

## 11

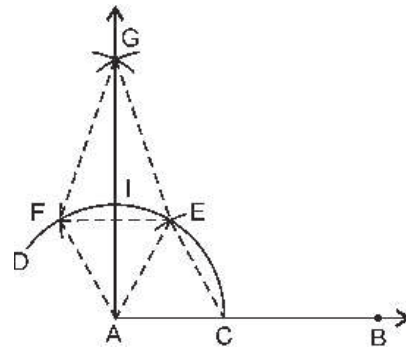
## CONSTRUCTIONS

## EXERCISE 11.1

**Q.1.** Construct an angle of  $90^\circ$  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 F as centre and the same radius as before, draw another arc, intersecting the previous arc at G.
- (vi) Draw the ray AG.



Then  $\angle BAG$  is the required angle of  $90^\circ$ .

**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)

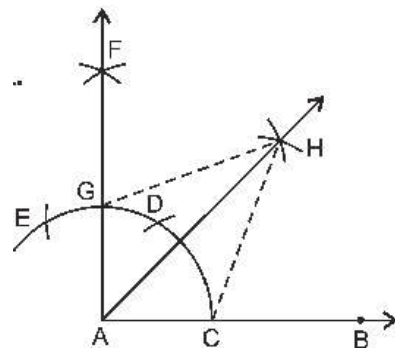
$\therefore \angle GAB = \angle GIE = 90^\circ$  [Corresponding angles]

$GF = GE$  [Arcs of equal radii]

**Q.2.** Construct an angle of  $45^\circ$  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  $\frac{1}{2} AC$ , 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  $45^\circ$ .



**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)  $30^\circ$

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

(iii)  $15^\circ$

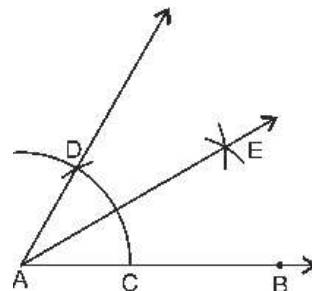
**(i) Steps of Construction**

(a) Draw a ray AB, with initial point A.

(b) With A as centre and some convenient radius, draw an arc, intersecting AB at C.

(c) With C as centre and the same radius as before, draw another arc, intersecting the previously drawn arc at D.

(d) Draw ray AD.



(e) 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.

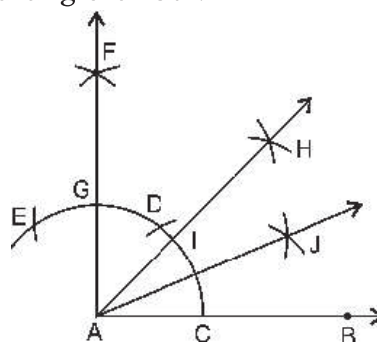
(f) Draw ray AE. Then  $\angle BAE$  is the required angle of  $30^\circ$ .

**(ii) Steps of Construction**

(a) Draw a ray AB with initial point A.

(b) Draw  $\angle BAH = 45^\circ$  as discussed in Q. 2.

(c) Taking I and C as centres and with the radius more than  $\frac{1}{2} CI$ , draw arcs to intersect each other at J.



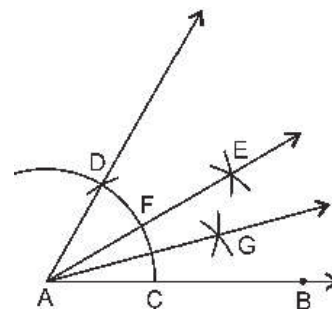
(d) Draw ray AJ. Then  $\angle BAJ$  is the required angle of  $22\frac{1}{2}^\circ$ .

**(iii) Steps of Construction**

(a) Draw  $\angle BAE = 30^\circ$  as discussed in part (i).

(b) Taking C and F as centres and with the radius more than  $\frac{1}{2} CF$ , draw arcs to intersect each other at G.

(c) Draw ray AG. Then  $\angle BAG$  is the required angle of  $15^\circ$ .



