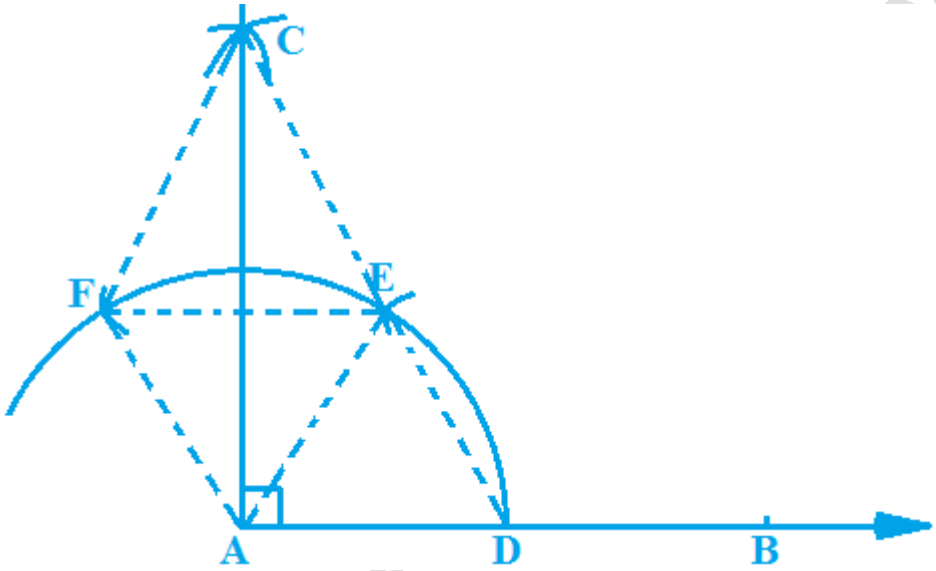
NCERT Solutions for Class 9th Mathematics

Chapter 11 – CONSTRUCTIONS

EXERCISE 11.1

1. Construct an angle of 90° at the initial point of a given ray and justify the construction.

Ans



Given: A ray AB with the initial point A as shown in the figure.

To Construct: A ray AC such that ∠ CAB = 90°.

Steps of Construction:

1) Draw a ray AB with A as the initial point.

2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point E.

4) Taking E as centre and with the same radius as before (in step 2), draw an arc intersecting the previously drawn arc in step 2 at point F.

5) Now, taking E and F as centres and with the radius more than $\frac{1}{2}$ EF, draw arcs to intersect each other at point C.

6) Join AC. Then AC is the required ray making an angle of 90° with ray AB at the initial point i.e. ∠ CAB = 90°.

Justification:

Join AE, AF, DE, CE, CF and EF.

In Δ ADE

AD = DE = AE (by construction)

Thus, Δ ADE is an equilateral triangle.

» ∠ EAD = 60° (angle of an equilateral triangle) ----------(1)

Similarly Δ AEF is an equilateral triangle

» ∠ EAF = 60° (angle of an equilateral triangle) ----------(2)

In Δ AEC and Δ AFC

AE = AF (by construction; radii of same arc)

CE = CF (by construction; formed by arcs of equal length)

AC = AC (common)

» Δ AEC ≅ Δ AFC (SSS congruence rule)

So, ∠ EAC = ∠ FAC (CPCT) ----------(3)

But ∠ EAC + ∠ FAC = ∠ EAF = 60° (using equation (2))

» ∠ EAC + ∠ EAC = 60° (using equation (3))

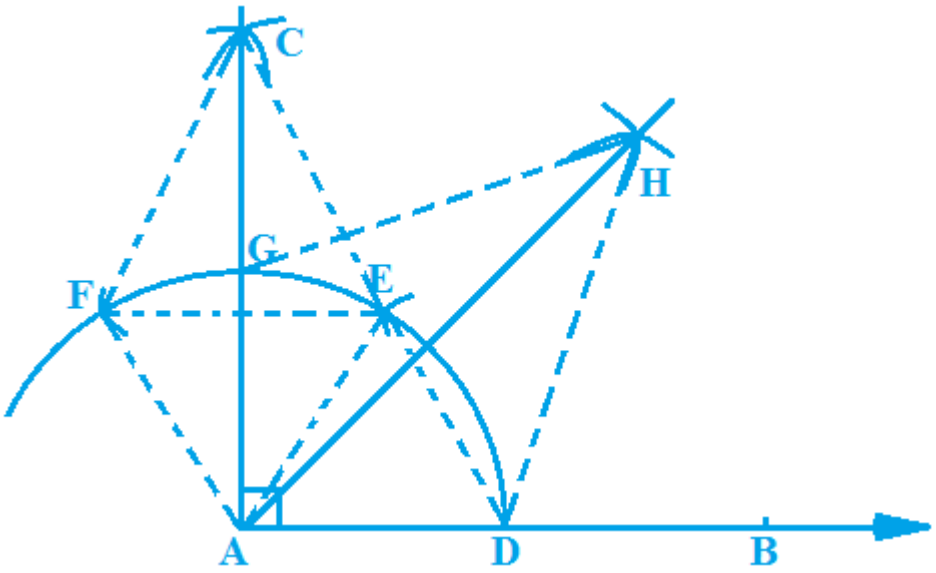
∠ EAC = 30° ----------(4)

Therefore, ∠ CAB = ∠ EAD + ∠ EAC

= 60° + 30° = 90° (using equations (1) and (4))

2. Construct an angle of 45° at the initial point of a given ray and justify the construction.

Ans



Given: A ray AB with the initial point A as shown in the figure.

