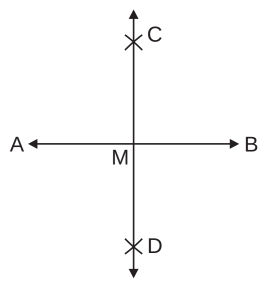
CHAPTER 11 Constructions

EXERCISE 11A

Section A

1. **Steps of Construction:**
   1. Draw a line segment AB = 6.8 cm.
   2. With centre A and radius more than half of AB, draw arcs on both sides of the line segment AB.
   3. With centre B and the same radius as in step 2, draw arcs cutting the previous arc at C and D.
   4. Join CD and let it intersect at M. Then, the line CMD bisects AB at M.

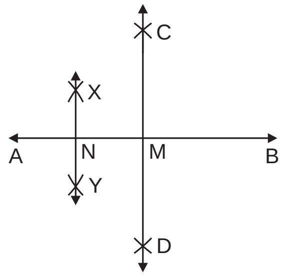
   Length of each part = 3.4 cm.



AM = MB = 3.4 cm

2. **Refer to solution of Q.1. (Steps of construction)**
3. Draw a line segment AB = 12 cm. Bisect is by following the steps of construction given in solution to Q.1.

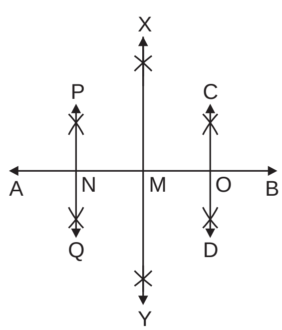
   Let M be the point of bisection. repeat the steps given in solution of Q.1 to bisect either AM or MB, as shown in the figure. Length of each bisected part of AM (or MB) = 3 cm.



AN = NM = 3 cm

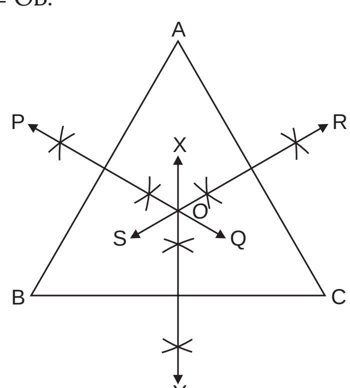
4. Draw a line segment AB = 10 cm. Using the steps of construction given in the solution to Q.1, draw perpendicular bisector of AB bisecting it at M and then draw perpendicular bisectors of AM and MB bisecting then at N and O respectively.

   Then, AN = NM = MO = OB.

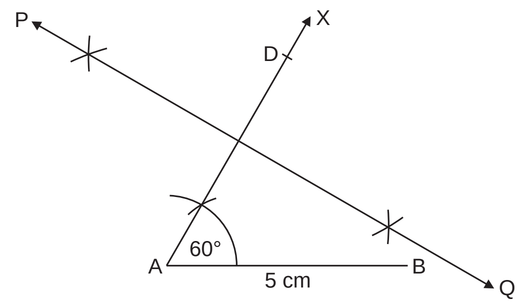


5. Draw any ΔABC. Using the steps of construction given in the solution to Q.1, draw perpendicular bisectors PQ, RS and XY of sides AB, AC and BC respectively.

   Yes, the perpendicular bisectors of the sides of the triangle meet at a point (circumcentre).



6. **Steps of Construction:**

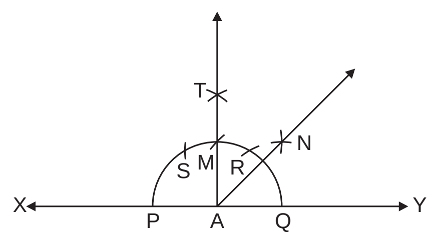


   1. Draw a line segment AB = 5 cm.
   2. At A, construct ∠XAB = 60°.
   3. With centre A and radius = 6 cm, draw an arc cutting XA at D.
   4. Using the steps of construction given in the solution to Q.1, draw PQ the perpendicular bisector of AD.

   No, the perpendicular bisector of AD does not pass through B.

