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Chapter - 11: Constructions

Exercise 11.1 (Page 191 of Grade 9 NCERT Textbook)

Q1. Construct an angle of 90° at the initial point of a given ray and justify the construction.

Difficulty Level:

Easy

Known/given:

A ray on which 90-degree angle have to construct.

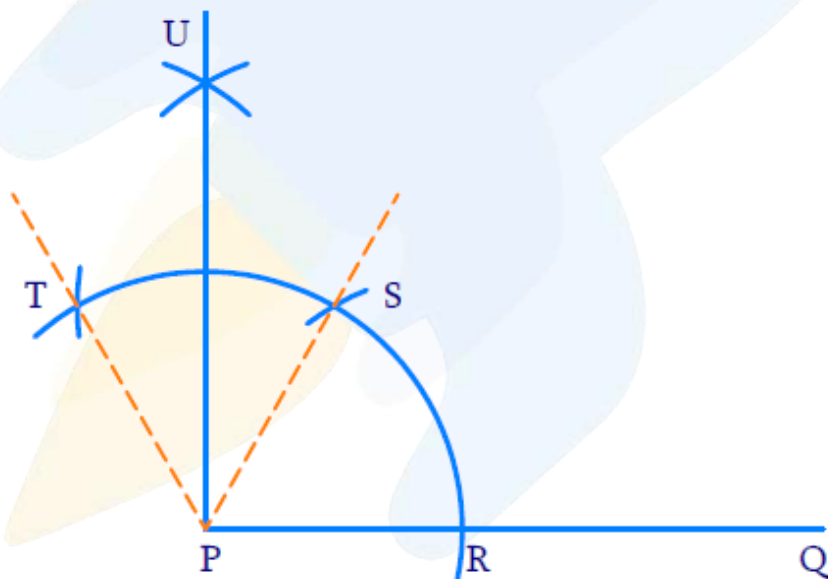
Unknown:

Construction of 90-degree angle and its justification.

Reasoning:

We need to construct two adjacent angles each of 60 degrees and bisect the second one to construct 90 degree.

Steps of Construction:



- (i) Draw ray PQ.
- (ii) To construct 60° angle.
Draw an arc of any radius with P as center intersecting PQ at R. With R as center and same radius draw an arc intersecting the previous arc at S. $\angle SPQ = 60^\circ$
- (iii) To construct adjacent 60° angle. With S as the center and same radius as before intersecting the initial arc at T. $\angle TPS$ will be 60°

(iv) To bisect $\angle TPS$:

With T and S as centers and same radius as before draw two arcs to intersect each other at U.

$$\angle UPS = \frac{1}{2} \angle TPS = 30^\circ$$

(v) Join P and U to get an angle of 90° at initial point P.

$$\begin{aligned} \angle UPQ &= \angle UPS + \angle SPR \\ &= 30^\circ + 60^\circ \\ &= 90^\circ \end{aligned}$$

Q2. Construct an angle of 45° at the initial point of a given ray and justify the construction.

Difficulty Level:

Easy

Known/given:

A ray on which 45-degree angle have to construct.

Unknown:

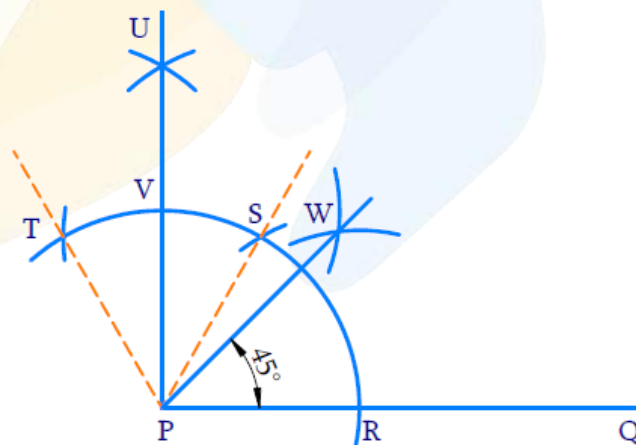
Construction of 45-degree angle and its justification.

Reasoning:

We need to construct two adjacent angles each of 60° and bisect the second one to construct 90° . Then bisect the 90° angle to get 45° .

$$\frac{60^\circ + \frac{60^\circ}{2}}{2} = 45^\circ$$

Steps of Construction:



(i) Draw ray PQ.

