

8



Quadrilaterals

Lesson at a Glance

1. There are four sides of a quadrilateral.
2. The sum of the angles of a quadrilateral is 360° . This property is called *Angle Sum Property of a Quadrilateral*.
3. **Types of quadrilaterals:** Trapezium, parallelogram, rectangle, rhombus, square.
4. One pair of opposite sides of a trapezium is parallel.
5. **Properties of parallelogram:**
 - (i) Opposite sides are equal and parallel.
 - (ii) Opposite angles are equal.
 - (iii) Diagonals bisect each other.
 - (iv) Each of diagonals divides the parallelogram into two congruent triangles.
6. **Properties of a rectangle:**
 - (i) Opposite sides are equal and parallel.
 - (ii) Each of angles is of 90° .
 - (iii) Diagonals are of equal lengths.
 - (iv) Diagonals bisect each other.
 - (v) Each of diagonals divides the rectangle into two congruent triangles.
7. A kite is not a parallelogram.
8. **Properties of a rhombus:**
 - (i) All the sides are of equal lengths.
 - (ii) Opposite angles are equal.
 - (iii) Diagonals bisect each other at right angles.
 - (iv) Each diagonal divides the rhombus into two congruent triangles.
9. **Properties of a square:**
 - (i) All the sides are of equal lengths.
 - (ii) Each of angle is of 90° .

- (iii) Diagonals are of equal lengths.
 - (iv) Diagonals bisect each other at right angles.
 - (v) Each diagonal divides the square into two congruent triangles.
10. A parallelogram is a trapezium.
 11. A square is a rectangle as well as a rhombus.
 12. The line segment joining the mid-points of any two sides of a triangle is parallel to the third side and half of it.

TEXTBOOK QUESTIONS SOLVED

Exercise 8.1 (Pages – 146-147)

1. The angles of quadrilateral are in the ratio 3 : 5 : 9 : 13. Find all the angles of the quadrilateral.

Sol. Let the angles be $3x$, $5x$, $9x$ and $13x$.

$$\text{Then } 3x + 5x + 9x + 13x = 360^\circ$$

[Sum of angles of a quadrilateral is 360° .]

$$\Rightarrow 30x = 360^\circ \Rightarrow x = 12^\circ$$

\therefore Angles are 36° , 60° , 108° and 156° .

2. If the diagonals of a parallelogram are equal, then show that it is a rectangle.

Sol. Consider triangles DAB and CBA,

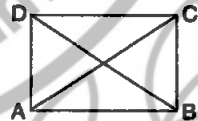
$$AD = BC \quad [\text{Opposite sides of a parallelogram}]$$

AB is common.

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

$$\therefore \triangle DAB \cong \triangle CBA \quad [\text{SSS}]$$

$$\Rightarrow \angle DAB = \angle CBA$$



... (i) [CPCT]

As ABCD is a parallelogram. $AD \parallel BC$ and AB is transversal.

$$\therefore \angle DAB + \angle CBA = 180^\circ \quad [\text{Sum of interior angles on the same side of transversal is } 180^\circ.]$$

$$\Rightarrow 2\angle DAB = 180^\circ \quad [\text{From (i)}]$$

$$\Rightarrow \angle DAB = 90^\circ$$

As in a parallelogram, $\angle DAB = 90^\circ$. Hence, the parallelogram is a rectangle.

3. Show that if the diagonals of a quadrilateral bisect each other at right angles, then it is a rhombus.

Sol. Consider triangles AOB and COD,

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

$$OB = OD \quad [\text{Given}]$$

$$\angle AOB = \angle COD \quad [90^\circ \text{ each}]$$

$$\therefore \triangle AOB \cong \triangle COD \quad [\text{SAS}]$$

$$\Rightarrow AB = CD \quad \dots(i)$$

Similarly, we can show that $BC = DA$

$$\dots(ii)$$

Consider triangles AOB and BOC,

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

BO is common.

$$\text{and } \angle AOB = \angle BOC \quad [90^\circ \text{ each}]$$

$$\therefore \triangle AOB \cong \triangle COB \quad [\text{SAS}]$$

$$\Rightarrow AB = BC \quad \dots(iii)$$

From (i), (ii) and (iii), we get

$$AB = BC = CD = DA$$

Hence, ABCD is a rhombus.

