



With the help of scale (Ruler) and Compass

- Bisect the given line segment.
- To construct an angle, equal to a given angle.
- Bisect the given angle
- Draw a parallel line to the given line.
- Draw perpendicular, from the given point, on the given line segment, when—
 - (a) The point lies on the line-segment.
 - (b) The point lies outside the line-segment.

4.1 Introduction :

The important aim of studying geometry is that on the basis of given information we draw exact and correct shape.

These shapes are related to line-segment, rays, lines, triangles, quadrilaterals and circle. Sometimes, in daily life, we need such type of practical knowledge. It is often used in the construction of temple, mosque, Gurudhwara and huge building (multi-storied building). It has important uses in the field of science and technology.

There are various examples in line-segment, angles, circle etc in which on the basis of measurement, it is impossible to divide into small parts with accuracy but it is possible by the method of geometrical construction.

Construction – 1

4.2 Divide the given line-segment into two equal parts :

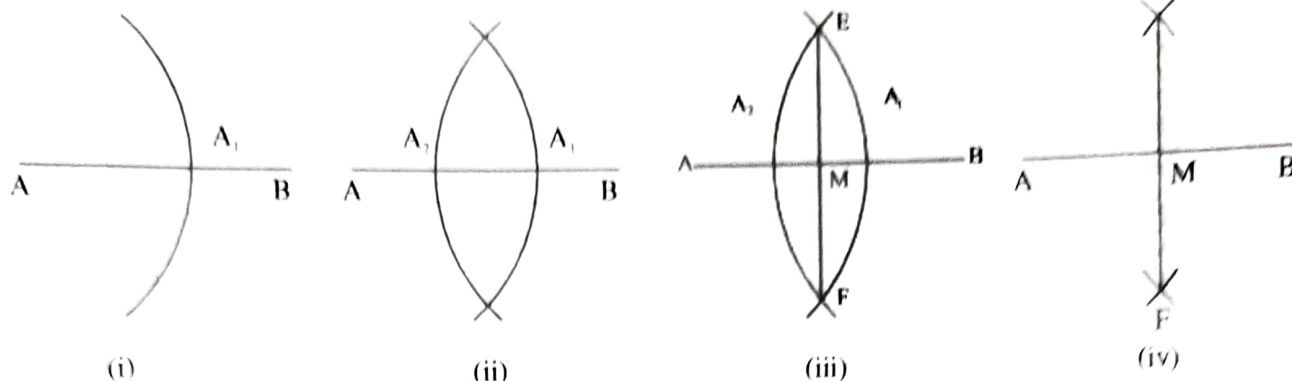
Given : line-segment AB

To construct : Bisector of line segment AB.



Steps of construction :

1. Taking radius more than half of the length of line segment AB and centre at A draw a semi-circular arc A_1 , using compass.



- (2) Now on the line-segment AB consider B as centre draw another semi-circular arc A_2 with the same radius which cuts the first arc at the points E & F .
- (3) Join EF which intersects the line-segment AB at the point M .

The point M divide the line-segment AB into two equal parts.

In the above construction on making line EF there is need of point E and F .

On making these points, in place of semi-circular arc we can use small arc.

Do it, see it and find conclusions :

Draw a line-segment AB on your note-book and on the basis of construction of Axiom-1, divide the line-segment AB into two equal parts at the point M . Like this :

- Measure the line-segment AM & BM respectively and measure the equality of AM and MB .
- Measure the $\angle AME$ and $\angle BME$ and find the relationship between $\angle AME$ and $\angle BME$.

We find out that $AM = MB$ and $\angle AME = \angle BME = 90^\circ$

We conclude that the line EF divide line-segment AB into two equal parts as well as it is perpendicular to AB also.

The obtained line EF is the perpendicular bisector of line-segment AB .

Try it :

Draw a circle on your note book. Draw any chord of the circle and draw its perpendicular bisector.

Is the perpendicular bisector of the chord passes through the centre of the circle?

We concluded that :

Perpendicular bisector of any chord of the circle passes through the centre of the circle.

