

ML Aggarwal Solutions for Class 9 Maths
Chapter 13: Rectilinear Figures

Exercise 13.1

1. If two angles of a quadrilateral are 40° and 110° and the other two are in the ratio 3 : 4, find these angles.

Solution:

We know that,

Sum of all four angles of a quadrilateral = 360°

Sum of two given angles = $40^\circ + 110^\circ = 150^\circ$

So, the sum of remaining two angles = $360^\circ - 150^\circ = 210^\circ$

Also given,

Ratio in these angles = 3 : 4

Hence,

$$\begin{aligned}\text{Third angle} &= (210^\circ \times 3)/(3 + 4) \\ &= (210^\circ \times 3)/7 \\ &= 90^\circ\end{aligned}$$

And,

$$\begin{aligned}\text{Fourth angle} &= (210^\circ \times 4)/(3 + 4) \\ &= (210^\circ \times 4)/7 \\ &= 120^\circ\end{aligned}$$

2. If the angles of a quadrilateral, taken in order, are in the ratio 1 : 2 : 3 : 4, prove that it is a trapezium.

Solution:

Given,

In trapezium ABCD in which

$$\angle A : \angle B : \angle C : \angle D = 1 : 2 : 3 : 4$$

We know,

The sum of angles of the quad. ABCD = 360°

$$\angle A = (360^\circ \times 1)/10 = 36^\circ$$

$$\angle B = (360^\circ \times 2)/10 = 72^\circ$$

$$\angle C = (360^\circ \times 3)/10 = 108^\circ$$

$$\angle D = (360^\circ \times 4)/10 = 144^\circ$$

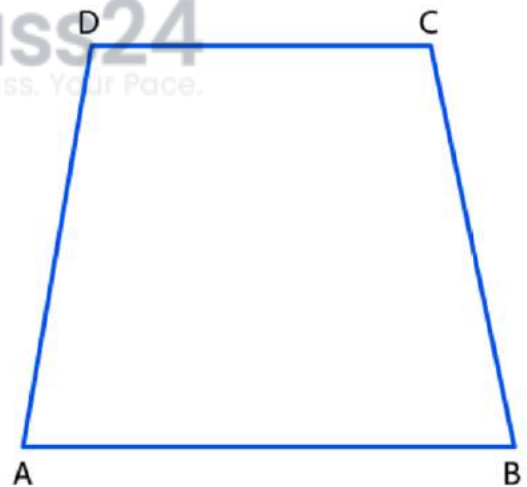
Now,

$$\angle A + \angle D = 36^\circ + 114^\circ = 180^\circ$$

Since, the sum of angles $\angle A$ and $\angle D$ is 180° and these are co-interior angles

Thus, $AB \parallel DC$

Therefore, ABCD is a trapezium.



3. If an angle of a parallelogram is two-thirds of its adjacent angle, find the angles of the parallelogram.

Solution:

Here ABCD is a parallelogram.

Let $\angle A = x^\circ$

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Then, $\angle B = (2x/3)^\circ$ (Given condition)

So,

$\angle A + \angle B = 180^\circ$ (As the sum of adjacent angles in a parallelogram is 180°)

$$x^\circ + \frac{2}{3}x^\circ = 180^\circ \Rightarrow \frac{3x + 2x}{3} = 180$$

$$\frac{5x}{3} = 180 \Rightarrow 5x = 180 \times 3$$

$$x = \frac{180 \times 3}{5} \Rightarrow x = 36 \times 3 \Rightarrow x = 108$$

Hence, $\angle A = 108^\circ$

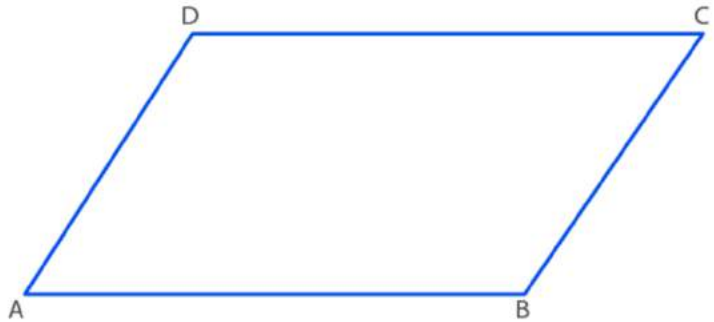
$\angle B = 2/3 \times 108^\circ = 2 \times 36^\circ = 72^\circ$

$\angle B = \angle D = 72^\circ$ (opposite angles in a parallelogram is same)

Also,

$\angle A = \angle C = 108^\circ$ (opposite angles in a parallelogram is same)

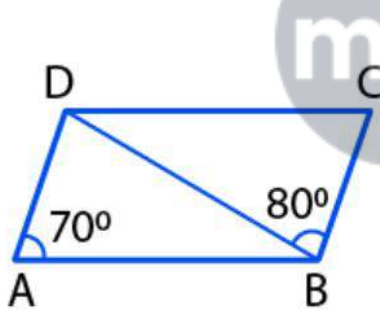
Therefore, angles of parallelogram are $108^\circ, 72^\circ, 108^\circ$ and 72° .



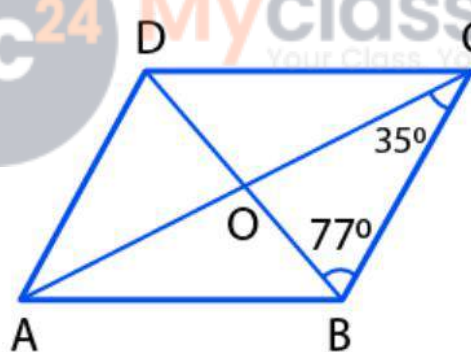
4. (a) In figure (1) given below, ABCD is a parallelogram in which $\angle DAB = 70^\circ, \angle DBC = 80^\circ$. Calculate angles CDB and ADB.

(b) In figure (2) given below, ABCD is a parallelogram. Find the angles of the AAOD.

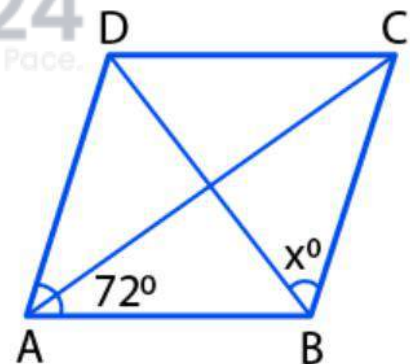
(c) In figure (3) given below, ABCD is a rhombus. Find the value of x.



(1)



(2)



(3)

Solution:

(a) Since, ABCD is a || gm

We have, $AB \parallel CD$

$\angle ADB = \angle DBC$ (Alternate angles)

$\angle ADB = 80^\circ$ (Given, $\angle DBC = 80^\circ$)

Now,

In $\triangle ADB$, we have

$\angle A + \angle ADB + \angle ABD = 180^\circ$ (Angle sum property of a triangle)

$70^\circ + 80^\circ + \angle ABD = 180^\circ$

$150^\circ + \angle ABD = 180^\circ$

$\angle ABD = 180^\circ - 150^\circ = 30^\circ$

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Now, $\angle CDB = \angle ABD$ (Since, $AB \parallel CD$ and alternate angles)

So,

$$\angle CDB = 30^\circ$$

Hence, $\angle ADB = 80^\circ$ and $\angle CDB = 30^\circ$.

(b) Given, $\angle BOC = 35^\circ$ and $\angle CBO = 77^\circ$

In $\triangle BOC$, we have

$$\angle BOC + \angle BCO + \angle CBO = 180^\circ \quad (\text{Angle sum property of a triangle})$$

$$\angle BOC = 180^\circ - 112^\circ = 68^\circ$$

Now, in \parallel gm ABCD

We have,

$$\angle AOD = \angle BOC \quad (\text{Vertically opposite angles})$$

Hence, $\angle AOD = 68^\circ$.

(c) ABCD is a rhombus

So, $\angle A + \angle B = 180^\circ$ (Sum of adjacent angles of a rhombus is 180°)

$$72^\circ + \angle B = 180^\circ \quad (\text{Given, } \angle A = 72^\circ)$$

$$\angle B = 180^\circ - 72^\circ = 108^\circ$$

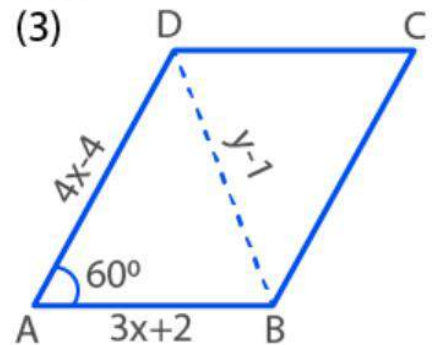
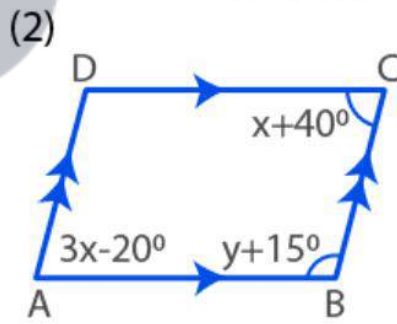
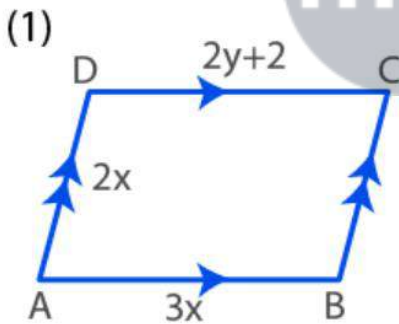
Hence,

$$x = \frac{1}{2} B = \frac{1}{2} \times 108^\circ = 54^\circ$$

5. (a) In figure (1) given below, ABCD is a parallelogram with perimeter 40. Find the values of x and y.

(b) In figure (2) given below. ABCD is a parallelogram. Find the values of x and y.

(c) In figure (3) given below. ABCD is a rhombus. Find x and y.



Solution:

(a) Since, ABCD is a parallelogram

So, $AB = CD$ and $BC = AD$

$$\Rightarrow 3x = 2y + 2$$

$$3x - 2y = 2 \dots (i)$$

Also, $AB + BC + CD + DA = 40$

$$\Rightarrow 3x + 2x + 2y + 2 + 2x = 40$$

$$7x + 2y = 40 - 2$$

$$7x + 2y = 38 \dots (ii)$$

Now, adding (i) and (ii) we get

$$3x - 2y = 2$$

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$$7x + 2y = 38$$

 $10x = 40$

$$\Rightarrow x = 40/10 = 4$$

On substituting the value of x in (i), we get

$$3(4) - 2y = 2$$

$$12 - 2y = 2$$

$$2y = 12 - 2$$

$$\Rightarrow y = 10/2 = 5$$

Hence, $x = 4$ and $y = 5$

(b) In parallelogram ABCD, we have

$$\angle A = \angle C \quad (\text{Opposite angles are same in } \parallel \text{ gm})$$

$$3x - 20^\circ = x + 40^\circ$$

$$3x - x = 40^\circ + 20^\circ$$

$$2x = 60^\circ$$

$$x = 60^\circ/2 = 30^\circ \dots (i)$$

Also, $\angle A + \angle B = 180^\circ$ (Sum of adjacent angles in \parallel gm is equal to 180°)

$$3x - 20^\circ + y + 15^\circ = 180^\circ$$

$$3x + y = 180^\circ + 20^\circ - 15^\circ$$

$$3x + y = 185^\circ$$

$$3(30^\circ) + y = 185^\circ$$

$$90^\circ + y = 185^\circ$$

$$y = 185^\circ - 90^\circ = 95^\circ$$

Hence,

$$x = 30^\circ \text{ and } 95^\circ$$



(c) ABCD is a rhombus

So, $AB = CD$

$$3x + 2 = 4x - 4$$

$$3x - 4x = -4 - 2$$

$$-x = -6$$

$$x = 6$$

Now, in $\triangle ABD$ we have

$$\angle BAD = 60^\circ \text{ and } AB = AD$$

$$\angle ADB = \angle ABD$$

So,

$$\angle ADB = (180^\circ - \angle BAD)/2$$

$$= (180^\circ - 60^\circ)/2$$

$$= 120^\circ/2 = 60^\circ$$

As $\triangle ABD$ is an equilateral triangle, all the angles of the triangle are 60°

Hence, $AB = BD$

$$3x + 2 = y - 1$$

$$3(6) + 2 = y - 1 \quad (\text{Substituting the value of } x)$$

$$18 + 2 = y - 1$$

$$20 = y - 1$$

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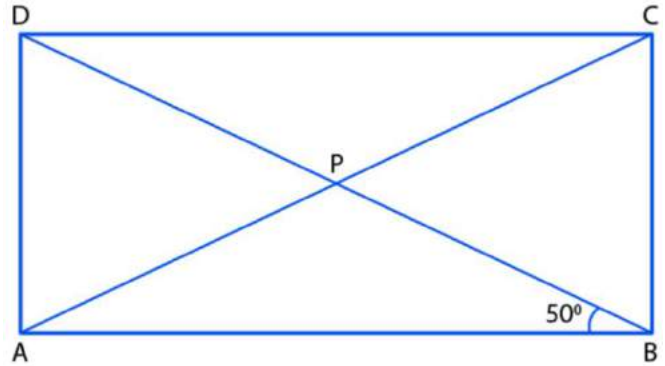
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$y = 20 + 1$
 $y = 21$
 Thus, $x = 6$ and $y = 21$.

6. The diagonals AC and BD of a rectangle ABCD intersect each other at P. If $\angle ABD = 50^\circ$, find $\angle DPC$.

Solution:

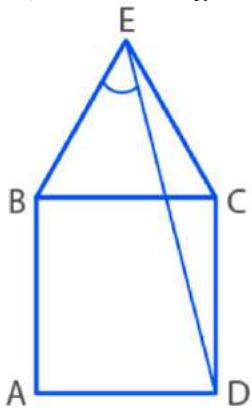
Given, ABCD is a rectangle
 We know that the diagonals of rectangle are same and bisect each other
 So, we have
 $AP = BP$
 $\angle PAB = \angle PBA$ (Equal sides have equal opposite angles)
 $\angle PAB = 50^\circ$ (Since, given $\angle PBA = 50^\circ$)
 Now, in $\triangle APB$
 $\angle APB + \angle ABP + \angle BAP = 180^\circ$
 $\angle APB + 50^\circ + 50^\circ = 180^\circ$
 $\angle APB = 180^\circ - 100^\circ$
 $\angle APB = 80^\circ$
 Then,
 $\angle DPB = \angle APB$ (Vertically opposite angles)
 Hence,
 $\angle DPB = 80^\circ$



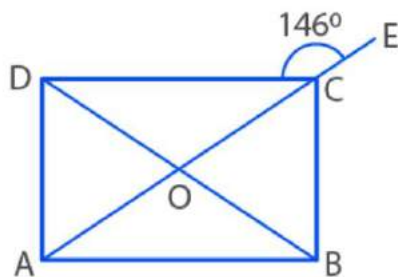
7. (a) In figure (1) given below, equilateral triangle EBC surmounts square ABCD. Find angle BED represented by x.

(b) In figure (2) given below, ABCD is a rectangle and diagonals intersect at O. AC is produced to E. If $\angle ECD = 146^\circ$, find the angles of the $\triangle AOB$.

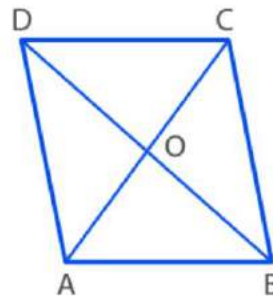
(c) In figure (3) given below, ABCD is rhombus and diagonals intersect at O. If $\angle OAB : \angle OBA = 3:2$, find the angles of the $\triangle AOD$.



(1)



(2)



(3)

Solution:

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Since, EBC is an equilateral triangle, we have

$$EB = BC = EC \dots (i)$$

Also, ABCD is a square

$$\text{So, } AB = BC = CD = AD \dots (ii)$$

From (i) and (ii), we get

$$EB = EC = AB = BC = CD = AD \dots (iii)$$

Now, in $\triangle ECD$

$$\angle ECD = \angle BCD + \angle ECB$$

$$= 90^\circ + 60^\circ$$

$$= 150^\circ \dots (iv)$$

$$\text{Also, } EC = CD \quad [\text{From (iii)}]$$

$$\text{So, } \angle DEC = \angle CDE \dots (v)$$

$$\angle ECD + \angle DEC + \angle CDE = 180^\circ \quad [\text{Angles sum property of a triangle}]$$

$$150^\circ + \angle DEC + \angle DEC = 180^\circ \quad [\text{Using (iv) and (v)}]$$

$$2 \angle DEC = 180^\circ - 150^\circ = 30^\circ$$

$$\angle DEC = 30^\circ/2$$

$$\angle DEC = 15^\circ \dots (vi)$$

$$\text{Now, } \angle BEC = 60^\circ \quad [\text{BEC is an equilateral triangle}]$$

$$\angle BED + \angle DEC = 60^\circ$$

$$x^\circ + 15^\circ = 60^\circ \quad [\text{From (vi)}]$$

$$x = 60^\circ - 15^\circ$$

$$x = 45^\circ$$

Hence, the value of x is 45° .

