







## Parallelograms Exercise 16A

### What is a Parallelogram?

- Opposite sides are parallel
- Opposite sides are congruent
- Opposite angles are equal
- Consecutive angles supplementary
- Diagonals bisect each other



Type	Properties
Parallelogram 	<ul style="list-style-type: none"> <li>• Opposite sides are equal and parallel</li> <li>• Opposite angles are equal</li> </ul>
Rectangle 	<ul style="list-style-type: none"> <li>• Opposite sides are equal and parallel</li> <li>• All angles are right angles (<math>90^\circ</math>)</li> </ul>
Square 	<ul style="list-style-type: none"> <li>• Opposite sides are parallel</li> <li>• All sides are equal</li> <li>• All angles are right angles (<math>90^\circ</math>)</li> </ul>
Rhombus 	<ul style="list-style-type: none"> <li>• Opposite sides are parallel</li> <li>• All sides are equal</li> <li>• Opposite angles are equal</li> <li>• Diagonals bisect each other at right angles (<math>90^\circ</math>)</li> </ul>
Trapezoid 	<ul style="list-style-type: none"> <li>• One pair of opposite sides is parallel</li> </ul>
Kite 	<ul style="list-style-type: none"> <li>• Two pairs of adjacent sides are equal</li> <li>• One pair of opposite sides are equal</li> <li>• One diagonal bisects the other</li> <li>• Diagonals intersect at right angle (<math>90^\circ</math>)</li> </ul>

Q1

**Answer :**

It is given that  $ABCD$  is a parallelogram in which  $\angle A$  is equal to  $110^\circ$ .

Sum of *the* adjacent angles of a parallelogram is  $180^\circ$ .

$$\begin{aligned}\therefore \angle A + \angle B &= 180^\circ \\ \Rightarrow 110^\circ + \angle B &= 180^\circ \\ \Rightarrow \angle B &= (180^\circ - 110^\circ) \\ \Rightarrow \angle B &= 70^\circ \\ \therefore \angle B &= 70^\circ\end{aligned}$$

Also,  $\angle B + \angle C = 180^\circ$

$$\begin{aligned}\Rightarrow 70^\circ + \angle C &= 180^\circ \\ \Rightarrow \angle C &= (180^\circ - 70^\circ) \\ \Rightarrow \angle C &= 110^\circ \\ \therefore \angle C &= 110^\circ\end{aligned}$$

Further,  $\angle C + \angle D = 180^\circ$

$$\begin{aligned}\Rightarrow 110^\circ + \angle D &= 180^\circ \\ \Rightarrow \angle D &= (180^\circ - 110^\circ) \\ \Rightarrow \angle D &= 70^\circ \\ \therefore \angle D &= 70^\circ\end{aligned}$$

Q2

**Answer :**

Let the required angle be  $x^\circ$ .

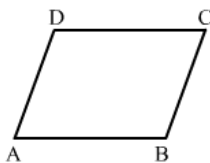
As the adjacent angles are equal, we have :

$$\begin{aligned}x + x &= 180 && \text{(since the sum of adjacent angles of a parallelogram is } 180^\circ\text{)} \\ \Rightarrow 2x &= 180 \\ \Rightarrow x &= \frac{180}{2} \\ \Rightarrow x &= 90^\circ\end{aligned}$$

Hence, the measure of each of the angles is  $90^\circ$ .

Q3

**Answer :**



Let  $ABCD$  be the parallelogram.

Then,  $\angle A$  and  $\angle B$  are its adjacent angles.

$$\text{Let } \angle A = (4x)^\circ$$

$$\angle B = (5x)^\circ$$

$$\begin{aligned}\therefore \angle A + \angle B &= 180^\circ && \text{[since sum of the adjacent angles of a parallelogram is } 180^\circ\text{]} \\ \Rightarrow 4x + 5x &= 180 \\ \Rightarrow 9x &= 180 \\ \Rightarrow x &= \frac{180}{9} \\ \Rightarrow x &= 20\end{aligned}$$

$$\therefore \angle A = (4 \times 20)^\circ = 80^\circ$$

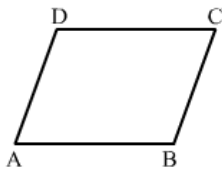
$$\angle B = (5 \times 20)^\circ = 100^\circ$$

Opposite angles of parallelogram are equal.

$$\therefore \angle C = \angle A = 80^\circ$$

$$\angle D = \angle B = 100^\circ$$

Q4



Let  $ABCD$  be a parallelogram.