Exercise-4(a)

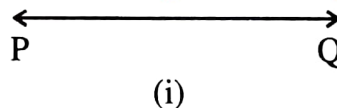
1. With the help of scale and compass, divide the line-segment 6 cm into two equal parts.
2. Draw a circle of radius 3 cm with centre O on your rot-book. Draw two chords AB and CD such that they are not parallel to each other. Draw perpendicular bisector of these chords. At which point these perpendicular bisectors cut each other?
3. Divide 8 cm line-segment into four equal parts.
4. With the help of compass draw a circle of radius 4 cm. Draw a chord of the circle. Find the distance from the centre of the circle to the mid-point of the chord.
5. Draw a line segment PQ of 4cm. Draw a perpendicular bisector which cuts line PQ at point D . Is $PD=QD$? Now we draw a circle whose centre at D and its radius is PD , and observe that this circle passes through P and Q .
6. Draw a line segment AB of 6.4 cm and make its symmetrical axis.



Construction - 2

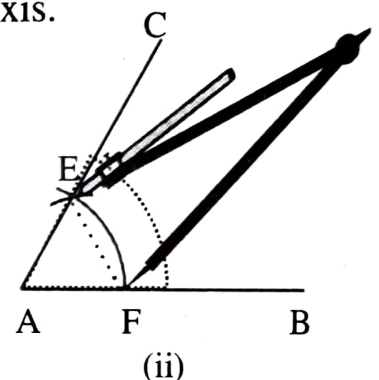
4.3 To construct an angle equal to a given angle.

Given : angle BAC



To construct :

An angle equal to $\angle BAC$,
whose measurement is unknown :



Steps of constructions :

1. Draw a line-segment PQ
2. Draw an arc of any radius considering A as the centre of the given $\angle ABC$ which cuts the line-segments AB and AC at E and F respectively. With the

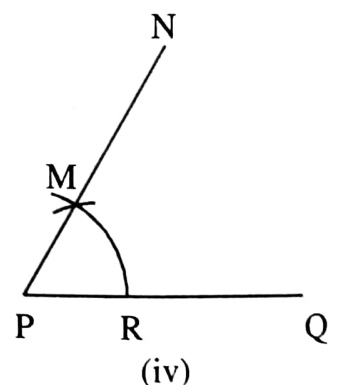
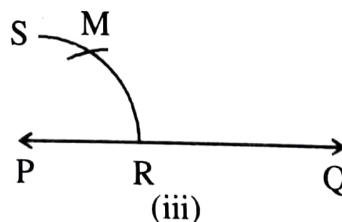


Figure 4.2

same radius or distance
draw an arc RS
considering or taking P
a centre.

3. Take the length EF with compass.
4. Taking R as the centre draw an arc which cut the previous arc RS at the point M .
5. Joining PM extend it upto some point N . This angle QPN is equal to the given angle BAC .

Verification :

Do it, think and find conclusion :

In your note-book draw a construction like construction 2 and with the help of protactor measure the values of $\angle BAC$ and $\angle QPN$.

Is the measure of the $\angle BAC$ and $\angle QPN$ are equal? We find that $\angle BAC$ and $\angle QPN$ have equal values that is

$$\angle BAC = \angle QPN.$$

Try it :

With the help of tracing paper check the equality of $\angle BAC$ and $\angle QPN$.

Construction – 3

4.4 Bisect the given angle :

Given : angle ABC

To construct : bisect the $\angle ABC$

Steps of construction :

