

# Class IX Chapter 8 – Quadrilaterals

## Maths

### Exercise 8.1 Question 1:

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

Answer:

Let the common ratio between the angles be  $x$ . Therefore, the angles will be  $3x$ ,  $5x$ ,  $9x$ , and  $13x$  respectively.

As the sum of all interior angles of a quadrilateral is  $360^\circ$ ,

$$\therefore 3x + 5x + 9x + 13x = 360^\circ$$

$$30x = 360^\circ$$

$$x = 12^\circ$$

Hence, the angles are

$$3x = 3 \times 12 = 36^\circ$$

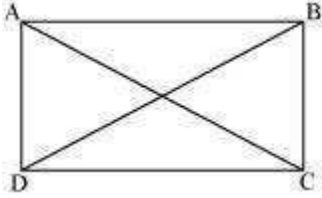
$$5x = 5 \times 12 = 60^\circ$$

$$9x = 9 \times 12 = 108^\circ$$

$$13x = 13 \times 12 = 156^\circ$$

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

Answer:



Let ABCD be a parallelogram. To show that ABCD is a rectangle, we have to prove that one of its interior angles is  $90^\circ$ .

In  $\triangle ABC$  and  $\triangle DCB$ ,

$AB = DC$  (Opposite sides of a parallelogram are equal)

$BC = BC$  (Common)

$AC = DB$  (Given)

$\therefore \triangle ABC \cong \triangle DCB$  (By SSS Congruence rule)

$$\Rightarrow \angle ABC = \angle DCB$$

It is known that the sum of the measures of angles on the same side of transversal is  $180^\circ$ .

$$\angle ABC + \angle DCB = 180^\circ \text{ (AB || CD)}$$

$$\Rightarrow \angle ABC + \angle ABC = 180^\circ$$

$$\Rightarrow 2 \angle ABC = 180^\circ$$

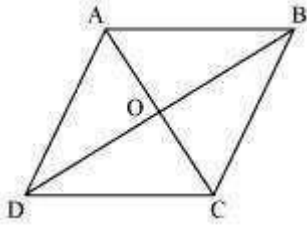
$$\Rightarrow \angle ABC = 90^\circ$$

Since ABCD is a parallelogram and one of its interior angles is  $90^\circ$ , ABCD is a rectangle.

Question 3:

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

Answer:



Let ABCD be a quadrilateral, whose diagonals AC and BD bisect each other at right angle i.e.,  $OA = OC$ ,  $OB = OD$ , and  $\angle AOB = \angle BOC = \angle COD = \angle AOD = 90^\circ$ . To prove ABCD a rhombus, we have to prove ABCD is a parallelogram and all the sides of ABCD are equal.

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

$OA = OC$  (Diagonals bisect each other)

$\angle AOD = \angle COD$  (Given)

$OD = OD$  (Common)

$\therefore \triangle AOD \cong \triangle COD$  (By SAS congruence rule)

$\therefore AD = CD$  (1)

Similarly, it can be proved that

$AD = AB$  and  $CD = BC$  (2)

From equations (1) and (2),

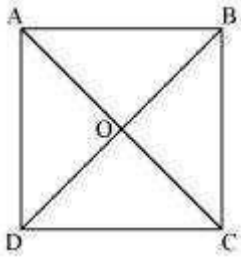
$AB = BC = CD = AD$

Since opposite sides of quadrilateral ABCD are equal, it can be said that ABCD is a parallelogram. Since all sides of a parallelogram ABCD are equal, it can be said that ABCD is a rhombus.

Question 4:

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

Answer:



Let ABCD be a square. Let the diagonals AC and BD intersect each other at a point O. To prove that the diagonals of a square are equal and bisect each other at right angles, we have to prove  $AC = BD$ ,  $OA = OC$ ,  $OB = OD$ , and  $\angle AOB = 90^\circ$ .

