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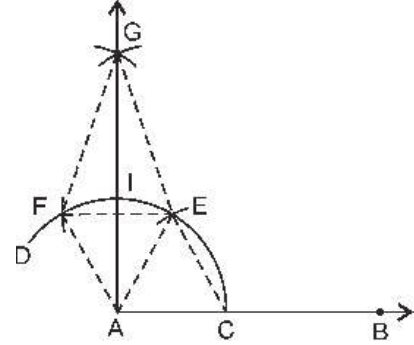
CONSTRUCTIONS

EXERCISE 11.1

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

Steps of Construction

- (i) Let us take a ray AB with initial point A.
- (ii) Taking A as centre and some radius, draw an arc of a circle, which intersects AB at C.
- (iii) With C as centre and the same radius as before, draw an arc, intersecting the previous arc at E.
- (iv) With E as centre and the same radius, as before, draw an arc, which intersects the arc drawn in step (ii) at F.
- (v) With E as centre and some radius, draw an arc.
- (vi) With F as centre and the same radius as before, draw another arc, intersecting the previous arc at G.
- (vii) Draw the ray AG.



Then $\angle BAG$ is the required angle of 90° .

Justification : Join AE, CE, EF, FG and GE

$AC = CE = AE$ [By construction]

$\Rightarrow \triangle ACE$ is an equilateral triangle

$\Rightarrow \angle CAE = 60^\circ$... (i)

Similarly, $\angle AEF = 60^\circ$... (ii)

From (i) and (ii), $FE \parallel AC$... (iii) [Alternate angles are equal]

Also, $FG = EG$ [By construction]

$\Rightarrow G$ lies on the perpendicular bisector of EF

$\Rightarrow \angle GIE = 90^\circ$... (iv)

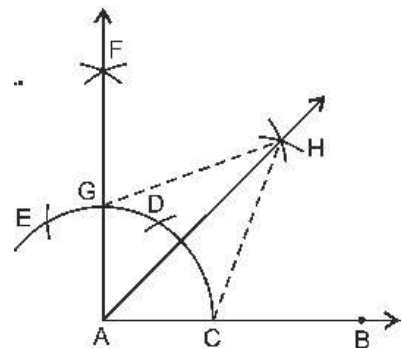
$\therefore \angle GAB = \angle GIE = 90^\circ$ [Corresponding angles]

$GF = GE$ [Arcs of equal radii]

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

Steps of Construction

- (i) Let us take a ray AB with initial point A.
- (ii) Draw $\angle BAF = 90^\circ$, as discussed in Q. 1.
- (iii) Taking C as centre and radius more than $\frac{1}{2}$ CG, draw an arc.
- (iv) Taking G as centre and the same radius as before, draw another arc, intersecting the previous arc at H.
- (v) Draw the ray AH. Then $\angle BAH$ is the required angle of 45° .



Justification : Join GH and CH.

In $\triangle AHG$ and $\triangle AHC$, we have

$$HG = HC$$

[Arcs of equal radii]

$$AG = AC$$

[Radii of the same arc]

$$AH = AH$$

[Common]

$$\therefore \triangle AHG \cong \triangle AHC$$

[SSS congruence]

$$\Rightarrow \angle HAG = \angle HAC$$

[CPCT] ... (i)

$$\text{But } \angle HAG + \angle HAC = 90^\circ$$

[By construction] ... (ii)

$$\Rightarrow \angle HAG = \angle HAC = 45^\circ$$

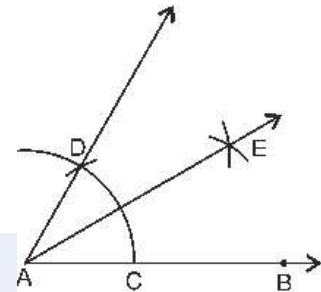
[From (i) and (ii)]

Q.3. Construct the angles of the following measurements.