To Construct: A ray AH such that ∠ HAB = 45°.

Steps of Construction:

1) Draw a ray AB with A as the initial point.

2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point E.

4) Taking E as centre and with the same radius as before (in step 2), draw an arc intersecting the previously drawn arc in step 2 at point F.

5) Now, taking E and F as centres and with the radius more than $\frac{1}{2}$ EF, draw arcs to intersect each other at point C.

6) Join AC. Then AC is the ray making an angle of 90° with ray AB at the initial point A i.e. ∠ CAB = 90°. Let AC cut the arc drawn in step 2 at point G.

7) Taking D and G as centres and with the radius more than $\frac{1}{2}$ DG, draw arcs to intersect each other at point H.

8) Join AH. Then AH is the required ray making an angle of 45° with ray AB at the initial point A i.e. ∠ HAB = 45°.

Justification:

Join AE, AF, DE, CE, CF, EF, HD and HG.

In Δ ADE

AD = DE = AE (by construction)

Thus, Δ ADE is an equilateral triangle.

» ∠ EAD = 60° (angle of an equilateral triangle) ----------(1)

Similarly Δ AEF is an equilateral triangle

» ∠ EAF = 60° (angle of an equilateral triangle) ----------(2)

In Δ AEC and Δ AFC

AE = AF (by construction; radii of same arc)

CE = CF (by construction; formed by arcs of equal length)

AC = AC (common)

» Δ AEC ≅ Δ AFC (SSS congruence rule)

So, ∠ EAC = ∠ FAC (CPCT) ----------(3)

But ∠ EAC + ∠ FAC = ∠ EAF = 60° (using equation (2))

» ∠ EAC + ∠ EAC = 60° (using equation (3))

∠ EAC = 30° ----------(4)

Therefore, ∠ CAB = ∠ EAD + ∠ EAC

= 60° + 30° = 90° (using equations (1) and (4)) ----------(5)

In Δ DAH and Δ GAH

AD = AG (by construction; radii of same arc)

DH = GH (by construction; formed by arcs of equal length)

AH = AH (common)

» Δ DAH ≅ Δ GAH (SSS congruence rule)

So, ∠ DAH = ∠ GAH (CPCT) ----------(6)

But ∠ DAH + ∠ GAH = ∠ CAB = 90° (using equation (5))

» ∠ DAH + ∠ DAH = 90° (using equation (6))

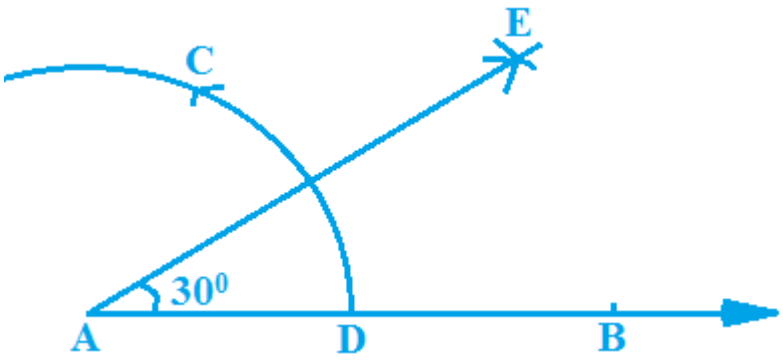
» ∠ DAH = 45°

Hence, ∠ HAB = ∠ DAH = 45°

3. Construct the angles of the following measurements:

(i) 30° (ii) $22\frac{1}{2}^{\circ}$ (iii) 15°

Ans (i) 30°



Steps of Construction:

1) Draw a ray AB with A as the initial point.