In  $\triangle ABC$  and  $\triangle DCB$ ,

$AB = DC$  (Sides of a square are equal to each other)

$\angle ABC = \angle DCB$  (All interior angles are of  $90^\circ$ )

$BC = CB$  (Common side)

$\therefore \triangle ABC \cong \triangle DCB$  (By SAS congruency)

$\therefore AC = DB$  (By CPCT)

Hence, the diagonals of a square are equal in length.

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

$\angle AOB = \angle COD$  (Vertically opposite angles)

$\angle ABO = \angle CDO$  (Alternate interior angles)

$AB = CD$  (Sides of a square are always equal)

$\angle AOB = \angle COD$  (By AAS congruence rule)

$\therefore AO = CO$  and  $OB = OD$  (By CPCT)

Hence, the diagonals of a square bisect each other.

In  $\triangle AOB$  and  $\triangle COB$ ,

As we had proved that diagonals bisect each other, therefore,

$AO = CO$

$AB = CB$  (Sides of a square are equal)

$BO = BO$  (Common)

$\triangle AOB \cong \triangle COB$  (By SSS congruency)

$\angle AOB = \angle COB$  (By CPCT)

However,  $\angle AOB + \angle COB = 180^\circ$  (Linear pair)

$\angle AOB = 180^\circ / 2$

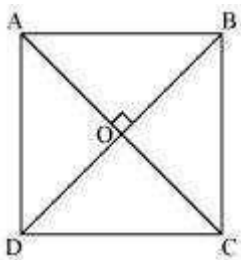
$\angle AOB = 90^\circ$

Hence, the diagonals of a square bisect each other at right angles.

Question 5:

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

Answer:



Let us consider a quadrilateral ABCD in which the diagonals AC and BD intersect each other at O. It is given that the diagonals of ABCD are equal and bisect each other at right angles. Therefore,  $AC = BD$ ,  $OA = OC$ ,  $OB = OD$ , and  $\angle AOB = \angle BOC = \angle COD = \angle AOD = 90^\circ$ . To prove ABCD is a square, we have to prove that ABCD is a parallelogram,  $AB = BC = CD = AD$ , and one of its interior angles is  $90^\circ$ .

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

$AO = CO$  (Diagonals bisect each other)

$OB = OD$  (Diagonals bisect each other)

$\angle AOB = \angle COD$  (Vertically opposite angles)

$\triangle AOB \cong \triangle COD$  (SAS congruence rule)

$AB = CD$  (By CPCT) ... (1)

And,  $\angle OAB = \angle OCD$  (By CPCT)

However, these are alternate interior angles for line AB and CD and alternate interior angles are equal to each other only when the two lines are parallel.  $AB \parallel CD$  ... (2)

From equations (1) and (2), we obtain ABCD is a parallelogram.

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

$AO = CO$  (Diagonals bisect each other)

$\angle AOD = \angle COD$  (Given that each is  $90^\circ$ )

$OD = OD$  (Common)

$\triangle AOD \cong \triangle COD$  (SAS congruence rule)

$AD = DC$  ... (3)

However,  $AD = BC$  and  $AB = CD$  (Opposite sides of parallelogram ABCD)

$AB = BC = CD = DA$

Therefore, all the sides of quadrilateral ABCD are equal to each other.

In  $\triangle ADC$  and  $\triangle BCD$ ,

$AD = BC$  (Already proved)

$AC = BD$  (Given)

$DC = CD$  (Common)

$\triangle ADC \cong \triangle BCD$  (SSS Congruence rule)

$\angle ADC = \angle BCD$  (By CPCT)

However,  $\angle ADC + \angle BCD = 180^\circ$  (Co-interior angles)

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

$$\angle 2 \angle ADC = 180^\circ$$

$\angle \angle ADC = 90^\circ$  One of the interior angles of quadrilateral ABCD is a right angle.

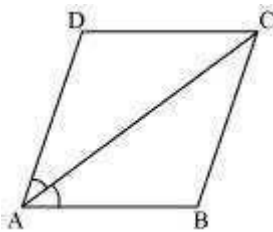
Thus, we have obtained that ABCD is a parallelogram,  $AB = BC = CD = AD$  and one of its interior angles is  $90^\circ$ . Therefore, ABCD is a square.

