CHAPTER 19

CONSTRUCTION OF ANGLES
(Using ruler and compass)

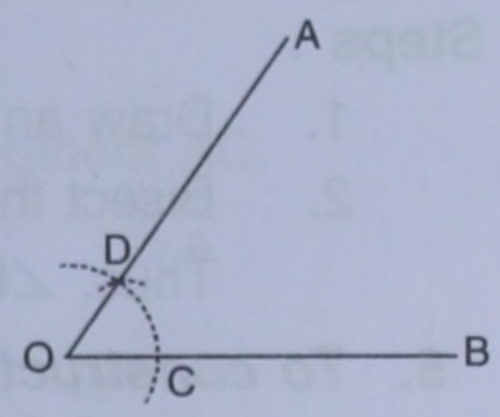
19.1 RULER AND COMPASS CAN BE USED :

(i) To copy a given angle.
(ii) To bisect a given angle.
(iii) To construct certain angles from a given point.
(iv) To bisect a given line segment by drawing its perpendicular bisector.
(v) To drop a perpendicular on to a line from a given exterior point.
(vi) To draw a perpendicular at a point on a given line.

1. *Copying a given angle*

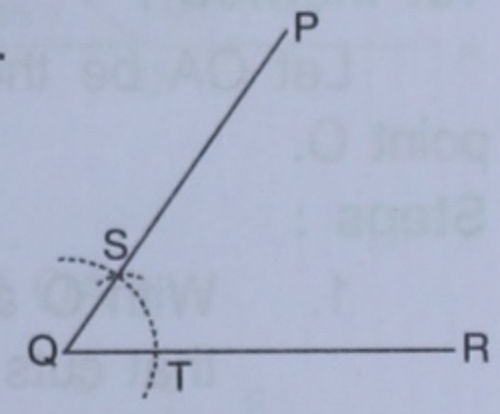
[To draw an angle equal to the given angle].

Let ∠AOB be the given angle of certain size, that we have to copy at a given point Q.



Steps :

1. At point Q, draw line segment QR of any suitable length.
2. With O as centre, draw an arc of any suitable radius, to cut the arms of the angle at C and D.
3. With Q as centre, draw an arc of the same radius as drawn for C and D.
   Let this arc cuts the line, segment QR at point T.
4. In your compasses, take the distance equal to the distance between C and D, and then, with T as centre, draw an arc of the radius equal to distance between C and D. Let this arc cuts the first arc at point S.
5. Join QS and extend up to a suitable point P.
   ∠PQR so obtained is equal to the given ∠AOB.

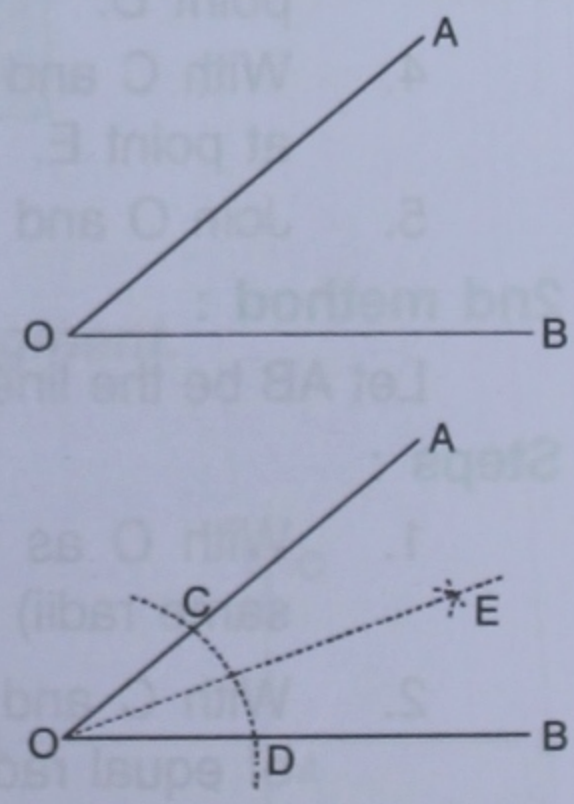


2. *To bisect a given angle.*

Let ∠AOB be the angle to be bisected.

Steps :

1. With O as centre, draw an arc of any suitable measure that cuts the two arms AO and BO at points C and D, respectively.
2. Taking C and D as centres, draw arcs of equal radii (plural of radius) to cut each other at point E.
3. Join O and E.
   The line OE bisects ∠AOB *i.e.* ∠AOE = ∠BOE



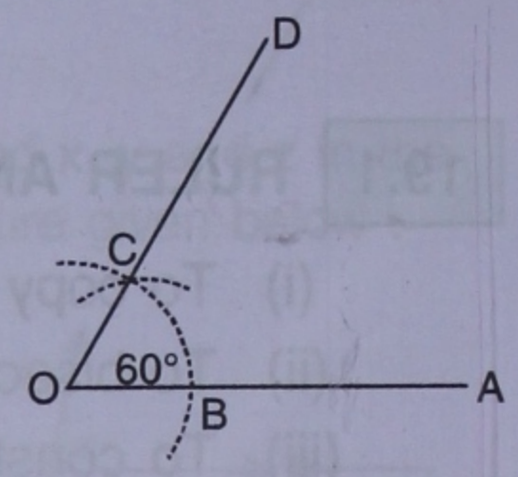
The radius of each arc in step 2 must be of more than half the distance between C and D.

