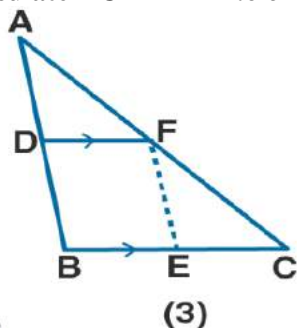
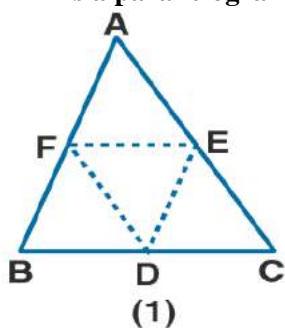


EXERCISE 11

1. (a) In the figure (1) given below, D, E and F are mid-points of the sides BC, CA and AB respectively of ΔABC . If $AB = 6$ cm, $BC = 4.8$ cm and $CA = 5.6$ cm, find the perimeter of (i) the trapezium FBCE (ii) the triangle DEF.

(b) In the figure (2) given below, D and E are mid-points of the sides AB and AC respectively. If $BC = 5.6$ cm and $\angle B = 72^\circ$, compute (i) DE (ii) $\angle ADE$.

(c) In the figure (3) given below, D and E are mid-points of AB, BC respectively and $DF \parallel BC$. Prove that DBEF is a parallelogram. Calculate AC if $AF = 2.6$ cm.

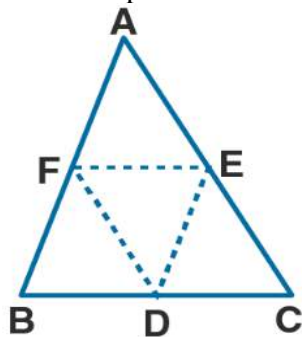


Solution:

(a) (i) It is given that

$AB = 6$ cm, $BC = 4.8$ cm and $CA = 5.6$ cm

To find: The perimeter of trapezium FBCE



It is given that

F is the mid-point of AB

We know that

$$BF = \frac{1}{2} AB = \frac{1}{2} \times 6 = 3 \text{ cm} \dots\dots (1)$$

It is given that

E is the mid-point of AC

We know that

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$$CE = \frac{1}{2} AC = \frac{1}{2} \times 5.6 = 2.8 \text{ cm} \dots\dots (2)$$

Here F and E are the mid-point of AB and CA

$FE \parallel BC$

We know that

$$FE = \frac{1}{2} BC = \frac{1}{2} \times 4.8 = 2.4 \text{ cm} \dots\dots (3)$$

Here

Perimeter of trapezium FBCE = $BF + BC + CE + EF$

Now substituting the value from all the equations

$$= 3 + 4.8 + 2.8 + 2.4$$

$$= 13 \text{ cm}$$

Therefore, the perimeter of trapezium FBCE is 13 cm.

(ii) D, E and F are the midpoints of sides BC, CA and AB of ΔABC

Here $EF \parallel BC$

$$EF = \frac{1}{2} BC = \frac{1}{2} \times 4.8 = 2.4 \text{ cm}$$

$$DE = \frac{1}{2} AB = \frac{1}{2} \times 6 = 3 \text{ cm}$$

$$FD = \frac{1}{2} AC = \frac{1}{2} \times 5.6 = 2.8 \text{ cm}$$



We know that

Perimeter of $\Delta DEF = DE + EF + FD$

Substituting the values

$$= 3 + 2.4 + 2.8$$

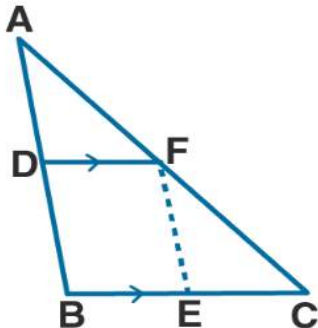
$$= 8.2 \text{ cm}$$

(b) It is given that

D and E are the mid-point of sides AB and AC

$BC = 5.6 \text{ cm}$ and $\angle B = 72^\circ$

To find: (i) DE (ii) $\angle ADE$



We know that

In ΔABC

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Mid Point Theorem**

D and E is the mid-point of the sides AB and AC
Using mid-point theorem
 $DE \parallel BC$

(i) $DE = \frac{1}{2} BC = \frac{1}{2} \times 5.6 = 2.8 \text{ cm}$

(ii) $\angle ADE = \angle B$ are corresponding angles

It is given that

$\angle B = 72^\circ$ and $BC \parallel DE$

$\angle ADE = 72^\circ$

(c) It is given that

D and E are the midpoints of AB and BC respectively

$DF \parallel BC$ and $AF = 2.6 \text{ cm}$

To find: (i) BEF is a parallelogram

(ii) Calculate the value of AC

Proof:

(i) In ΔABC

D is the midpoint of AB and $DF \parallel BC$

F is the midpoint of AC (1)

F and E are the midpoints of AC and BC

$EF \parallel AB$ (2)

Here $DF \parallel BC$

$DF \parallel BE$ (3)

Using equation (2)

$EF \parallel AB$

$EF \parallel DB$ (4)

Using equation (3) and (4)

DBEF is a parallelogram

(ii) F is the midpoint of AC

So we get

$AC = 2 \times AF = 2 \times 2.6 = 5.2 \text{ cm}$

2. Prove that the four triangles formed by joining in pairs the mid-points of the sides C of a triangle are congruent to each other.