1. Taking B as the centre draw an arc of any radius which cuts the sides BA and BC at the points P and Q respectively.

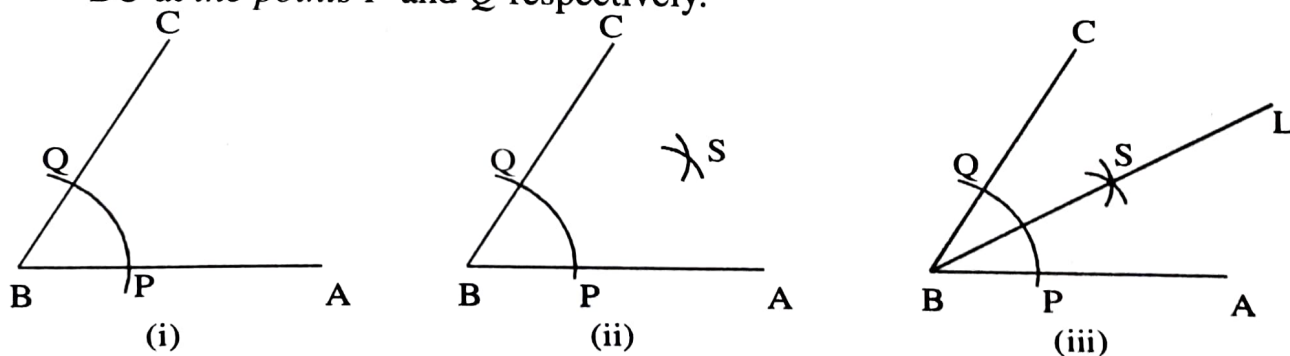


Figure 4.3

2. Taking P and Q as centres, draw arcs of the same radius or with value more than half of PQ which cut each other at point S .
3. Join the points B and S extending it upto L . This line-segment BL , bisect $\angle ABC$. This line-segment is also known as bisector of the angle ABC .

Verification :

Do, see and find conclusion :

On your note-book like construction 3, draw a bisector line-segment BL of any angle ABC .

With the help of protactor measure $\angle ABL$ and $\angle CBL$.

Is the measure (values) of $\angle ABL$ and $\angle CBL$ are equal?

We find that the value of $\angle ABL$ and $\angle CBL$ are equal.

Think :

Why the length of a radius is taken more than half, because if the radius is not taken more than half then the arcs will not cut each other at any point.

Draw angles of small measure by drawing bisectors of angles :

Try it, and find conclusion :

Draw a line-segment AL on your exercise book. Assume point A as centre and draw an arc from any radius, which cut the line at point B . Now assuming B as centre and draw one more arc of the same radius which cuts the first arc at the point C . Join AC & proceed.

How many degrees of $\angle CAL$ will be ? We see that it is an angle of 60° .

Now bisect $\angle CAL$ find the value of $\angle LAK$

$$\angle LAK = \frac{1}{2} \angle BAC = \frac{1}{2} (60^\circ) = 30^\circ = \angle CAK$$

Therefore,

Angle of small measurements can be drawn by dividing the angles.

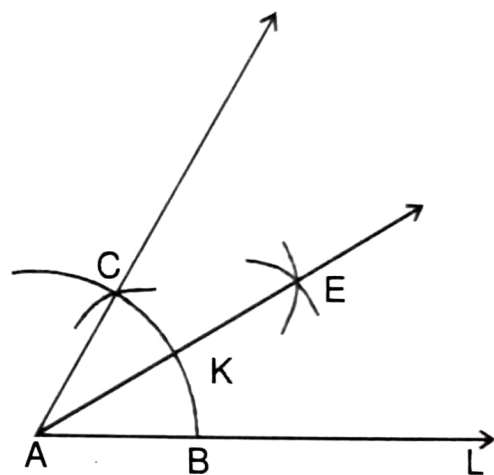


Figure 4.4

Do these, argue and conclude :

Draw a line segment AB on the exercise book. Assume point A as the centre of the line-segment AB and draw an arc of any radius, which cut the line-segment AB and consider the point P . Again consider the point P as the centre draw an arc PQ and from Q draw an arc QR of the same radius.

Join AQ and AR and extend.

$$\angle LAB = 60^\circ \text{ and } \angle MAB = 120^\circ$$

$$\angle QAR = \angle MAB - \angle LAB = 60^\circ$$

Now bisect $\angle QAR$.

Extend the bisector AN of $\angle QAR$.