(b) Given, ABCD is a rectangle

$$\angle ECD = 146^\circ$$

As ACE is a straight line, we have

$$146^\circ + \angle ACD = 180^\circ \quad [\text{Linear pair}]$$

$$\angle ACD = 180^\circ - 146^\circ = 34^\circ \dots (i)$$

$$\text{And, } \angle CAB = \angle ACD \quad [\text{Alternate angles}] \dots (ii)$$

From (i) and (ii), we have

$$\angle CAB = 34^\circ \Rightarrow \angle OAB = 34^\circ \dots (iii)$$

In $\triangle AOB$

$$AO = OB \quad [\text{Diagonals of a rectangle are equal and bisect each other}]$$

$$\angle OAB = \angle OBA \dots (iv) \quad [\text{Equal sides have equal angles opposite to them}]$$

From (iii) and (iv),

$$\angle OBA = 34^\circ \dots (v)$$

Now,

$$\angle AOB + \angle OBA + \angle OAB = 180^\circ$$

$$\angle AOB + 34^\circ + 34^\circ = 180^\circ \quad [\text{Using (3) and (5)}]$$

$$\angle AOB + 68^\circ = 180^\circ$$

$$\angle AOB = 180^\circ - 68^\circ = 112^\circ$$

Hence, $\angle AOB = 112^\circ$, $\angle OAB = 34^\circ$ and $\angle OBA = 34^\circ$

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(c) Here, ABCD is a rhombus and diagonals intersect at O and $\angle OAB : \angle OBA = 3 : 2$

Let $\angle OAB = 2x^\circ$

Then, $\angle OBA = 2x^\circ$

We know that diagonals of rhombus intersect at right angle,

So, $\angle OAB = 90^\circ$

Now, in $\triangle AOB$

$\angle OAB + \angle OBA = 180^\circ$

$90^\circ + 3x^\circ + 2x^\circ = 180^\circ$

$90^\circ + 5x^\circ = 180^\circ$

$5x^\circ = 180^\circ - 90^\circ = 90^\circ$

$x^\circ = 90^\circ/5 = 18^\circ$

Hence,

$\angle OAB = 3x^\circ = 3 \times 18^\circ = 54^\circ$

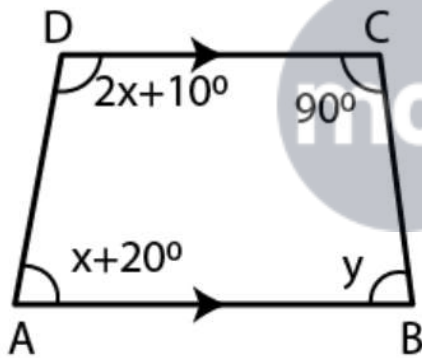
$\angle OBA = 2x^\circ = 2 \times 18^\circ = 36^\circ$ and

$\angle AOB = 90^\circ$

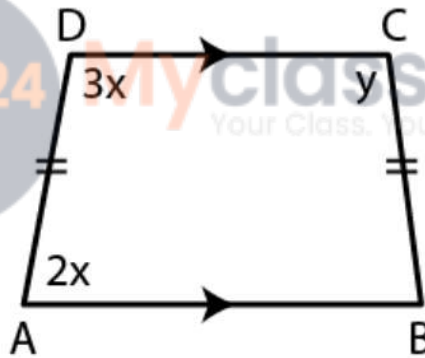
8. (a) In figure (1) given below, ABCD is a trapezium. Find the values of x and y.

(b) In figure (2) given below, ABCD is an isosceles trapezium. Find the values of x and y.

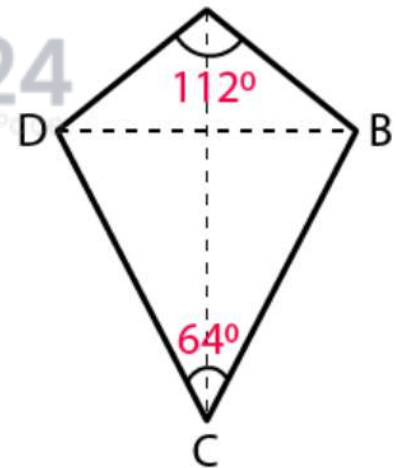
(c) In figure (3) given below, ABCD is a kite and diagonals intersect at O. If $\angle DAB = 112^\circ$ and $\angle DCB = 64^\circ$, find $\angle ODC$ and $\angle OBA$.



(1)



(2)



(3)

Solution:

(a) Given: ABCD is a trapezium

$\angle A = x + 20^\circ$, $\angle B = y$, $\angle C = 92^\circ$, $\angle D = 2x + 10^\circ$

We have,

$\angle B + \angle C = 180^\circ$ [Since $AB \parallel DC$]

$y + 92^\circ = 180^\circ$

$y = 180^\circ - 92^\circ = 88^\circ$

Also, $\angle A + \angle D = 180^\circ$

$x + 20^\circ + 2x + 10^\circ = 180^\circ$

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$$3x + 30^\circ = 180^\circ$$

$$3x = 180^\circ - 30^\circ = 150^\circ$$

$$x = 150^\circ/3 = 50^\circ$$

Hence, the value of $x = 50^\circ$ and $y = 88^\circ$.

(b) Given: ABCD is an isosceles trapezium $BC = AD$

$$\angle A = 2x, \angle C = y \text{ and } \angle D = 3x$$

Since, ABCD is a trapezium and $AB \parallel DC$

$$\Rightarrow \angle A + \angle D = 180^\circ$$

$$2x + 3x = 180^\circ$$

$$5x = 180^\circ$$

$$x = 180^\circ/5 = 36^\circ \dots \text{(i)}$$

Also, $AB = BC$ and $AB \parallel DC$

$$\text{So, } \angle A + \angle C = 180^\circ$$

$$2x + y = 180^\circ$$

$$2 \times 36^\circ + y = 180^\circ$$

$$72^\circ + y = 180^\circ$$

$$y = 180^\circ - 72^\circ = 108^\circ$$

Hence, value of $x = 36^\circ$ and $y = 108^\circ$.

(c) Given: ABCD is a kite and diagonal intersect at O.

$$\angle DAB = 112^\circ \text{ and } \angle DCB = 64^\circ$$

As AC is the diagonal of kite ABCD, we have

$$\angle DCO = 64^\circ/2 = 32^\circ$$

And, $\angle DOC = 90^\circ$ [Diagonal of kites bisect at right angles]

In $\triangle OCD$, we have

$$\angle ODC = 180^\circ - (\angle DCO + \angle DOC)$$

$$= 180^\circ - (32^\circ + 90^\circ)$$

$$= 180^\circ - 122^\circ$$

$$= 58^\circ$$

In $\triangle OAB$, we have

$$\angle OAB = 112^\circ/2 = 56^\circ$$

$\angle AOB = 90^\circ$ [Diagonal of kites bisect at right angles]

In $\triangle OAB$, we have

$$\angle OBA = 180^\circ - (\angle OAB + \angle AOB)$$

$$= 180^\circ - (56^\circ + 90^\circ)$$

$$= 180^\circ - 146^\circ$$

$$= 34^\circ$$

Hence, $\angle ODC = 58^\circ$ and $\angle OBA = 34^\circ$.

9. (i) Prove that each angle of a rectangle is 90° .

(ii) If the angle of a quadrilateral are equal, prove that it is a rectangle.

(iii) If the diagonals of a rhombus are equal, prove that it is a square.

(iv) Prove that every diagonal of a rhombus bisects the angles at the vertices.

Solution:

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(i) Given: ABCD is a rectangle

To prove: Each angle of rectangle = 90°

Proof:

In a rectangle opposite angles of a rectangle are equal

So, $\angle A = \angle C$ and $\angle B = \angle D$

But, $\angle A + \angle B + \angle C + \angle D = 360^\circ$ [Sum of angles of a quadrilateral]

$$\angle A + \angle B + \angle A + \angle B = 360^\circ$$

$$2(\angle A + \angle B) = 360^\circ$$

$$(\angle A + \angle B) = 360^\circ/2$$

$$\angle A + \angle B = 180^\circ$$

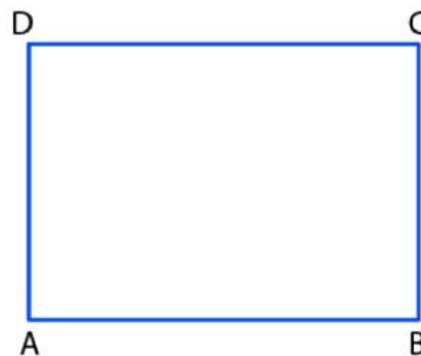
But, $\angle A = \angle B$ [Angles of a rectangle]

So, $\angle A = \angle B = 90^\circ$

Thus,

$$\angle A = \angle B = \angle C = \angle D = 90^\circ$$

Hence, each angle of a rectangle is 90° .



(ii) Given: In quadrilateral ABCD, we have

$$\angle A = \angle B = \angle C = \angle D$$

To prove: ABCD is a rectangle

Proof:

$$\angle A = \angle B = \angle C = \angle D$$

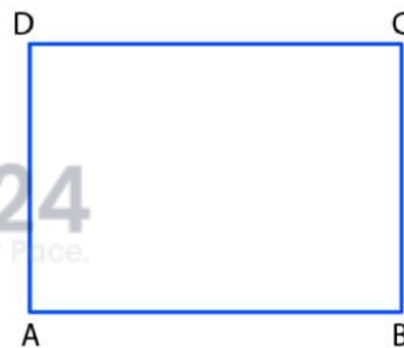
$$\Rightarrow \angle A = \angle C \text{ and } \angle B = \angle D$$

But these are opposite angles of the quadrilateral.

So, ABCD is a parallelogram

And, as $\angle A = \angle B = \angle C = \angle D$

Therefore, ABCD is a rectangle.



(iii) Given: ABCD is a rhombus in which $AC = BD$

To prove: ABCD is a square

Proof:

Join AC and BD.

Now, in $\triangle ABC$ and $\triangle DCB$ we have

$$\angle ABC = \angle DCB \text{ [Sides of a rhombus]}$$

$$\angle ACB = \angle DCB \text{ [Common]}$$

$$\angle AC = \angle BD \text{ [Given]}$$

So, $\triangle ABC \cong \triangle DCB$ by S.S.S axiom of congruency

Thus,

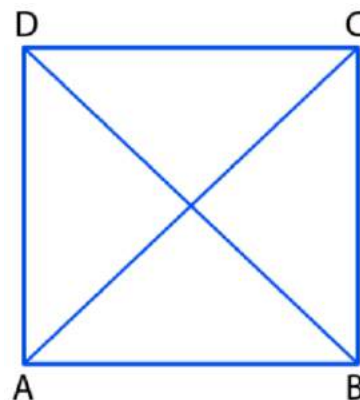
$$\angle ABC = \angle DCB \text{ [By C.P.C.T.]}$$

But these are made by transversal BC on the same side of parallel lines AB and CD.

$$\text{So, } \angle ABC + \angle DCB = 180^\circ$$

$$\angle ABC = 90^\circ$$

Hence, ABCD is a square.



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(iv) Given: ABCD is rhombus.

To prove: Diagonals AC and BD bisect $\angle A$, $\angle C$, $\angle B$ and $\angle D$ respectively

Proof:

In $\triangle AOD$ and $\triangle COD$, we have

$AD = CD$ [sides of a rhombus are all equal]

$OD = OD$ [Common]

$AO = OC$ [Diagonal of rhombus bisect each other]

So, $\triangle AOD \cong \triangle COD$ by S.S.S axiom of congruency

Thus,

$\angle AOD = \angle COD$ [By C.P.C.T]

So, $\angle AOD + \angle COD = 180^\circ$ [Linear pair]

$\angle AOD = 180^\circ$

$\angle AOD = 90^\circ$

And, $\angle COD = 90^\circ$

Thus,

$OD \perp AC \Rightarrow BD \perp AC$

Also, $\angle ADO = \angle CDO$ [By C.P.C.T]

So,

OD bisect $\angle D$ BD bisect $\angle D$

Similarly, we can prove that BD bisect $\angle B$ and AC bisect the $\angle A$ and $\angle C$.

10. ABCD is a parallelogram. If the diagonal AC bisects $\angle A$, then prove that:

(i) AC bisects $\angle C$

(ii) ABCD is a rhombus

(iii) $AC \perp BD$.

Solution:

Given: In parallelogram ABCD in which diagonal AC bisects $\angle A$

To prove: (i) AC bisects $\angle C$

(ii) ABCD is a rhombus

(iii) $AC \perp BD$

Proof:

(i) As $AB \parallel CD$, we have [Opposite sides of a || gm]

$\angle DCA = \angle CAB$

Similarly, $\angle DAC = \angle DCB$

But, $\angle CAB = \angle DAC$ [Since, AC bisects $\angle A$]

Hence,

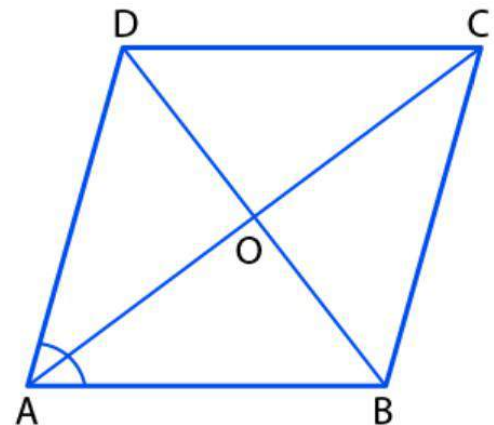
$\angle DCA = \angle ACB$ and AC bisects $\angle C$.

(ii) As AC bisects $\angle A$ and $\angle C$

And, $\angle A = \angle C$

Hence, ABCD is a rhombus.

(iii) Since, AC and BD are the diagonals of a rhombus and AC and BD bisect each other at right angles



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Hence, $AC \perp BD$

11. (i) Prove that bisectors of any two adjacent angles of a parallelogram are at right angles.

(ii) Prove that bisectors of any two opposite angles of a parallelogram are parallel.

(iii) If the diagonals of a quadrilateral are equal and bisect each other at right angles, then prove that it is a square.

Solution:

(i) Given AM bisect angle A and BM bisects angle of || gm ABCD.

To prove: $\angle AMB = 90^\circ$

Proof:

We have,

$$\angle A + \angle B = 180^\circ \quad [\text{AD} \parallel \text{BC and AB is the transversal}]$$

$$\Rightarrow \frac{1}{2} (\angle A + \angle B) = 180^\circ/2$$

$$\frac{1}{2} \angle A + \frac{1}{2} \angle B = 90^\circ$$

$$\angle MAB + \angle MBA = 90^\circ \quad [\text{Since, AM bisects } \angle A \text{ and BM bisects } \angle B]$$

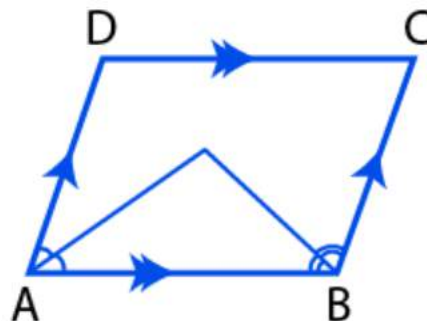
Now, in $\triangle AMB$

$$\angle AMB + \angle MAB + \angle MBA = 180^\circ \quad [\text{Angles sum property of a triangle}]$$

$$\angle AMB + 90^\circ = 180^\circ$$

$$\angle AMB = 180^\circ - 90^\circ = 90^\circ$$

Hence, bisectors of any two adjacent angles of a parallelogram are at right angles.



(ii) Given: A || gm ABCD in which bisector AR of $\angle A$ meets DC in R and bisector CQ of $\angle C$ meets AB in Q

To prove: $AR \parallel CQ$

Proof:

In || gm ABCD, we have

$$\angle A = \angle C \quad [\text{Opposite angles of || gm are equal}]$$

$$\frac{1}{2} \angle A = \frac{1}{2} \angle C$$

$$\angle DAR = \angle BCQ \quad [\text{Since, AR is bisector of } \frac{1}{2} \angle A \text{ and CQ is the bisector of } \frac{1}{2} \angle C]$$

Now, in $\triangle ADR$ and $\triangle CBQ$

$$\angle DAR = \angle BCQ \quad [\text{Proved above}]$$

$$AD = BC \quad [\text{Opposite sides of || gm ABCD are equal}]$$

So, $\triangle ADR \cong \triangle CBQ$, by A.S.A axiom of congruency

Then by C.P.C.T, we have

$$\angle DRA = \angle BCQ$$

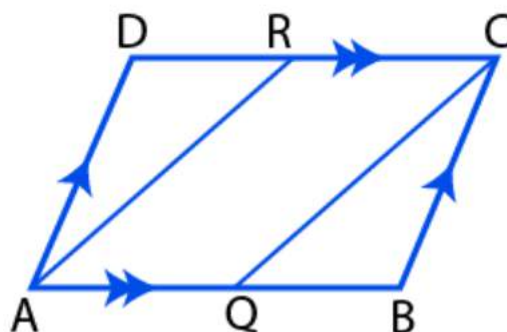
And,

$$\angle DRA = \angle RAQ \quad [\text{Alternate angles since, DC} \parallel \text{AB}]$$

$$\text{Thus, } \angle RAQ = \angle BCQ$$

But these are corresponding angles,

Hence, $AR \parallel CQ$.



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(iii) Given: In quadrilateral ABCD, diagonals AC and BD are equal and bisect each other at right angles
To prove: ABCD is a square

Proof:

In $\triangle AOB$ and $\triangle COD$, we have

$AO = OC$ [Given]

$BO = OD$ [Given]

$\angle AOB = \angle COD$ [Vertically opposite angles]

So, $\triangle AOB \cong \triangle COD$, by S.A.S axiom of congruency

By C.P.C.T, we have

$AB = CD$

and $\angle OAB = \angle OCD$

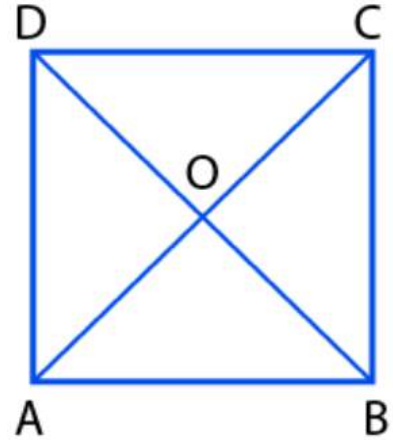
But these are alternate angles

$AB \parallel CD$

Thus, ABCD is a parallelogram

In a parallelogram, the diagonal bisect each other and are equal

Hence, ABCD is a square.



12. (i) If ABCD is a rectangle in which the diagonal BD bisect $\angle B$, then show that ABCD is a square.

(ii) Show that if the diagonals of a quadrilateral are equal and bisect each other at right angles, then it is a square.

