## Class IX Chapter 11 - Constructions Maths

1:

Construct an angle of $90^{\circ}$ at the initial point of a given ray and justify the construction.

Answer:
The below given steps will be followed to construct an angle of $90^{\circ}$.
(i) Take the given ray PQ. Draw an arc of some radius taking point $P$ as its centre, which intersects PQ at R.
(ii) Taking R as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at S.
(iii) Taking $S$ as centre and with the same radius as before, draw an arc intersecting the arc at T (see figure).
(iv)Taking S and T as centre, draw an arc of same radius to intersect each other at U .
(v) Join PU, which is the required ray making $90^{\circ}$ with the given ray PQ .


Justification of Construction:
We can justify the construction, if we can prove $\angle \mathrm{UPQ}=90^{\circ}$.
For this, join PS and PT.


We have, $\angle \mathrm{SPQ}=\angle \mathrm{TPS}=60^{\circ}$. In (iii) and (iv) steps of this construction, PU was drawn as the bisector of $\angle$ TPS.
$\therefore \angle \mathrm{UPS}=\frac{\frac{1}{2}}{2}=\frac{1}{2} \times 60^{\circ}=30^{\circ}$, TPS
Also, $\angle \mathrm{UPQ}=\angle \mathrm{SPQ}+\angle \mathrm{UPS}$
$=60^{\circ}+30^{\circ}$
$=90^{\circ}$

## Question 2:

Construct an angle of $45^{\circ}$ at the initial point of a given ray and justify the construction.
Answer:

The below given steps will be followed to construct an angle of $45^{\circ}$.
(i) Take the given ray PQ. Draw an arc of some radius taking point P as its centre, which intersects PQ at R.
(ii) Taking R as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at S.
(iii) Taking S as centre and with the same radius as before, draw an arc intersecting the arc at $T$ (see figure).
(iv) Taking S and T as centre, draw an arc of same radius to intersect each other at U .
(v) Join PU. Let it intersect the arc at point V .
(vi) From $R$ and $V$, draw arcs with radius more than $\frac{1}{2} R V$ to intersect each other at $W$. Join PW.

PW is the required ray making $45^{\circ}$ with PQ .


Justification of Construction:
We can justify the construction, if we can prove $\angle \mathrm{WPQ}=45^{\circ}$.
For this, join PS and PT.


We have, $\angle \mathrm{SPQ}=\angle \mathrm{TPS}=60^{\circ}$. In (iii) and (iv) steps of this construction, PU was drawn as the bisector of $\angle$ TPS.
$\therefore \angle$ UPS $=\frac{\frac{1}{2}}{2}=\frac{60^{\circ}}{2}=30^{\circ} \div$ TPS

Also, $\angle \mathrm{UPQ}=\angle \mathrm{SPQ}+\angle \mathrm{UPS}$
$=60^{\circ}+30^{\circ}$
$=90^{\circ}$
In step (vi) of this construction, PW was constructed as the bisector of $\angle \mathrm{UPQ}$.
$\therefore \angle W P Q=\frac{1}{2}, \mathrm{UPQ}=\frac{90^{\circ}}{2}=45^{\circ}$

## Question 3:

Construct the angles of the following measurements:
(i) $30^{\circ}$ (ii) $22 \frac{1}{2}^{\circ}$ (iii) $15^{\circ}$ Answer:
(i) $30^{\circ}$

The below given steps will be followed to construct an angle of $30^{\circ}$.
Step I: Draw the given ray PQ . Taking P as centre and with some radius, draw an arc of a circle which intersects PQ at R.

Step II: Taking R as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point $S$.

Step III: Taking $R$ and $S$ as centre and with radius more than $\frac{1}{2}$ RS, draw arcs to intersect each other at T. Join PT which is the required ray making $30^{\circ}$ with the
given ray PQ.

(ii) $22 \frac{1}{2}$ 。
(ii)

The below given steps will be followed to construct an angle of $22 \frac{1}{2}^{\circ}$.
(1) Take the given ray PQ. Draw an arc of some radius, taking point $P$ as its centre, which intersects PQ at R.
(2) Taking $R$ as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at S.
(3) Taking $S$ as centre and with the same radius as before, draw an arc intersecting the arc at T (see figure).
(4) Taking S and T as centre, draw an arc of same radius to intersect each other at U .
(5) Join PU. Let it intersect the arc at point V .
(6) From $R$ and $V$, draw arcs with radius more than $\frac{1}{2} R V$ to intersect each other at $W$. Join PW.
(7) Let it intersect the arc at $X$. Taking $X$ and $R$ as centre and radius more than $\frac{1}{2}$

RX, draw arcs to intersect each other at Y .