$$\text{Let } \angle A = (3x - 4)^\circ$$

$$\angle B = (3x + 16)^\circ$$

$$\therefore \angle A + \angle B = 180^\circ \quad [\text{since the sum of adjacent angles of a parallelogram is } 180^\circ]$$

$$\Rightarrow 3x - 4 + 3x + 16 = 180$$

$$\Rightarrow 3x - 4 + 3x + 16 = 180$$

$$\Rightarrow 6x + 12 = 180$$

$$\Rightarrow 6x = 168$$

$$\Rightarrow x = \frac{168}{6}$$

$$\Rightarrow x = 28$$

$$\therefore \angle A = (3 \times 28 - 4)^\circ$$

$$= (84 - 4)^\circ$$

$$= 80^\circ$$

$$\angle B = ((3 \times 28) + 16)^\circ$$

$$= (84 + 16)^\circ$$

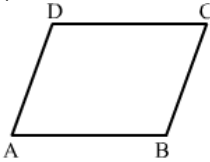
$$= 100^\circ$$

The opposite angles of a parallelogram are equal.

$$\therefore \angle C = \angle A = 80^\circ$$

$$\angle D = \angle B = 100^\circ$$

Q5



Let  $ABCD$  be a parallelogram and let the sum of its opposite angles be  $130^\circ$ .

$$\angle A + \angle C = 130^\circ$$

The opposite angles are equal in a parallelogram.

$$\therefore \angle A = \angle C = x^\circ$$

$$\Rightarrow x + x = 130$$

$$\Rightarrow 2x = 130$$

$$\Rightarrow x = \frac{130}{2}$$

$$\Rightarrow x = 65$$

$$\therefore \angle A = 65^\circ \text{ and } \angle C = 65^\circ$$

$$\angle A + \angle B = 180^\circ \quad [\text{since the sum of adjacent angles of a parallelogram is } 180^\circ]$$

$$\Rightarrow 65^\circ + \angle B = 180^\circ$$

$$\Rightarrow \angle B = (180 - 65)^\circ$$

$$\Rightarrow \angle B = 115^\circ$$

$$\angle D = \angle B = 115^\circ \quad [\text{opposite angles of parallelogram are equal}]$$

Q6

Answer :

Let the lengths of two sides of the parallelogram be  $5x$  cm and  $3x$  cm, respectively.

Then, its perimeter =  $2(5x + 3x)$  cm

$$= 16x \text{ cm}$$

$$\therefore 16x = 64$$

$$\Rightarrow x = \frac{64}{16}$$

$$\Rightarrow x = 4$$

$$\therefore \text{One side} \Rightarrow (5 \times 4) \text{ cm} = 20 \text{ cm}$$

$$\text{Other side} \Rightarrow (3 \times 4) \text{ cm} = 12 \text{ cm}$$

Q7

Answer :

Let the lengths of two sides of the parallelogram be  $x$  cm and  $(x + 10)$  cm, respectively.

Then, its perimeter =  $2[x + (x + 10)]$  cm

$$= 2[x + x + 10] \text{ cm}$$

$$= 2[2x + 10] \text{ cm}$$

$$= 4x + 20 \text{ cm}$$

$$4x + 20 = 140$$

$$\Rightarrow 4x = 140 - 20$$

$$\Rightarrow 4x = 120$$

$$\Rightarrow x = \frac{120}{4}$$

$$\Rightarrow x = 30$$

Length of one side = 30 cm

Length of the other side  $\Rightarrow (30 + 10) \text{ cm} = 40 \text{ cm}$

Q8

Answer :

Refer to the figure given in the book.

In  $\triangle BMC$  and  $\triangle DNA$  :

$$\angle DNA = \angle BMC = 90^\circ$$

$$\angle BCM = \angle DAN \quad (\text{alternate angles})$$

$$BC = DA \quad (\text{opposite sides})$$

By AAS congruency criteria :

$$\triangle BMC \cong \triangle DNA$$

Yes, it is true that  $BM$  is equal to  $DN$ .

(by corresponding parts of congruent triangles  $BMC$  and  $DNA$ )

Q9

Refer to the figure of the book.

$$\angle A = \angle C \quad (\text{opposite angles of a parallelogram are equal})$$

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

$$\Rightarrow \angle EAD = \angle FCB \quad (AE \text{ and } CF \text{ bisect the angles } A \text{ and } C, \text{ respectively})$$

In  $\triangle ADE$  and  $\triangle CBF$  :

$$\angle B = \angle D \quad (\text{opposite angles of a parallelogram are equal})$$

$$\angle EAD = \angle FCB \quad (\text{proved above})$$

$$AD = BC \quad (\text{opposite sides of a parallelogram are equal})$$

By AAS congruency criteria :

$$\triangle ADE \cong \triangle CBF$$

$$DE = BF \quad (\text{corresponding parts of congruent triangles})$$

$$CD = AB \quad (\text{opposite sides of a parallelogram are equal})$$

$$\text{Also, } CD - DE = AB - BF$$

$$\Rightarrow CE = AF$$

$ABCD$  is a parallelogram.

$$\therefore CD \parallel AB \quad (\text{opposite sides of a parallelogram are parallel})$$

$$\Rightarrow CE \parallel AF$$

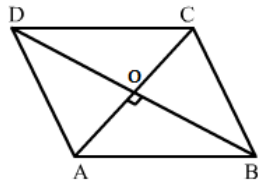
If one pair of sides of a quadrilateral is parallel and equal, then it is a parallelogram.

