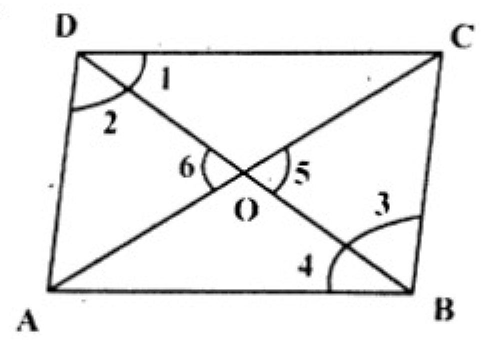
THEOREM 11.1.1

Prove that in a parallelogram:

(i) **Opposite sides are congruent**
(ii) **Opposite angles are congruent.**
(iii) **The diagonals bisect each other.**

Solution:



Given

In a quadrilateral ABCD, $\overline{BC} \parallel \overline{AD}$, $\overline{AB} \parallel \overline{DC}$, and the diagonals $\overline{AC}$, $\overline{BD}$ meet each other at point O.

To Prove

(i) $\overline{AB} \cong \overline{DC}$, $\overline{AD} \cong \overline{BC}$,
(ii) $\angle ADC \cong \angle ABC$, $\angle BAD \cong \angle BCD$
(iii) $\overline{OB} \cong \overline{OD}$, $\overline{OA} \cong \overline{OC}$

Construction

In the figure as shown, we label the angles as $\angle 1, \angle 2, \angle 3, \angle 4, \angle 5$ and $\angle 6$.

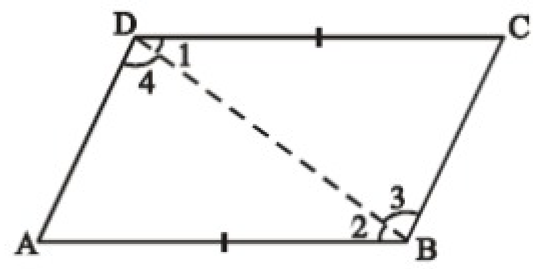
Proof:

Statements	**Reasons**
In $\Delta ABD \leftrightarrow \Delta CDB$	
$\angle 4 \cong \angle 1$	alternate angles
$\overline{BD} \cong \overline{BD}$,	Common

$\angle 2 \cong \angle 3$	alternate angles
$\therefore \Delta ABD \cong \Delta CDB$	A.S.A. ≅ A.S.A.
So, $\overline{AB} \cong \overline{DC}$	(corresponding sides of congruent triangles)
$\overline{AD} \cong \overline{BC}$,	
and $\angle A \cong \angle C$	(corresponding angles of congruent triangles)
(ii) In $\Delta ADB \leftrightarrow \Delta CDB$	Proved
$\angle 1 \cong \angle 4$ ...... (a)	Proved
and $\angle 2 \cong \angle 3$ ...... (b)	from (a) and (b)
$\therefore m\angle 1 + m\angle 2 = m\angle 4 + m\angle 3$	Proved in (i)
or $m\angle ADC \cong m\angle ABC$	
$\angle ADC \cong \angle ABC$ and	
$\angle BAD \cong \angle BCD$	
(iii) In $\Delta BOC \leftrightarrow \Delta DOA$	Proved in (i)
$\overline{BC} \cong \overline{AD}$	vertical angles
$\angle 5 \cong \angle 6$	Proved
$\angle 3 \cong \angle 2$	(A.A.S. ≅ A. A. S.)
$\therefore \Delta BOC \cong \Delta DOA$	(corresponding sides of congruent triangles)
Hence $\overline{OC} \cong \overline{OA}$, $\overline{OB} \cong \overline{OD}$	

THEOREM 11.1.2

If two opposite sides of a quadrilateral are congruent and parallel, it is a parallelogram.



Given

In a quadrilateral ABCD,

$\overline{AB} \simeq \overline{DC}$ and ABDC

To Prove

ABCD is a parallelogram.

Construction

Join the point B to D and in the figure, name the angles as indicated: $\angle1, \angle2, \angle3$ and $\angle4$.