7. (i) 45°

   Steps of Construction:



   1. Draw any lien XY.
   2. Take any point A on it.
   3. With A as centre and any convenient radius, draw a semicircular arc cutting XY at points P and Q.
   4. With centre Q and same radius, draw an arc cutting the semicircular arc at R.
   5. With centre R and same radius, draw another arc cutting the semicircular arc at S.
   6. With R and S as centres and radius more than $\frac{1}{2}$ RS, draw arcs to intersect each other at a point (say) T.
   7. Draw the ray AT cutting the semicircular arc at a point (say) M.

      Then, ∠TAY = 90°
   8. With centres M and Q and radius more than $\frac{1}{2}$ MQ, draw arcs to intersect each other at a point (say) N.

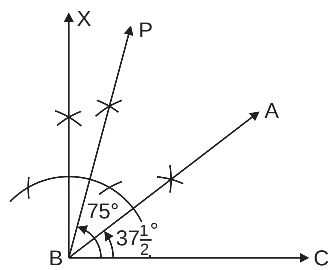
9. Draw the ray AN.

Then $\angle NAY = \frac{1}{2}\angle TAY = \frac{1}{2} \times 90° = 45°$

(ii) $37\frac{1}{2}°$

1. Bisect the angle between 60° and 90° to get

$$\angle PBC = 60° + \frac{90° - 60°}{2} = 60° + \frac{30°}{2}$$
$$= 60° + 15° = 75°$$



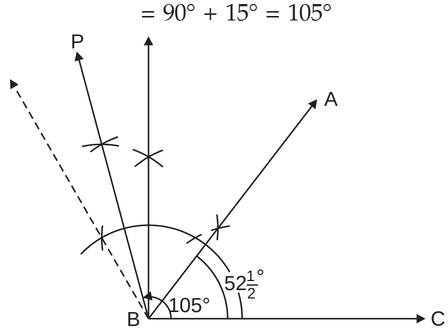
2. Bisect angle of 75° to get an angle of $37\frac{1}{2}°$.

Note: To draw angle bisectors refer to example 2 on page 5.2 of textbook.

(iii) $52\frac{1}{2}°$

1. Bisect the angle between 90° and 120° to get

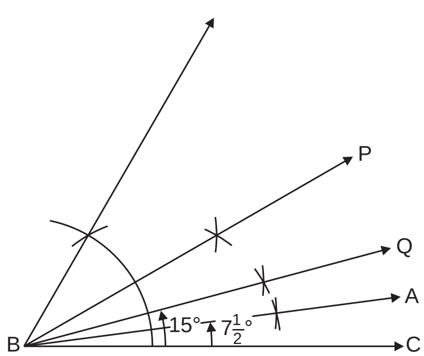
$$\angle PBC = 90° + \left(\frac{120° - 90°}{2}\right) = 90° + \frac{30°}{2}$$
$$= 90° + 15° = 105°$$



2. Bisect 105° angle to get two required angle of $52\frac{1}{2}°$.

$$\angle ABC = 52\frac{1}{2}°$$

(iv) $7\frac{1}{2}°$



1. Bisect 60° angle to obtain ∠PBC = 30°
2. Bisect 30° angle to obtain ∠QBC = 15°
3. Bisect 15° angle to get the required angle of $7\frac{1}{2}°$

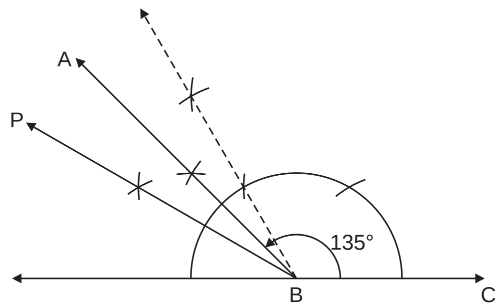
$$\angle ABC = 7\frac{1}{2}°$$

(v) 105° Refer to part (iii)

(vi) 135°

1. Bisect the angle between 120° and 180° to get

$$\angle PBC = 120° + \frac{(180° - 120°)}{2}$$
$$= 120° + \frac{60°}{2}$$
$$= 120° + 30° = 150°$$