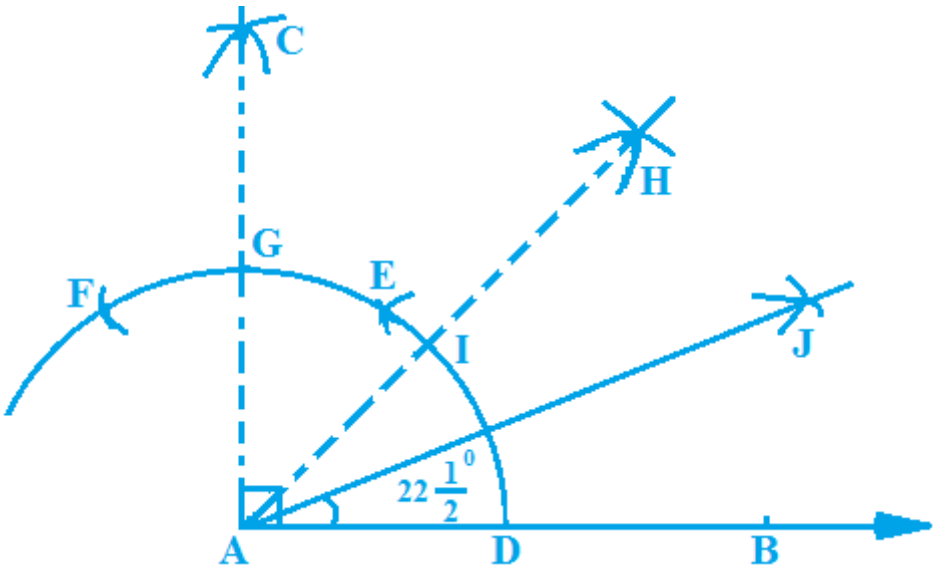
2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point C.

4) Now, taking C and D as centres and with the radius more than $\frac{1}{2}$ CD, draw arcs to intersect each other at point E.

5) Join AE. Then AE is the required ray making an angle of 30° with ray AB at the initial point A i.e. ∠ EAB = 30°.

(ii) $22\frac{1}{2}^{\circ}$



Steps of Construction:

1) Draw a ray AB with A as the initial point.

2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point E.

4) Taking E as centre and with the same radius as before (in step 2), draw an arc intersecting the previously drawn arc in step 2 at point F.

5) Now, taking E and F as centres and with the radius more than $\frac{1}{2}$ EF, draw arcs to intersect each other at point C.

6) Join AC. Then AC is the ray making an angle of 90° with ray AB at the initial point A i.e. ∠ CAB = 90°. Let AC cut the arc drawn in step 2 at point G.

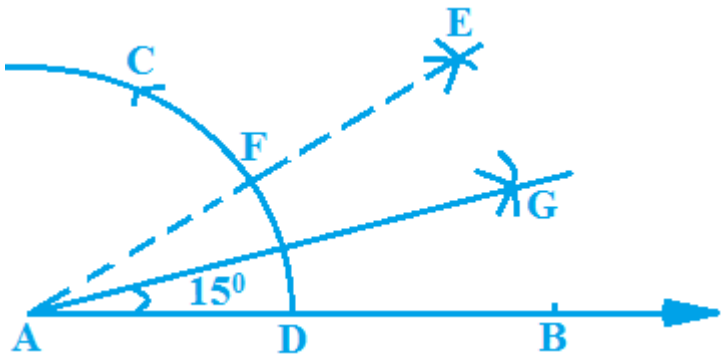
7) Taking D and G as centres and with the radius more than $\frac{1}{2}$ DG, draw arcs to intersect each other at point H.

8) Join AH. Then AH is the ray making an angle of 45° with ray AB at the initial point A i.e. ∠ HAB = 45°. Let AH cut the arc drawn in step 2 at point I.

9) Taking D and I as centres and with the radius more than $\frac{1}{2}$ DI, draw arcs to intersect each other at point J.

10) Join AJ. Then AJ is the required ray making an angle of $22\frac{1}{2}^{\circ}$ with ray AB at the initial point A i.e. ∠ JAB = 45°.

(iii) 15°



Steps of Construction:

1) Draw a ray AB with A as the initial point.

2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point C.

4) Taking C and D as centres and with the radius more than $\frac{1}{2}$ CD, draw arcs to intersect each other at point E.

5) Join AE. Then AE is the ray making an angle of 30° with ray AB at the initial point A i.e. ∠ EAB = 30°. Let AE cut the arc drawn in point 2 at F.