4. Show that the diagonals of a square are equal and bisect each other at right angles.

Sol. Consider triangles DAB and CBA,

$$AD = BC \quad [\text{Sides of a square}]$$

AB is common.

$$\angle DAB = \angle CBA \quad [90^\circ \text{ each}]$$

$$\therefore \triangle DAB \cong \triangle CBA \quad [\text{SAS}]$$

$$\Rightarrow BD = AC \quad [\text{CPCT}]$$

$$\text{and } \angle 1 = \angle 2 \quad \dots(i) \quad [\text{CPCT}]$$

$$\text{Proving as above we can show } \angle 3 = \angle 4. \quad \dots(ii)$$

$$\text{Also, } \angle 2 = \angle 3$$

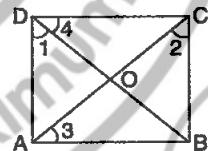
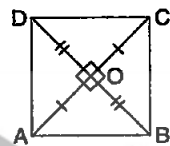
$$[\because AB = BC, \text{ angles opposite to equal sides are equal.}]$$

$$\therefore \angle 1 = \angle 4 \quad [\text{From (i), (ii), (iii)}]$$

Consider triangles AOD and COD,

$$AD = DC \quad [\text{Sides of a square}]$$

OD is common.



$\angle 1 = \angle 4$ [Proved above]
 $\therefore \triangle AOD \cong \triangle COD$ [SAS]
 $\therefore OA = OC$...(iv) [CPCT]

Similarly, we can show that

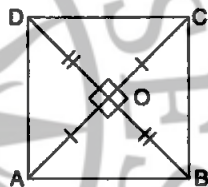
$OB = OD$
 and $\angle AOD = \angle COD$...(v) [CPCT]
 Also, $\angle AOD + \angle COD = 180^\circ$ [Linear pair]
 $\Rightarrow 2\angle AOD = 180^\circ$ [Using (v)]
 $\Rightarrow \angle AOD = 90^\circ$...(vi)

Hence, diagonals are equal and bisect each other at right angles.

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

Sol. Consider triangles AOB and COD,

$AO = OC$ [Given]
 $OB = OD$ [Given]
 $\angle AOB = \angle COD$ [90° each]
 $\therefore \triangle AOB \cong \triangle COD$ [SAS]
 $\Rightarrow AB = CD$...(i)



Similarly, we can show that $BC = DA$...(ii)

Consider triangles AOB and BOC,
 $AO = OC$ [Given]
 BO is common.
 and $\angle AOB = \angle BOC$ [90° each]
 $\therefore \triangle AOB \cong \triangle BOC$ [SAS]
 $\Rightarrow AB = BC$...(iii)

From (i), (ii) and (iii), we get

$$AB = BC = CD = DA$$

Hence, ABCD is a rhombus.

Further, consider $\triangle DAB$ and $\triangle CBA$

$AD = BC$ [Proved rhombus]
 AB is common
 $BD = AC$ [Given]
 $\therefore \triangle DAB \cong \triangle CBA$ [SSS]
 $\Rightarrow \angle DAB = \angle CBA$...(i)

Also, as $AD \parallel BC$ (opposite sides of a rhombus) and AB is transversal.

$$\therefore \angle DAB + \angle CBA = 180^\circ \quad (\text{Sum of interior angles on the same side of transversal is } 180^\circ.)$$

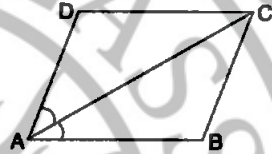
$$\Rightarrow 2\angle DAB = 180^\circ \quad [\text{From (i)}]$$

$$\Rightarrow \angle DAB = 90^\circ.$$

As in a rhombus one angle is 90° . Hence rhombus is a square.

6. Diagonal AC of a parallelogram $ABCD$ bisects $\angle A$ (see figure). Show that

- (i) it bisects $\angle C$ also,
(ii) $ABCD$ is a rhombus.



