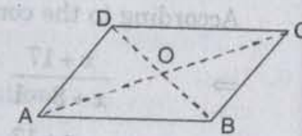
3 Understanding Quadrilaterals

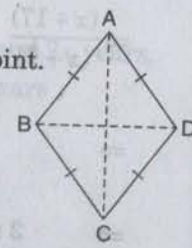
Learn and Remember

1. **Parallelogram.** A quadrilateral having two pairs of opposite sides equal and parallel is known as a parallelogram. It has following properties :



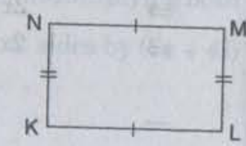
   (*i*) Opposite sides are equal.
   (*ii*) Opposite angles are equal.
   (*iii*) Diagonals bisect one another at mid point.

2. **Rhombus.** A rhombus which is a kind of parallelogram having all its sides equal is known as rhombus. It has following properties :



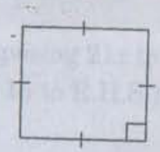
   (*i*) All sides are equal.
   (*ii*) Diagonals bisect each other at 90° at mid point.
   (*iii*) Opposite angles are equal.

3. **Rectangle.** A parallelogram having adjacent angle 90° each is known as rectangle. It has following properties :



   (*i*) Opposite sides and opposite angles are equal.
   (*ii*) Each adjacent angle is a right angle.
   (*iii*) Diagonals are of equal lengths.

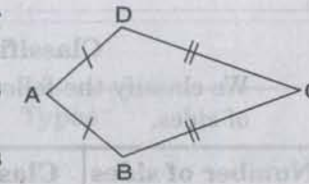
4. **Square.** A rectangle having all four sides of equal length, is known as a square. It has following properties :



   (*i*) All four sides are of equal length.
   (*ii*) Adjacent angle are of 90°.
   (*iii*) Diagonals are equal and they bisect each other at 90°.

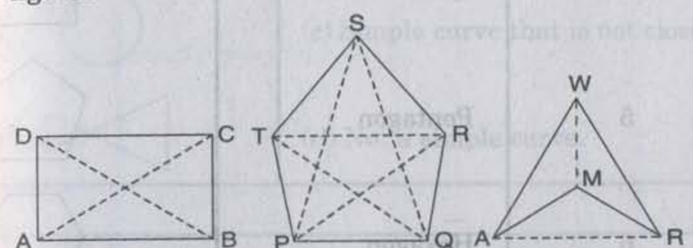
5. **Kite.** A quadrilateral with exactly two pairs of equal consecutive sides

is known as a kite. It has following properties :



   (*i*) Diagonals are perpendiculars to one another.
   (*ii*) One of the diagonals bisects the other.
   (*iii*) One pair of opposite angles of short diagonal is equal while another pair of angles is unequal.

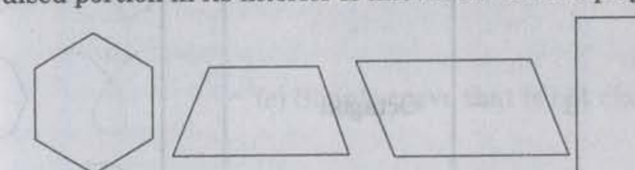
6. **Diagonal.** A diagonal is a line segment connecting two consecutive vertices of a polygon. It is given in the following figures.



A convex and concave polygons

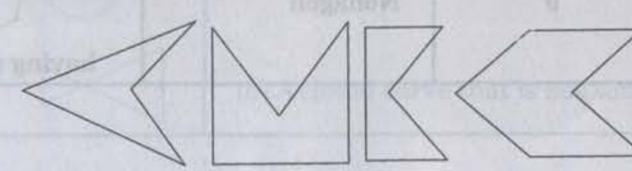
A polygon having pointed portion or raised portion in its exterior part is known as convex and those which have pointed or raised portion in its interior is known as concave polygon.

(*i*)



Convex polygons.

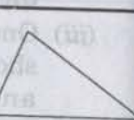
(*ii*)



Concave polygons.

Classification of polygons

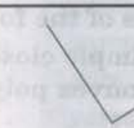
We classify the following polygons according to the number of sides.

Number of sides	Classification	Sample figure
3	Triangle	
4	Quadrilateral	
5	Pentagon	
6	Hexagon	
7	Heptagon	
8	Octagon	
9	Nonagon	 having nine sides

Match the following :

	Figures	Types
(1)		(*a*) Simple closed curve.
(2)		(*b*) A closed curve that is not simple.
(3)		(*c*) Simple curve that is not closed.
(4)		(*d*) Not a simple curve.

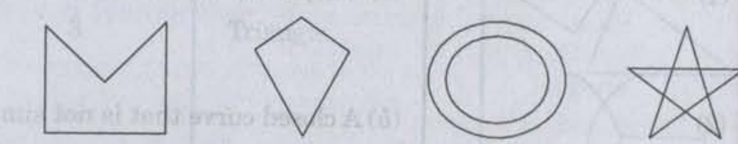
Sol.

	Figures	Types
(1)		(*d*) Not a simple curve.
(2)		(*c*) Simple curve that is not closed.
(3)		(*a*) Simple closed curve.
(4)		(*b*) A closed curve that is not simple.

