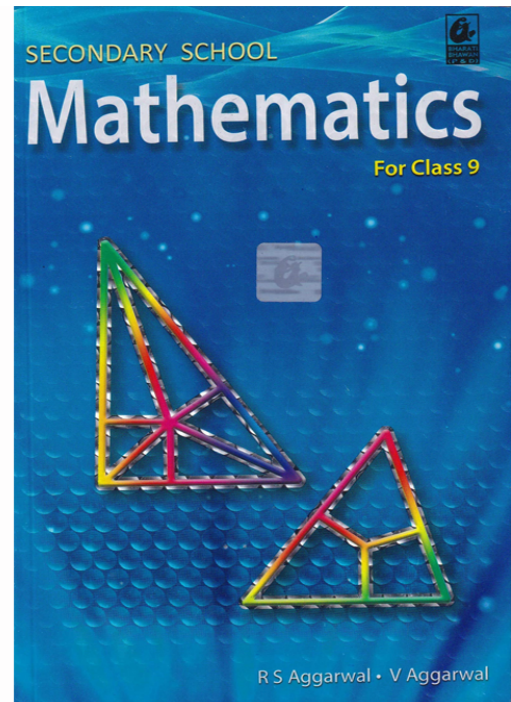


RS Aggarwal Solutions for Class 9 Maths Chapter 5–Congruence of Triangles and Inequalities in a Triangle

Class 9 - Chapter 5 Congruence of Triangles and Inequalities in a Triangle



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RS Aggarwal Solutions for Class 9 Maths Chapter 5–Congruence of Triangles and Inequalities in a Triangle

Class 9: Maths Chapter 5 solutions. Complete Class 9 Maths Chapter 5 Notes.

RS Aggarwal Solutions for Class 9 Maths Chapter 5–Congruence of Triangles and Inequalities in a Triangle

RS Aggarwal 9th Maths Chapter 5, Class 9 Maths Chapter 5 solutions

Question 1.

Solution:

In $\triangle ABC$, $\angle A = 70^\circ$ and $AB = AC$ (given)

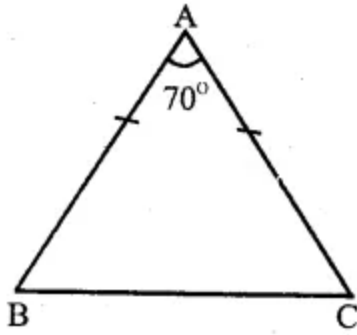
$\therefore \angle C = \angle B$

(Angles opposite to equal sides)

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

(Sum of angles of a triangle)

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$$\Rightarrow 70^\circ + \angle B + \angle B = 180^\circ$$

$$(\therefore \angle B = \angle C)$$

$$\Rightarrow 2\angle B = 180^\circ - 70^\circ = 110^\circ$$

$$\angle B = 110^\circ / 2 = 55^\circ \text{ and}$$

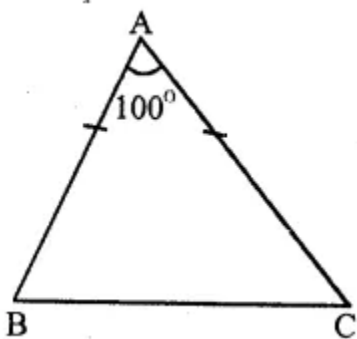
Hence $\angle B = 55^\circ, \angle C = 55^\circ$ Ans.

Question 2.

Solution:

In $\triangle ABC$, $\angle A = 100^\circ$

It is an isosceles triangle



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$$\therefore AB = AC$$

$$\angle B = \angle C$$

(Angles opposite to equal sides)

$$\text{But } \angle A + \angle B + \angle C = 180^\circ$$

(Sum of angles of a triangle)

$$\Rightarrow 100^\circ + \angle B + \angle B = 180^\circ$$

$$(\therefore \angle B = \angle C)$$

$$\Rightarrow 2\angle B + 100^\circ = 180^\circ$$

$$\Rightarrow 2\angle B = 180^\circ - 100^\circ = 80^\circ$$

$$\angle B = 80^\circ / 2 = 40^\circ$$

$$\text{and } \angle C = 40^\circ$$

$\therefore$ Base angles are $40^\circ, 40^\circ$ Ans.

Question 3.