Solution:

It is given that

In ΔABC

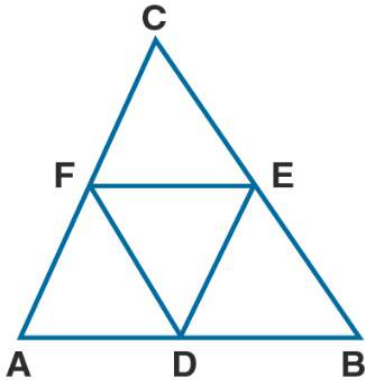
D, E and F are the mid-points of AB, BC and CA

Now join DE, EF and FD

To find:

$\Delta ADF \cong \Delta DBE \cong \Delta ECF \cong \Delta DEF$





To prove:

In $\triangle ABC$

D and E are the mid-points of AB and BC

$DE \parallel AC$ or FC

Similarly $DF \parallel EC$

DECF is a parallelogram

We know that

Diagonal FE divides the parallelogram DECF in two congruent triangles DEF and CEF

$\triangle DEF \cong \triangle ECF$ (1)

Here we can prove that

$\triangle DBE \cong \triangle DEF$ (2)

$\triangle DEF \cong \triangle ADF$ (3)

Using equation (1), (2) and (3)

$\triangle ADF \cong \triangle DBE \cong \triangle ECF \cong \triangle DEF$

3. If D, E and F are mid-points of sides AB, BC and CA respectively of an isosceles triangle ABC, prove that $\triangle DEF$ is also isosceles.

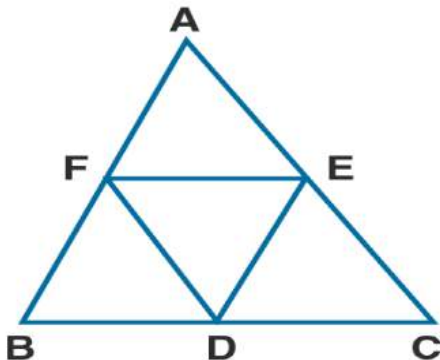
Solution:

It is given that

ABC is an isosceles triangle in which $AB = AC$

D, E and F are the midpoints of the sides BC, CA and AB

Now D, E and F are joined



To find:

$\triangle DEF$ is an isosceles triangle

Proof:

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Mid Point Theorem**

D and E are the midpoints of BC and AC

Here $DE \parallel AB$ and $DE = \frac{1}{2} AB$ (1)

D and F are the midpoints of BC and AB

Here $DF \parallel AC$ and $DF = \frac{1}{2} AC$ (2)

It is given that

$AB = BC$ and $DE = DF$

Hence, $\triangle DEF$ is an isosceles triangle.

4. The diagonals AC and BD of a parallelogram ABCD intersect at O. If P is the midpoint of AD, prove that

(i) $PQ \parallel AB$

(ii) $PO = \frac{1}{2} CD$.

Solution:

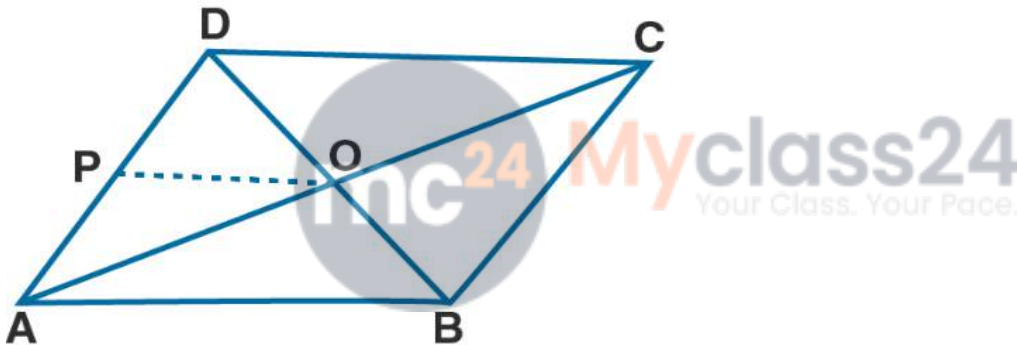
It is given that

ABCD is a parallelogram in which diagonals AC and BD intersect each other

At the point O, P is the midpoint of AD

Join OP

To find: (i) $PQ \parallel AB$ (ii) $PQ = \frac{1}{2} CD$



Proof:

(i) In parallelogram diagonals bisect each other

$BO = OD$

Here O is the mid-point of BD

In $\triangle ABD$

P and O is the midpoint of AD and BD

$PO \parallel AB$ and $PO = \frac{1}{2} AB$ (1)

Hence, it is proved that $PO \parallel AB$.

(ii) ABCD is a parallelogram

$AB = CD$ (2)

Using both (1) and (2)

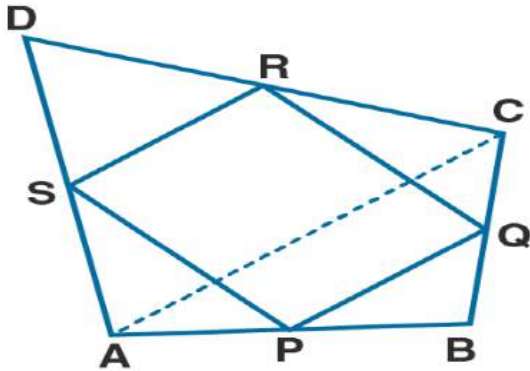
$PO = \frac{1}{2} CD$

5. In the adjoining figure, ABCD is a quadrilateral in which P, Q, R and S are mid-points of AB, BC, CD and DA respectively. AC is its diagonal. Show that

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

(ii) $PQ = SR$

(iii) PQRS is a parallelogram.



