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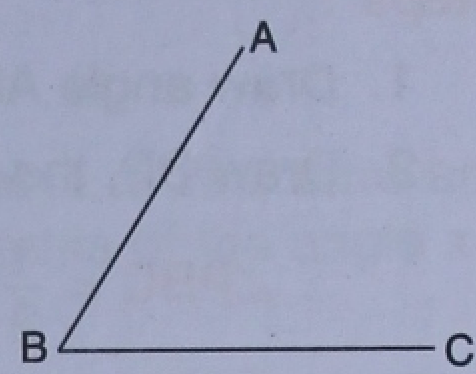
CHAPTER 28

CONSTRUCTIONS

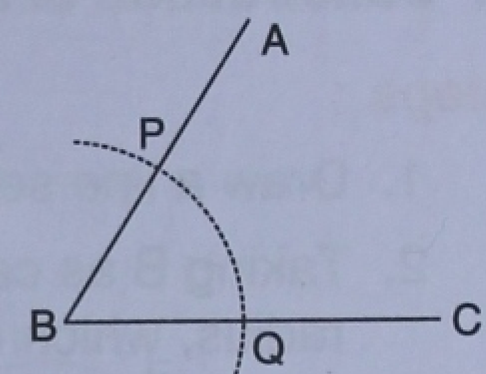
(Using ruler and compasses only)

28.1 CONSTRUCTION OF AN ANGLE



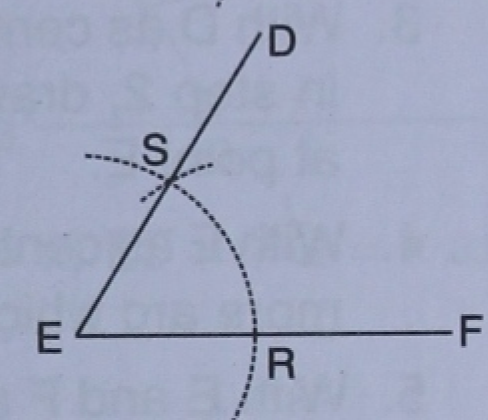
1. To construct an angle equal to given angle.

Let the given angle be ∠ABC as shown alongside and we have to construct another angle (say, ∠DEF) equal to ∠ABC.



Steps :

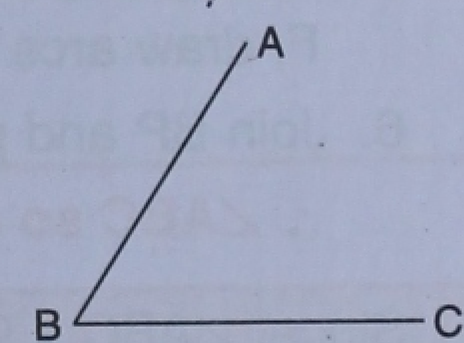
1. Draw a line segment EF of any suitable size.
2. With B as centre, draw an arc of any suitable radius which cuts AB at point P and BC at point Q.
3. With E as centre and the same radius as taken in step 2, draw an arc which cuts EF at point R.
4. With R as centre and radius equal to PQ, draw an arc which cuts the previous arc at point S.
5. Join E and S, and produce upto point D.



∠DEF so obtained is equal to ∠ABC.

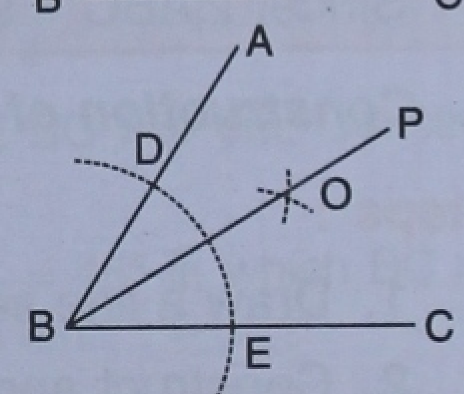
2. To draw the bisector of a given angle.

Let the given angle be ∠ABC whose bisector is to be drawn.



Steps :

1. With B as centre, draw an arc of any suitable radius which cuts AB at point D and BC at point E.
2. Taking D and E as centres, draw arcs of equal radii and let these arcs cut each other at point O.



The radii of these arcs must be more than half the distance between points D and E.

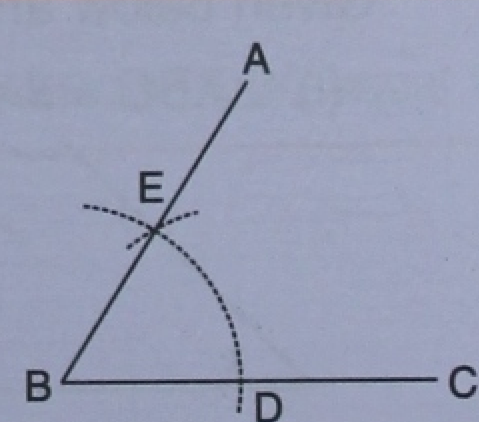
3. Join BO and produce upto point P.

∴ **BP is the required bisector of ∠ABC.**

Thus, $\angle ABP = \angle PBC = \frac{1}{2}\angle ABC$.

3. Construction of angles of 60°, 30°, 90° and 45°.

1. Construction of angle of 60° :



Steps :

1. Draw a line segment BC of any suitable length.
2. With B as centre, draw an arc of any suitable radius which cuts BC at point D.

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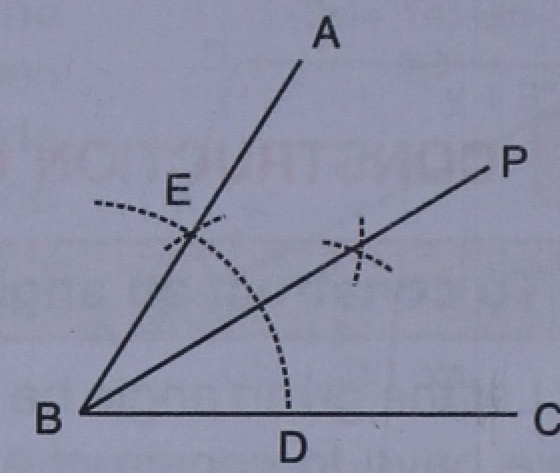
3. With D as centre and the same radius as taken in step 2, draw one more arc which cuts the previous arc at point E.
4. Join BE and produce upto any point A.

   ∴ **$\angle ABC$ so obtained is of 60° *i.e.* $\angle ABC = 60°$.**

2. *Construction of angle of 30° :*

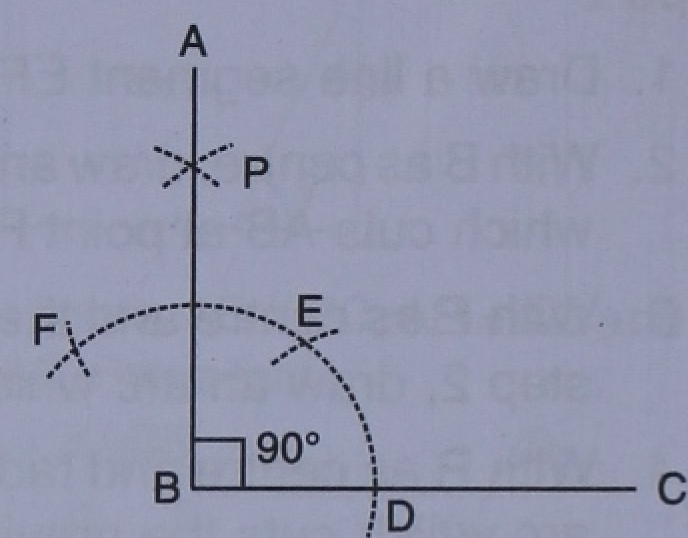


Steps :

1. Draw angle ABC = 60°.
2. Draw BP, the bisector of $\angle ABC$.

   $\therefore \angle PBC = \frac{1}{2}\angle ABC = \frac{1}{2} \times 60° = 30°$

3. *Construction of angle of 90° :*



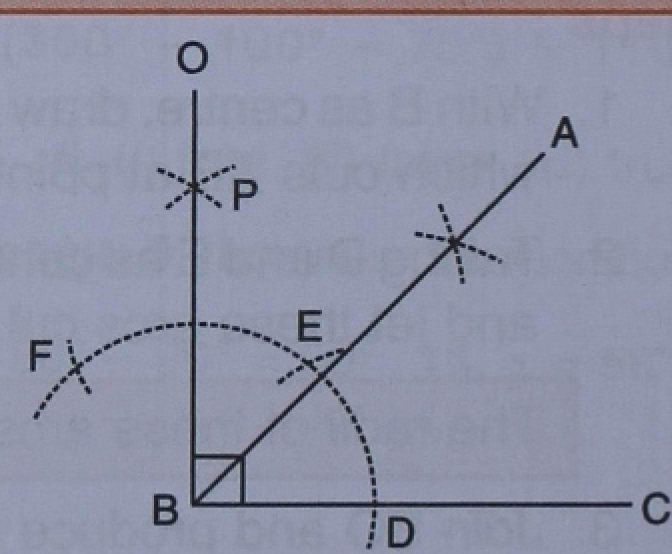
Steps :

1. Draw a line segment BC of any suitable length.
2. Taking B as centre, draw an arc of any suitable radius, which cuts BC at point D.
3. With D as centre and the same radius, as taken in step 2, draw an arc which cuts previous arc at point E.
4. With E as centre and the same radius, draw one more arc which cuts the first arc at point F.
5. With E and F as centres and radii equal to more than half the distance between E and F, draw arcs which cut each other at point P.
6. Join BP and produce upto any point A.

   ∴ **$\angle ABC$ so obtained is of 90° *i.e.* $\angle ABC = 90°$.**

Since, $\angle ABC = 90° \Rightarrow$ AB and BC are perpendicular to each other.

4. *Construction of angle of 45° :*



Steps :

1. Draw a line segment BC of any suitable length.
2. Construct angle OBC = 90°.
3. Draw BA, the bisector of angle OBC.

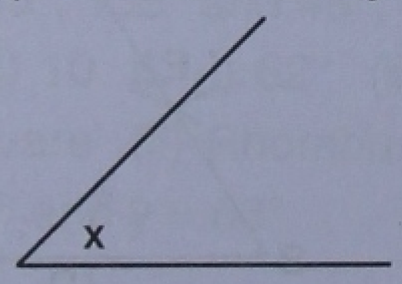
   ∴ **$\angle ABC$ so obtained is the angle of 45°.**

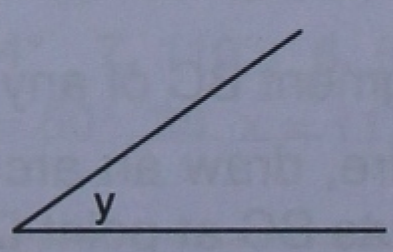
Since, BA is bisector of angle OBC, $\angle ABC = \angle ABO = \frac{90°}{2} = 45°$.