(ii) To construct an angle of 60° .

With P as center draw a wide arc of any radius to intersect the ray at R. With R as center and same radius draw an arc to intersect the initial one at S. $\angle SPR = 60^\circ$.

(iii) To construct adjacent angle of 60° .

With S as center and same radius draw an arc to intersect the previous arc at T.

$$\angle TPS = 60^\circ$$

(iv) To bisect $\angle TPS$

With T and S as center and same radius, draw arcs to intersect each other at U.

$$\angle UPS = \frac{1}{2} \angle TPS = 30^\circ$$

(v) Join P and U to intersect the initial arc at V.

$$\begin{aligned} \angle UPQ &= \angle UPS + \angle SPR \\ &= 30^\circ + 60^\circ \\ &= 90^\circ \end{aligned}$$

(vi) To bisect $\angle UPQ$

With R and V as centers and radius greater than half of RV, draw arc to intersect each other at W. Join PW. PW is the angle bisector of $\angle UPQ$

$$\begin{aligned} \angle WPQ &= \frac{1}{2} \angle UPQ \\ &= \frac{1}{2} \times 90^\circ \\ &= 45^\circ \end{aligned}$$

(vii) Ray PW forms an angle of 45° with ray PQ at the initial point.

Q3. Construct the angles of the following measurements:

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

Difficulty Level:

Medium

Known/given:

Measurement of angles.

Unknown:

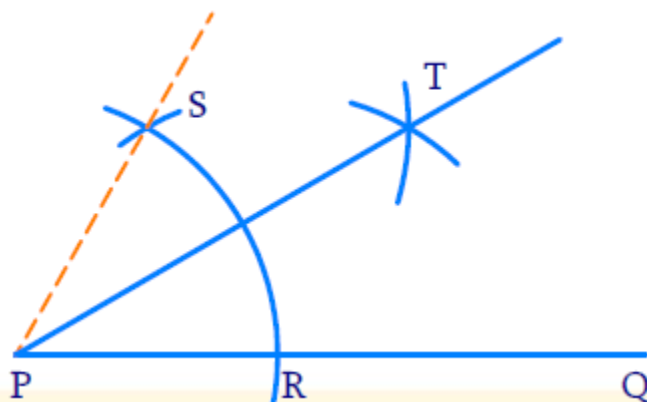
Constructions of angles

- (i) 30°

Reasoning:

We need to construct an angle of 60 degrees and then bisect it to get an angle measuring 30° .

Steps of Construction:



i) Draw ray PQ.

ii) To construct an angle of 60° .

With P as center and any radius, draw a wide arc to intersect PQ at R. With R as center and same radius draw an arc to intersect the initial arc at S. $\angle SPR = 60^\circ$

iii) (iii) To bisect $\angle SPR$

With R and S as centers and same radius draw two arcs to intersect at T. Join P and T i.e. PT is the angle bisector. Hence,

$$i. \quad \angle TPR = \frac{1}{2} \angle SPR = 30^\circ$$

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

Reasoning:

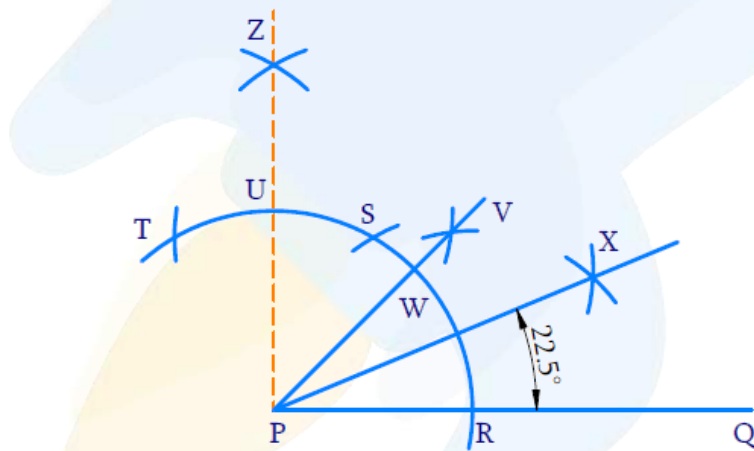
We need to construct two adjacent angles of 60° and bisect the second one to get a 90° angle. This has to be bisected again to get a 45° angle. The 45° angle has to be further

bisected to get $22\frac{1}{2}^\circ$ angle.