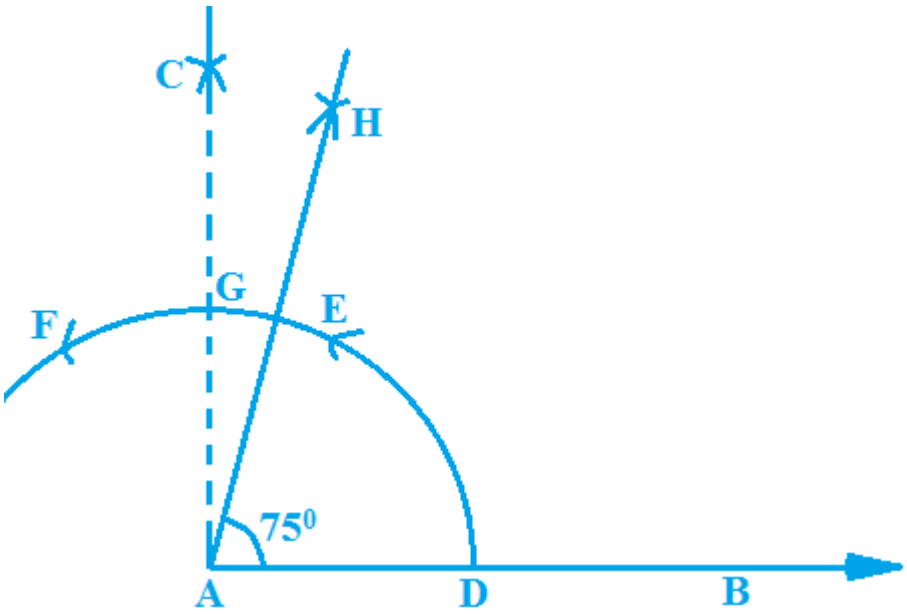
6) Now, taking D and F as centres and with the radius more than $\frac{1}{2}$ DF, draw arcs to intersect each other at point G.

7) Join AG. Then AG is the required ray making an angle of 15° with ray AB at the initial point A i.e. ∠ GAB = 15°.

4. Construct the following angles and verify by measuring them by a protractor:

(i) 75° (ii) 105° (iii) 135°

Ans (i) 75°



Steps of Construction:

1) Draw a ray AB with A as the initial point.

2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point E.

4) Taking E as centre and with the same radius as before (in step 2), draw an arc intersecting the previously drawn arc in step 2 at point F.

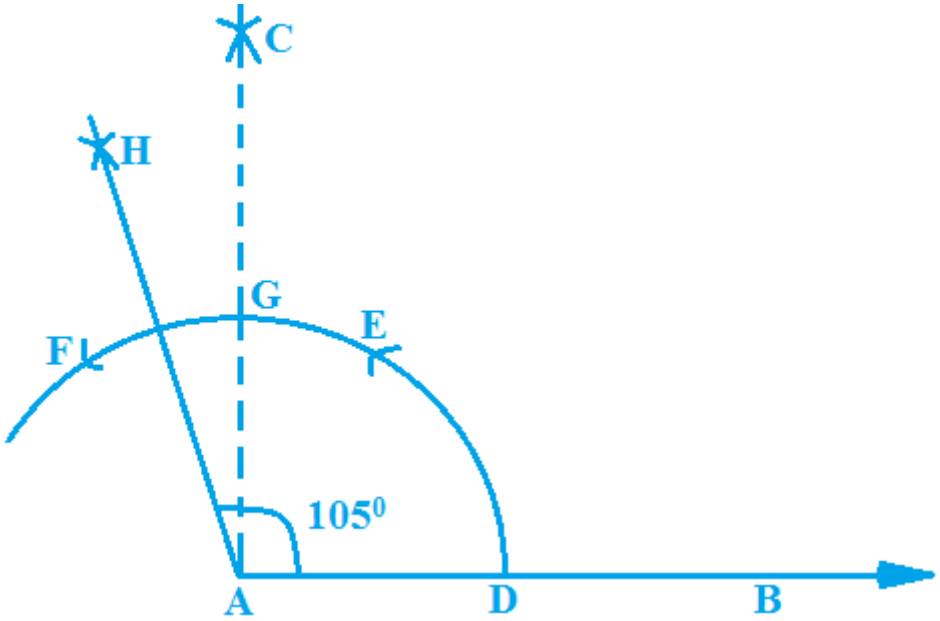
5) Now, taking E and F as centres and with the radius more than $\frac{1}{2}$ EF, draw arcs to intersect each other at point C.

6) Join AC. Then AC is the ray making an angle of 90° with ray AB at the initial point A i.e. ∠ CAB = 90°. Let AC cut the arc drawn in step 2 at point G.

7) Taking E and G as centres and with the radius more than $\frac{1}{2}$ EG, draw arcs to intersect each other at point H.

8) Join AH. Then AH is the required ray making an angle of 75° with ray AB at the initial point A i.e. ∠ HAB = 75°.

(ii) 105°



Steps of Construction:

1) Draw a ray AB with A as the initial point.

2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point E.

4) Taking E as centre and with the same radius as before (in step 2), draw an arc intersecting the previously drawn arc in step 2 at point F.