19.2 CONSTRUCTION OF PARTICULAR ANGLES :

Such as : 60°, 30°, 90°, 45°, 120°, 135°, 75°, 105°, 15°, 165°, etc.

3. *To construct an angle of 60°.*

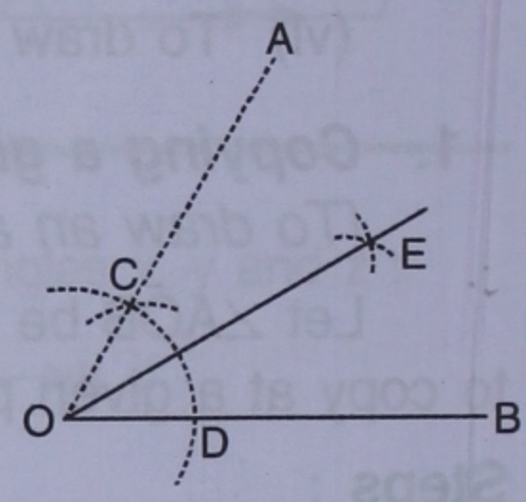
Steps :



1. Draw a line segment OA of any suitable length.
2. With O as centre, draw an arc of any suitable radius that cuts OA at point B.
3. With B as centre, draw an arc of same size to cut the first arc at point C.
4. Join OC and extend upto a suitable point D.
   Then, $\angle DOA = 60°$.

4. *To construct an angle of 30°.*

Steps :



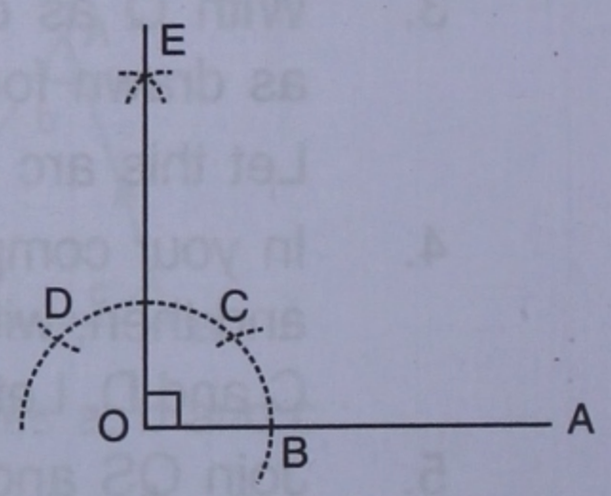
1. Draw an angle AOB of 60°, as explained above.
2. Bisect this angle to get two angles of 30° each.
   Thus, $\angle EOB = 30°$.

5. *To construct an angle of 90°.*

1st method :

Let OA be the line segment on which an angle of 90° is to be constructed at point O.

Steps :

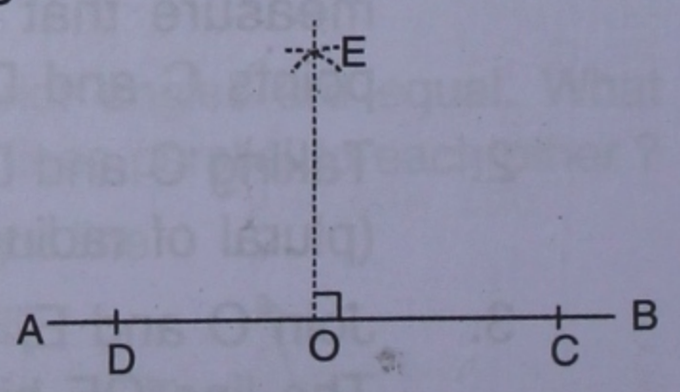


1. With O as centre, draw an arc of a suitable radius that cuts OA at point B.
2. With B as centre, draw an arc (with the same radius, as taken in step 1) that cuts the first arc at point C.
3. Again, with C as centre and with the same radius, draw one more arc so that it cuts the first arc at point D.
4. With C and D as centres, draw two arcs of equal radii so that they intersect at point E.
5. Join O and E. Then, $\angle AOE = 90°$.

2nd method :

Let AB be the line segment and O the point where an angle of 90° is to be drawn.

Steps :



1. With O as centre, draw two arcs (both of the same radii) to cut AB at points C and D.
2. With C and D as centres, draw two more arcs of equal radii so that they intersect at point E.
3. Join points O and E. Then, $\angle AOE = 90°$ and $\angle BOE = 90°$.