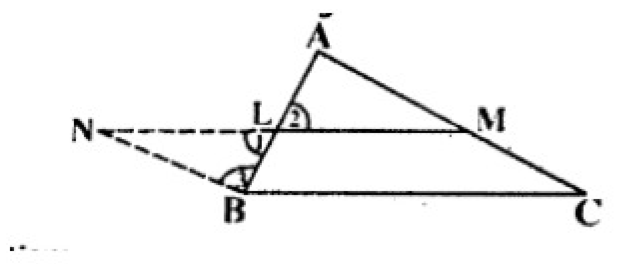
Proof:

Statements	**Reasons**
$\angle1 \cong \angle2$	Alternate angles
In $\Delta ABD \leftrightarrow \Delta CDB$	
$\overline{AB} \cong \overline{DC}$,	given
$\angle2 \cong \angle1$	Alternate angles
$\overline{BD} \cong \overline{BD}$	Common
$\therefore \Delta ABD \cong \Delta CDB$	S.A.S. postulate

Now $\angle4 \cong \angle3$ ....(i)	(corresponding angles of congruent triangles)
$\therefore \overline{AD} \parallel \overline{BC}$ ....(ii)	from (i)
and $\overline{AD} \parallel \overline{DC}$ ....(iii)	given
Hence ABCD is a parallelogram	from (ii) - (iii)

THEOREM 11.1.3

The line segment, joining the mid-points of two sides of a triangle, is parallel to the third side and is equal to one half of its length.



Solution:

Given

In ΔABC, the mid-points of $\overline{AB}$ and $\overline{AC}$ are L and M respectively.

To Prove

$\overline{LM} \parallel \overline{BC}$ and $m\overline{LM} = \frac{1}{2} m\overline{BC}$

Construction

Join M to L and produce $\overline{ML}$ to N such that $\overline{ML} \cong \overline{LN}$

Join N to B and in the figure, name the angles as $\angle 1, \angle 2$ and $\angle 3$ as shown.

Proof

Statements	Reasons
In $\Delta BLN \leftrightarrow \Delta ALM$	
$\overline{BL} \cong \overline{AL}$	Given
$\angle 1 \cong \angle 2$	Vertical angles
$\overline{NL} \cong \overline{ML}$	Construction
$\therefore \Delta BLN \cong \Delta ALM$	S.A.S. postulate
$\therefore \angle A \cong \angle 3$ ....(i)	(corresponding angles of congruent triangles)
and $\overline{NB} \cong \overline{AM}$ ....(ii)	(corresponding sides of congruent triangles)
But $\overline{NB} \parallel \overline{AM}$	From (i)
=> $\overline{NB} \parallel \overline{MC}$ ....(iii)	M is a point of $\overline{AC}$
$\overline{MC} \cong \overline{AM}$ ....(iv)	Given
$\overline{NB} \cong \overline{MC}$ ....(v)	{from (ii) and (iv)}
∴ BCMN is a parallelogram	from (iii) and (v)
$\therefore \overline{BC} \parallel \overline{LM}$ or $\overline{BC} \parallel \overline{NL}$	(opposite sides of a parallelogram BCMN
$\overline{BC} \cong \overline{NM}$ ....(vi)	Opposite sides of a parallelogram
$m\overline{LM} = m\frac{1}{2}\overline{NM}$ ....(vii)	Construction

Statements	Reasons
Thus $m\overline{LM} = \frac{1}{2} m\overline{BC}$	{from (vi) and (vii)}

THEOREM 11.1.4

The medians of a triangle are concurrent, and their point of concurrency is the point of trisection of each median.

Given

ABC is the triangle

To prove

The medians of the ABC are concurrent, and the point of concurrency is the point of trisection of each median.

Construction

Draw two medians $\overline{BE}$ and $\overline{CF}$ of the ΔABC which intersect each other at G. Join A to G and produce it to point H such that $\overline{AG} \cong \overline{GH}$. Join H to the points B and C.

$\overline{AH}$ intersects $\overline{BC}$ at the point D.