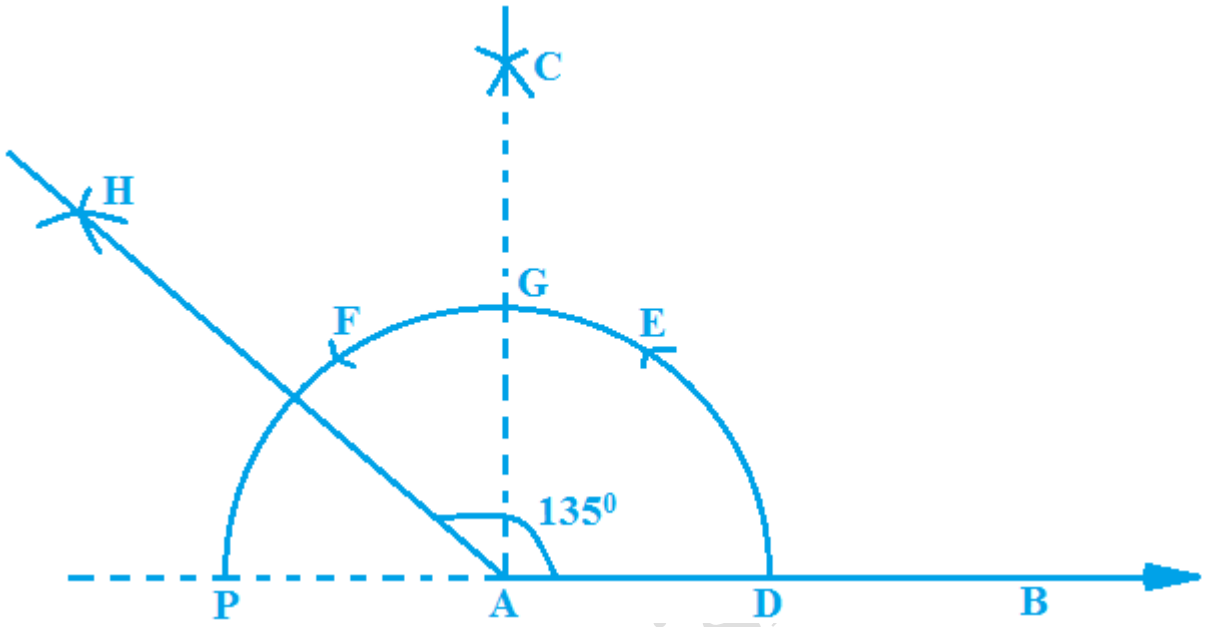
5) Now, taking E and F as centres and with the radius more than $\frac{1}{2}$ EF, draw arcs to intersect each other at point C.

6) Join AC. Then AC is the ray making an angle of 90° with ray AB at the initial point A i.e. ∠ CAB = 90°. Let AC cut the arc drawn in step 2 at point G.

7) Taking F and G as centres and with the radius more than $\frac{1}{2}$ FG, draw arcs to intersect each other at point H.

8) Join AH. Then AH is the required ray making an angle of 105° with ray AB at the initial point A i.e. ∠ HAB = 105°.

(iii) 135°



Steps of Construction:

1) Draw a ray AB with A as the initial point.

2) Taking A as centre and some radius, draw a semi-circle, which intersects AB at D and BA produced at P as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn semi-circle at point E.

4) Taking E as centre and with the same radius as before (in step 2), draw an arc intersecting the previously drawn semi-circle in step 2 at point F.

5) Now, taking E and F as centres and with the radius more than $\frac{1}{2}$ EF, draw arcs to intersect each other at point C.

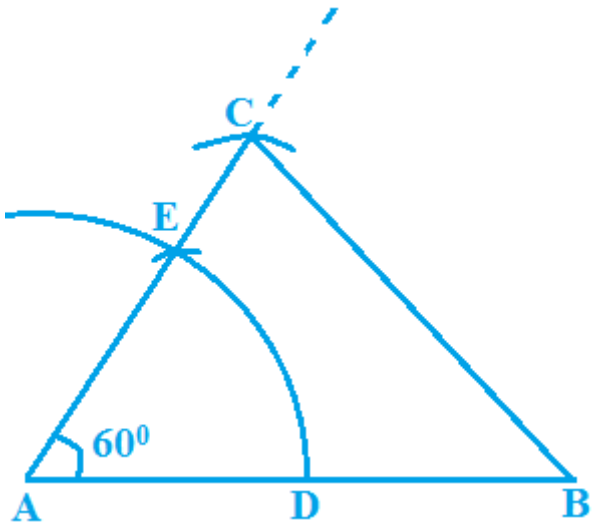
6) Join AC. Then AC is the ray making an angle of 90° with ray AB at the initial point A i.e. ∠ CAB = 90°. Let AC cut the semi-circle drawn in step 2 at point G.

7) Taking P and G as centres and with the radius more than $\frac{1}{2}$ PG, draw arcs to intersect each other at point H.

8) Join AH. Then AH is the required ray making an angle of 135° with ray AB at the initial point A i.e. ∠ HAB = 135°.

5. Construct an equilateral triangle, given its side and justify the construction.

Ans



Given: A side of a triangle of given length. Let the side is AB such that AB = 10 cm.

To Construct: An equilateral triangle ABC with each side equals to 10 cm.

Steps of Construction:

1) Draw a line segment AB as one side of the triangle such that AB = 10 cm.

2) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at D as shown in the figure.

3) Taking D as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point E.

4) Join AE.