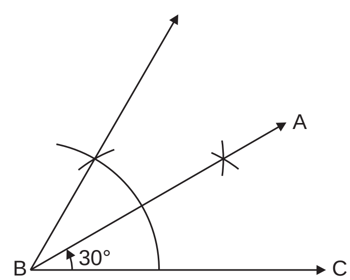


2. Bisect the angle between 120° and 150° to get

$$\angle ABC = 120° + \frac{150° - 120°}{2}$$
$$= 120° + 15° = 135°$$
$$\angle ABC = 135°$$

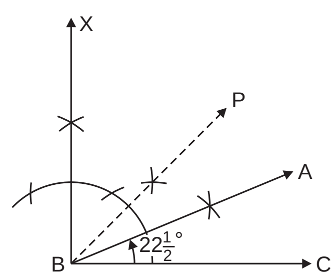
8. (i) 30°

Bisect 60° angle to obtain 30° angle.



∠ABC = 30°

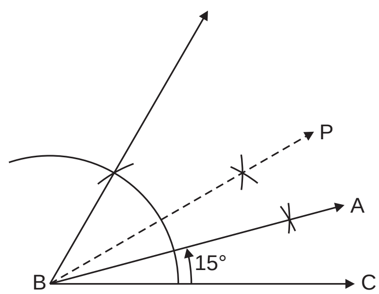
(ii) $22\frac{1}{2}°$



1. Bisect 90° angle to obtain ∠PBC = 45°
2. Bisect 45° angle to get the required angle = $22\frac{1}{2}^\circ$

$\angle ABC = 22\frac{1}{2}^\circ$

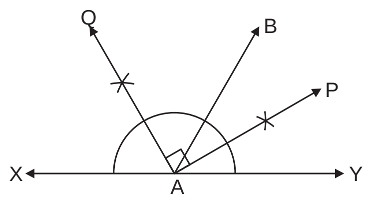
(iii) 15°



1. Bisect 60° angle to obtain ∠PBC = 30°
2. Bisect 30° angle to get the required angle of 15°.

∠ABC = 15°

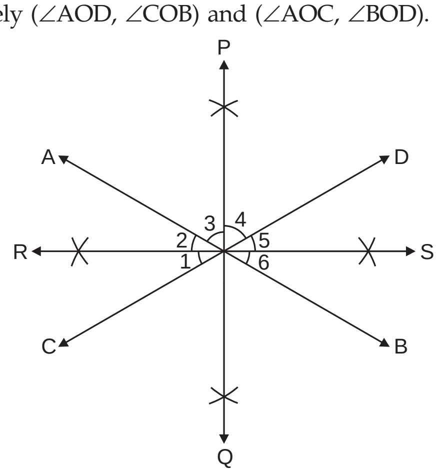
9. 1. Draw any line XY.



2. Take any point A on it and through A draw a ray AB to obtain linear pair of angles namely BAX and BAY.
3. Draw AP the angle bisector of ∠BAY (Refer to example 2 on page 5.2 for drawing the angle bisector).
4. Draw AQ the angle bisector of ∠BAX.

Measure of ∠QAP formed between the bisecting rays AQ and AP is 90°.

10. 1. Draw two intersecting lines AB and CA, intersecting at O to form two pairs of vertically opposite angles namely (∠AOD, ∠COB) and (∠AOC, ∠BOD).



2. Draw OP and OQ the angle bisectors of ∠AOD and ∠COB respectively.

OP and OQ form opposite rays and so they lie in the same straight line.

3. Draw OR and OS the angle bisectors of ∠AOC and ∠BOD respectively.

OR and OS form opposite rays and so they lie in the same straight line.

Justification: ∠1 = ∠2 [∵ OR is the bisector of ∠AOC] ...(1)

∠5 = ∠6 [∵ OS is the bisector of ∠BOD] ...(2)

∠AOC = ∠BOD [V. opposite angles]

⇒ ∠1 + ∠2 = ∠5 + ∠6

⇒ 2∠1 = 2∠5 [Using (1) and (2)]

⇒ ∠1 = ∠5 ...(3)

We know that the sum of all the angles at a point on a straight line on the same side of it is 180°.

∴ Sum of all the angles at point O on line CD on the same side of it is 180°.