Solution:

It is given that

In quadrilateral ABCD

P, Q, R and S are the mid-points of sides AB, BC, CD and DA

AC is the diagonal

To find:

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

(ii) $PQ = SR$

(iii) PQRS is a parallelogram

Proof:

(i) In $\triangle ADC$

S and R are the mid-points of AD and DC

$SR \parallel AC$ and $SR = \frac{1}{2} AC$ (1) Using the mid-point theorem

(ii) In $\triangle ABC$

P and Q are the midpoints of AB and BC

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

Using equation (1) and (2)

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

(iii) $PQ = SR$ and $PQ \parallel SR$

Hence, PQRS is a parallelogram.

6. Show that the quadrilateral formed by joining the mid-points of the adjacent sides of a square, is also a square.

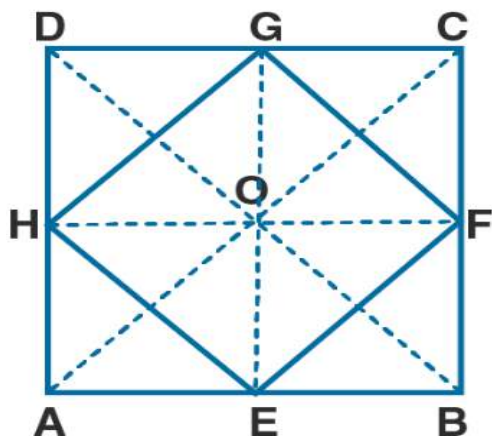
Solution:

It is given that

A square ABCD in which E, F, G and H are mid-points of AB, BC, CD and DA

Join EF, FG, GH and HE.

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To find:

EFGH is a square

Construct AC and BD

Proof:

In $\triangle ACD$

G and H are the mid-points of CD and AC

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

In $\triangle ABC$, E and F are the mid-points of AB and BC

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

Using both the equations

$EF \parallel GH$ and $EF = GH = \frac{1}{2} AC$ (3)

In the same way we can prove that

$EF \parallel GH$ and $EH = GF = \frac{1}{2} BD$

We know that the diagonals of square are equal

$AC = BD$

By dividing both sides by 2

$\frac{1}{2} AC = \frac{1}{2} BD$ (4)

Using equation (3) and (4)

$EF = GH = EH = GF$ (5)

Therefore, EFGH is a parallelogram

In $\triangle GOH$ and $\triangle GOF$

$OH = OF$ as the diagonals of parallelogram bisect each other

$OG = OG$ is common

Using equation (5)

$GH = GF$

$\triangle GOH \cong \triangle GOF$ (SSS axiom of congruency)

$\angle GOH = \angle GOF$ (c.p.c.t)

We know that

$\angle GOH + \angle GOF = 180^\circ$ as it is a linear pair

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

So we get

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Mid Point Theorem**

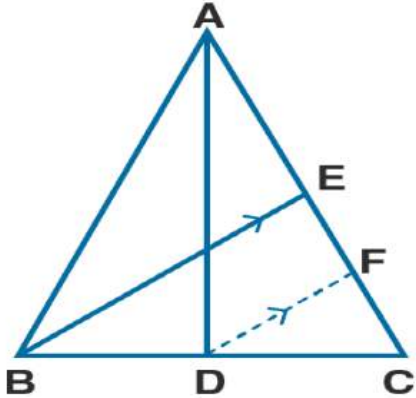
$$2 \angle GOH = 180^\circ$$

$$\angle GOH = 180^\circ/2 = 90^\circ$$

So the diagonals of a parallelogram ABCD bisect and perpendicular to each other

Hence, it is proved that EFGH is a square.

7. In the adjoining figure, AD and BE are medians of $\triangle ABC$. If $DF \parallel BE$, prove that $CF = \frac{1}{4} AC$.



Solution:

It is given that

AD and BE are the medians of $\triangle ABC$

Construct $DF \parallel BE$

To find:

$$CF = \frac{1}{4} AC$$

Proof:

In $\triangle BCE$

D is the mid-point of BC and $DF \parallel BE$

F is the mid-point of EC

$$CF = \frac{1}{2} EC \dots\dots (1)$$

E is the mid-point of AC

$$EC = \frac{1}{2} AC \dots\dots (2)$$

Using both the equations

$$CF = \frac{1}{2} EC = \frac{1}{2} \left(\frac{1}{2} AC\right)$$

So we get

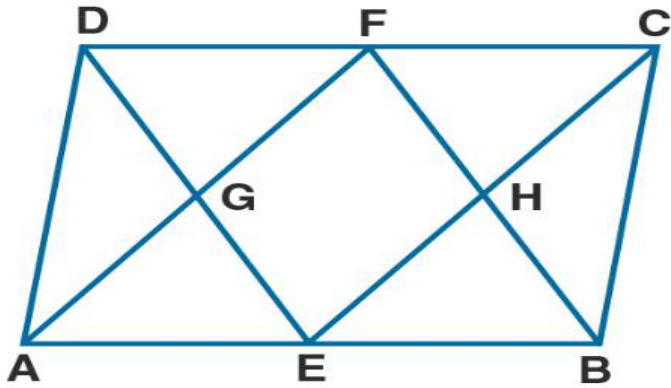
$$CF = \frac{1}{4} AC$$

Hence, it is proved.