Proof

Statements	Reasons
In ΔACH,	
$\overline{GE} \parallel \overline{CH}$	E and G are mid-points of $\overline{AC}$ and $\overline{AH}$
or $\overline{BE} \parallel \overline{CH}$ ....(i)	G is a point of $\overline{BE}$
Similarly, $\overline{CF} \parallel \overline{BH}$ ....(ii)	from (i)
∴ BHCG is a parallelogram	from (i) and (ii)
and $m\overline{GD} = \frac{1}{2} m\overline{GH}$ ....(iii)	Diagonals $\overline{BC}$ and $\overline{GH}$ of a parallelogram BHCG intersect

	each other at point D.
$\overline{BD} \cong \overline{CD}$	
$\overline{AD}$ is a median of ΔABC	G is the intersecting point of $\overline{BE}$
Medians $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$ pass through the point G	and $\overline{CF}$ and $\overline{AD}$ pass through it.
Now $\overline{GH} \cong \overline{AG}$ ....(iv)	Construction
∴ $m\overline{GD} = \frac{1}{2} m\overline{AG}$	from (iii) and (iv)
and G is the point of trisection of AD ....(v)	
Similarly, it can be proved that G is also the point of trisection of $\overline{CF}$ and $\overline{BE}$.	

THEOREM 11.1.5

If three or more parallel lines make congruent segments on one transversal, they also intercept congruent segments on any other transversal.

Solution:

Given

$\overline{AB} \parallel \overline{CD} \parallel \overline{EF}$

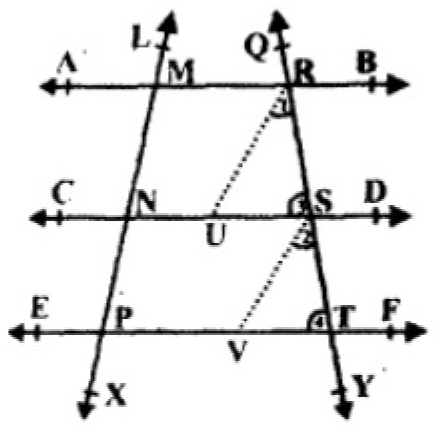
The transversal $\overline{LX}$ intersects $\overline{AB}$, $\overline{CD}$ and $\overline{EF}$ at the points M, N and P respectively, such that $MN \cong \overline{NP}$. The transversal $\overline{QY}$ intersects them at points R, S and T respectively.

To prove

$\overline{RS} \cong \overline{ST}$

Constructio

From R, draw $\overline{RU} \parallel \overline{LX}$, which meets $\overline{CD}$ at U. From S, draw $\overline{SV} \parallel \overline{LX}$ which meets $\overline{EF}$ at V and according to the figure the names of the angles are $\angle 1, \angle 2, \angle 3$ and $\angle 4$.



Proof

Statements	Reasons
MNUR is a parallelogram	$\overline{RU} \parallel \overline{LX}$ (construction) $\overline{AB} \parallel \overline{CD}$ (given)
$\therefore \overline{MN} \cong \overline{RU}$ (i)	opposite sides of a parallelogram
Similarly,	
$\overline{NP} \cong \overline{SV}$ (ii)	
But $\overline{MN} \cong \overline{NP}$ (iii)	Given
$\therefore \overline{RU} \cong \overline{SV}$	from (i), (ii) and (iii)
Also $\overline{RU} \parallel \overline{SV}$	each one $\parallel \overline{LX}$ (construction)
$\therefore \angle 1 \cong \angle 2$	Corresponding angles
and $\angle 3 \cong \angle 4$	Corresponding angles
In $\Delta RUS \leftrightarrow \Delta SVT$,	
$\overline{RU} \cong \overline{SV}$	Proved
$\angle 1 \cong \angle 2$	Proved
$\angle 3 \cong \angle 4$	Proved
$\therefore \Delta RUS \cong \Delta SVT$	S.A.A. ≅ S.A.A.
And $\overline{RS} \cong \overline{ST}$	(corresponding sides of congruent triangles)

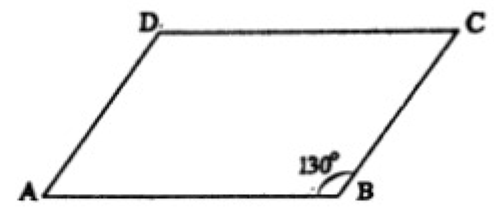
EXERCISE 11.1

Q1. One angle of a parallelogram is 130°. Find the measures of its remaining angles.