In both the constructions discussed above, **OE** is said to be **perpendicular** to line segment OA at point O.

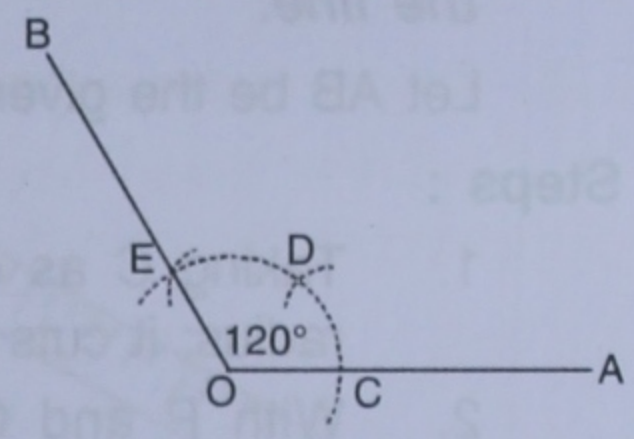
6. *To construct an angle of 45°.*

Draw an angle of 90° and bisect it. Each angle so obtained will be 45°.

7. *To construct an angle of 120°.*

Steps :

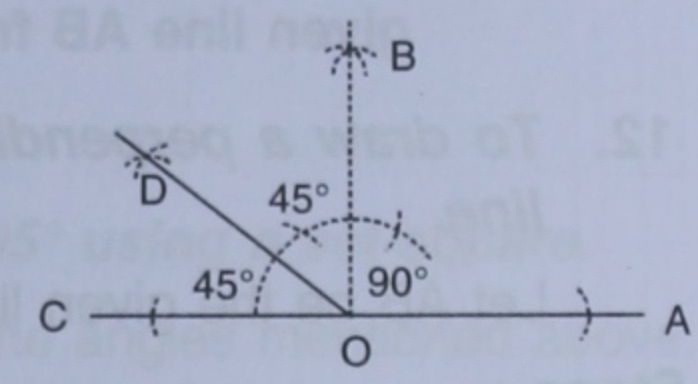
1. With centre O on the line segment OA, draw an arc to cut OA at point C.
2. With C as centre, draw one more arc with the same radius so that it cuts the first arc at point D.
3. With D as centre, draw one more arc of the same radius so that it cuts the first arc at E.
4. Join OE and extend it up to a suitable point B. Then, **∠AOB = 120°.**



8. *To construct an angle of 135°.*

Steps :

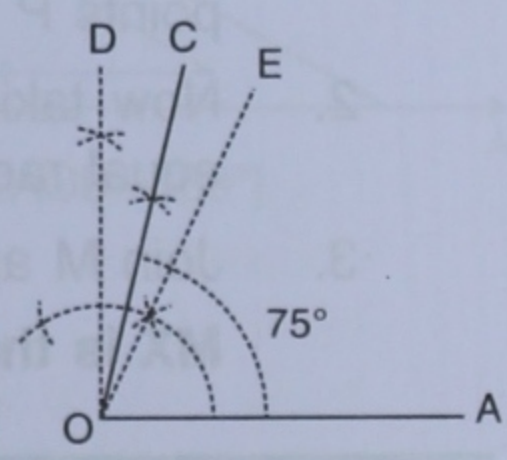
1. Draw an angle BOA = 90° at point O of the given line segment AC.
2. Bisect the angle BOC (clearly, angle BOC is also 90°).
   Thus, ∠BOD = ∠COD = 45°
   And, **∠AOD** = 90° + 45° = **135°.**



9. *To construct an angle of 75°.*

Steps :

1. Draw an angle AOD = 90° at point O of the line segment OA.
2. At the same point O, draw angle AOE = 60°.
3. Bisect ∠DOE so that
   ∠EOC = ∠DOC = 15°
   Thus, **∠AOC** = ∠AOE + ∠EOC = 60° + 15° = **75°.**



Many more angles can be drawn with such combinations.
e.g. : (i) 105° = 90° + 15°
(ii) 150° = 90° + 60° or 150 ° = 120° + 30° and so on.

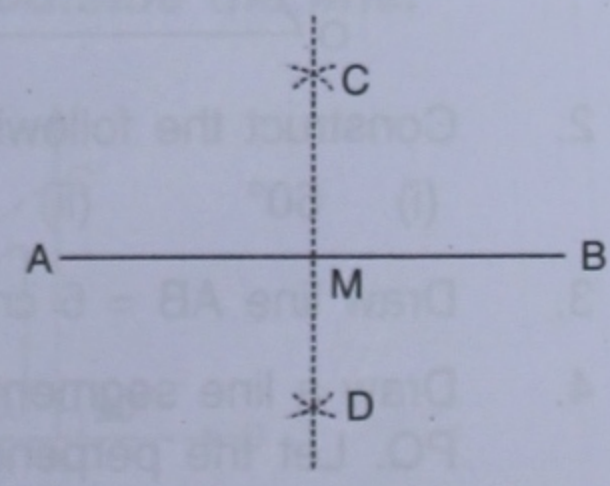
19.3 PERPENDICULARS :

10. *To draw the perpendicular bisector of a given line segment.*

Let AB be the given line segment.