Measure $\angle QAN$ and $\angle RAN$

We see that each angle is 30°

Describe the measurement of $\angle BAN$

$$\angle BAN = \angle BAQ + \angle QAN$$

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

$$= 90^\circ$$

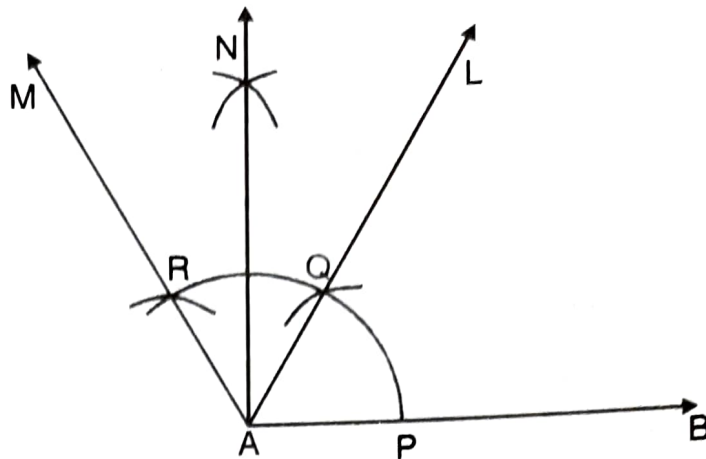


Figure 4.5

Exercise – 4(b)

1. Make a 45° angle on your exercise book. With the help of scale and compass divide it into two equal angles.
2. Draw an angle PQR . Draw a ray QS in this way $\angle PQS = \angle RQS$.
3. Draw an angle of 120° . Divide it into four equal parts with the help of scale and compass and verify it by measuring.
4. Draw a right angle and construct its bisector.
5. To construct these angles with the help of scale and compass :

- (i) 30° (ii) 45° (iii) $22\frac{1}{2}^\circ$ (iv) 75° (v) 135°

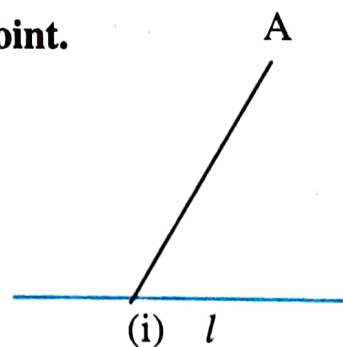
Construction – 4

4.5 Draw a parallel line to a given line from a given point.

Given : A line l and a point A outside of it?

To be construct :

A line parallel to the line l , which passes through the point A .



Steps of construction :

1. Take a point B on the line l . Join B to A .
2. Take point B as centre and draw an arc of any radius, which intersects line l at the point C and the line-segment BA at the point D respectively.

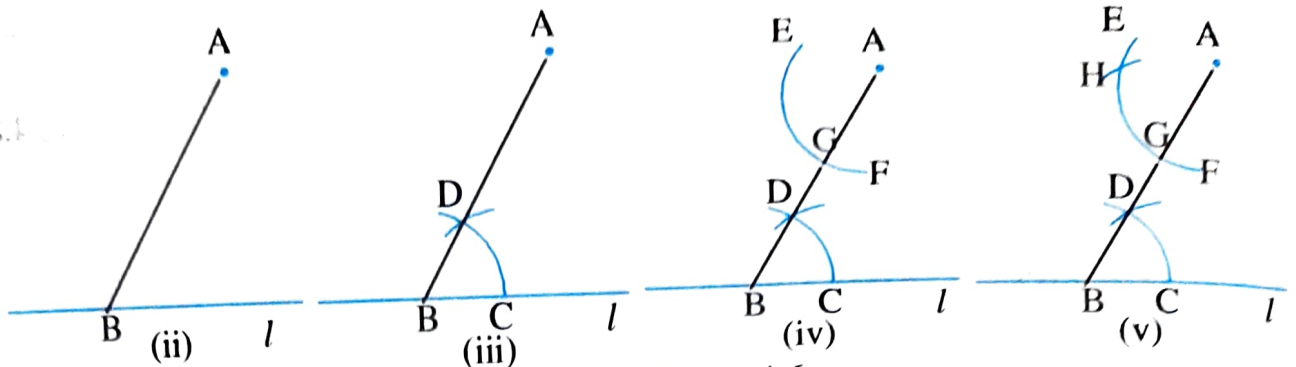
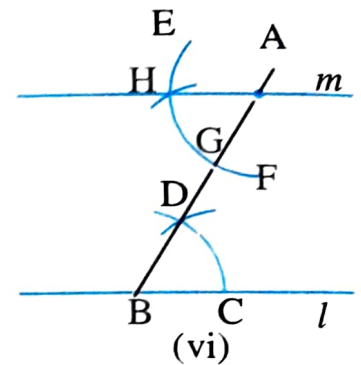


Figure 4.6

3. Assume point A as centre and take a radius equal to step 2 draw an arc EF such that which cuts the line-segment at the point G .
4. With the help of compass measure DC and assuming G as the centre draw an arc of radius DC which cuts the arc GE at the point H .
5. Now draw a line from the point H to the point A . line l and line m are the required parallel lines).



