

# MATHEMATICS

## Class-VIII

### Topic-6

## CONSTRUCTION OF QUADRILATERAL



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# CH-06

## CONSTRUCTION OF QUADRILATERAL

### TERMINOLOGIES

Concave Quadrilateral, Convex Quadrilateral.

### INTRODUCTION

In the previous chapter, we have learnt about some special types of quadrilaterals and their properties. In this chapter, we shall learn to construct some quadrilaterals with given measurements.

### 6.1 CONSTRUCTION OF QUADRILATERALS

We know that a quadrilateral has total ten parts i.e. four sides, four angles and two diagonals. If out of these ten parts any five independent parts are given then we can construct easily a convex quadrilateral. If we have to construct a **non-convex** quadrilateral then we are required six elements out of these ten elements. In this section, we shall learn to construct a **convex** quadrilateral by using ruler and compass in the following simple cases.

- (i) When the lengths of four sides and one diagonal are given.
- (ii) When the lengths of three sides and two diagonals are given.
- (iii) When the lengths of four sides and one angle is given.
- (iv) When the lengths of three sides and two included angles are given.
- (v) When three angles and two included sides are given.

Now we will illustrate one by one these cases by following examples.

#### (a) One Diagonal & Four Sides are Given

In this case, since the four sides and a diagonal are given, so we consider the quadrilateral ABCD as a figure made of two triangles,

- (i)  $\triangle ABC$  and  $\triangle ADC$  when diagonal AC as the common side is given.
- (ii)  $\triangle ABD$  and  $\triangle BCD$  when diagonal BD as the common side is given.

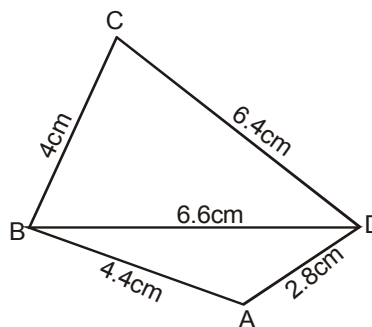
The following examples illustrate the process.

#### Illustration 6.1

Construct a quadrilateral ABCD in which  $AB = 4.4$  cm,  $BC = 4$  cm,  $CD = 6.4$  cm,  $DA = 2.8$  and  $BD = 6.6$  cm.

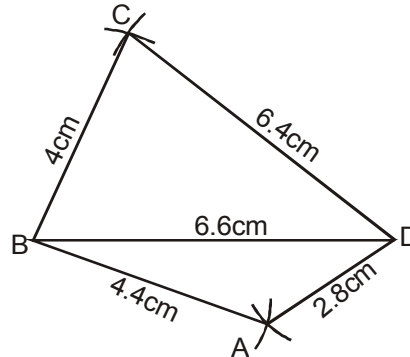
**Sol.** First, we draw a rough sketch of the quadrilateral ABCD and write down its dimensions along the sides.

We may divide the quadrilateral ABCD into two constructible triangles ABD and BCD.



**Steps of Construction :**

- (i) Draw  $BD = 6.6$  cm.
- (ii) With B as centre and radius  $BC = 4$  cm, draw an arc.
- (iii) With D as centre and radius  $CD = 6.4$  cm, draw an arc, to intersect the arc drawn in step 2 at C.



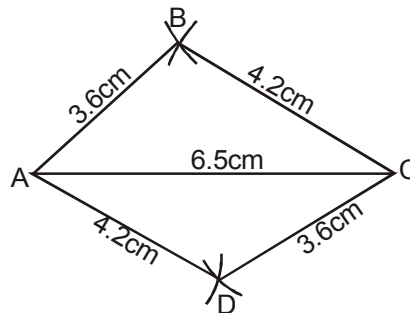
- (iv) With B as centre and radius  $BA = 4.4$  cm, draw an arc on the side of BD opposite to that of C.
- (v) With D as centre and radius  $AD = 2.8$  cm, draw another arc to intersect the arc drawn in step (iv) at A.
- (vi) Join BA, DA, BC and CD.

The quadrilateral ABCD so obtained is the required quadrilateral.

**Illustration 6.2**

Construct a parallelogram ABCD where  $AB = 3.6$  cm,  $BC = 4.2$  cm and  $AC = 6.5$  cm.