Solution:

(i) ABCD is a rectangle and its diagonal AC bisects $\angle A$ and $\angle C$

To prove: ABCD is a square

Proof:

We know that the opposite sides of a rectangle are equal and each angle is 90°

As AC bisects $\angle A$ and $\angle C$

So, $\angle 1 = \angle 2$ and $\angle 3 = \angle 4$

But, $\angle A = \angle C = 90^\circ$

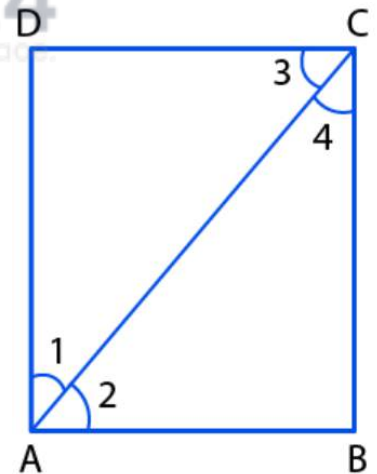
$\angle 2 = 45^\circ$ and $\angle 4 = 45^\circ$

And, $AB = BC$ [Opposite sides of equal angles]

But, $AB = CD$ and $BC = AD$

So, $AB = BC = CD = DA$

Therefore, ABCD is a square.



(ii) In quadrilateral ABCD diagonals AC and BD are equal and bisect each other at right angle

To prove: ABCD is a square

Proof:

In $\triangle AOB$ and $\triangle BOC$, we have

$AO = CO$ [Diagonals bisect each other at right angles]

$OB = OB$ [Common]

$\angle AOB = \angle COB$ [Each 90°]

So, $\triangle AOB \cong \triangle BOC$, by S.A.S axiom

By C.P.C.T, we have

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$$AB = BC \dots (i)$$

Similarly, in $\triangle BOC$ and $\triangle COD$

$$OB = OD \quad [\text{Diagonals bisect each other at right angles}]$$

$$OC = OC \quad [\text{Common}]$$

$$\angle BOC = \angle COD \quad [\text{Each } 90^\circ]$$

So, $\triangle BOC \cong \triangle COD$, by S.A.S axiom

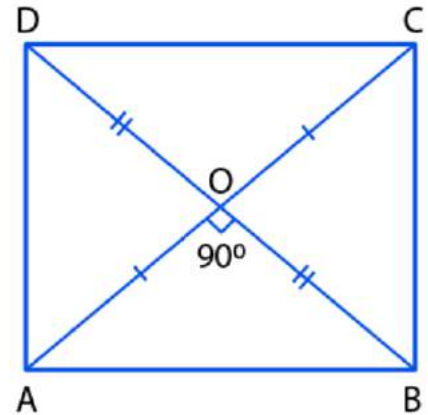
By C.P.C.T, we have

$$BC = CD \dots (ii)$$

From (i) and (ii), we have

$$AB = BC = CD = DA$$

Hence, ABCD is a square.



13. P and Q are points on opposite sides AD and BC of a parallelogram ABCD such that PQ passes through the point of intersection O of its diagonals AC and BD. Show that PQ is bisected at O.

Solution:

Given: ABCD is a parallelogram, P and Q are the points on AB and DC. Diagonals AC and BD intersect each other at O.

To prove:

Diagonals of || gm ABCD bisect each other at O

$$\text{So, } AO = OC \text{ and } BO = OD$$

Now, in $\triangle AOP$ and $\triangle COQ$ we have

$$AO = OC \text{ and } BO = OD$$

Now, in $\triangle AOP$ and $\triangle COQ$

$$AO = OC \quad [\text{Proved}]$$

$$\angle OAP = \angle OCQ \quad [\text{Alternate angles}]$$

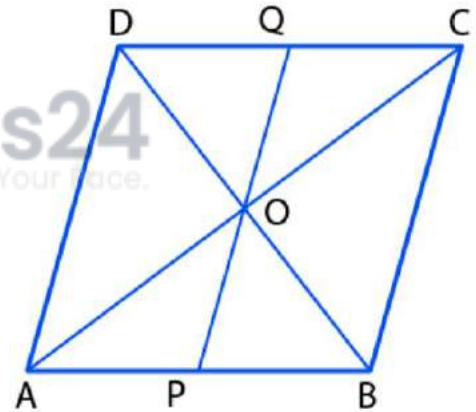
$$\angle AOP = \angle COQ \quad [\text{Vertically opposite angles}]$$

So, $\triangle AOP \cong \triangle COQ$ by S.A.S axiom

Thus, by C.P.C.T

$$OP = OQ$$

Hence, O bisects PQ.



14. (a) In figure (1) given below, ABCD is a parallelogram and X is mid-point of BC. The line AX produced meets DC produced at Q. The parallelogram ABPQ is completed.

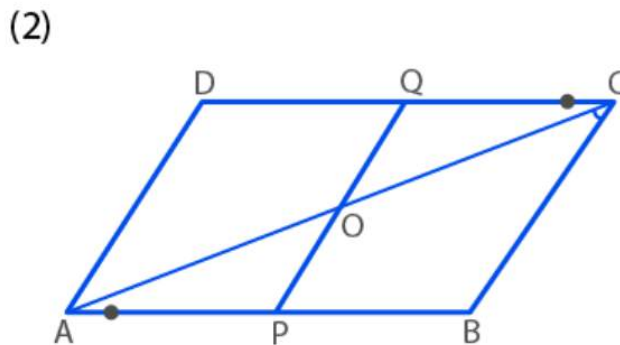
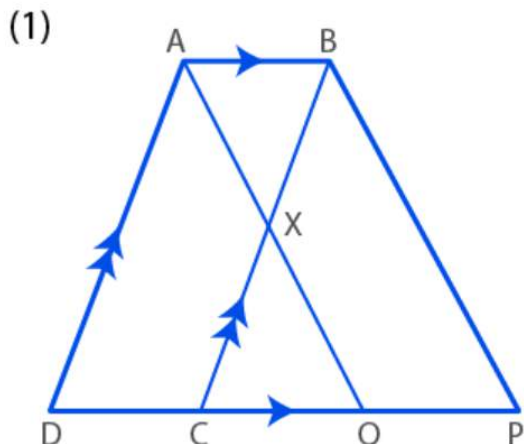
Prove that:

(i) the triangles ABX and QCX are congruent;

(ii) DC = CQ = QP

(b) In figure (2) given below, points P and Q have been taken on opposite sides AB and CD respectively of a parallelogram ABCD such that AP = CQ. Show that AC and PQ bisect each other.

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Solution:

(a) Given: ABCD is parallelogram and X is mid-point of BC. The line AX produced meets DC produced at Q and ABPQ is a \parallel gm.

To prove: (i) $\triangle ABX \cong \triangle QCX$

(ii) $DC = CQ = QP$

Proof:

In $\triangle ABX$ and $\triangle QCX$, we have

$BX = XC$ [X is the mid-point of BC]

$\angle AXB = \angle CXQ$ [Vertically opposite angles]

$\angle XCQ = \angle XBA$ [Alternate angle, since $AB \parallel CQ$]

So, $\triangle ABX \cong \triangle QCX$ by A.S.A axiom of congruence

Now, by C.P.C.T

$CQ = AB$

But,

$AB = DC$ and $AB = QP$ [As ABCD and ABPQ are \parallel gms]

Hence,

$DC = CQ = QP$

(b) In \parallel gm ABCD, P and Q are points on AB and CD respectively, PQ and AC intersect each other at O and $AP = CQ$

To prove: AC and PQ bisect each other i.e. $AO = OC$ and $PO = OQ$

Proof:

In $\triangle AOP$ and $\triangle COQ$

$AP = CQ$ [Given]

$\angle AOP = \angle COQ$ [Vertically opposite angles]

$\angle OAP = \angle OCP$ [Alternate angles]

So, $\triangle AOP \cong \triangle COQ$ by A.A.S axiom of congruence

Now, by C.P.C.T

$OP = OQ$ and $OA = OC$

Hence proved.

15. ABCD is a square. A is joined to a point P on BC and D is joined to a point Q on AB. If $AP =$

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DQ, prove that AP and DQ are perpendicular to each other.

Solution:

Given: ABCD is a square. P is any point on BC and Q is any point on AB and these points are taken such that $AP = DQ$

To prove: $AP \perp DQ$

Proof:

In $\triangle ABP$ and $\triangle ADQ$, we have

$AP = DQ$ [Given]

$AD = AB$ [Sides of square ABCD]

$\angle DAQ = \angle ABP$ [Each 90°]

So, $\triangle ABP \cong \triangle ADQ$ by R.H.S axiom of congruency

Now, by C.P.C.T

$\angle BAP = \angle ADQ$

But, $\angle BAD = 90^\circ$

$\angle BAD = \angle BAP + \angle PAD \dots (i)$

$90^\circ = \angle BAP + \angle PAD$

$\angle BAP + \angle PAD = 90^\circ$

$\angle BAP + \angle ADQ = 90^\circ$

Now, in $\triangle ADM$ we have

$(\angle MAD + \angle ADM) + \angle AMD = 180^\circ$ [Angles sum property of a triangle]

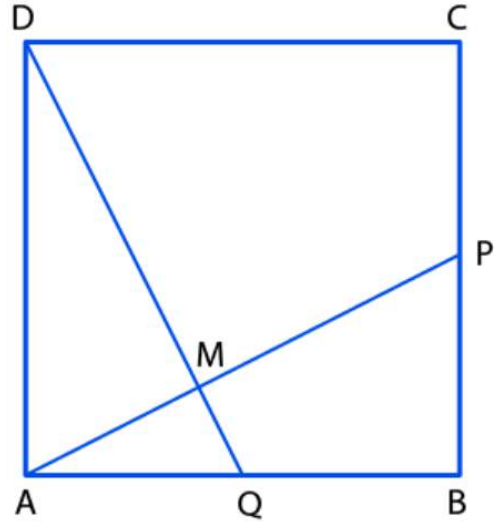
$90^\circ + \angle AMD = 180^\circ$ [From (i)]

$\angle AMD = 180^\circ - 90^\circ = 90^\circ$

So, $DM \perp AP$

$\Rightarrow DQ \perp AP$

Hence, $AP \perp DQ$

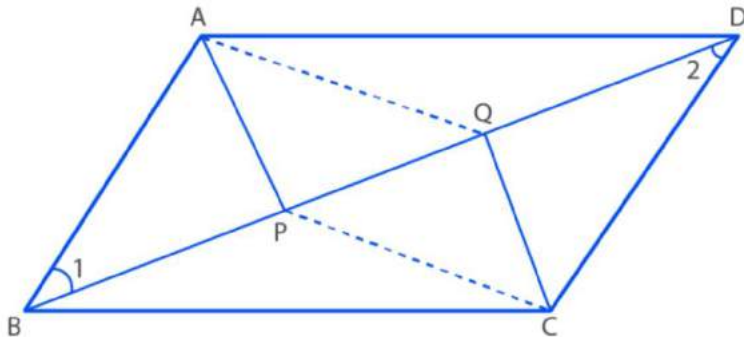


16. If P and Q are points of trisection of the diagonal BD of a parallelogram ABCD, prove that $CQ \parallel AP$.

Solution:

Given: ABCD is a || gm in which $BP = PQ = QD$

To prove: $CQ \parallel AP$



Proof:

In || gm ABCD, we have

$AB = CD$ [Opposite sides of a || gm are equal]

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And BD is the transversal

So, $\angle 1 = \angle 2$ [Alternate interior angles] ... (i)

Now, in $\triangle ABP$ and $\triangle DCQ$

$AB = CD$ [Opposite sides of a || gm are equal]

$\angle 1 = \angle 2$ [From (i)]

$BP = QD$ [Given]

So, $\triangle ABP \cong \triangle DCQ$ by S.A.S axiom of congruency

Then by C.P.C.T, we have

$AP = QC$

Also, $\angle APB = \angle DQC$ [By C.P.C.T]

$-\angle APB = -\angle DQC$ [Multiplying both sides by -1]

$180^\circ - \angle APB = 180^\circ - \angle DQC$ [Adding 180° both sides]

$\angle APQ = \angle CQP$

But, these are alternate angles

Hence, $AP \parallel QC \Rightarrow CQ \parallel AP$.

17. A transversal cuts two parallel lines at A and B. The two interior angles at A are bisected and so are the two interior angles at B ; the four bisectors form a quadrilateral ABCD. Prove that

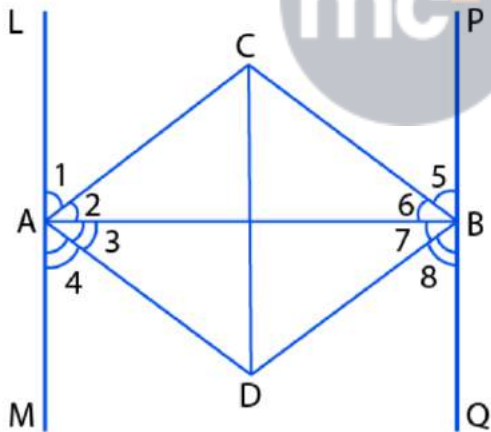
(i) ABCD is a rectangle.

(ii) CD is parallel to the original parallel lines.

18. In a parallelogram ABCD, the bisector of $\angle A$ meets DC in E and $AB = 2 AD$. Prove that

(i) BE bisects $\angle B$

(ii) $\angle AEB =$ a right angle.



Solution:

Given: $LM \parallel PQ$ and AB is the transversal line cutting $\angle M$ at A and PQ at B

AC, AD, BC and BD is the bisector of $\angle LAB, \angle BAM, \angle PAB$ and $\angle ABQ$ respectively.

AC and BC intersect at C and AD and BD intersect at D .

A quadrilateral $ABCD$ is formed.

To prove: (i) $ABCD$ is a rectangle

(ii) $CD \parallel LM$ and PQ

Proof:

(1) $\angle LAB + \angle BAM = 180^\circ$ [LAM is a straight line]

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$$\frac{1}{2} (\angle LAB + \angle BAM) = 90^\circ$$

$$\frac{1}{2} \angle LAB + \frac{1}{2} \angle BAM = 90^\circ$$

$$\angle 2 + \angle 3 = 90^\circ$$

[Since, AC and AD is bisector of $\angle LAB$ & $\angle BAM$ respectively]

$$\angle CAD = 90^\circ$$

$$\angle A = 90^\circ$$

(2) Similarly, $\angle PBA + \angle QBA = 180^\circ$ [PBQ is a straight line]

$$\frac{1}{2} (\angle PBA + \angle QBA) = 90^\circ$$

$$\frac{1}{2} \angle PBA + \frac{1}{2} \angle QBA = 90^\circ$$

$$\angle 6 + \angle 7 = 90^\circ$$

[Since, BC and BD is bisector of $\angle PAB$ & $\angle QBA$ respectively]

$$\angle CBD = 90^\circ$$

$$\angle B = 90^\circ$$

(3) $\angle LAB + \angle ABP = 180^\circ$ [Sum of co-interior angles is 180° and given $LM \parallel PQ$]

$$\frac{1}{2} \angle LAB + \frac{1}{2} \angle ABP = 90^\circ$$

$$\angle 2 + \angle 6 = 90^\circ$$

[Since, AC and BC is bisector of $\angle LAB$ & $\angle PBA$ respectively]

(4) In $\triangle ACB$,

$$\angle 2 + \angle 6 + \angle C = 180^\circ$$

[Angles sum property of a triangle]

$$(\angle 2 + \angle 6) + \angle C = 180^\circ$$

$$90^\circ + \angle C = 180^\circ$$

[using (3)]

$$\angle C = 180^\circ - 90^\circ$$

$$\angle C = 90^\circ$$

(5) $\angle MAB + \angle ABQ = 180^\circ$ [Sum of co-interior angles is 180° and given $LM \parallel PQ$]

$$\frac{1}{2} \angle MAB + \frac{1}{2} \angle ABQ = 90^\circ$$

$$\angle 3 + \angle 7 = 90^\circ$$

[Since, AD and BD is bisector of $\angle MAB$ & $\angle ABQ$ respectively]

(6) In $\triangle ADB$,

$$\angle 3 + \angle 7 + \angle D = 180^\circ$$

[Angles sum property of a triangle]

$$(\angle 3 + \angle 7) + \angle D = 180^\circ$$

$$90^\circ + \angle D = 180^\circ$$

[using (5)]

$$\angle D = 180^\circ - 90^\circ$$

$$\angle D = 90^\circ$$

(7) $\angle LAB + \angle BAM = 180^\circ$

$$\angle BAM = \angle ABP$$

[From (1) and (2)]

$$\frac{1}{2} \angle BAM = \frac{1}{2} \angle ABP$$

$$\angle 3 = \angle 6$$

[Since, AD and BC is bisector of $\angle BAM$ and $\angle ABP$ respectively]

Similarly, $\angle 2 = \angle 7$

(8) In $\triangle ABC$ and $\triangle ABD$,

$$\angle 2 = \angle 7$$

[From (7)]

$$AB = AB$$

[Common]

$$\angle 6 = \angle 3$$

[From (7)]

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So, $\triangle ABC \cong \triangle ABD$ by A.S.A axiom of congruency

Then, by C.P.C.T we have

$$AC = DB$$

$$\text{Also, } CB = AD$$

$$(9) \angle A = \angle B = \angle C = \angle D = 90^\circ \quad [\text{From (1), (2), (3) and (4)}]$$

$$AC = DB \quad [\text{Proved in (8)}]$$

$$CB = AD \quad [\text{Proved in (8)}]$$

Hence, ABCD is a rectangle.

$$(10) \text{ Since, ABCD is a rectangle} \quad [\text{From (9)}]$$

$$OA = OD \quad [\text{Diagonals of rectangle bisect each other}]$$

(11) In $\triangle AOD$, we have

$$OA = OD \quad [\text{From (10)}]$$

$$\angle 9 = \angle 3 \quad [\text{Angles opposite to equal sides are equal}]$$

$$(12) \angle 3 = \angle 4 \quad [\text{AD bisects } \angle MAB]$$

$$(13) \angle 9 = \angle 4 \quad [\text{From (11) and (12)}]$$

But these are alternate angles.

$$OD \parallel LM \Rightarrow CD \parallel LM$$

Similarly, we can prove that

$$\angle 10 = \angle 8$$

But these are alternate angles,

$$\text{So, } OD \parallel PQ \Rightarrow CD \parallel PQ$$

$$(14) CD \parallel LM \quad [\text{Proved in (13)}]$$

$$CD \parallel PQ \quad [\text{Proved in (13)}]$$

18. In a parallelogram ABCD, the bisector of $\angle A$ meets DC in E and $AB = 2 AD$. Prove that:

(i) BE bisects $\angle B$

(ii) $\angle AEB$ is a right angle

Solution:

Given: ABCD is a || gm in which bisectors of angle A and B meets in E and $AB = 2 AD$

To prove: (i) BE bisects $\angle B$

$$(ii) \angle AEB = 90^\circ$$

Proof:

(1) In || gm ABCD

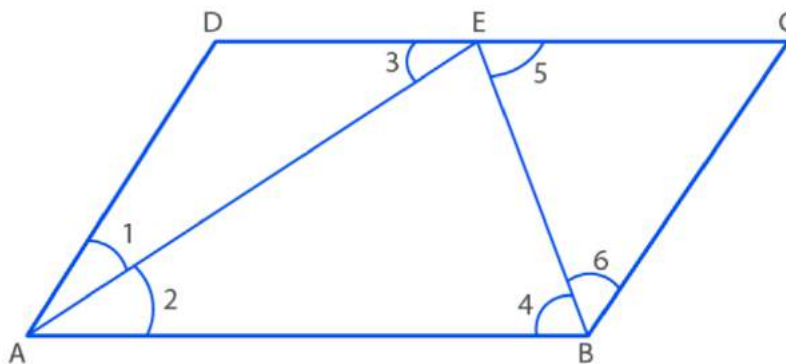
$$\angle 1 = \angle 2 \quad [\text{AD bisects angles } \angle A]$$

(2) $AB \parallel DC$ and AE is the transversal

$$\angle 2 = \angle 3 \quad [\text{Alternate angles}]$$

$$(3) \angle 1 = \angle 2 \quad [\text{From (1) and (2)}]$$

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(4) In $\triangle ADE$, we have

$$\angle 1 = \angle 3 \quad [\text{Proved in (3)}]$$

$DE = AD$ [Sides opposite to equal angles are equal]

$$\Rightarrow AD = DE$$

(5) $AB = 2 AD$ [Given]

$$AB/2 = AD$$

$$AB/2 = DE \quad [\text{using (4)}]$$

$$DC/2 = DE \quad [AB = DC, \text{ opposite sides of a } \parallel \text{ gm are equal}]$$

So, E is the mid-point of D.

$$\Rightarrow DE = EC$$

(6) $AD = BC$ [Opposite sides of a \parallel gm are equal]

(7) $DE = BC$ [From (4) and (6)]

(8) $EC = BC$ [From (5) and (7)]

(9) In $\triangle BCE$, we have

$$EC = BC \quad [\text{Proved in (8)}]$$

$$\angle 6 = \angle 5 \quad [\text{Angles opposite to equal sides are equal}]$$

(10) $AB \parallel DC$ and BE is the transversal
 $\angle 4 = \angle 5$ [Alternate angles]

(11) $\angle 4 = \angle 6$ [From (9) and (10)]

So, BE is bisector of $\angle B$

(12) $\angle A + \angle B = 180^\circ$ [Sum of co-interior angles is equal to 180° , $AD \parallel BC$]

$$\frac{1}{2} \angle A + \frac{1}{2} \angle B = 180^\circ / 2$$

$$\angle 2 + \angle 4 = 90^\circ \quad [AE \text{ is bisector of } \angle A \text{ and BE is bisector of } \angle B]$$

(13) In $\triangle APB$,

$$\angle AEB + \angle 2 + \angle 4 = 180^\circ$$

$$\angle AEB + 90^\circ = 180^\circ$$

$$\text{Hence, } \angle AEB = 90^\circ$$

19. ABCD is a parallelogram, bisectors of angles A and B meet at E which lie on DC. Prove that AB.

Solution:

Given: ABCD is a parallelogram in which bisector of $\angle A$ and $\angle B$ meets DC in E

To prove: $AB = 2 AD$

Proof:

In parallelogram ABCD, we have

$$AB \parallel DC$$

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$\angle 1 = \angle 5$ [Alternate angles, AE is transversal]

$\angle 1 = \angle 2$ [AE is bisector of $\angle A$, given]

Thus, $\angle 2 = \angle 5 \dots$ (i)

Now, in $\triangle AED$

$DE = AD$ [Sides opposite to equal angles are equal]

$\angle 3 = \angle 6$ [Alternate angles]

$\angle 3 = \angle 4$ [Since, BE is bisector of $\angle B$ (given)]

Thus, $\angle 4 = \angle 6 \dots$ (ii)

In $\triangle BCE$, we have

$BC = EC$ [Sides opposite to equal angles are equal]

$AD = BC$ [Opposite sides of \parallel gm are equal]

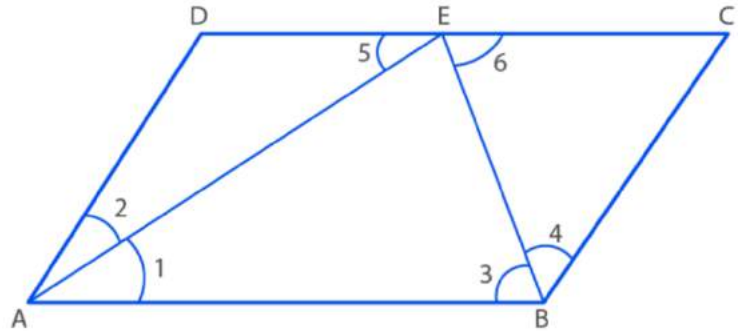
$AD = DE = EC$ [From (i) and (ii)]

$AB = DC$ [Opposite sides of a \parallel gm are equal]

$AB = DE + EC$
 $= AD + AD$

Hence,

$AB = 2 AD$



20. ABCD is a square and the diagonals intersect at O. If P is a point on AB such that $AO = AP$, prove that $3 \angle POB = \angle AOP$.

Solution:

Given: ABCD is a square and the diagonals intersect at O. P is the point on AB such that $AO = AP$

To prove: $3 \angle POB = \angle AOP$

Proof:

(1) In square ABCD, AC is a diagonal

So, $\angle CAB = 45^\circ$

$\angle OAP = 45^\circ$

(2) In $\triangle AOP$,

$\angle OAP = 45^\circ$

[From (1)]

$AO = AP$

[Sides opposite to equal angles are equal]

Now,

$\angle AOP + \angle APO + \angle OAP = 180^\circ$ [Angles sum property of a triangle]

$\angle AOP + \angle AOP + 45^\circ = 180^\circ$

$2 \angle AOP = 180^\circ - 45^\circ$

$\angle AOP = 135^\circ/2$

(3) $\angle AOB = 90^\circ$

[Diagonals of a square bisect at right angles]

So, $\angle AOP + \angle POB = 90^\circ$

$135^\circ/2 + \angle POB = 90^\circ$

[From (2)]

$\angle POB = 90^\circ - 135^\circ/2$

$= (180^\circ - 135^\circ)/2$

$= 45^\circ/2$

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$3 \angle POB = 135^\circ/2$ [Multiplying both sides by 3]
Hence,
 $\angle AOP = 3 \angle POB$ [From (2) and (3)]

21. ABCD is a square. E, F, G and H are points on the sides AB, BC, CD and DA respectively such that $AE = BF = CG = DH$. Prove that EFGH is a square.

Solution:

Given: ABCD is a square in which E, F, G and H are points on AB, BC, CD and DA

Such that $AE = BF = CG = DH$

EF, FG, GH and HE are joined

To prove: EFGH is a square

Proof:

Since, $AE = BF = CG = DH$

So, $EB = FC = GD = HA$

Now, in $\triangle AEH$ and $\triangle BFE$

$AE = BF$ [Given]

$AH = EB$ [Proved]

$\angle A = \angle B$ [Each 90°]

So, $\triangle AEH \cong \triangle BFE$ by S.A.S axiom of congruency

Then, by C.P.C.T we have

$EH = EF$

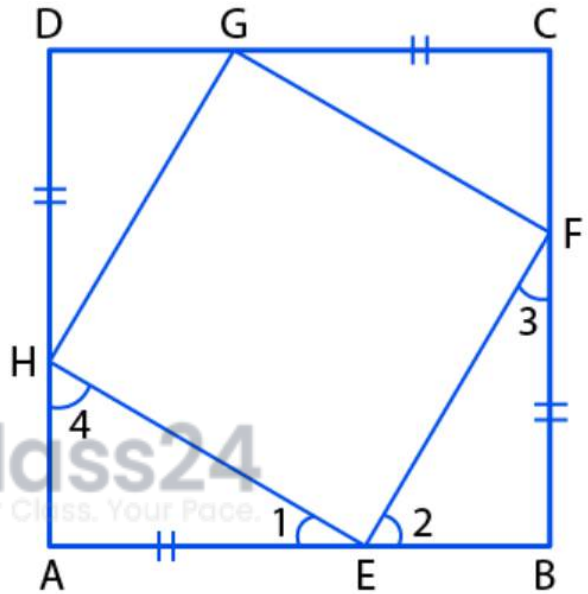
And $\angle 4 = \angle 2$

But $\angle 1 + \angle 4 = 90^\circ$

$\angle 1 + \angle 2 = 90^\circ$

Thus, $\angle HEF = 90^\circ$

Hence, EFGH is a square.



22. (a) In the Figure (1) given below, ABCD and ABEF are parallelograms. Prove that

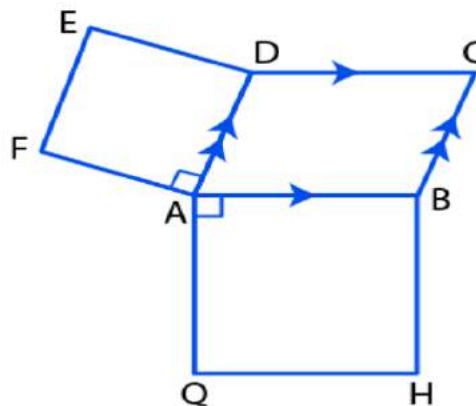
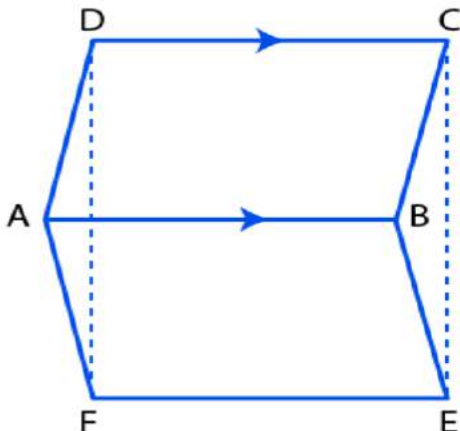
(i) CDFE is a parallelogram

(ii) $FD = EC$

(iii) $\triangle AFD = \triangle BEC$.

(b) In the figure (2) given below, ABCD is a parallelogram, ADEF and AGHB are two squares.

Prove that $FG = AC$.



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Solution:

Given: ABCD and ABEF are \parallel gms

To prove: (i) CDFE is a parallelogram

(ii) $FD = EC$

(iii) $\triangle AFD = \triangle BEC$

Proof:

(1) $DC \parallel AB$ and $DC = AB$ [ABCD is a \parallel gm]

(2) $FE \parallel AB$ and $FE = AB$ [ABEF is a \parallel gm]

(3) $DC \parallel FE$ and $DC = FE$ [From (1) and (2)]

Thus, CDFE is a \parallel gm

(4) $CDEF$ is a \parallel gm

So, $FD = EC$

(5) In $\triangle AFD$ and $\triangle BEC$, we have

$AD = BC$ [Opposite sides of \parallel gm ABCD are equal]

$AF = BE$ [Opposite sides of \parallel gm ABEF are equal]

$FD = EC$ [From (4)]

Hence, $\triangle AFD \cong \triangle BEC$ by S.S.S axiom of congruency

(b) Given: ABCD is a \parallel gm, ADEF and AGHB are two squares

To prove: $FG = AC$

Proof:

(1) $\angle FAG + 90^\circ + 90^\circ + \angle BAD = 360^\circ$ [At a point total angle is 360°]

$\angle FAG = 360^\circ - 90^\circ - 90^\circ - \angle BAD$

$\angle FAG = 180^\circ - \angle BAD$

(2) $\angle B + \angle BAD = 180^\circ$ [Adjacent angle in \parallel gm is equal to 180°]

$\angle B = 180^\circ - \angle BAD$

(3) $\angle FAG = \angle B$ [From (1) and (2)]

(4) In $\triangle AFG$ and $\triangle ABC$, we have

$AF = BC$ [FADE and ABCD both are squares on the same base]

Similarly, $AG = AB$

$\angle FAG = \angle B$ [From (3)]

So, $\triangle AFG \cong \triangle ABC$ by S.A.S axiom of congruency

Hence, by C.P.C.T

$FG = AC$

23. ABCD is a rhombus in which $\angle A = 60^\circ$. Find the ratio $AC : BD$.

Solution:

Let each side of the rhombus ABCD be a

$\angle A = 60^\circ$

So, ABD is an equilateral triangle

$\Rightarrow BD = AB = a$

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We know that, the diagonals of a rhombus bisect each other at right angles

So, in right triangle AOB, we have

$$AO^2 + OB^2 = AB^2 \quad [\text{By Pythagoras Theorem}]$$

$$AO^2 = AB^2 - OB^2$$

$$= a^2 - (\frac{1}{2} a)^2$$

$$= a^2 - \frac{a^2}{4}$$

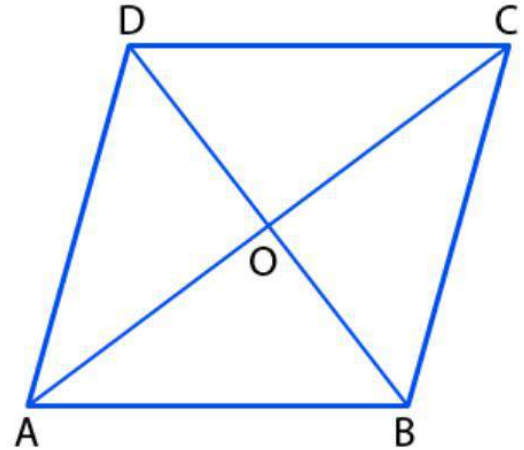
$$= \frac{3a^2}{4}$$

$$AO = \sqrt{\frac{3a^2}{4}} = \frac{\sqrt{3}a}{2}$$

$$\text{But, } AC = 2 AO = 2 \times \frac{\sqrt{3}a}{2} = \sqrt{3}a$$

Hence,

$$AC : BD = \sqrt{3}a : a = \sqrt{3} : 1$$

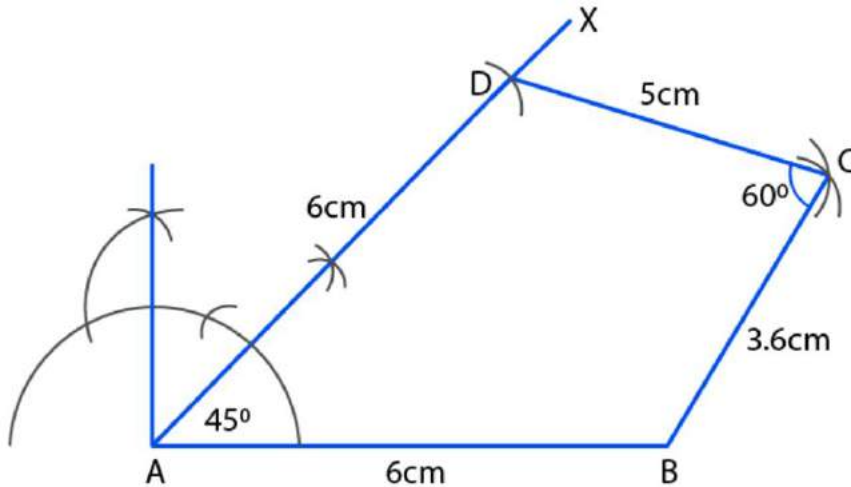


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Exercise 13.2

1. Using ruler and compasses only, construct the quadrilateral ABCD in which $\angle BAD = 45^\circ$, $AD = AB = 6\text{cm}$, $BC = 3.6\text{cm}$, $CD = 5\text{cm}$. Measure $\angle BCD$.

Solution:



Steps of construction:

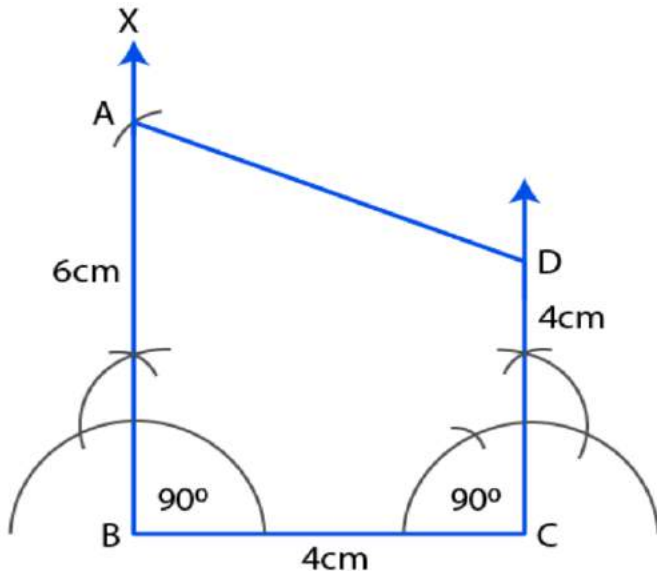
- (i) Draw a line segment $AB = 6\text{cm}$
- (ii) At A, draw a ray AX making an angle of 45° and cut off $AD = 6\text{cm}$
- (iii) With centre B and radius 3.6cm and with centre D and radius 5cm , draw two arcs intersecting each other at C.
- (iv) Join BC and DC.

Thus, ABCD is the required quadrilateral.

On measuring $\angle BCD$, it is 60° .

2. Draw a quadrilateral ABCD with $AB = 6\text{cm}$, $BC = 4\text{cm}$, $CD = 4\text{cm}$ and $\angle B = \angle C = 90^\circ$.