$$22\frac{1}{2}^\circ = \frac{45^\circ}{2}$$

$$45^\circ = \frac{90^\circ}{2} = \frac{30^\circ + 60^\circ}{2}$$

Steps of Construction:



i) Draw ray PQ

ii) To construct an angle of 60°

With P as center and any radius draw a wide arc to intersect PQ at R. With R as center and same radius draw an arc to intersect the initial arc at S. $\angle SPR = 60^\circ$

iii) To construct adjacent angle of 60° .

With S as the center and same radius as before, draw an arc to intersect the initial arc at T.

$$i. \quad \angle TPS = 60^\circ$$

iv) To bisect $\angle TPS$

With T and S as centers and same radius as before, draw arcs to intersect each other at Z. Join P and Z. $\angle ZPQ = 90^\circ$

v) To bisect $\angle ZPQ$

With R and U as centers and radius than half of RU, draw arcs to intersect each other at V. Join P and V. $\angle VPQ = 45^\circ$

vi) To bisect $\angle VPQ = 45^\circ$

With W and R as centers and radius greater than half of WR, draw arcs to intersect each other at X. Join P and X. PX bisects $\angle VPQ$

Hence,

$$\begin{aligned}\angle XPQ &= \frac{1}{2} \angle WPQ \\ &= \frac{1}{2} \times 45^\circ \\ &= 22\frac{1}{2}\end{aligned}$$

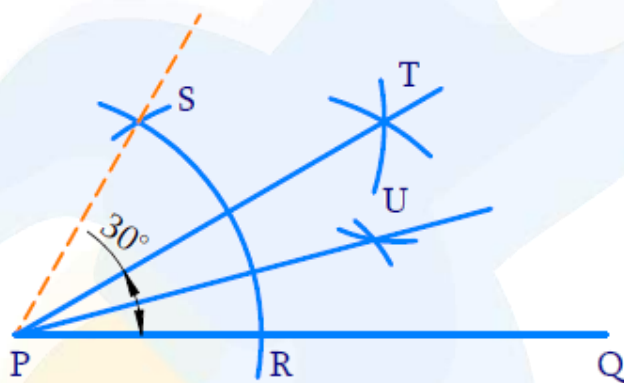
(iii) 15°

Reasoning:

We need to construct an angle of 60 degrees and then bisect it to get an angle measuring 30° . This has to be bisected again to get a 15° angle.

$$15^\circ = \frac{30^\circ}{2} = \frac{60^\circ}{2}$$

Steps of Construction:



- i) Draw ray PQ.
- ii) To construct an angle of 60° .
- iii) With P as center and any radius draw a wide arc to intersect PQ at R. With R as center and same radius draw an arc to intersect the initial arc at S. $\angle SPR = 60^\circ$
- iv) Bisect $\angle SPR$.
With R and S as centers and radius greater than half of RS, draw arcs to intersect each other at T. Join P and T i.e. PT is the angle bisector of $\angle SPR$.

$$\begin{aligned}\angle TPQ &= \frac{1}{2} \angle SPR \\ &= \frac{1}{2} \times 60^\circ \\ &= 30^\circ\end{aligned}$$

- (iv) To bisect $\angle TPQ$
With R and T as centers and radius greater than half of RT, draw arcs to intersect each other at U. Join P and U. PU is the angle bisector of $\angle TPQ$.

$$\angle UPQ = \frac{1}{2} \angle TPQ = 15^\circ$$

Q4. Construct the following angles and verify by measuring them by a protractor:

- (i) 75° (ii) 105° (iii) 135°

Difficulty Level:

Medium

Known/given:

Measurement of angles.