Therefore,  $AECF$  is a parallelogram.

$$\therefore AE \parallel CF$$

Q10

Answer :



Let  $ABCD$  be a rhombus.

Let  $AC$  and  $BD$  be the diagonals of the rhombus intersecting at a point  $O$ .

Let  $AC = 16$  cm

$BD = 12$  cm

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

$$\therefore AO = \frac{1}{2} AC$$

$$= \left( \frac{1}{2} \times 16 \right) \text{ cm}$$

$$= 8 \text{ cm}$$

$$BO = \frac{1}{2} BD$$

$$= \left( \frac{1}{2} \times 12 \right) \text{ cm}$$

$$= 6 \text{ cm}$$

From the right  $\triangle AOB$  :

$$\begin{aligned} AB^2 &= AO^2 + BO^2 \\ &= \{(8)^2 + (6)^2\} \text{ cm}^2 \\ &= (64 + 36) \text{ cm}^2 \\ &= 100 \text{ cm}^2 \\ \Rightarrow AB &= \sqrt{100} \text{ cm} \\ &= 10 \text{ cm} \end{aligned}$$

Hence, the length of the side  $AB$  is  $10$  cm.

$$AB = BC = CD = DA = 10 \text{ cm} \quad (\text{all sides of a rhombus are equal})$$

Q11

Answer :

Refer to the figure given in the book.

In  $\triangle ADC$  :

$$DA = DC \quad (\text{all sides of a square are equal})$$

$$\Rightarrow \angle ACD = \angle CAD$$

$$\text{Let } \angle ACD = \angle CAD = x^\circ \quad [\text{Angle opposite to the equal sides are equal}]$$

$$x + x + 90 = 180 \quad [\text{since the sum of the angles of a triangle is } 180^\circ]$$

$$\Rightarrow 2x + 90 = 180$$

$$\Rightarrow 2x = 90$$

$$\Rightarrow x = \frac{90}{2}$$

$$\Rightarrow x = 45$$

$$\therefore \angle CAD = 45^\circ$$

Q12

Answer :

Let the length of two sides of the rectangle be  $5x$  cm and  $4x$  cm, respectively.

$$\begin{aligned} \text{Then, its perimeter} &= 2(5x + 4x) \text{ cm} \\ &= 18x \text{ cm} \end{aligned}$$

$$\therefore 18x = 90$$

$$\Rightarrow x = \frac{90}{18}$$

$$\Rightarrow x = 5$$

$$\text{Length of one side} \Rightarrow (5 \times 5) \text{ cm} = 25 \text{ cm}$$

$$\text{Length of the other side} \Rightarrow (4 \times 5) \text{ cm} = 20 \text{ cm}$$

$$\therefore \text{Length of the rectangle} = 25 \text{ cm}$$

$$\text{Breadth} = 20 \text{ cm}$$

Q13

Answer :

(i) The diagonals are equal and the adjacent sides are unequal.

Hence, the given parallelogram is a rectangle.

(ii) The diagonals are equal and the adjacent sides are equal.

Hence, the given parallelogram is a square.

(iii) The diagonals are unequal and the adjacent sides are equal.

Hence, the given parallelogram is a rhombus.

(iv) All the sides are equal and one angle is  $60^\circ$ .

Hence, the given parallelogram is a rhombus.

(v) All the sides are equal and one angle is  $90^\circ$ .

Hence, the given parallelogram is a square.

(vi) All the angles are equal and the adjacent sides are unequal.

Hence, the given parallelogram is a rectangle.

Q14

Answer :

(i) The given statement is false.

The diagonals of a parallelogram bisect each other, but they are not equal in length.

(ii) The given statement is false.

The diagonals of a rectangle are equal and bisect each other, but they are not perpendicular.

(iii) The given statement is false.

All the sides of a rhombus are equal, but the diagonals are not equal.

(iv) The given statement is true.

(v) The given statement is false.

Every square is a rectangle, but every rectangle is not a square.

(vi) The given statement is true.

(vii) The given statement is true.

(viii) The given statement is true.

(ix) The given statement is false.

A rectangle is a special type of parallelogram, but every parallelogram is not a rectangle.

(x) The given statement is true.