**Sol.** In a parallelogram opposite sides are equal. Thus, we have to construct a quadrilateral ABCD in which  $AB = 3.6$  cm,  $BC = 4.2$  cm,  $CD = 3.6$  cm,  $AD = 4.2$  cm and  $AC = 6.5$  cm.


**Steps of Construction :**

- (i) Draw  $AC = 6.5$  cm as shown in figure.
- (ii) With A as centre and radius  $AB = 3.6$  cm, draw an arc.
- (iii) With C as centre and radius  $BC = 4.2$  cm, draw an arc, intersecting the arc drawn in step (ii) at B.
- (iv) With A as centre and radius  $AD = 4.2$  cm, draw an arc on the side of AC opposite to that of B.
- (v) With C as centre and radius  $CD = 3.6$  cm, draw another arc to intersect the arc drawn in step (iv) at D.
- (vi) Join AB, BC, AD and CD to obtain the required parallelogram ABCD.

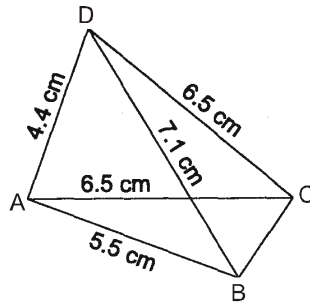
**(b) When Three Sides and Both Diagonals are given**

In this case also, we divide the quadrilateral into two conveniently constructible triangles as illustrated in the following examples :

**Illustration 6.3**

Construct a quadrilateral ABCD in which  $AB = 5.5$  cm,  $AD = 4.4$  cm,  $CD = 6.5$  cm,  $AC = 6.5$  cm and  $BD = 7.1$  cm.

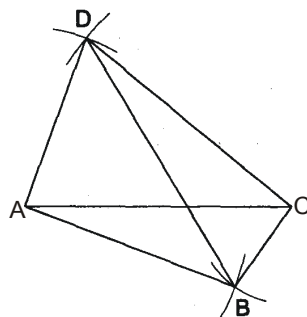
**Sol.** First we draw a rough sketch of quadrilateral ABCD. It is evident from the rough sketch that we have sufficient data to draw triangles ADC and ABD.



Now, we follow the following steps to construct the required quadrilateral.

**Steps of construction :**

- (i) Draw  $AC = 6.5$  cm.
- (ii) With A as centre and radius  $AD = 4.4$  cm, draw an arc.
- (iii) With C as centre and radius  $CD = 6.5$  cm, draw an arc to intersect the arc drawn in step (ii) at D.
- (iv) With A as centre and radius  $AB = 5.5$  cm, draw an arc on the side of AC opposite to that of D.
- (v) With D as centre and radius  $BD = 7.1$  cm, draw an arc intersecting the arc drawn in step (iv) at B.
- (vi) Join AD, CD, AB and CB to obtain the required quadrilateral.



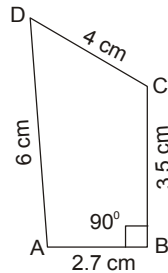
**(c) Four Sides and one Angle is Given**

Constructing a quadrilateral when its four sides and one angle are given :  
The following examples illustrate the procedure.

### Illustration 6.4

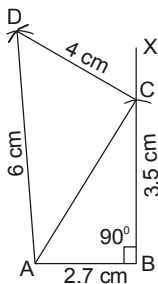
Construct a quadrilateral ABCD, where  $AB = 2.7$  cm,  $BC = 3.5$  cm,  $CD = 4$  cm,  $AD = 6$  cm and  $\angle B = 90^\circ$ .

**Sol.** Here, four sides and one angle are given. We first draw the rough sketch as shown in figure. It is evident from the rough sketch that in  $\triangle ABC$ , two sides and the included angle are given. So, we first construct  $\triangle ABC$ . Now,  $AC$  is known from  $\triangle ABC$  and  $AD$  and  $CD$  are given. So,  $\triangle ACD$  can also be drawn. Thus, to draw the quadrilateral ABCD, we follow the following steps.



#### Steps of Construction :

- (i) Draw  $AB = 2.7$  cm.
- (ii) Construct  $\angle ABX = 90^\circ$
- (iii) With B as centre and radius  $BC = 3.5$ , cut off  $BC = 3.5$  cm along BX.
- (iv) Join AC.
- (v) With A as centre and radius  $AD = 6$  cm draw an arc.
- (vi) With C as centre and radius  $CD = 4$  cm draw an arc to cut the arc drawn in step (v) at D.
- (vii) Join CD and AD.