Solution:



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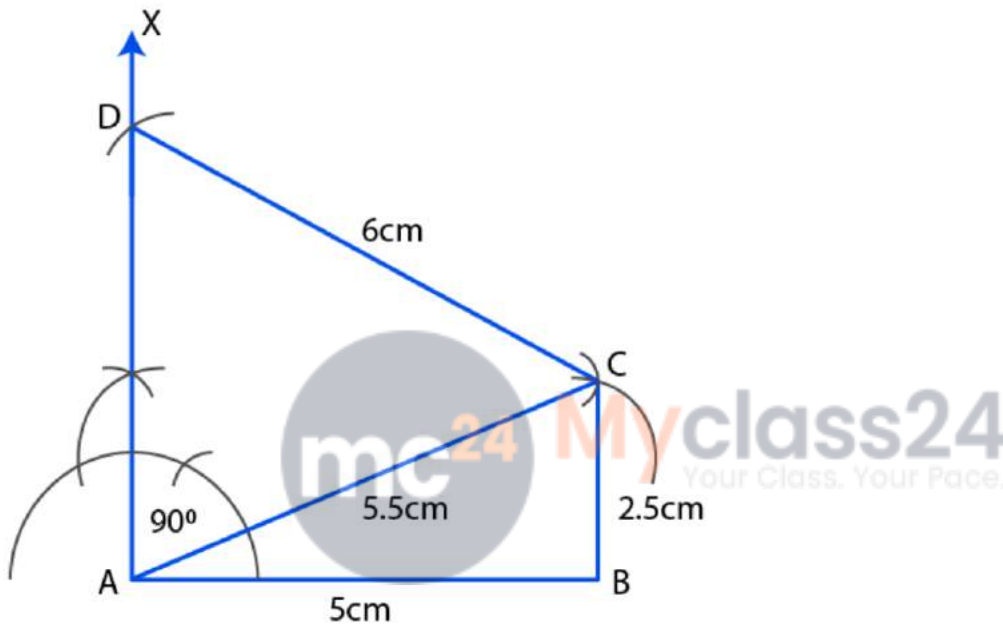
Steps of construction:

- (i) Draw a line segment $BC = 4$ cm
- (ii) At B and C draw rays BX and CY making an angle of 90° each
- (iii) From BX , cut off $BA = 6$ cm and from CY , cut off $CD = 4$ cm
- (iv) Join AD .

Thus, $ABCD$ is the required quadrilateral.

3. Using ruler and compasses only, construct the quadrilateral $ABCD$ given that $AB = 5$ cm, $BC = 2.5$ cm, $CD = 6$ cm, $\angle BAD = 90^\circ$ and the diagonal $AC = 5.5$ cm.

Solution:



Steps of construction:

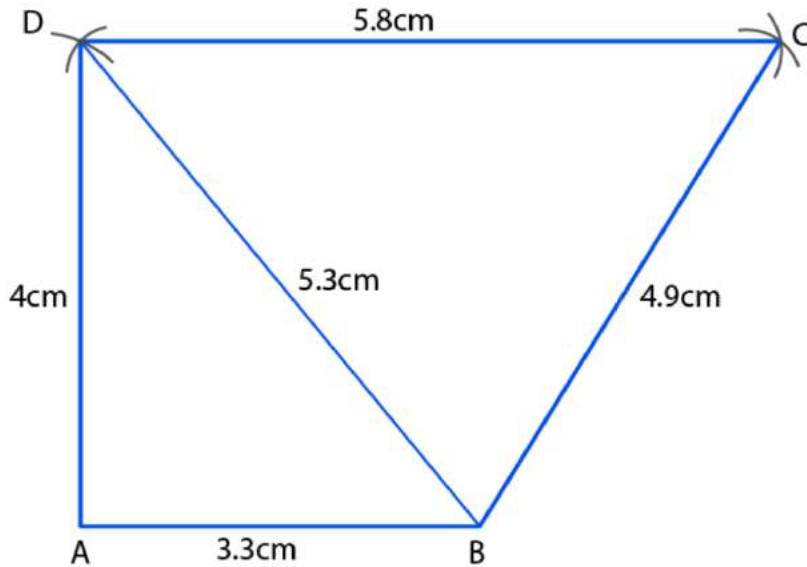
- (i) Draw a line segment $AB = 5$ cm
- (ii) With centre A and radius 5.5 cm and with centre B and radius 2.5 cm draw arcs which intersect each other at C.
- (iii) Join AC and BC .
- (iv) At A, draw a ray AX making an angle of 90° .
- (v) With centre C and radius 6 cm, draw an arc intersecting AX at D
- (vi) Join CD .

Thus, $ABCD$ is the required quadrilateral.

4. Construct a quadrilateral $ABCD$ in which $AB = 3.3$ cm, $BC = 4.9$ cm, $CD = 5.8$ cm, $DA = 4$ cm and $BD = 5.3$ cm.

Solution:

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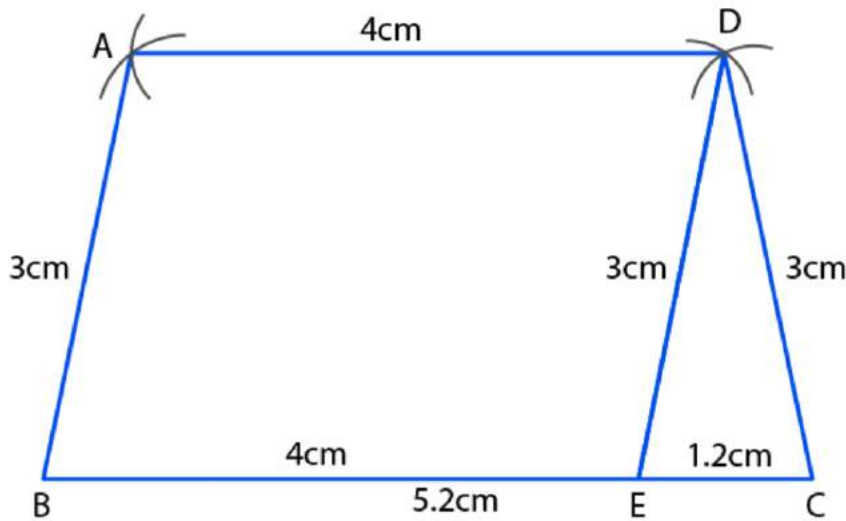


Steps of construction:

- (i) Draw a line segment $AB = 3.3\text{cm}$
- (ii) with centre A and radius 4cm, and with centre B and radius 5.3cm, draw arcs intersecting each other at D.
- (iii) Join AD and BD.
- (iv) With centre B and radius 4.9 cm and with centre D and radius 5.8cm, draw arcs intersecting each other at C.
- (v) Join BC and DC.

Thus, ABCD is the required quadrilateral.

5. Construct a trapezium ABCD in which $AD \parallel BC$, $AB = CD = 3\text{ cm}$, $BC = 5.2\text{cm}$ and $AD = 4\text{ cm}$.
Solution:



Steps of construction:

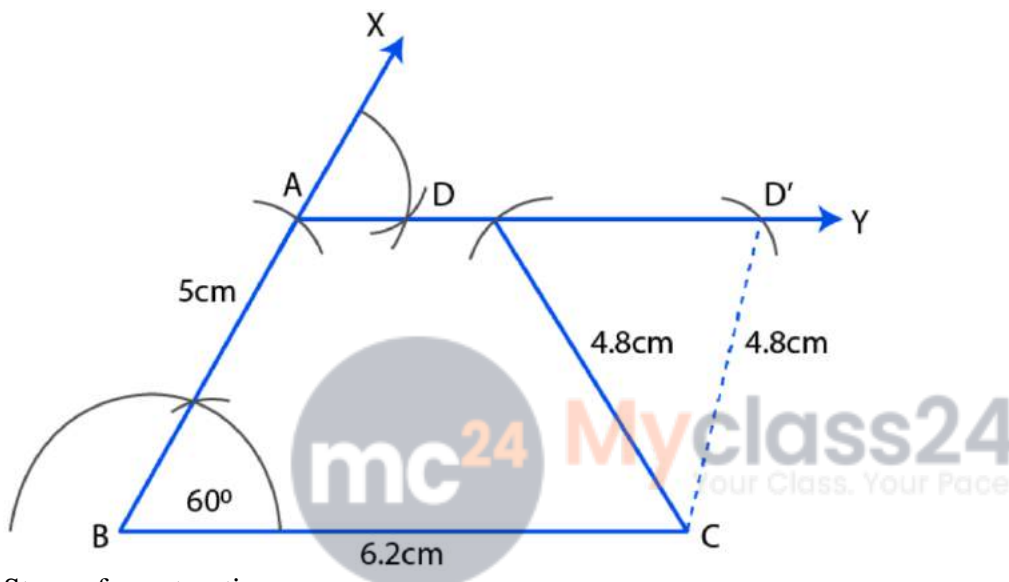
- (i) Draw a line segment $BC = 5.2\text{cm}$
- (ii) From BC, cut off $BE = AD = 4\text{cm}$

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- (iii) With centre E and C, and radius 3 cm, draw arcs intersecting each other at D.
 - (iv) Join ED and CD.
 - (v) With centre D and radius 4cm and with centre B and radius 3cm, draw arcs intersecting each other at A.
 - (vi) Join BA and DA
- Thus, ABCD is the required trapezium.

6. Construct a trapezium ABCD in which $AD \parallel BC$, $\angle B = 60^\circ$, $AB = 5$ cm. $BC = 6.2$ cm and $CD = 4.8$ cm.

Solution:



Steps of construction:

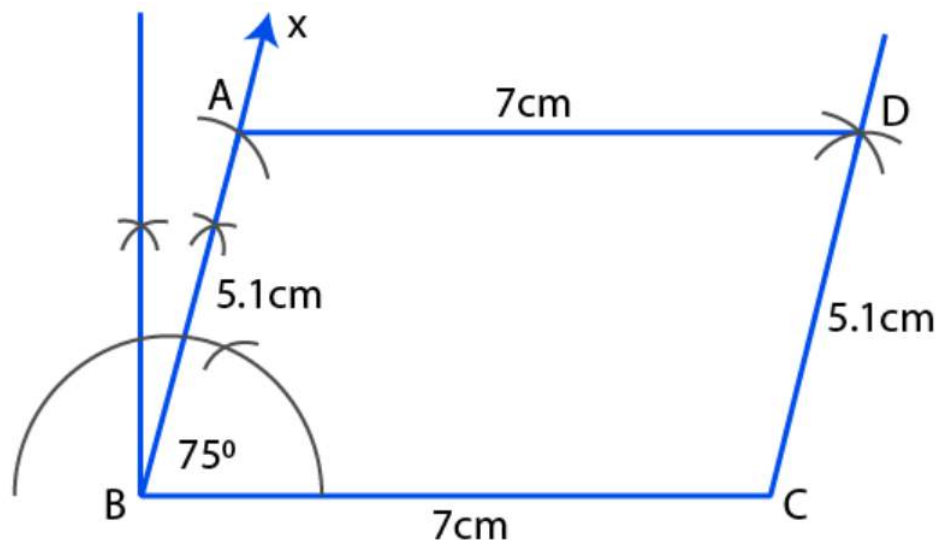
- (i) Draw a line segment $BC = 6.2$ cm
- (ii) At B, draw a ray BX making an angle of 60° and cut off $AB = 5$ cm
- (iii) From A, draw a line AY parallel to BC.
- (iv) With centre C and radius 4.8cm, draw an arc which intersects AY at D and D'.
- (v) Join CD and CD'

Thus, ABCD and ABCD' are the required two trapeziums.

7. Using ruler and compasses only, construct a parallelogram ABCD with $AB = 5.1$ cm, $BC = 7$ cm and $\angle ABC = 75^\circ$.

Solution:

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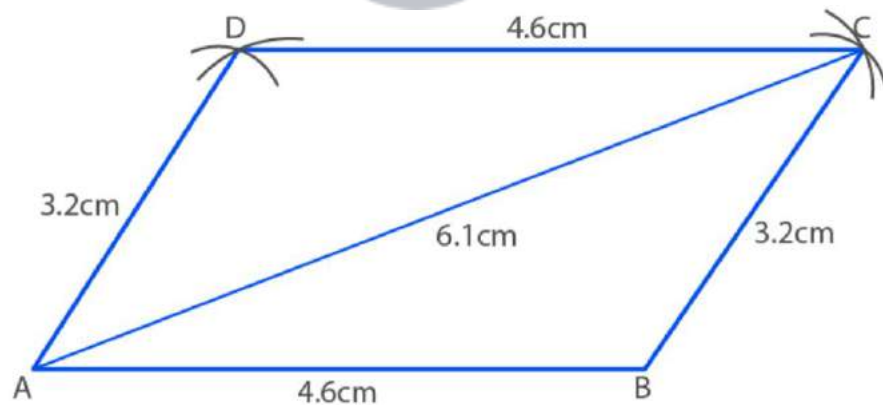
Steps of construction:

- (i) Draw a line segment $BC = 7\text{cm}$
- (ii) A to B, draw a ray Bx making an angle of 75° and cut off $AB = 5.1\text{cm}$
- (iii) With centre A and radius 7cm with centre C and radius 5.1cm , draw arcs intersecting each other at D.
- (iv) Join AD and CD.

Thus, ABCD is the required parallelogram.

8. Using ruler and compasses only, construct a parallelogram ABCD in which $AB = 4.6\text{ cm}$, $BC = 3.2\text{ cm}$ and $AC = 6.1\text{ cm}$.

Solution:



Steps of construction:

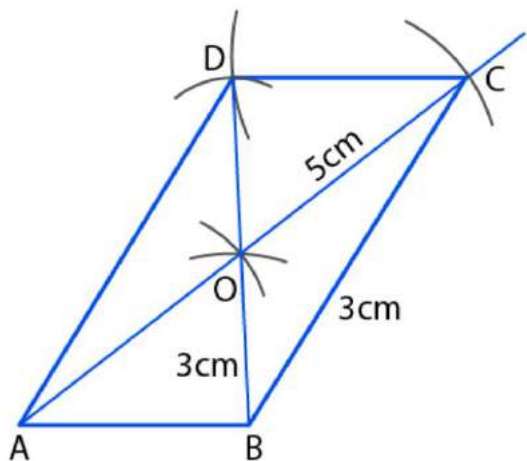
- (i) Draw a line segment $AB = 4.6\text{cm}$
- (ii) With centre A and radius 6.1cm and with centre B and radius 3.2cm , draw arcs intersecting each other at C.
- (iii) Join AC and BC.
- (iv) Again, with centre A and radius 3.2cm and with centre C and radius 4.6cm , draw arcs intersecting each other at D.
- (v) Join AD and CD.

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Thus, ABCD is the required parallelogram.

9. Using ruler and compasses, construct a parallelogram ABCD give that $AB = 4$ cm, $AC = 10$ cm, $BD = 6$ cm. Measure BC.

Solution:



Steps of construction:

(i) Construct triangle OAB such that

$$OA = \frac{1}{2} \times AC = \frac{1}{2} \times 10\text{cm} = 5\text{cm}$$

$$OB = \frac{1}{2} \times BD = \frac{1}{2} \times 6\text{cm} = 3\text{cm}$$

As, diagonals of || gm bisect each other and $AB = 4\text{cm}$

(ii) Produce AO to C such that $OA = OC = 5\text{cm}$

(iii) Produce BO to D such that $OB = OD = 3\text{cm}$

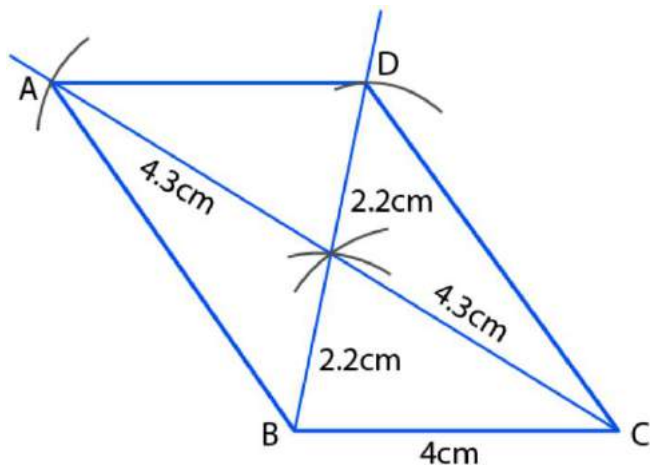
(iv) Join AD, BC and CD

Thus, ABCD is the required parallelogram

(v) Measure BC which is equal to 7.2cm

10. Using ruler and compasses only, construct a parallelogram ABCD such that $BC = 4$ cm, diagonal $AC = 8.6$ cm and diagonal $BD = 4.4$ cm. Measure the side AB.

Solution:



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Steps of construction:

(i) Construct triangle OBC such that

$$OB = \frac{1}{2} \times BD = \frac{1}{2} \times 4.4\text{cm} = 2.2\text{cm}$$

$$OC = \frac{1}{2} \times AC = \frac{1}{2} \times 8.6\text{cm} = 4.3\text{cm}$$

Since, diagonals of || gm bisect each other and $BC = 4\text{cm}$

(ii) Produce BO to D such that $BO = OD = 2.2\text{cm}$

(iii) Produce CO to A such that $CO = OA = 4.3\text{cm}$

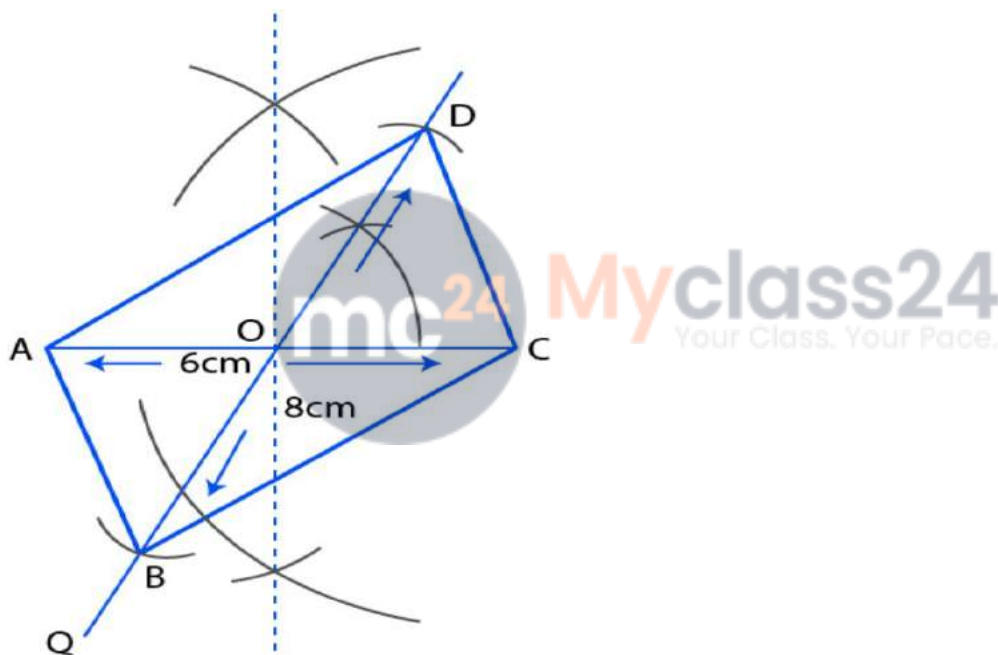
(iv) Join AB, AD and CD

Thus, ABCD is the required parallelogram.