Example 1 :

Given below are the two angles x and y. Construct an angle ABC such that :

(i) $\angle ABC = x + y$ (ii) $\angle ABC = 2x + y$





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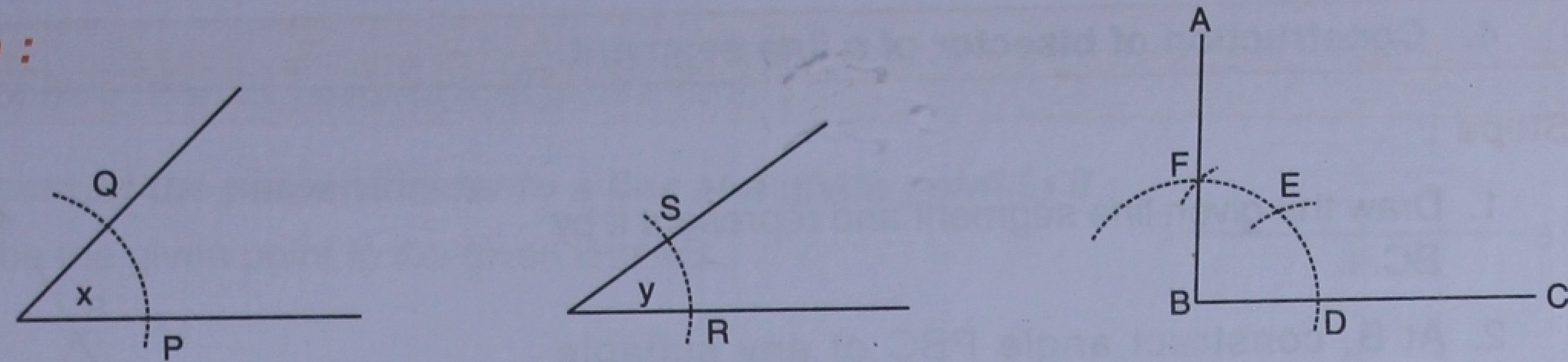
Solution :

(i)



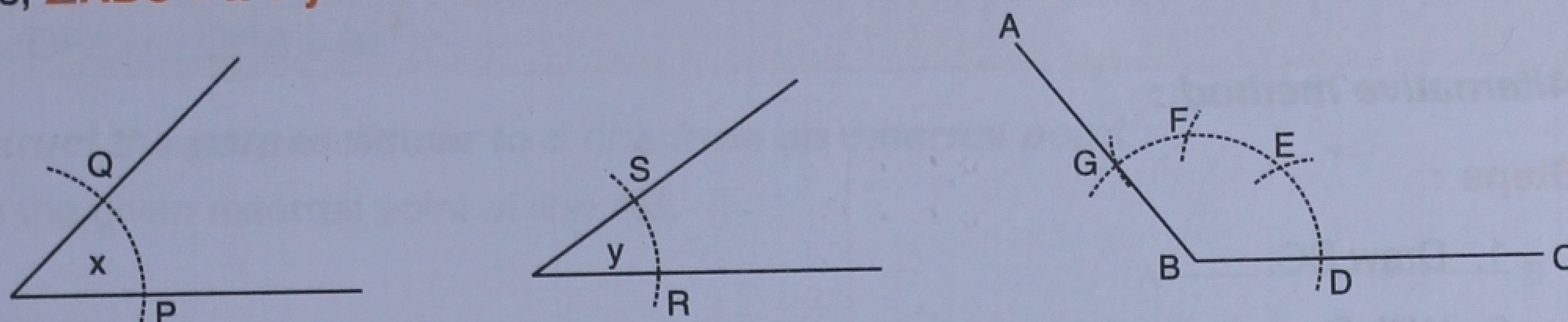
Steps :

As shown above :

1. Draw line segment BC of any suitable length.
2. With B as centre, draw an arc of any suitable radius. With the same radius, draw arcs with the vertices of given angles as centres. Let these arcs cut arms of the angle *x* at points P and Q, and arms of the angle *y* at points R and S.
3. From the arc, with centre B, cut DE = PQ = x and EF = SR = y.
4. Join BF and produce upto point A.

   Thus, **∠ABC = x + y**

(ii)

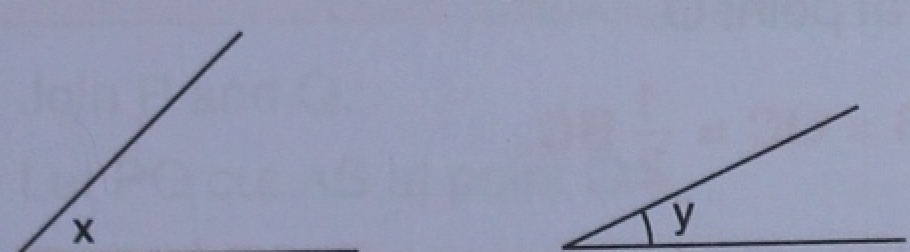


Proceed in exactly the same way as in part (i) taking DE = PQ = x, EF = PQ = x and FG = RS = y.

Thus, **∠ABC** = x + x + y = **2x + y**

EXERCISE 28 (A)

1. Given below are the angles *x* and *y*.



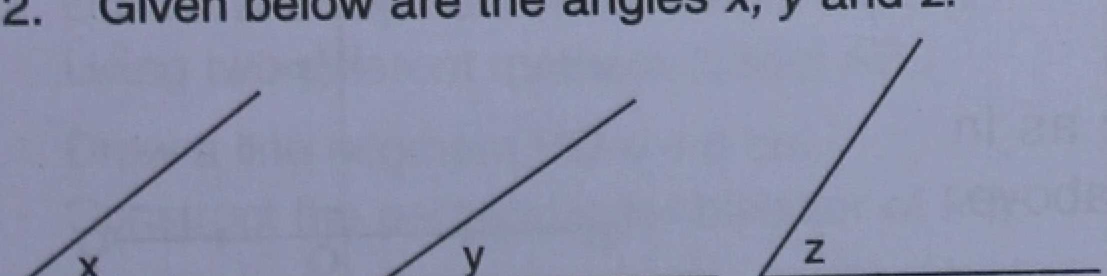
Without measuring these angles, construct :

(i) ∠ABC = x + y

(ii) ∠ABC = 2x + y

(iii) ∠ABC = x + 2y

2. Given below are the angles *x*, *y* and *z*.



Without measuring these angles construct :

(i) ∠ABC = x + y + z

(ii) ∠ABC = 2x + y + z

(iii) ∠ABC = x + 2y + z

3. Draw a line segment BC = 4 cm. Construct angle ABC = 60°.
4. Construct angle ABC = 45° in which BC = 5 cm and AB = 4·6 cm.
5. Construct angle ABC = 90°. Draw BP, the bisector of angle ABC. State, the measure of angle PBC.
6. Draw angle ABC of any suitable measure.

   (i) Draw BP, the bisector of angle ABC.

   (ii) Draw BR, the bisector of angle PBC and draw BQ, the bisector of angle ABP.

   (iii) Are the angles ABQ, QBP, PBR and RBC equal ?

   (iv) Are the angles ABR and QBC equal ?

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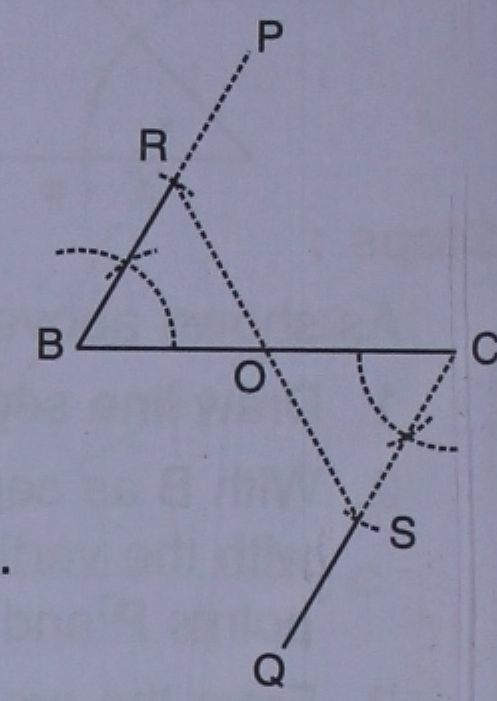
4. Construction of bisector of a line segment.

Steps :



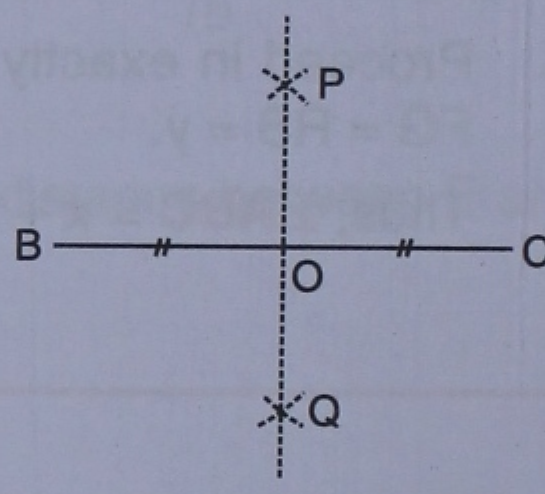
1. Draw the given line segment and represent it by BC.
2. At B, construct angle PBC of any suitable measure and at C, construct angle QCB equal to angle PBC.

   i.e. $\angle PBC = \angle QCB$.
3. From BP, cut BR of any suitable length and from CQ, cut CS = BR.
4. Join R and S.
5. Let RS cut the given line segment BC at point O.

   Thus, **RS is a bisector of BC** such that **$OB = OC = \frac{1}{2}BC$.**

Alternative method :

Steps :

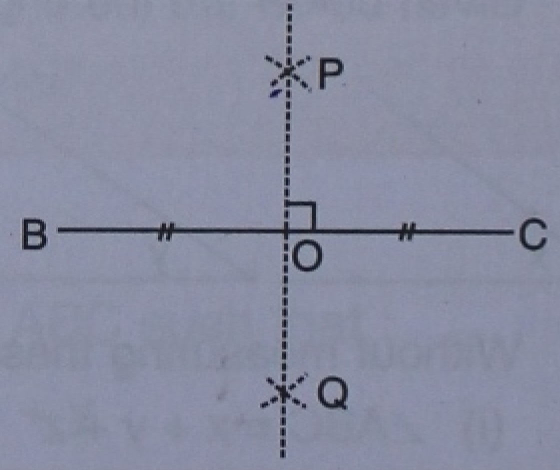


1. Draw BC.
2. With B as centre, and radius equal to more than half of BC, draw arcs on both the sides of BC.
3. With C as centre and with the same radius as taken in step 2, draw arcs on both the sides of BC.
4. Let the arcs intersect each other at points P and Q.
5. Join P and Q.
6. The line PQ cuts the given line segment BC at point O.

   Thus, **PQ is a bisector of BC** such that **$OB = OC = \frac{1}{2}BC$.**

5. Construction of perpendicular bisector of a line segment.

Steps :



1. Draw the given line segment and represent it by BC.
2. Now proceed in exactly the same way as in alternative method of construction 4, given above.