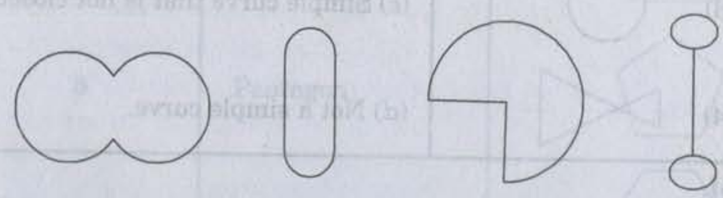
TEXTBOOK QUESTIONS SOLVED

EXERCISE 3.1 (*Page – 41-42*)

Q1. Given here are some figures.



(1) (2) (3) (4)

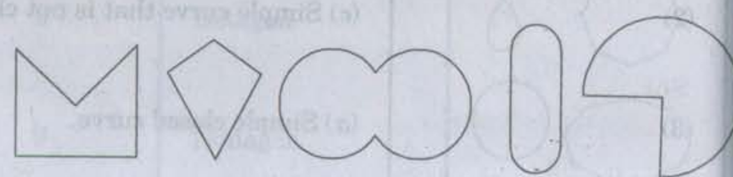


(5) (6) (7) (8)

Classify each of them on the basis of the following :

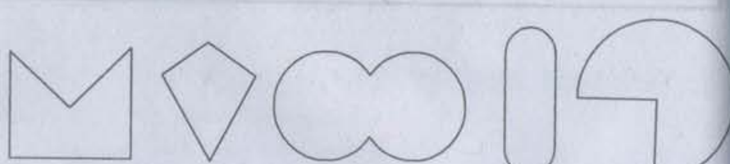
(*a*) Simple curve **(*b*) Simple closed curve**
(*c*) Polygon **(*d*) Convex polygon**
(*e*) Concave polygon

Sol. (*a*) Simple curve :



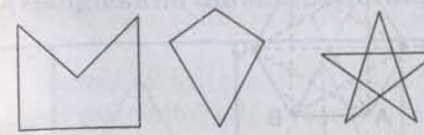
(1) (2) (5) (6) (7)

(*b*) Simple closed curve :



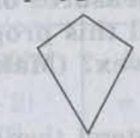
(1) (2) (5) (6) (7)

(*c*) Polygon :



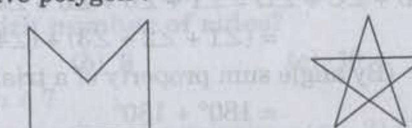
(1) (2) (4)

(*d*) Convex polygon :



(1)

(*e*) Concave polygon :



(1) (4)

(*a*) Figures 1, 2, 5, 6 and 7 are simple curve.

(*b*) Figures 1, 2, 5, 6 and 7 are simple closed curve.

(*c*) Figures 1, 2 and 4 are polygon.

(*d*) Figure 1 is convex polygon

(*e*) Figures 1 and 4 are concave polygon.

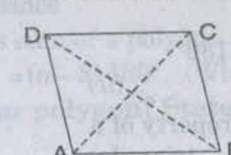
Q2. How many diagonals does each of the following have?

(*a*) A convex quadrilateral **(*b*) A regular hexagon**

(*c*) A triangle

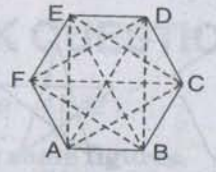
Sol. (*a*) A convex quadrilateral has two diagonals.

AC and BD are two diagonals.



(*b*) A regular hexagon has 9 diagonals as AD, AE, BD, BE and FC.

FB, AC, EC, FD.



(c) A triangle has no diagonal.

Q3. What is the sum of the measures of the angles of a convex quadrilateral? Will this property hold if the quadrilateral is not convex? (Make a non-convex quadrilateral and try!)

Sol. Let ABCD is a convex quadrilateral, then we draw a diagonal AC which divides the quadrilateral in two triangles.

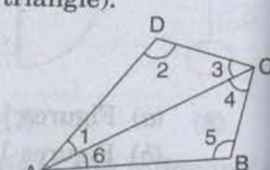
$\angle A + \angle B + \angle C + \angle D = \angle 1 + \angle 6 + \angle 5 + \angle 4 + \angle 3 + \angle 2$

$= (\angle 1 + \angle 2 + \angle 3) + (\angle 4 + \angle 5 + \angle 6)$

(By angle sum property of a triangle).

$= 180° + 180°$

$= 360°$



Hence, the sum of measures of the triangles of a convex quadrilateral is 360°.

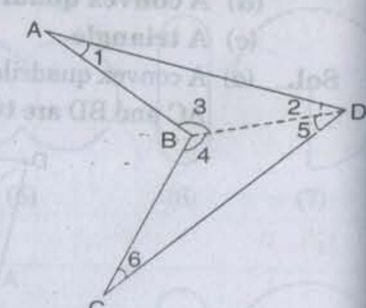
Yes, if quadrilateral is not convex then, this property will also be applied.

Let ABCD is a non-convex quadrilateral and join BD. Which also divides the quadrilateral in two triangles.