The quadrilateral ABCD so obtained is the required quadrilateral.

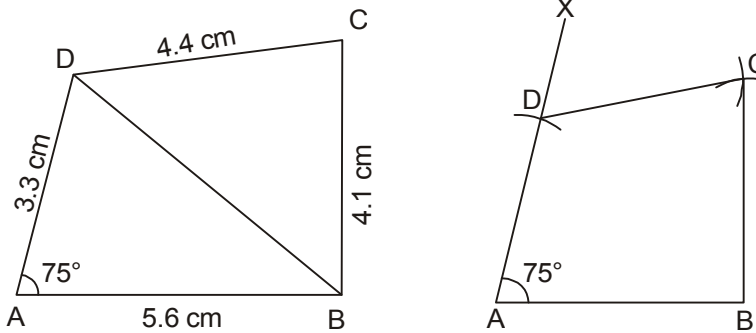
### Illustration 6.5

Construct a quadrilateral ABCD given  $AB = 5.6$  cm,  $BC = 4.1$  cm,  $CD = 4.4$  cm,  $AD = 3.3$  cm and  $\angle A = 75^\circ$ .

**Sol.** We first draw a rough sketch of the required quadrilateral and write down its dimensions along the sides. We can divide the construction of required quadrilateral into two parts

- (i) construction of  $\triangle ABD$
- (ii) Construction  $\triangle BCD$ .

The following steps are used to construct the required quadrilateral.



**Steps of Construction :**

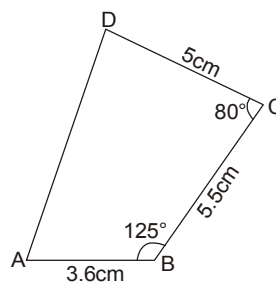
- (i) Draw  $AB = 5.6\text{cm}$ .
- (ii) Construct  $\angle BAX = 75^\circ$
- (iii) With A as centre and radius  $AD = 3.3\text{ cm}$ , cut off  $AD = 3.3\text{ cm}$  along AX.
- (iv) Join BD.
- (v) With D as centre and radius  $DC = 4.4\text{ cm}$ , draw an arc.
- (vi) With B as centre and radius  $BC = 4.1\text{ cm}$ , draw an arc to cut the arc drawn in step (v) at C.
- (vii) Join BC & CD to obtain the required quadrilateral ABCD

**(d) Three Sides and Two Included Angles are Given**

**Illustration 6.6**

Construct a quadrilateral ABCD, where  $AB = 3.6\text{ cm}$ ,  $BC = 5.5\text{ cm}$ ,  $CD = 5\text{ cm}$ ,  $\angle B = 125^\circ$  and  $\angle C = 80^\circ$ .

**Sol.** We first draw the rough sketch of the quadrilateral and indicate on it the data as shown in figure.

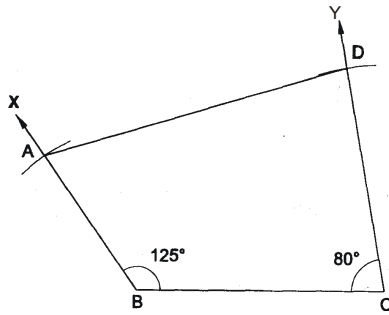


We observe that the data is sufficient to draw triangles BCA and BCD. Because in each case two sides and the included angle are given. The side BC is common to both. This suggests us the following steps of construction.

**Steps of Construction :**

- (i) Draw  $BC = 5.5\text{ cm}$
- (ii) At B construct  $\angle XBC = 125^\circ$
- (iii) At C construct  $\angle YCB = 80^\circ$ , such that X and Y are on the same side of BC
- (iv) With B as centre and radius  $AB = 3.6\text{ cm}$ , draw an arc to intersect BX at A.
- (v) With C as centre and radius  $CD = 5\text{ cm}$ , draw an arc to intersect CY at D.

(vi) Join AD.



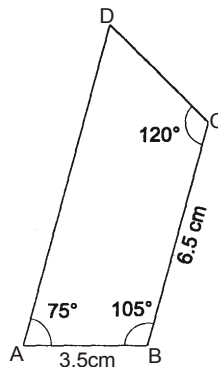
The quadrilateral ABCD so obtained is the required quadrilateral.