Steps :

1. With A and B as centres, draw arcs of equal radii on both the sides of AB. *The radii of these arcs must be more than half the length of AB.*
2. Let these arcs cut each other at points C and D.



3. Join CD, which cuts AB at M.

Then, AM = BM. And $\angle AMC = 90°$

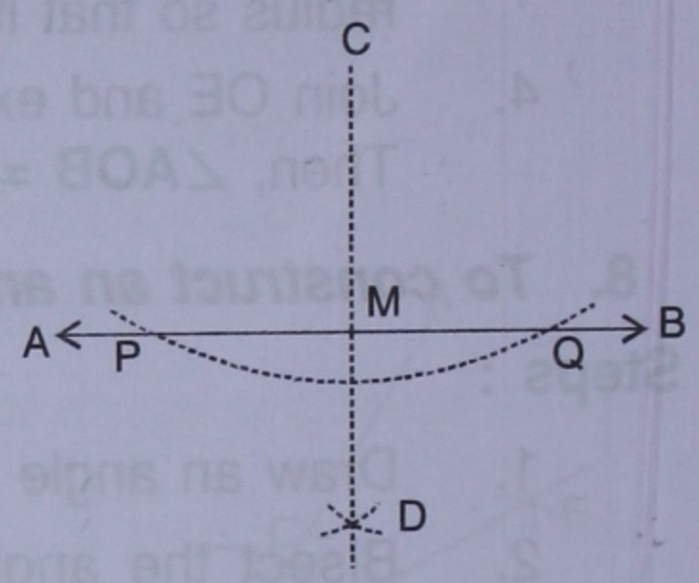
Thus, the line segment CD is the perpendicular bisector of AB as it bisects AB at M and is also perpendicular to AB.

11. *To draw a perpendicular on to a given line from a given point outside the line.*

Let AB be the given line and C the given point lying outside the line AB.

Steps :

1. Taking C as centre, draw an arc of a suitable radius; it cuts AB at the two points P and Q.
2. With P and Q as centres, draw two arcs of equal radii intersecting at point D on the other side of AB.
3. Join C and D. Let CD cut line AB at point M. **CM is the required perpendicular on to the given line AB from the exterior point C.**



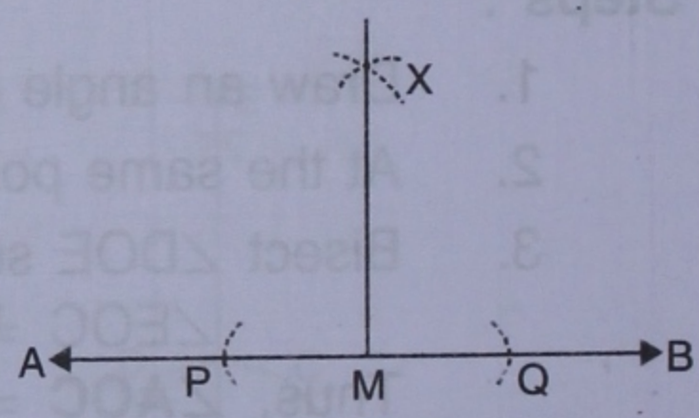
12. *To draw a perpendicular on to a line through a given point on the given line.*

Let AB be the given line and let M be a point on the line AB.

Steps :

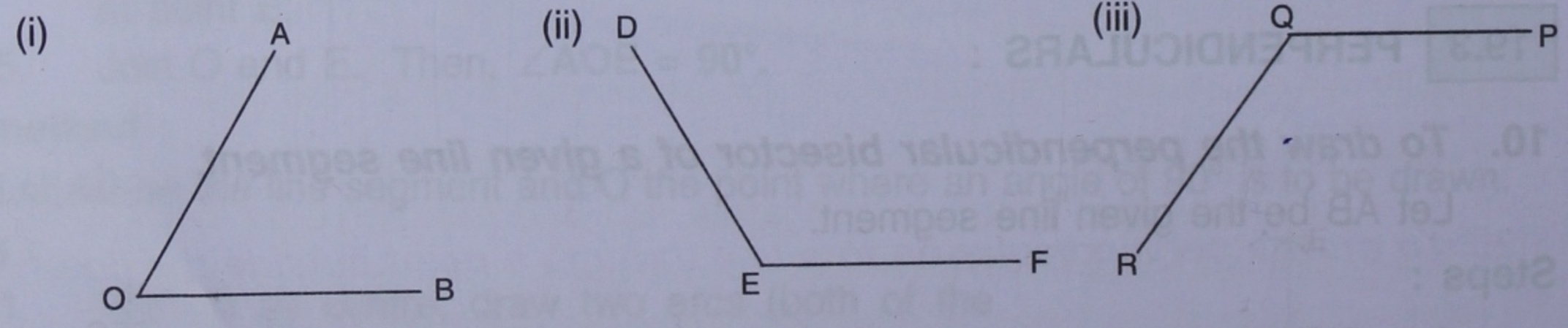
1. Taking M as centre, draw two arcs of the same radii. Let these arcs cut AB at points P and Q.
2. Now taking P and Q as centres, draw arcs of equal radii intersecting at point X.
3. Join M and X.

