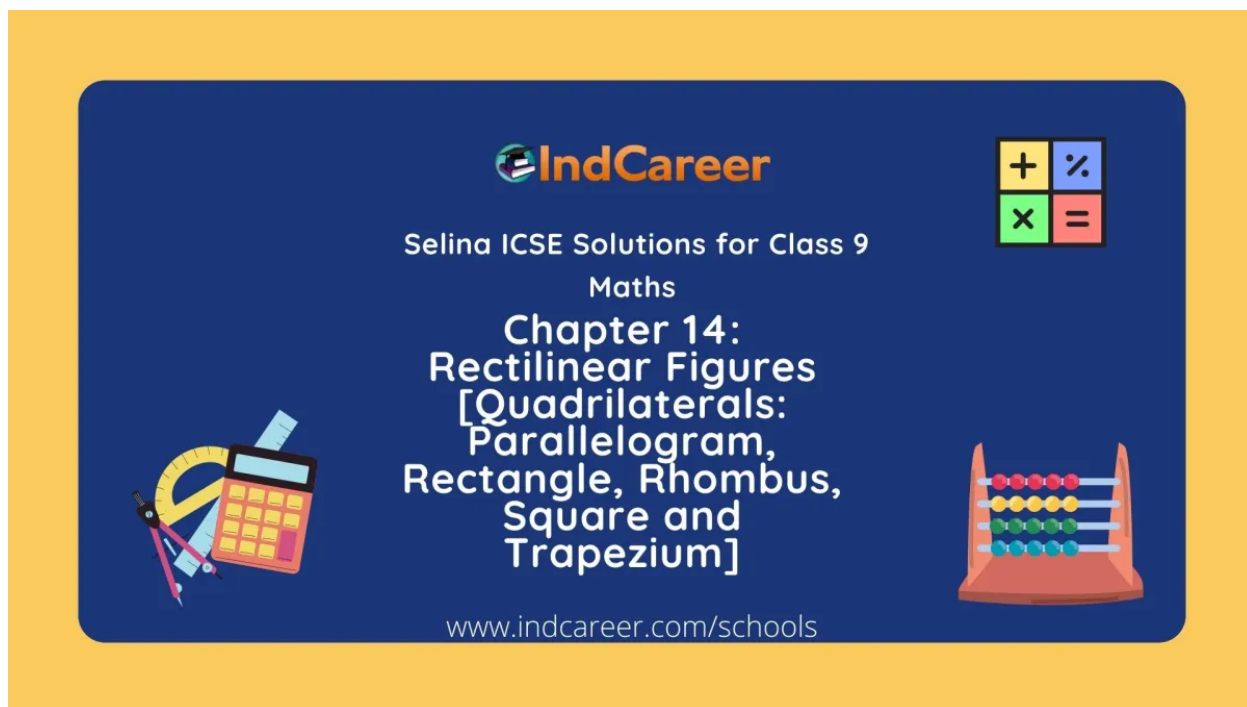


Selina Class 9 ICSE Solutions Mathematics : Chapter 14- Rectilinear Figures [Quadrilaterals: Parallelogram, Rectangle, Rhombus, Square and Trapezium]



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Postal Address

IndCareer.com, 52, Shilpa Nagar, Somalwada Nagpur - 440015
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Selina Class 9 ICSE Solutions Mathematics :

Chapter 14- Rectilinear Figures

[Quadrilaterals: Parallelogram, Rectangle, Rhombus, Square and Trapezium]

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Exercise 14(A)

Solution 1:

The sum of the interior angle = 4 times the sum of the exterior angles.

Therefore the sum of the interior angles = $4 \times 360^\circ = 1440^\circ$.

Now we have

$$(2n - 4) \times 90^\circ = 1440^\circ$$

$$2n - 4 = 16$$

$$2n = 20$$

$$n = 10$$

Thus the number of sides in the polygon is 10.

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Solution 2:

Let the angles of the pentagon are $4x$, $8x$, $6x$, $4x$ and $5x$.

Thus we can write

$$4x + 8x + 6x + 4x + 5x = 540^\circ$$

$$27x = 540^\circ$$

$$x = 20^\circ$$

Hence the angles of the pentagon are:

$$4 \times 20^\circ = 80^\circ, 8 \times 20^\circ = 160^\circ, 6 \times 20^\circ = 120^\circ, 4 \times 20^\circ = 80^\circ, 5 \times 20^\circ = 100^\circ$$

Solution 3:

Let the measure of each equal angles are x .

Then we can write

$$140^\circ + 5x = (2 \times 6 - 4) \times 90^\circ$$

$$140^\circ + 5x = 720^\circ$$

$$5x = 580^\circ$$

$$x = 116^\circ$$

Therefore the measure of each equal angles are 116°

Solution 4:

Let the number of sides of the polygon is n and there are k angles with measure 195° .

Therefore we can write:

$$5 \times 90^\circ + k \times 195^\circ = (2n - 4) 90^\circ$$

$$180^\circ n - 195^\circ k = 450^\circ - 360^\circ$$

$$180^\circ n - 195^\circ k = 90^\circ$$

$$12n - 13k = 6$$

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In this linear equation n and k must be integer. Therefore to satisfy this equation the minimum value of k must be 6 to get n as integer.

Hence the number of sides are: $5 + 6 = 11$.

Solution 5:

Let the measure of each equal angles are x .

Then we can write:

$$3 \times 132^\circ + 4x = (2 \times 7 - 4) 90^\circ$$

$$4x = 900^\circ - 396$$

$$4x = 504$$

$$x = 126^\circ$$

Thus the measure of each equal angles are 126° .

Solution 6:

Let the measure of each equal sides of the polygon is x .

Then we can write:

$$142^\circ + 176^\circ + 6x = (2 \times 8 - 4) 90^\circ$$

$$6x = 1080^\circ - 318^\circ$$

$$6x = 762^\circ$$

$$x = 127^\circ$$

Thus the measure of each equal angles are 127° .

Solution 7:

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Let the measure of the angles are $3x$, $4x$ and $5x$.

Thus

$$\angle A + \angle B + \angle C + \angle D + \angle E = 540^\circ$$

$$3x + (\angle B + \angle C) + 4x + 5x = 540^\circ$$

$$12x + 180^\circ = 540^\circ$$

$$12x = 360^\circ$$

$$x = 30^\circ$$

Thus the measure of angle E will be $4 \times 30^\circ = 120^\circ$

Solution 8:

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(i)

Let each angle of measure x degree.

Therefore measure of each angle will be:

$$x = 180^\circ - 2 \times 15^\circ = 150^\circ$$

(ii)

Let each angle of measure x degree.