**(e) Three Angles and Two Included Sides are Given**

**Illustration 6.7**

Construct a quadrilateral ABCD where  $AB = 3.5$  cm,  $BC = 6.5$  cm,  $\angle A = 75^\circ$ ,  $\angle B = 105^\circ$  and  $\angle C = 120^\circ$ .

**Sol.** Let us draw a rough sketch of the required quadrilateral and write down the given data as shown in figure.

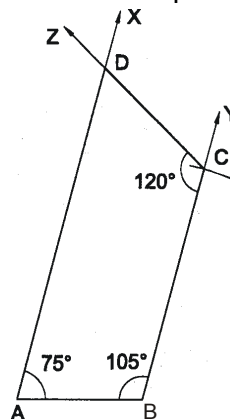


We now follow the following steps to construct the required quadrilateral.

**Step of Construction :**

- (i) Draw  $AB = 3.5$  cm
- (ii) Draw  $\angle XAB = 75^\circ$  at A and  $\angle ABY = 105^\circ$ .
- (iii) With B as centre and radius  $BC = 6.5$  cm, draw an arc to intersect BY at C.
- (iv) At C draw  $\angle BCZ = 120^\circ$  such that CZ meets AX at D.

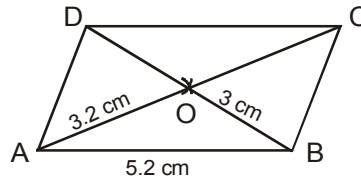
The quadrilateral ABCD so obtained is the required quadrilateral.





**Illustration 6.8**

Construct a parallelogram one of whose sides is 5.2 cm and whose diagonals are 6 cm and 6.4 cm.



**Sol.**

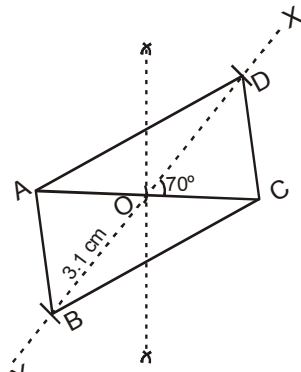
- (i) Draw  $AB = 5.2$  cm
- (ii) With A as centre and radius 3.2 cm draw an arc.
- (iii) With B as centre and radius 3 cm draw another arc cutting the previous arc at O.
- (iv) Join OA and OB
- (v) Produce AO to C such that  $AO = OC$  and produce BO to D such that  $BO = OD$ .
- (vi) Join AD, BC and CD.

ABCD is the required parallelogram.

**Illustration 6.9**

Construct a parallelogram whose diagonals are 5.4 cm and 6.2 cm and an angle between them is  $70^\circ$ .

**Sol.**



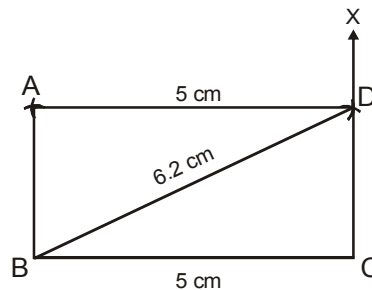
- (i) Draw  $AC = 5.4$  cm
- (ii) Bisect AC at O.
- (iii) Make  $\angle COX = 70^\circ$  and produce XO to Y.
- (iv) Cut off  $OB = \frac{1}{2} (6.2) = 3.1$  cm and  $OD = \frac{1}{2} (6.2) = 3.1$  cm
- (v) Join AB, BC, CD and DA

ABCD is the required parallelogram

**Illustration 6.10**

Construct a rectangle ABCD in which side  $BC = 5$  cm and diagonal  $BD = 6.2$  cm.