⇒ ∠1 + ∠2 + ∠3 + ∠4 = 180°

⇒ ∠5 + ∠2 + ∠3 + ∠4 = 180° [Using (3)]

⇒ RS is a straight line

⇒ Bisecting rays OR and OS lie in the same straight line.

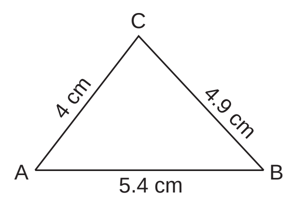
Similarly, it can be proved that bisecting rays OP and OQ lie in the same straight line.

Section B

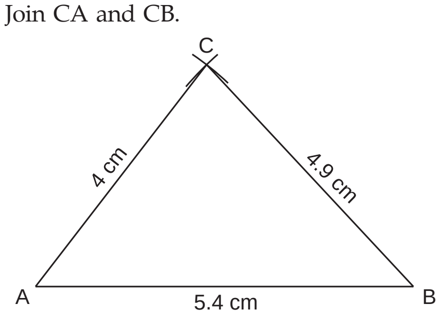
[Draw rough figure before constructing the final figure]

1. (i) **Steps of Construction**

1. Draw a line segment AB = 5.4 cm.
2. With centre A and radius = 4 cm, draw an arc.
3. With centre B and radius = 4.9 cm, draw another arc cutting the previous arc at C.
4. Join CA and CB.



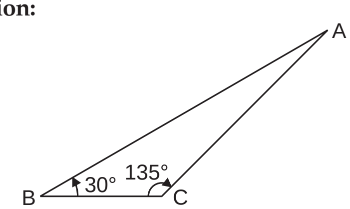
Rough Figure



Then ΔCAB is the required triangle.

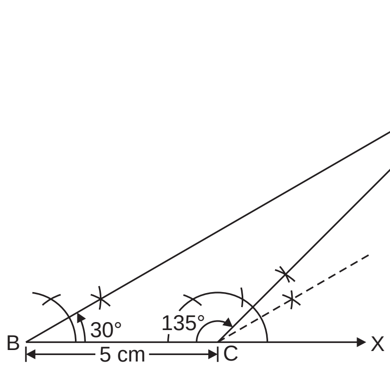
(ii) **Steps of Construction:**

1. Draw ray BX.
2. With centre B and radius = 5 cm draw an arc cutting BX at C.
3. At B construct ∠PBC = 30°.



Rough Figure

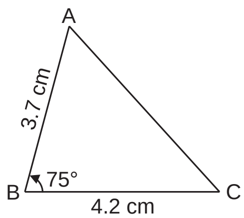
4. At C construct ∠QCB = 135°.
Let BP and CQ intersect at A.



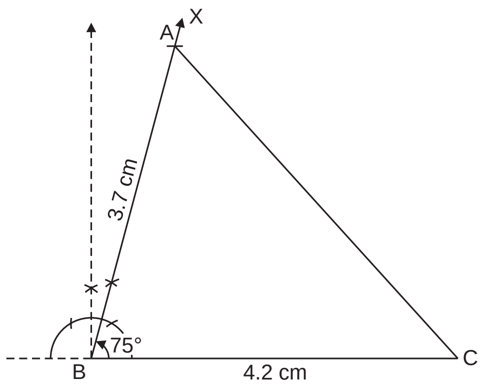
Then, ΔABC is the required triangle.

(iii) **Steps of Construction**

1. Draw line segment
BC = 4.2 cm.
2. At B construct
∠XBC = 75°.
3. With centre B and radius = 3.7 cm, draw an arc cutting XB at A.
4. Join AC.

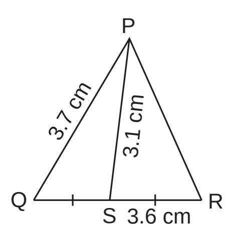


Rough Figure



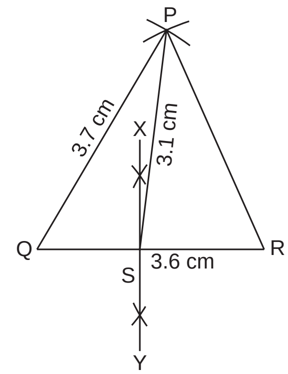
Then, ΔABC is the required triangle.