In ΔABD,

$\angle 1 + \angle 2 + \angle 3 = 180°$ ...(*i*)

(By angle sum property of triangle)



In ΔBDC,

$\angle 4 + \angle 5 + \angle 6 = 180°$ ...(*ii*)

(By angle sum property of a triangle)

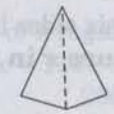
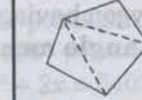
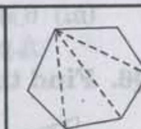
Adding equation, (*i*) and (*ii*),

$\angle 1 + \angle 2 + \angle 3 + \angle 4 + \angle 5 + \angle 6 = 180° + 180°$

$\angle 1 + \angle 2 + (\angle 3 + \angle 4) + \angle 5 + \angle 6 = 360°$

$\angle A + \angle B + \angle C + \angle D = 360°$. Proved.

Q4. Examine the table. (Each figure is divided into triangles and the sum of the angles deduced from that.)

Figure				
Side	**3**	**4**	**5**	**6**
Angle sum	**1 × 180° = (3 – 2) × 180°**	**2 × 180° = (4 – 2) × 180°**	**3 × 180° = (5 – 2) × 180°**	**4 × 180° = (6 – 2) × 180°**

What can you say about the angle sum of a convex polygon with number of sides?

(*a*) 7 (*b*) 8 (*c*) 10 (*d*) *n*

Sol. (*a*) When $n = 7$

Then, angle sum of a polygon $= (n - 2) \times 180°$

$= (7 - 2) \times 180$

$= 5 \times 180° = 900°$.

(*b*) When $n = 8$

Then, angle sum of a polygon

$= (n - 2) \times 180°$

$= (8 - 2) \times 180°$

$= 6 \times 180° = 1080°$.

(*c*) When $n = 10$

Then, angle sum of a polygon $= (n - 2) \times 180°$

$= (10 - 2) \times 180°$

$= 8 \times 180° = 1440°$.

(*d*) When $n = n$ sides

Then, angles sum of a polygon $= (n - 2) \times 180°$

$= (n - 2) 180°$. (Where n is number of sides.)

Q5. What is a regular polygon? State the name of a regular polygon of

(*i*) 3 sides (*ii*) 4 sides (*iii*) 6 sides

Sol. A regular polygon : A polygon having all sides of equal length and the interior angles of equal size is known as regular polygon.

(*i*) 3 sides

Polygon having three sides is called **triangle.**

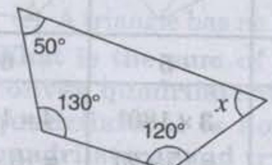
(ii) 4 sides

Polygon having four sides is called a **quadrilateral.**

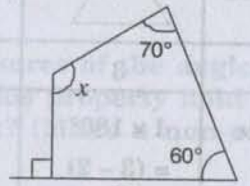
(iii) 6 sides

A polygon having six sides is called **hexagon.**

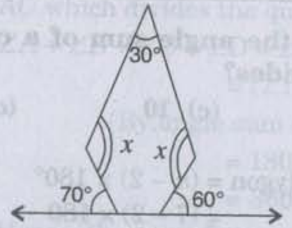
Q6. Find the angle measure x in the following figures.



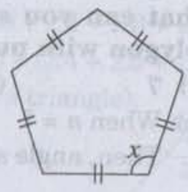
(a)



(b)

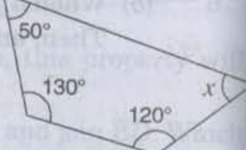


(c)



(d)

Sol. (a) We know that sum of angles of a quadrilateral is 360°.



(a)

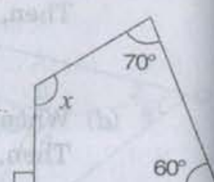
Now, $50° + 130° + 120° + x = 360°$

$\Rightarrow \quad 300° + x = 360°$

$\Rightarrow \quad x = 360° - 300°$

or $\quad x = 60°.$

(b) We know that sum of angles of a quadrilateral is 360°.



(b)

Now, $90° + 60° + 70° + x = 360°$

$\Rightarrow \quad 220° + x = 360°$

$\Rightarrow \quad x = 360° - 220°$

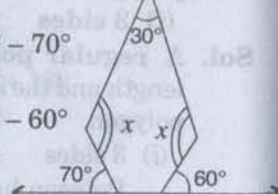
or $\quad x = 140°$

(c) First base interior angle $= 180° - 70°$

$= 110°$

Second base interior angle $= 180° - 60°$

$= 120°$



(c)

There are five sides, $n = 5$

Angle sum of a polygon $= (n - 2) \times 180°$

$= (5 - 2) \times 100$

$= 3 \times 180 = 540.$

Sum of angles of irregular pentagon = 540.

Then, $\quad 30° + x + 110° + 120° + x = 540°$

$\Rightarrow \quad 260° + 2x = 540°$

$\Rightarrow \quad 2x = 540° - 260°$

$\Rightarrow \quad 2x = 280°$

or $\quad x = = 140°$

Hence, each unknown angle is 140°.