Question 6:

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

It bisects  $\angle C$  also, (

(ii) ABCD is a rhombus.



Answer:

(i) ABCD is a parallelogram.

$$\angle \angle DAC = \angle BCA \text{ (Alternate interior angles) ... (1)}$$

And,  $\angle BAC = \angle DCA$  (Alternate interior angles) ... (2) However, it is given that AC bisects  $\angle A$ .

$$\angle \angle DAC = \angle BAC \text{ ... (3)}$$

From equations (1), (2), and (3), we obtain

$$\angle DAC = \angle BCA = \angle BAC = \angle DCA \text{ ... (4)}$$

$$\angle \angle DCA = \angle BCA$$

Hence, AC bisects  $\angle C$ .

(ii) From equation (4), we obtain

$$\angle DAC = \angle DCA$$

$\angle A = \angle C$  (Side opposite to equal angles are equal)

However,  $DA = BC$  and  $AB = CD$  (Opposite sides of a parallelogram)

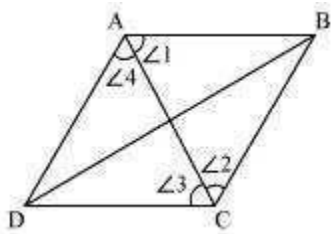
$\angle A = \angle C = \angle B = \angle D$  Hence,

ABCD is a rhombus.

Question 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  $\angle D$ .

Answer:



Let us join AC.

In  $\triangle ABC$ ,

$BC = AB$  (Sides of a rhombus are equal to each other)

$\angle 1 = \angle 2$  (Angles opposite to equal sides of a triangle are equal)

However,  $\angle 1 = \angle 3$  (Alternate interior angles for parallel lines AB and CD)

$\angle 2 = \angle 3$

Therefore, AC bisects  $\angle C$ .

Also,  $\angle 2 = \angle 4$  (Alternate interior angles for  $\parallel$  lines BC and DA)

$\angle 1 = \angle 4$

Therefore, AC bisects  $\angle A$ .

Similarly, it can be proved that BD bisects  $\angle B$  and  $\angle D$  as well.

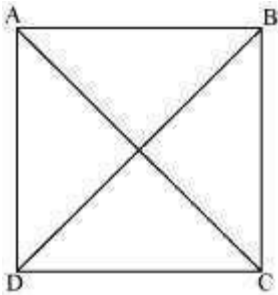
Question 8:



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  $\angle D$ .

Answer:



(i) It is given that ABCD is a rectangle.

$$\angle A = \angle C$$

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

$$\Rightarrow \angle DAC = \angle DCA \quad (\text{AC bisects } \angle A \text{ and } \angle C)$$

$CD = DA$  (Sides opposite to equal angles are also equal)

However,  $DA = BC$  and  $AB = CD$  (Opposite sides of a rectangle are equal)

$$\angle AB = BC = CD = DA$$

ABCD is a rectangle and all of its sides are equal.

Hence, ABCD is a square.

(ii) Let us join BD.

In  $\triangle BCD$ ,

$BC = CD$  (Sides of a square are equal to each other)

$\angle CDB = \angle CBD$  (Angles opposite to equal sides are equal)

However,  $\angle CDB = \angle ABD$  (Alternate interior angles for  $AB \parallel CD$ )

$$\angle CBD = \angle ABD$$

$\angle BD$  bisects  $\angle B$ .

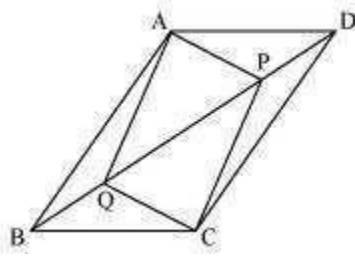
Also,  $\angle CBD = \angle ADB$  (Alternate interior angles for  $BC \parallel AD$ )

$\angle CDB = \angle ABD$

BD bisects  $\angle D$ .