Solution:

In parallelogram ABCD $m\angle B = 130^\circ$

$\angle D \cong \angle B$



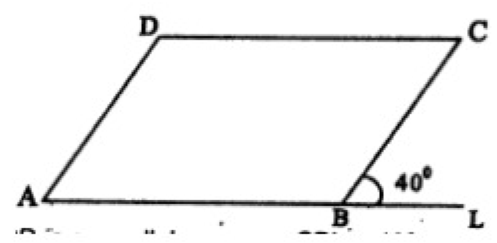
Opposite angles of a parallelogram

$$m\angle D = m\angle B = 130^\circ$$
$$m\angle B + m\angle A = 180^\circ$$
$$\therefore \quad 130^\circ + m\angle A = 180^\circ$$
$$m\angle A = 180^\circ - 130^\circ = 50^\circ$$
$$m\angle C = m\angle A = 50^\circ$$

So unknown angles of parallelogram are 130°, 50°.

Q2. One exterior angle formed on producing one side of a Parallelogram is 40°.

Solution:



ABCD is parallelogram $m\angle CBL = 40^\circ$

$$m\angle ABC + 40^\circ = 180^\circ$$

$\therefore$ ABL is a straight line

$$\therefore \quad m\angle ABC = 180^\circ - 40^\circ = 140^\circ$$
$$m\angle D = m\angle ABC = 140^\circ$$

Opposite angles of a parallelogram

$$m\angle D + m\angle C = 180^\circ$$
$$140^\circ + m\angle C = 180^\circ$$
$$m\angle C = 180^\circ - 140^\circ = 40^\circ$$
$$m\angle A = m\angle C .= 40^\circ$$

Opposite angles of parallelogram

So, the measures of interior angles of the parallelogram are 140°, 40°, 140° and 40°.

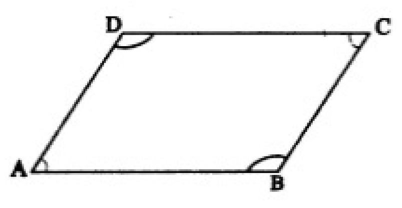
EXERCISE 11.2

Q1. Prove that a quadrilateral is a parallelogram if its

a. **Opposite angles are congruent.**
b. **Diagonals bisect each other.**

Solution:

(a) Opposite angles are congruent.



Given:

In a quadrilateral ABCD

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

To Prove:

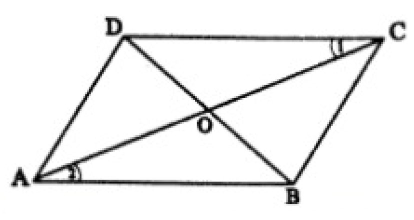
ABCD is a parallelogram

Proof:

Statements	Reasons
$m\angle A = m\angle C$ (i)	Given
$m\angle B = m\angle D$ (ii)	Given
$m\angle A + m\angle B + m\angle C + m\angle D = 360°$	Angles of quadrilateral
$m\angle A + m\angle B + m\angle A + m\angle B = 360°$	From (i) and (ii)

$2m\angle A + 2m\angle B = 360°$	
$\therefore m\angle A + m\angle B = 180°$	
$\therefore \overline{AD} \parallel \overline{BC}$	Sum of internal angles
Similarly, it can be proved	
that $\overline{AB} \parallel \overline{CD}$	
Hence ABCD is a parallelogram.	

(b) Diagonals bisect each other.



Solution:

Given:

In quadrilateral ABCD, diagonals $\overline{AC}$ and $\overline{BD}$ bisect each other, i.e. $\overline{OA} \cong \overline{OC}$, $\overline{OB} \cong \overline{OD}$

To prove:

ABCD is a parallelogram

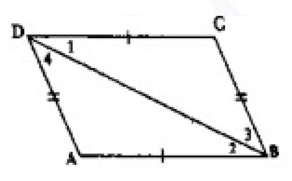
Proof:

Statements	Reasons
In $\Delta ABO \leftrightarrow \Delta CDO$	
$\overline{OA} \cong \overline{OC}$,	Given

$\overline{OB} \cong \overline{OD}$	Given
$\therefore \angle AOB \cong \angle COD$	Vertical opposite angles
$\therefore \angle AOB \cong \angle COD$	S.A. S ≅ S.A.S.
$\angle 1 \cong \angle 2$	Corresponding angles of congruent triangles
Hence $\overline{AB} \parallel \overline{OC}$ (i)	$\angle 1 = \angle 2$
By taking Δ,s AOD and BOC we can prove that	
$\overline{AD} \parallel \overline{BC}$ (ii)	From (i) and (ii)
Hence ABCD is a parallelogram.	