Sol. (i) Consider triangles ABC and ADC ,

$$AB = CD \quad [\text{Opposite sides of parallelogram}]$$

AC is common.

$$AD = BC \quad [\text{Opposite sides of parallelogram}]$$

$$\therefore \triangle DAC \cong \triangle BCA \quad [\text{SSS}]$$

$$\Rightarrow \angle DAC = \angle BCA \quad \dots(i) \quad [\text{CPCT}]$$

$$\Rightarrow \angle DCA = \angle BAC \quad \dots(ii) \quad [\text{CPCT}]$$

$$\text{Also, } \angle DAC = \angle BAC \quad \dots(iii) \quad [\text{Given}]$$

$$\Rightarrow \angle DCA = \angle BCA \quad [\text{From (i), (ii), (iii)}]$$

$\therefore AC$ bisects $\angle C$ also.

- (ii) In parallelogram $\angle DAB = \angle DCB$,

[Opposite angles of a parallelogram are equal.]

$$\Rightarrow \frac{1}{2} \angle DAB = \frac{1}{2} \angle DCB.$$

$$\Rightarrow \angle DAC = \angle DCA \quad [\because AC \text{ is bisector of } \angle A \text{ and } \angle C.]$$

$$\therefore CD = AD \quad [\text{Sides opposite to equal angles are equal.}]$$

In parallelogram, as adjacent sides are equal, hence $ABCD$ is a rhombus.

7. *ABCD is a rhombus. Show that diagonal AC bisects $\angle A$ as well as $\angle C$ and diagonal BD bisects $\angle B$ as well as $\angle D$.*

Sol. Consider triangles ADC and ABC,

$$AD = AB$$

[Sides of a rhombus]

AC is common.

$$CD = CB$$

[Sides of a rhombus]

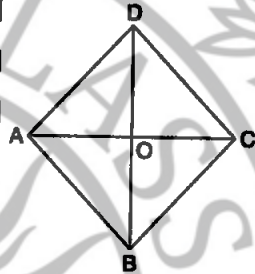
$$\therefore \triangle ADC \cong \triangle ABC \quad \text{[SSS]}$$

$$\Rightarrow \angle DAC = \angle BAC \quad \dots(i) \text{ [CPCT]}$$

$$\text{and } \angle DCA = \angle BCA \quad \dots(ii) \text{ [CPCT]}$$

Hence AC bisects $\angle A$ and $\angle C$.

Similarly, by taking triangles BAD and BCD, we can show that BD bisects $\angle B$ and $\angle D$.



8. *ABCD is a rectangle in which diagonal AC bisects $\angle A$ as well as $\angle C$. Show that:*

(i) *ABCD is a square*

(ii) *diagonal BD bisects $\angle B$ as well as $\angle D$.*

Sol. (i) Consider triangles ADC and ABC,

$$\angle DAC = \angle BAC$$

[AC is bisector of $\angle A$]

$$\angle DCA = \angle BCA$$

[AC is bisector of $\angle C$]

AC is common.

$$\therefore \triangle ADC \cong \triangle ABC$$

[ASA]

$$AD = AB.$$

[CPCT]

As in rectangle ABCD, adjacent sides are equal. Hence ABCD is a square.

(ii) Consider triangles DAB and BCD,

$$AB = BC = CD = DA$$

[Sides of a square]

BD is common.

$$\therefore \triangle DAB \cong \triangle DCB$$

[SSS]

$$\therefore \angle ADB = \angle CDB$$

[CPCT]



and $\angle ABD = \angle CBD$ [CPCT]

\therefore BD bisects $\angle B$ and $\angle D$. [Using above results]

9. In parallelogram ABCD, two points P and Q are taken on diagonal BD such that $DP = BQ$ (see figure). Show that:

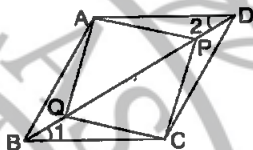
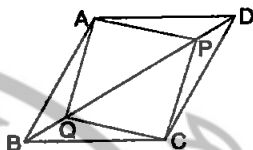
(i) $\triangle APD \cong \triangle CQB$

(ii) $AP = CQ$

(iii) $\triangle AQB \cong \triangle CPD$

(iv) $AQ = CP$

(v) APCQ is a parallelogram.