(v) Measure the side AB, $AB = 5.6\text{cm}$

11. Use ruler and compasses to construct a parallelogram with diagonals 6 cm and 8 cm in length having given the acute angle between them is 60° . Measure one of the longer sides.

Solution:



Steps of construction:

(i) Draw $AC = 6\text{cm}$

(ii) Find the mid-point O of AC. [Since, diagonals of || gm bisect each other]

(iii) Draw line POQ such that $POC = 60^\circ$ and $OB = OD = \frac{1}{2} BD = \frac{1}{2} \times 8\text{cm} = 4\text{cm}$

So, from OP cut $OD = 4\text{cm}$ and from OQ cut $OB = 4\text{cm}$

(iv) Join AB, BC, CD and DA.

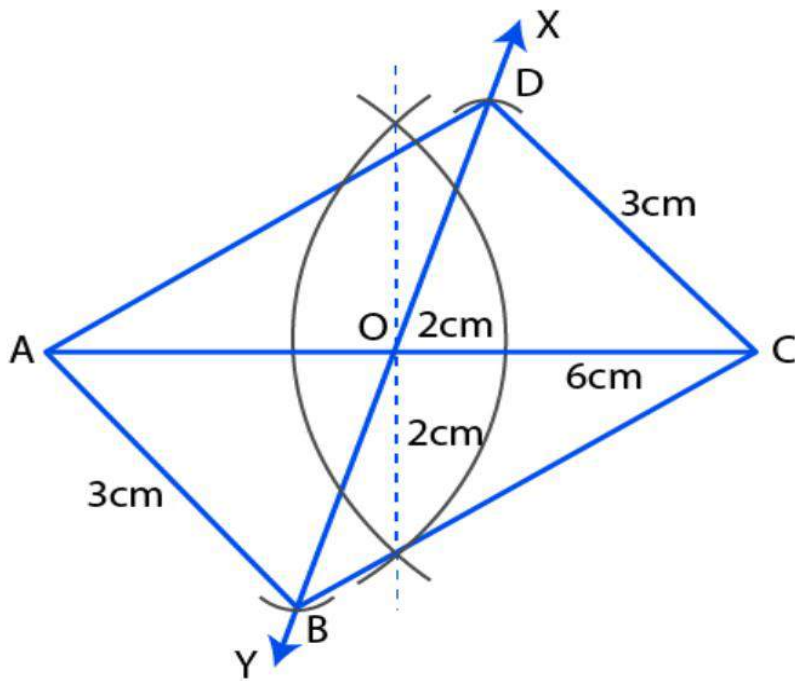
Thus, ABCD is the required parallelogram.

(v) Measure the length of side $AD = 6.1\text{cm}$

12. Using ruler and compasses only, draw a parallelogram whose diagonals are 4 cm and 6 cm long and contain an angle of 75° . Measure and write down the length of one of the shorter sides of the parallelogram.

Solution:

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Steps of construction:

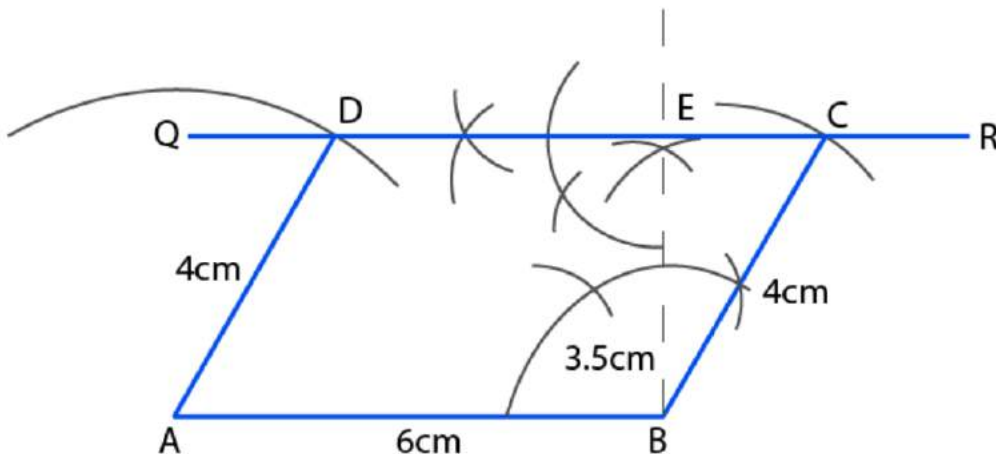
- (i) Draw a line segment $AC = 6\text{ cm}$
- (ii) Bisect AC at O .
- (iii) At O , draw a ray XY making an angle of 75° at O .
- (iv) From OX and OY , cut off $OD = OB = 4/2 = 2\text{ cm}$
- (v) Join AB, BC, CD and DA .

Thus, $ABCD$ is the required parallelogram.

On measuring one of the shorter sides, we get
 $AB = CD = 3\text{ cm}$

13. Using ruler and compasses only, construct a parallelogram $ABCD$ with $AB = 6\text{ cm}$, altitude = 3.5 cm and side $BC = 4\text{ cm}$. Measure the acute angles of the parallelogram.

Solution:



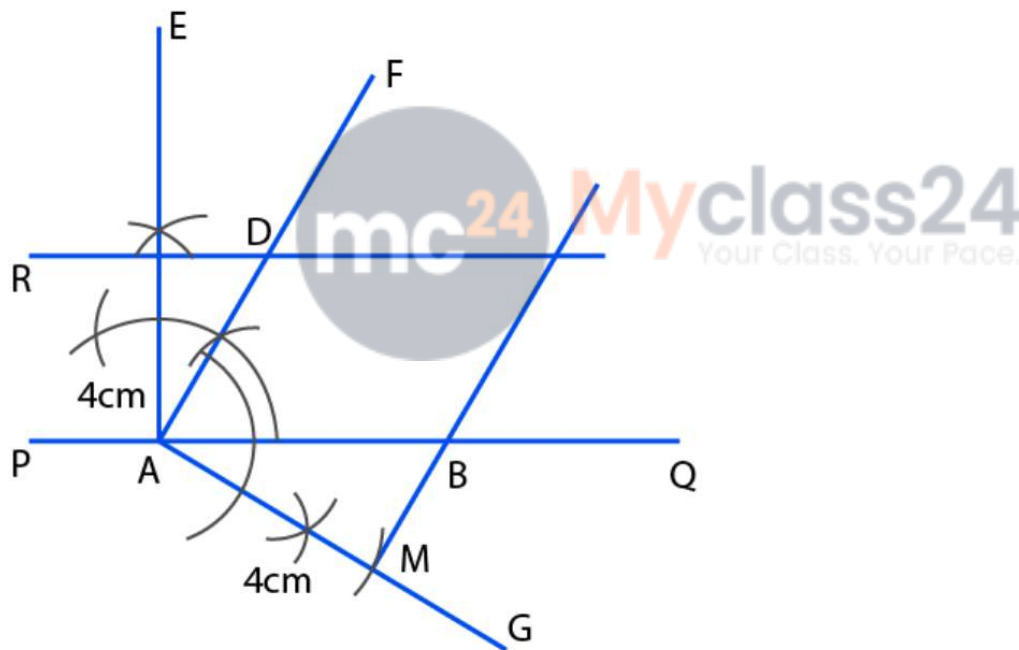
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Steps of construction:

- (i) Draw $AB = 6\text{cm}$
 - (ii) At B, draw $BP \perp AB$
 - (iii) From BP, cut $BE = 3.5\text{cm} = \text{height of } \parallel \text{ gm}$
 - (iv) Through E draw QR parallel to AB
 - (v) With B as centre and radius $BC = 4\text{cm}$ draw an arc which cuts QR at C.
 - (vi) Since, opposite sides of $\parallel \text{ gm}$ are equal
So, $AD = BC = 4\text{cm}$
 - (vii) With A as centre and radius $= 4\text{cm}$ draw an arc which cuts QR at D.
- Thus, ABCD is the required parallelogram.
- (viii) To measure the acute angle of parallelogram which is equal to 61° .

14. The perpendicular distances between the pairs of opposite sides of a parallelogram ABCD are 3 cm and 4 cm and one of its angles measures 60° . Using ruler and compasses only, construct ABCD.

Solution:



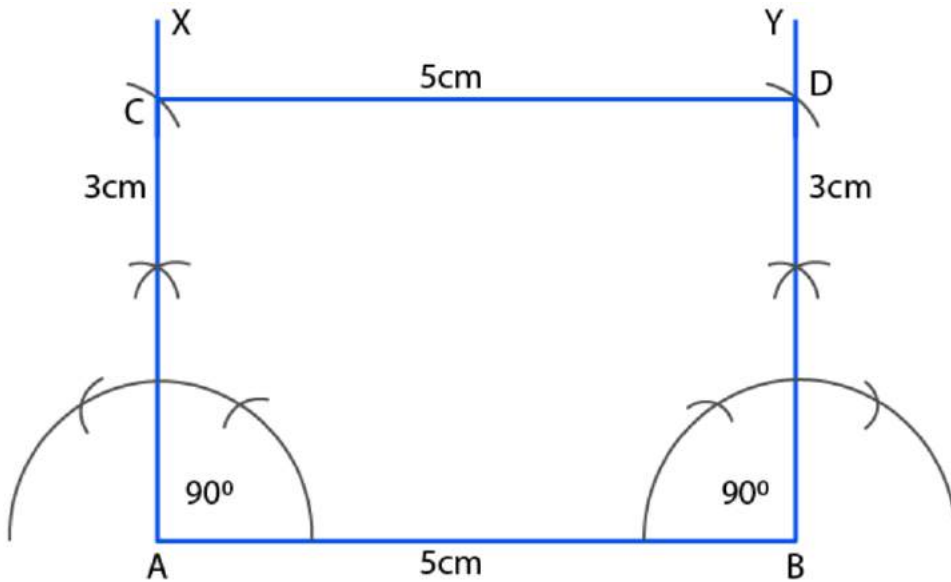
Steps of construction:

- (i) Draw a straight-line PQ, take a point A on it.
 - (ii) At A, construct $\angle QAF = 60^\circ$
 - (iii) At A, draw $AE \perp PQ$ from AE cut off $AN = 3\text{cm}$
 - (iv) Through N draw a straight line to PQ to meet AF at D.
 - (v) At D, draw $AG \perp AD$, from AG cut off $AM = 4\text{cm}$
 - (vi) Through M, draw a straight line parallel to AD to meet AQ in B and ND in C.
- Then, ABCD is the required parallelogram

15. Using ruler and compasses, construct a rectangle ABCD with $AB = 5\text{cm}$ and $AD = 3\text{cm}$.

Solution:

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Steps of construction:

- (i) Draw a straight-line $AB = 5\text{cm}$
- (ii) At A and B construct $\angle XAB$ and $\angle YBA = 90^\circ$
- (iii) From A and B cut off AC and $BD = 3\text{cm}$ each
- (iv) Join CD

Thus, $ABCD$ is the required rectangle.

16. Using ruler and compasses only, construct a rectangle each of whose diagonals measures 6cm and the diagonals intersect at an angle of 45° .

Solution:

Steps of construction:

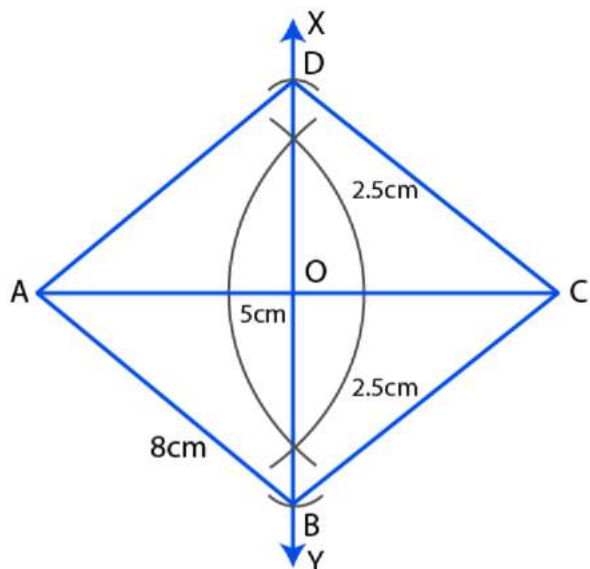
- (i) Draw a line segment $AC = 6\text{cm}$
- (ii) Bisect AC at O .
- (iii) At O , draw a ray XY making an angle of 45° at O .
- (iv) From XY , cut off $OB = OD = 6/2 = 3\text{cm}$ each
- (v) Join AB , BC , CD and DA .

Thus, $ABCD$ is the required rectangle.

17. Using ruler and compasses only, construct a square having a diagonal of length 5cm. Measure its sides correct to the nearest millimeter.

Solution:

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Steps of construction:

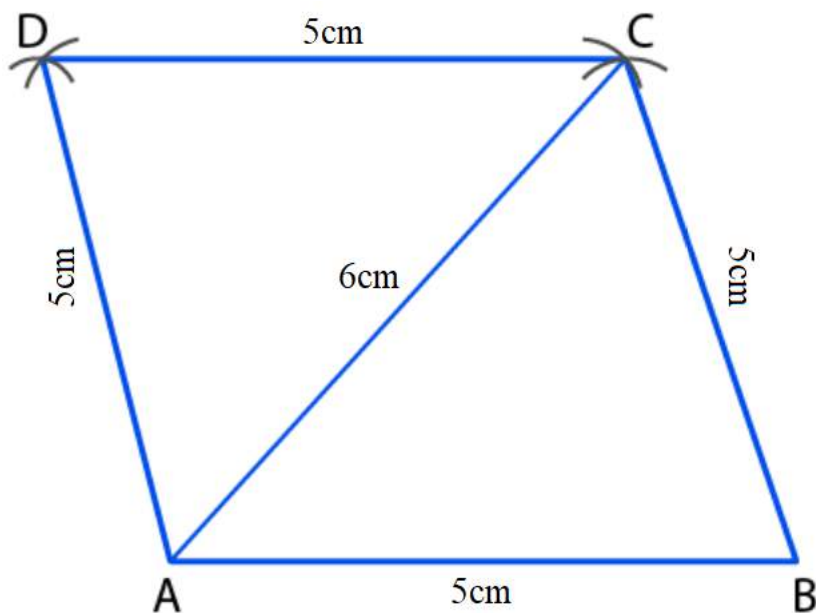
- (i) Draw a line segment $AC = 5\text{cm}$
- (ii) Draw its perpendicular bisector XY bisecting it at O
- (iii) From XY , cut off
 $OB = OD = \frac{5}{2} = 2.5\text{cm}$
- (iv) Join AB, BC, CD and DA .

Thus, $ABCD$ is the required square

On measuring its sides, each = 3.6cm (approximately)

18. Using ruler and compasses only construct A rhombus $ABCD$ given that $AB = 5\text{cm}$, $AC = 6\text{cm}$ measure $\angle BAD$.

Solution:



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Steps of construction:

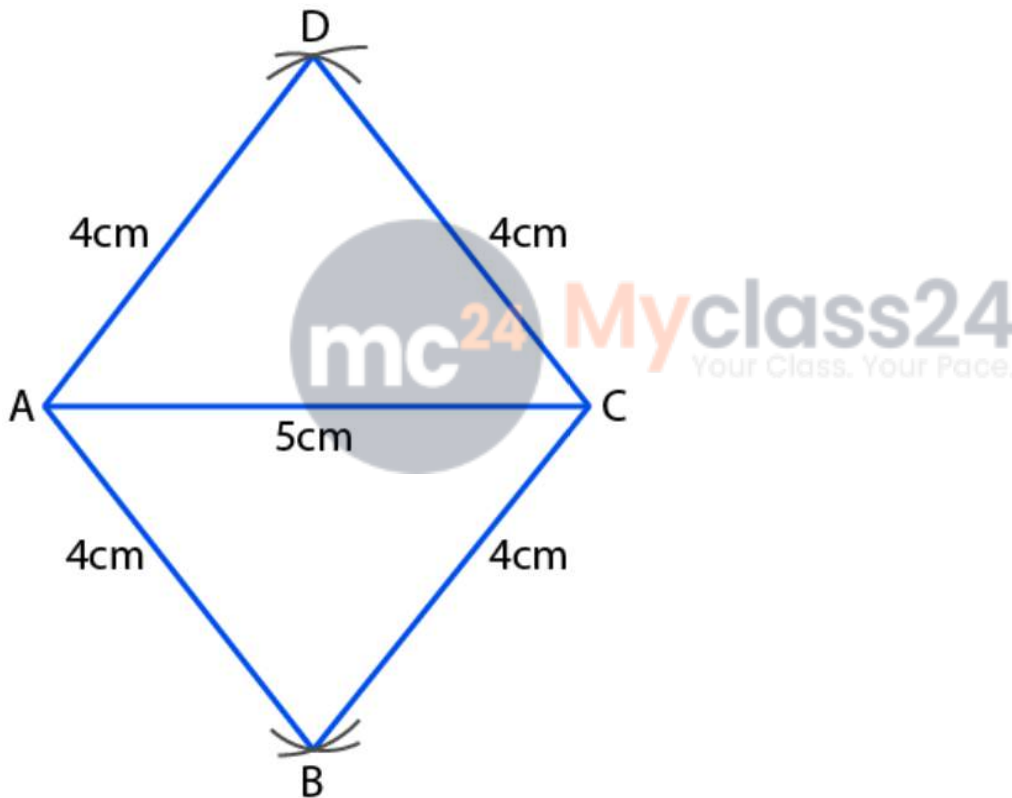
- (i) Draw a line segment $AB = 5\text{cm}$
- (ii) With centre A and radius 6cm , with centre B and radius 5cm , draw arcs intersecting each other at C.
- (iii) Join AC and BC
- (iv) With centre A and C and radius 5cm , draw arcs intersecting each other at D
- (v) Join AD and CD.