Unknown:

Constructions of angles

- (i) 75°

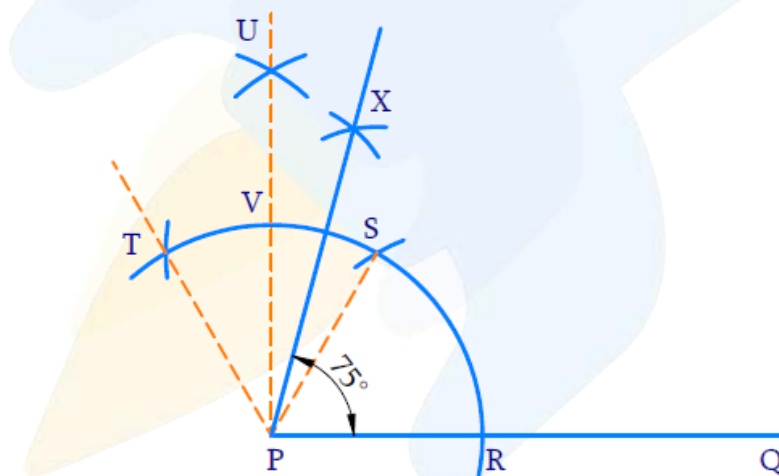
Reasoning:

We need to construct two adjacent angles of 60° . The second angle should be bisected twice to get a 15° angle.

$$75^\circ = 60^\circ + 15^\circ$$

$$15^\circ = \frac{30^\circ}{2} = \frac{60^\circ}{2} \div \frac{1}{2}$$

Steps of Construction:



- i) Draw ray PQ.
- ii) To construct an angle of 60° .
With P as center and any radius draw a wide arc to intersect PQ at R. With R as center and same radius draw an arc to intersect the initial arc at S.
 $\angle SPR = 60^\circ$
- iii) (iii) To construct adjacent angle of 60° with S as center and same radius draw an arc to T intersect the initial arc.
- iv) To bisect $\angle SPT$
With T and S as centers and same radius draw arcs to bisect each other at U. Join U and P. $\angle UPS = \frac{1}{2} \angle TPS = \frac{1}{2} \times 60^\circ = 30^\circ$

iv) To bisect $\angle UPS$

With V and S as centers and radius greater than half of VS draw arcs to intersect each other at X.

$$\angle XPS = \frac{1}{2} \angle UPS = \frac{1}{2} \times 30^\circ = 15^\circ$$

$$\begin{aligned} \angle XPQ &= \angle XPS + \angle SPQ \\ &= 15^\circ + 60^\circ \\ &= 75^\circ \end{aligned}$$

(ii) 105°

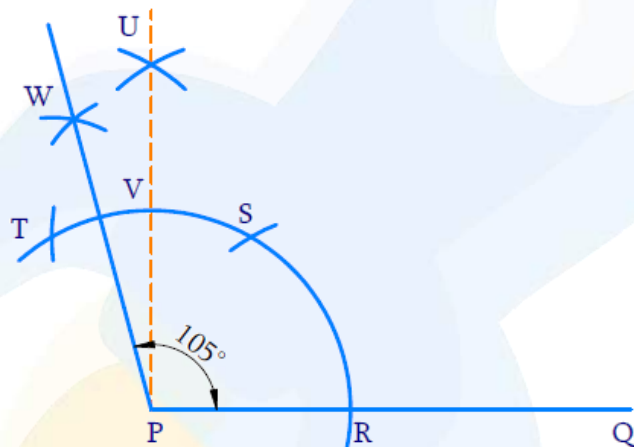
Reasoning:

We need to construct two adjacent angles of 60° . In the second angle we need to bisect it to get two 30° angles. The second 30° angle should be bisected again to get a 15° angle. Together we can make an angle of 105° .

$$105^\circ = 60^\circ + 45^\circ$$

$$105^\circ = 60^\circ + 30^\circ + 15^\circ$$

Steps of Construction:



- i) Draw ray PQ
- ii) To construct an angle of 60°
- iii) With P as centre and any radius draw a wide arc to intersect PQ at R. With R as centre and same radius draw an arc to intersect the initial arc at S. $\angle SPR = 60^\circ$
- iv) To construct an adjacent angle of 60° with S as the center and same radius as before draw an arc to intersect the initial arc at T. $\angle TPS = 60^\circ$
- v) To bisect $\angle TPS$
- vi) With T and S as centres and same radius draw arcs to bisect each other at U. Join U and P. $\angle UPS = \frac{1}{2} \angle TPS = \frac{1}{2} \times 60^\circ = 30^\circ$
- vii) To bisect $\angle UPT$
- viii) With T and V as centers and radius greater than half of TV, draw arcs to intersect each other at W. Join P and W.