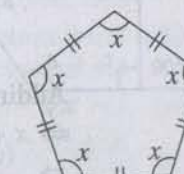
(d) Angle sum of a regular pentagon

$= (n - 2) \times 180° = (5 - 2) \times 180°$

$= 3 \times 180° = 540°$

Since, sum of angles of regular pentagon = 540°

(From part (c))



(d)

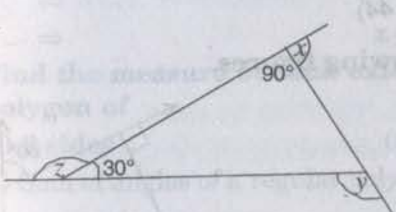
So, $\quad x + x + x + x + x = 540°$

$\Rightarrow \quad 5x = 540°$

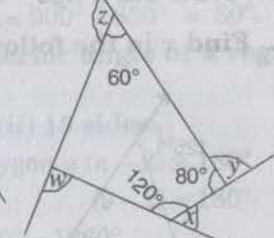
$\Rightarrow \quad x = = 108°$

Hence, each interior angle is 108°.

Q7.



(a) Find $x + y + z$



(b) Find $x + y + z + w$

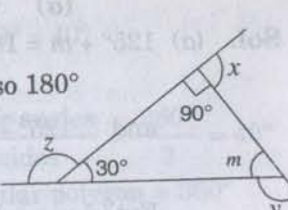
Sol. (a) $30° + 90° + m = 180°$ (Angle sum property of triangle)

$120° + m = 180°$

$m = 180° - 120°$

$m = 60°$

Since, sum of linear pair is also 180°



$90° + x = 180°$ ...(i)

$z + 30° = 180°$ ...(ii)

$y + 60° = 180°$...(iii)

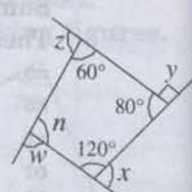
Adding equations (i), (ii) and (iii)

$90° + x + z + 30° + y + 60° = 180° + 180° + 180°$

$$\Rightarrow \quad x + y + z + 180^\circ = 540^\circ$$
$$\Rightarrow \quad x + y + z = 540^\circ - 180^\circ$$
$$\Rightarrow \quad x + y + z = 360^\circ.$$

(*b*) $x + y + z + w$

Sum of angles of a quadrilateral = 360°



$$60^\circ + 80^\circ + 120^\circ + n = 360^\circ$$
$$\Rightarrow \quad 260^\circ + n = 360^\circ$$
$$\Rightarrow \quad n = 360^\circ - 260^\circ$$
$$\Rightarrow \quad n = 100^\circ$$

Since, sum of linear pair is also 180°.

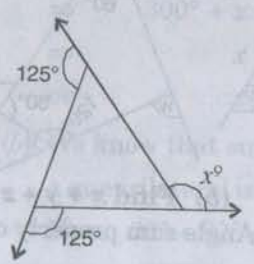
$$w + 100^\circ = 180^\circ \quad ...(i)$$
$$x + 120^\circ = 180^\circ \quad ...(ii)$$
$$y + 80^\circ = 180^\circ \quad ...(iii)$$
$$z + 60^\circ = 180^\circ \quad ...(iv)$$

Adding equations, (*i*), (*ii*), (*iii*) and (*iv*)

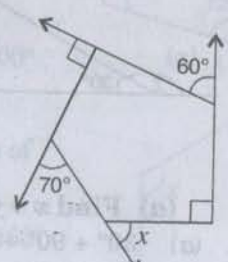
$$\Rightarrow x + y + z + w + 360^\circ = 720^\circ$$
$$\Rightarrow \quad x + y + z + w = 720^\circ - 360^\circ$$
$$\text{or} \quad x + y + z + w = 360^\circ.$$

EXERCISE 3.2 (*Page – 44*)

Q1. Find x in the following figures.



(*a*)



(*b*)

Sol. (*a*) $125^\circ + m = 180^\circ$ (Linear pair of angles)

$m = 180^\circ - 125^\circ = 55^\circ$ (Linear pair of angles)

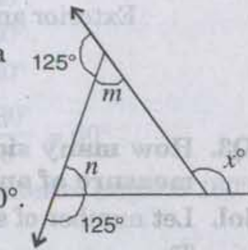
and $125^\circ + n = 180^\circ$

$n = 180^\circ - 125^\circ = 55^\circ$

Exterior angle x° = sum of opposite interior angles

or $x^\circ = 55^\circ + 55^\circ = 110^\circ$

Or

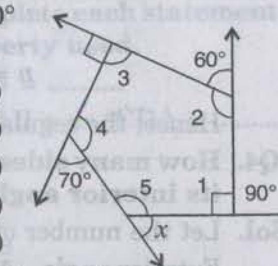


Since, sum of exterior angles of a triangle = 360°

$$125^\circ + 125^\circ + x^\circ = 360^\circ$$
$$\Rightarrow \quad 250^\circ + x^\circ = 360^\circ$$
$$x^\circ = 360^\circ - 250^\circ = 110^\circ.$$

(*b*) Sum of angles of a pentagon

$$= (n - 2) \times 180^\circ$$
$$= (5 - 2) \times 180^\circ$$
$$= 3 \times 180^\circ = 540^\circ$$