Question 9:

In parallelogram ABCD, two points P and Q are taken on diagonal BD such that  $DP = BQ$  (see the given 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

Answer:

(i) In  $\triangle APD$  and  $\triangle CQB$ ,

$\angle ADP = \angle CBQ$  (Alternate interior angles for  $BC \parallel AD$ )

$AD = CB$  (Opposite sides of parallelogram  $ABCD$ )

$DP = BQ$  (Given)

$\angle \triangle APD \cong \triangle CQB$  (Using  $SA S$  congruence rule) ii)

As we had observed that  $\triangle APD \cong \triangle CQB$ , (

$\angle AP = CQ$  (CPCT)

(iii) In  $\triangle AQB$  and  $\triangle CPD$ ,

$\angle ABQ = \angle CDP$  (Alternate interior angles for  $AB \parallel CD$ )

$AB = CD$  (Opposite sides of parallelogram  $ABCD$ )

$BQ = DP$  (Given)

$\angle \triangle AQB \cong \triangle CPD$  (Using  $SAS$  congruence rule) iv)

As we had observed that  $\triangle AQB \cong \triangle CPD$ , (

$\angle AQ = CP$  (CPCT)

(v) From the result obtained in (ii) and (iv),

$AQ = CP$  and  $AP = CQ$

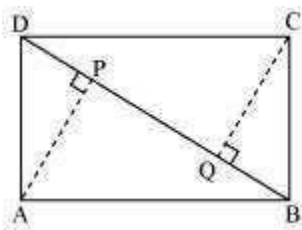
Since

opposite sides in  
 quadrilateral APCQ  
 are equal

to each other,  
 APCQ is a parallelogram.

Question 10:

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



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

(ii)  $AP = CQ$  Answer:

(i) In  $\triangle APB$  and  $\triangle CQD$ ,

$\angle APB = \angle CQD$  (Each  $90^\circ$ )

$AB = CD$  (Opposite sides of parallelogram ABCD)  $\angle ABP$

$= \angle CDQ$  (Alternate interior angles for  $AB \parallel CD$ )

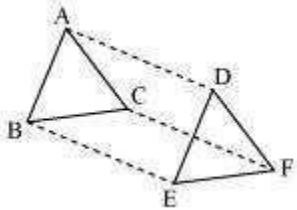
$\triangle APB \cong \triangle CQD$  (By AAS congruency)

(ii) By using the above result

$\triangle APB \cong \triangle CQD$ , we obtain

$AP = CQ$  (By CPCT) Question 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 the given 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)  $\triangle ABC \cong \triangle DEF$ . (

Answer:

(i) It is given that  $AB = DE$  and  $AB \parallel DE$ .

If two opposite sides of a quadrilateral are equal and parallel to each other, then it will be a parallelogram.

Therefore, quadrilateral ABED is a parallelogram.

(ii) Again,  $BC = EF$  and  $BC \parallel EF$

Therefore, quadrilateral BCEF is a parallelogram.

(iii) As we had observed that ABED and BEFC are parallelograms, therefore

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

(Opposite sides of a parallelogram are equal and parallel)

And,  $BE = CF$  and  $BE \parallel CF$

(Opposite sides of a parallelogram are equal and parallel)  $\therefore$

$AD = CF$  and  $AD \parallel CF$

(iv) As we had observed that one pair of opposite sides (AD and CF) of quadrilateral ACFD are equal and parallel to each other, therefore, it is a parallelogram.

(v) As ACFD is a parallelogram, therefore, the pair of opposite sides will be equal and parallel to each other.

$\angle AC \parallel DF$  and  $AC = DF$

(vi)  $\triangle ABC$  and  $\triangle DEF$ ,  $AB = DE$  (Given)

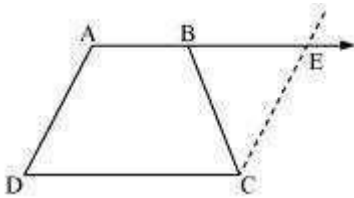
$BC = EF$  (Given)

$AC = DF$  (ACFD is a parallelogram)  $\triangle ABC$

$\triangle DEF$  (By SSS congruence rule)

Question 12:

ABCD is a trapezium in which  $AB \parallel CD$  and  $AD = BC$  (see the given 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.]