2. **Steps of Construction:**



Rough Figure

1. Draw a line segment OR = 3.6 cm.
2. Draw XY, the perpendicular bisector of QR and let it intersect QR at S.
3. With centre S and radius = 3.1 cm, draw an arc.
4. With centre Q and radius = 3.7 cm, draw another arc cutting the previous arc at P.
5. Join PQ and PR.

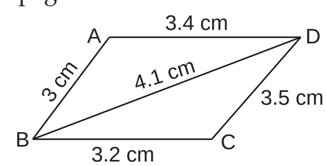


Then ΔPQR is the required triangle.

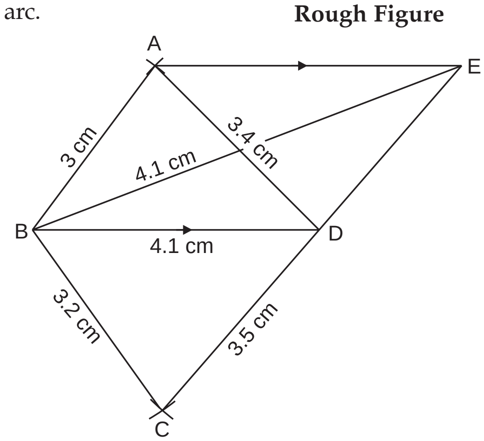
3. Refer to example 5 page 5.4 of textbook.
4. Refer to example 6 page 5.4 of textbook.
5. Refer to example 7 page 5.4 of textbook.
6. Refer to example 8 page 5.5 of textbook.

EXERCISE 11B

1. to 6. Refer to example 1 on page 5.6
7. and 8. Refer to example 2 on page 5.7
9. Refer to example 3 on page 5.7
10. Refer to example 2 on page 5.7
11. to 13. Refer to example 4 on page 5.8
14. to 15. Refer to example 5 on page 5.8
16. **Steps of Construction:**
   1. Draw a line segment BD = 4.1 cm.
   2. With centre B and radius = 3 cm, draw an arc.



Rough Figure

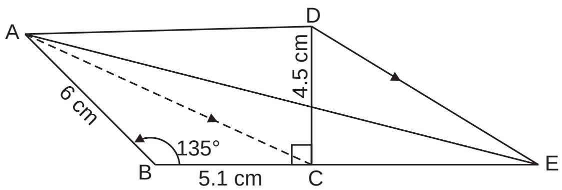


   3. With centre D and radius = 3.4 cm, draw another arc cutting the previous arc to get the point A.
   4. Join AB and AD.
   5. Again with centre B and radius = 3.2 cm draw an arc on the side opposite to point A.
   6. With centre D and radius = 3.5 cm, draw another arc cutting the previous arc at C.
   7. Join BC and CD.

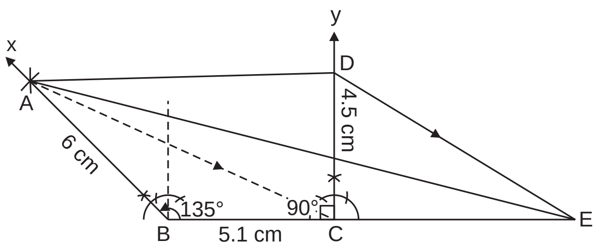
Then ABCD is the required quadrilateral.

8. Through A draw AE || BD and let it meet CD produced at E.
9. Join BE.
10. Then ΔBEC is the required triangle equal in area to the quadrilateral ABCD.

17. Steps of Construction:



Rough Figure

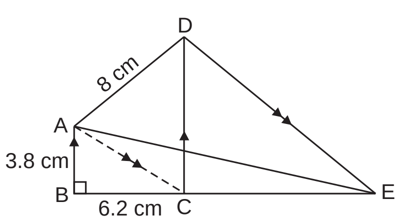


1. Draw line segment BC = 5.1 cm.
2. At B construct ∠XBC = 135°.
3. At C construct ∠YCB = 90°.
4. With centre B and radius = 6 cm, draw an arc cutting XB at A.
5. With centre C and radius = 4.5 cm, draw an arc cutting YC at D.
6. Join AD.