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

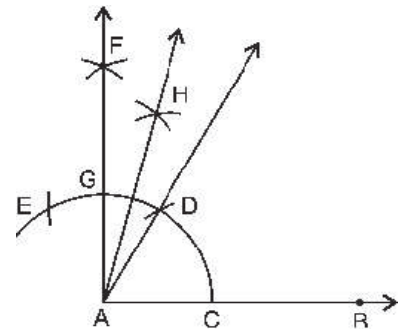
(i)  $75^\circ$

(ii)  $105^\circ$

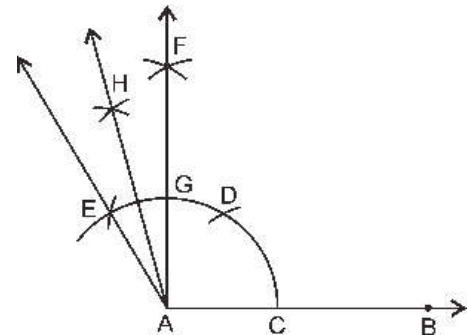
(iii)  $135^\circ$

**(i) Steps of Construction**

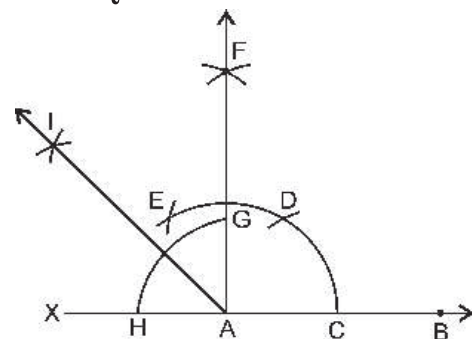
- Draw a ray AB with initial point A.
- With A as centre and any convenient radius, draw an arc, intersecting AB at C.
- With C as centre and the same radius, draw an arc, cutting the previous arc at D.
- With D as centre and the same radius, draw another arc, cutting the arc drawn in step (b) at E.
- 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  $75^\circ$ .  
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  $105^\circ$ .  
On measuring using a protractor, we find that  $\angle BAH = 105^\circ$ .

**(iii) Steps of Construction**

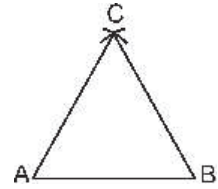
- At A, draw angle  $BAF = 90^\circ$ , as discussed in Q.1.
- Produce BA to X.
- With A as centre and some convenient radius, draw an arc, which cuts AF and AX at G and H respectively.
- With G and H as centres and radius more than  $\frac{1}{2}GH$ , draw arcs to intersect each other at I.
- Draw ray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

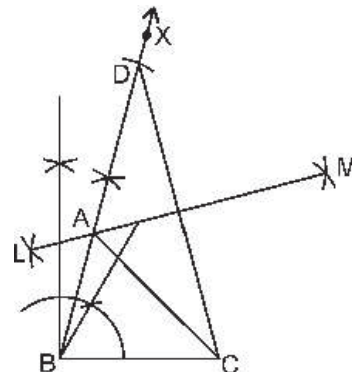
# 11 CONSTRUCTIONS

## 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

$$AC = AD \quad [A \text{ lies on the perpendicular bisector of } DC.]$$

$$AB = BD - AD$$

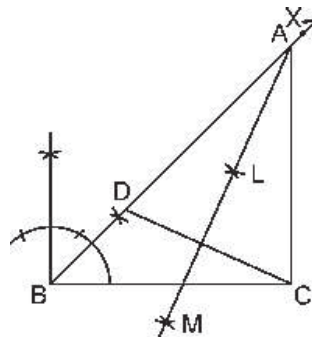
$$= BD - AC$$

$$\Rightarrow AB + AC = BD$$

**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  $\triangle ADC$ ,

$$AD = AC \quad [A \text{ lies on the perpendicular bisector of } DC]$$

$$BD = AB - AD$$

$$\Rightarrow BD = AB - AC$$

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

### Steps of Construction

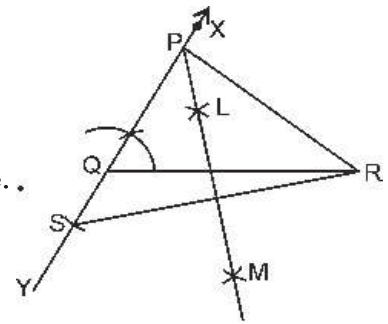
- (i) Draw a line segment  $QR = 6$  cm
- (ii) At  $Q$ , draw  $\angle RQX = 60^\circ$ .

- (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  $\triangle PSR$ , we have

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

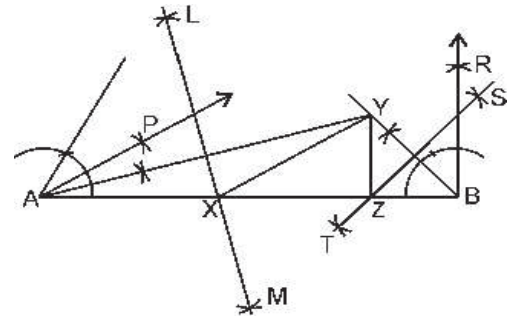
$$\begin{aligned} QS &= PS - PQ \\ &= PR - PQ \end{aligned}$$



**Q.4.** Construct a  $\triangle XYZ$  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  $\triangle AXY$ , we have

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

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

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

$$= AB$$

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

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

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

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

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

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

**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  $\triangle ABC$  is the required triangle.