8. In the figure (1) given below, ABCD is a parallelogram. E and F are mid-points of the sides AB and CO respectively. The straight lines AF and BF meet the straight lines ED and EC in points G and H respectively. Prove that

(i) $\triangle HEB = \triangle HCF$

(ii) GEHF is a parallelogram.



Solution:

It is given that

ABCD is a parallelogram

E and F are the mid-points of sides AB and CD

To prove:

(i) $\triangle HEB = \triangle HCF$

(ii) GEHF is a parallelogram

Proof:

(i) We know that

ABCD is a parallelogram

$FC \parallel BE$

$\angle CEB = \angle FCE$ are alternate angles

$\angle HEB = \angle FCH$ (1)

$\angle EBF = \angle CFB$ are alternate angles

$\angle EBH = \angle CFM$ (2)

Here E and F are mid-points of AB and CD

$BE = \frac{1}{2} AB$ (3)

$CF = \frac{1}{2} CD$ (4)

We know that

ABCD is a parallelogram

$AB = CD$

Now dividing both sides by $\frac{1}{2}$

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

Using equation (3) and (4)

$BE = CF$ (5)

In $\triangle HEB$ and $\triangle HCF$

$\angle HEB = \angle FCH$ using equation (1)

$\angle EBH = \angle CFH$ using equation (2)

$BE = CF$ using equation (5)

So we get

$\triangle HEB \cong \triangle HCF$ (ASA axiom of congruency)

Hence, it is proved.



(ii) It is given that

E and F are the mid-points of AB and CD

$$AB = CD$$

So we get

$$AE = CF$$

Here $AE \parallel CF$

$$AE = CF \text{ and } AE \parallel CF$$

So AECF is a parallelogram.

G and H are the mid-points of AF and CE

$$GF \parallel EH \dots\dots (6)$$

In the same way we can prove that GFHE is a parallelogram

So G and H are the points on the line DE and BF

$$GE \parallel HF \dots\dots (7)$$

Using equation (6) and (7) GEHF is a parallelogram.

Hence, it is proved.

9. ABC is an isosceles triangle with $AB = AC$. D, E and F are mid-points of the sides BC, AB and AC respectively. Prove that the line segment AD is perpendicular to EF and is bisected by it.

Solution:

It is given that

ABC is an isosceles triangle with $AB = AC$

D, E and F are mid-points of the sides BC, AB and AC

To find:

AD is perpendicular to EF and is bisected by it.

Proof:

In $\triangle ABD$ and $\triangle ACD$

ABC is an isosceles triangle

$$\angle ABD = \angle ACD$$

Here D is the mid-point of BC

$$BD = CD$$

It is given that $AB = AC$

$\triangle ABD \cong \triangle ACD$ (SAS axiom of congruency)

$$\angle ADB = \angle ADC \text{ (c. p. c. t)}$$

We know that

$$\angle ADB + \angle ADC = 180^\circ \text{ is a linear pair}$$

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

By further calculation

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

So we get

$$\angle ADB = 180/2 = 90^\circ$$

So AD is perpendicular to BC (1)

D and E are the mid-points of BC and AB

$$DE \parallel AC \dots\dots (2)$$

D and F are the mid-points of BC and AC

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$EF \parallel AD \dots (3)$

Using equation (2) and (3)

AEDF is a parallelogram.

Here the diagonals of a parallelogram bisect each other

AD and EF bisect each other

Using equation (1) and (3)

$EF \parallel BC$

So AD is perpendicular to EF

Hence, it is proved.

10. (a) In the quadrilateral (1) given below, $AB \parallel DC$, E and F are the mid-points of AD and BD respectively. Prove that:

(i) G is mid-point of BC

(ii) $EG = \frac{1}{2}(AB + DC)$

(b) In the quadrilateral (2) given below, $AB \parallel DC \parallel EG$. If E is mid-point of AD prove that:

(i) G is the mid-point of BC

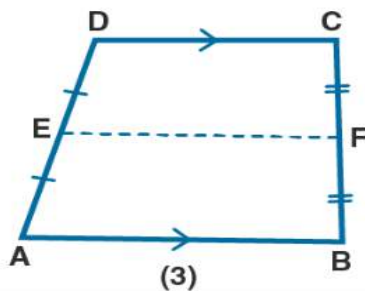
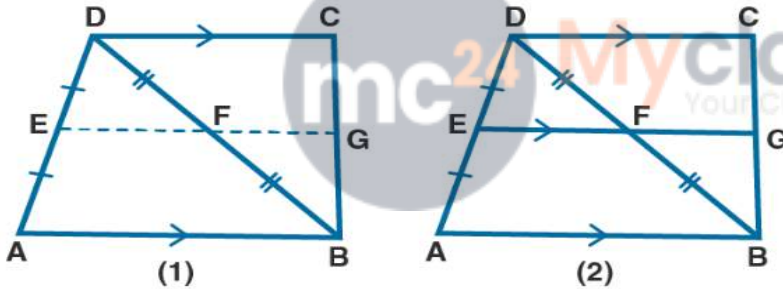
(ii) $2EG = AB + CD$

(c) In the quadrilateral (3) given below, $AB \parallel DC$.

E and F are mid-point of non-parallel sides AD and BC respectively. Calculate:

(i) EF if $AB = 6$ cm and $DC = 4$ cm.