Sol. (i) Consider triangles APD and CQB,
AD \parallel BC and BD is transversal.

$\therefore \angle 1 = \angle 2$

[Alternate angles]

AD = BC [Opposite sides of a parallelogram]

DP = BQ [Given]

$\therefore \triangle APD \cong \triangle CQB$. [SAS]

(ii) $AP = CQ$ [CPCT] [From result (i)]

(iii) Consider triangles AQB and CPD,

AB = CD [Opposite sides of a parallelogram]

$\angle ABQ = \angle CDP$ [Alternate interior angles
as AB \parallel CD and BD is transversal]

BQ = DP [Given]

$\therefore \triangle AQB \cong \triangle CPD$ [SAS]

(iv) From result (iii),

$\triangle AQB \cong \triangle CPD$

$\therefore AQ = CP$ [Corresponding sides]

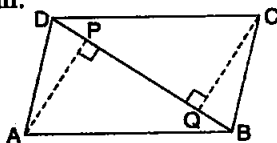
(v) In quadrilateral APCQ,

AP = CQ [From result (ii)]

AQ = CP [From result (iv)]

Thus, opposite sides of quadrilateral APCQ are equal.
Hence, APCQ is a parallelogram.

10. ABCD is a parallelogram and AP and CQ are perpendiculars from vertices A and C on diagonal BD (see figure). Show that



(i) $\triangle APB \cong \triangle CQD$

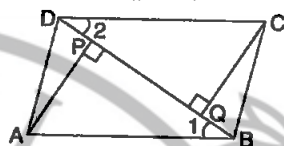
(ii) $AP = CQ$.

Sol. Consider triangles APB and CQD,

$\angle 1 = \angle 2$ [Alternate angles, $AB \parallel CD$, BD is transversa]

$\angle APB = \angle DQC$ [90° each]

$AB = CD$ [Opposite sides of a parallelogram]



(i) $\therefore \triangle APB \cong \triangle CQD$ [AAS]

(ii) $AP = CQ$. [CPCT]

11. In $\triangle ABC$ and $\triangle DEF$, $AB = DE$, $AB \parallel DE$, $BC = EF$ and $BC \parallel EF$. Vertices A, B and C are joined to vertices D, E and F respectively (see figure). Show that

(i) quadrilateral ABED is a parallelogram

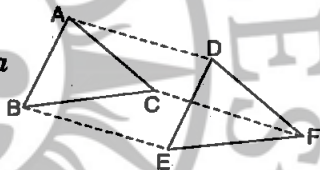
(ii) quadrilateral BEFC is a parallelogram

(iii) $AD \parallel CF$ and $AD = CF$

(iv) quadrilateral ACFD is a parallelogram

(v) $AC = DF$

(vi) $\triangle ABC \cong \triangle DEF$.



Sol. (i) Consider quadrilateral ABED,

$AB = DE$ and $AB \parallel DE$ [Given]

\Rightarrow ABED is a parallelogram. [In a quadrilateral if a pair of opposite sides is equal and parallel, then it is a parallelogram.]

(ii) Consider quadrilateral BEFC,

$BC = EF$ and $BC \parallel EF$ [Given]

\Rightarrow BEFC is a parallelogram. [Reason same as above]

(iii) From result (i), ABED is a parallelogram.

$AD \parallel BE$ and $AD = BE$

From result (ii), BEFC is a parallelogram.