MX is the required perpendicular on to the line AB through point M on it.



EXERCISE 19(A)

1. In your note-book, copy the following angles using ruler and compasses only.



2. Construct the following angles, using ruler and compass only

(i) 60° (ii) 90° (iii) 45° (iv) 30° (v) 120° (vi) 135°

3. Draw line AB = 6 cm. Construct angle ABC = 60°. Then draw the bisector of angle ABC.
4. Draw a line segment PQ = 8 cm. Construct the perpendicular bisector of the line segment PQ. Let the perpendicular bisector drawn meets PQ at point R. Measure the lengths of PR and QR. Is PR = QR ?

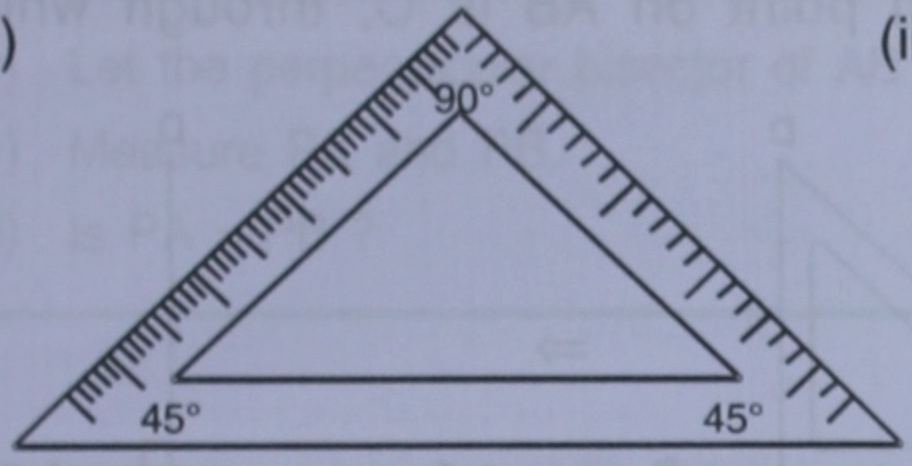
5. Draw a line segment AB = 7 cm. Mark a point P on AB such that AP = 3 cm. Draw perpendicular on to AB at point P.

6. Draw a line segment AB = 6·5 cm. Locate a point P that is 5 cm from A and 4·6 cm from B. Through the point P, draw a perpendicular on to the line segment AB.

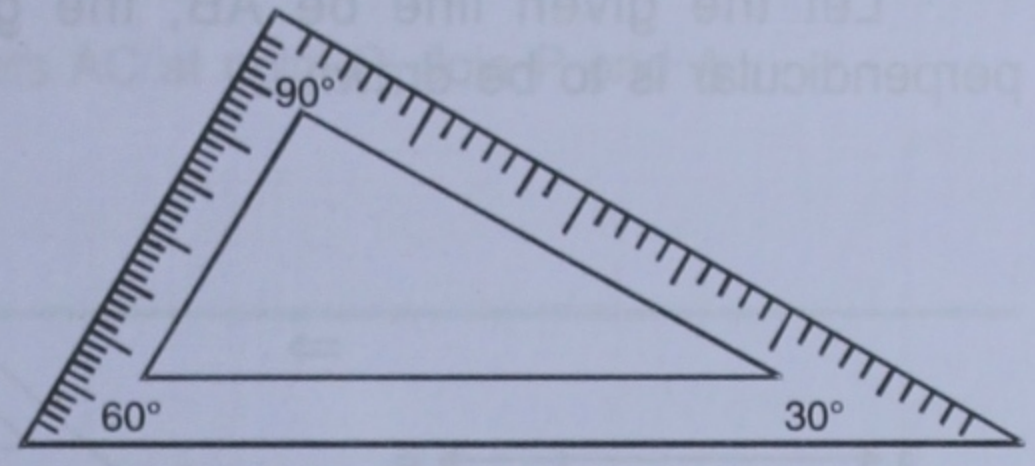
19.4 USING SET-SQUARES :

A set-square is a triangular piece of plastic or metal.