Therefore measure of each exterior angle will be:

$$\begin{aligned} x &= 180^\circ - 150^\circ \\ &= 30^\circ \end{aligned}$$

(iii)

Let the number of each sides is n .

Now we can write

$$\begin{aligned} n \cdot 150^\circ &= (2n - 4) \times 90^\circ \\ 180^\circ n - 150^\circ n &= 360^\circ \\ 30^\circ n &= 360^\circ \\ n &= 12 \end{aligned}$$

Thus the number of sides are 12.

Solution 9:

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Let measure of each interior and exterior angles are $3k$ and $2k$.

Let number of sides of the polygon is n .

Now we can write:

$$\begin{aligned}n \cdot 3k &= (2n - 4) \times 90^\circ \\3nk &= (2n - 4)90^\circ \quad \dots(1)\end{aligned}$$

Again

$$\begin{aligned}n \cdot 2k &= 360^\circ \\nk &= 180^\circ\end{aligned}$$

From (1)

$$\begin{aligned}3 \cdot 180^\circ &= (2n - 4)90^\circ \\3 &= n - 2 \\n &= 5\end{aligned}$$

Thus the number of sides of the polygon is 5.

Solution 10:

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For $(n-1)$ sided regular polygon:

Let measure of each angle is x .

Therefore

$$(n-1)x = (2(n-1)-4)90^\circ$$
$$x = \frac{n-3}{n-1}180^\circ$$

For $(n+1)$ sided regular polygon:

Let measure of each angle is y .

Therefore

$$(n+2)y = (2(n+2)-4)90^\circ$$
$$y = \frac{n}{n+2}180^\circ$$

Now we have

$$y - x = 6^\circ$$
$$\frac{n}{n+2}180^\circ - \frac{n-3}{n-1}180^\circ = 6^\circ$$
$$\frac{n}{n+2} - \frac{n-3}{n-1} = \frac{1}{30}$$
$$30n(n-1) - 30(n-3)(n+2) = (n+2)(n-1)$$
$$-30n + 30n + 180 = n^2 + n - 2$$
$$n^2 + n - 182 = 0$$
$$(n-13)(n+14) = 0$$
$$n = 13, -14$$

Thus the value of n is 13.

Solution 11:

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(i)

Let the measure of each exterior angle is x and the number of sides is n .

Therefore we can write:

$$n = \frac{360^\circ}{x}$$

Now we have

$$x + x + 90^\circ = 180^\circ$$

$$2x = 90^\circ$$

$$x = 45^\circ$$

(ii)

Thus the number of sides in the polygon is:

$$\begin{aligned} n &= \frac{360^\circ}{45^\circ} \\ &= 8 \end{aligned}$$

Exercise 14(B)

Solution 1:

(i) True.

This is true, because we know that a rectangle is a parallelogram. So, all the properties of a parallelogram are true for a rectangle. Since the diagonals of a parallelogram bisect each other, the same holds true for a rectangle.

(ii) False

This is not true for any random quadrilateral. Observe the quadrilateral shown below.

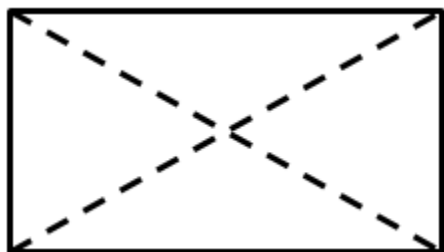
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Clearly the diagonals of the given quadrilateral do not bisect each other. However, if the quadrilateral was a special quadrilateral like a parallelogram, this would hold true.

(iii) False

Consider a rectangle as shown below.



It is a parallelogram. However, the diagonals of a rectangle do not intersect at right angles, even though they bisect each other.

(iv) True

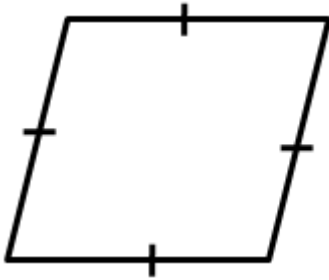
Since a rhombus is a parallelogram, and we know that the diagonals of a parallelogram bisect each other, hence the diagonals of a rhombus too, bisect other.

(v) False

This need not be true, since if the angles of the quadrilateral are not right angles, the quadrilateral would be a rhombus rather than a square.

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(vi) True



A parallelogram is a quadrilateral with opposite sides parallel and equal.

Since opposite sides of a rhombus are parallel, and all the sides of the rhombus are equal, a rhombus is a parallelogram.

(vii) False

This is false, since a parallelogram in general does not have all its sides equal. Only opposite sides of a parallelogram are equal. However, a rhombus has all its sides equal. So, every parallelogram cannot be a rhombus, except those parallelograms that have all equal sides.

(viii) False

This is a property of a rhombus. The diagonals of a rhombus need not be equal.

(ix) True

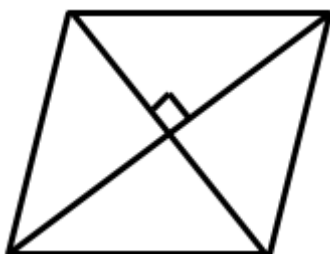
A parallelogram is a quadrilateral with opposite sides parallel and equal.

A rhombus is a quadrilateral with opposite sides parallel, and all sides equal.

If in a parallelogram the adjacent sides are equal, it means all the sides of the parallelogram are equal, thus forming a rhombus.

(x) False

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Observe the above figure. The diagonals of the quadrilateral shown above bisect each other at right angles, however the quadrilateral need not be a square, since the angles of the quadrilateral are clearly not right angles.

Solution 2:

From the given figure we conclude that

$$\angle A + \angle D = 180^\circ \text{ [since consecutive angles are supplementary]}$$

$$\frac{\angle A}{2} + \frac{\angle D}{2} = 90^\circ$$

Again from the $\triangle ADM$

$$\frac{\angle A}{2} + \frac{\angle D}{2} + \angle M = 180^\circ$$

$$\Rightarrow 90^\circ + \angle M = 180^\circ \quad \left[\text{since } \frac{\angle A}{2} + \frac{\angle D}{2} = 90^\circ \right]$$

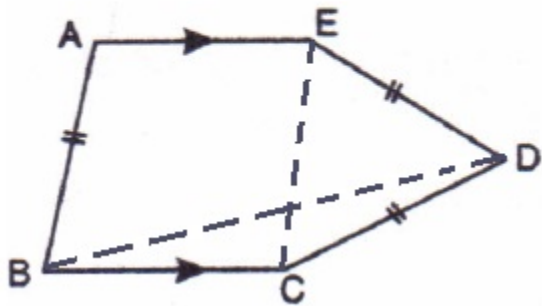
$$\Rightarrow \angle M = 90^\circ$$

Hence $\angle AMD = 90^\circ$

Solution 3:

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In the given figure



Given that $AE = BC$

We have to find $\angle AEC$ $\angle BCD$

Let us join EC and BD .