$BE \parallel CF$ and $BE = CF$

- $\Rightarrow AD \parallel CF$ and $AD = CF$. [From results (i) and (ii)]
 (iv) As $AD \parallel CF$ and $AD = CF$ [From result (iii)]
 \therefore Quadrilateral $ACFD$ is a parallelogram.
 (v) $AC = DF$. [\because $ACFD$ is a parallelogram, result (iv)]
 (vi) Consider triangles ABC and DEF ,

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

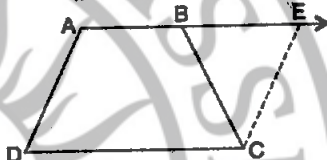
$$BC = EF \quad \text{[Given]}$$

$$AC = DF \quad \text{[From result (v)]}$$

$$\therefore \triangle ABC \cong \triangle DEF. \quad \text{[SSS]}$$

12. $ABCD$ is a trapezium in which $AB \parallel CD$ and $AD = BC$ (see figure). Show that

- (i) $\angle A = \angle B$
 (ii) $\angle C = \angle D$
 (iii) $\triangle ABC \cong \triangle BAD$
 (iv) diagonal $AC =$ diagonal BD



[Hint: Extend AB and draw a line through C parallel to DA intersecting AB produced at E .]

Sol. (i) **Construction:** Draw $CE \parallel AD$, meeting AB produced at E .

Proof: $AB \parallel CD$ [Given]

and $AD \parallel CE$ [Construction]

\therefore $AECD$ is a parallelogram.

$\Rightarrow AD = CE$ [Opposite sides of a parallelogram]

Also, $AD = BC$ [Given]

$\therefore CE = BC$.

$\Rightarrow \angle 1 = \angle 2$... (i)

[Angles opposite to equal sides are equal]

Also, $\angle D = \angle 2$... (ii)

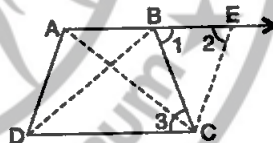
[Opposite angles of a parallelogram]

and $\angle 1 = \angle 3$... (iii) [Alternate angles]

$\Rightarrow \angle D = \angle 3$ [From equations (i), (ii), (iii)]

$\Rightarrow \angle D = \angle C$

As $AB \parallel CD$ and AD, BC are transversals.



$\therefore \angle A + \angle D = 180^\circ$...*(iv)* [Sum of interior angles on the same side of transversal is 180° .]

$\angle B + \angle C = 180^\circ$...*(v)* [Reason same as above]

Also, $\angle C = \angle D$...*(vi)* [Proved above]

$\therefore \angle A = \angle B$ [From equations *(iv)*, *(v)*, *(vi)*]

(iii) **Construction:** Draw AC and BD.

Proof: Consider triangles DAB and CBA.

$AD = BC$ [Given]

AB is common.

$\angle DAB = \angle CBA$ [Proved above]

$\therefore \triangle ABC \equiv \triangle BAD$ [SAS]

(iv) $AC = BD$. [CPCT]

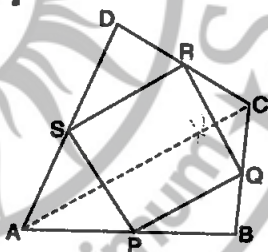
Exercise 8.2 (Pages – 150-151)

1. ABCD is a quadrilateral in which P, Q, R and S are mid-points of the sides AB, BC, CD and DA (see figure). AC is a diagonal. Show that:

(i) $SR \parallel AC$ and $SR = \frac{1}{2} AC$

(ii) $PQ = SR$

(iii) PQRS is a parallelogram.



Sol. *(i)* Consider triangle ACD,

S and R are mid-points of sides AD and DC respectively.

$\therefore SR \parallel AC$ and $SR = \frac{1}{2} AC$...*(i)*

[Line segment joining mid-points of two sides of a triangle is parallel to the third and half of it.]

(ii) Consider triangle ABC, P and Q are mid-points of sides AB and BC respectively.

$\therefore PQ \parallel AC$ and $PQ = \frac{1}{2} AC$...*(ii)*

[Reason same as above]

From (i) and (ii),

$$SR \parallel AC \text{ and } PQ \parallel AC \Rightarrow SR \parallel PQ \quad \dots(iii)$$

$$\text{and } SR = \frac{1}{2} AC \text{ and } PQ = \frac{1}{2} AC \Rightarrow SR = PQ. \dots(iv)$$

(iii) $SR \parallel PQ$ and $SR = PQ$. [From (iii) and (iv)]

\Rightarrow PQRS is a parallelogram.