By linear pairs of angles

$$\angle 1 + 90^\circ = 180^\circ \quad ....(i)$$
$$\angle 2 + 60^\circ = 180^\circ \quad ....(ii)$$
$$\angle 3 + 90^\circ = 180^\circ \quad ....(iii)$$
$$\angle 4 + 70^\circ = 180^\circ \quad ....(iv)$$
$$\angle 5 + x = 180^\circ \quad ....(v)$$

Adding equations (*i*), (*ii*), (*iii*), (*iv*) and (*v*)

$$\Rightarrow \quad x + (\angle 1 + \angle 2 + \angle 3 + \angle 4 + \angle 5) + 310^\circ = 900^\circ$$
$$\Rightarrow \quad x + 540^\circ + 310^\circ = 900^\circ$$
$$\Rightarrow \quad x + 850^\circ = 900^\circ$$
$$\Rightarrow \quad x = 900^\circ - 850^\circ = 50^\circ.$$

Q2. Find the measure of each exterior angle of a regular polygon of

(*i*) 9 sides **(*ii*) 15 sides.**

Sol. (*i*) Sum of angles of a regular polygon = $(n - 2) \times 180^\circ$

$$(9 - 2) \times 180^\circ$$
$$= 7 \times 180^\circ = 1260^\circ$$

$$\text{Each interior angle} = \frac{\text{Sum of interior angles}}{\text{Number of sides}} = \frac{1260}{9}$$
$$= 140^\circ$$

$$\text{Each exterior angle} = 180^\circ - 140^\circ = 40^\circ$$

Or

$$\text{Exterior angle} = \frac{\text{Sum of exterior angles}}{\text{Number of sides}} = \frac{360^\circ}{9} = 40^\circ$$

(*ii*) Sum of exterior angles of a regular polygon = 360°

$$\text{Exterior angle having 15 sides} = \frac{\text{Sum of exterior angles}}{\text{Number of sides}}$$

$$= \frac{360^\circ}{15} = 24^\circ.$$

Q3. How many sides does a regular polygon have, if the measure of an exterior angle is 24°?

Sol. Let number of sides be n

The measures of all exterior angles = 360°

$$\text{Number of sides} = \frac{\text{Sum of exterior angles}}{\text{Each exterior angle}}$$

$$n = \frac{360^\circ}{24^\circ} = 15$$

Hence, the regular polygon has 15 sides.

Q4. How many sides does a regular polygon have if each of its interior angles is 165°?

Sol. Let the number of sides be n.

Exterior angle = 180° – 165° = 15°.

Sum of exterior angles of a regular polygon = 360°.

$$\text{Number of sides} = \frac{\text{Sum of exterior angles}}{\text{Each exterior angle}}$$

$$n = \frac{360^\circ}{15^\circ} = 24$$

Hence, the regular polygon has 24 sides.

Q5. (*a*) Is it possible to have a regular polygon with of each exterior angle as 22°?

(*b*) Can it be an interior angle of a regular polygon? Why?

Sol. (*a*) No; (since, 22 is not a divisor of 360°).

(*b*) No; (because each exterior angle is 180° – 22° = 158°, which is not a divisor of 360°).

Q6. (*a*) What is the minimum interior angle possible for a regular polygon? Why?

(*b*) What is the maximum exterior angle possible for a regular polygon?

Sol. (*a*) The equilateral triangle being a regular polygon of 3 sides has the least measure of an interior angle = 60°.

Since, angle-sum of a triangle = 180°.

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

$$3x = 180^\circ$$

$$x = \frac{180^\circ}{3} = 60^\circ$$

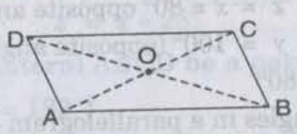
(*b*) By (*a*), we can see that the greatest exterior angle is 180° – 60° = 120°.

EXERCISE 3.3 (*Page–50-52*)

Q1. Given a parallelogram ABCD. Complete each statement along with the definition or property used.

(*i*) AD = ... **(*ii*) ∠DCB = ...**

(*iii*) OC = ... **(*iv*) m∠DAB + m∠CDA = ...**



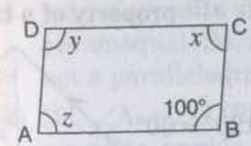
Sol. (*i*) AD = BC (Since, opposite sides of a parallelogram are equal.)

(*ii*) ∠DCB = ∠DAB (Opposite angles are equal in ‖ gm)

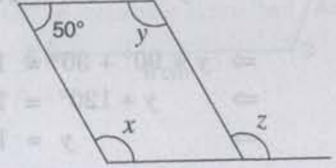
(*iii*) OC = OA (Since diagonals of a parallelogram bisect each other)

(*iv*) m∠DAB + m∠CDA = 180° (∵ The adjacent angles in a parallelogram are supplementary)

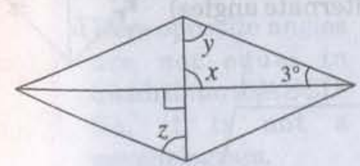
Q2. Consider the following parallelograms. Find the values of the unknowns *x, y, z*.



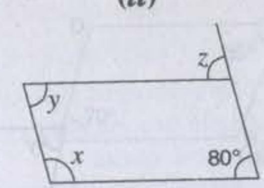
(*i*)



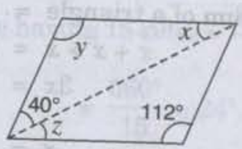
(*ii*)



(*iii*)



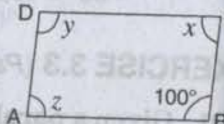
(*iv*)



(v)

Note. For getting correct answer, read 3° = 30° in (Fig. (iii)).