Q2. Prove that a quadrilateral is a parallelogram if its opposite sides are congruent.

Solution:



Given:

In quadrilateral ABCD

$\overline{AB} \cong \overline{DC}$, and $\overline{AD} \cong \overline{BC}$

To prove:

ABCD is a parallelogram

Construction:

Join B to D

Proof:

Statements	Reasons
In $\Delta ABD \leftrightarrow \Delta CBD$	
$\overline{AD} \cong \overline{CB}$,	Given
$\overline{AB} \cong \overline{CD}$	Given
$\overline{BD} \cong \overline{BD}$	Common
$\therefore \angle ABD \cong \angle CDB$	S.A. S ≅ S.A.S.
$\angle 1 \cong \angle 2$ (i)	Corresponding angles of congruent triangles
And $\angle 4 \cong \angle 3$ (ii)	(i) alternate angles
Hence $\overline{AB} \parallel \overline{DC}$	(ii) alternate angles
And $\overline{BC} \parallel \overline{AD}$	
Hence ABCD is a paralleloaram.	

EXERCISE 11.3

Q1. Prove that the line-segments joining the midpoints of the opposite sides of a quadrilateral bisect each other.

Solution:

Given:

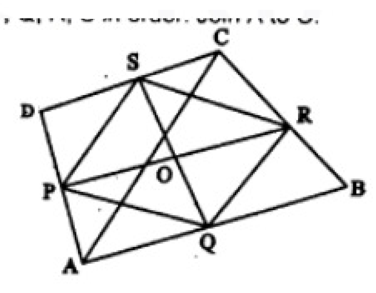
In quadrilateral ABCD, P, Q, R, S are the mid-points of the sides PR and QS are joined, they meet at O.

To prove:

$\overline{OP} \cong \overline{OR}$, $\overline{OS} \cong \overline{OQ}$

Construction:

Join P, Q, R, S in order. Join A to C.



Proof

Statements	Reasons
$\overline{SD} \cong \overline{AC}$ (i)	In ΔADC, S, P, are mid points of AD, DC.
$m\overline{SP} = \frac{1}{2} m\overline{AC}$ (ii)	In ΔABC, P, Q are mid points of AB, BC.

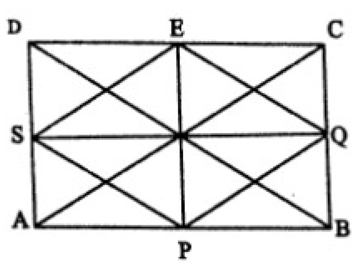
$\overline{RQ} \parallel \overline{AC}$ (iii)	
$m\overline{RQ} = \frac{1}{2} m\overline{AC}$ (iv)	From (ii) and (iv)
$\therefore \overline{SP} \parallel \overline{RQ}$ (v)	
and M$\overline{RQ} = \frac{1}{2} m\overline{AC}$ (vi)	From (v) and (vi)
∴ PQRS is a parallelogram	
Now $\overline{PR}$ and $\overline{SQ}$ diagonals of parallelogram PQRS intersect at O	Diagonals of a parallelogram bisect each other
$\therefore \overline{OP} \cong \overline{OR}$	
And $\overline{OS} \cong \overline{OQ}$	

Q2. Prove that the fine-segments joining the midpoints of the opposite sides of a rectangle are the right-bisectors of each other.

Solution:

Given:

In rectangle ABCD, P, Q, R, S are mid-point of the sides P is joined to R, Q is joined to S. $\overline{PR}$ and $\overline{QS}$ intersect at O.



To prove:

$\overline{PR}$ and $\overline{QS}$ are right bisectors of each other.

Construction:

Join P, Q, R, S in order. Join A to C and B to D.