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

(i) Steps of Construction

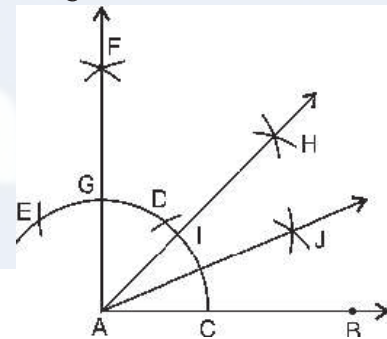
- Draw a ray AB, with initial point A.
- With A as centre and some convenient radius, draw an arc, intersecting AB at C.
- With C as centre and the same radius as before, draw another arc, intersecting the previously drawn arc at D.
- Draw ray AD.



- Now, taking C and D as centres and with the radius more than $\frac{1}{2} DC$, draw arcs to intersect each other at E.
- Draw ray AE. Then $\angle BAE$ is the required angle of 30° .

(ii) Steps of Construction

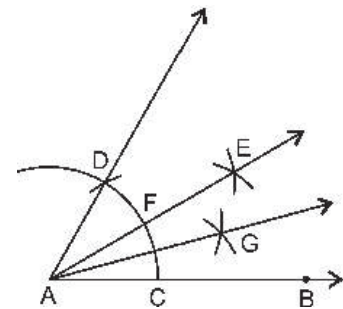
- Draw a ray AB with initial point A.
- Draw $\angle BAH = 45^\circ$ as discussed in Q. 2.
- Taking I and C as centres and with the radius more than $\frac{1}{2} CI$, draw arcs to intersect each other at J.



- Draw ray AJ. Then $\angle BAJ$ is the required angle of $22\frac{1}{2}^\circ$.

(iii) Steps of Construction

- Draw $\angle BAE = 30^\circ$ as discussed in part (i).
- Taking C and F as centres and with the radius more than $\frac{1}{2} CF$, draw arcs to intersect each other at G.
- Draw ray AG. Then $\angle BAG$ is the required angle of 15° .

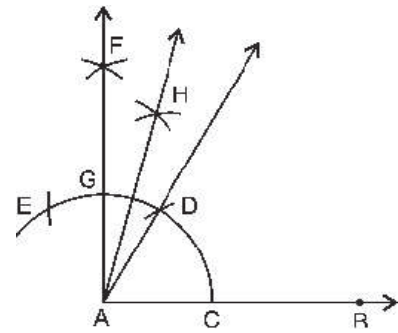


Q.4. Construct the following angles and verify by measuring them by a protractor.

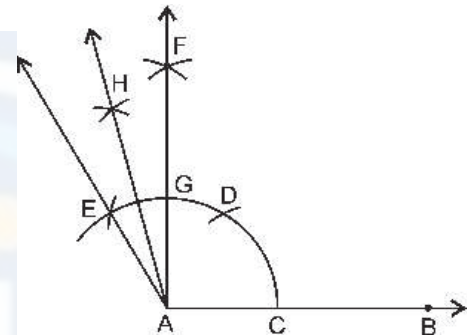
- (i) 75° (ii) 105° (iii) 135°

(i) Steps of Construction

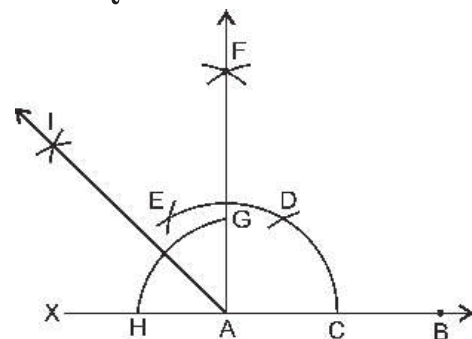
- Draw a ray AB with initial point A.
- With A as centre and any convenient radius, draw an arc, intersecting AB at C.
- With C as centre and the same radius, draw an arc, cutting the previous arc at D.
- With D as centre and the same radius, draw another arc, cutting the arc drawn in step (b) at E.
- With D and E as centres and some radius, draw arcs to intersect each other at F.
- Draw ray AF and AD.
- With D and G as centres, and radius more than $\frac{1}{2}GD$, draw arcs to intersect each other at H.
- Draw ray AH. Then $\angle BAH$ is the required angle of 75° .
On measuring using a protractor, we find that $\angle BAH = 75^\circ$.