**Sol.**

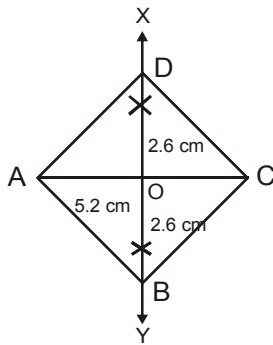


- (i) Draw  $BC = 5$  cm
  - (ii) Draw  $CX \perp BC$ .
  - (iii) With B as centre and radius 6.2 cm draw an arc to cut CX at D.
  - (iv) Join BD.
  - (v) With D as centre and radius 5 cm draw an arc.
  - (vi) With B as centre and radius equal to CD draw another arc, cutting the previous arc at A.
  - (vii) Join AB and AD.
- ABCD is the required rectangle

### Illustration 6.11

Construct a square with diagonal of 5.2 cm

**Sol.**

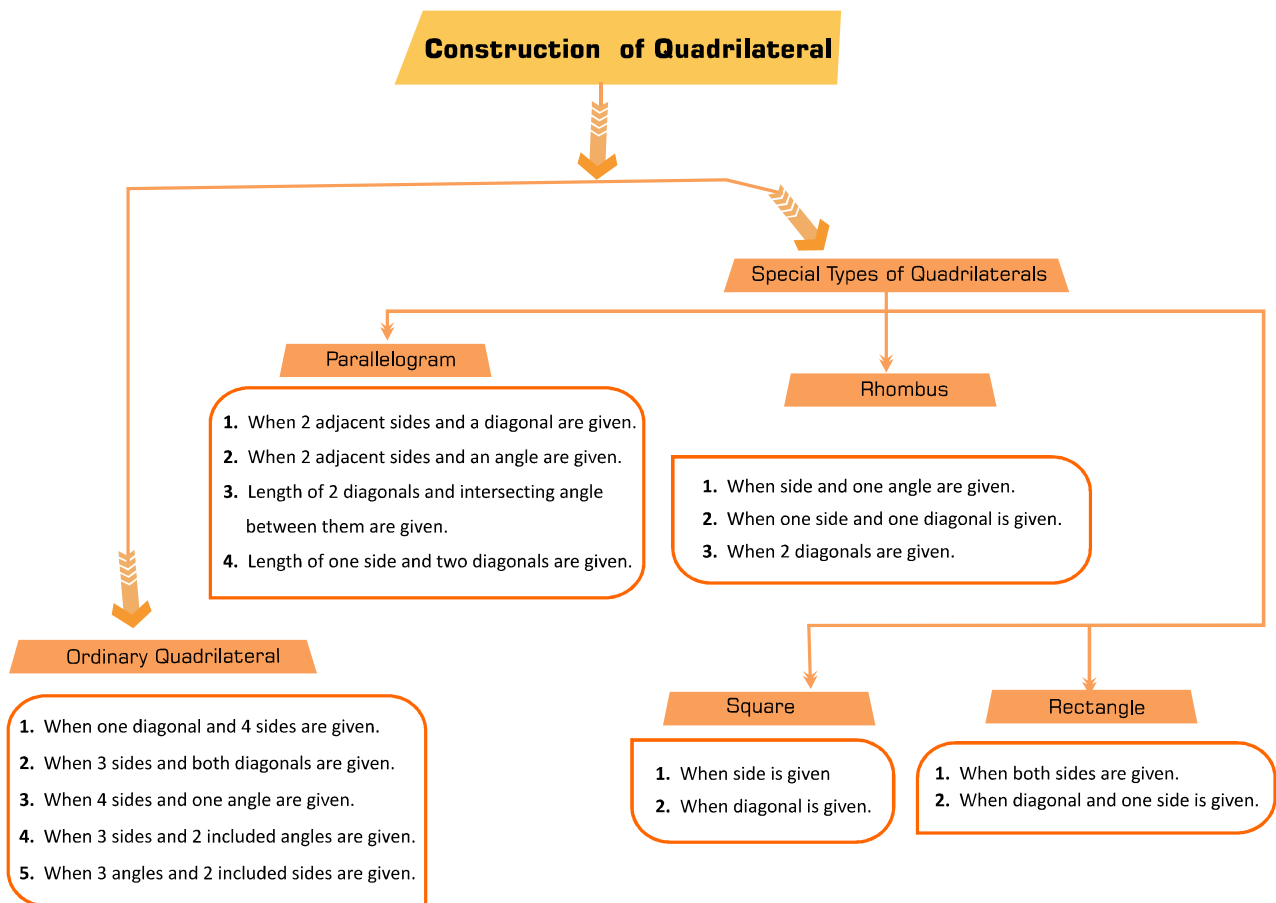


- (i) Draw  $AC = 5.2$  cm
- (ii) Draw the perpendicular bisector XY of AC meeting AC at O
- (iii) From O cut off  $OB = \frac{1}{2} (5.2) = 2.6$  cm along OY and  $OD = 2.6$  cm along OX.
- (iv) Join AB, BC, CD and DA. ABCD is the required square.