Solution:

In $\triangle ABC$,

$$AB = AC$$

$$\therefore \angle C = \angle B$$

(Angles opposite to equal sides)

$$\text{But } \angle B = 65^\circ$$

$$\therefore \angle C = 65^\circ$$

$$\text{But } \angle A + \angle B + \angle C = 180^\circ$$

(Sum of angles of a triangle)

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$$\Rightarrow \angle A + 65^\circ + 65^\circ = 180^\circ$$

$$\Rightarrow \angle A + 130^\circ = 180^\circ$$

$$\Rightarrow \angle A = 180^\circ - 130^\circ$$

$$\Rightarrow \angle A = 50^\circ$$

Hence $\angle A = 50^\circ$ and $\angle C = 65^\circ$ Ans.

Question 4.

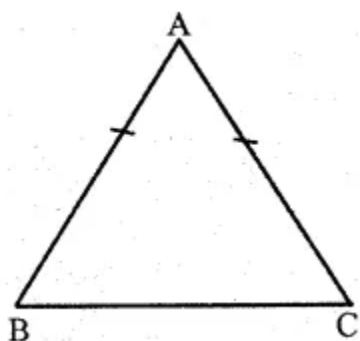
Solution:

In $\triangle ABC$

$$AB = AC$$

$$\therefore \angle C = \angle B$$

(Angles opposite to equal sides)



$$\text{But } \angle A = 2(\angle B + \angle C)$$

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

$$\text{But } \angle A + \angle B + \angle C = 180^\circ$$

(sum of angles of a triangle)

$$\Rightarrow \angle A + \frac{1}{2} \angle A = 180^\circ$$

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$$\Rightarrow 32 \angle A = 180^\circ$$

$$\Rightarrow \angle A = 180^\circ \div 32 = 120^\circ$$

$$\text{and } \angle B + \angle C = 12 \angle A = 12 \times 120^\circ$$

$$= 60^\circ$$

$$\therefore \angle B = \angle C$$

$$\therefore \angle B = \angle C = 60^\circ \div 2 = 30^\circ$$

Hence $\angle A = 120^\circ$, $\angle B = 30^\circ$, $\angle C = 30^\circ$ Ans.

Question 5.

Solution:

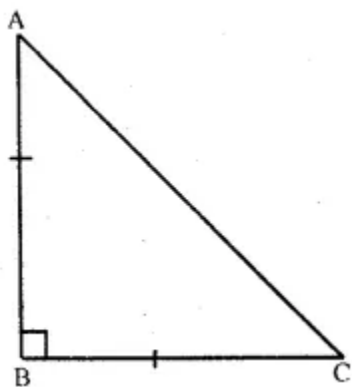
In $\triangle ABC$,

$$AB = BC \text{ and } \angle B = 90^\circ$$

$$\therefore AB = BC$$

$$\therefore \angle C = \angle A$$

(Angles opposite to equal sides)



$$\text{Now } \angle A + \angle B + \angle C = 180^\circ$$

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(Sum of angles of a triangle)

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

$$(\therefore \angle C = \angle A)$$

$$\Rightarrow 2\angle A + 90^\circ = 180^\circ$$

$$\Rightarrow 2\angle A = 180^\circ - 90^\circ = 90^\circ$$

$$\angle A = 90^\circ / 2 = 45^\circ$$

$$\therefore \angle C = 45^\circ (\therefore \angle C = \angle A)$$

Hence, each of the equal angles is 45° Ans.

Question 6.

Solution:

Given : $\triangle ABC$ is an isosceles triangle in which $AB = AC$

Base BC is produced to both sides upto D and E respectively forming exterior angles

$\angle ABD$ and $\angle ACE$

To Prove : $\angle ABD = \angle ACE$

Proof : In $\triangle ABC$

$$\therefore AB = AC \text{ (given)}$$

$$\therefore \angle C = \angle B$$

(Angles opposite to equal sides)

$$\Rightarrow \angle ABC = \angle ACB$$

But $\angle ABC + \angle ABD = 180^\circ$ (Linear pair)

Similarly $\angle ACB + \angle ACE = 180^\circ$

$$\angle ABC + \angle ABD = \angle ACB + \angle ACE$$

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But $\angle ABC = \angle ACB$ (proved)

$$\angle ABD = \angle ACE$$

Hence proved.