Sol. (i) $\angle B + \angle C = 180°$



(The adjacent angles in a parallelogram are supplementary.)

$\Rightarrow \quad 100° + x = 180°$

$\Rightarrow \quad x = 180° - 100°$

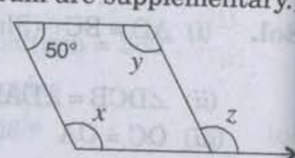
$\Rightarrow \quad x = 80°,$

$z = x = 80°$ opposite angle of $\parallel^{gm}$)

$y = 100°$ (opposite angle of $\parallel^{gm}$ are equal).

(ii) $x + 50° = 180°$

(The adjacent angles in a parallelogram are supplementary.)



$\Rightarrow \quad x = 180° - 50°$

$\Rightarrow \quad x = 130°$

$\Rightarrow \quad z = x = 130°$

(Corresponding angles)

$\Rightarrow \quad y = z = 130°$ (Alternate angles)

$\Rightarrow \quad x = y = 130°$ (Opposite angles of a parallelogram are equal)

(iii) $x = 90°$ (Vertically opposite angles)

$\Rightarrow \quad y + x + 30° = 180°$ (Angle sum property of a triangle)

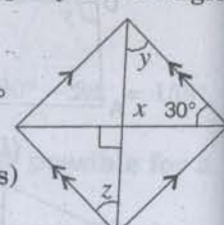
$\Rightarrow \quad y + 90° + 30° = 180°$

$\Rightarrow \quad y + 120° = 180°$

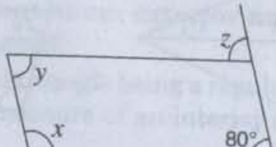
$\Rightarrow \quad y = 180° - 120° = 60°$

$\Rightarrow \quad z = y = 60°$

(Alternate angles)



(iv)



$\Rightarrow \quad z = 80°$ (Corresponding angles)

$\Rightarrow \quad x + 80° = 180°$

(The adjacent angles in a parallelogram are supplementary.)

$\Rightarrow \quad x = 180° - 80° = 100°$

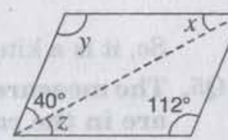
$y = 80°$ (Opposite angles are equal in $\parallel^{gm}$.)

(v) $y = 112°$ (Opposite angles of parallelogram are equal.)

$\Rightarrow 40° + y + x = 180°$ (Angle-sum property of a triangle.)

$\Rightarrow 40° + 112° + x = 180$

$\Rightarrow \quad 152° + x = 180°$



$\Rightarrow \quad x = 180° - 152°$

$\Rightarrow \quad x = 28°$

$\Rightarrow \quad z = x = 28°$ (Alternate angles).

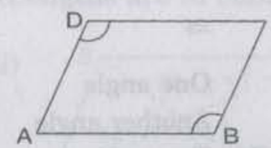
Q3. Can a quadrilateral ABCD be a parallelogram, if

(i) $\angle D + \angle B = 180°$?

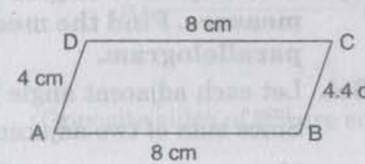
(ii) AB = DC = 8 cm, AD = 4 cm and BC = 4.4 cm?

(iii) $\angle A = 70°$ and $\angle C = 65°$?

Sol. (i) $\angle D + \angle B = 180°$. It can be, but here, it needs not to be?

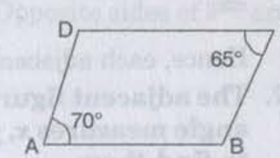


(ii) No. In this case. One pair of opposite sides are equal and another pair of opposite sides are unequal. So, it is not a parallelogram.



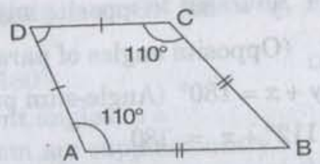
(iii) No; $\angle A \neq \angle C$ (Since opposite angles are equal in $\parallel^{gm}$)

Here opposite angles are not equal in quadrilateral ABCD. So, it is not a parallelogram.



Q4. Draw a rough figure of a quadrilateral that is not a parallelogram but has exactly two opposite angles of equal measure.

Sol. ABCD is a quadrilateral in which opposite angles ∠A = ∠C = 110°.

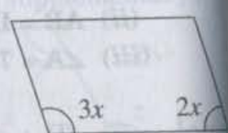


So, it is a kite.

Q5. The measure of two adjacent angles of a parallelogram are in the ratio 3 : 2. Find the measure of each of the angles of the parallelogram.

Sol. Let two adjacent angles be $3x$ and $2x$.

Since the adjacent angles in a parallelogram are supplementary.



$\Rightarrow \quad 3x + 2x = 180°$

$\Rightarrow \quad 5x = 180°$

$\Rightarrow \quad x = \frac{180°}{5} = 36°$

One angle $= 3 \times 36° = 108°$

Another angle $= 2 \times 36° = 72°$.