(i)



(ii)



In general, set-squares are of two types :

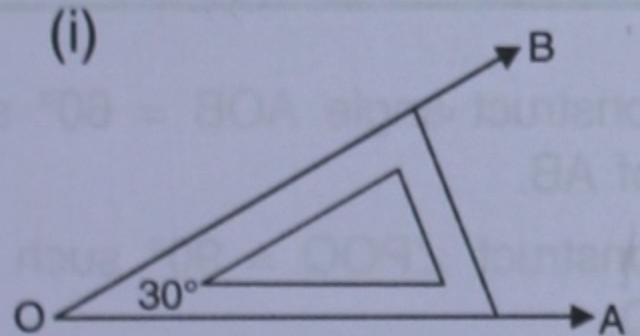
(i) a set-square with angles 45°, 90° and 45°.

(ii) a set-square with angles 60°, 90° and 30°.

1. *To draw the angles of 30°, 45°, 60°, 75°, 90° and 105° using a set-square.*

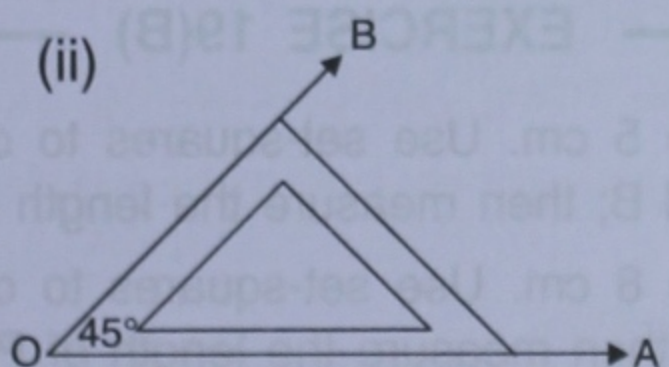
The lines drawn along the sides of a set-square give the angles mentioned above.

(i)



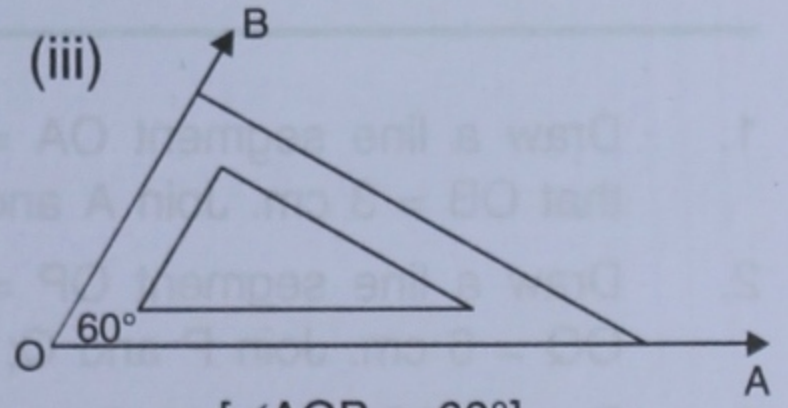
[∠AOB = 30°]

(ii)



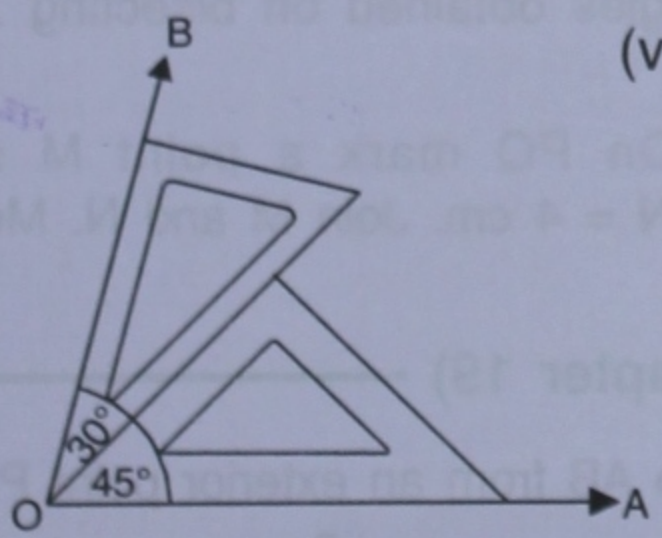
[∠AOB = 45°]

(iii)



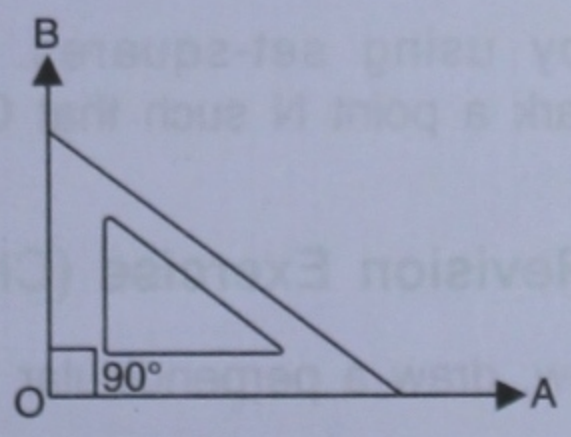
[∠AOB = 60°]