   Then ABCD is the required quadrilateral.
7. Join diagonal AC.
8. Through D, draw DE || AC meeting BC produced at E.
9. Join AE.
10. Then ΔABE is the required triangle equal in area to quadrilateral ABCD.

18. Steps of Construction:

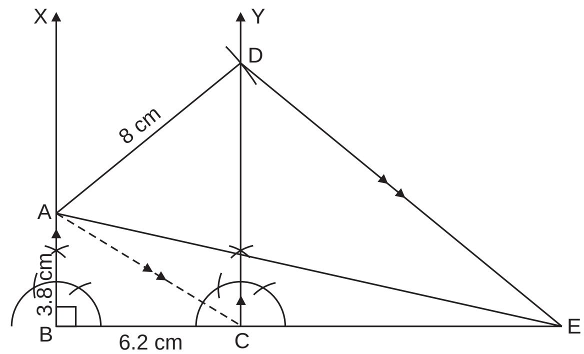
1. Draw line segment BC = 6.2 cm.
2. At B construct ∠XBC = 90°.
3. At C construct ∠YCB = 90°.



Rough Figure

4. With centre B and radius = 3.8 cm, draw an arc to cut XB at A.
5. With centre A and radius = 8 cm, draw an arc to cut YC at D.
6. Join AD.

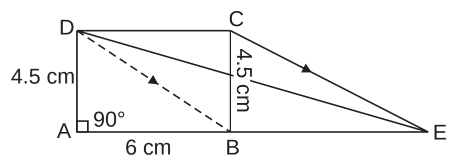
   Then, ABCD is the required quadrilateral.
7. Join diagonal AC.
8. Through D, draw DE || AC meeting BC produced at E.



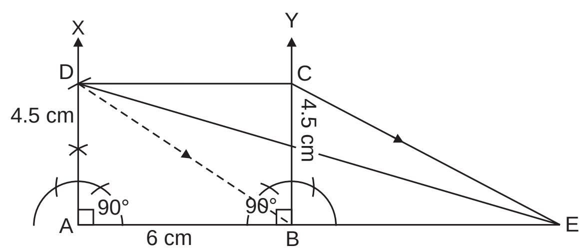
9. Join AE.

   Then ΔABE is the required triangle equal in area to quadrilateral ABCD.

19. Steps of Construction:



Rough Figure

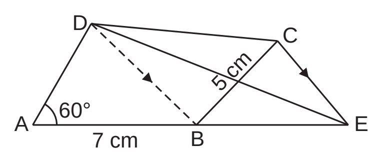


1. Draw line segment AB = 6 cm.
2. At A and B construct ∠XAB and ∠YBA each equal to 90°.
3. With centre A and radius equal to 4.5 cm, draw an arc to cut XA at D.
4. With centre B and radius equal to 4.5 cm, draw an arc to cut YB at C.
5. Join CD.

   Then, ABCD is the required rectangle.
6. Join DB.
7. Through C draw CE || DB meeting AB produced at E.
8. Join DE.

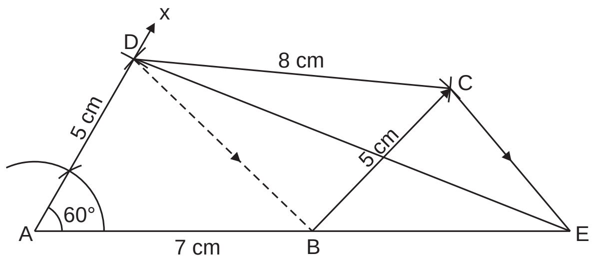
   Then, ΔADE is the required triangle equal in area to rectangle ABCD.

20. Steps of Construction:



Rough Figure

1. Draw line segment AB = 7 cm.
2. At A construct ∠XAB = 60°.



3. With centre A and radius = 5 cm, draw an arc to cut XA at D.
4. With centre D and radius = 7 cm, draw an arc.
5. With centre B and radius = 5 cm, draw another arc to cut the previous arc at C.
6. Join BC and DC. Then ABCD is the required ||gm.
7. Join DB.
8. Through C, draw CE || BD to meet AB produced at E.
9. Join DE.