   In this construction, the line PQ bisects the given line segment BC and is perpendicular to it.

   i.e. OB = OC and $\angle POC = 90°$.

   Hence, **PQ is perpendicular bisector of BC.**

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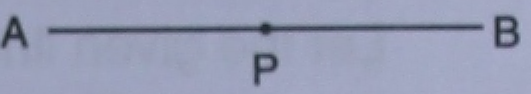
6. Construction of perpendicular to a line.

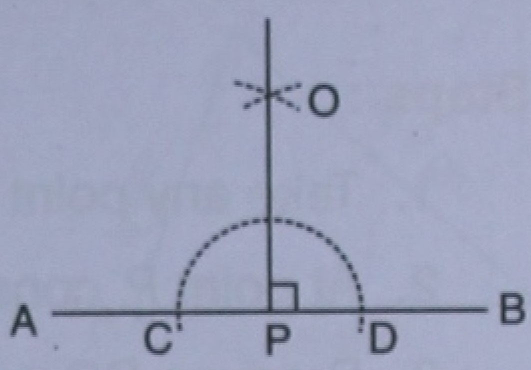
1. *To construct the perpendicular to a line at a given point in it :*

Let P be the given point in the given line AB.



Steps :

1. With P as centre, draw an arc with a suitable radius which cuts AB at points C and D.
2. Taking C and D as centres, draw arcs of equal radii which cut each other at point O.



The radius must be more than half the distance between C and D.

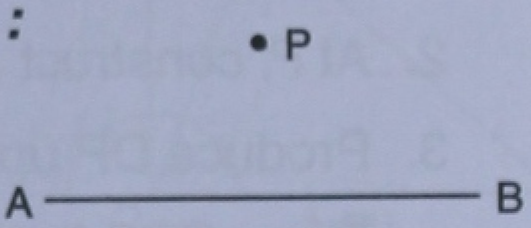
3. Join P and O

   Then, **OP is the required perpendicular.**

So, $\angle OPA = \angle OPB = 90°$

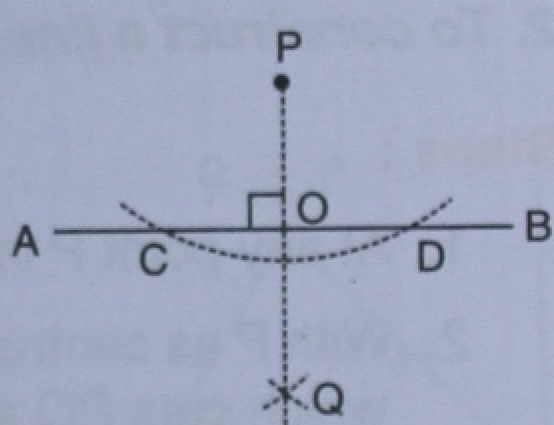
2. *To construct the perpendicular to a line from an external point :*

Let P be the given external point of line AB.



Steps :

1. With P as centre, draw an arc of a suitable radius which cuts AB as points C and D.
2. With C and D as centres, draw arcs of equal radii and let these arcs intersect each other at point Q.



The radius of these arcs must be more than half of CD and both the arcs must be drawn on the other side.

3. Join P and Q.
4. Let PQ cut AB at point O.

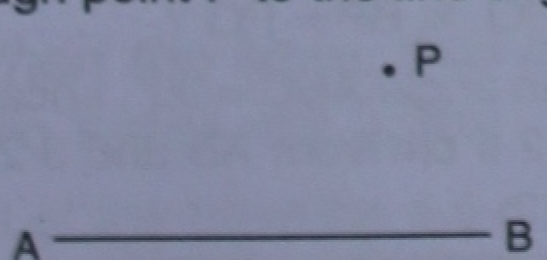
   Thus, **OP is the required perpendicular.**

Clearly, $\angle AOP = \angle BOP = 90°$

EXERCISE 28 (B)

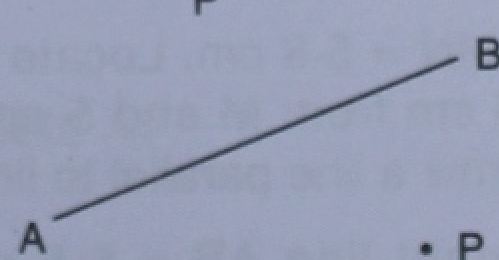
1. Draw a line segment AB of length 5·3 cm. Using two different methods bisect AB.
2. Draw a line segment PQ = 4·8 cm. Construct the perpendicular bisector of PQ.
3. In each of the following, draw a perpendicular through point P to the line segment AB :

   (i)



   (ii)

   (iii)



4. Draw a line segment AB = 5·5 cm. Mark a point P, such that PA = 6 cm and PB = 4·8 cm. From the point P, draw a perpendicular to AB.
5. Draw a line segment AB = 6·2 cm. Mark a point P in AB such that BP = 4 cm. Through point P draw a perpendicular to AB.

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7. Constructions of Parallel Lines.

1. *To construct a line parallel to a given line and passing through a given point :*

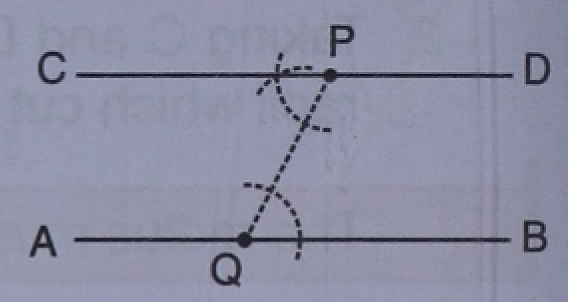
Let the given line be AB and the given point be P.

First Method : (*By drawing alternate angles*)

Steps :

1. Take any point Q in line AB and join it with the given point P.
2. At point P, construct ∠CPQ = ∠PQB.
3. Produce CP upto any point D.

   Thus, **CPD is the required parallel line.**

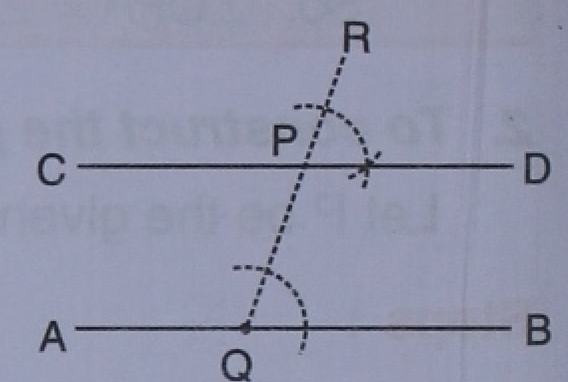


Alternative method : (By drawing corresponding angles)

Steps :

1. Join QP and produce it to any point R.
2. At P, construct ∠RPD = ∠PQB.
3. Produce DP upto any point C.

   Thus, **CPD is the required parallel line.**

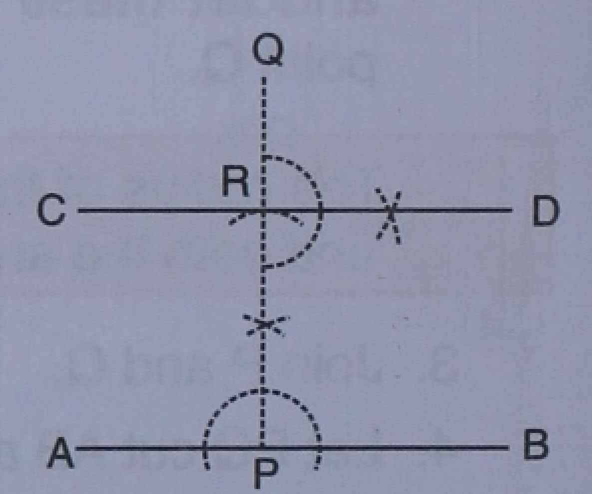


2. *To construct a line parallel to a given line at a given distance from it :*

Steps :

1. At any point P in line AB, draw PQ perpendicular to AB.
2. With P as centre and radius equal to 3·6 cm, draw an arc which cuts PQ at point R.
3. At point R, draw RD perpendicular to PQ.
4. Produce DR upto any point C.

   Then, **CD is the required parallel line.**



EXERCISE 28 (C)

1. Draw a line AB = 6 cm. Mark a point P any where outside the line AB. Through the point P, construct a line parallel to AB.
2. Draw a line MN = 5·8 cm. Locate a point A which is 4·5 cm from M and 5 cm from N. Through A draw a line parallel to line MN.
3. Draw a straight line AB = 6·5 cm. Draw another line which is parallel to AB at a distance of 2·8 cm from it.
4. Construct an angle PQR = 80°. Draw a line parallel to PQ at a distane of 3 cm from it and another line parallel to QR at a distance of 3·5 cm from it. Mark the point of intersection of these parallel lines as A.
5. Draw an angle ABC = 60°. Draw the bisector of it. Also draw a line parallel to BC a distance of 2·5 cm from it.

   Let this parallel line meet AB at point P and angle bisectors at point Q. Measure the length of BP and PQ. Is BP = PQ ?
6. Construct an angle ABC = 90°. Locate a point P which is 2·5 cm from AB and 3·2 cm from BC.

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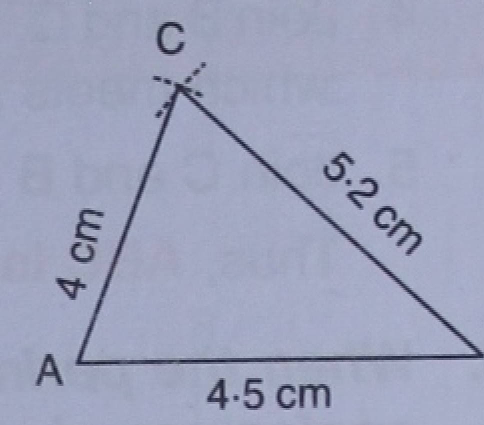
8. Construction of Scalene Triangles.

1. When lengths of its three sides are given :

Let the lengths of three sides be 4·5 cm, 4 cm and 5·2 cm.

Steps :



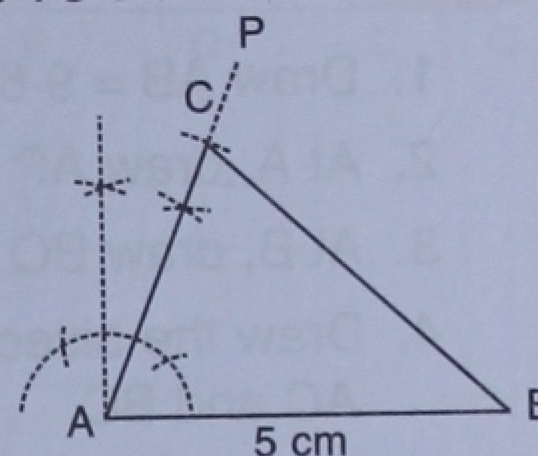
1. Draw AB = 4·5 cm.
2. With A as centre and radius = 4 cm, draw an arc.
3. With B as centre and radius = 5·2 cm, draw one more arc which cuts the former arc at point C.
4. Join AC and BC.