2. ABCD is a rhombus and P, Q, R and S are the mid-points of the sides AB, BC, CD and DA respectively. Show that the quadrilateral PQRS is a rectangle.

Sol. First prove that PQRS is a parallelogram.

(i) Consider triangle ACD,

S and R are mid-points of sides AD and DC respectively.

$$\therefore SR \parallel AC \text{ and } SR = \frac{1}{2} AC \quad \dots(i)$$

[Line segment joining mid-points of two sides of a triangle is parallel to the third and half of it.]

(ii) Consider triangle ABC, P and Q are mid-points of sides AB and BC respectively.

$$\therefore PQ \parallel AC \text{ and } PQ = \frac{1}{2} AC \quad \dots(ii)$$

[Reason same as above]

From (i) and (ii),

$$SR \parallel AC \text{ and } PQ \parallel AC \Rightarrow SR \parallel PQ \quad \dots(iii)$$

$$\text{and } SR = \frac{1}{2} AC \text{ and } PQ = \frac{1}{2} AC \Rightarrow SR = PQ. \dots(iv)$$

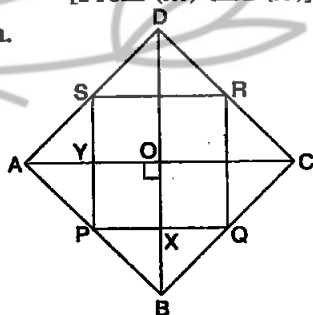
(iii) $SR \parallel PQ$ and $SR = PQ$. [From (iii) and (iv)]

\Rightarrow PQRS is a parallelogram.

As $PX \parallel YO$ and $PY \parallel OX$,
PXOY is a parallelogram.

$$\Rightarrow \angle YPX = \angle YOX = 90^\circ$$

\therefore Diagonals of a rhombus bisect each other and are at right angles.]



As in parallelogram PQRS,
 $\angle SPQ$ is 90° .

\therefore PQRS is a rectangle.

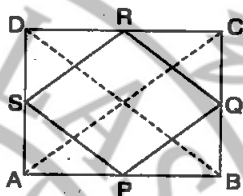
3. ABCD is a rectangle and P, Q, R and S are mid-points of the sides AB, BC, CD and DA respectively. Show that the quadrilateral PQRS is a rhombus.

Sol. Construction: Join AC and BD.

As ABCD is a rectangle.

$\therefore AC = BD$... (i)

Consider $\triangle ABC$, P and Q are mid-points of sides AB and BC respectively.



$\therefore PQ \parallel AC$ and $PQ = \frac{1}{2} AC$... (ii)

Similarly, consider $\triangle ADC$, S and R are mid-points of sides AD and DC respectively.

$\therefore SR \parallel AC$ and $SR = \frac{1}{2} AC$... (iii)

From (ii) and (iii),

$PQ = SR = \frac{1}{2} AC$... (iv)

Similarly, we can show

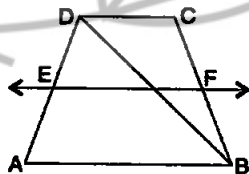
$PS = QR = \frac{1}{2} BD$... (v)

From (i), (iv) and (v), we have

$PQ = QR = RS = SP$

\therefore PQRS is a rhombus.

4. ABCD is a trapezium in which $AB \parallel DC$, BD is a diagonal and E is the mid-point of AD. A line is drawn through E parallel to AB intersecting BC at F (see figure). Show that F is the mid-point of BC.



Sol. Consider $\triangle ADB$, $AB \parallel EF \Rightarrow AB \parallel EG$.

\Rightarrow G is mid-point of BD. ...(i)

[\because A line drawn through mid-point of one side, parallel to other bisects the third side.]

Consider triangle BCD,

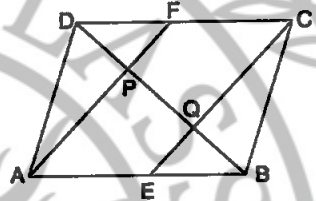
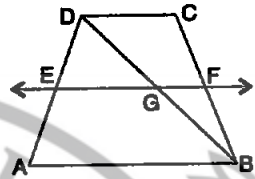
$AB \parallel CD$ and $EF \parallel AB$

$\Rightarrow EF \parallel CD \Rightarrow GF \parallel CD$

\Rightarrow F is mid-point of BC.