(iii) $15^{\circ}$

The below given steps will be followed to construct an angle of $15^{\circ}$.
Step I: Draw the given ray PQ. Taking P as centre and with some radius, draw an arc of a circle which intersects PQ at R.

Step II: Taking R as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at point $S$.

Step III: Taking R and S as centre and with radius more than $\frac{1}{2}$ RS, draw arcs to intersect each other at T. Join PT.

Step IV: Let it intersect the arc at $U$. Taking $U$ and $R$ as centre and with radius more than $\frac{1}{2}$
ray making $15^{\circ}$ with the given ray PQ .


Question 4:
RU, draw an arc to intersect each other at V. Join PV which is the required

Construct the following angles and verify by measuring them by a protractor:
(i) $75^{\circ}$ (ii) $105^{\circ}$ (iii) $135^{\circ}$ Answer:
(i) $75^{\circ}$

The below given steps will be followed to construct an angle of $75^{\circ}$.
(1) Take the given ray PQ. Draw an arc of some radius taking point $P$ as its centre, which intersects PQ at R.
(2) Taking $R$ as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at S.
(3) Taking $S$ as centre and with the same radius as before, draw an arc intersecting the arc at T (see figure).
(4) Taking S and T as centre, draw an arc of same radius to intersect each other at U .
(5) Join PU. Let it intersect the arc at V . Taking S and V as centre, draw arcs with radius more than $\frac{1}{2}$ SV. Let those intersect each other at W. Join PW which is the required ray making $75^{\circ}$ with the given ray PQ .


The angle so formed can be measured with the help of a protractor. It comes to be $75^{\circ}$.
(ii) $105^{\circ}$

The below given steps will be followed to construct an angle of $105^{\circ}$.
(1) Take the given ray PQ. Draw an arc of some radius taking point $P$ as its centre, which intersects PQ at R.
(2) Taking $R$ as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at S.
(3) Taking $S$ as centre and with the same radius as before, draw an arc intersecting the arc at T (see figure).
(4) Taking S and T as centre, draw an arc of same radius to intersect each other at U .
(5) Join PU. Let it intersect the arc at V . Taking T and V as centre, draw arcs with radius more than $\frac{1}{2}$ TV. Let these arcs intersect each other at W . Join PW which is the required ray making $105^{\circ}$ with the given ray PQ.


The angle so formed can be measured with the help of a protractor. It comes to be 1050 .
(iii) $135^{\circ}$

The below given steps will be followed to construct an angle of $135^{\circ}$.
(1) Take the given ray PQ. Extend PQ on the opposite side of Q. Draw a semi-circle of some radius taking point P as its centre, which intersects PQ at R and W .
(2) Taking $R$ as centre and with the same radius as before, draw an arc intersecting the previously drawn arc at S.
(3) Taking $S$ as centre and with the same radius as before, draw an arc intersecting the arc at T (see figure).
(4) Taking S and T as centre, draw an arc of same radius to intersect each other at U .
(5) Join PU. Let it intersect the arc at V . Taking V and W as centre and with radius
more than $\frac{1}{2}$ VW, draw arcs to intersect each other at $X$. Join $P X$, which is the required ray making $135^{\circ}$ with the given line PQ .


The angle so formed can be measured with the help of a protractor. It comes to be 1350 .

## Question 5:

Construct an equilateral triangle, given its side and justify the construction Answer:

Let us draw an equilateral triangle of side 5 cm . We know that all sides of an equilateral triangle are equal. Therefore, all sides of the equilateral triangle will be 5 cm . We also know that each angle of an equilateral triangle is $60^{\circ}$.

The below given steps will be followed to draw an equilateral triangle of 5 cm side. Step I: Draw a line segment $A B$ of 5 cm length. Draw an arc of some radius, while taking $A$ as its centre. Let it intersect $A B$ at $P$.

Step II: Taking P as centre, draw an arc to intersect the previous arc at E. Join AE. Step III: Taking $A$ as centre, draw an arc of 5 cm radius, which intersects extended line segment $A E$ at $C$. Join $A C$ and $B C . \triangle A B C$ is the required equilateral triangle of side 5 cm .


## Justification of Construction:

We can justify the construction by showing $A B C$ as an equilateral triangle i.e., $A B=B C$ $=A C=5 \mathrm{~cm}$ and $\angle A=\angle B=\angle C=60^{\circ}$.