Thus, **ABC is the required triangle.**

2. When lengths of two sides and the included angle are given :

Let the two sides be 5 cm and 4·2 cm, and the included angle be 75°.

Steps :



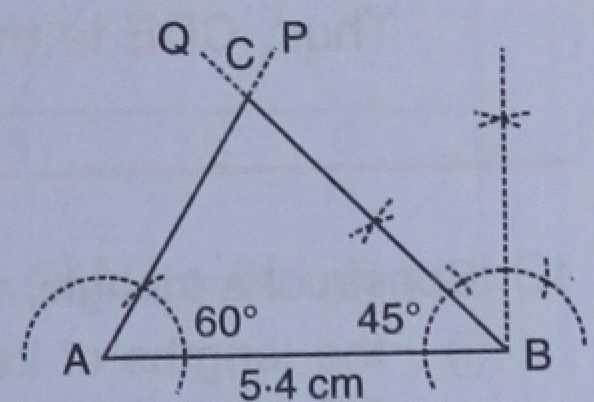
1. Draw AB = 5 cm.
2. At A, draw line AP, so that angle ∠PAB = 75°.
3. From AP, cut AC = 4·2 cm and then join B and C.

Thus, **ABC is the required triangle.**

3. When two angles and the included side are given :

Let the two angles be 60° and 45°, and the included side be 5·4 cm.

Steps :



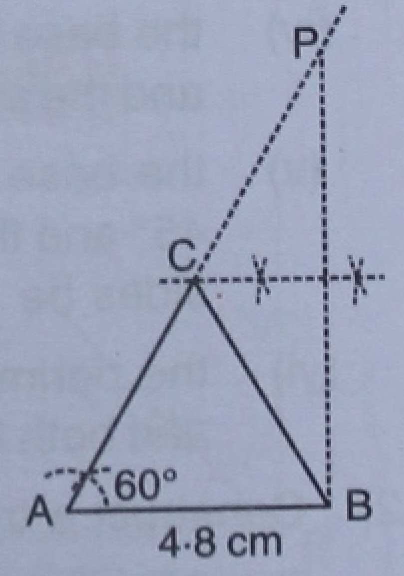
1. Draw AB = 5·4 cm.
2. At A, draw AP so that ∠PAB = 60°.
3. At B, draw BQ so that ∠QBA = 45°.
4. Let AP and BQ intersect at point C.

Thus, **ABC is the required triangle.**

4. When the base, one base angle and the sum of lengths of other two sides are given :

Let the base be 4·8 cm, one base angle be 60° and the sum of other two sides be 9·2 cm.

Steps :



1. Draw AB = 4·8 cm.
2. At A, draw AP = 9·2 cm such that ∠PAB = 60°.
3. Join P and B.
4. Draw the perpendicular bisector of BP which meets AP at point C. Join C and B.

Thus, **ABC is the required triangle.**

5. When the base, one base angle and the difference between the lengths of other two sides are given :

Let the base be 4·5 cm, one base angle be 30° and the difference between the lengths of other two sides be 1·2 cm.

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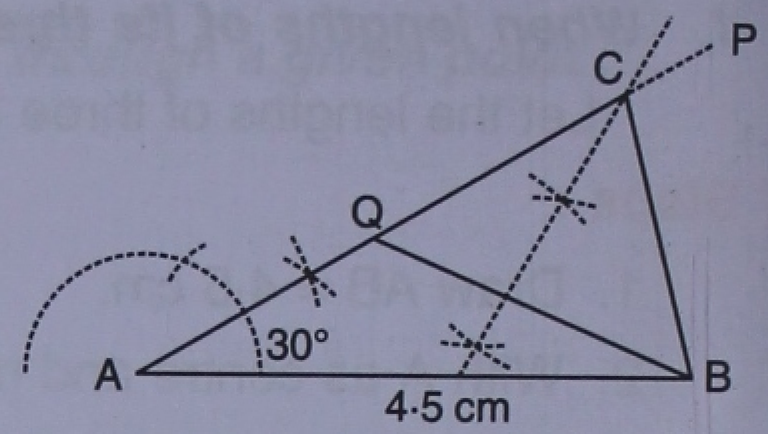
Steps :

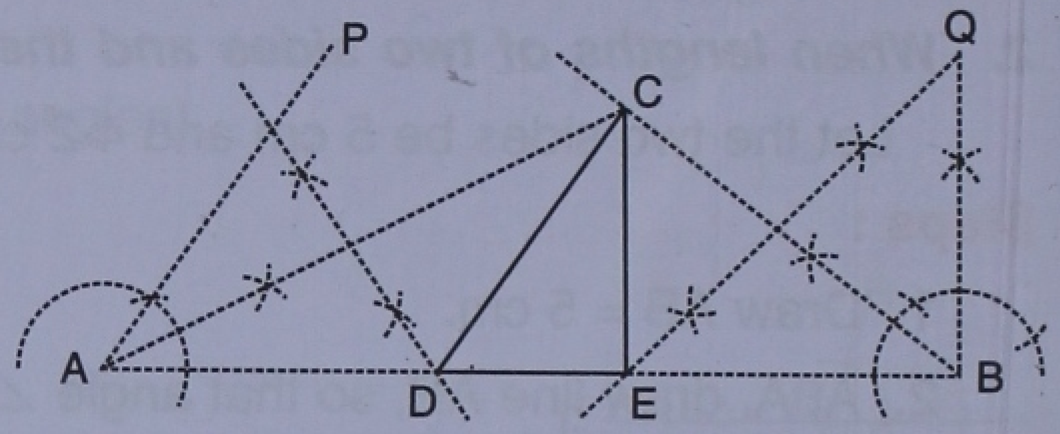
1. Draw AB = 4·5 cm.
2. At A, draw AP such that ∠PAB = 30°.
3. From AP, cut AQ = 1·2 cm.
4. Join B and Q, and draw the perpendicular bisector of BQ which meets AP at point C.
5. Join C and B

   Thus, **ABC is the required triangle.**



6. *When the perimeter* (the sum of lengths of all the three sides) ***and both the base angles are given :***

Let the perimeter be 9·6 cm and both the base angles be 60° and 90°.



Steps :

1. Draw AB = 9·6 cm.
2. At A, draw AP so that ∠PAB = 60°.
3. At B, draw BQ so that ∠ABQ = 90°.
4. Draw the bisectors of angles PAB and ABQ. Let these bisectors meet at point C. Join AC and BC.
5. Draw the perpendicular bisector of AC which meets AB at point D. Also, draw the perpendicular bisector of BC which meets AB at point E.
6. Join DC and EC.

   Thus, **CDE is the required triangle.**

EXERCISE 28(D)

1. Construct a triangle, when :
   (i) the lengths of its three sides be 6 cm, 5·2 cm and 4·6 cm.
   (ii) the lengths of two sides be 6·3 cm and 4 cm, and the included angle be 45°.
   (iii) two angles be 75° and 60°; and the included side be 5 cm.
   (iv) the base be 4 cm, one base angle be 60° and the sum of other two sides be 8·4 cm.
   (v) the base be 5·1 cm, one base angle be 45° and the difference between other two sides be 1·5 cm.
   (vi) the perimeter of the triangle be 10·8 cm and both the base angles be 60° and 75°.
2. Construct a triangle ABC, when :
   (i) AB = 6·3 cm, BC = 7·5 cm and CA = 6 cm.
   (ii) BC = 6 cm, CA = 4·8 cm and ∠C = 60°.
   (iii) CA = 5·5 cm, ∠C =45° and ∠A = 75°.
   (iv) BC = 5·7 cm, ∠B = 45° and AB + AC = 8·2 cm.
   (v) AB = 5·0 cm, ∠A = 60° and AC – BC = 1·5 cm.
   (vi) AB + BC + CA = 11·6 cm, ∠A = 60° and ∠B = 45°.
3. Construct a Δ ABC with AB = 6·3 cm, ∠B = 60° and AC + BC = 10·0 cm. Measure the length of AC.
4. Construct a triangle ABC with AB = 7 cm, BC = 6·5 cm and ∠CAB = 60°. Measure the length of AC.
5. Using ruler and compasses only, construct a triangle ABC, having AB = 4·7 cm, AC = 3·4 cm and ∠BAC = 75°.
   Draw the perpendicular bisector of BC and the bisector of angle BAC. If the perpendicular bisector and the angle bisector meet at a point M, measure ∠BMC.
6. Using ruler and compasses only, construct a triangle ABC having ∠C = 135° and ∠B = 30°, BC = 5 cm. Bisect angles B and C and measure the distance of A from the point where the bisectors meet.

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7. Using ruler and compasses only, construct a triangle ABC from the following data :
AB + BC + AC = 12 cm, ∠B = 45° and ∠C = 60°. Measure BC.

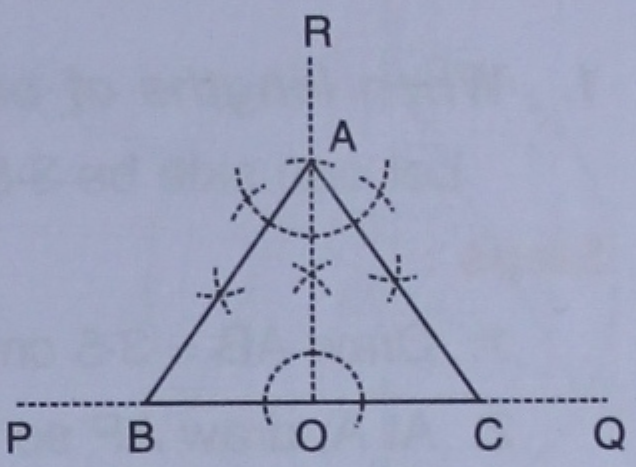
8. Construct a triangle ABC, given : BC = 7 cm, AB – AC = 1 cm and ∠ABC = 45°. Measure the lengths of AB and AC.

9. Construction of Equilateral Triangles.

When altitude is given :

Let the altitude of the required triangle be 3·6 cm.

Steps :

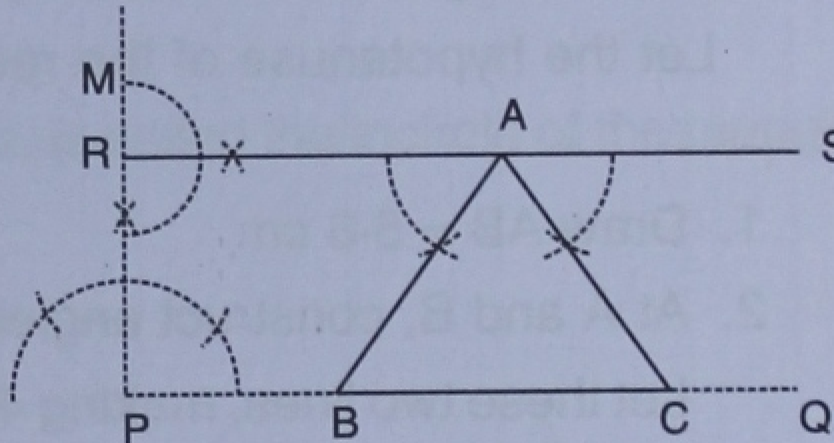


1. Draw a line PQ of any suitable length.
2. In PQ, mark a point O.
3. At O, draw a line OR perpendicular to PQ and from OR cut OA = 3·6 cm.
4. At A, draw AB so that ∠OAB = 30° and AC so that ∠OAC = 30°. B and C being the points on PQ.