5) Taking A as centre and radius equal to 10 cm, draw an arc which intersects AE produced at C as shown in the figure.

6) Join AC and BC. Then Δ ABC is the required equilateral triangle with each side equal to 10 cm.

Justification:

In Δ ABC

AB = AC = 10 cm (by construction) ----------(1)

» ∠ ACB = ∠ ABC (angles opposite to equal sides of a triangle are equal) ----------(2)

∠ CAB = 60° (by construction) ----------(3)

But, ∠ ACB + ∠ ABC + ∠ CAB = 180° (angle sum property of a triangle)

» ∠ ABC + ∠ ABC + 60° = 180° (using equations (2) and (3))

» ∠ ABC = 60° = ∠ ACB

Thus, ∠ ABC = ∠ ACB = ∠ CAB = 60° ----------(4)

» AB = BC = 10 cm {sides opposite to equal angles (∠ ACB and ∠ CAB) of a triangle are equal} --(5)

From equations (1) and (5), we get

AB = BC = AC = 10 cm ----------(6)

Hence, Δ ABC is an equilateral triangle with each side equal to 10 cm. (using equations (4) and (6)).

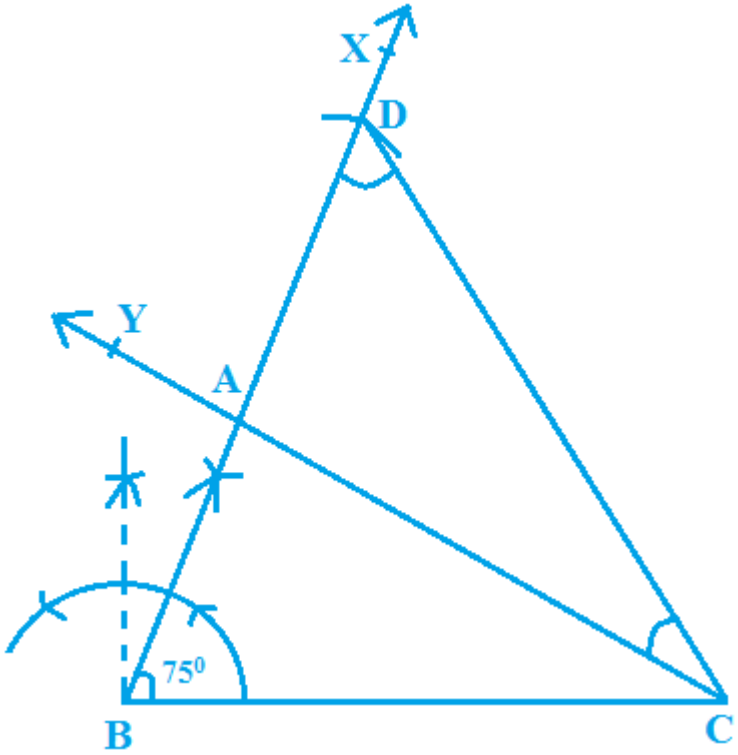
EXERCISE 11.2

1. Construct a triangle ABC in which BC = 7cm, ∠B = 75° and AB + AC = 13 cm.

Ans **Given:** Side BC, ∠ B and sum of two sides other than BC of a ΔABC, such that BC = 7cm, ∠B = 75° and AB + AC = 13 cm.

To Construct: Δ ABC

Construction:



Steps of Construction:

1) Draw the given base BC = 7cm.

2) At B, draw an angle XBC such that ∠ XBC = 75°.

3) Cut the line segment BD equal to 13 cm (AB + AC) from the ray BX.

4) Join DC and draw ∠ DCY equal to ∠ BDC.

5) Let CY intersect BX at A as shown in the figure.

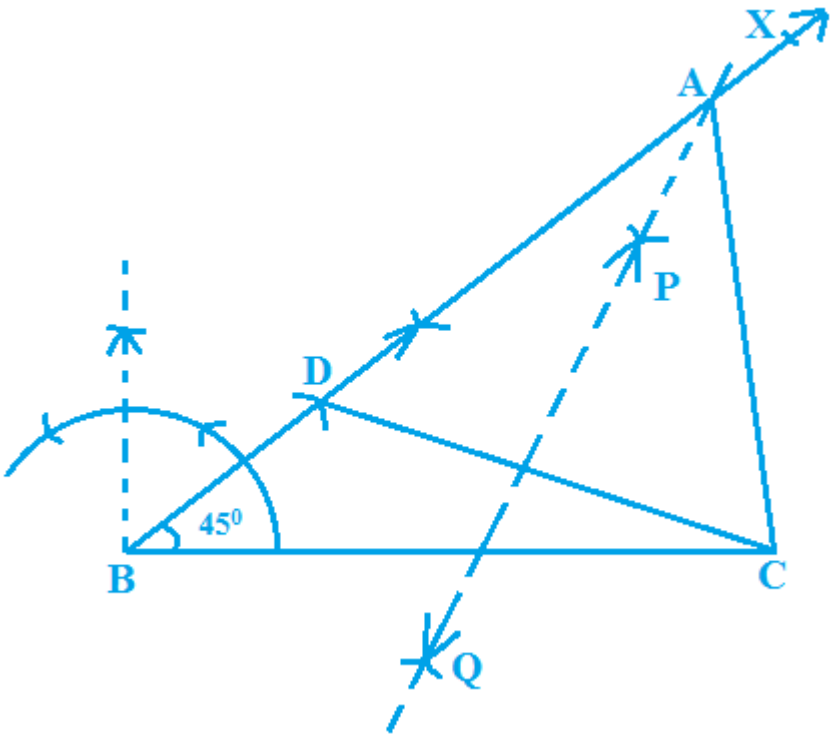
Then, Δ ABC is the required triangle.