**(ii) Steps of Construction**

- At A, draw an $\angle BAF = 90^\circ$, as discussed in Q. 1.
- With A as centre and some convenient radius, draw an arc, intersecting AB at C.
- With C as centre and the same radius, draw an arc, which cuts the previous arc at D.
- With D as centre and the same radius, draw an arc, which cuts the arc drawn in step (b) at E.
- Draw ray AE.
- With G and E as centres and radius more than $\frac{1}{2}GE$, draw arcs to intersect each other at H.
- Join AH. Then $\angle BAH$ is the required angle of 105° .
On measuring using a protractor, we find that $\angle BAH = 105^\circ$.

**(iii) Steps of Construction**

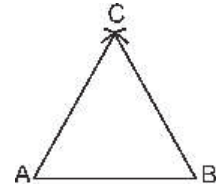
- At A, draw angle $BAF = 90^\circ$, as discussed in Q.1.
- Produce BA to X.
- With A as centre and some convenient radius, draw an arc, which cuts AF and AX at G and H respectively.
- With G and H as centres and radius more than $\frac{1}{2}GH$, draw arcs to intersect each other at I.
- Draw ray AI. Then $\angle BAI$ is the required angle of 135° .
On measuring using a protractor, we find that $\angle BAI = 135^\circ$.



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

(i) Steps of Construction

- (i) Draw a line segment AB of given length.
- (ii) With A and B as centres and radius equal to AB, draw arcs to intersect each other at C.
- (iii) Join AC and BC. Then ABC is the required equilateral triangle.



Justification : $AB = AC$ [By construction]

$AB = BC$ [By construction]

$\Rightarrow AB = AC = BC$

Hence, $\triangle ABC$ is an equilateral triangle.



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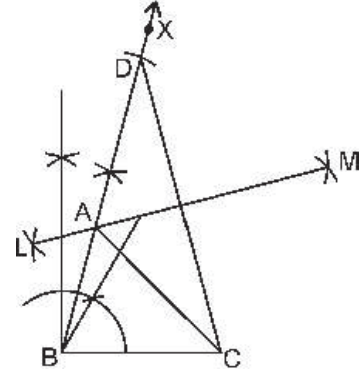
11 | CONSTRUCTIONS

EXERCISE 11.2

Q.1. Construct a triangle ABC in which $BC = 7$ cm, $\angle B = 75^\circ$ and $AB + AC = 13$ cm.

Steps of Construction

- (i) Draw a line segment $BC = 7$ cm.
- (ii) At B , draw $\angle CBX = 75^\circ$.
- (iii) Cut a line segment $BD = 13$ cm from BX .
- (iv) Join DC
- (v) Draw the perpendicular bisector LM of CD , which intersects BD at A .
- (vi) Join AC . Then ABC is the required triangle.



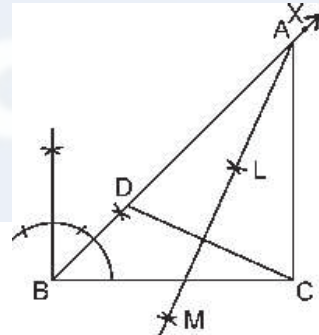
Justification : In $\triangle ACD$, we have

$$\begin{aligned} AC &= AD && [A \text{ lies on the perpendicular bisector of } DC.] \\ AB &= BD - AD \\ &= BD - AC \\ \Rightarrow AB + AC &= BD \end{aligned}$$

Q.2. Construct a triangle ABC , in which $BC = 8$ cm, $\angle B = 45^\circ$ and $AB - AC = 3.5$ cm.

Steps of Construction

- (i) Draw a line segment $BC = 3.5$ cm
- (ii) At B , draw $\angle CBX = 45^\circ$.
- (iii) From BX , cut off $BD = 3.5$ cm.
- (iv) Join DC .
- (v) Draw the perpendicular bisector LM of DC , which intersects BX at A .
- (vi) Join AC . Then ABC is the required triangle.