Proof

Statements	Reasons
$\overline{SR} \cong \overline{AC}$ (i)	In ΔADC, S, R, are mid points of AD, DC.
$m\overline{SR} = \frac{1}{2} m\overline{AC}$ (ii)	In ΔABC, P, Q are mid points of AB, BC.
And $\overline{PQ} \parallel \overline{AC}$ (iii)	From (i) and (ii)
$m\overline{PQ} = \frac{1}{2} m\overline{AC}$ (iv)	From (ii) and (iv)
$\therefore \overline{SR} \parallel \overline{PQ}$ (v)	
and $m\ \overline{SR} = m\overline{PQ}$ (vi)	From (v) and (vi)
∴ PQRS is a parallelogram	Diagonals of a rectangle
$m\ \overline{AC} = m\ \overline{BD}$	
$m\ \overline{AC} = m\ \overline{BD}$	

$m\ \overline{PQ} = m\ \overline{QR}$	
$\therefore m\ \overline{PQ} = m\ \overline{QR} = m\ \overline{RS} = m\ \overline{SP}$	
∴ PQRS is a rhombus.	
$\overline{PR}$ and $\overline{QS}$ are diagonals of rhombus PQRS.	Diagonals of a parallelogram bisect each other
$\therefore \overline{PR}$ and $\overline{QS}$ are right bisectors of each other.	

Q3. Prove that the line-segment passing through the mid-points of one side and parallel to another side of a triangle also bisect the third side.

Solution.

Given:

In ΔABC, D is mid-point of AB $\overline{DE} \parallel \overline{BC}$

To prove:

$\overline{EA} \parallel \overline{EC}$

Construction:

Take $\overline{EF} \parallel \overline{AB}$

Proof

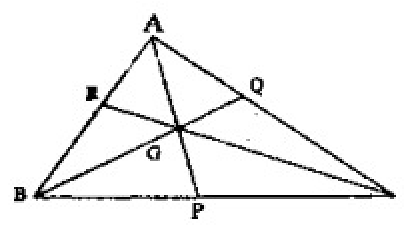
Statements	Reasons
$\overline{DE} \parallel \overline{BC}$	Given
$\overline{EF} \parallel \overline{BD}$	Construction

∴ DBEF is a parallelogram.	
$\overline{EF} \cong \overline{DB}$	Opposite sides
$\overline{AD} \cong \overline{DB}$	Given
$\overline{EF} \cong \overline{AD}$	From (i) and (ii)
$\angle 1 \cong \angle B$	corresponding angles
and $\angle 2 \cong \angle B$	
$\therefore \angle 1 \cong \angle 2$	
In $\triangle ADE \leftrightarrow \triangle EFC$	From (iv)
$\angle 2 \cong \angle 1$	Corresponding angle
$\therefore \angle 3 \cong \angle C$	From (iii)
$\overline{AD} \cong \overline{EF}$	S.S.A.=S.S.A
Hence $\triangle ADE \cong \triangle EFC$	Corresponding sides
$\therefore \overline{EA} \cong \overline{EC}$ [redacted]	[redacted]

EXERCISE 11.4

Q1. The distance of the point of concurrency of the medians of a triangle from its vertices are respectively 1.2 cm, 1.4 cm and 1.6 cm. Find the lengths of its medians.

Solution:



Let ABC be triangle with the point of concurrency of medians at G.

$m\,\overline{AG} = 1.2$cm, $m\,\overline{BG} = 1.4$cm and $m\,\overline{CG} = 1.6$cm

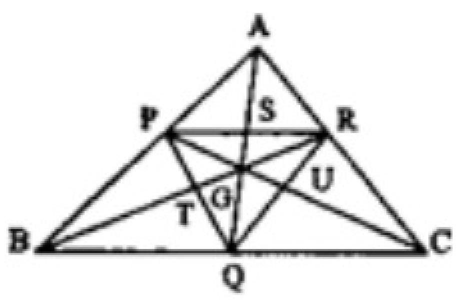
$m\,\overline{AP} = \frac{3}{2}\,(m\,\overline{AG}) = \frac{3}{2} \times 1.2 = 1.8$cm

$m\,\overline{BQ} = \frac{3}{2}\,(m\,\overline{BG}) = \frac{3}{2} \times 1.4 = 2.1$cm

$m\,\overline{CR} = \frac{3}{2}\,(m\,\overline{CG}) = \frac{3}{2} \times 1.6 = 2.4$cm

Q2. Prove that the point of concurrency of the medians of a triangle and the triangle which is made by joining the mid-points of its sides is the same.

Solution:



Given:

In triangle ABC, $\overline{CP}$, $\overline{AQ}$, $\overline{BR}$ are medians, with meet at G. ΔPQR is formed by joining the mid points P, Q, R.

To prove:

G is the point of concurrency of the medians of ΔABC and ΔPQR.