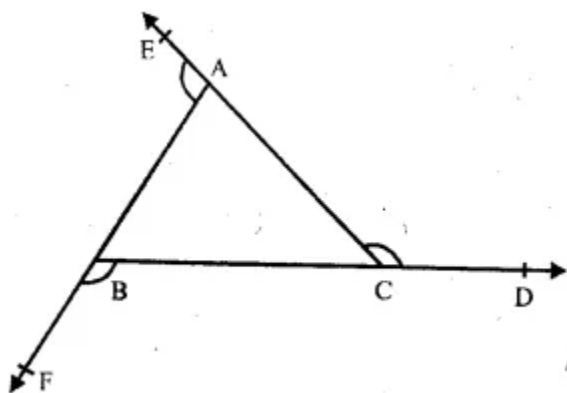
Question 7.

Solution:

$\triangle ABC$ is an equilateral triangle

$$\therefore AB = BC = CA$$

$$\text{and } \angle A = \angle B = \angle C = 60^\circ$$



The sides of the $\triangle ABC$ are produced in order to D, E and F forming exterior angles

$\angle ACD$, $\angle BAE$ and $\angle CBF$

$$\angle ACD + \angle ACB = 180^\circ$$

$$\Rightarrow \angle ACD + 60^\circ = 180^\circ$$

$$\Rightarrow \angle ACD = 180^\circ - 60^\circ$$

$$\Rightarrow \angle ACD = 120^\circ$$

Similarly, $\angle BAE + \angle BAC = 180^\circ$

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$$\Rightarrow \angle BAE + 60^\circ = 180^\circ$$

$$\Rightarrow \angle BAE = 180^\circ - 60^\circ = 120^\circ$$

$$\text{and } \angle BAF + \angle ABC = 180^\circ$$

$$\Rightarrow \angle BAF + 60^\circ = 180^\circ$$

$$\Rightarrow \angle BAF = 180^\circ - 60^\circ = 120^\circ$$

Hence each exterior angle of an equilateral triangle is 120° .

Question 8.

Solution:

Given : In the figure,

O is mid-point of AB and CD.

i.e. OA = OB and OC = OD

To Prove : AC = BD and AC $\parallel$ BD.

Proof : In $\triangle OAC$ and $\triangle OBD$,

$$OA = OB \text{ \{given\}}$$

$$OC = OD \text{ \{given\}}$$

$$\angle AOC = \angle BOD$$

(Vertically opposite angles)

$$\therefore \triangle OAC \cong \triangle OBD \text{ (S.A.S. axiom)}$$

$$\therefore AC = BD \text{ (c.p.c.t.)}$$

$$\text{and } \angle C = \angle D$$

But these are alt. angles

$$\therefore AC \parallel BD$$

Hence proved.

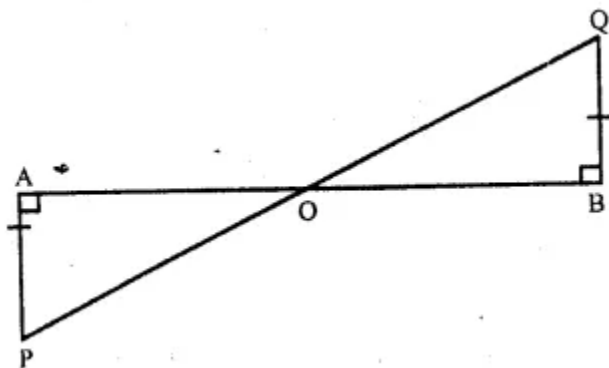
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Question 9.**Solution:**

Given : In the figure,

$PA \perp AB$, $QB \perp AB$ and

$PA = QB$, PQ intersects AB at O .



To Prove : O is mid-point of AB and PQ .

Proof : In $\triangle AOP$ and $\triangle BOQ$,

$$\angle A = \angle B$$

$$AP = BQ \text{ (given)}$$

$$\angle AOP = \angle BOQ$$

(Vertically opposite angles)

$$\therefore \triangle AOP \cong \triangle BOQ \text{ (A.A.S. axiom)}$$

$$\therefore OA = OB \text{ (c.p.c.t)}$$

$$\text{and } OP = OQ \text{ (c.p.c.t)}$$

Hence, O is the mid-point of AB as well as PQ

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Question 10.**Solution:**

Given : Two line segments AB and CD intersect each other at O and $OA = OB$, $OC = OD$

AC and BD are joined.

To Prove : $AC = BD$

Proof : In $\triangle AOC$ and $\triangle BOD$,

$OA = OB$ {given}

$OC = OD$

$\angle AOC = \angle BOD$

(vertically opposite angles)

$\therefore \triangle AOC \cong \triangle BOD$ (S.A.S. axiom)

$\therefore AC = BD$ (c.p.c.t)

and $\angle A = \angle D$ (c.p.c.t.)