In the quadrilateral $AECB$

$AE = BC$ and $AB = EC$

also $AE \parallel BC$

$\Rightarrow AB \parallel EC$

So quadrilateral is a parallelogram.

In parallelogram consecutive angles are supplementary

$$\Rightarrow \angle A + \angle B = 180^\circ$$

$$\Rightarrow 102^\circ + \angle B = 180^\circ$$

$$\Rightarrow \angle B = 78^\circ$$

In parallelogram opposite angles are equal

$$\Rightarrow \angle A = \angle BEC \text{ and } \angle B = \angle AEC$$

$$\Rightarrow \angle BEC = 102^\circ \text{ and } \angle AEC = 78^\circ$$

Now consider $\triangle ECD$

$EC = ED = CD$ [Since $AB = EC$]

Therefore $\triangle ECD$ is an equilateral triangle.

$$\Rightarrow \angle ECD = 60^\circ$$

$$\angle BCD = \angle BEC + \angle ECD$$

$$\Rightarrow \angle BCD = 102^\circ + 60^\circ$$

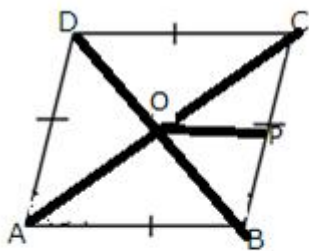
$$\Rightarrow \angle BCD = 162^\circ$$

Therefore $\angle AEC = 78^\circ$ and $\angle BCD = 162^\circ$

Solution 4:

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Given ABCD is a square and diagonals meet at O. P is a point on BC such that OB=BP



In the

$\triangle BOC$ and $\triangle DOC$

$\Rightarrow BD = BD$ [common side]

$\Rightarrow BO = CO$

$\angle BOD = \angle ODC$ [since diagonals cut at O]

$\triangle BOC \cong \triangle DOC$ [by SSS]

Therefore

$$\angle BOC = 90^\circ$$

NOW

$$\angle POC = 22.5$$

$$\angle BOP = 67.5 \text{ [since } \angle BOC = 67.5^\circ + 22.5^\circ \text{]}$$

Again

$$\triangle BDC$$

$$\angle BDC = 45^\circ \text{ [since } \angle B = 45^\circ, \angle C = 90^\circ \text{]}$$

Therefore

$$\angle BDC = 2\angle POC$$

AGAIN

$$\angle BOP = 67.5^\circ$$

$$\Rightarrow \angle BOP = 2\angle POC$$

Hence proved that

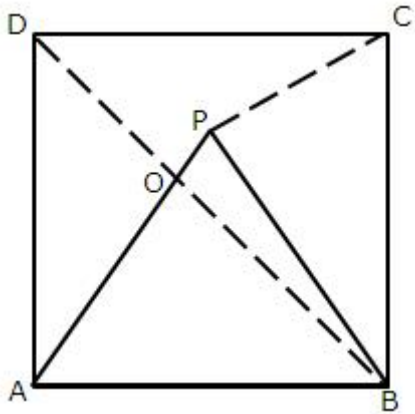
$$\text{i) } \angle PC = \left(22\frac{1}{2}^\circ \right)$$

$$\text{(ii) } \angle BDC = 2 \angle POC$$

$$\text{(iii) } \angle BOP = 3 \angle CPO$$

Solution 5:

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In the given figure $\triangle APB$ is an equilateral triangle

Therefore all its angles are 60°

Again in the

$\triangle ADB$

$$\angle ABD = 45^\circ$$

$$\begin{aligned}\angle AOB &= 180^\circ - 60^\circ - 45^\circ \\ &= 75^\circ\end{aligned}$$

Again

$\triangle BPC$

$$\Rightarrow \angle BPC = 75^\circ \text{ [Since } BP = CB\text{]}$$

Now

$$\begin{aligned}\angle C &= \angle BCP + \angle PCD \\ \Rightarrow \angle PCD &= 90^\circ - 75^\circ \\ \Rightarrow \angle PCD &= 15^\circ\end{aligned}$$

Therefore

$$\begin{aligned}\angle APC &= 60^\circ + 75^\circ \\ \Rightarrow \angle APC &= 135^\circ \\ \Rightarrow \text{Reflex } \angle APD &= 360^\circ - 135^\circ = 225^\circ\end{aligned}$$

$$(i) \angle AOB = 75^\circ$$

$$(ii) \angle BPC = 75^\circ$$

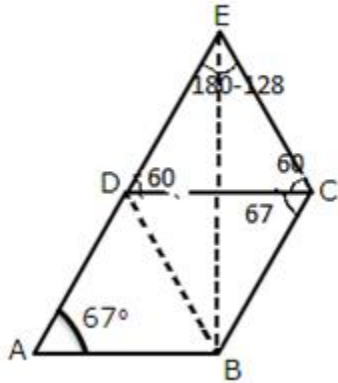
$$(iii) \angle PCD = 15^\circ$$

$$(iv) \text{Reflex } \angle APD = 225^\circ$$

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Solution 6:

Given that the figure ABCD is a rhombus with angle $A = 67^\circ$



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In the rhombus We have

$$\angle A = 67^\circ = \angle C \text{ [Opposite angles]}$$

$$\angle A + \angle D = 180^\circ \text{ [Consecutive angles are supplementary]}$$

$$\Rightarrow \angle D = 113^\circ$$

$$\Rightarrow \angle ABC = 113^\circ$$

Consider $\triangle DBC$,

$$DC = CB \text{ [Sides of rhombus]}$$

So $\triangle DBC$ is an isosceles triangle

$$\Rightarrow \angle CDB = \angle CBD$$

Also,

$$\angle CDB + \angle CDB + \angle BCD = 180^\circ$$

$$\Rightarrow 2\angle CBD = 113^\circ$$

$$\Rightarrow \angle CDB = \angle CBD = 56.5^\circ \dots\dots\dots(i)$$

Consider $\triangle DCE$,

$$EC = CB$$

So $\triangle DCE$ is an isosceles triangle

$$\Rightarrow \angle CBE = \angle CEB$$

Also,

$$\angle CBE + \angle CEB + \angle BCE = 180^\circ$$

$$\Rightarrow 2\angle CBE = 53^\circ$$

$$\Rightarrow \angle CDE = 26.5^\circ$$

From (i)

$$\angle CBD = 56.5^\circ$$

$$\Rightarrow \angle CBE + \angle DBE = 56.5^\circ$$

$$\Rightarrow 26.5^\circ + \angle DBE = 56.5^\circ$$

$$\Rightarrow \angle DBE = 30.5^\circ$$

Solution 7:

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(i) ABCD is a parallelogram

Therefore

$$AD=BC$$

$$AB=DC$$

Thus

$$4y = 3x - 3 \quad [\text{since } AD=BC]$$

$$\Rightarrow 3x - 4y = 3 \quad (i)$$

$$6y + 2 = 4x \quad [\text{since } AB=DC]$$

$$4x - 6y = 2 \quad (ii)$$

Solving equations (i) and (ii) we have

$$x=5$$

$$y=3$$

(ii)

In the figure ABCD is a parallelogram

$$\angle A = \angle C$$

$$\angle B = \angle D \quad [\text{since opposite angles are equal}]$$

Therefore

$$7y = 6y + 3y - 8^\circ \quad (i) \quad [\text{Since } \angle A = \angle C]$$

$$4x + 20^\circ = 0 \quad (ii)$$

Solving (i), (ii) we have

$$X = 12^\circ$$

$$Y = 16^\circ$$

Solution 8:

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Given that the angles of a quadrilateral are in the ratio 3 : 4 : 5 : 6 Let the angles be $3x, 4x, 5x, 6x$

$$3x + 4x + 5x + 6x = 360^\circ$$

$$\Rightarrow x = \frac{360^\circ}{18}$$

$$\Rightarrow x = 20^\circ$$

Therefore the angles are

$$3 \times 20 = 60^\circ,$$

$$4 \times 20 = 80^\circ,$$

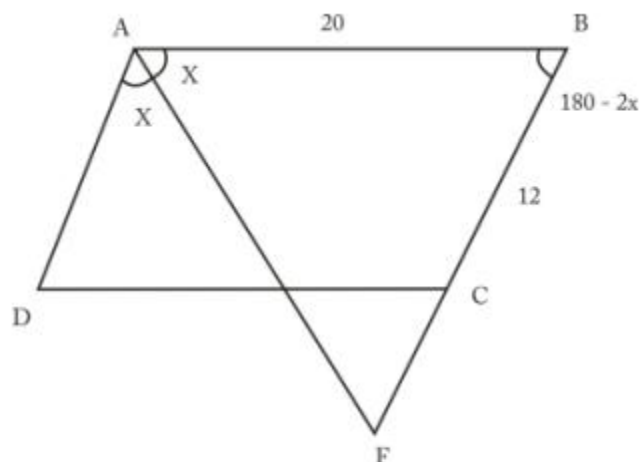
$$5 \times 20 = 100^\circ,$$

$$6 \times 20 = 120^\circ$$

Since all the angles are of different degrees thus forms a trapezium

Solution 9:

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Given $AB = 20$ cm and $AD = 12$ cm.

From the above figure, it's evident that ABF is an isosceles triangle with angle $BAF = \text{angle } BFA = x$

So $AB = BF = 20$

$BF = 20$

$BC + CF = 20$

$CF = 20 - 12 = 8$ cm

Solution 10:

We know that $AQCP$ is a quadrilateral. So sum of all angles must be 360.

$$\therefore x + y + 90 + 90 = 360$$

$$x + y = 180$$

Given $x:y = 2:1$

So substitute $x = 2y$

$$3y = 180$$

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$$y = 60$$

$$x = 120$$

We know that angle C = angle A = $x = 120$

$$\text{Angle D} = \text{Angle B} = 180 - x = 180 - 120 = 60$$

Hence, angles of parallelogram are 120, 60, 120 and 60.

Exercise 14(C)

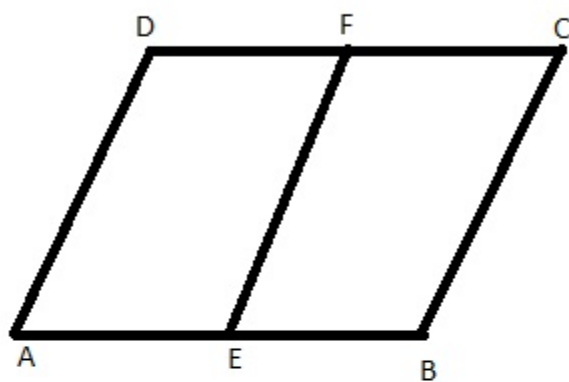
Solution 1:

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Let us draw a parallelogram $ABCD$ Where F is the midpoint

Of side DC of parallelogram $ABCD$

To prove: $AEDF$ is a parallelogram



Proof:

Therefore $ABCD$

$$AB \parallel DC$$

$$BC \parallel AD$$

$$AB = DC$$

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

$$AE = DF$$

Also $AD \parallel EF$

therefore $AEDF$ is a parallelogram.

Solution 2:

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GIVEN: $ABCD$ is a parallelogram where the diagonal BD bisects

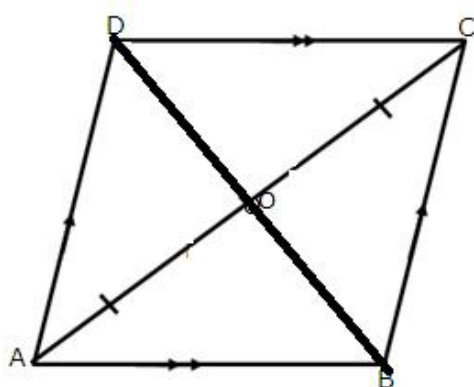
parallelogram $ABCD$ at angle B and D

TO PROVE: $ABCD$ is a rhombus

Proof : Let us draw a parallelogram $ABCD$ where the diagonal BD bisects the parallelogram at angle B and D

Construction : Let us join AC as a diagonal of the parallelogram

$ABCD$



Since $ABCD$ is a parallelogram

Therefore

$$AB = DC$$

$$AD = BC$$

Diagonal BD bisects angle B and D

$$\text{So } \angle COD = \angle DOA$$

Again AC also bisects at A and C

$$\text{Therefore } \angle AOB = \angle BOC$$

Thus $ABCD$ is a rhombus.

Solution 3:

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Given $ABCD$ is a parallelogram and $AE=EF=FC$.

We have to prove at first that $DEBF$ is a parallelogram.

Proof : From $\triangle ADE$ and $\triangle BCF$

$$AE=FC$$

$$AD=BC$$

$$\angle D = \angle B$$

$$\triangle ADE \cong \triangle BCF \quad [SAS]$$

Therefore $DE=FB$

$$DC=EF \quad [\text{since } AE+EF+FC=AC \text{ and } AE=EF=FC]$$

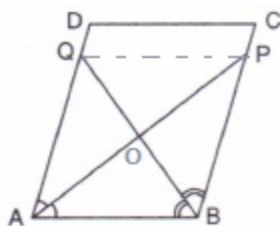
Therefore $DEBF$ is a parallelogram.