$$\angle WPU = \frac{1}{2} \angle UPT = \frac{1}{2} \times 30^\circ = 15^\circ$$

$$\begin{aligned} \angle WPR &= \angle WPU + \angle UPS + \angle SPR \\ &= 15^\circ + 30^\circ + 60^\circ \\ &= 105^\circ \end{aligned}$$

(iii) 135°

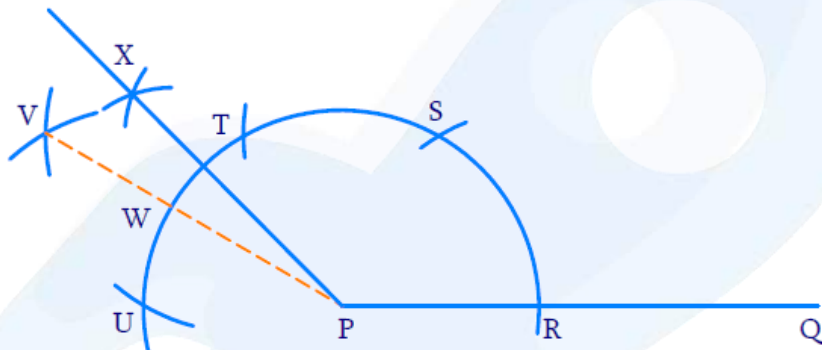
Reasoning:

We need to construct three adjacent angles of 60° each. The third angle should be bisected twice successively to get an angle of 15° . Together we will get an angle of 135° .

$$135^\circ = 15^\circ + 60^\circ + 60^\circ$$

$$15^\circ = \frac{60^\circ}{2} \div \frac{1}{2}$$

Steps of Construction:



- i) Draw ray PQ.
- ii) To construct an angle of 60° .
With P as the center and any radius draw an arc to intersect PQ at R.
 $\angle SPR = 60^\circ$
- iii) To construct adjacent angle of 60°
With S as center and same radius as before draw an arc to intersect the initial arc at T. $\angle TPS = 60^\circ$
- iv) To construct the second adjacent angle of 60°
With T as center and same radius as before draw an arc to intersect the initial arc at U.
 $\angle UPT = 60^\circ$.
- v) To bisect $\angle UPT$
With T and U as centers and same radius as before draw an arc to intersect each other at V.
 $\angle VPT = \angle VPU = \frac{1}{2} \angle UPT = \frac{1}{2} \times 60^\circ = 30^\circ$
- vi) To bisect $\angle VPT$
With W and T as centers and radius greater than half of WT, draw arcs to intersect each other at X.

$$\angle XPT = \angle XPV = \frac{1}{2} \angle VPT = \frac{1}{2} \times 30^\circ = 15^\circ$$

$$\begin{aligned} \angle XPQ &= \angle XPT + \angle TPS + \angle SPR \\ &= 15^\circ + 60^\circ + 60^\circ \\ &= 135^\circ \end{aligned}$$

Q5. Construct an equilateral triangle, given its side and justify the construction.

Difficulty Level:

Medium

Known/given:

An equilateral triangle to be constructed.

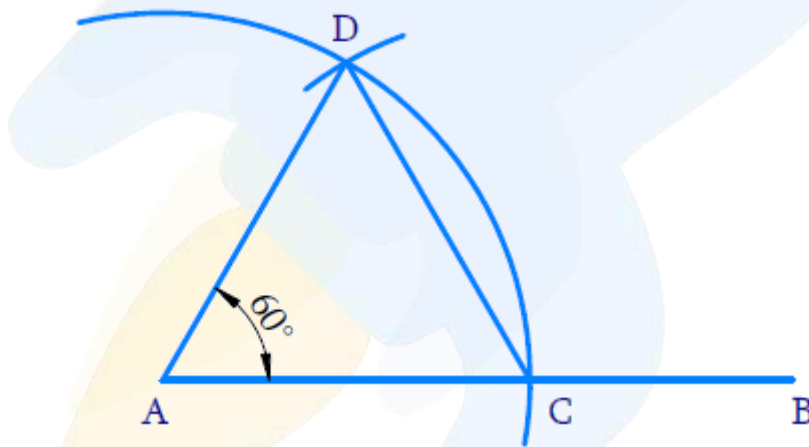
Unknown:

Construction of an equilateral triangle and its justification.

