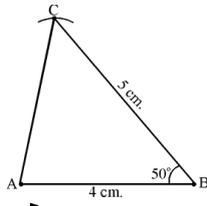
- (iv) The hypotenuse and one adjacent side of a right angle triangle are given.
- (v) Two sides and the not included angle are given.

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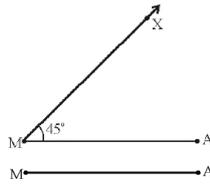
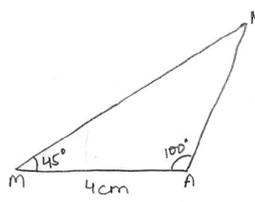


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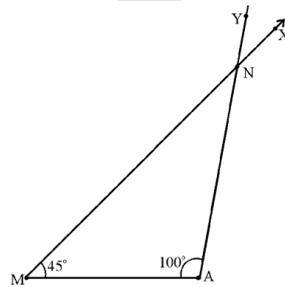


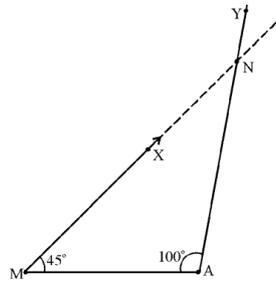
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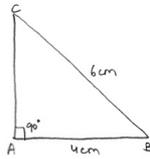
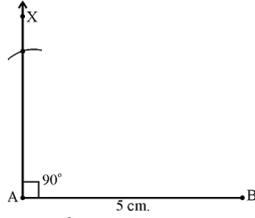
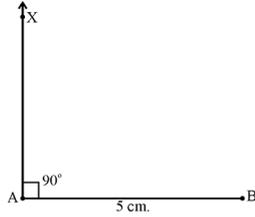
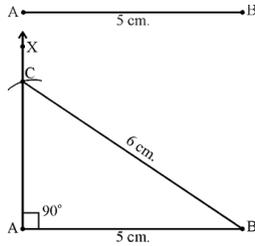
4 cm.

4 cm.





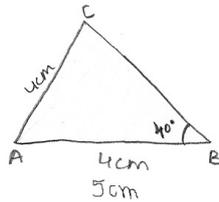
4 cm  
4 cm



5cm



X  
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40°  
B  
A  
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B



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