# Parallelograms Exercise 16B

Q1

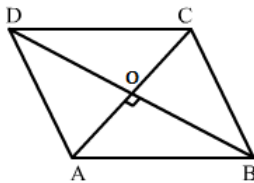
Answer :

(c) rhombus

In a rhombus, the two diagonals are not necessarily equal.

Q2

(c) 10 cm



Let  $ABCD$  be a rhombus.

Let  $AC$  and  $BD$  be the diagonals of the rhombus intersecting at a point  $O$ .

$AC = 16$  cm

$BD = 12$  cm

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

$$\therefore AO = \frac{1}{2} AC$$

$$= \left(\frac{1}{2} \times 16\right) \text{ cm}$$

$$= 8 \text{ cm}$$

$$BO = \frac{1}{2} BD$$

$$= \left(\frac{1}{2} \times 12\right) \text{ cm}$$

$$= 6 \text{ cm}$$

From the right  $\triangle AOB$  :

$$AB^2 = AO^2 + BO^2$$

$$= \{(8)^2 + (6)^2\} \text{ cm}^2$$

$$= (64 + 36) \text{ cm}^2$$

$$= 100 \text{ cm}^2$$

$$\Rightarrow AB = \sqrt{100} \text{ cm}$$

$$= 10 \text{ cm}$$

Hence, the length of the side  $AB$  is 10 cm.

Therefore, the length of each side of the rhombus is 10 cm because all the sides of a rhombus are equal.

Q3

Answer :

(b) 32

We know that the sum of adjacent angles of a parallelogram is  $180^\circ$ .

$$\Rightarrow 2x + 25 + 3x - 5 = 180$$

$$\Rightarrow 5x + 20 = 180$$

$$\Rightarrow 5x = 180 - 20$$

$$\Rightarrow 5x = 160$$

$$\Rightarrow x = \frac{160}{5}$$

$$\Rightarrow x = 32$$

Therefore, the value of  $x$  is 32.

Q4

Answer :

(a) parallelogram

In a parallelogram, the diagonals do not necessarily intersect at right angles.

Q5

Answer :

(c) 70 cm

Let  $ABCD$  be a rectangle and let the diagonal  $AC$  be 25 cm, length  $AB$  be  $4x$  cm and breadth  $BC$  be  $3x$  cm.

Each angle of a rectangle is a right angle.

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

From the right  $\triangle ABC$  :

$$AC^2 = AB^2 + BC^2$$

$$\Rightarrow (25)^2 = (4x)^2 + (3x)^2$$

$$\Rightarrow 625 = 16x^2 + 9x^2$$

$$\Rightarrow 625 = 25x^2$$

$$x^2 = \frac{625}{25} = 25$$

$$\Rightarrow x = 5$$

$$\therefore \text{Length} = 4 \times 5 = 20 \text{ cm}$$

$$\text{Breadth} = 3 \times 5 = 15 \text{ cm}$$

Q6  $\therefore$  Perimeter of the rectangle =  $2(20+15)$  cm  
= 70 cm

Answer :

(d)  $90^\circ$

The bisectors of any two adjacent angles of a parallelogram intersect at  $90^\circ$ .

Q7

Answer :

(b)  $72^\circ$

Let  $x^\circ$  be the angle of the parallelogram.

Sum of the adjacent angles of a parallelogram is  $180^\circ$ .

$$\therefore x + \left(\frac{2}{3} \times x\right) = 180$$

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

$$\Rightarrow \left(x + \frac{2x}{3}\right) = 180$$

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

$$\Rightarrow x = \left(180 \times \frac{3}{5}\right)$$

$$\Rightarrow x = 108$$

Hence, one angle of the parallelogram is  $108^\circ$ .

Its adjacent angle =  $(180 - 108)^\circ = 72^\circ$

Therefore, the smallest angle of the parallelogram is  $72^\circ$ .

Q8

Answer :

(a) rectangle

In a rectangle, the diagonals do not necessarily bisect the interior angles at the vertices.

Q9

Q10

Answer :

(d) 8

All the sides of a square are equal.

$$\therefore AB = BC$$

$$\Rightarrow 2x + 3 = 3x - 5$$

$$\Rightarrow 3 + 5 = 3x - 2x$$

$$\Rightarrow 8 = x$$

Therefore, the value of  $x$  is 8.

Answer :

(c)  $112^\circ$

Let  $x^\circ$  be the smallest angle of the parallelogram.

The sum of adjacent angles of a parallelogram is  $180^\circ$ .

$$\therefore x + 2x - 24 = 180$$

$$\Rightarrow 3x - 24 = 180$$

$$\Rightarrow 3x = 180 + 24$$

$$\Rightarrow 3x = 204$$

$$\Rightarrow x = \frac{204}{3}$$

$$\Rightarrow x = 68$$

$\therefore$  Smallest angle =  $68^\circ$

Largest angle =  $(180 - 68)^\circ = 112^\circ$