Thus, **ABC is the required triangle.**

Alternative method :

Steps :



1. Draw a line PQ of any suitable length.
2. Through point P, draw PM perpendicular to PQ and from PM cut PR = 3·6 cm.
3. Through point R, draw RS perpendicular to PM. Clearly, RS is parallel to PQ at a distance of 3·6 cm from it.
4. Mark a point A in RS.
5. At A, draw a line AB so that ∠RAB = 60° and a line AC so that ∠SAC = 60°. B and C being the points on PQ.

Thus, **ABC is the required triangle.**

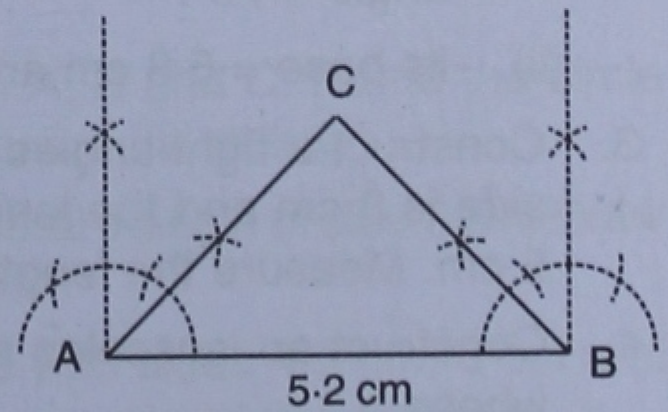
10. Construction of Isosceles Triangles.

1. ***When base and one base angle are given :***

Let the base be 5·2 cm and one base angle be 45°.

Students know that the two base angles of an isosceles triangle are equal.

Steps :



1. Draw AB = 5·2 cm
2. At A and B both, construct angles = 45° each.

Let the two lines making 45° angles meet at C.

Thus, **ABC is the required triangle.**

2. ***When base and altitude*** (height) ***are given :***

Let the base be 5·4 cm and height be 3·0 cm.

Steps :

1. Draw AB = 5·4 cm

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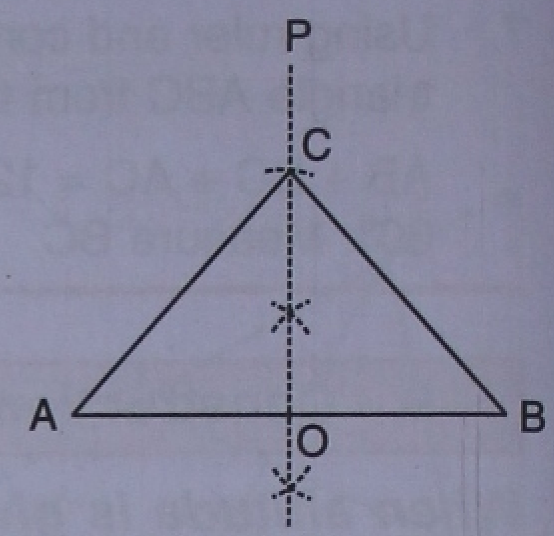
2. Draw OP, the perpendicular bisector of AB, which meets AB at point O.
3. From OP, cut OC = 3·0 cm.
4. Join AC and BC.

   Thus, **ABC is the required triangle.**



11. Construction of right-angled triangles.

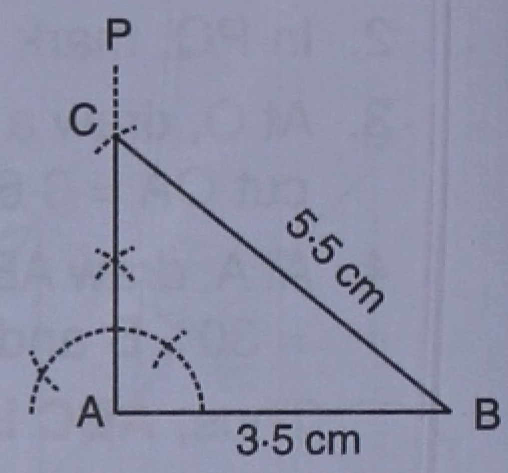
1. *When lengths of one side and hypotenuse are given :*

Let one side be 3·5 cm and hypotenuse be 5·5 cm.

Steps :

1. Draw AB = 3·5 cm
2. At A, draw AP so that AP ⊥ AB *i.e.* ∠PAB = 90°.
3. With B as centre and radius = 5·5 cm, draw an arc which cuts AP at point C. Join C and B.

   Thus, **ABC is the required triangle.**



2. *When triangle is isosceles and its hypotenuse is given :*

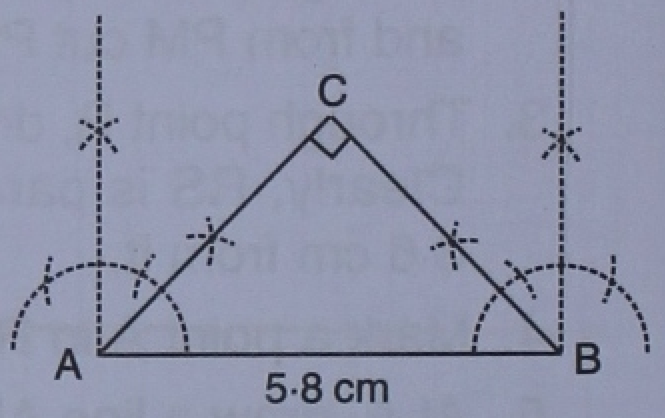
Let the hypotenuse of the required right-angled isoscele triangle be 5·8 cm.

Steps :

1. Draw AB = 5·8 cm
2. At A and B, construct angles of 45° each.

   Let these two lines, making 45° angles with AB, intersect each other at point C.

   Thus, **ABC is the required triangle.**



EXERCISE 28 (E)

1. Construct an equilateral triangle, whose :
   (i) one side is 3·8 cm.
   (ii) altitude is 3 cm.
2. Construct an isosceles triangle, if :
   (i) its base = 4·3 cm and one base angle = 75°.
   (ii) its base = 5·8 cm and altitude = 4 cm.
3. Construct a right-angled triangle, whose one side is 3 cm and the length of hypotenuse is 5 cm. Measure the length of its other side.
4. Construct an isosceles right-angled triangle, whose :
   (i) hypotenuse is = 6 cm.
   (ii) one side is 3·5 cm.
5. Construct a triangle ABC; if :
   (i) AB = BC = CA = 4·2 cm.
   (ii) AB = BC = 4 cm and AC = 4·5 cm.
   (iii) ∠A = 90°, AB = 4 cm and BC = 6 cm.
   (iv) AB = BC = CA and altitude AD = 4·5 cm
6. Construct an isosceles triangle PQR; if :
   (i) base QR = 5·6 cm and base ∠PQR = 75°.
   (ii) base PQ = 6·4 cm and altitude = 4 cm.
7. Construct a right-angled triangle XYZ, if :
   (i) ∠Z = 90°, YZ = 5 cm and XY = 7·2 cm.
   (ii) ∠X = 90°, XY = 3·8 cm and YZ = 6 cm.
   (iii) ∠Y = 90°, XY = YZ and XZ = 6·4 cm.
8. Using ruler and compasses only, draw a triangle ABC, such that AB = AC = 4·8 cm and ∠B = 45°. Measure the length of BC.

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12. Circumcircle and Incircle of a triangle.

1. *Circumcircle of a triangle :*

The circle, which passes through all the three vertices of a triangle, is called circumcircle of the triangle. Its **centre** is called **circumcentre** and **radius** is called **circumradius**.

To construct the circumcircle of a given triangle :

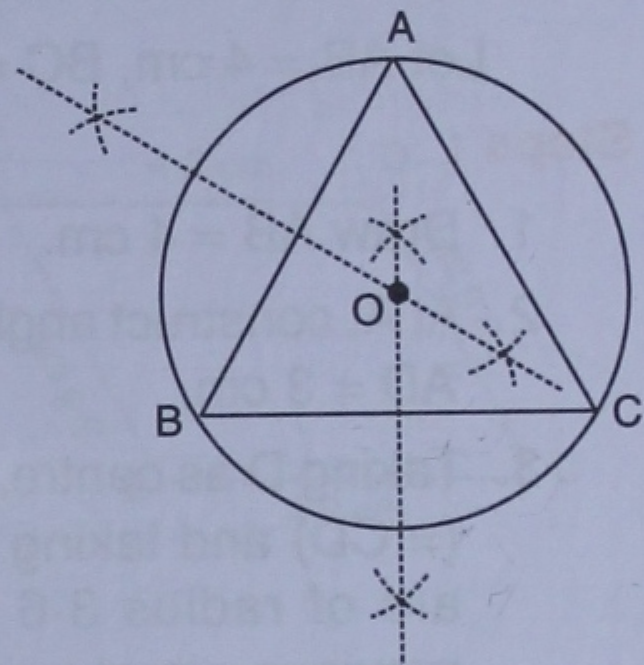
Steps :

1. Construct the triangle ABC with given measures.
2. Draw perpendicular bisectors of any two sides of the triangle.

   Here the perpendicular bisectors of sides AB and BC are drawn.

   Let these bisectors intersect each other at point O.
3. With O as centre and OA or OB or OC as radius (since, OA = OB = OC), draw a circle. This circle will pass through all the three vertices of the triangle.

   In this construction, O is the circumcentre and OA = OB = OC = circumradius.



2. *Incircle of a triangle :*

A circle, which touches all the three sides of a triangle, is called the incircle of the triangle. Its **centre** is called the **incentre**.

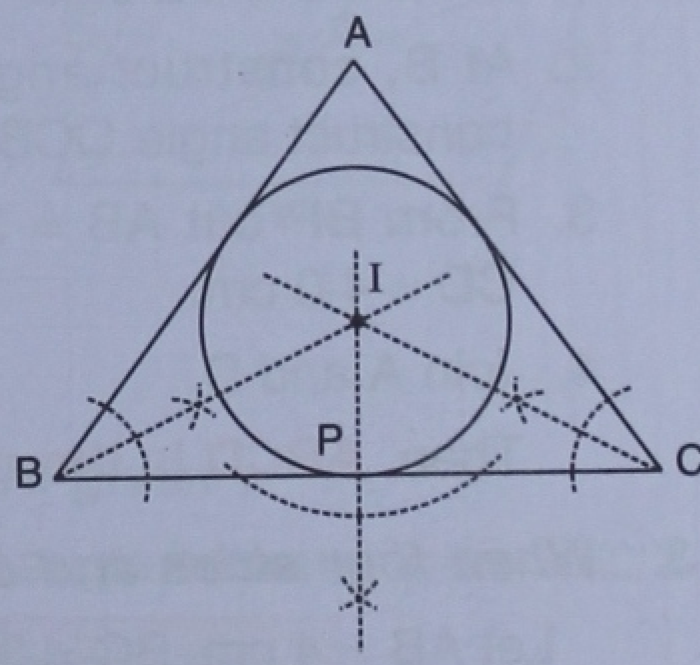
To construct the incircle of a given triangle :

Steps :

1. Construct the Δ ABC with given measurements.
2. Draw bisectors of any two angles of the triangle.

   Here the bisectors of angles B and C are drawn which intersect each other at point I.
3. From I draw IP, the perpendicular to BC.
4. With I as centre and IP as radius, draw a circle which will touch all the three sides of the triangle.