Reasoning:

An equilateral triangle has three equal sides and three angles equal to 60° . We know that how to construct an angle of 60° .

Steps of Construction:



- i) Draw ray AB
- ii) With A as center and radius equal to 3 cm, draw an arc to cut ray AB at C such that AC = 3 cm
- iii) (iii) With C as the center and radius equal to AC, draw an arc to intersect the initial arc at D.
- iv) Join AD and CD.
- v) Thus, Triangle ADC is an equilateral triangle.

Justification:

AC = AD (By construction since the radius of the arc is the same)

AC = CD (By construction since the same radius was used again)

$\therefore AC = AD = CD$

\therefore ADC is an equilateral triangle.

Chapter - 11: Constructions

Exercise 11.2 (Page 195 of Grade 9 NCERT Textbook)

Q1. Construct a triangle ABC in which $BC = 7$ cm, $\angle B = 75^\circ$ and $AB + AC = 13$ cm.

Difficulty Level:

Easy

Known/given:

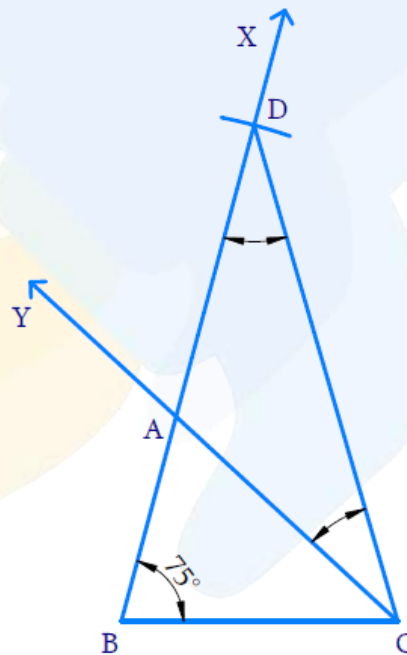
A triangle ABC in which $BC = 7$ cm, $\angle B = 75^\circ$ and $AB + AC = 13$ cm.

Unknown:

Construction of the triangle ABC.

Reasoning:

First of all draw base $BC = 7$ cm and at point B make an angle of 75° using protractor then draw an arc to intersect ray BX at D. Join DC, Measure $\angle D$ and make $\angle ACD = \angle D$.



Steps of Construction:

- i) Draw base $BC = 7$ cm and at point B make an angle of 75° using protractor.
- ii) With B as center and radius equal to 13cm, draw an arc to intersect ray BX at D.
- iii) Join DC
- iv) Measure $\angle D$ and make $\angle ACD = \angle D$
- v) Let CY intersect BD at A
- vi) ABC is the required triangle

Q2. Construct a triangle ABC in which $BC = 8\text{cm}$, $\angle B = 45^\circ$ and $AB - AC = 3.5\text{ cm}$.

Difficulty Level:
Medium

Known/given:

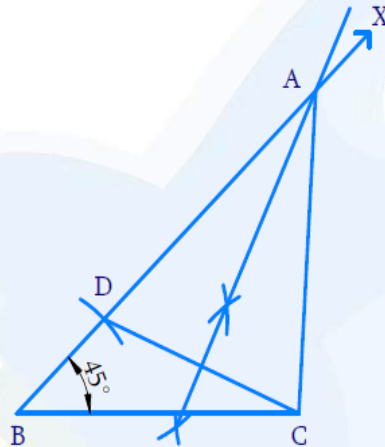
A triangle ABC in which $BC = 8\text{cm}$, $\angle B = 45^\circ$ and $AB - AC = 3.5\text{ cm}$.

Unknown:

Construction of the triangle ABC.

Reasoning:

First of all, draw base $BC = 8\text{cm}$ and at point B make an angle of 45° using a protractor. Draw an arc to intersect ray BX at D. Join DC and draw bisector of this which intersect ray BX at A. Join AC to get the required triangle.