Then, ΔADE is the required triangle equal in area to the parallelogram ABCD.

CHECK YOUR UNDERSTANDING

MULTIPLE-CHOICE QUESTIONS

1. (c) **37.5°**

Since 37.5° is a multiple of 7.5°, therefore, it can be constructed using a ruler and compass.

Step 1. Bisect the angle between 60° and 120° to get an angle.

$$= 60° + \frac{(120° - 60°)}{2} = 60° + \frac{60°}{2}$$

$$= 60° + 30° = 90°$$

Step 2. Bisect the angle between 60° and 90° to get an angle

$$= 60° + \frac{90° - 60°}{2} = 60° + \frac{30°}{2}$$

$$= 60° + 15° = 75°.$$

Step 3. Finally angle of 75°, can be bisected to get its half i.e. 37.5°.

The remaining angles are not multiples or submultiples of 7.5°. So, they cannot be constructed using a compass and a ruler.

2. (c) **35°**

Since 35° is not a multiple or submultiple of 7.5°, therefore, it is not possible to construct it with the help of a ruler and compass. The remaining angles whose measures are 7.5°, 82.5° and 67.5° can be constructed with the help of a ruler and compass as they are all multiples or factor 7.5°.

3. (b) **5.5 cm**

In a triangle the difference of any two sides is always less than third side.

When the difference between BC and AC = 5.5 cm, then this difference is greater than AB = 5 cm. Thus, it is not possible to construct the given ΔABC in such a case.

Since in all the remaining three cases, the difference between BC and AC is less than AB (= 5 cm), therefore it is possible to construct ΔABC.

4. (d) **5.9 cm**

In a triangle the difference of any two sides is always less than the third side. When the difference between AB and AC = 5.9 cm, then this difference is greater than BC = 5 cm. Thus, it is not possible to construct the given ΔABC in such a case.

Since in all the remaining three cases, the difference between AB and AC is less than BC (= 5 cm), so it is possible to construct ΔABC in such cases.

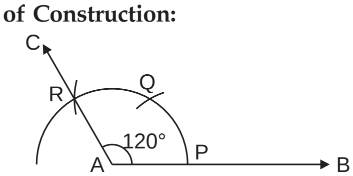
5. (c) **2.8 cm**

In a triangle the difference of any two sides is always less than the third side. But 3.1 cm > 3 cm, 3.2 cm > 3 cm and 3 cm = 3 cm. So, out of the given options, it is possible to construct the given ΔABC only when the difference of AB and AC is equal to 2.8 cm which is less than 3 cm.

SHORT ANSWER QUESTIONS

1. Refer to the solution of Q.4. of Exercise 5A.

2. (i) **Steps of Construction:**



1. Draw a line segment AB
2. With centre A and convenient radius, draw a semicircular arc cutting AB at P.
3. With centre P and same radius, draw an arc cutting the semicircular arc at Q.
4. With centre Q and same radius, draw another arc cutting the semicircular arc at R.
5. Join AR and extend it to a point (say C).
6. Then ∠CAB is the required angle of measure 120°.

(ii) Refer to the solution of Q.7. (ii) of Exercise 5A.

3. Refer to the solution of Q.8. (ii) of Exercise 5A.

4. Refer to example 3 on page 5.3 and Q.5. of Exercise 5A.

5. Refer to example 7 on page 5.4.

VALUE-BASED QUESTION

1. (i) Refer to example 12 on page 5.8.

(ii) Creative skill, empathy, helpfulness, caring and social responsibility.

UNIT TEST

Multiple-Choice Questions

1. (a) **42°**

   42° is not a multiple 7.5° $\left(7.5° = \frac{1}{4} \text{ of } 30°\right)$.

   So, it cannot be constructed using a ruler and compass. All the angles given in the remaining options are multiples (or factor) of 7.5°.

   So, it is possible to construct them using a ruler and compass.

2. (c) **37.5°**

   Since, 37.5° is a multiple of 7.5°, therefore, it can be constructed with the help of a ruler and compass. Angles given in the remaining options are neither multiples nor factors of 7.5°, so they cannot be constructed with the help of a ruler and compass.