Note : $\angle ABC$ and $\angle BAH$ are alternate angles,
 $\angle ABC = \angle BAH$.

Group discussion :

Can any other line passing through the point A be drawn which is parallel to the line l ?

Draw a line parallel to the given line :

- Draw a line on your exercise book. Take any two points A and B on this line.
- Assuming A and B as a centre with the help of compass draw two arcs of any radius on the same side of the given line.
- Now with the help of scale joint the triumph points C and D of these two arcs.
- The line CD is the required line which is parallel to the given line AB .

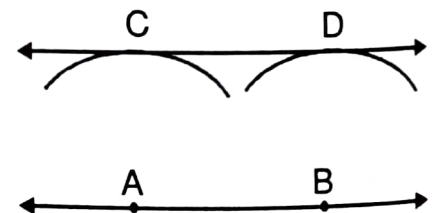
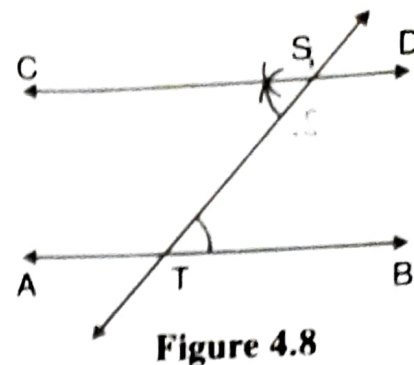


Figure 4.7

Try, think and conclude :

- Draw a line AB , outside of which a point S is located. Draw a transversal line going through the point S . Line ST intersects the line AB at the point T . Construct $\angle CST$ equal to $\angle STB$ at point S of line ST . Line CD , drawn through the point S is parallel to line AB . Why?



Conclusion :

$$\angle STB = \angle CST \text{ (alternate angle)}$$

$\therefore$ line CD and AB are parallel lines.

Exercise 4(c)

1. Draw two parallel lines AB and CD on your exercise book. Make the line segment AM and line segment CM , respectively, at points A and C , making angles of 30° and 60° respectively. Find the measurement of $\angle AMC$.
2. Construct a square with each side of 5 cm with the help of scale and compass. Write the length of diagonal by measurement.
3. Construct $\angle BAC = 60^\circ$, on the end point A of the line segment AB of 4 cm. Draw parallel lines from the point B to AC .
4. Construct a triangle ABC , when $BC = 4$ cm, $CA = 8$ cm and $AB = 6$ cm. From the mid point of AB , draw a line, parallel to BC , which cuts AC at the point M . Measure the length of AM and CM and write down. Is $AM = CM$?

Construction – 5

4.6 Draw a perpendicular line on a given line-segment

4.6.1 (i) When the point is located on the line-segment.

Known : line segment AB and the point P on it.

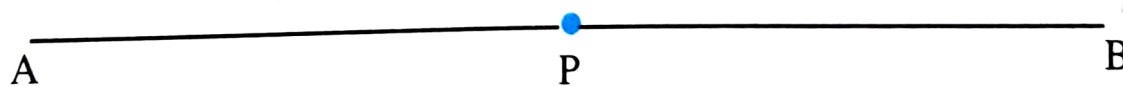


Figure 4.9

To construct ; Perpendicular to line segment AB at the point P .

Steps of construction :

1. Take a point P on the line-segment AB as centre and draw an arc of any radius which cuts the line at L and M respectively.

2. Consider point L as centre and draw an arc with a radius more than LP .
3. Assume point M as centre and draw another arc from the same radius.
4. Both arcs cut each other at point N .
5. Join the points of P and N and extend on both sides.
6. This line PN will be perpendicular to the given line segment AB .

