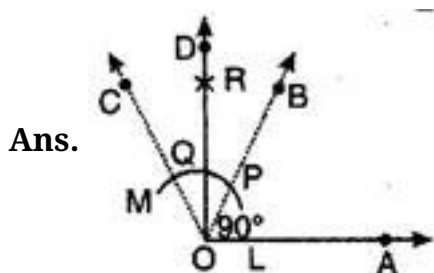


CBSE Class 9 Mathematics
NCERT Solutions
CHAPTER 11
Constructions(Ex. 11.1)

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



Steps of construction:

(a) Draw a ray OA.

(b) With O (initial point of a ray OA) as centre and convenient radius, draw an arc LM cutting OA at L.

(c) Now with L as centre and radius OL, draw an arc cutting the arc LM at P.

(d) Then taking P as centre and radius OL, draw an arc cutting arc PM at the point Q.

(e) Join OP to draw the ray OB. Also join O and Q to draw the OC. We observe that:

$$\angle AOB = \angle BOC = 60^\circ$$

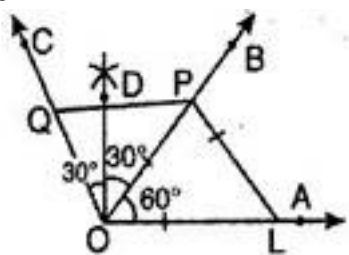
(f) Now we have to bisect $\angle BOC$. For this, with P as centre and radius greater than $\frac{1}{2} PQ$ draw an arc.

(g) Now with Q as centre and the same radius as in step 6, draw another arc cutting the arc drawn in step 6 at R.

(h) Join O and R and draw ray OD.

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

Justification:



Join PL, then $OL = OP = PL$ [by construction]

Therefore $\triangle POL$ is an equilateral triangle and $\angle POL$ which is same as $\angle BOA$ is equal to 60° .

Now join QP, then $OP = OQ = PQ$ [by construction]

Therefore $\triangle OQP$ is an equilateral triangle.

$\therefore \angle POQ$ which is same as $\angle BOC$ is equal to 60° .

By construction OD is bisector of $\angle BOC$.

$$\therefore \angle DOC = \angle DOB = \frac{1}{2} \angle BOC = \frac{1}{2} \times 60^\circ = 30^\circ$$

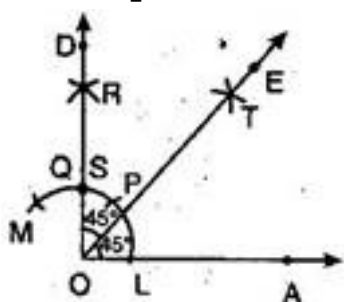
Now, $\angle DOA = \angle BOA + \angle DOB$

$$\Rightarrow \angle DOA = 60^\circ + 30^\circ$$

$$\Rightarrow \angle DOA = 90^\circ$$

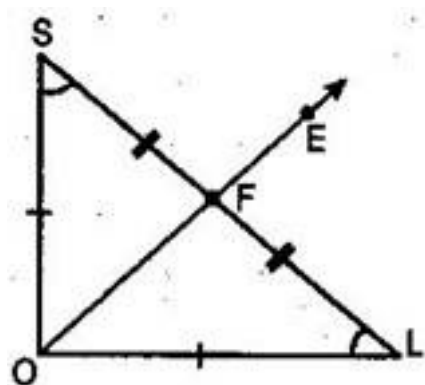
2. Construct an angle of 45° at the initial point of a given ray and justify the construction.

Ans. Steps of construction:



- (a) Draw a ray OA.
- (b) With O as centre and convenient radius, draw an arc LM cutting OA at L.
- (c) Now with L as centre and radius OL, draw an arc cutting the arc LM at P.
- (d) Then taking P as centre and radius OL, draw an arc cutting arc PM at the point Q.
- (e) With P and Q as centres and radius greater than ED, draw two arcs intersecting each other at R and let OR intersect the arc PM at S. Then, we get $\angle ROA = 90^\circ$
- (f) Now we have to bisect $\angle ROA$. With L as centre and radius greater than $\frac{1}{2} LS$, draw an arc.
- (g) Now with S as centre and the same radius as in step 2, draw another arc cutting the arc draw in step 2 at T.
- (h) Join O and T and draw ray OE.