Q6. Two adjacent angles of a parallelogram have equal measure. Find the measure of each of the angles of the parallelogram.

Sol. Let each adjacent angle be x.

Since sum of two adjacent angles in ||^{gm} are supplementary.

$\Rightarrow \quad x + x = 180°$

$\Rightarrow \quad 2x = 180°$

$\Rightarrow \quad x = \frac{180°}{2} = 90°$

Hence, each adjacent angle is 90°. **Ans.**

Q7. The adjacent figure HOPE is a parallelogram. Find the angle measures x, y and z. State the properties you use to find them.

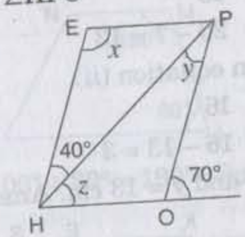
∠HOP + 70° = 180°

Sol. ∠HOP = 180° – 70° = 110°. (Angles of linear pair)

∠E = ∠HOP (Opposite angles of a paralellogram are equal)

$x = 110°$

∠PHE = ∠HPO (Alternate angles)



∴ $y = 40°$

∵ ∠EHO = ∠O = 70° (Corresponding angles)

$40° + z = 70°$

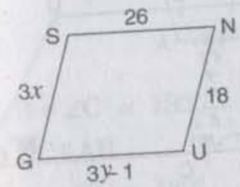
$z = 70° - 40°$

⇒ $x = 110°$, $y = 40°$, $z = 30°$. **Ans.**

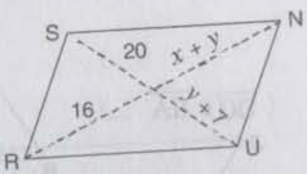
⇒ Hence, $z = 30°$, $x = 110°$, $y = 40°$, $z = 30°$. **Ans.**

Q8. The following figures GUNS and RUNS are parallelogram. Find x and y. (Lengths are in cm).

(*i*)



(*ii*)



Sol. (*i*) In ||^{gm} GUNS

GS = UN (Opposite sides of ||^{gm} are equal.)

$3x = 18$

$\Rightarrow \quad x = \frac{18}{3} = 6$ cm

and GU = SN (Opposite sides of ||^{gm} are equal)

$\Rightarrow \quad 3y - 1 = 26$

$\Rightarrow \quad 3y = 26 + 1$

$\Rightarrow \quad 3y = 27$

$\Rightarrow \quad y = \frac{27}{3} = 9$ cm

⇒ Hence, $x = 6$ cm, $y = 9$ cm. **Ans.**

(*ii*) In $\|^{gm}$ RUNS

$$y + 7 = 20 \quad ...(i)$$

(The diagonals of a parallelogram bisect each other.)

$$x + y = 16 \quad ...(ii)$$

From equation (*i*),

$$y + 7 = 20$$

$$\Rightarrow \quad y = 20 - 7 = 13$$

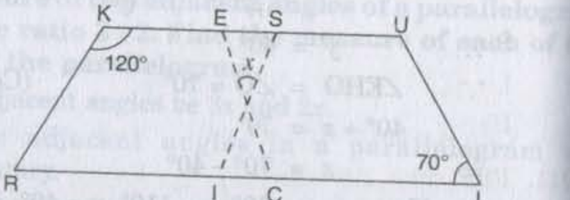
Putting $y = 13$ in equation (*ii*),

$$x + 13 = 16$$

$$\Rightarrow \quad x = 16 - 13 = 3$$

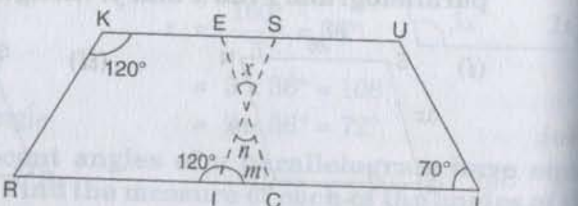
Hence, $x = 3$ cm and $y = 13$ cm. **Ans.**

Q9.



In the above figure both RISK and CLUE are parallelograms. Find the value of *x*.

Sol.



In $\|^{gm}$ RISK

$$\angle RIS = \angle K$$

$$\angle RIS = 120° \quad \text{(Opposite angles of a parallelogram are equal.)}$$

$$\angle m + 120° = 180° \quad \text{(Sum of linear pairs)}$$

$$\angle m = 180° - 120° = 60°$$

and $\angle ECI = \angle L = 70°$ (Corresponding angles)

$$m + n + \angle ECI = 180 \quad \text{(Angles sum property of triangle)}$$

$$60° + n + 70° = 180°$$

$$130° + n = 180°$$

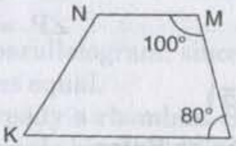
$$n = 180° - 130°$$

$$n = 50°$$

$$x = n = 50° \quad \text{(Vertically opposite angles)}$$

$$x = 50°.$$

Q10. Explain how this figure is a trapezium. Which of its two sides are parallel?