Thus, ABCD is a rhombus

On measuring, $\angle BAD = 106^\circ$.

19. Using ruler and compasses only, construct rhombus ABCD with sides of length 4cm and diagonal AC of length 5cm . Measure $\angle ABC$.

Solution:



Steps of construction:

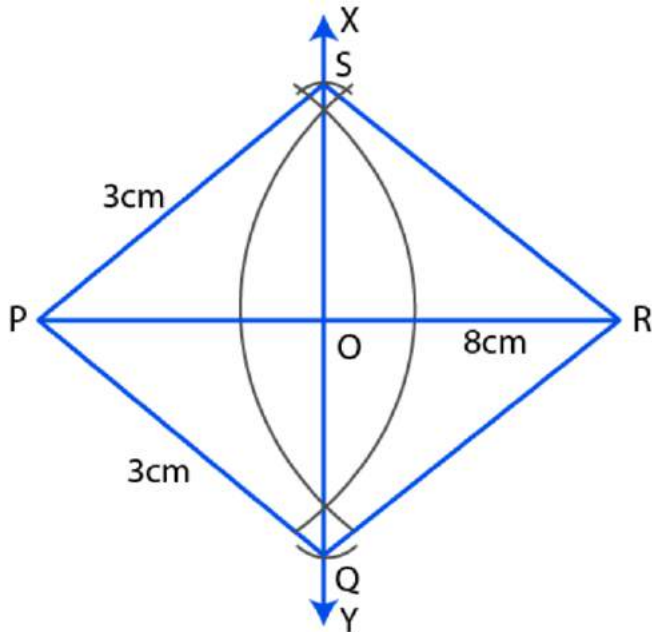
- (i) Draw a line segment $AC = 5\text{cm}$
- (ii) With centre A and C and radius 4cm , draw arcs intersecting each other above and below AC at D and B.
- (iii) Join AB, BC, CD and DA.

Thus, ABCD is the required rhombus.

20. Construct a rhombus PQRS whose diagonals PR and QS are 8cm and 6cm respectively.

Solution:

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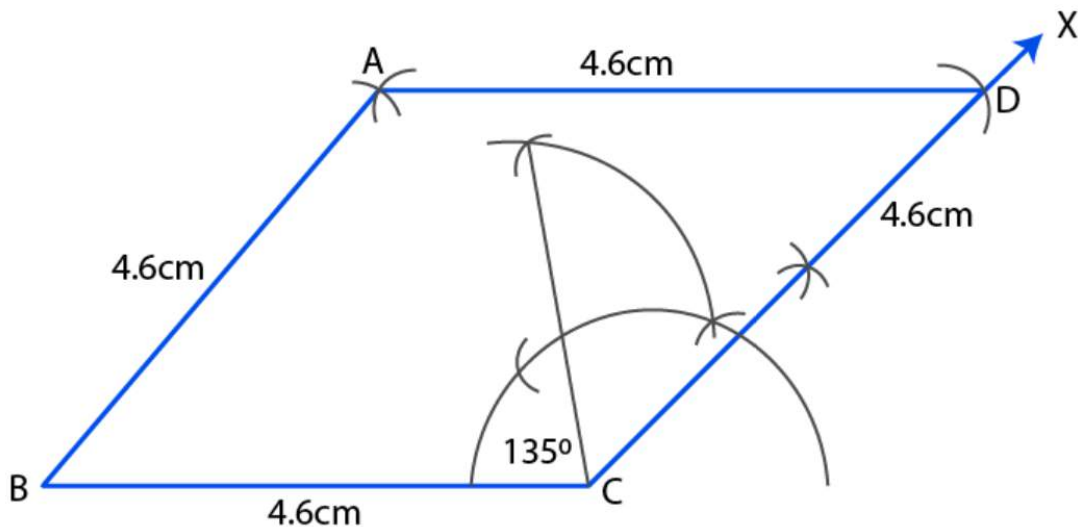


Steps of construction:

- (i) Draw a line segment $PR = 8\text{cm}$
 - (ii) Draw its perpendicular bisector XY intersecting it at O .
 - (iii) From XY , cut off $OQ = OS = 6/2 = 3\text{cm}$ each
 - (iv) Join PQ, QR, RS and SP
- Thus, $PQRS$ is the required rhombus.

21. Construct a rhombus $ABCD$ of side 4.6 cm and $\angle BCD = 135^\circ$, by using ruler and compasses only.

Solution:



Steps of construction:

- (i) Draw a line segment $BC = 4.6\text{cm}$
- (ii) At C , draw a ray CX making an angle of 135° and cut off $CD = 4.6\text{cm}$

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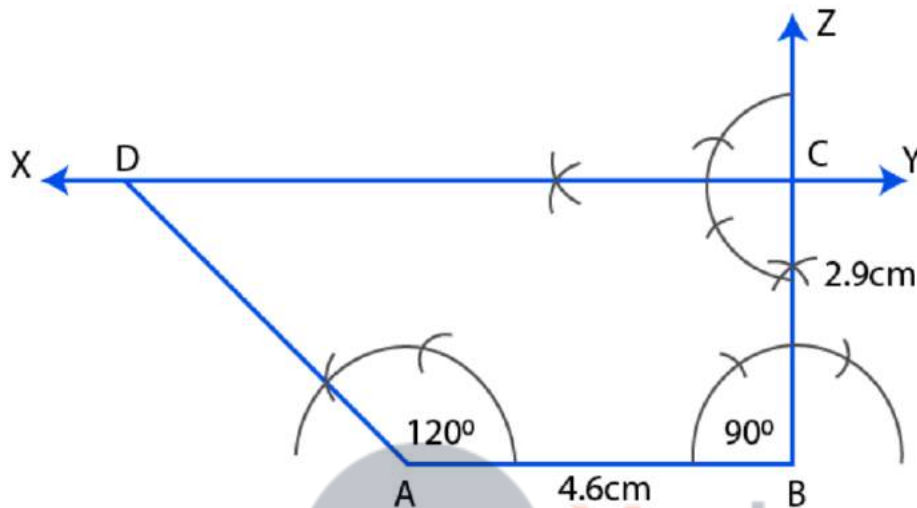
(iii) With centres B and D, and radius 4.6cm draw arcs intersecting each other at A.

(iv) Join BA and DA.

Thus, ABCD is the required rhombus.

22. Construct a trapezium in which $AB \parallel CD$, $AB = 4.6$ cm, $\angle ABC = 90^\circ$, $\angle DAB = 120^\circ$ and the distance between parallel sides is 2.9 cm.

Solution:



Steps of construction:

(i) Draw a line segment $AB = 4.6$ cm

(ii) At B, draw a ray BZ making an angle of 90° and cut off $BC = 2.9$ cm (distance between AB and CD)

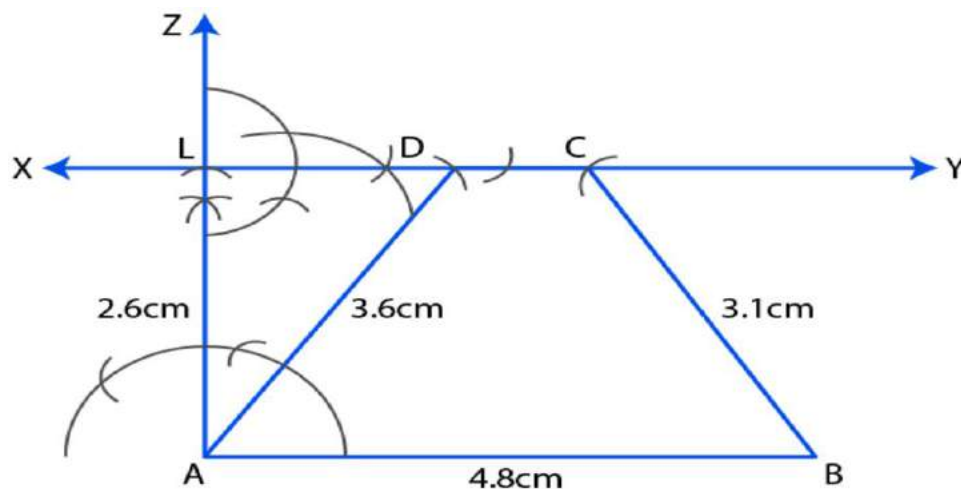
(iii) At C, draw a parallel line XY to AB.

(iv) At A, draw a ray making an angle of 120° meeting XY at D.

Thus, ABCD is the required trapezium.

23. Construct a trapezium ABCD when one of parallel sides $AB = 4.8$ cm, height = 2.6 cm, $BC = 3.1$ cm and $AD = 3.6$ cm.

Solution:



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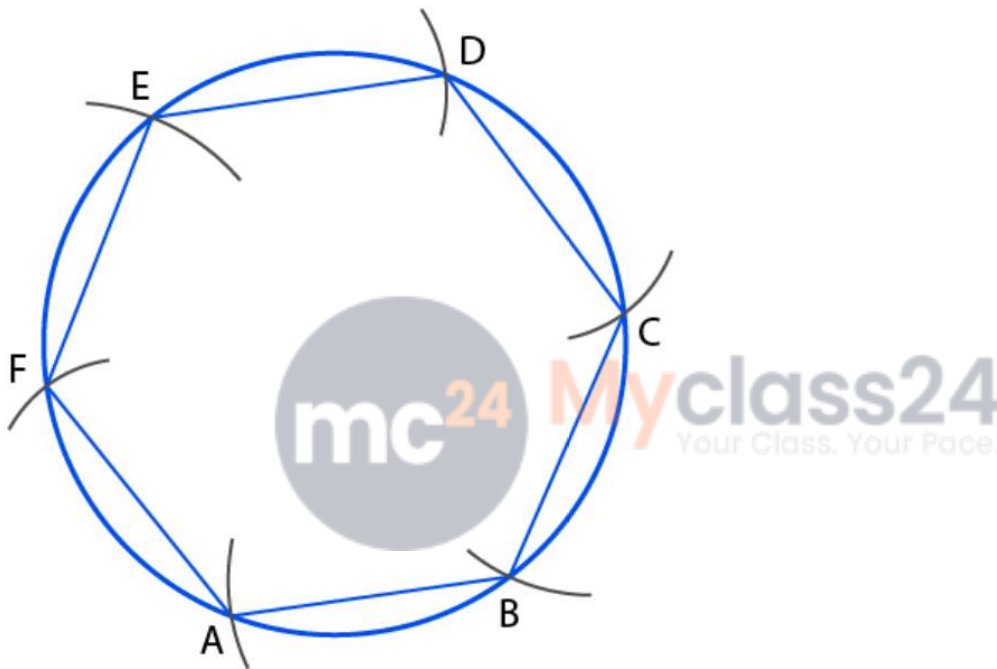
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Step construction:

- (i) Draw a line segment $AB = 4.8\text{cm}$
 - (ii) At A, draw a ray AZ making an angle of 90° cut off $AL = 2.6\text{cm}$
 - (iii) At L, draw a line XY parallel to AB.
 - (iv) With centre A and radius 3.6cm and with centre B and radius 3.1cm , draw arcs intersecting XY at D and C respectively.
 - (v) Join AD and BC
- Thus, ABCD is the required trapezium.

24. Construct a regular hexagon of side 2.5 cm.

Solution:



Steps of construction:

- (i) With O as centre and radius = 2.5cm , draw a circle
- (ii) take any point A on the circumference of circle.
- (iii) With A as centre and radius = 2.5cm , draw an arc which cuts the circumference of circle at B.
- (iv) With B as centre and radius = 2.5cm , draw an arc which cuts the circumference of circle at C.
- (v) With C as centre and radius = 2.5cm , draw an arc which cuts the circumference of circle at D.
- (vi) With D as centre and radius = 2.5cm , draw an arc which cuts the circumference of circle at E.
- (vii) With E as centre and radius = 2.5cm , draw an arc which cuts the circumference of circle at F.
- (viii) Join AB, BC, CD, DE, EF and FA.
- (ix) ABCDEF is the required Hexagon.

Chapter Test

1. In the given figure, ABCD is a parallelogram. CB is produced to E such that BE=BC. Prove that AEBD is a parallelogram.

Solution:

Given ABCD is a || gm in which CB is produced to E such that

BE = BC

BD and AE are joined

To prove: AEBD is a parallelogram

Proof:

In $\triangle AEB$ and $\triangle BDC$

EB = BC [Given]

$\angle ABE = \angle DCB$ [Corresponding angles]

AB = DC [Opposite sides of || gm]

Thus, $\triangle AEB \cong \triangle BDC$ by S.A.S axiom

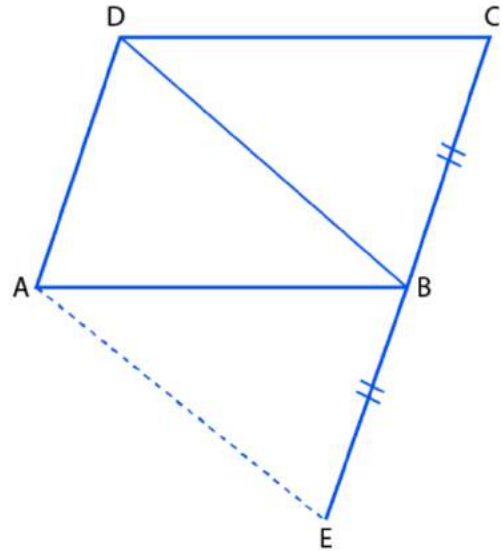
So, by C.P.C.T

But, AD = CB = BE [Given]

As the opposite sides are equal and $\angle AEB = \angle DCB$

But these are corresponding angles

Hence, AEBD is a parallelogram.



2. In the given figure, ABC is an isosceles triangle in which AB = AC. AD bisects exterior angle PAC and CD || BA. Show that (i) $\angle DAC = \angle BCA$ (ii) ABCD is a parallelogram.

Solution:

Given: In isosceles triangle ABC, AB = AC. AD is the bisector of ext. $\angle PAC$ and CD || BA

To prove: (i) $\angle DAC = \angle BCA$

(ii) ABCD is a || gm

Proof:

In $\triangle ABC$

AB = AC [Given]

$\angle C = \angle B$ [Angles opposite to equal sides]

Since, ext. $\angle PAC = \angle B + \angle C$

$$= \angle C + \angle C$$

$$= 2 \angle C$$

$$= 2 \angle BCA$$

So, $\angle DAC = 2 \angle BCA$

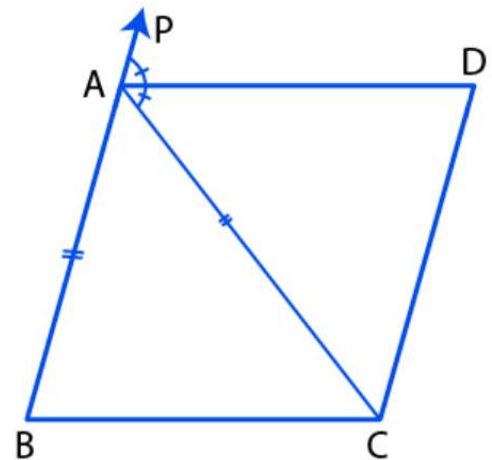
$\angle DAC = \angle BCA$

But these are alternate angles

Thus, AD || BC

But, AB || AC

Hence, ABCD is a || gm.



3. Prove that the quadrilateral obtained by joining the mid-points of an isosceles trapezium is a rhombus.

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Solution:

Given: ABCD is an isosceles trapezium in which $AB \parallel DC$ and $AD = BC$

P, Q, R and S are the mid-points of the sides AB, BC, CD and DA respectively PQ, QR, RS and SP are joined.

To prove: PQRS is a rhombus

Construction: Join AC and BD

Proof:

Since, ABCD is an isosceles trapezium

Its diagonals are equal

$AC = BD$

Now, in $\triangle ABC$

P and Q are the mid-points of AB and BC

So, $PQ \parallel AC$ and $PQ = \frac{1}{2} AC \dots (i)$

Similarly, in $\triangle ADC$

S and R mid-point of CD and AD

So, $SR \parallel AC$ and $SR = \frac{1}{2} AC \dots (ii)$

From (i) and (ii), we have

$PQ \parallel SR$ and $PQ = SR$

Thus, PQRS is a parallelogram.