Thus OE bisects $\angle AOD$ and therefore $\angle AOE = \angle DOE = 45^\circ$



Justification:

Join LS then $\triangle OLS$ is isosceles right triangle, right angled at O.

$$\therefore OL = OS$$

Therefore, O lies on the perpendicular bisector of SL.

$$\therefore SF = FL$$

And $\angle OFS = \angle OFL$ [Each 90°]

Now in $\triangle OFS$ and $\triangle OFL$,

$OF = OF$ [Common]

$OS = OL$ [By construction]

$SF = FL$ [Proved]

$\therefore \triangle OFS \cong \triangle OFL$ [By SSS rule]

$\Rightarrow \angle SOF = \angle LOF$ [By CPCT]

Now $\angle SOF + \angle LOF = \angle SOL$

$\Rightarrow \angle SOF + \angle LOF = 90^\circ$

$\Rightarrow 2\angle LOF = 90^\circ$

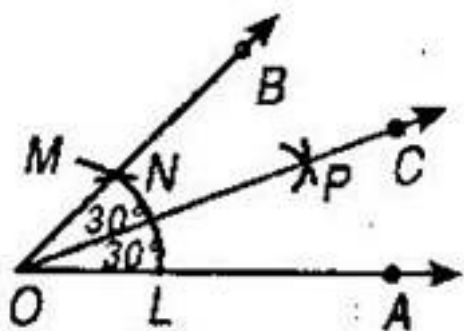
$\Rightarrow \angle LOF = \frac{1}{2} \times 90^\circ = 45^\circ$

And $\angle AOE = 45^\circ$

3. Construct the angles of the following measurements:

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

Ans. (i) 30° Steps of construction:



(a) Draw a ray OA.

(b) With O as centre and a suitable radius, draw an arc LM that cuts OA at L.

(c) With L as centre and radius OL, draw an arc to cut LM at N.

(d) Join O and N draw ray OB. Then $\angle AOB = 60^\circ$.

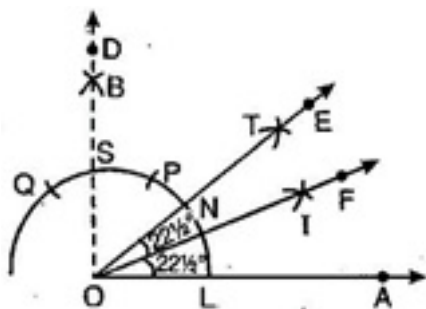
(e) With L as centre and radius greater than $\frac{1}{2} LN$, draw an arc.

(f) Now with N as centre and same radius as in step 5, draw another arc cutting the arc drawn in step 5 at P.

(g) Join O and P and draw ray OC. Thus OC bisects $\angle AOB$ and therefore $\angle AOC = \angle BOC = 30^\circ$

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

Steps of construction:



(a) Draw a ray OA.

(b) With O as centre and convenient radius, draw an arc LM cutting OA at L.

(c) Now with L as centre and radius OL, draw an arc cutting the arc LM at P.

(d) Then taking P as centre and radius OL, draw an arc cutting arc PM at the point Q.

(e) With P and Q as centres and radius greater than PQ, draw two arcs intersecting each other at B and let OB intersect the arc PQ at S. Then we get $\angle AOB = 90^\circ$.

(f) Now we have to bisect $\angle BOA$. For this, with L as centre and radius greater than $\frac{1}{2} LS$ draw an arc.

(g) Now with S as centre and the same radius as in step 6, draw another arc cutting the arc drawn in step 6 at T.

(h) Join O and T and draw ray OE. Then $\angle AOE$ is the required angle of 45° .