2. Construct a triangle ABC in which BC = 8 cm, ∠ B = 45° and AB – AC = 3.5 cm.

Ans **Given:** Side BC, ∠ B and difference of two sides other than BC of a Δ ABC, such that BC = 8 cm, ∠ B = 45° and AB – AC = 3.5 cm.

To Construct: Δ ABC

Construction:



Steps of Construction:

1) Draw the given base BC = 8 cm.

2) At B, draw an angle XBC such that ∠ XBC = 45°.

3) Cut the line segment BD equal to 3.5 cm (AB – AC) from the ray BX.

4) Join DC and draw the perpendicular bisector PQ of line segment DC .

5) Let PQ intersect BX at A as shown in the figure. Join AC.

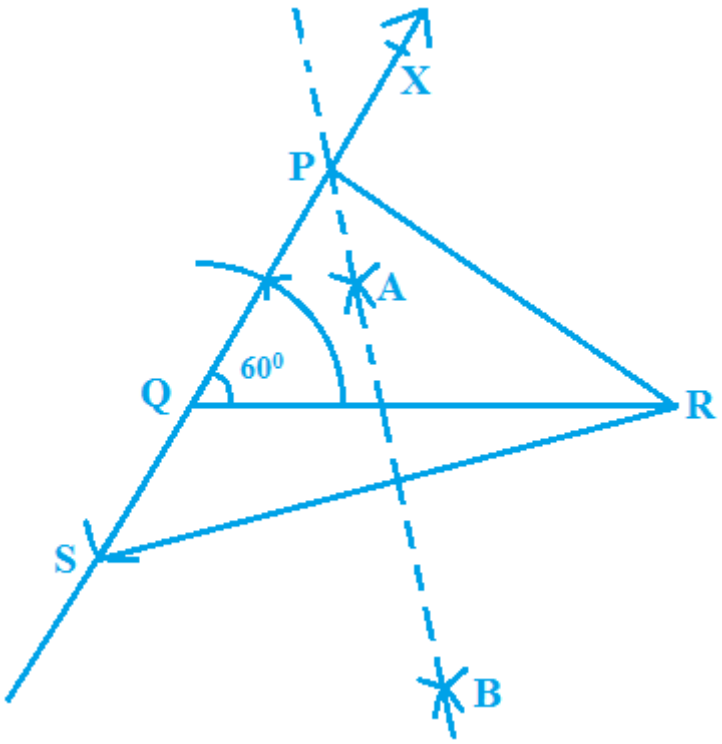
Then, Δ ABC is the required triangle.

3. Construct a triangle PQR in which QR = 6cm, ∠ Q = 60° and PR – PQ = 2cm.

Ans **Given:** Side QR, ∠ Q and difference of two sides other than QR of Δ PQR, such that QR = 6cm, ∠ Q = 60° and PR – PQ = 2cm.

To Construct: Δ PQR

Construction:



Steps of Construction:

1) Draw the given base QR = 6 cm.

2) At Q, draw an angle XQR such that ∠ XQR = 60°.

3) Cut the line segment QS equal to 2 cm (PR – PQ) from the ray XQ extended on the opposite side of line segment QR.

4) Join SR and draw the perpendicular bisector AB of line segment SR .

5) Let AB intersect XQ at P as shown in the figure. Join PR.