Steps of Construction:

- i) Draw base $BC = 8\text{cm}$ and at point B make an angle of 45° using a protractor.
- ii) With B as centre and radius $BD = 3.5\text{ cm}$, draw an arc to intersect ray BX at D.
- iii) Join DC
- iv) With D and C as the centre and radius greater than half of DC. Draw arcs above and below the line to intersect ray BX at A.
- v) Join AC. ABC is the required triangle.

Q3. Construct a triangle PQR in which $QR = 6\text{cm}$, $\angle Q = 60^\circ$ and $PR - PQ = 2\text{cm}$.

Difficulty Level:
Medium

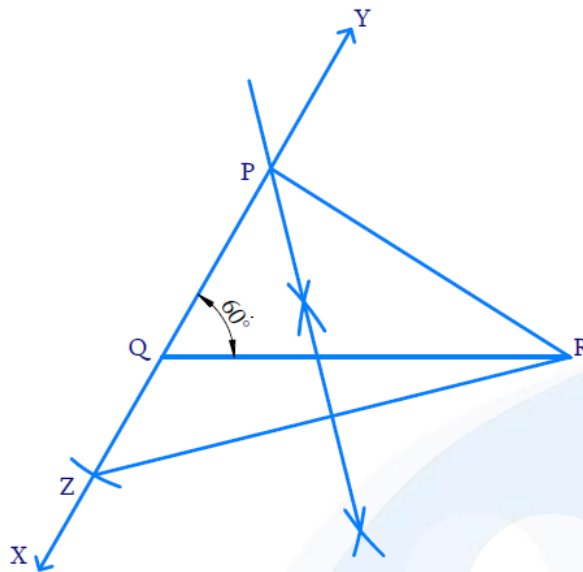
Known/given:

A triangle PQR in which $QR = 6\text{cm}$, $\angle Q = 60^\circ$ and $PR - PQ = 2\text{cm}$.

Unknown:

Construction of the triangle PQR.

First of all draw line $QR = 6$ cm. Make an angle of 60° at a point Q using a protractor and extend it below line QR . Mark an arc at a distance of 2cm from Q as Z and join RZ . Draw perpendicular bisector of RZ which cuts the arm of angle P . Now join PR to get the required triangle.



Steps of Construction:

- i) Draw line $QR = 6$ cm. Make an angle of 60° at a point Q using a protractor and extend it below line QR .
- ii) With Q as center and radius as 2 cm, draw an arc to intersect the ray QX at Z .
- iii) Join RZ
- iv) With Z and R as centres and radius greater than half of ZR , draw arcs on either side to intersect each other.
- v) Join the intersecting points and extend it to meet the ray QY at P .
- vi) Join P and R . PQR is the required triangle.

Q4. Construct a triangle XYZ in which $\angle Y = 30^\circ$, $\angle Z = 90^\circ$ and $XY + YZ + ZX = 11$ cm.

Difficulty Level:

Medium

Known/given:

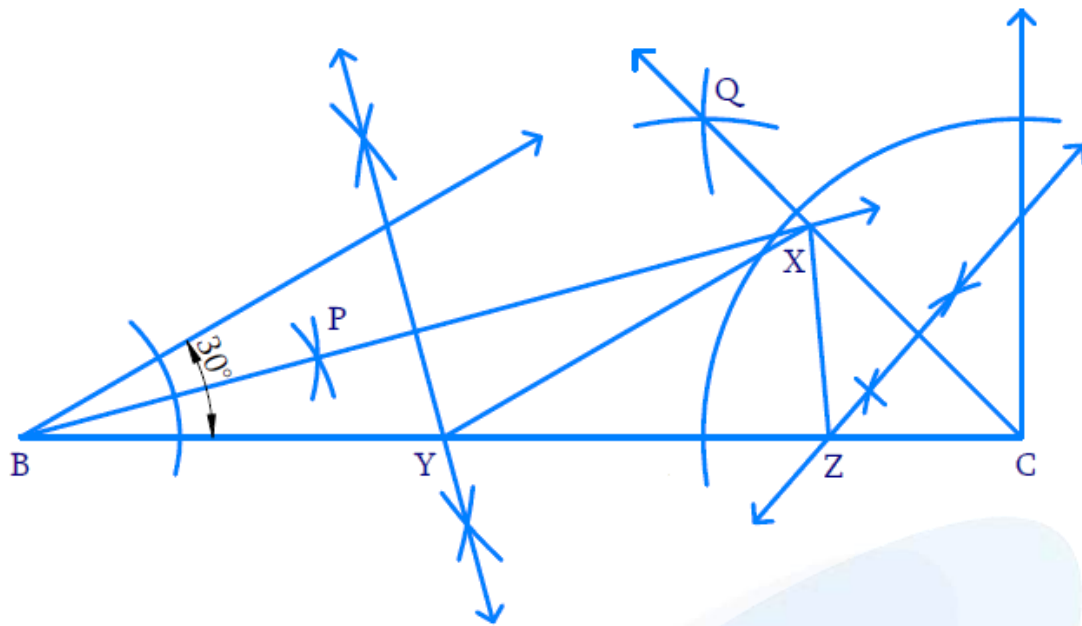
A triangle XYZ in which $\angle Y = 30^\circ$, $\angle Z = 90^\circ$ and $XY + YZ + ZX = 11$ cm.