Answer:

Let us extend AB. Then, draw a line through C, which is parallel to AD, intersecting AE at point E. It is clear that AECD is a parallelogram.

(i)  $AD = CE$  (Opposite sides of parallelogram AECD)

However,  $AD = BC$  (Given)

Therefore,  $BC = CE$

$\angle CEB = \angle CBE$  (Angle opposite to equal sides are also equal)

Consider parallel lines AD and CE. AE is the transversal line for them.

$\angle A + \angle CEB = 180^\circ$  (Angles on the same side of transversal)

$\angle A + \angle CBE = 180^\circ$  (Using the relation  $\angle CEB = \angle CBE$ ) ... (1)

However,  $\angle B + \angle CBE = 180^\circ$  (Linear pair angles) ... (2)

From equations (1) and (2), we obtain  $\angle A$

$= \angle B$

(ii)  $AB \parallel CD$

$\angle A + \angle D = 180^\circ$  (Angles on the same side of the transversal)

Also,  $\angle C + \angle B = 180^\circ$  (Angles on the same side of the transversal)

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

However,  $\angle A = \angle B$  [Using the result obtained in (i)]

$\angle C = \angle D$

(iii) In  $\triangle ABC$  and  $\triangle BAD$ ,

$AB = BA$  (Common side)

$BC = AD$  (Given)

$\angle B = \angle A$  (Proved before)

$\triangle ABC \cong \triangle BAD$  (SAS congruence rule)

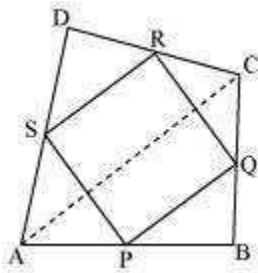
(iv) We had observed that,  $\triangle ABC \cong \triangle BAD$

$AC = BD$  (By CPCT)

Exercise 8.2 Question 1:

ABCD is a quadrilateral in which P, Q, R and S are mid-points of the sides AB, BC, CD and DA (see the given 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.

Answer:

(i) In  $\triangle ADC$ , S and R are the mid -points of sides AD and CD respectively. In a triangle, the line segment joining the mid-points of any two sides of the triangle is parallel to the third side and is half of it.

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

(ii) In  $\triangle ABC$ , P and Q are mid -points of sides AB and BC respectively. Therefore, by using mid-point theorem,

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

Using equations (1) and (2), we obtain

$$PQ \parallel SR \text{ and } PQ = SR \dots (3)$$

$$PQ = SR$$

(iii) From equation (3), we obtained

$$PQ \parallel SR \text{ and } PQ = SR$$

Clearly, one pair of opposite sides of quadrilateral PQRS is parallel and equal.

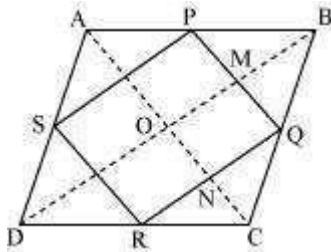
Hence, PQRS is a parallelogram.

Question 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.

Answer:

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



$PQ \parallel AC$  (Using mid-point theorem) ... (1)

R and S are the mid-points of CD and AD respectively.

$\angle PQ \parallel AC$  and  $PQ = \frac{1}{2} AC$  (2)  $RS \parallel AC$  and  $RS = \frac{1}{2} AC$  (Using mid-point theorem) ...

In  $\triangle ADC$ ,

From equations (1) and (2), we obtain

$PQ \parallel RS$  and  $PQ = RS$

Since in quadrilateral PQRS, one pair of opposite sides is equal and parallel to each other, it is a parallelogram.

Let the diagonals of rhombus ABCD intersect each other at point O.

In quadrilateral OMQN,

$\therefore$

$MQ \parallel ON$   $\because$  ( $PQ \parallel AC$ )

$QN \parallel OM$  ( $QR \parallel BD$ )

Therefore, OMQN is a parallelogram.