So $DE \parallel FB$

Hence proved

Solution 4:

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Let us join PQ.

Consider the $\triangle AOQ$ and $\triangle BOP$

$\angle AOQ = \angle BOP$ [opposite angles]

$\angle OAQ = \angle BPO$ [alternate angles]

$\Rightarrow \triangle AOQ \cong \triangle BOP$ [AA test]

Hence $AQ = BP$

Consider the $\triangle QOP$ and $\triangle AOB$

$\angle AOB = \angle QOP$ [opposite angles]

$\angle OAB = \angle OPQ$ [alternate angles]

$\Rightarrow \triangle QOP \cong \triangle AOB$ [AA test]

Hence $PQ = AB = CD$

Consider the quadrilateral QPCD

$DQ = CP$ and $DQ \parallel CP$ [Since $AD = BC$ and $AD \parallel BC$]

Also $QP = DC$ and $AB \parallel QP \parallel DC$

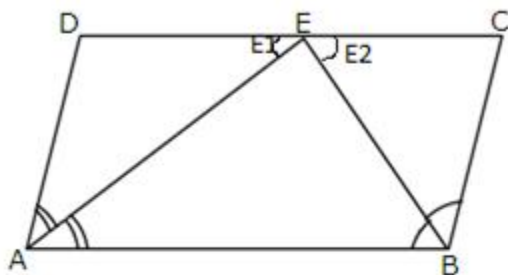
Hence quadrilateral QPCD is a parallelogram.

Solution 5:

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Given $ABCD$ is a parallelogram

To prove: $AB = 2BC$



Proof: $ABCD$ is a parallelogram

$$\angle A + \angle D = \angle B + \angle C = 180^\circ$$

From the $\triangle AEB$ we have

$$\Rightarrow \frac{\angle A}{2} + \frac{\angle B}{2} + \angle E = 180^\circ$$

$$\Rightarrow \angle A - \frac{\angle A}{2} + \angle D + \angle E1 = 180^\circ \quad [\text{taking } E1 \text{ as new angle}]$$

$$\Rightarrow \angle A + \angle D + \angle E1 = 180^\circ + \frac{\angle A}{2}$$

$$\Rightarrow \angle E1 = \frac{\angle A}{2} \quad [\text{Since } \angle A + \angle D = 180^\circ]$$

Again,

similarly,

$$\angle E2 = \frac{\angle B}{2}$$

NOW

$$AB = DE + EC$$

$$= AD + BC$$

$$= 2BC \quad [\text{since } AD = BC]$$

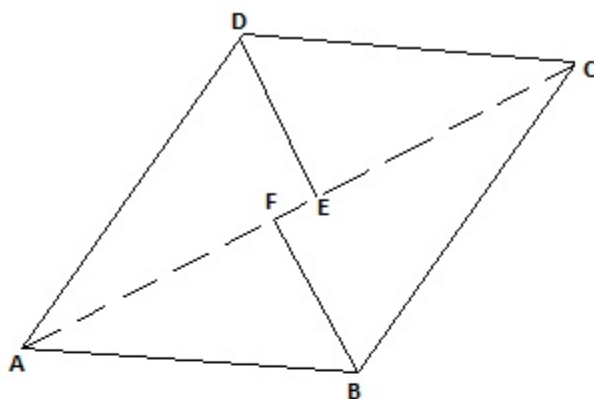
Hence proved

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Solution 6:

Given ABCD is a parallelogram. The bisectors of $\angle ADC$ and $\angle BCD$ meet at E. The bisectors of $\angle ABC$ and $\angle BCD$ meet at F

From the parallelogram ABCD we have



$$\angle ADC + \angle BCD = 180^\circ \text{ [sum of adjacent angles of a parallelogram]}$$

$$\Rightarrow \frac{\angle ADC}{2} + \frac{\angle BCD}{2} = 90^\circ$$

$$\Rightarrow \angle EDC + \angle ECD = 90^\circ$$

In triangle ECD sum of angles = 180°

$$\Rightarrow \angle EDC + \angle ECD + \angle CED = 180^\circ$$

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

Similarly taking triangle BCF it can be prove that $\angle BFC = 90^\circ$

Now since

$$\angle BFC = \angle CED = 90^\circ$$

Therefore the lines DE and BF are parallel

Hence proved

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Solution 7:

Given: $ABCD$ is a parallelogram

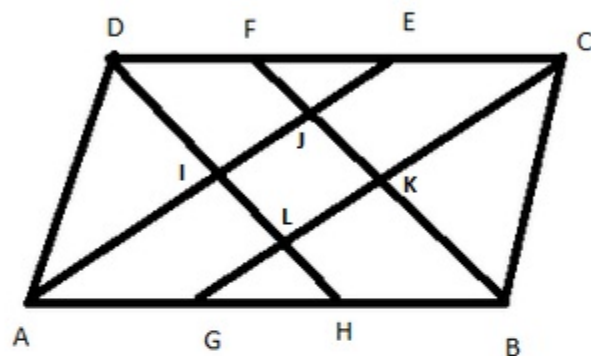
AE bisects $\angle BAD$

BF bisects $\angle ABC$

CG bisects $\angle BCD$

DH bisects $\angle ADC$

TO PROVE: $LKJI$ is a rectangle



Proof:

$\angle BAD + \angle ABC = 180^\circ$ [adjacent angles of a parallelogram are supplementary]

$\angle BAJ = \frac{1}{2} \angle BAD$ [AE bisects $\angle BAD$]

$\angle ABJ = \frac{1}{2} \angle ABC$ [DH bisect $\angle ABC$]

$\angle BAJ + \angle ABJ = 90^\circ$ [halves of supplementary angles are complementary]

$\triangle ABJ$ is a right triangle because its acute interior angles are complementary.

Similarly

$\angle DLC = 90^\circ$

$\angle AID = 90^\circ$

Then $\angle JIL = 90^\circ$ because $\angle AID$ and $\angle JIL$ are vertical angles

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since 3 angles of quadrilateral $LKJI$ are right angles, $\angle I$ is the 4th one and so $LKJI$ is a rectangle, since its interior angles are all right angles

Hence proved

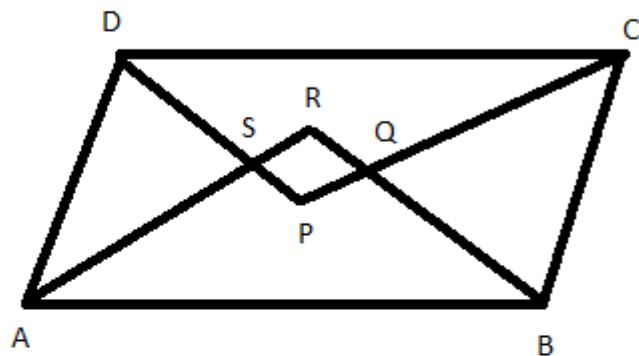
Solution 8:

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Given: A parallelogram $ABCD$ in which AR, BR, CP, DP

Are the bisectors of $\angle A, \angle B, \angle C, \angle D$ respectively forming quadrilaterals $PQRS$.