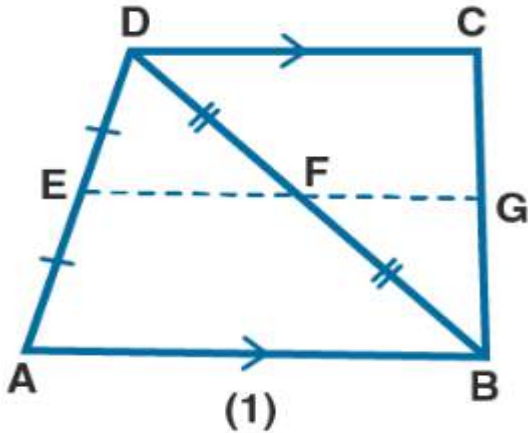
(ii) AB if $DC = 8$ cm and $EF = 9$ cm.



Solution:

(a) It is given that

$AB \parallel DC$, E and F are mid-points of AD and BD



To prove:

(i) G is mid-point of BC

(ii) $EG = \frac{1}{2} (AB + DC)$

Proof:

In $\triangle ABD$

F is the mid-point of BD

$DF = BF$

E is the mid-point of AD

$EF \parallel AB$ and $EF = \frac{1}{2} AB$ (1)

It is given that $AB \parallel DC$

$EG \parallel CD$

F is the mid-point of BD

$FG \parallel DC$

G is the mid-point of BC

$FG = \frac{1}{2} DC$ (2)

By adding both the equations

$EF + FG = \frac{1}{2} AB + \frac{1}{2} DC$

Taking $\frac{1}{2}$ as common

$EG = \frac{1}{2} (AB + DC)$

Therefore, it is proved.

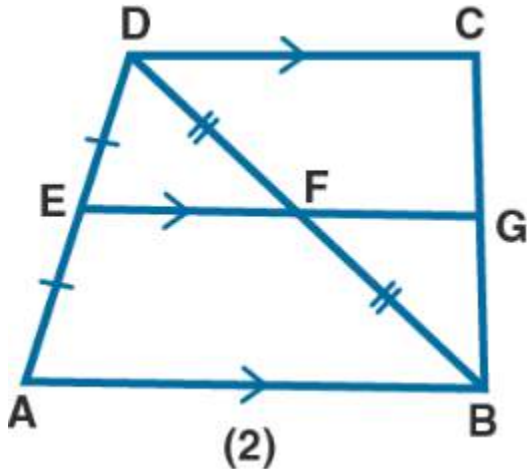
(b) It is given that

Quadrilateral ABCD in which $AB \parallel DC \parallel EG$

E is the mid-point of AD



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To prove:

- (i) G is the mid-point of BC
- (ii) $2EG = AB + CD$

Proof:

$AB \parallel DC$

$EG \parallel AB$

So we get

$EG \parallel DC$

In $\triangle DAB$,

E is the mid-point of AD and F is the mid-point of BD and $EF = \frac{1}{2} AB$ (1)

In $\triangle BCD$,

F is the mid-point of BD and G is the mid-point of BC and $FG \parallel DC$

$FG = \frac{1}{2} CD$ (2)

By adding both the equations

$$EF + FG = \frac{1}{2} AB + \frac{1}{2} CD$$

Taking out the common terms

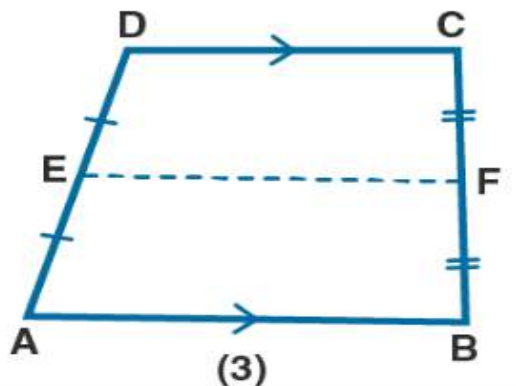
$$EG = \frac{1}{2} (AB + CD)$$

Hence, it is proved.

(c) It is given that

A quadrilateral in which $AB \parallel DC$

E and F are the mid-points of non-parallel sides AD and BC



To prove:

- (i) $EF = \frac{1}{2}(AB + DC)$ if $AB = 6$ cm and $DC = 4$ cm.
 (ii) $AB = 2EF - DC$ if $DC = 8$ cm and $EF = 9$ cm.

Proof:

We know that

The length of line segment joining the mid-points of two non-parallel sides is half the sum of the lengths of the parallel sides

E and F are the mid-points of AD and BC

$$EF = \frac{1}{2}(AB + DC) \dots\dots (1)$$

- (i) $AB = 6$ cm and $DC = 4$ cm

Substituting in equation (1)

$$EF = \frac{1}{2}(6 + 4)$$

By further calculation

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

- (ii) $DC = 8$ cm and $EF = 9$ cm

Substituting in equation (1)

$$EF = \frac{1}{2}(AB + DC)$$

By further calculation

$$9 = \frac{1}{2}(AB + 8)$$

$$18 = AB + 8$$

So we get

$$18 - 8 = AB$$

$$AB = 10 \text{ cm}$$

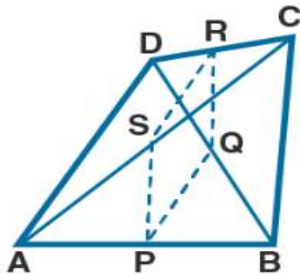
11. (a) In the quadrilateral (1) given below, $AD = BC$, P, Q, R and S are mid-points of AB, BD, CD and AC respectively. Prove that $PQRS$ is a rhombus.