Now, in $\triangle APS$ and $\triangle BPQ$

$AP = BP$ [P is the mid-point]

$AS = BQ$ [Half of equal sides]

$\angle A = \angle B$ [As ABCD is an isosceles trapezium]

So, $\triangle APS \cong \triangle BPQ$ by SAS Axiom of congruency

Thus, by C.P.C.T we have

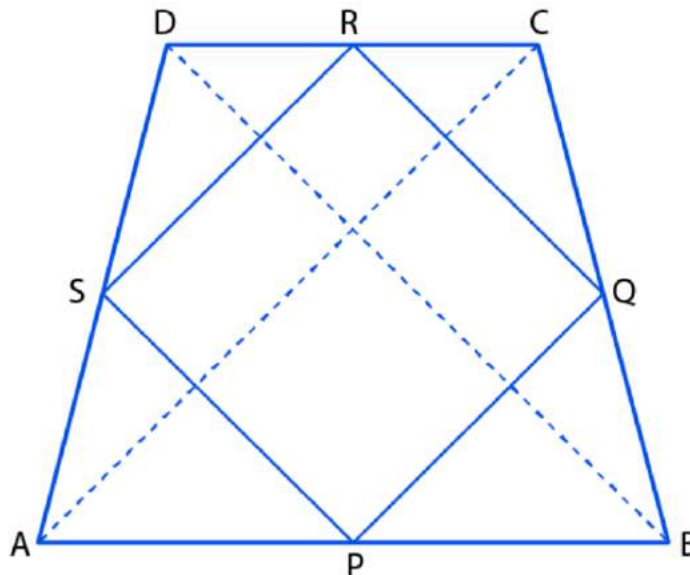
$PS = PQ$

But these are the adjacent sides of a parallelogram

So, sides of PQRS are equal

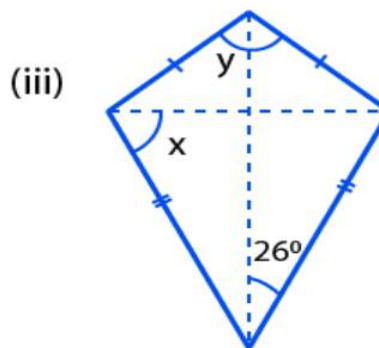
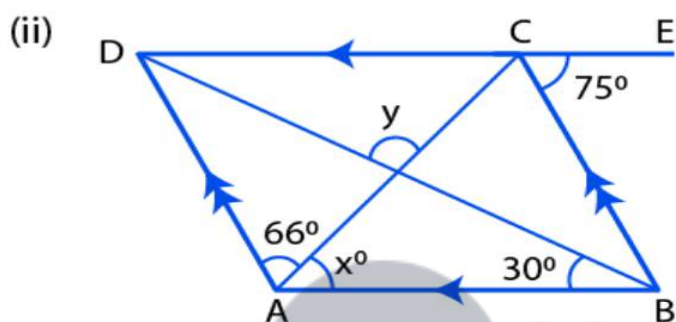
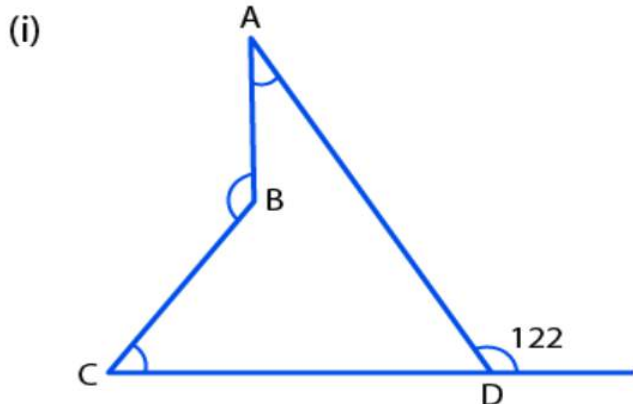
Hence, PQRS is a rhombus

- Hence proved



4. Find the size of each lettered angle in the following figures.

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Solution:

(i) As CDE is a straight line

$$\angle ADE + \angle ADC = 180^\circ$$

$$122^\circ + \angle ADC = 180^\circ$$

$$\angle ADC = 180^\circ - 122^\circ = 58^\circ \dots \text{(i)}$$

$$\angle ABC = 360^\circ - 140^\circ = 220^\circ \dots \text{(ii)}$$

[At any point the angle is 360°]

Now, in quadrilateral ABCD we have

$$\angle ADC + \angle BCD + \angle BAD + \angle ABC = 360^\circ$$

$$58^\circ + 53^\circ + x + 220^\circ = 360^\circ \quad [\text{Using (i) and (ii)}]$$

$$331^\circ + x = 360^\circ$$

$$x = 360^\circ - 331^\circ$$

$$x = 29^\circ$$

(ii) As $DE \parallel AB$ [Given]

$\angle ECB = \angle CBA$ [Alternate angles]

$$75^\circ = \angle CBA$$

$$\Rightarrow \angle CBA = 75^\circ$$

Since, $AD \parallel BC$ we have

$$(x + 66^\circ) + 75^\circ = 180^\circ$$

$$x + 141^\circ = 180^\circ$$

$$x = 180^\circ - 141^\circ$$

$$x = 39^\circ \dots \text{(i)}$$

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Now, in $\triangle AMB$

$$x + 30^\circ + \angle AMB = 180^\circ \quad [\text{Angles sum property of a triangle}]$$

$$39^\circ + 30^\circ + \angle AMB = 180^\circ \quad [\text{From (i)}]$$

$$69^\circ + \angle AMB = 180^\circ$$

$$\angle AMB = 180^\circ - 69^\circ = 111^\circ \dots \text{(ii)}$$

$$\text{Since, } \angle AMB = y \quad [\text{Vertically opposite angles}]$$

$$\Rightarrow y = 111^\circ$$

$$\text{Hence, } x = 39^\circ \text{ and } y = 111^\circ$$

(iii) In $\triangle ABD$

$$AB = AD \quad [\text{Given}]$$

$$\angle ABD = \angle ADB \quad [\text{Angles opposite to equal sides are equal}]$$

$$\angle ABD = 42^\circ \quad [\text{Since, given } \angle ADB = 42^\circ]$$

And,

$$\angle ABD + \angle ADB + \angle BAD = 180^\circ \quad [\text{Angles sum property of a triangle}]$$

$$42^\circ + 42^\circ + y = 180^\circ$$

$$84^\circ + y = 180^\circ$$

$$y = 180^\circ - 84^\circ$$

$$y = 96^\circ$$

$$\angle BCD = 2 \times 26^\circ = 52^\circ$$

In $\triangle BCD$,

$$\text{As } BC = CD \quad [\text{Given}]$$

$$\angle CBD = \angle CDB = x \quad [\text{Angles opposite to equal sides are equal}]$$

$$\angle CBD + \angle CDB + \angle BCD = 180^\circ$$

$$x + x + 52^\circ = 180^\circ$$

$$2x + 52^\circ = 180^\circ$$

$$2x = 180^\circ - 52^\circ$$

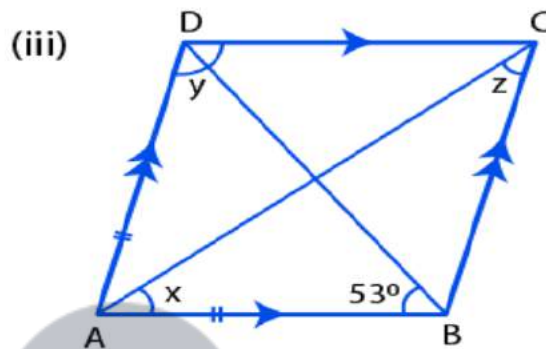
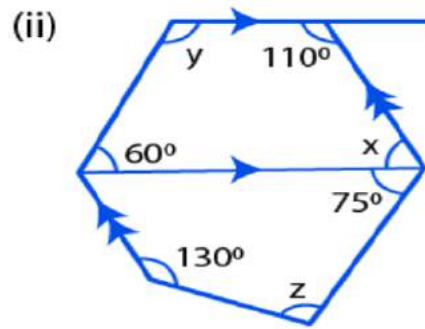
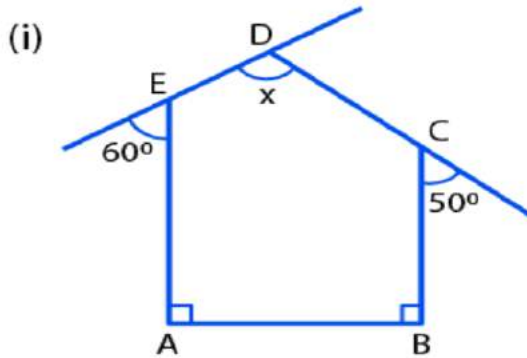
$$x = 128^\circ/2$$

$$x = 64^\circ$$

$$\text{Hence, } x = 64^\circ \text{ and } y = 90^\circ.$$

5. Find the size of each lettered angle in the following figures:

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Solution:

(i) Here, $AB \parallel CD$ and $BC \parallel AD$

So, ABCD is a || gm

$$y = 2 \times \angle ABD$$

$$y = 2 \times 53^\circ = 106^\circ \dots (1)$$

$$\text{Also, } y + \angle DAB = 180^\circ$$

$$\begin{aligned} \angle DAB &= 180^\circ - 106^\circ \\ &= 74^\circ \end{aligned}$$

Thus, $x = \frac{1}{2} \angle DAB$ [As AC bisects $\angle DAB$]

$$x = \frac{1}{2} \times 74^\circ = 37^\circ$$

and $\angle DAC = x = 37^\circ \dots (ii)$

Also, $\angle DAC = z \dots (iii)$ [Alternate angles]

From (ii) and (iii),

$$z = 37^\circ$$

Hence, $x = 37^\circ$, $y = 106^\circ$ and $z = 37^\circ$

(ii) As ED is a straight line, we have

$$60^\circ + \angle AED = 180^\circ \quad [\text{Linear pair}]$$

$$\angle AED = 180^\circ - 60^\circ$$

$$\angle AED = 120^\circ \dots (i)$$

Also, as CD is a straight line

$$50^\circ + \angle BCD = 180^\circ \quad [\text{Linear pair}]$$

$$\angle BCD = 180^\circ - 50^\circ$$

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$$\angle BCD = 130^\circ \dots \text{(ii)}$$

In pentagon ABCDE, we have

$$\angle A + \angle B + \angle AED + \angle BCD + \angle x = 540^\circ \quad [\text{Sum of interior angles in pentagon is } 540^\circ]$$

$$90^\circ + 90^\circ + 120^\circ + 130^\circ + x = 540^\circ$$

$$430^\circ + x = 540^\circ$$

$$x = 540^\circ - 430^\circ$$

$$x = 110^\circ$$

Hence, value of $x = 110^\circ$

(iii) In given figure, $AD \parallel BC$ [Given]

$$60^\circ + y = 180^\circ \text{ and } x + 110^\circ = 180^\circ$$

$$y = 180^\circ - 60^\circ \text{ and } x = 180^\circ - 110^\circ$$

$$y = 120^\circ \text{ and } x = 70^\circ$$

Since, $CD \parallel AF$ [Given]

$$\angle FAD = 70^\circ \dots \text{(i)}$$

In quadrilateral ADEF,

$$\angle FAD + 75^\circ + z + 130^\circ = 360^\circ$$

$$70^\circ + 75^\circ + z + 130^\circ = 360^\circ$$

$$275^\circ + z = 360^\circ$$

$$z = 360^\circ - 275^\circ = 85^\circ$$

Hence,

$$x = 70^\circ, y = 120^\circ \text{ and } z = 85^\circ$$

6. In the adjoining figure, ABCD is a rhombus and DCFE is a square. If $\angle ABC = 56^\circ$, find (i) $\angle DAG$ (ii) $\angle FEG$ (iii) $\angle GAC$ (iv) $\angle AGC$.

Solution:

Here ABCD and DCFE is a rhombus and square respectively.

So, $AB = BC = DC = AD \dots \text{(i)}$

Also, $DC = EF = FC = EC \dots \text{(ii)}$

From (i) and (ii), we have

$AB = BC = DC = AD = EF = FC = EC \dots \text{(iii)}$

$$\angle ABC = 56^\circ \quad [\text{Given}]$$

$$\angle ADC = 56^\circ \quad [\text{Opposite angle in rhombus are equal}]$$

$$\text{So, } \angle EDA = \angle EDC + \angle ADC = 90^\circ + 56^\circ = 146^\circ$$

In $\triangle ADE$,

$$DE = AD \quad [\text{From (iii)}]$$

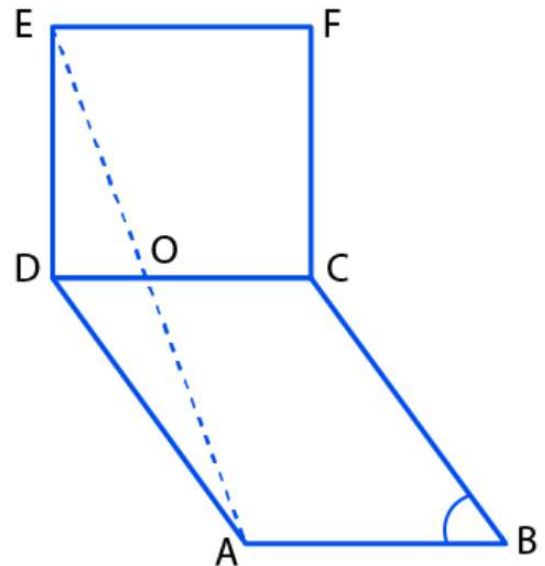
$\angle DEA = \angle DAE$ [Equal sides have equal opposite angles]

$$\begin{aligned} \angle DEA = \angle DAG &= (180^\circ - \angle EDA) / 2 \\ &= (180^\circ - 146^\circ) / 2 \\ &= 34^\circ / 2 = 17^\circ \end{aligned}$$

$$\Rightarrow \angle DAG = 17^\circ$$

$$\text{Also, } \angle DEG = 17^\circ$$

$$\begin{aligned} \angle FEG &= \angle E - \angle DEG \\ &= 90^\circ - 17^\circ \end{aligned}$$



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$$= 73^\circ$$

In rhombus ABCD,

$$\angle DAB = 180^\circ - 56^\circ = 124^\circ$$

$$\angle DAC = 124^\circ / 2 \quad [\text{Since, AC diagonals bisect the } \angle A]$$

$$\angle DAC = 62^\circ$$

$$\angle GAC = \angle DAC - \angle DAG$$

$$= 62^\circ - 17^\circ$$

$$= 45^\circ$$

In $\triangle EDG$,

$$\angle D + \angle DEG + \angle DGE = 180^\circ \quad [\text{Angles sum property of a triangle}]$$

$$90^\circ + 17^\circ + \angle DGE = 180^\circ$$

$$\angle DGE = 180^\circ - 107^\circ = 73^\circ \dots \text{(iv)}$$

$$\text{Thus, } \angle AGC = \angle DGE \dots \text{(v)} \quad [\text{Vertically opposite angles}]$$

Hence from (iv) and (v), we have

$$\angle AGC = 73^\circ$$

7. If one angle of a rhombus is 60° and the length of a side is 8 cm, find the lengths of its diagonals.

Solution:

Each side of rhombus ABCD is 8cm

So, $AB = BC = CD = DA = 8\text{cm}$

Let $\angle A = 60^\circ$

So, $\triangle ABD$ is an equilateral triangle

Then,

$$AB = BD = AD = 8\text{cm}$$

As we know, the diagonals of a rhombus bisect each other at right angles

$$AO = OC, BO = OD = 4\text{cm and } \angle AOB = 90^\circ$$

Now, in right $\triangle AOB$

By Pythagoras theorem

$$AB^2 = AO^2 + OB^2$$

$$8^2 = AO^2 + 4^2$$

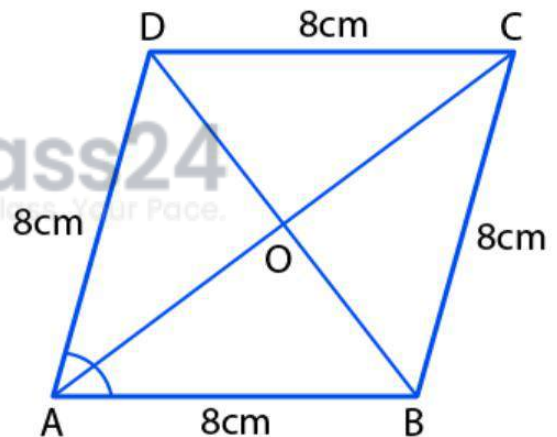
$$64 = AO^2 + 16$$

$$AO^2 = 64 - 16 = 48$$

$$AO = \sqrt{48} = 4\sqrt{3}\text{cm}$$

But, $AC = 2 AO$

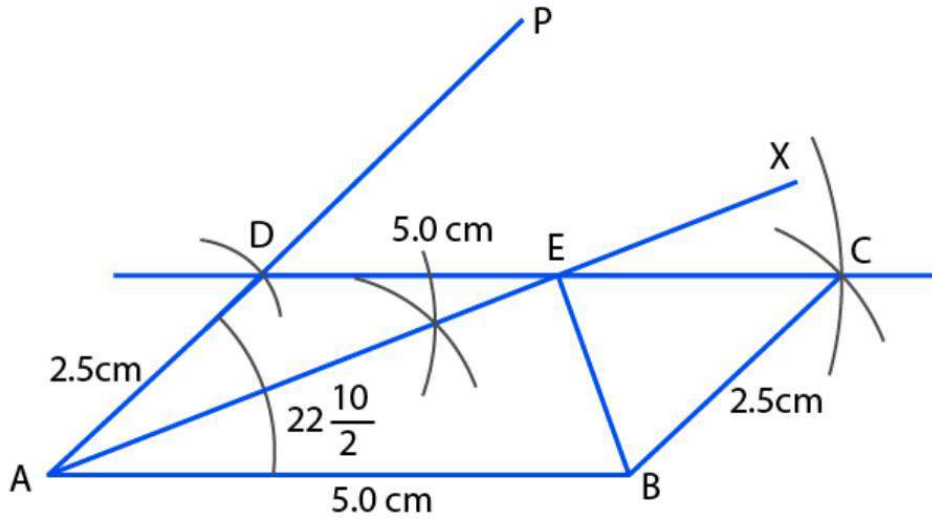
$$\text{Hence, } AC = 2 \times 4\sqrt{3} = 8\sqrt{3}\text{cm.}$$



8. Using ruler and compasses only, construct a parallelogram ABCD with $AB = 5\text{ cm}$, $AD = 2.5\text{ cm}$ and $\angle BAD = 45^\circ$. If the bisector of $\angle BAD$ meets DC at E, prove that $\angle AEB$ is a right angle.

Solution:

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Steps of construction:

- (i) Draw $AB = 5.0\text{cm}$
- (ii) Draw $\angle BAP = 45^\circ$ on side AB
- (iii) Take A as centre and radius 2.5cm cut the line AP at D
- (iv) Take D as centre and radius 5.0cm draw an arc
- (v) Take B as centre and radius equal to 2.5cm cut the arc of step (iv) at C
- (vi) Join BC and CD
- (vii) $ABCD$ is the required parallelogram
- (viii) Draw the bisector of $\angle BAD$, which cuts the DC at E
- (ix) Join EB
- (x) Measure $\angle AEB$ which is equal to 90° .