[Reason same as above]

5. In a parallelogram ABCD, E and F are the mid-points of sides AB and CD respectively (see figure). Show that the line segments AF and EC trisect the diagonal BD.



Sol. $AB = CD \Rightarrow \frac{1}{2}AB = \frac{1}{2}CD$

$\Rightarrow AE = CF$

As $AE = CF$ and $AE \parallel CF$

[$\because AB \parallel CD$]

\Rightarrow AECF is a parallelogram.

$\Rightarrow AP \parallel CE$

...(i)

Consider triangle ABP,

E is mid-point of AB and $EQ \parallel AP$

[From (i)]

\Rightarrow Q is mid-point of BP [A line segment drawn through mid-point of one side of a triangle and parallel to other, bisects the third side.]

$BQ = PQ$

...(ii)

Similarly, by considering triangle DCQ and proceeding as above, we can show that

$DP = PQ$

...(iii)

$\Rightarrow BQ = PQ = DP$

[From (ii) and (iii)]

\Rightarrow P and Q trisect BD.

6. Show that the line segments joining the mid-points of the opposite sides of a quadrilateral bisect each other.

Sol. (i) Consider triangle ACD,

S and R are mid-points of sides AD and DC respectively.

$$\therefore SR \parallel AC \text{ and } SR = \frac{1}{2} AC \quad \dots(i)$$

[Line segment joining mid-points of two sides of a triangle is parallel to the third and half of it.]

(ii) Consider triangle ABC, P and Q are mid-points of sides AB and BC respectively.

$$\therefore PQ \parallel AC \text{ and } PQ = \frac{1}{2} AC \quad \dots(ii)$$

[Reason same as above]

From (i) and (ii),

$$SR \parallel AC \text{ and } PQ \parallel AC \Rightarrow SR \parallel PQ \quad \dots(iii)$$

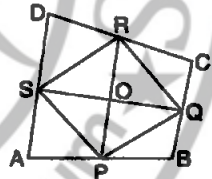
$$\text{and } SR = \frac{1}{2} AC \text{ and } PQ = \frac{1}{2} AC \Rightarrow SR = PQ. \quad \dots(iv)$$

(iii) $SR \parallel PQ$ and $SR = PQ$. [From (iii) and (iv)]

$\Rightarrow PQRS$ is a parallelogram.

We know that diagonals of a parallelogram bisect each other, i.e., $OP = OR$ and $OQ = OS$.

Hence, line segments joining mid-points of opposite sides of a quadrilateral bisect each other.



7. ABC is a triangle right angled at C . A line through the mid-point M of hypotenuse AB and parallel to BC intersects AC at D . Show that

(i) D is the mid-point of AC

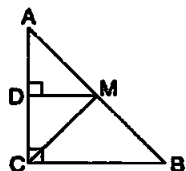
(ii) $MD \perp AC$

(iii) $CM = MA = \frac{1}{2} AB$.

Sol. (i) $MD \parallel BC$, meets AC at D .

$\therefore D$ is mid-point of AC .

[A line through the mid-point of a side of a triangle parallel to other bisects third side.]



(ii) $MD \parallel BC$ and AC is transversal.

$$\therefore \angle ADM = \angle ACB \quad [\text{Corresponding angles}]$$

$$\Rightarrow \angle ADM = 90^\circ \quad [\because \angle ACB = 90^\circ]$$

$$\Rightarrow MD \perp AC.$$

(iii) Consider triangles ADM and CDM ,

$$AD = DC \quad [\text{From result (i)}]$$

MD is common.

$$\angle ADM = \angle CDM \quad [90^\circ \text{ each}] \quad [\text{From result (ii)}]$$

$$\therefore \triangle ADM \cong \triangle CDM \quad [\text{SAS}]$$

$$\therefore MA = CM = \frac{1}{2} AB.$$

[$\because M$ is mid-point of AB)]

□□