(b) In the figure (2) given below, $ABCD$ is a kite in which $BC = CD, AB = AD$, E, F, G are mid-points of CD, BC and AB respectively. Prove that:

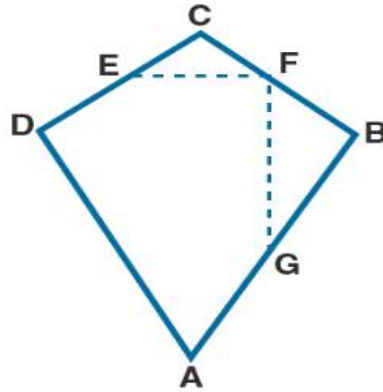
- (i) $\angle EFG = 90^\circ$

(ii) The line drawn through G and parallel to FE bisects DA .

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(1)



(2)

Solution:

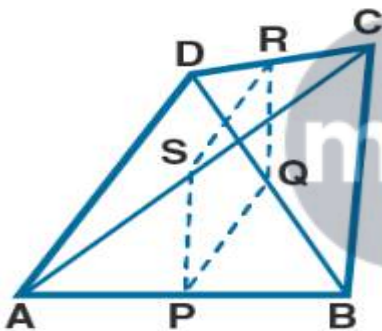
(a) It is given that

A quadrilateral ABCD in which $AD = BC$

P, Q, R and S are mid-points of AB, BD, CD and AC

To prove:

PQRS is a rhombus



Proof:

In $\triangle ABD$

P and Q are mid points of AB and BD

$PQ \parallel AD$ and $PQ = \frac{1}{2} AD$ (1)

In $\triangle BCD$,

R and Q are mid points of DC and BD

$RQ \parallel BC$ and $RQ = \frac{1}{2} BC$ (2)

P and S are mid-points of AB and AC

$PS \parallel BC$ and $PS = \frac{1}{2} BC$ (3)

$AD = BC$

Using all the equations

$PS \parallel RQ$ and $PQ = PS = RQ$

Here $PS \parallel RQ$ and $PS = RQ$

PQRS is a parallelogram

$PQ = RS = PS = RQ$

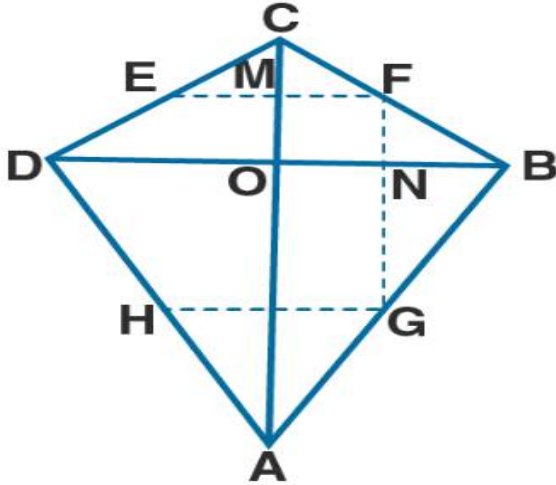
PQRS is a rhombus

Therefore, it is proved.

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(ii) It is given that

ABCD is a kite in which $BC = CD$, $AB = AD$, E, F, G are mid-points of CD, BC and AB



To prove:

(i) $\angle EFG = 90^\circ$

(ii) The line drawn through G and parallel to FE bisects DA

Construction:

Join AC and BD

Construct GH through G parallel to FE

Proof:

(i) We know that

Diagonals of a kite intersect at right angles

$\angle MON = 90^\circ \dots (1)$

In $\triangle BCD$

E and F are mid-points of CD and BC

$EF \parallel DB$ and $EF = \frac{1}{2} DB \dots (2)$

$EF \parallel DB$

$MF \parallel ON$

Here

$\angle MON + \angle MFN = 180^\circ$

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

By further calculation

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

So $\angle EFG = 90^\circ$

Hence, it is proved.

(ii) In $\triangle ABD$

G is the mid-point of AB and $HG \parallel DB$

Using equation (2)

$EF \parallel DB$ and $EF \parallel HG$

$HG \parallel DB$

Here H is the mid-point of DA

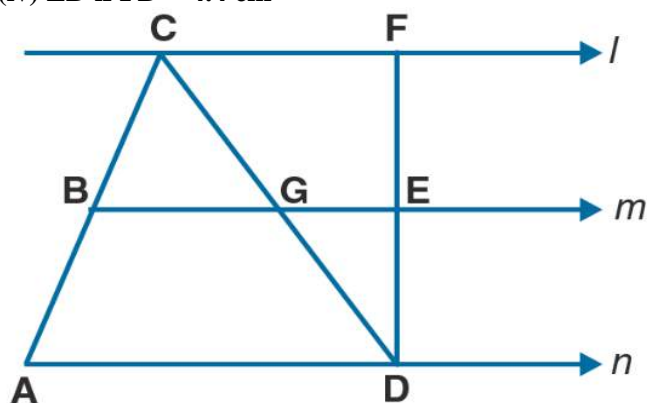


Therefore, the line drawn through G and parallel to FE bisects DA.