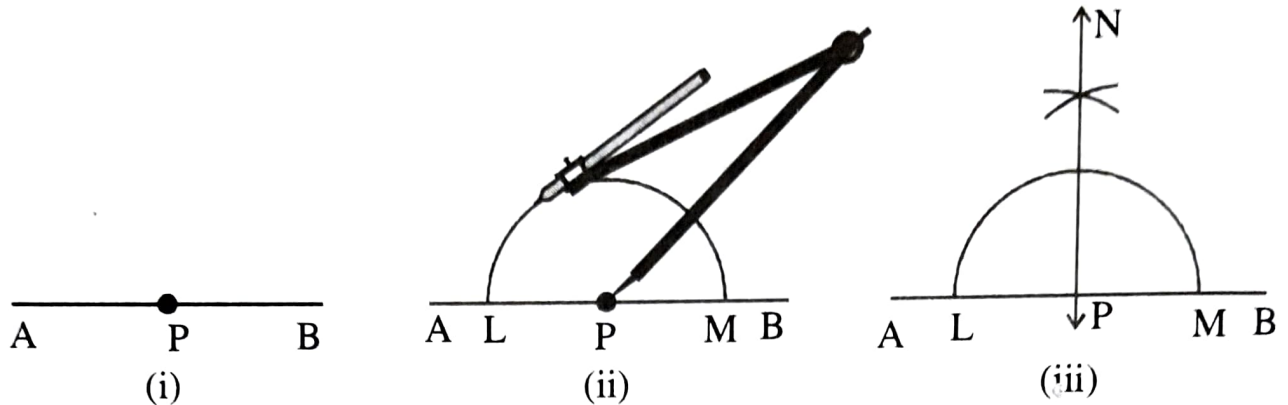


Figure. 4.10

Verification :

Do it, Consider them, think and conclude

Draw a perpendicular NP at the point P on a line segment AB in your exercise book as given above and find the values of $\angle NPA$ and $\angle NPB$.

Find out whether PN is perpendicular to the line AB ?

We find that measurement $\angle APN$ and $\angle BPN$ are 90° .

Thus PN is perpendicular to AB .

4.6.2 (ii) When the point is outside the line-segment.

Given : A line-segment AB and a point P outside of it.

To construct : Draw a perpendicular from the point P on the line-segment AB .

Steps of Construction :

1. Draw an arc with appropriate radius taking P as centre which cuts the line-segment AB at the points L and M respectively.
2. Draw an arc with L as centre opposite of point P taking radius more than half of LM .

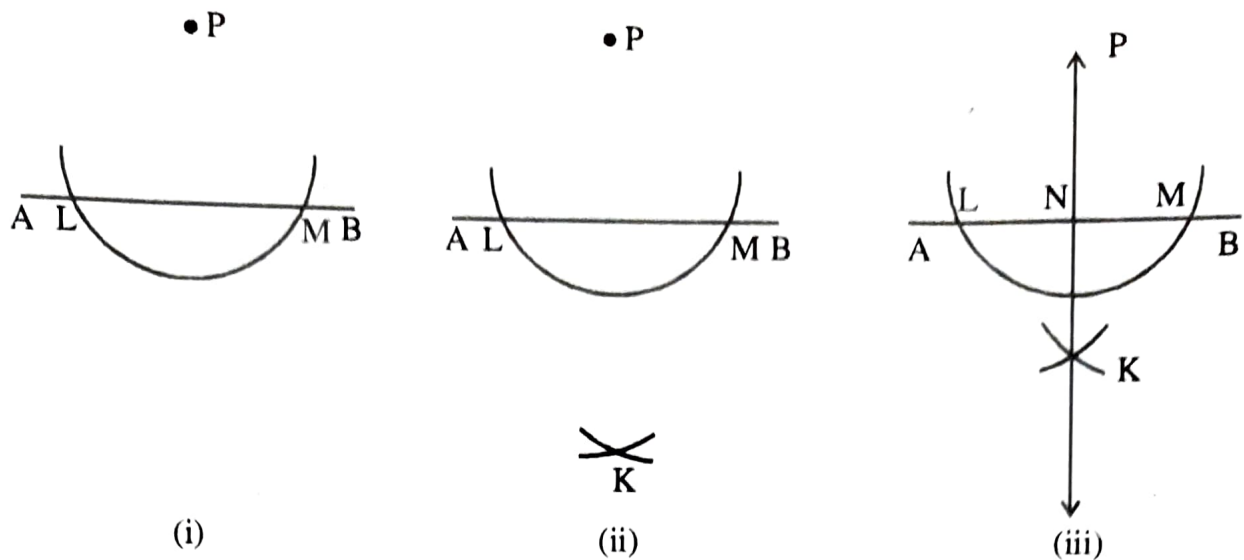


Figure 4.11

3. Draw one more arc in the same direction taking M as the centre just like step 2. Both arcs cut at point K .
4. Join the points P and K . This line PK , cut the line AB at the point N .
This line PN is perpendicular to the given line AB .