### Ask yourself

1. Construct a quadrilateral ABCD in which  $AB = 4.2$  cm,  $BC = 6$  cm,  $CD = 5.2$  cm,  $DA = 5$  cm and  $AC = 8$  cm.
2. Construct a quadrilateral ABCD, given that  $AB = 4.2$  cm,  $BC = 5$  cm,  $CD = 4.3$  cm,  $\angle B = 60^\circ$  and  $\angle C = 120^\circ$ .
3. Construct a quadrilateral ABCD, given that  $AD = 5$  cm,  $CD = 7$  cm,  $\angle A = 125^\circ$ ,  $\angle B = 105^\circ$ ,  $\angle C = 100^\circ$ .
4. Construct a square whose each side is 5 cm.
5. Construct a rhombus PQRS where each side measures 5 cm and  $\angle P = 60^\circ$
6. Construct a square each of whose sides measures 6.3 cm.

## Concept Map



## Summary

- To construct a quadrilateral uniquely, it is necessary to know at least five of its parts.
- Measurements of five parts of a quadrilateral are sufficient to construct it in the following cases :
  - Four sides and one diagonal.
  - Three sides and both diagonals.
  - Two adjacent sides and three angles.
  - Three sides and two included angles.
  - Four sides and one angle.
- Measurements of five parts of a quadrilateral, are sufficient for its construction, must also satisfy, wherever relevant,
  - triangle inequality property, i.e., sum of two sides is greater than the third side.
  - angle sum property of a quadrilateral.
- It is always convenient and helpful to draw a rough sketch of the quadrilateral and indicate the given measurements.

**Exercise-1****SECTION -B (FREE RESPONSE TYPE)****SHORT ANSWER TYPE**

1. Construct a quadrilateral ABCD in which  $AB = 4.5$  cm,  $BC = 4$  cm,  $CD = 6.5$  cm,  $DA = 3$  cm and  $BD = 6.5$  cm.
2. Construct a quadrilateral ABCD in which  $AB = 4$  cm,  $BC = 3$  cm,  $AD = 2.5$  cm,  $AC = 4.5$  cm and  $BD = 4$  cm.
3. Construct a quadrilateral ABCD in which  $AB = 3.5$  cm,  $BC = 5$  cm,  $CD = 4.6$  cm,  $\angle B = 125^\circ$  and  $\angle C = 60^\circ$ .
4. Construct a quadrilateral PQRS in which  $PQ = 4$  cm,  $QR = 5$  cm,  $\angle P = 50^\circ$ ,  $\angle Q = 110^\circ$  and  $\angle R = 70^\circ$ .
5. Construct a parallelogram ABCD in which  $AB = 5.2$  cm,  $BC = 4.7$  cm and  $AC = 7.6$  cm
6. Construct a rhombus whose diagonals are 6 cm and 8 cm.
7. Construct a rhombus ABCD in which  $AB = 4$  cm and diagonal AC is 6.5 cm.
8. Construct a rhombus with side 4.2 cm and one of its angles  $65^\circ$
9. Construct a rectangle ABCD whose adjacent sides are 5 cm and 4.5 cm
10. Construct a square each of whose side measure 4.6 cm
11. Construct a square each of whose diagonals measure 5.8 cm
12. Construct a quadrilateral PQRS in which  $PQ = 3$  cm,  $QR = 5$  cm,  $QS = 5$  cm,  $PS = 4$  cm and  $SR = 4$  cm.
13. Construct a quadrilateral ABCD in which  $AB = 7.7$  cm,  $BC = 6.8$  cm,  $CD = 5.1$  cm,  $AD = 3.6$  cm,  $\angle C = 120^\circ$ .
14. Construct a quadrilateral ABCD when  $BC = 5.5$  cm,  $CD = 4.1$  cm,  $\angle A = 70^\circ$ ,  $\angle B = 110^\circ$  and  $\angle D = 85^\circ$
15. Construct a quadrilateral PQRS in which  $QR = 7.5$  cm,  $PR = PS = 6$  cm,  $RS = 5$  cm and  $QS = 10$  cm. Measure the fourth side.
16. Construct a quadrilateral ABCD in which  $AB = BC = 3.5$  cm,  $AD = CD = 5.2$  cm and  $\angle ABC = 120^\circ$ .
17. Construct a quadrilateral ABCD in which  $AB = 2.9$  cm,  $BC = 3.2$  cm,  $CD = 2.7$  cm,  $DA = 3.4$  cm and  $\angle A = 70^\circ$ .