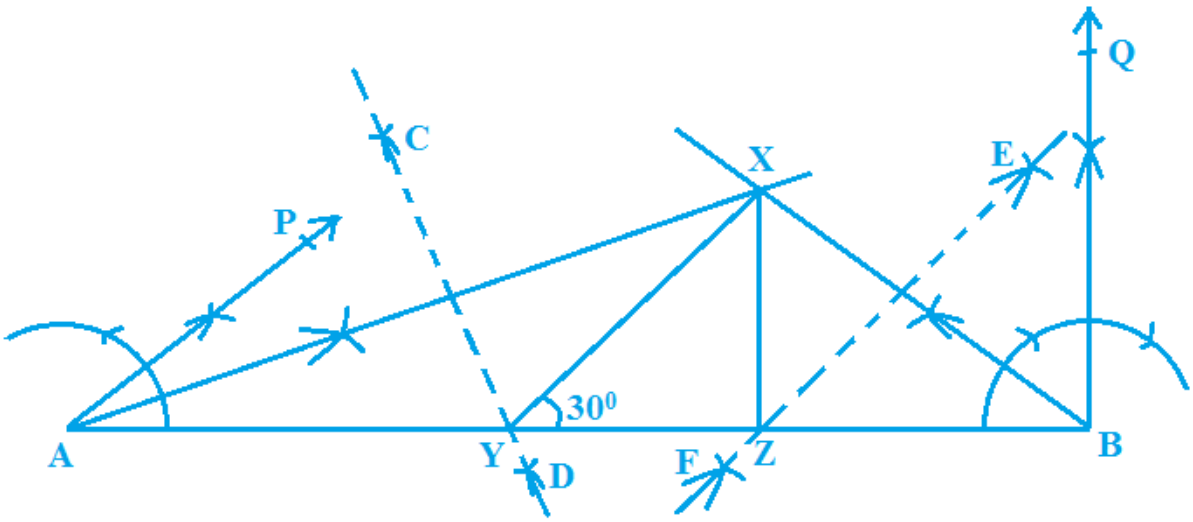
Then, Δ PQR is the required triangle.

4. Construct a triangle XYZ in which ∠Y = 30°, ∠Z = 90° and XY + YZ + ZX = 11 cm.

Ans **Given:** ∠ Y, ∠ Z and perimeter of ΔXYZ such that ∠Y = 30°, ∠Z = 90° and XY + YZ + ZX = 11 cm.

To Construct: Δ XYZ

Construction:



Steps of Construction:

1) Draw a line segment AB = 11 cm (XY + YZ + ZX).

2) At A, draw an angle of 30° and at B, draw an angle of 90° i.e. ∠ PAB = 30° and ∠ QBA = 90°.

3) Bisect ∠ PAB and ∠ QBA. Let these bisectors intersect each other at a point X.

4) Draw perpendicular bisectors CD of AX intersecting AB at Y and EF of BX intersecting AB at Z as shown in the figure.

5) Join XY and XZ.

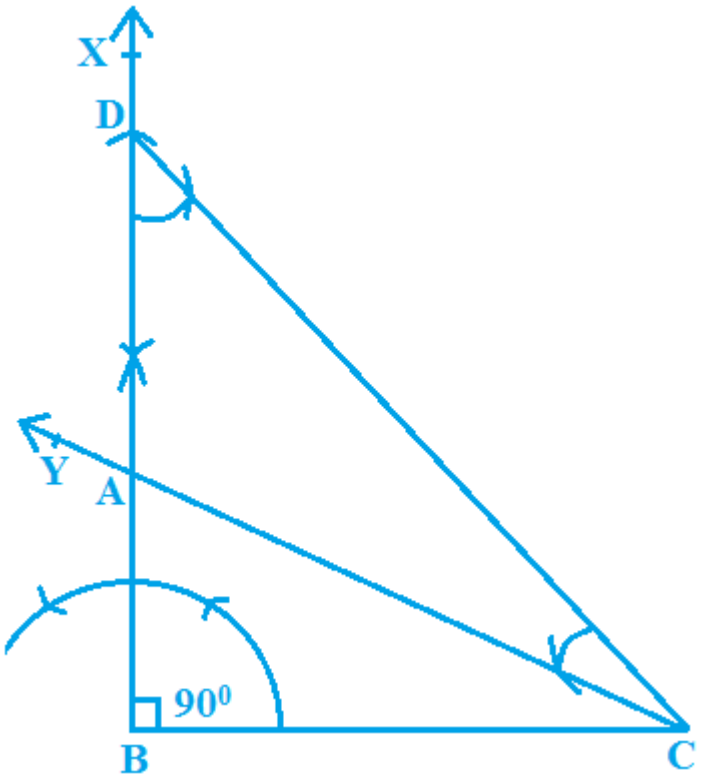
Then, Δ XYZ is the required triangle.

5. Construct a right triangle whose base is 12cm and sum of its hypotenuse and other side is 18 cm.

Ans **Given:** Base length and sum of hypotenuse and other side of a right angled Δ ABC, such that BC (base) = 12cm, ∠ B = 90° and AB (other side) + AC (hypotenuse) = 18 cm.

To Construct: Δ ABC

Construction:



Steps of Construction:

1) Draw the given base BC = 12 cm.

2) At B, draw an angle XBC such that ∠ XBC = 90°.

3) Cut the line segment BD equal to 18 cm (AB + AC) from the ray BX.

4) Join DC and draw ∠ DCY equal to ∠ BDC.

5) Let CY intersect BX at A as shown in the figure.

Then, Δ ABC is the required triangle.