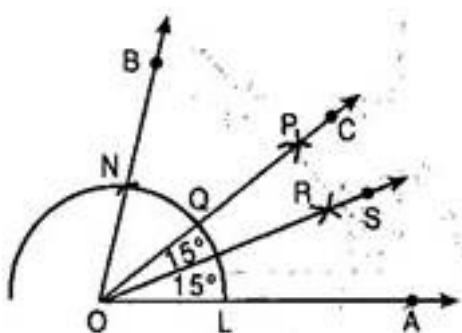
(i) With L as centre and radius greater than $\frac{1}{2} LP$, draw an arc.

(j) Now with PS as centre and the same radius as in step 6, draw another arc cutting the arc drawn in step 7 at I.

(k) Join O and I and draw ray OF. Thus OF bisects $\angle AOE$ and therefore $\angle AOF = \angle FOE = 22\frac{1}{2}^\circ$.

(iii) 15°

Steps of construction:



(a) Draw a ray OA.

(b) With O as centre and a suitable radius, draw an arc LM that cuts OA at L.

(c) With L as centre and radius OL, draw an arc to cut LM at N.

(d) Join O and N draw ray OB. Then $\angle AOB = 60^\circ$.

(e) With L as centre and radius greater than $\frac{1}{2} LN$, draw an arc.

(f) Now with N as centre and same radius as in step 5, draw another arc cutting the arc drawn in step 5 at P.

(g) Join O and P and draw ray OC. Thus OC bisects $\angle AOB$ and

therefore $\angle AOC = \angle BOC = 30^\circ$.

(h) Let ray OC intersects the arc of circle at point Q.

(i) Now with L as centre and radius greater than $\frac{1}{2} LQ$; draw an arc.

(j) With Q as centre and same radius as in above step, draw another arc cutting the arc shown in above step at R.

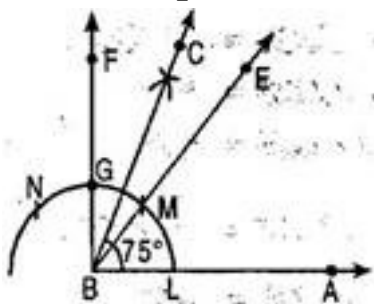
(k) Join O and R and draw ray OS. Thus OS bisects $\angle AOC$ and therefore

$$\angle COS = \angle AOS = 15^\circ$$

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

(i) 75° (ii) 105° (iii) 135°

Ans. (i) Step of construction of 75°



(a) Draw $\angle ABE = 60^\circ$ and $\angle ABF = 90^\circ$. [Follow the same steps as done in Question 1 and Question 3 (i)]

(b) Let ray BF intersects the arc of circle at G.

(c) Now with M as centre and radius greater than $\frac{1}{2} MG$ draw an arc.

(d) With G as centre and with same radius as in step (c), draw an arc which intersects the previous arc at point H.

(e) Draw a ray BC passing through H which bisects $\angle EBF$.

Thus $\angle ABC = 75^\circ$ is the required angle.

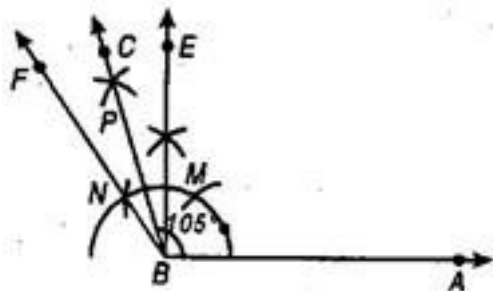
Justification:

$$\angle EBF = \angle ABF - \angle ABE = 90^\circ - 60^\circ = 30^\circ$$

$$\text{Now } \angle EBF = \angle CBF = \frac{1}{2} \angle EBF = \frac{1}{2} \times 30^\circ = 15^\circ \quad [\because BC \text{ is the bisector of } \angle EBF]$$

$$\therefore \angle ABC = \angle ABE + \angle EBC = 60^\circ + 15^\circ = 75^\circ$$

(ii) Steps of construction of 105°



(a) Draw $\angle ABE = 90^\circ$ and $\angle ABF = 120^\circ$.