12. In the adjoining figure, the lines l , m and n are parallel to each other, and G is mid-point of CD.

Calculate:

- (i) BG if $AD = 6$ cm
- (ii) CF if $GE = 2.3$ cm
- (iii) AB if $BC = 2.4$ cm
- (iv) ED if $FD = 4.4$ cm



Solution:

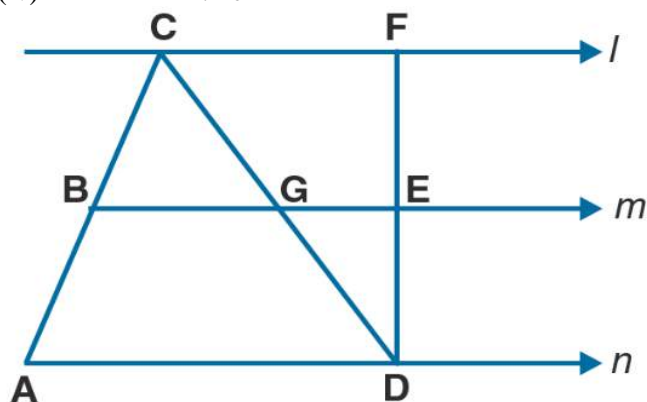
It is given that

The straight line l , m and n are parallel to each other

G is the mid-point of CD

To find:

- (i) BG if $AD = 6$ cm
- (ii) CF if $GE = 2.3$ cm
- (iii) AB if $BC = 2.4$ cm
- (iv) ED if $FD = 4.4$ cm



Proof:

(i) In $\triangle ACD$,

G is the mid-point of CD

$BG \parallel AD$ as $m \parallel n$

Here B is the mid-point of AC and $BG = \frac{1}{2} AD$

So we get

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

(ii) In ΔCDF

G is the mid-point of CD

$GE \parallel CF$ as $m \parallel l$

Here E is the mid-point of DF and $GE = \frac{1}{2} CF$

So we get

$$CF = 2GE$$

$$CF = 2 \times 2.3 = 4.6 \text{ cm}$$

(iii) From (i)

B is the mid-point of AC

$$AB = BC$$

We know that

$$BC = 2.4 \text{ cm}$$

$$\text{So } AB = 2.4 \text{ cm}$$

(iv) From (ii)

E is the mid-point of FD

$$ED = \frac{1}{2} FD$$

We know that

$$FD = 4.4 \text{ cm}$$

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



CHAPTER TEST

1. ABCD is a rhombus with P, Q and R as midpoints of AB, BC and CD respectively. Prove that $PQ \perp QR$.

Solution:

It is given that

ABCD is a rhombus with P, Q and R as mid-points of AB, BC and CD

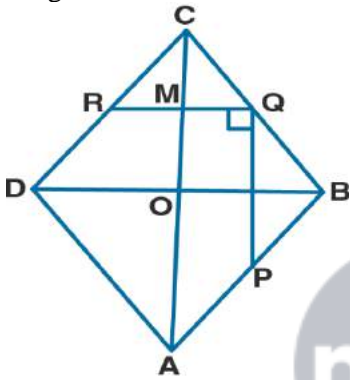
To prove:

$PQ \perp QR$

Construction: Join AC and BD

Proof:

Diagonals of rhombus intersect at right angle



$$\angle MON = 90^\circ \dots\dots (1)$$

In $\triangle BCD$

Q and R are mid-points of BC and CD.

$$RQ \parallel DB \text{ and } RQ = \frac{1}{2} DB \dots\dots (2)$$

Here

$$RQ \parallel DB$$

$$MQ \parallel ON$$

We know that

$$\angle MQN + \angle MON = 180^\circ$$

Substituting the values

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

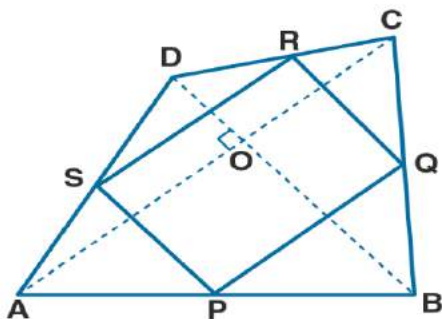
$$\angle MQN = 180 - 90 = 90^\circ$$

So $NQ \perp MQ$ or $PQ \perp QR$

Hence, it is proved.

2. The diagonals of a quadrilateral ABCD are perpendicular. Show that the quadrilateral formed by joining the mid-points of its adjacent sides is a rectangle.

Solution:



It is given that

ABCD is a quadrilateral in which diagonals AC and BD are perpendicular to each other
P, Q, R and S are mid-points of AB, BC, CD and DA

To prove:

PQRS is a rectangle

Proof:

We know that

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

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

S and R are mid-points of AD and DC

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

Using both the equations

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

So PQRS is a parallelogram

AC and BD intersect at right angles

$SP \parallel BD$ and $BD \perp AC$

So $SP \perp AC$ i.e. $SP \perp SR$

$\angle RSP = 90^\circ$

$\angle RSP = \angle SRQ = \angle RQS = \angle SPQ = 90^\circ$

Hence, PQRS is a rectangle.

3. If D, E, F are mid-points of the sides BC, CA and AB respectively of a ΔABC , prove that AD and FE bisect each other.

Solution:

It is given that

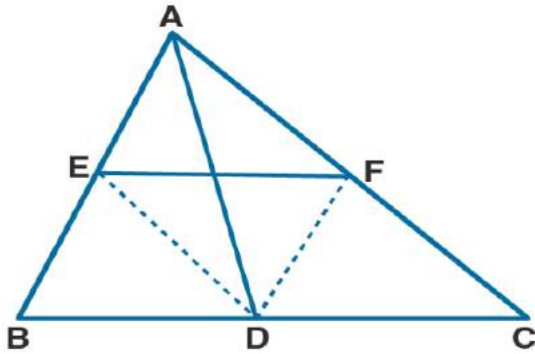
D, E, F are mid-points of sides BC, CA and AB of a ΔABC

To prove:

AD and FE bisect each other

Construction:

Join ED and FD



Proof:

We know that

D and E are the midpoints of BC and AB

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

D and F are the midpoints of BC and AC

$DF \parallel AB$ and $DF = \frac{1}{2} AB$ (2)

Using both the equations

ADEF is a parallelogram

Here the diagonals of a parallelogram bisect each other

AD and EF bisect each other.