   In this construction, I is the incentre and IP is the radius of the incircle.



EXERCISE 28 (F)

1. Construct a triangle ABC, having given AB = 6 cm, AC = 7 cm and $\angle C = 30°$. Draw the circumcircle of the triangle. Measure its radius.
2. Using ruler and compasses only, draw a Δ ABC such that AB = 4·5 cm, AC = 5·4 cm and $\angle A = 90°$. Draw the circumcircle of the triangle and measure its radius.
3. Construct a triangle ABC in which base BC = 6·0 cm, $\angle B = 60°$ and altitude (height) is 4·5 cm.

   In the same figure, construct a circle which passes through A, B and C. Name the circle drawn and measure its radius.
4. Draw an equilateral triangle of side 5 cm. Draw its circumcircle.
5. Draw a triangle with sides 4·5 cm, 5 cm and 6 cm. Draw the incircle of this triangle.
6. Draw an equilateral triangle of side 4·5 cm. Draw a circle which touches all its sides.
7. Using ruler and compasses only, construct a triangle PQR such that $\angle P = 120°$, PQ = 5 cm and PR = 6 cm.

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In the same figure, find a point which is equidistant from its sides. Name this point. With this point as centre draw a circle touching all the sides of the triangle.

8. Construct a triangle ABC such that : BC = 6 cm, $\angle B = 60°$ and $\angle C = 45°$.

In the same figure, find a point which is equidistant from the vertices of the triangle. Name this point. Draw the circumcircle of the triangle.

13. Construction of quadrilateral ABCD.

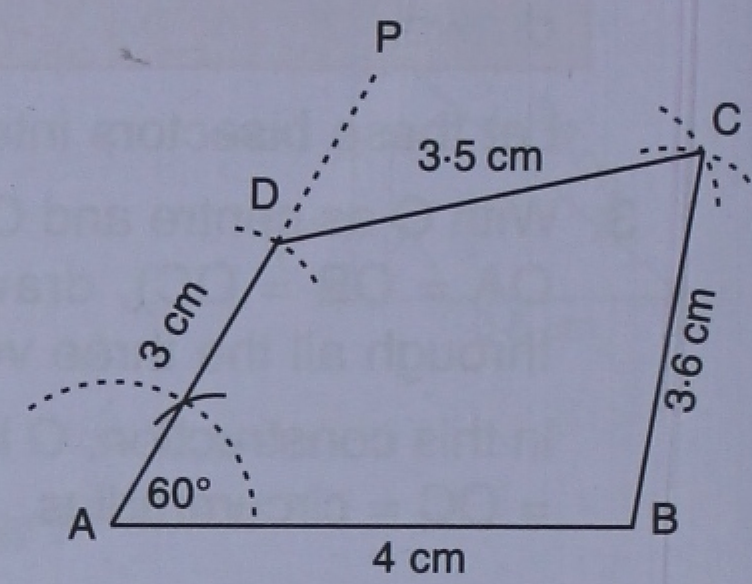
1. *When four sides and one angle are given :*

Let AB = 4 cm, BC = 3·6 cm, CD = 3·5 cm, AD = 3 cm and ĐA = 60°.

Steps :

1. Draw AB = 4 cm.
2. At A, construct angle PAB = 60° and from AP cut AD = 3 cm.
3. Taking D as centre, draw an arc of radius 3·5 cm (= CD) and taking B as centre draw one more arc of radius 3·6 cm (= BC) which cuts the previous arc at point C.
4. Join CD and CB.

Then, **ABCD is the required quadrilateral.**



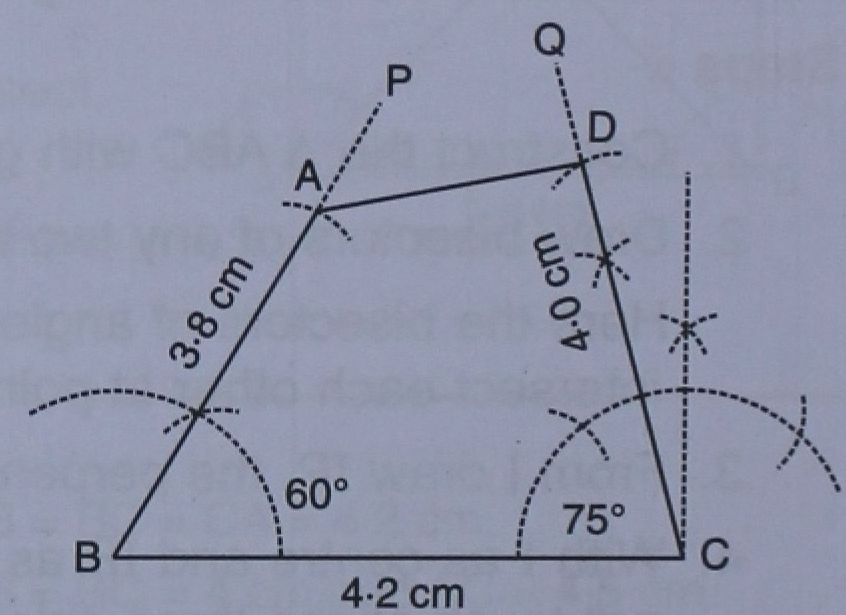
2. *When three consecutive sides and two included angles are given :*

Let AB = 3·8 cm, BC = 4·2 cm, CD = 4·0 cm, $\angle B = 60°$ and $\angle C = 75°$.

Steps :

1. Draw BC = 4·2 cm.
2. At B, construct angle PBC = 60° and at C, construct angle QCB = 75°.
3. From BP cut AB = 3·8 cm and from CQ cut CD = 4·0 cm.
4. Join A and D.

Then, **ABCD is the required quadrilateral.**



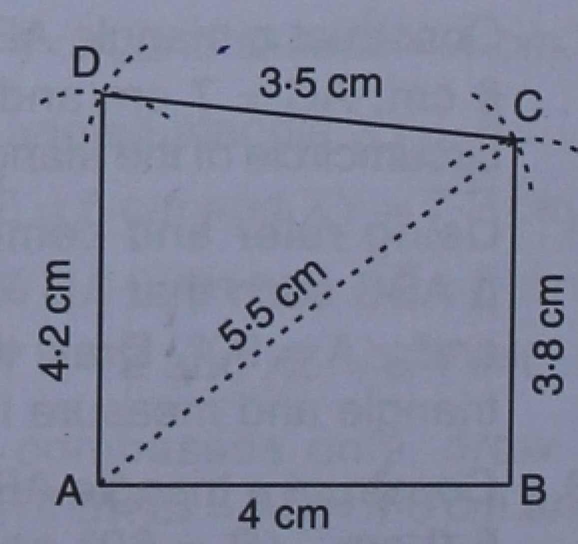
3. *When four sides and one diagonal are given :*

Let AB = 4 cm, BC = 3·8 cm, CD = 3·5 cm, AD = 4·2 cm and diagonal AC = 5·5 cm.

Steps :

1. Draw AB = 4 cm.
2. Taking B as centre, draw an arc of radius 3·8 cm (= BC) and taking A as centre, draw one more arc of radius 5·5 cm (= diagonal AC). Let the two arcs intersect at point C.
3. Taking C as centre, draw an arc of radius 3·5 cm (= CD) and taking A as centre, draw one more arc of radius 4·2 cm (= AD). Let the two arcs intersect at point D.

Then, **ABCD is the required quadrilateral.**



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14. Construction of parallelogram ABCD.

1. ***When two consecutive sides and the included angles are given :***

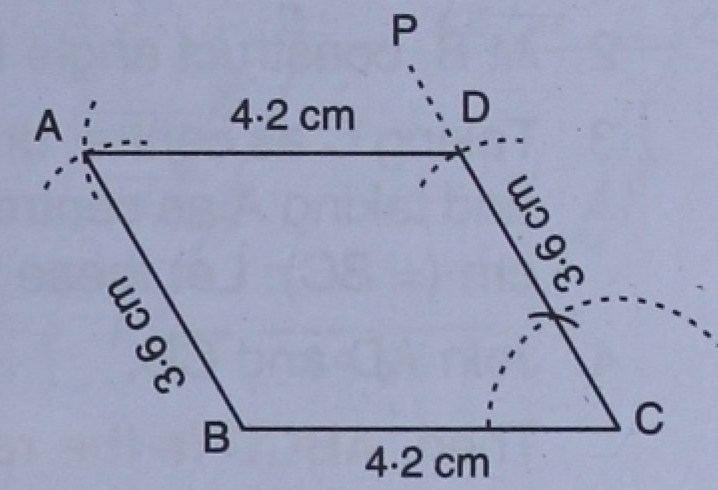
Let BC = 4·2 cm, CD = 3·6 cm and ĐC = 60°.

Students know that the opposite sides of a parallelogram are always equal.

∴ BC = 4·2 cm = AD and CD = 3·6 cm = AB.

Steps :

1. Draw BC = 4·2 cm.
2. At C, construct angle PCB = 60° and from CP cut CD = 3·6 cm.
3. Taking D as centre, draw an arc of radius 4·2 cm (= AD) and taking B as centre draw one more arc of radius 3·6 cm (= AB). Let the two arcs intersect at point A.
4. Join AB and AD.



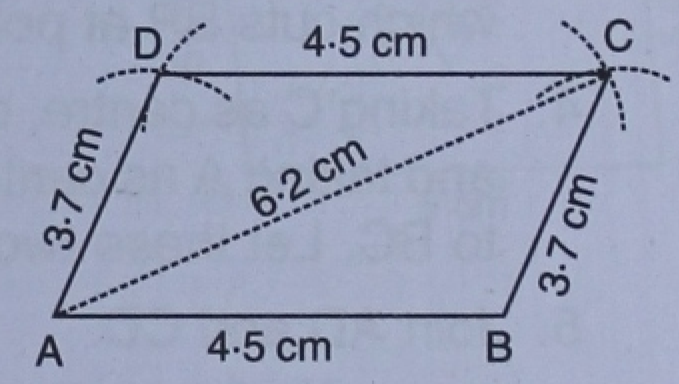
Then, **ABCD is the required parallelogram.**

2. ***When two consecutive sides and one diagonal are given :***

Let AB = 4·5 cm, BC = 3·7 cm and diagonal AC = 6·2.