Proof

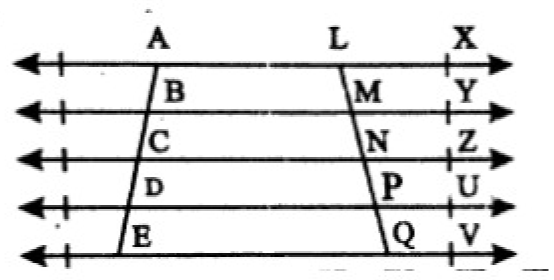
Statements	Reasons
$\overline{PR} \parallel \overline{BC}$	P, R, are mid-points of $\overline{AB}$, $\overline{AC}$.
$\overline{PR} \parallel \overline{BQ}$	
Similarly, $\overline{QR} \parallel \overline{BP}$	
∴ PBQR is a parallelogram.	
Its diagonal $\overline{BR}$ and $\overline{PQ}$	
I bisect each other at T.	
i.e. T is mid-point of $\overline{PQ}$.	
Similarly, U is midpoint of $\overline{QR}$ and S is mid-point of $\overline{PR}$.	
∴ $\overline{PU}$, $\overline{QS}$, $\overline{RT}$ are medians of ΔPQR	
(i) $\overline{AQ}$ and $\overline{SQ}$ pass through G.	
(ii) $\overline{BR}$ and $\overline{TR}$ pass through G.	
(iii) $\overline{CP}$ and $\overline{UP}$ pass through G.	

Hence G is point of concurrency of medians of ΔAGC and ΔPQR.	

EXERCISE 11.5

Q1. In the given figure $\overline{AX} \parallel \overline{BY} \parallel \overline{CZ} \parallel \overline{DU} \parallel \overline{EV}$ and $\overline{AB} \cong \overline{BC} \cong \overline{CD} \cong \overline{DE}$. If m$\overline{MN}$ = 1cm, then find the length of $\overline{LN}$ and $\overline{LQ}$.

Solution:



$\overline{AX} \parallel \overline{BY} \parallel \overline{CZ} \parallel \overline{DU} \parallel \overline{EV}$ and $\overline{AB} \cong \overline{BC} \cong \overline{CD} \cong \overline{DE}$

$\overline{LM} \cong \overline{MN} \cong \overline{NP} \cong \overline{PQ}$

$m\overline{LN} = m\ \overline{LM} + m\ \overline{MN}$

$= m\ \overline{MN} + m\ \overline{MN}$

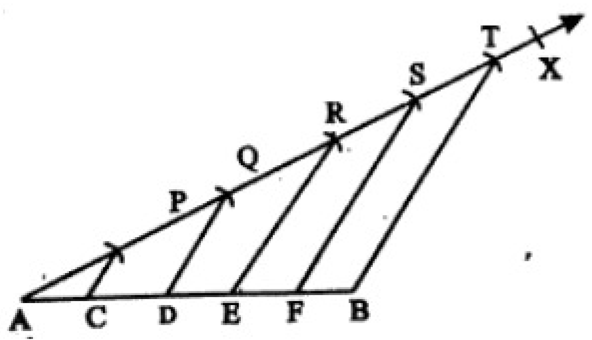
$= 1\ cm + 1\ m = 2\ cm$

$m\ \overline{LQ} = m\ \overline{LM} + m\ \overline{MN} + m\ \overline{NP} + m\ \overline{PQ}$

$= 1cm + 1\ cm + 1\ cm + 1\ cm = 4\ cm$

Q2. Take a line segment of length 5.5 cm and divide it into five congruent parts.

Solution



Construction:

(i) Draw a line segment $\overline{AB}$ of length 5 cm.

(ii) Draw an acute angle $\angle BAX$.

(iii) On $\overline{AX}$ with the help of compass take five points P, Q, R, S, T such that $\overline{AP} \cong \overline{PQ} \cong \overline{QR} \cong \overline{RS} \cong \overline{ST}$.

(IV) Join T to B.

(v) Draw lines $\overline{SF}$, $\overline{RE}$, $\overline{QD}$, $\overline{PC}$ parallel to $\overline{TB}$.

The points C, D, E, F divide the line Segment $\overline{AB}$ into five congruent parts.

REVIEW EXERCISE 11

Q1. Fill in the blanks

(i) In a parallelogram opposite sides are ....

(ii) In a parallelogram opposite angles are ....