(iv)



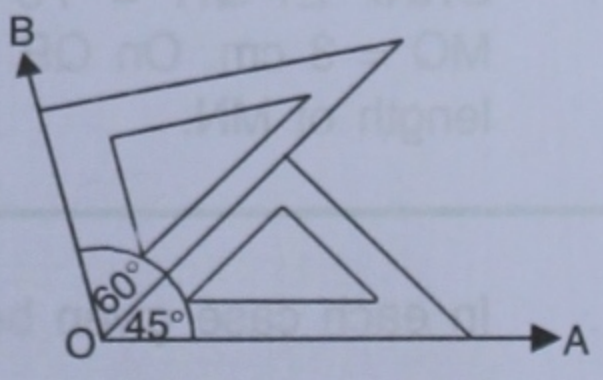
[∠AOB = 75°]

(v)



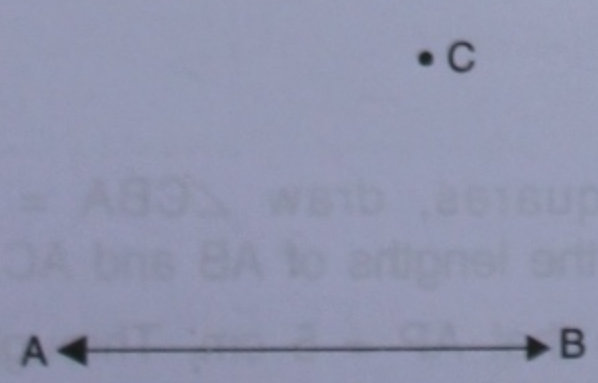
[∠AOB = 90°]

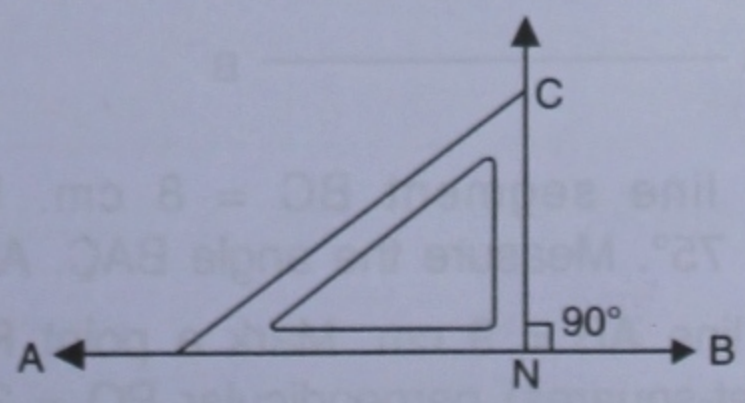
(vi)



[∠AOB = 105°]

2. *To draw a perpendicular on to a line through a point outside the line.*



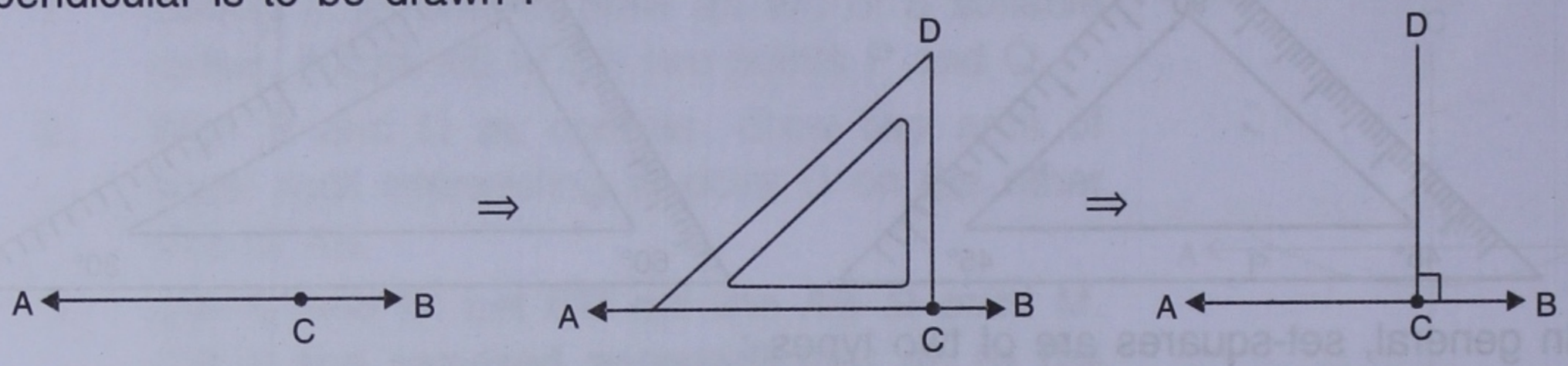


Let AB be the given line and C the given point outside the line AB. Place the suitable set-square in such a way that one of its edges, *i.e.* the one containing angle 90°, coincides with line AB and the other edge with point C (see the figure given above). Then, through point C, draw a line along the edge of the set-square such that it meets the given line AB at point N.