Unknown:

Construction of the triangle XYZ .

Reasoning:

Draw line $BC = 11$ cm. Make angle of 30° at B and 90° at C using a protractor. Bisect angles B and C and these bisectors will meet at one-point X . Now draw perpendicular bisectors on BX and CX which will cut the line segment BC on point Y and Z . Now join XY and XZ to get the required triangle.



Steps of Construction:

- i) Draw line $BC = 11$ cm.
- ii) Make angle of 30° at B and 90° at C using a protractor.
- iii) Bisect angle B. With B as center and any radius draw a wide arc to intersect both the arms of angle B.
- iv) With intersecting points as the center and same radius draw two arcs to intersect each other at P. Draw line joining B and P and extend it beyond P.
- v) Bisect angle C. With C as the center and radius draw two arcs to intersect each other at Q. Join Q and C such that it intersects ray BP at X.
- vi) Draw perpendicular bisector of BX.
With B and X as centers and radius greater than half of BX draw arcs on either side of line BX to intersect each other. Join the intersecting lines such that the perpendicular bisector intersects BC at Y.
- vii) Perpendicular bisector of CX.
With C and X as centers and radius greater than half of CX draw arcs on either side of line CX to intersect each other. Join the intersecting lines such that the perpendicular bisector intersects BC at Z.
- viii) Join XY and XZ. XYZ is the required triangle.

Q5. Construct a right triangle whose base is 12 cm and sum of its hypotenuse and other side is 18 cm.

Difficulty Level:

Medium

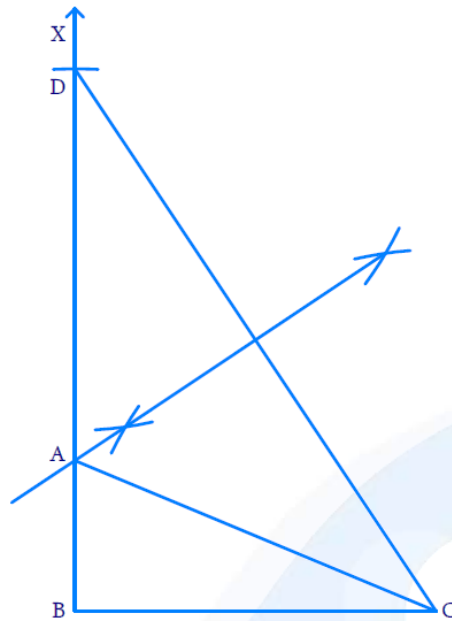
Known/given:

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

Unknown:

Construction of the right triangle.

Draw the base $BC = 12$ cm. Make an angle $CBX = 90^\circ$ using a protractor. Cut a line segment $BD = 18$ cm from the ray BX and Join DC . Now draw perpendicular bisector of CD which intersect the arm of angle CBX at point A . Join AC to get the required triangle.



Steps of Construction:

- i) Draw the base $BC = 12$ cm.
- ii) At the point B , make an angle $CBX = 90^\circ$ using a protractor.
- iii) Cut a line segment $BD = 18$ cm from the ray BX .
- iv) (iv) Join DC
- v) With D and C as the centres and radius greater than half of DC draw arcs on either side of the line to intersect each other. Join the intersecting points and extend the perpendicular bisector to meet BD at A .
- vi) Join A and C . ABC is the required right-angled triangle

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