(iii) Diagonals of a parallelogram .... each other at a point.

(iv) Medians of a triangle are ....

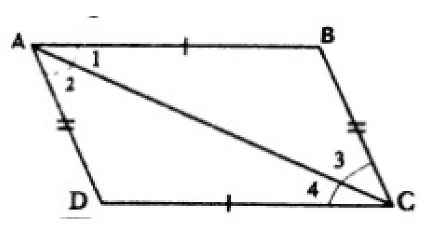
(v) Diagonal of a parallelogram divides the parallelogram into two .... triangles

Answers:

(i) parallel/congruent **(ii)** equal/ congruent **(iii)** Intersect

(iv) concurrent **(v)** congruent

Q2. In parallelogram ABCD



(i) $m\overline{AB}$ .... $m\overline{DC}$ **(ii)** $m\overline{BC}$ .... $m\overline{AD}$ **(iii)** $m\angle 1 \cong$.... **(iv)** $m\angle 2 \cong$....

Answers:

(i) $\cong$ **(ii)** $\cong$ **(iii)** $m\angle 3$ **(iv)** $m\angle 1$

Q3. Find the unknowns in the given figure.

Solution:

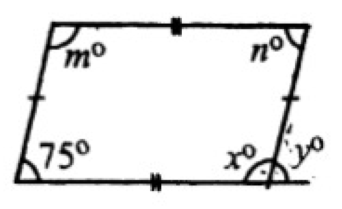
$n° \cong 75°$ opposite angles are congruent

$n = 75$

$y° \cong n°$ Alternate angles

$\mathbf{y° \cong n° \cong 75°}$

$\mathbf{y = 45}$



$x° + y° = 180°$ suppletory angles

$x + y = 180$

$x + 75 = 180$

$x = 180 - 75 = 105$

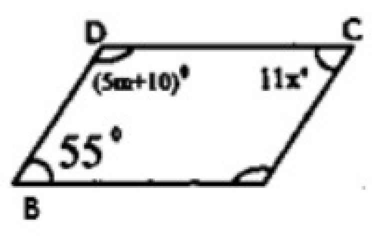
$m° \cong x°$ opposite angles

$m = x = 105$

$m° = 105°$

Q4. If the given figure ABCD is a parallelogram, then find x, m.

Solution



$11x \cong 55°$
$11x = 55$
$x = 5°$
$(5m + 10)° + 55° = 180°$

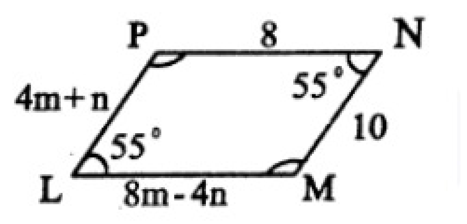
Sum of interior angles of II lines

$5m + 10 + 55 = 180$
$5m + 65 = 180$
$m = 23°$

Q5. The given figure LMNP is a parallelogram. Find the value of m, n.

Solution:

As opposite sides of a parallelogram are congruent



$8m - 4n = 8$

Or $2m - n = 2$ (i)

And $4m + n = 10$ (ii)

Adding (i) and (ii)

$6m = 12$

or $m = 2$

Putting $m = 2$ in (i)

We have

$2(2) - n = 2$

$4 - n = 2$

Or $-n = -2$

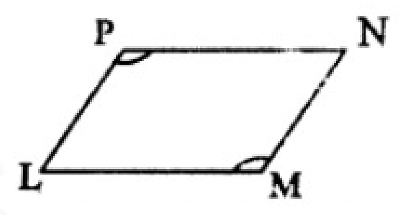
Or $n = 2$

$m = 2, n = 2$

Q6. In the question 5, sum of the opposite angles of the parallelogram is 110°, find the remaining angles.

Solution:

Opposite angles of a parallelogram are congruent



$\angle L \cong \angle N$

But it is given that

$m\angle L + m\angle N = 110$
$2(m\angle L) = 110 \; m\angle L = 55$
$m\angle L = m\angle N = 55°$

$m\angle L + m\angle P = 180°$

Sum of interior angles between parallel lines

$55 + m\angle P = 180°$
$m\angle P = 180° - 55° = 125°$

Angles of the parallelogram are

$55°, 125°, 55° \text{ and } 125°$
$m\angle M = m\angle P = 125°$