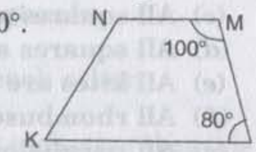


Sol. $\angle M + \angle L = 100° + 80° = 180°$ (Sum of interior opposite angles is 180°)

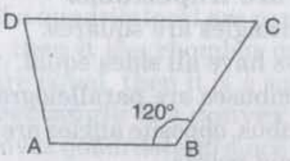
Since, sum of co-interior angles is 180°.

Lines NM and KL are parallel.

Hence, KLMN is a trapezium.



Q11. Find $m\angle C$ in figure if $\overline{AB} \parallel \overline{DC}$,

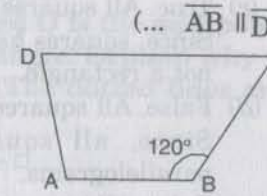


Sol. $\angle B + \angle C = 180°$ (... $\overline{AB} \parallel \overline{DC}$)

Since DC $\|$ AB

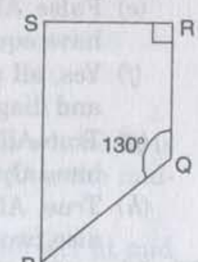
$$120° + m\angle C = 180°$$

$$m\angle C = 180° - 120° = 60°.$$



Q12. Find the measure of $\angle P$ and $\angle S$ if $\overline{SP} \parallel \overline{RQ}$ in given figure.

(If you find $m\angle R$, is there more than one method to find $m\angle P$?)



Sol. $\angle P + \angle Q = 180°$

(... Sum of co-interior angles is 180°)

$$\angle P + 130° = 180°$$

$$\angle P = 180° - 130° = 50°$$

$$\angle R = 90° \text{ (given)}$$

$$\angle S + 90° = 180°$$

$$\angle S = 180° - 90° = 90° \text{ each}$$

Or

Yes, angle sum property of quadrilateral.

$$\angle S + \angle R + \angle Q + \angle P = 360^\circ$$
$$90^\circ + 90^\circ + 130^\circ + \angle P = 360^\circ$$
$$310^\circ + \angle P = 360^\circ$$
$$\angle P = 360^\circ - 310^\circ$$
$$\angle P = 50^\circ. \textbf{ Ans.}$$

EXERCISE 3.4 *(Page–55)*

Q1. State whether True or False.

(a) All rectangles are squares.
(b) All rhombuses are parallelograms.
(c) All squares are rhombuses and also rectangles.
(d) All squares are not parallelograms.
(e) All kites are rhombuses.
(f) All rhombuses are kites.
(g) All parallelograms are trapeziums.
(h) All squares are trapeziums.

Sol. (a) False. All rectangles are squares.
Since, squares have all sides equal.

(b) True. All rhombuses are parallelograms.
Since, in rhombus, opposite angles are equal and diagonals intersect at mid points.

(c) True. All squares are rhombus and also rectangles.
Since, squares have the same property of rhombus, but not a rectangle.

(d) False. All squares are not parallelograms.
Since, all squares have the same property of parallelograms.

(e) False. All kites are not rhombuses. Since, all kites do not have equal sides.

(f) Yes, all rhombus are kites, since, they have equal sides and diagonals bisect each other.

(g) True. All parallelograms are trapezium because trapezium has only two parallel sides.

(h) True. All squares are trapeziums. Since, squares have also two parallel sides.

Q2. Identify all the quadrilaterals that have.

(a) four sides of equal length.
(b) four right angles.

Sol. (a) Rhombus and square have sides of equal length.
(b) Square and rectangle have four right angles.

Q3. Explain how a square is

(i) a quadrilateral. **(ii) a parallelogram.**
(iii) a rhombus. **(iv) a rectangle.**

Sol. (i) A square is a quadrilateral, if it has four unequal length of sides.

(ii) A square is a parallelogram, since it contains both pairs of opposite sides equal.

(iii) A square is already a rhombus. Since, it has four equal sides and diagonals bisect at 90° to each other.

(iv) A square is a parallelogram, since having each adjacent angle a right angle, and opposite sides are equal.

Q4. Name the quadrilaterals whose diagonals

(i) bisect each other.
(ii) are perpendicular bisectors of each other.
(iii) are equal.

Sol. (i) If diagonals of a quadrilateral bisect each other then it is a rhombus, parallelogram, rectangle or square.

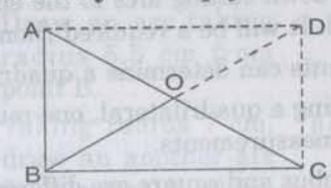
(ii) If diagonals of a quadrilateral are perpendicular bisector of each other, then it is a rhombus or square.

(iii) If diagonals are equal, then it is a square or rectangle.

Q5. Explain why a rectangle is a convex quadrilateral.

Sol. A rectangle is a convex quadrilateral since its vertex are raised and both of its diagonals lie in its interior.

Q6. ABC is a right-angled triangle and O is the mid point of the side opposite to the right angle. Explain why O is equidistant from A, B and C. (The dotted lines are drawn additionally to help you.)



Sol. Since, two right triangles make a rectangle where O is equidistant point from A, B, C and D because O is the mid-point of the two diagonals of a rectangle.

Since AC and BD are equal diagonals and intersect at mid point.

So, O is the equidistant from A, B, C and D.

□□