Steps :

1. Draw AB = 4·5 cm.
2. Taking B as centre, draw an arc of radius 3·7 cm (= BC) and taking A as centre draw one more arc of radius 6·2 cm (= diagonal AC). Let the two arcs intersect at point C. Join B and C.
3. Taking C as centre, draw an arc of radius 4·5 cm (= AB) and taking A as centre draw one more arc of radius 3·7 cm (= BC). Let the two arcs intersect at point D.
4. Join AD and CD.



Then, **ABCD is the required parallelogram.**

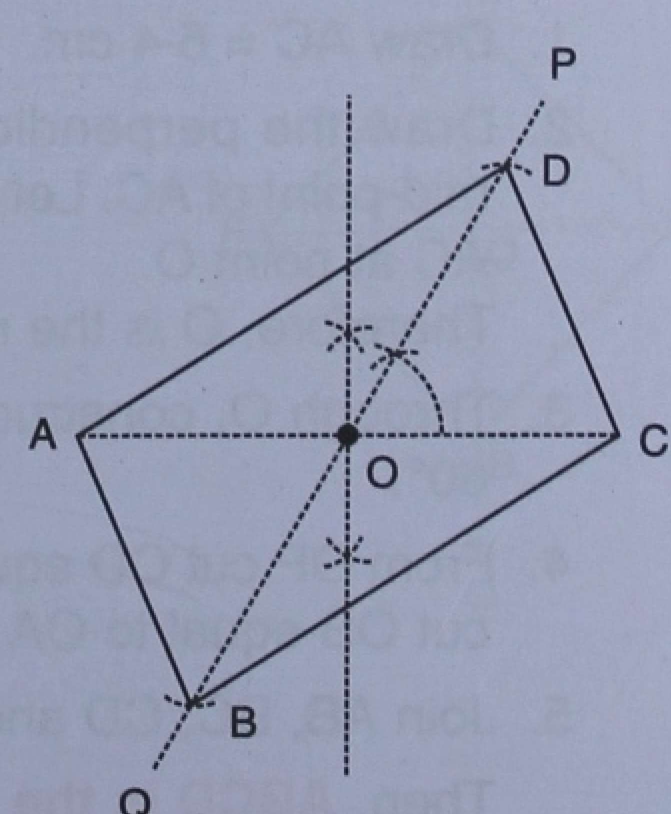
3. ***When both the diagonals and the angle between them are given :***

Let the diagonal AC = 5·5 cm, diagonal BD = 6·0 cm and the angle between them = 60°.

Students know that the diagonals of a parallelogram bisect each other.

Steps :

1. Draw AC = 5·5 cm.
2. Locate the mid-point O of AC by drawing its perpendicular bisector.
3. Through O, construct a line POQ so that angle POC = 60°.
4. From PQ, cut OD = $\frac{BD}{2} = \frac{6\cdot0}{2}$ = 3·0 cm and also OB = $\frac{6\cdot0}{2}$ = 3·0 cm.
5. Join AB, BC, CD and DA.



Then, **ABCD is the required parallelogram.**

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15. Construction of rectangle ABCD.

1. *When two adjacent sides are given :*

Let AB = 5·0 cm and BC = 3·5 cm.

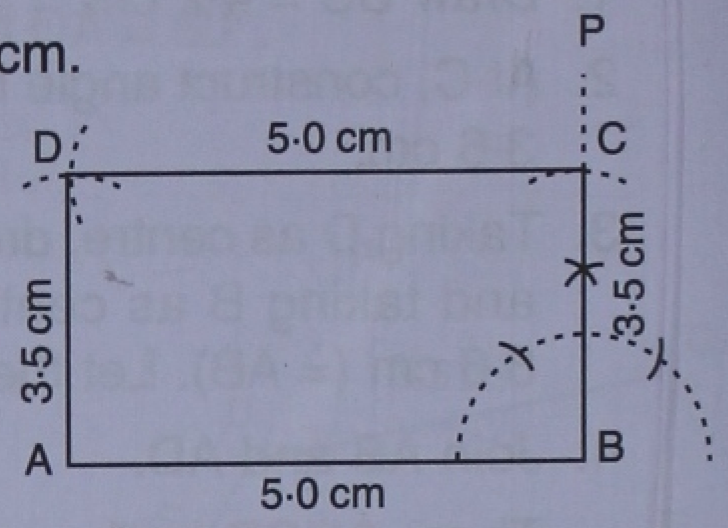
The opposite sides of a rectangle are equal and each angle of it is 90°.

∴ AB = 5·0 cm = DC, BC = 3·5 cm = AD and ∠A = ∠B = ∠C = ∠D = 90°.

Steps :

1. Draw AB = 5·0 cm.
2. At B, construct angle PBA = 90°. From BP cut BC = 3·5 cm.
3. Taking C as centre, draw an arc of radius 5·0 cm (= AB) and taking A as centre, draw one more arc of radius 3·5 cm (= BC). Let these two arcs intersect at point D.
4. Join AD and CD.

Then, **ABCD is the required rectangle.**



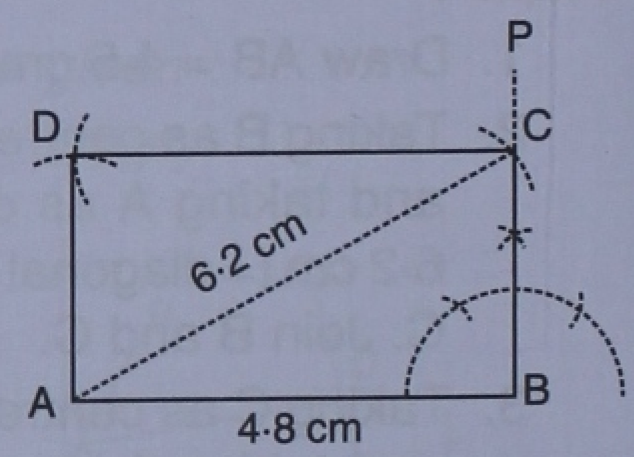
2. *When one side and one diagonal are given :*

Let AB = 4·8 cm and diagonal AC = 6·2 cm.

Steps :

1. Draw AB = 4·8 cm.
2. At B, construct angle PBA = 90°.
3. Taking A as centre, draw an arc of radius 6·2 cm (= AC) which cuts BP at point C.
4. Taking C as centre, draw an arc of radius 4·8 cm (= AB) and taking A as centre draw another arc of radius equal to BC. Let these two arcs intersect at point D.
5. Join AD and CD.

Then, **ABCD is the required rectangle.**



3. *When one diagonal and the angle between the two diagonals are given :*

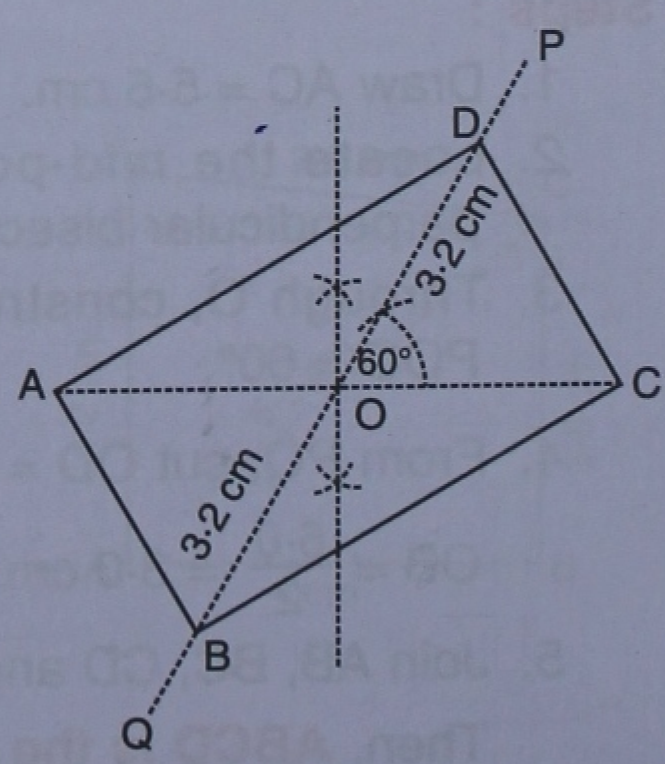
Let diagonal AC = 6·4 cm and the angle between the two diagonals be 60°.

The diagonals of a rectangle are equal *i.e.* AC = BD = 6·4 cm.

Steps :

1. Draw AC = 6·4 cm.
2. Draw the perpendicular bisector of AC to locate the mid-point of AC. Let the perpendicular bisector intersect AC at point O.
   Therefore, O is the mid-point of AC.
3. Through O, construct a line POQ so that angle POC = 60°.
4. From OP cut OD equal to OC (*i.e.* 3·2 cm) and from OQ cut OB equal to OA (*i.e.* 3·2 cm).
5. Join AB, BC, CD and DA.

Then, **ABCD is the required rectangle.**



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16. Construction of rhombus ABCD.

1. *When one side and one angle are given :*

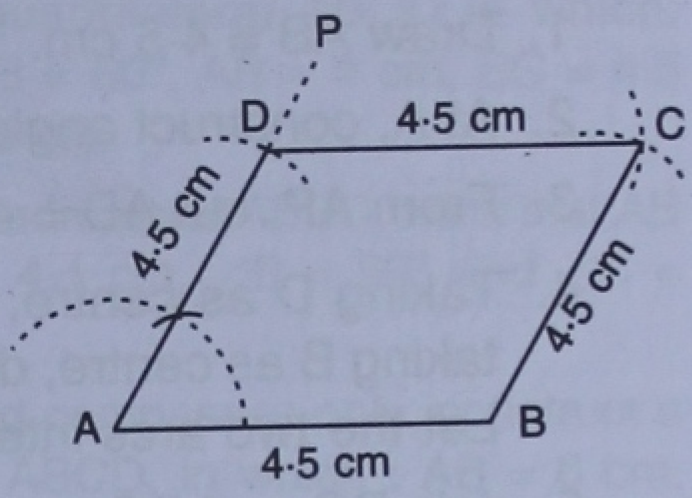
Let the side AB = 4·5 cm and angle A = 60°.

Students know that the sides of a rhombus are equal *i.e.* AB = BC = CD = AD = 4·5 cm

Steps :

1. Draw AB = 4·5 cm.
2. At A, construct angle PAB = 60°
3. From AP, cut AD = 4·5 m.
4. Taking D as centre, draw an arc of radius 4·5 cm (= AB) and taking B as centre draw one more arc of radius 4·5 cm (= AB). Let the two arcs intersect at point C.
5. Join BC and DC.

Then, **ABCD is the required rhombus.**



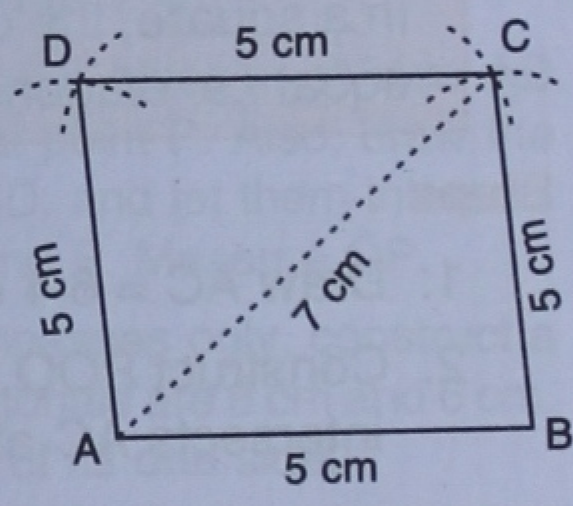
2. *When one side and one diagonal are given :*

Let the side AB = 5 cm and the diagonal AC = 7 cm.