$\angle MQN = \angle NOM$

$\angle PQR = \angle NOM$

However,  $\angle NOM = 90^\circ$  (Diagonals of a rhombus are perpendicular to each other)  $\angle PQR = 90^\circ$

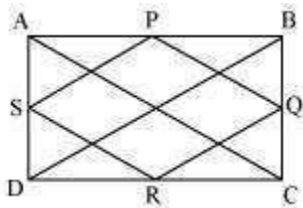
Clearly, PQRS is a parallelogram having one of its interior angles as  $90^\circ$ .

Hence, PQRS is a rectangle.

Question 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.

Answer:



Let us join AC and BD.

In  $\triangle ABC$ ,

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

$$\angle PQ \parallel AC \text{ and } PQ = \frac{1}{2} AC \text{ (Mid-point theorem) ... (1)}$$

Similarly in

$$\triangle ADC, \quad SR = \frac{1}{2} AC$$

$$SR \parallel AC \text{ and } SR = \frac{1}{2} AC \text{ (Mid-point theorem) ... (2)}$$

Clearly,  $PQ \parallel SR$  and  $PQ = SR$

Since in quadrilateral PQRS, one pair of opposite sides is equal and parallel to each other, it is a parallelogram.

$$\angle PS \parallel QR \text{ and } PS = QR \text{ (Opposite sides of parallelogram)... (3)}$$

In  $\triangle BCD$ , Q and R are the mid -points of side BC and CD respectively.

$\angle QR \parallel BD$  and  $QR = \frac{1}{2} BD$  (Mid-point theorem) ... (4)

However, the diagonals of a rectangle are equal.  $\angle$

$AC = BD$  ... (5)

By using equation (1), (2), (3), (4), and (5), we obtain

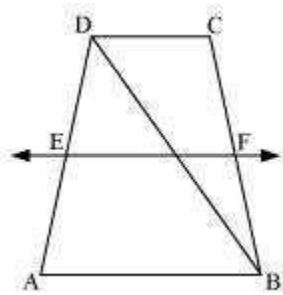
$PQ = QR = SR = PS$  Therefore, PQRS is a rhombus.

Question 4:

ABCD is a trapezium in which  $AB \parallel DC$ , BD is a diagonal and E is the mid - point of AD.

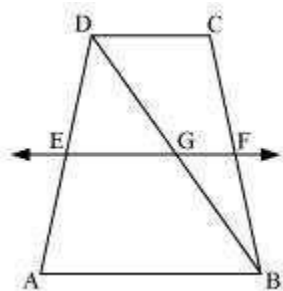
A line is drawn through E parallel to AB intersecting BC at F (see the given figure).

Show that F is the mid-point of BC.



Answer:

Let EF intersect DB at G.



By converse of mid-point theorem, we know that a line drawn through the mid-point of any side of a triangle and parallel to another side, bisects the third side.

In  $\triangle ABD$ ,

$EF \parallel AB$  and E is the mid-point of AD.

Therefore, G will be the mid-point of DB.

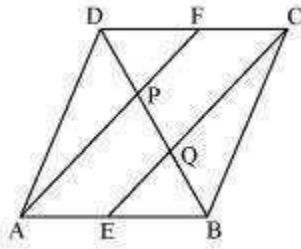
As  $EF \parallel AB$  and  $AB \parallel CD$ ,

$\angle EF \parallel CD$  (Two lines parallel to the same line are parallel to each other)

In  $\triangle BCD$ ,  $GF \parallel CD$  and G is the mid-point of line BD. Therefore, by using converse of mid-point theorem, F is the mid-point of BC.

Question 5:

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



Answer:

ABCD is a parallelogram.