Verification :

Do, think and conclude :

On your note book as above draw a perpendicular PN from an outside point P on a line-segment AB and measure $\angle PNA$ and $\angle PNB$ with the help of protractor.

Is the line PN is perpendicular to the line-segment AB ?

We find that $\angle PNA = \angle PNB = 90^\circ$

Thus, line PN is perpendicular to line-segment AB .

Exercise – 4(d)

1. Draw a line-segment AB . Take any point M on it. Draw a perpendicular at M on the line-segment AB with the help of scale and compass.
2. Draw a line-segment PQ . Take any point R which is not on line PQ . Draw a perpendicular on the line PQ through the point R .
3. Draw a line-segment MN of 5 cm. Take a point P on the line-segment MN , draw a perpendicular on line-segment MN from point P .

Ability Exercise – 4

1. Draw an angle of 30° with the help of protactor. Now bisect it with the help of ruler and compass. Verify each angle by measurement.

2. Draw two lines AB and CD which intersect at the point O . Bisect the both vertically opposite angles $\angle COA$ and $\angle BOD$ with the help of scale and compass and verify that their bisectors are on the same line.
3. Draw an obtuse angle $\angle PQR$ and an acute angle $\angle ABC$. Construct an angle equal to the difference between them. Tell the measurement of the angle so drawn. Is this an acute or an obtuse angle ?
4. Construct the angles $(7\frac{1}{2})^\circ$ and $(22\frac{1}{2})^\circ$ with the help of scale and compass.
5. At end A of the line segment AB of length 3 cm, draw a perpendicular AC of length 3 cm. Join points B and C . Verify by measurement that $\angle ABC = \angle ACB = 45^\circ$.
6. Draw a line-segment AB of measurement 5 cm. Construct angles 60° and 120° at the point A and B respectively with the help of ruler and compass. Draw the bisectors of these angles. Let these meet at the point C . Measure $\angle ACB$.
7. Draw a circle of any radius. Take two chords PQ and QR in it. Draw the perpendicular bisectors of these chords.
Join P , Q and R to their point of intersection C . Verify by construction that C is the centre of the circle.
8. Draw a triangle PQR . Draw bisectors of their internal angles. Do their bisectors meeting at a point ?
9. Draw a triangle ABC . Draw perpendicular bisectors of their sides. Do these perpendiculars meeting at a point?
10. Construct an angle 210° with the help of ruler and compass.
(Hint : $210^\circ = 180^\circ + \frac{1}{2} \times 60^\circ$)
11. Draw a line-segment AB . Take any point O outside the line AB . Draw a line PQ parallel to AB passing through O . Join O to the point B . Take any other point S on the line PQ . Draw a parallel line to the line OB through S which cut the line AB at the point T . Which type of figure is formed from these pairs of parallel lines?

We have learnt :

1. We have study about following constructions with the help of scale and compass :
 - (i) Draw the perpendicular bisector line of given line-segment.
 - (ii) Construction of an angle equal to the given angle.
 - (iii) Draw a bisector line of the given angle.

- (iv) Draw a parallel line to the given line.
 - (v) Draw a perpendicular from the given point on the given line when—
 - (a) the point lies on the line-segment.
 - (b) the point lies outside of the line-segment.
2. We used the following concept to draw a line parallel to the given line :
- (i) If a transversal intersects two lines such that alternate angles are equal then the two lines are parallel.
 - (ii) If a transversal drawn to two lines such that corresponding angles are equal then two lines will be parallel.



ANSWERS

Exercise – 4(a)

2. Center on O; 5. Yes

Exercise – 4(c)

1. $\angle AMC = 90^\circ$, 2. Approximate 7.1 cm

Ability Exercise – 4

6. $\angle ACB = 90^\circ$