To prove: $PQRS$ is a rectangle



Proof :

$$\angle DCB + \angle ABC = 180^\circ \text{ [co-interior angles of parallelogram are supplementary]}$$

$$\Rightarrow \frac{1}{2} \angle DCB + \frac{1}{2} \angle ABC = 90^\circ$$

Also in

$$\Rightarrow \angle 1 + \angle 2 = 90^\circ$$

$$\triangle CQB, \angle 1 + \angle 2 + \angle CQB = 180^\circ$$

From the above equation we get

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

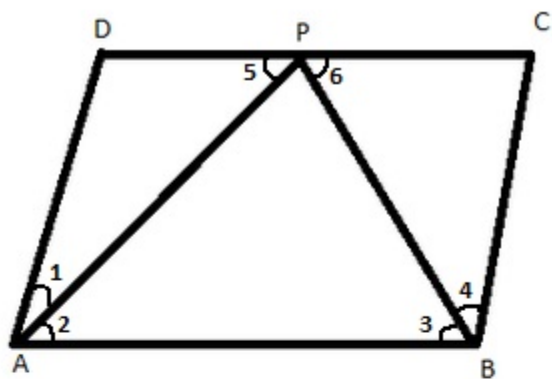
$$\angle RQP = 90^\circ \text{ [}\angle CQB = \angle RQP, \text{vertically opposite angles]}$$

$$\angle QRP = \angle RSP = \angle SPQ = 90^\circ$$

Hence $PQRS$ is a rectangle

Solution 9:

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(i) Let $AD = x$

$$AB = 2AD = 2x$$

Also AP is the bisector $\angle A$

$$\angle 1 = \angle 2$$

Now,

$$\angle 2 = \angle 5 \text{ [alternate angles]}$$

Therefore $\angle 1 = \angle 5$

Now

$$AP = DP = x \text{ [sides opposite to equal angles are also equal]}$$

Therefore

$$AB=CD \text{ [opposite sides of parallelogram are equal]}$$

$$CD = 2x$$

$$\Rightarrow DP+PC=2x$$

$$\Rightarrow x+PC=2x$$

$$\Rightarrow PC = x$$

Also, $BC=x$

$$\triangle BPC$$

$$\text{In } \Rightarrow \angle 6 = \angle 4 \text{ [angles opposite to equal sides are equal]}$$

$$\Rightarrow \angle 6 = \angle 3$$

$$\text{Therefore } \angle 3 = \angle 4$$

Hence BP bisect $\angle B$

(ii)

Opposite angles are supplementary

Therefore

$$\angle 1 + \angle 2 + \angle 3 + \angle 4 = 180^\circ$$

$$\Rightarrow 2\angle 2 + 2\angle 3 = 180^\circ \begin{bmatrix} \angle 1 = \angle 2 \\ \angle 3 = \angle 4 \end{bmatrix}$$

$$\Rightarrow \angle 2 + \angle 3 = 90^\circ$$

$$\triangle APB$$

$$\angle 2 + \angle 3 + \angle APB = 180^\circ$$

$$\Rightarrow \angle APB = 180^\circ - 90^\circ \text{ [by angle sum property]}$$

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

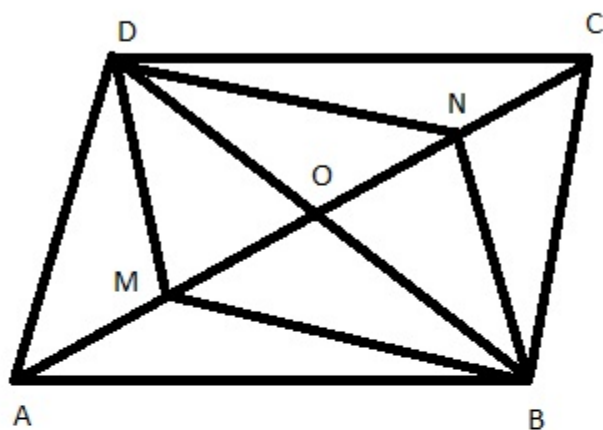
Hence proved

Solution 10:

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Points M and N are taken on the diagonal AC of a parallelogram $ABCD$ such that $AM=CN$.

Prove that $BMDN$ is a parallelogram



CONSTRUCTION: Join B to D to meet AC in O .

PROOF: We know that the diagonals of parallelogram bisect each other.

Now, AC and BD bisect each other at O .

$$OC=OA$$

$$AM=CN$$

$$\Rightarrow OA-AM=OC-CN$$

$$\Rightarrow OM=ON$$

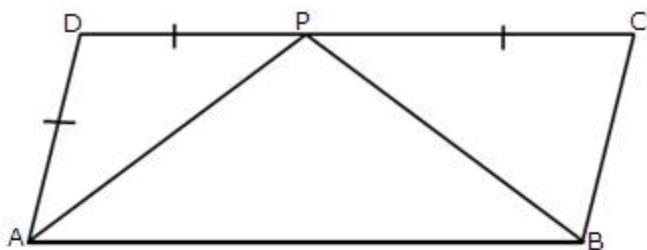
Thus in a quadrilateral $BMDN$, diagonal BD and MN are such that $OM=ON$ and $OD=OB$

Therefore the diagonals AC and PQ bisect each other.