Justification : In $\triangle ADC$,

$$\begin{aligned} AD &= AC && [A \text{ lies on the perpendicular bisector of } DC] \\ BD &= AB - AD \\ \Rightarrow BD &= AB - AC \end{aligned}$$

Q.3. Construct a triangle PQR in which $QR = 6$ cm, $\angle Q = 60^\circ$ and $PR - PQ = 2$ cm.

Steps of Construction

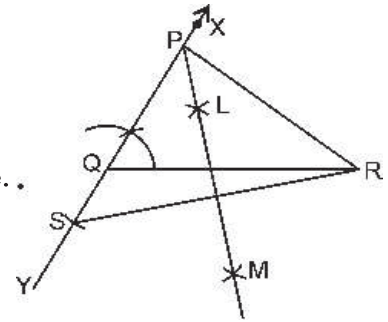
- (i) Draw a line segment $QR = 6$ cm
- (ii) At Q , draw $\angle RQX = 60^\circ$.

- (iii) Produce XQ to Y.
- (iv) Cut off QS = 2 cm from QY.
- (v) Join SR.
- (vi) Draw the perpendicular bisector LM of SR, which intersect QX at P.
- (vii) Join PR. Then PQR is the required triangle.

Justification : In ΔPSR , we have

$$SP = PR \quad [P \text{ lies on the perpendicular bisector of } SR]$$

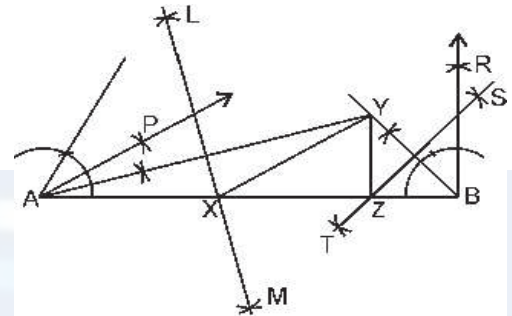
$$\begin{aligned} QS &= PS - PQ \\ &= PR - PQ \end{aligned}$$



Q.4. Construct a ΔXYZ in which $\angle X = 30^\circ$, $\angle Z = 90^\circ$ and $XY + YZ + ZX = 11$ cm.

Steps of Construction

- (i) Draw a line segment $AB = 11$ cm
- (ii) At A, draw $\angle BAP = 30^\circ$ and at B, draw $\angle ABR = 90^\circ$
- (iii) Draw the bisector of $\angle BAP$ and $\angle ABR$, which intersect each other at Y.
- (iv) Join AY and BY.
- (v) Draw the perpendicular bisectors LM and ST of AY and BY respectively. LM and ST intersect AB at X and Z respectively.
- (vi) Join XY and YZ. Then XYZ is the required triangle.



Justification : In ΔAXY , we have

$$AX = XY \quad [X \text{ lies on the perpendicular bisector of } AY] \dots (i)$$

$$\text{Similarly, } ZB = YZ \quad \dots (ii)$$

$$\therefore XY + YZ + ZX = AX + ZB + ZX \quad [\text{From (i) and (ii)}]$$

$$= AB$$

$$\text{From (i), } AX = AY$$

$$\Rightarrow \angle XAY = \angle XYA \quad [\text{Angles opposite to equal sides are equal}] \dots (iii)$$

$$\text{In } \Delta AXY, \angle YXZ = \angle XAY + \angle XYA \quad [\text{Exterior angle is equal to sum of interior opposite angles}]$$

$$\Rightarrow \angle YXZ = 2\angle XAY \quad [\text{From (iii)}]$$

$$\Rightarrow \angle YXZ = \angle XAP \quad [\because AY \text{ bisects } \angle XAP]$$

$$\text{Similarly, } \angle YZB = \angle ZBR.$$

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

Steps of Construction

- (i) Draw a line segment $AB = 12$ cm.
- (ii) At A, draw $\angle BAX = 90^\circ$.
- (iii) From AX, cut off $AD = 18$ cm.
- (iv) Join DB.
- (v) Draw the perpendicular bisector LM of BD, which intersects AD at C.
- (vi) Join BC. Then ΔABC is the required triangle.