$\angle AB \parallel CD$

And hence,  $AE \parallel FC$

Again,  $AB = CD$  (Opposite sides of parallelogram ABCD)

$$\frac{1}{2} AB = \frac{1}{2} CD$$

$AE = FC$  (E and F are mid-points of side AB and CD)

In quadrilateral AECF, one pair of opposite sides (AE and CF) is parallel and equal to each other. Therefore, AECF is a parallelogram.  $\angle AF \parallel EC$  (Opposite sides of a parallelogram)

In  $\triangle DQC$ , F is the mid -point of side DC and  $FP \parallel CQ$  (as  $AF \parallel EC$ ). Therefore, by using the converse of mid-point theorem, it can be said that P is the mid-point of

DQ.

$$\angle DP = PQ \dots (1)$$

Similarly, in  $\triangle APB$ , E is the mid -point of side AB and  $EQ \parallel AP$  (as  $AF \parallel EC$ ).

Therefore, by using the converse of mid-point theorem, it can be said that

Q is the mid-point of PB.

$$\angle PQ = QB \dots (2)$$

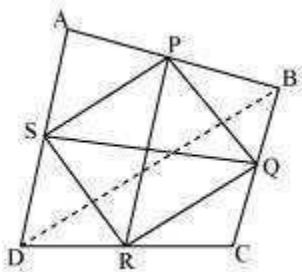
From equations (1) and (2),  $DP = PQ = BQ$

Hence, the line segments AF and EC trisect the diagonal BD.

Question 6:

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

Answer:



Let ABCD is a quadrilateral in which P, Q, R, and S are the mid-points of sides AB, BC, CD, and DA respectively. Join PQ, QR, RS, SP, and BD.

In  $\triangle ABD$ , S and P are the mid -points of AD and AB respectively. Therefore, by using mid-point theorem, it can be said that

$$SP \parallel BD \text{ and } SP = \frac{1}{2} BD \dots (1)$$

Similarly in  $\triangle BCD$ ,

$$QR \parallel BD \text{ and } QR = \frac{1}{2} BD \dots (2)$$

From equations (1) and (2), we obtain

$SP \parallel QR$  and  $SP = QR$

In quadrilateral  $SPQR$ , one pair of opposite sides is equal and parallel to each other.

Therefore,  $SPQR$  is a parallelogram.

We know that diagonals of a parallelogram bisect each other.

Hence,  $PR$  and  $QS$  bisect each other.

Question 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

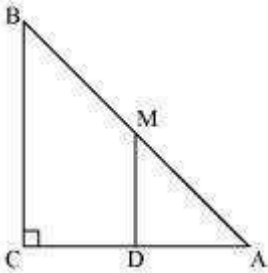
(i)  $D$  is the mid-point of  $AC$

(ii)  $MD \perp AC$

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

(iii)

Answer:



(i) In  $\triangle ABC$ ,

It is given that  $M$  is the mid-point of  $AB$  and  $MD \parallel BC$ .

Therefore,  $D$  is the mid-point of  $AC$ . (Converse of mid-point theorem)

(ii) As  $DM \parallel CB$  and  $AC$  is a transversal line for them, therefore,

$$\angle MDC + \angle DCB = 180^\circ \text{ (Co-interior angles)}$$

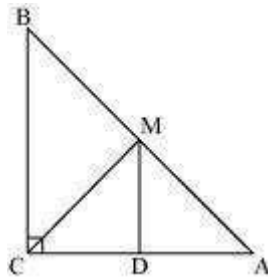
$$\angle MDC + 90^\circ = 180^\circ$$



$$\angle MDC = 90^\circ$$

$$\angle MD \perp AC$$

(iii) Join MC.



In  $\triangle AMD$  and  $\triangle CMD$ ,

$$AD = CD \text{ (D is the mid-point of side AC)} \quad \angle$$
$$ADM = \angle CDM \text{ (Each } 90^\circ)$$

$$DM = DM \text{ (Common)}$$

$$\angle \triangle AMD \cong \triangle CMD \text{ (By SAS congruence rule)}$$

Therefore,  $AM = CM$  (By CPCT)

$$\text{However, } AM = \frac{1}{2} AB \text{ (M is the mid-point of AB)}$$

Therefore, it can be said that

$$CM = AM = \frac{1}{2} AB$$