## Exercise-2

### SECTION -A (COMPETITIVE EXAMINATION QUESTION)

#### OBJECTIVE QUESTIONS

1. Given below are the steps of construction to construct a quadrilateral ABCD where  $AB = 5.6$  cm,  $BC = 4.1$  cm,  $CD = 4.4$  cm,  $AD = 3.3$  cm and  $\angle A = 75^\circ$ . Which of the following is Incorrect step ?
 

(P) **Step I** : Draw  $AB = 5.6$  cm and construct  $\angle BAX = 75^\circ$ .

(Q) **Step II** : With A as centre and radius = 3.3 cm, cut off  $AD = 3.3$  cm along AX.

(R) **Step III** : Join BD. With D as centre and radius = 4.1 cm, draw an arc.

(S) **Step IV** : With B as centre and radius = 4.1 cm, draw an arc to cut the arc drawn in above step at C. Join BC, CD to obtain the required quadrilateral ABCD.

(A) P                      (B) Q                      (C) R                      (D) S
  
2. If a quadrilateral has exactly two pairs of equal adjacent sides and the unequal opposite sides, then it is called \_\_\_\_\_.
 

(A) Parallelogram      (B) Square              (C) Rectangle          (D) Kite
  
3. To construct a convex quadrilateral, which of the following cases is not correct ?
 

(A) When the lengths of four sides and one diagonal are given.

(B) When the lengths of three sides and the two diagonals are given.

(C) When the lengths of four sides and one angle are given.

(D) When the lengths of two sides and two included angles are given.
  
4. To construct a quadrilateral uniquely, it is necessary to have the knowledge of at least \_\_\_\_\_ independent elements.
 

(A) Four                      (B) Five                      (C) Three                      (D) Six
  
5. Given below are the steps of construction of a quadrilateral ABCD, where  $AB = 3.5$  cm,  $BC = 6.5$  cm,  $\angle A = 75^\circ$ ,  $\angle B = 105^\circ$  and  $\angle C = 120^\circ$ . Which of the following is a wrong step ?
 

(P) **Step I** : Draw  $AB = 3.5$  cm

(Q) **Step II** : Draw  $\angle XAB = 75^\circ$  at A and  $\angle ABY = 105^\circ$  at B.

(R) **Step III** : With B as centre and radius  $BC = 6.5$  cm, draw an arc to intersect BY at C.

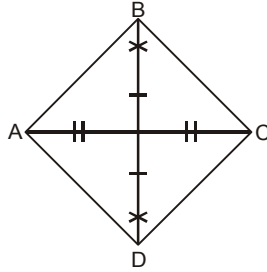
(S) **Step IV** : At C draw  $\angle ADC = 120^\circ$  such that CZ meets AX at D.

(A) P                      (B) Q                      (C) R                      (D) S

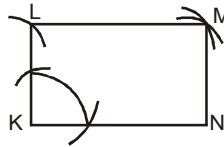
**Exercise-3**

**PREVIOUS YEAR EXAMINATION QUESTIONS**

1. The construction of which figure is shown in the diagram ? [NSTSE - 2013]



- (A) A trapezium      (B) A rhombus      (C) A rectangle      (D) A kite
2. The diagram shows the construction of a parallelogram KLMN. The width of the compasses for step-I and step-II are the same. How much does the angle KLM measure ? [NSTSE - 2014]



- (A)  $45^\circ$       (B)  $60^\circ$       (C)  $120^\circ$       (D)  $135^\circ$

**Answer Key****Exercise-2****SECTION -A (COMPETITIVE EXAMINATION QUESTION)****MULTIPLE CHOICE QUESTIONS**

<b>Ques.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Ans.</b>	C	D	D	B	D

**Exercise-3****(PREVIOUS YEAR EXAMINATION QUESTIONS)**

<b>Ques.</b>	<b>1</b>	<b>2</b>
<b>Ans.</b>	B	C