Hence $BMDN$ is a parallelogram

Solution 11:

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Consider $\triangle ADP$ and $\triangle BCP$

$AD=BC$ [since ABCD is a parallelogram]

$DC=AB$ [since ABCD is a parallelogram]

$\angle A = \angle C$ [opposite angles]

$\triangle ADP \cong \triangle BCP$ [SAS]

Therefore $AP=BP$

AP bisects $\angle A$

BP bisects $\angle B$

In $\triangle APB$

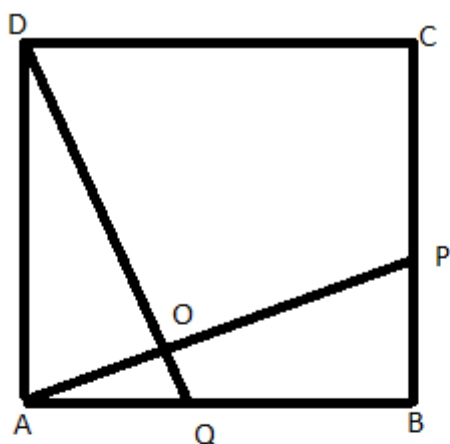
$AP=PB$

$\angle APB = \angle DAP + \angle BCP$

Hence proved

Solution 12:

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ABCD is a square and $AP=PQ$

Consider $\triangle DAQ$ and $\triangle ABP$

$$\angle DAQ = \angle ABP = 90^\circ$$

$$DQ = AP$$

$$AD = AB$$

$$\triangle DAQ \cong \triangle ABP$$

$$\Rightarrow \angle PAB = \angle QDA$$

Now,

$$\angle PAB + \angle APB = 90^\circ$$

$$\text{also } \angle QDA + \angle APB = 90^\circ \quad [\angle PAB = \angle QDA]$$

Consider $\triangle AOQ$ By ASP

$$\angle QDA + \angle APB + \angle AOD = 180^\circ$$

$$\Rightarrow 90^\circ + \angle AOD = 180^\circ$$

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

Hence AP and DQ are perpendicular.

Solution 13:

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Given: $ABCD$ is quadrilateral,

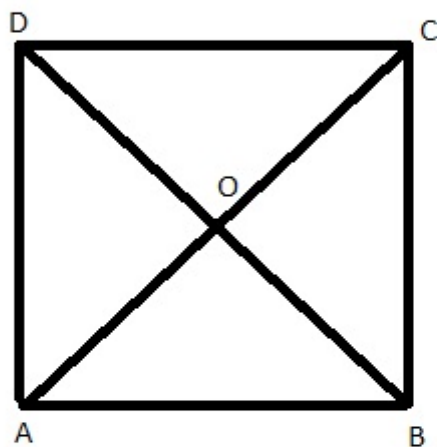
$$AB=AD$$

$$CB=CD$$

To prove: (i) AC bisects angle BAD .

(ii) AC is perpendicular bisector of BD .

Proof:



In $\triangle ABC$ and $\triangle ADC$

$$AB=AD \text{ [given]}$$

$$CB=CD \text{ [given]}$$

$$AC=AC \text{ [common side]}$$

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

Therefore AC bisects $\angle BAD$

$$OD=OB$$

$$OA=OA \text{ [diagonals bisect each other at O]}$$

Thus AC is perpendicular bisector of BD

Hence proved

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Solution 14:

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Given $ABCD$ is a trapezium, $AB \parallel DC$ and $AD=BC$

To prove (i) $\angle DAB = \angle CBA$

(ii) $\angle ADC = \angle BCD$

(iii) $AC = BD$

(iv) $OA = OB$ and $OC = OD$

Proof : (i) Since $AD \parallel CE$ and transversal AE cuts them at A and E respectively.

Therefore, $\angle A + \angle B = 180^\circ$

Since $AB \parallel CD$ and $AD \parallel BC$

Therefore $ABCD$ is a parallelogram

$\angle A = \angle C$

$\angle B = \angle D$ [since $ABCD$ is a parallelogram]

Therefore $\angle DAB = \angle CBA$

$\angle ADC = \angle BCD$

In $\triangle ABC$ and $\triangle BAD$, we have

$BC=AD$ [given]

$AB=BA$ [common]

$\angle A = \angle B$ [proved]

$\triangle ABC \cong \triangle BAD$ [SAS]

Since $\triangle ABC \cong \triangle BAD$

Therefore $AC=BD$ [corresponding parts of congruent triangles are equal]

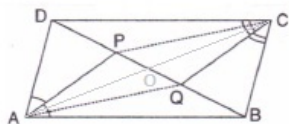
Again $OA=OB$

$OC=OD$ [since diagonals bisect each other at O]

Hence proved

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Solution 15:



Join AC to meet BD in O

We know that the diagonals of a parallelogram bisect each other. Therefore AC and BD bisect each other at O .

Therefore

$$OB = OD$$

But

$$BQ = DP$$

$$OB - PQ = OD - DP$$

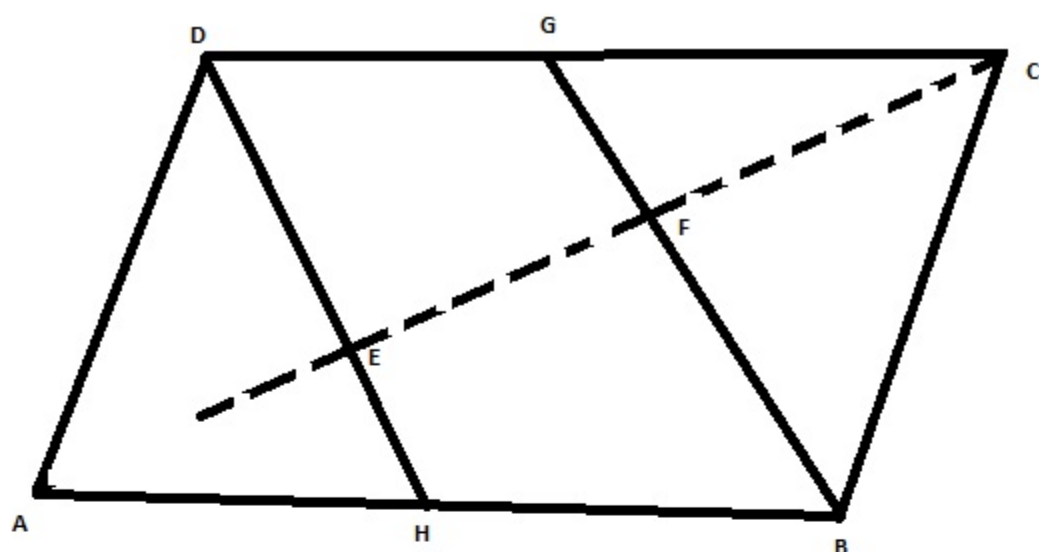
$$\Rightarrow OQ = OP$$

Thus in a quadrilateral $APCQ$ diagonals AC and PQ such that $OQ = OP$ and $OA = OC$. Since diagonals AC and PQ bisect each other.

Hence $APCQ$ is a parallelogram

Solution 16:

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ABCD is a parallelogram, the bisectors of $\angle ADC$ and $\angle BCD$ meet at a point E and the bisectors of $\angle BCD$ AND $\angle ABC$ meet at F.