Therefore, it is proved.

4. In $\triangle ABC$, D and E are mid-points of the sides AB and AC respectively. Through E, a straight line is drawn parallel to AB to meet BC at F. Prove that BDEF is a parallelogram. If $AB = 8$ cm and $BC = 9$ cm, find the perimeter of the parallelogram BDEF.

Solution:

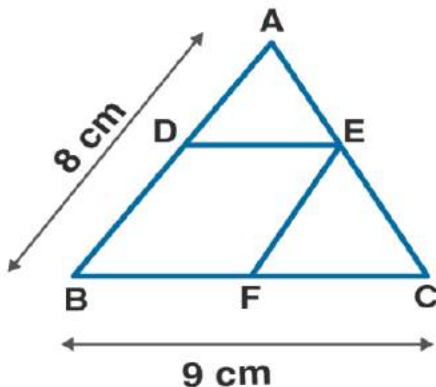
It is given that

In $\triangle ABC$

D and E are the mid points of sides AB and AC

DE is joined from E

$EF \parallel AB$ is drawn $AB = 8$ cm and $BC = 9$ cm



To prove:

(i) BDEF is a parallelogram

(ii) Find the perimeter of BDEF

Proof:

In $\triangle ABC$

B and E are the mid-points of AB and AC

Here $DE \parallel BC$ and $DE = \frac{1}{2} BC$

So $EF \parallel AB$

DEFB is a parallelogram

$DE = BF$

So we get

$DE = \frac{1}{2} BC = \frac{1}{2} \times 9 = 4.5 \text{ cm}$

$EF = \frac{1}{2} AB = \frac{1}{2} \times 8 = 4 \text{ cm}$

We know that

Perimeter of BDEF = 2 (DE + EF)

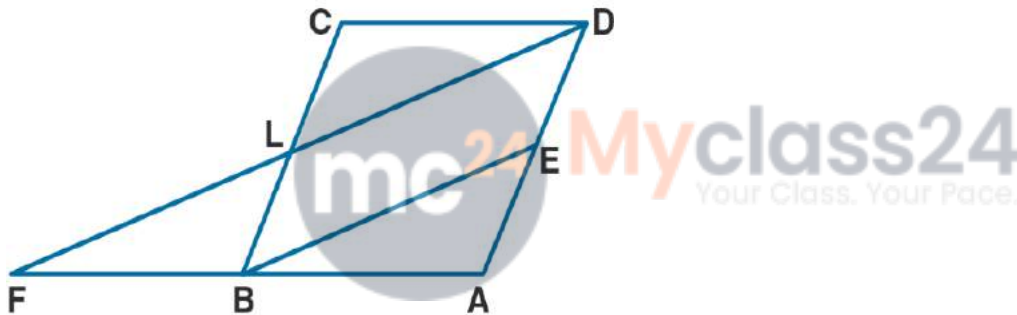
Substituting the values

= 2 (4.5 + 4)

= 2 \times 8.5

= 17 cm

5. In the given figure, ABCD is a parallelogram and E is mid-point of AD. DL \parallel EB meets AB produced at F. Prove that B is mid-point of AF and EB = LF.



Solution:

It is given that

ABCD is a parallelogram

E is the mid-point of AD

DL \parallel EB meets AB produced at F

To prove:

EB = LF

B is the mid-point of AF

Proof:

We know that

BC \parallel AD and BE \parallel LD

BEDL is a parallelogram

BE = LD and BL = AE

Here E is the mid-point of AD

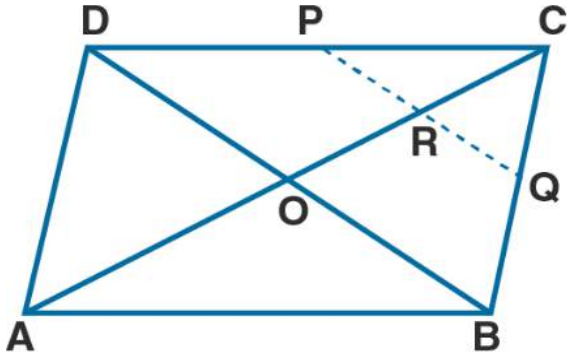
L is the mid-point of BC

In $\triangle FAD$

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E is the mid-point of AD and BE \parallel LD at FLD
So B is the mid-point of AF
Here
 $EB = \frac{1}{2} FD = LF$

6. In the given figure, ABCD is a parallelogram. If P and Q are mid-points of sides CD and BC respectively, show that $CR = \frac{1}{2} AC$.



Solution:

It is given that
ABCD is a parallelogram
P and Q are mid-points of CD and BC

To prove: $CR = \frac{1}{4} AC$

Construction: Join AC and BD

Proof:

In parallelogram ABCD
Diagonals AC and BD bisect each other at O
 $AO = OC$ or $OC = \frac{1}{2} AC$ (1)

In $\triangle BCD$

P and Q are mid points of CD and BC
 $PQ \parallel BD$

In $\triangle BCO$

Q is the mid-point of BC and $PQ \parallel OB$
Here R is the mid-point of CO

So we get

$$CR = \frac{1}{2} OC = \frac{1}{2} \left(\frac{1}{2} AC\right)$$

$$CR = \frac{1}{4} AC$$

Hence, it is proved.