In $\triangle A B C$, we have $A C=A B=5 \mathrm{~cm}$ and $\angle A=60^{\circ}$.
Since $A C=A B$,
$\angle B=\angle C$ (Angles opposite to equal sides of a triangle)
In $\triangle A B C$,
$\angle A+\angle B+\angle C=180^{\circ}$ (Angle sum property of a triangle)
$\angle 60^{\circ}+\angle C+\angle C=180^{\circ}$
$\angle 60^{\circ}+2 \angle C=180^{\circ}$
$\angle 2 \angle \mathrm{C}=180^{\circ}-60^{\circ}=120^{\circ}$
$\angle \angle C=60^{\circ}$
$\angle \angle B=\angle C=60^{\circ}$
We have, $\angle A=\angle B=\angle C=60^{\circ}$
$\angle \angle A=\angle B$ and $\angle A=\angle C$
$\angle B C=A C$ and $B C=A B$ (Sides opposite to equal angles of a triangle)
$\angle A B=B C=A C=5 \mathrm{~cm}$
From equations (1) and (2), $\triangle \mathrm{ABC}$ is an equilateral triangle.

## Exercise 11.2

## Question 1:

Construct a triangle $A B C$ in which $B C=7 \mathrm{~cm}, \angle B=75^{\circ}$ and $A B+A C=13 \mathrm{~cm}$.
Answer:

The below given steps will be followed to construct the required triangle.
Step I: Draw a line segment $B C$ of 7 cm . At point $B$, draw an angle of $75^{\circ}$, say $\angle X B C$.

Step II: Cut a line segment $B D=13 \mathrm{~cm}$ (that is equal to $A B+A C$ ) from the ray $B X$.
Step III: Join DC and make an angle DCY equal to $\angle B D C$.
Step IV: Let $C Y$ intersect $B X$ at $A . ~ \triangle A B C$ is the required triangle.


## Question 2:

Construct a triangle $A B C$ in which $B C=8 \mathrm{~cm}, \angle B=45^{\circ}$ and $A B-A C=3.5 \mathrm{~cm}$.
Answer:
The below given steps will be followed to draw the required triangle.
Step I: Draw the line segment $B C=8 \mathrm{~cm}$ and at point $B$, make an angle of $45^{\circ}$, say $\angle X B C$.

Step II: Cut the line segment $B D=3.5 \mathrm{~cm}$ (equal to $A B-A C$ ) on ray $B X$. Step III: Join DC and draw the perpendicular bisector PQ of DC.

Step IV: Let it intersect $B X$ at point $A$. Join $A C . \triangle A B C$ is the required triangle.


## Question 3:

Construct a triangle $P Q R$ in which $Q R=6 \mathrm{~cm}, \angle Q=60^{\circ}$ and $P R-P Q=2 \mathrm{~cm}$ Answer:

The below given steps will be followed to construct the required triangle.
Step I: Draw line segment $Q R$ of 6 cm . At point $Q$, draw an angle of $60^{\circ}$, say $\angle X Q R$. Step II: Cut a line segment QS of 2 cm from the line segment QT extended in the opposite side of line segment XQ. (As PR > PQ and PR $-P Q=2 \mathrm{~cm}$ ). Join SR. Step III: Draw perpendicular bisector $A B$ of line segment $S R$. Let it intersect $Q X$ at point $P$.

Join PQ, PR.
$\triangle P Q R$ is the required triangle.


## Question 4:

Construct a triangle $X Y Z$ in which $\angle Y=30^{\circ}, \angle Z=90^{\circ}$ and $X Y+Y Z+Z X=11 \mathrm{~cm}$.

## Answer:

The below given steps will be followed to construct the required triangle.
Step I: Draw a line segment $A B$ of 11 cm .
(As XY $+\mathrm{YZ}+\mathrm{ZX}=11 \mathrm{~cm}$ )
Step II: Construct an angle, $\angle \mathrm{PAB}$, of $30^{\circ}$ at point $A$ and an angle, $\angle \mathrm{QBA}$, of $90^{\circ}$ at point B.

Step III: Bisect $\angle \mathrm{PAB}$ and $\angle \mathrm{QBA}$. Let these bisectors intersect each other at point X . Step IV: Draw perpendicular bisector ST of AX and UV of BX.

Step V: Let ST intersect $A B$ at $Y$ and $U V$ intersect $A B$ at $Z$.
Join XY, XZ.
$\triangle X Y Z$ is the required triangle.


## Question 5:

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

Answer:
The below given steps will be followed to construct the required triangle.
Step I: Draw line segment AB of 12 cm . Draw a ray AX making $90^{\circ}$ with AB. Step II:
Cut a line segment AD of 18 cm (as the sum of the other two sides is 18 ) from ray $A X$.

Step III: Join DB and make an angle DBY equal to ADB.
Step IV: Let BY intersect AX at C. Join AC, BC.
$\triangle A B C$ is the required triangle.