Steps :

1. Draw AB = 5 cm.
2. Taking A as centre, draw an arc of radius 7 cm (= AC) and taking B as centre, draw one more arc of radius 5 cm (= AB). Let the two arcs intersect at point C.
3. Taking C as centre, draw an arc of radius 5 cm (= AB) and taking A as centre, draw one more arc of radius 5 cm (= AB). Let the two arcs intersect at point D.
4. Join BC, CD and DA.

Then, **ABCD is the required rhombus.**



3. *When both the diagonals are given :*

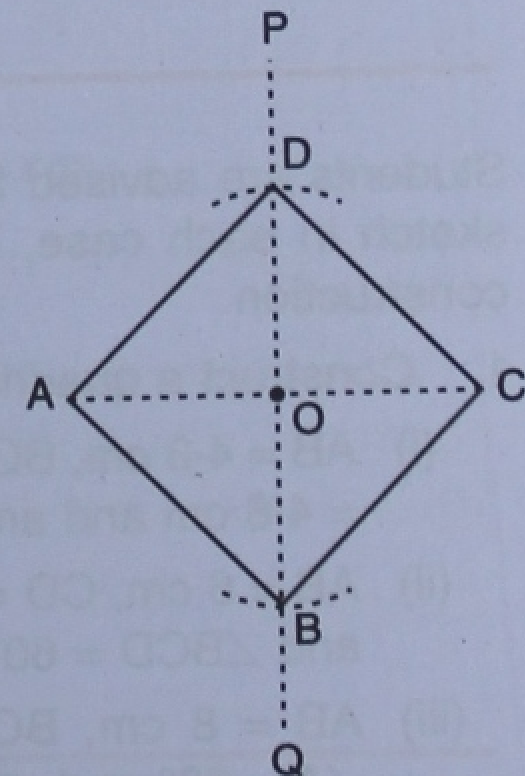
Let the diagonal AC = 4·8 cm and the diagonal BD = 5·4 cm.

The diagonals of a rhombus bisect each other at 90°.

Steps :

1. Draw AC = 4·8 cm.
2. Draw the perpendicular bisector of AC. Let PQ be the perpendicular bisector of AC which bisects AC at point O.
3. From OP, cut OD = $\frac{BD}{2} = \frac{5 \cdot 4 \text{ cm}}{2}$ = 2·7 cm and from OQ, cut OB = $\frac{BD}{2}$ = 2·7 cm.
4. Join AB, BC, CD and DA.

Then, **ABCD is the required rhombus.**



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17. Construction of square ABCD.

1. *When one side is given :*

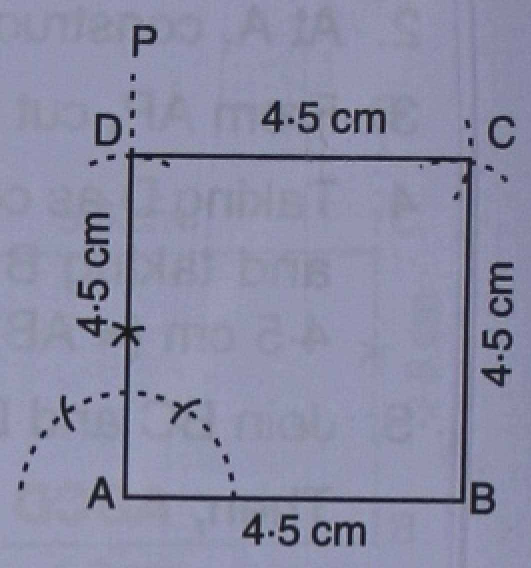
Let side AB = 4·5 cm.

Students know that sides of a square are equal *i.e.* AB = BC = CD = AD = 4·5 cm and each angle of the square is 90°.

Steps :

1. Draw AB = 4·5 cm.
2. At A, construct angle PAB = 90°
3. From AP, cut AD = 4·5 cm.
4. Taking D as centre, draw an arc of radius 4·5 cm and taking B as centre, draw one more arc of radius 4·5 cm. Let the two arcs intersect at point C.
5. Join BC and DC.

Then, **ABCD is the required square.**



2. *When a diagonal is given :*

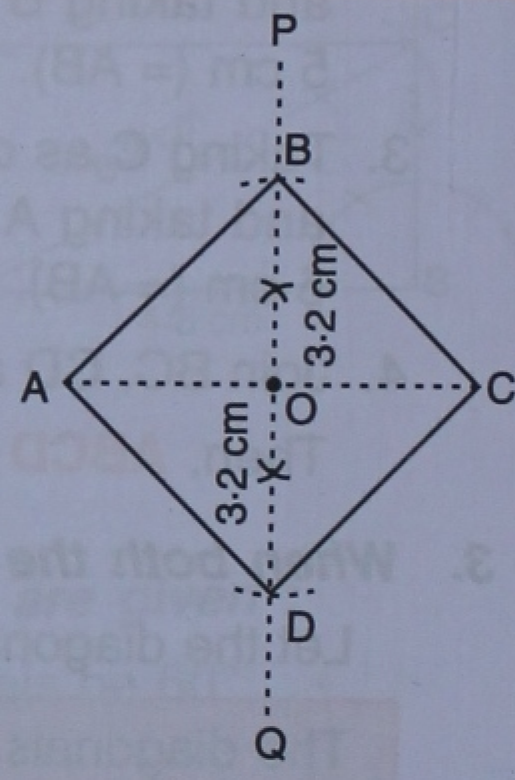
Let diagonal AC = 6·4 cm.

In a square, the diagonals bisect each other at 90°. Also, the diagonals of a square are equal *i.e.* diagonal AC = diagonal BD = 6·4 cm.

Steps :

1. Draw AC = 6·4 cm.
2. Construct POQ, the perpendicular bisector of AC which intersects AC at point O.
3. From OP, cut OB = $\frac{6 \cdot 4}{2}$ cm = 3·2 cm and from OQ cut OD = 3·2 cm.
4. Join AB, BC, CD and DA.

Then, **ABCD is the required square.**



EXERCISE 28 (G)

Students are advised to draw a rough free-hand sketch in each case, before starting the actual construction.

1. Construct a quadrilateral ABCD; if :
   (i) AB = 4·3 cm, BC = 5·4 cm, CD = 5 cm, DA = 4·8 cm and angle ABC = 75°.
   (ii) AB = 6 cm, CD = 4·5 cm, BC = AD = 5 cm and ∠BCD = 60°.
   (iii) AB = 8 cm, BC = 5·4 cm, AD = 6 cm, ∠A = 60° and ∠B = 75°.
   (iv) AB = 5 cm, BC = 6·5 cm, CD = 4·8 cm, ∠B = 75° and ∠C = 120°.
   (v) AB = 6 cm = AC, BC = 4 cm, CD = 5 cm and AD = 4·5 cm.
   (vi) AB = AD = 5 cm, BD = 7 cm and BC = DC = 5·5 cm.
2. Construct a parallelogram ABCD, if :
   (i) AB = 3·6 cm, BC = 4·5 cm and ∠ABC = 120°.
   (ii) BC = 4·5 cm, CD = 5·2 cm and ∠ADC = 75°.
   (iii) AD = 4 cm, DC = 5 cm and diagonal BD = 7 cm.

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(iv) AB = 5·8 cm, AD = 4·6 cm and diagonal AC = 7·5 cm.

(v) diagonal AC = 6·4 cm, diagonal BD = 5·6 cm and angle between the diagonals is 75°.

(vi) lengths of diagonals AC and BD are 6·3 cm and 7·0 cm respectively, and the angle between them is 45°.

(vii) lengths of diagonals AC and BD are 5·4 cm and 6·7 cm respectively, and the angle between them is 60°.

3. Construct a rectangle ABCD; if :

(i) AB = 4·5 cm and BC = 5·5 cm.

(ii) BC = 6·1 cm and CD = 6·8 cm.

(iii) AB = 5·0 cm and diagonal AC = 6·7 cm.

(iv) AD = 4·8 cm and diagonal AC = 6·4 cm.

(v) each diagonal is 6 cm and the angle between them is 45°.

(vi) each diagonal is 5·5 cm and the angle between them is 60°.

4. Construct a rhombus ABCD, if :

(i) AB = 4 cm and $\angle$B = 120°.

(ii) BC = 4·7 cm and $\angle$B = 75°.

(iii) CD = 5 cm and diagonal BD = 8·5 cm.

(iv) BC = 4·8 cm and diagonal AC = 7 cm.

(v) diagonal AC = 6 cm and diagonal BD = 5·8 cm

(vi) diagonal AC = 4·9 cm and diagonal BD = 6 cm.

(vii) diagonal AC = 6·6 cm and diagonal BD = 5·3 cm.

5. Construct a square, if :

(i) its one side is 3·8 cm.

(ii) its each side is 4·3 cm.

(iii) one diagonal is 6·2 cm.

(iv) each diagonal is 5·7 cm.

6. Construct a quadrilateral ABCD in which; $\angle$A = 120°, $\angle$B = 60°, AB = 4 cm, BC = 4·5 cm and CD = 5 cm.

7. Construct a quadrilateral ABCD, such that AB = BC = CD = 4·4 cm, $\angle$B = 90° and $\angle$C = 120°.

8. Using ruler and compasses only, construct a parellelogram ABCD, in which : AB = 6 cm, AD = 3 cm and $\angle$DAB = 60°.

In the same figure draw the bisector of angle DAB and let it meet DC at point P. Measure angle APB.

9. Draw a parallelogram ABCD, with AB = 6 cm, AD = 4·8 cm and $\angle$DAB = 45°.

Draw the perpendicular bisector of side AD and let it meet AD at point P. Also, draw the diagonals AC and BD, and let them intersect at point O. Join O and P. Measure OP.

10. Using ruler and compasses only, construct a rhombus whose diagonals are 8 cm and 6 cm. Measure the length of its one side.

ANSWERS

EXERCISE 28(A)

5. $\angle$PBC = 45° **6.** (iii) Yes (iv) Yes

EXERCISE 28(C)

5. Yes

EXERCISE 28(D)

3. 5·6 cm **4.** 5·7 cm **5.** 106° **6.** 9·4 cm **7.** 4·6 cm **8.** AB = 6·1 cm; AC = 5·1 cm

EXERCISE 28(E)

3. 4 cm **8.** 6·8 cm

EXERCISE 28(F)

1. 5·8 cm **2.** 3·5 cm **3.** Circumcircle; 3·3 cm **7.** Incentre **8.** Circumcentre

EXERCISE 28(G)

8. 90° **9.** 3 cm **10.** 5 cm

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