We have to prove that the $\angle CED = 90^\circ$ and $\angle CFG = 90^\circ$

Proof : In the parallelogram ABCD

$$\angle ADC + \angle BCD = 180^\circ \text{ [sum of adjacent angles of a parallelogram]}$$

$$\Rightarrow \frac{\angle ADC}{2} + \frac{\angle BCD}{2} = 90^\circ$$

$$\Rightarrow \angle EDC + \angle ECD + \angle CED = 180^\circ$$

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

Similarly taking triangle BCF it can be proved that $\angle BFC = 90^\circ$

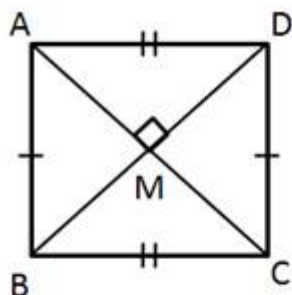
$$\text{Also } \angle BFC + \angle CFG = 180^\circ \text{ [adjacent angles on a line]}$$

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

Now since $\angle CFG = \angle CED = 90^\circ$ [it means that the lines DE and BG are parallel]

Hence proved

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Solution 17:

To prove : ABCD is a square,
that is, to prove that sides of the quadrilateral are equal
and each angle of the quadrilateral is 90° .
ABCD is a rectangle,
 $\Rightarrow \angle A = \angle B = \angle C = \angle D = 90^\circ$ and diagonals bisect each other
that is, $MD = BM \dots (i)$
Consider $\triangle AMD$ and $\triangle AMB$,
 $MD = BM$ (from (i))
 $\angle AMD = \angle AMB = 90^\circ$ (given)
 $AM = AM$ (common side)
 $\triangle AMD \cong \triangle AMB$ (SAS congruence criterion)
 $\Rightarrow AD = AB$ (cpctc)
Since ABCD is a rectangle, $AD = BC$ and $AB = CD$
Thus, $AB = BC = CD = AD$ and $\angle A = \angle B = \angle C = \angle D = 90^\circ$
 $\Rightarrow$ ABCD is a square.

Solution 18:

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ABCD is a parallelogram

$\Rightarrow$ opposite angles of a parallelogram are congruent

$$\Rightarrow \angle DAB = \angle BCD \text{ and } \angle ABC = \angle ADC = 120^\circ$$

In ABCD,

$$\angle DAB + \angle BCD + \angle ABC + \angle ADC = 360^\circ$$

.....(sum of the measures of angles of a quadrilateral)

$$\Rightarrow \angle BCD + \angle BCD + 120^\circ + 120^\circ = 360^\circ$$

$$\Rightarrow 2\angle BCD = 360^\circ - 240^\circ$$

$$\Rightarrow 2\angle BCD = 120^\circ$$

$$\Rightarrow \angle BCD = 60^\circ$$

PQRS is a parallelogram

$$\Rightarrow \angle PQR = \angle PSR = 70^\circ$$

In $\triangle CMS$,

$$\angle CMS + \angle CSM + \angle MCS = 180^\circ \text{(angle sum property)}$$

$$\Rightarrow x + 70^\circ + 60^\circ = 180^\circ$$

$$\Rightarrow x = 50^\circ$$

Solution 19:

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ABCD is a rhombus $\Rightarrow AD = CD$ and $\angle ADC = \angle ABC = 56^\circ$

DCFE is a square $\Rightarrow ED = CD$ and $\angle FED = \angle EDC = \angle DCF = \angle CFE = 90^\circ$

$\Rightarrow AD = CD = ED$

In $\triangle ADE$,

$AD = ED \Rightarrow \angle DAE = \angle AED \dots (i)$

$\angle DAE + \angle AED + \angle ADE = 180^\circ$

$\Rightarrow 2\angle DAE + 146^\circ = 180^\circ \dots (\text{Since } \angle ADE = \angle EDC + \angle ADC = 90^\circ + 56^\circ = 146^\circ)$

$\Rightarrow 2\angle DAE = 34^\circ$

$\Rightarrow \angle DAE = 17^\circ$

$\Rightarrow \angle DEA = 17^\circ \dots (ii)$

In ABCD,

$\angle ABC + \angle BCD + \angle ADC + \angle DAB = 360^\circ$

$\Rightarrow 56^\circ + 56^\circ + 2\angle DAB = 360^\circ \quad (\because \text{opposite angles of a rhombus are equal})$

$\Rightarrow 2\angle DAB = 248^\circ$

$\Rightarrow \angle DAB = 124^\circ$

We know that diagonals of a rhombus, bisect its angles.

$\Rightarrow \angle DAC = \frac{124^\circ}{2} = 62^\circ$

$\Rightarrow \angle EAC = \angle DAC - \angle DAE = 62^\circ - 17^\circ = 45^\circ$

Now, $\angle FEA = \angle FED - \angle DEA$

$= 90^\circ - 17^\circ \dots (\text{from (ii) and each angle of a square is } 90^\circ)$

$= 73^\circ$

We know that diagonals of a square bisect its angles.

$\Rightarrow \angle CED = \frac{90^\circ}{2} = 45^\circ$

So, $\angle AEC = \angle CED - \angle DEA$

$= 45^\circ - 17^\circ$

$= 28^\circ$

Hence, $\angle DAE = 17^\circ$, $\angle FEA = 73^\circ$, $\angle EAC = 45^\circ$ and $\angle AEC = 28^\circ$.



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- Chapter 2- Compound Interest (Without using formula)
- Chapter 3 - Compound Interest (Using Formula)
- Chapter 4- Expansions (Including Substitution)
- Chapter 5- Factorisation
- Chapter 6 - Simultaneous (Linear) Equations (Including Problems)
- Chapter 7- Indices (Exponents)
- Chapter 8- Logarithms
- Chapter 9- Triangles [Congruency in Triangles]
- Chapter 10- Isosceles Triangles
- Chapter 11- Inequalities
- Chapter 12- Mid-point and Its Converse [Including Intercept Theorem]
- Chapter 13- Pythagoras Theorem [Proof and Simple Applications with Converse]
- Chapter 14- Rectilinear Figures [Quadrilaterals: Parallelogram, Rectangle, Rhombus, Square and Trapezium]
- Chapter 15- Construction of Polygons
- Chapter 16- Area Theorems [Proof and Use]

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- Chapter 17- Circle
- Chapter 18- Statistics
- Chapter 19- Mean and Median
- Chapter 20 - Area and Perimeter of Plane Figures
- Chapter 21- Solids [Surface Area and Volume of 3-D Solids]
- Chapter 22- Trigonometrical Ratios
- Chapter 23- Trigonometrical Ratios of Standard Angles
- Chapter 24- Solution of Right Triangles
- Chapter 25- Complementary Angles
- Chapter 26- Co-ordinate Geometry
- Chapter 27- Graphical Solution (Solution of Simultaneous Linear Equations, Graphically)
- Chapter 28- Distance Formula

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