(b) Let ray BE intersects the arc of circle at M and ray BF intersects the arc of circle N.

(c) With point M as centre and radius greater than $\frac{1}{2} MN$, draw an arc.

(d) With N as centre and with same radius as in step (c), draw another arc which intersects the previous arc at P.

(e) Draw a ray BC passing through P which bisects $\angle EBF$.

Thus $\angle ABC = 105^\circ$ is the required angle.

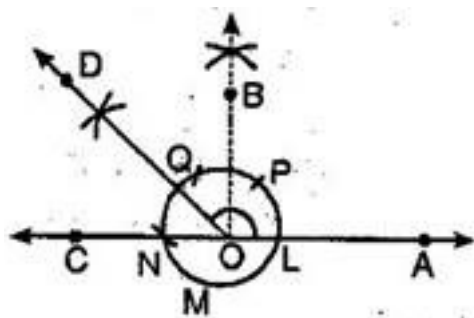
Justification:

$$\angle EBF = \angle ABF - \angle ABE = 120^\circ - 90^\circ = 30^\circ$$

$$\text{Now } \angle EBC = \angle CBF = \frac{1}{2} \angle EBF = \frac{1}{2} \times 30^\circ = 15^\circ \quad [\because BC \text{ is the bisector of } \angle EBF]$$

$$\therefore \angle ABC = \angle ABE + \angle EBC = 90^\circ + 15^\circ = 105^\circ$$

(iii) Steps of construction of 135°



(a) Draw a ray OA.

(b) With O as centre and convenient radius, draw an arc LM (having length more than the semicircle) cutting OA at L.

(c) Now with L as centre and radius = OL; draw an arc cutting the arc LM at P.

(d) Then taking P as centre and radius OL, draw an arc cutting arc PM at Q.

(e) Now bisect $\angle POQ$ by ray OB, we get $\angle AOB = 90^\circ$.

(f) Now taking Q as centre and radius OL, draw an arc cutting QM at N.

(g) Join O and N to draw the ray OC.

Thus we get $\angle AOC = 180^\circ \Rightarrow \angle BOC = \angle AOB = 90^\circ$

(h) Now bisect $\angle BOC$ by ray OD.

Then $\angle AOD$ is the required angle of 135° .

$$\angle AOD = \angle AOB + \angle BOD = 90^\circ + 45^\circ = 135^\circ$$

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

Ans. Steps of construction:

(a) Draw a line segment BC of length 5 cm.

(b) At B draw $\angle XBC = 60^\circ$.

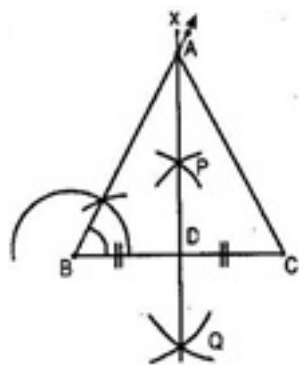
(c) Draw perpendicular bisector PQ of line segment BC.

(d) Let A and D be the points where PQ intersects the ray BX and side BC respectively.

(e) Join AC.

Thus ABC is the required equilateral triangle.

Justification:



In right triangle ADB and right triangle ADC,

$AD = AD$ [Common]

$\angle ADB = \angle ADC = 90^\circ$ [By construction]

$BD = CD$ [By construction]

$\therefore \triangle ADB \cong \triangle ADC$ [By SAS congruency]

$\therefore \angle B = \angle C = 60^\circ$ [By CPCT]

$\therefore \angle A = 180^\circ - (\angle B + \angle C)$

$$= 180^\circ - (60^\circ + 60^\circ) = 180^\circ - 120^\circ = 60^\circ$$

$\therefore \angle A = \angle B = \angle C = 60^\circ$

$\therefore \triangle ABC$ is an equilateral triangle.