∴ CN is the required perpendicular on to AB through the external point C.

3. *To construct a perpendicular on to a line at a point on the line.*

Let the given line be AB; the given point on AB is C, through which the perpendicular is to be drawn :



Place the suitable set-square at point C in such a way that one edge of it, *i.e.* the one containing 90°, coincides with line AB. Now, through C, draw a line segment CD along the other edge of the set-square containing 90°.

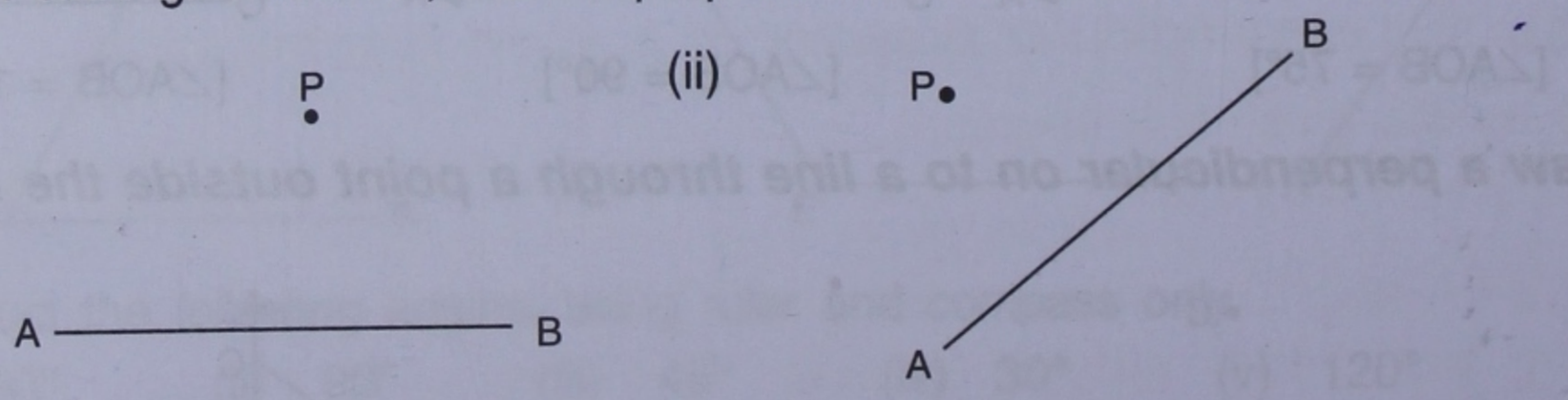
∴ CD is the required perpendicular on to AB through point C on the line AB.

EXERCISE 19(B)

1. Draw a line segment OA = 5 cm. Use set-squares to construct angle AOB = 60° such that OB = 3 cm. Join A and B; then measure the length of AB.
2. Draw a line segment OP = 8 cm. Use set-squares to construct ∠POQ = 90° such that OQ = 6 cm. Join P and Q; then measure the length of PQ.
3. Draw ∠ABC = 120°. Bisect the angle using ruler and compass. Measure each angle so obtained and check whether or not the new angles obtained on bisecting ∠ABC are equal.
4. Draw ∠PQR = 75° by using set-squares. On PQ mark a point M such that MQ = 3 cm. On QR mark a point N such that QN = 4 cm. Join M and N. Measure the length of MN.

Revision Exercise (Chapter 19)

1. In each case given below, draw a perpendicular to AB from an exterior point P.



2. Draw a line segment BC = 8 cm. Using set-squares, draw ∠CBA = 60° and ∠BCA = 75°. Measure the angle BAC. Also measure the lengths of AB and AC.
3. Draw a line AB = 9 cm. Mark a point P in AB such that AP = 5 cm. Through P draw (using set-squares) perpendicular PQ = 3 cm. Measure BQ.

4. Draw a line segment AB = 6 cm. Without using set squares, draw angle OAB = 60° and angle OBA = 90°. Measure angle AOB and write this measurement.

5. Without using set squares, construct angle ABC = 60° in which AB = BC = 5 cm. Join A and C and measure the length of AC.

6. Use a protractor to construct angle MON = 80°. Bisect the angle MON.

7. (i) Draw AB = 7 cm.
   (ii) Construct angle ABC = 60°.
   (iii) Draw the perpendicular bisector of AB.
   (iv) Let the perpendicular bisector of AB meets AC at point P. Join P and A.
   (v) Measure PA and PB.
   (vi) Is PA = PB ?