3. (d) **7 cm**

   The sum of any two sides of triangle is greater than the third side. When, QR + PR = 7 cm, then this sum is greater than PQ = 6 cm.

   Thus, it is possible to construct ΔPQR in such a case. Since the sum of QR and PR is given in the remaining three options is less than PQ, therefore, it is not possible to construct ΔPQR in such cases.

4. (d) **4.5 cm**

   The difference of any two sides of a triangle is less than the third side.

   When BC – AC = 4.5 cm, then this difference is less than AB = 5 cm. Thus, it is possible to construct ΔABC in such a case.

   Since, the difference of BC and AC given in the remaining three options is either equal to or greater than AB = 5 cm, therefore, it is not possible to construct ΔABC in such cases.

5. (a) **7 cm**

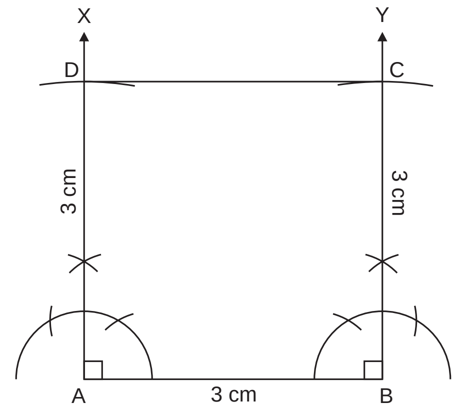
   The difference of any two sides of a triangle is less than the third side.

   When AB – AC = 7 cm, then this difference is not less than BC = 7 cm.

   Thus, it is not possible to construct ΔABC in such a case.

   Since AB – AC given in the remaining three options is less than BC = 7 cm, therefore, it is possible to construct ΔABC in all such cases.

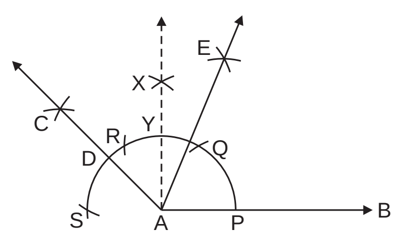
6. Refer to the solution of Q.7. (ii) of Exercise 5A
7. Refer to the solution of Q.7. (ii) of Exercise 5A
8. Refer to example 5 on page 5.4.
9. **Steps of Construction:**
   1. Draw a line segment AB = 3 cm.
   2. At A and B construct ∠XAB and ∠YBA, each of measure 90°.



   3. With centre A and radius = 3 cm, draw an arc cutting XA at D.
   4. With centre B and radius = 3 cm, draw an arc cutting YB at C.
   5. Join CD.

   Then, ABCD is the required square.

10. Refer to example 4 on page 5.3
11. Refer to example 7 on page 5.4
12. Refer to example 6 on page 5.4
13. Refer to the solution of Q.3. of Exercise 5A.
14. **Steps of Construction:**
    1. Draw any ray AB.
    2. With centre A and any convenient radius draw a semicircular arc cutting AB at P.



    3. With centre P and same radius draw an arc to cut the semicircular arc at Q.
    4. With centre Q and same radius draw an arc to cut the semicircular arc at R.
    5. With centre R and same radius draw an arc to cut the semicircular arc at S.
    6. With centres R and Q and radius more than $\frac{1}{2}$RQ, draw arcs to cut each other at X.
    7. Join AX to form the ray AX and let AX cut the semicircular arc at y.
    8. With centres y and S and radius more than $\frac{1}{2}$SY, draw arcs to cut each other at C.
    9. Join AC to form the ray AC and let it cut the semicircular arc at D.

       Then, m (∠CAB) = 135°
    10. With centres D and P and radius more than $\frac{1}{2}$DP, draw arcs to cut each other at E.

11. Join AE to form the ray AE.

Then, the bisector angles are CAE and EAB.

$$m\,(\angle CAE) = m(\angle EAB) = 67.5°$$

15. Refer to example 1 on page 5.6

16. Refer to example 2 on page 5.7

17. Refer to example 5 on page 5.8

18. Refer to the solution of Q.20. of Exercise 5B.