Hence $AC \neq BD$

Hence proved.

Question 11.**Solution:**

Given : In the given figure,

$l \parallel m$, m is mid-point of AB

CD is another line segment, which intersects AB at M.

To Prove : M is mid-point of CD

Proof : $l \parallel m$

$\therefore \angle CAM = \angle MBD$ (Alternate angles)

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Now, in $\triangle AMC$ and $\triangle BMD$,

$AM = MB$ (Given)

$\angle CAM = \angle MBD$ (proved)

$\angle AMC = \angle BMD$

(vertically opposite angles)

$\triangle AMC \cong \triangle BMD$ (ASA axiom)

$\therefore CM = MD$ (c.p.c.t.)

Hence, M is mid-point of CD.

Similarly we can prove that M is mid point of any other line whose end points are on l and m.

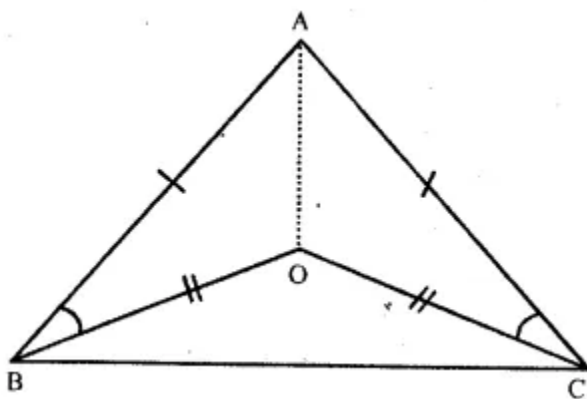
Hence proved.

Question 12.

Solution:

Given : In $\triangle ABC$, $AB = AC$ and in $\triangle OBC$,

$OB = OC$



To Prove : $\angle ABO = \angle ACO$

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Construction. Join AO.

Proof : In $\triangle ABO$ and $\triangle ACO$,

$AB = AC$ (Given)

$OB = OC$ (Given)

$AO = AO$ (Common)

$\therefore \triangle ABO \cong \triangle ACO$ (S.S.S. Axiom)

$\therefore \angle ABO = \angle ACO$ (c.p.c.t.)

Hence proved.

Question 13.

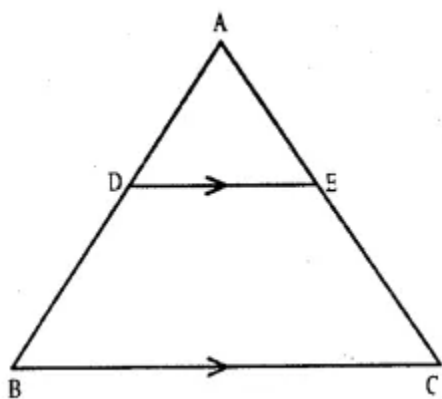
Solution:

Given : In $\triangle ABC$, $AB = AC$

D is a point on AB and a line $DE \parallel AC$ is drawn.

Which meets BC at E

To Prove : $AD = AE$



Proof : In $\triangle ABC$

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$AB = AC$ (given)

$\therefore \angle C = \angle B$ (Angles opposite to equal sides)

But $DE \parallel BC$ (given)

$\therefore \angle D = \angle B$ {corresponding angles}

and $\angle E = \angle C$

But $\angle C = \angle B$

$\therefore \angle E = \angle D$

$\therefore AD = AE$ (Sides opposite to equal angles)

Hence proved.

Question 14.

Solution:

Given : In $\triangle ABC$,

$AB = AC$

X and Y are two points on AB and AC respectively such that $AX = AY$

To Prove : $CX = BY$

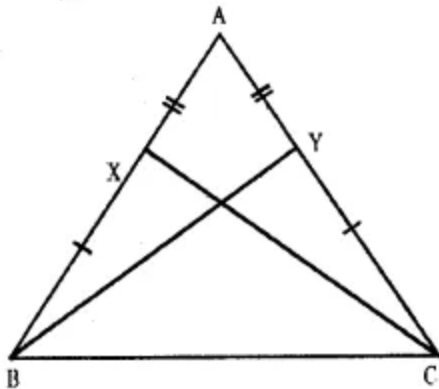
Proof : In $\triangle AXC$ and $\triangle AYB$

$AC = AB$ (given)

$AX = AY$ (given)

$\angle A = \angle A$ (common)

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$\therefore \triangle AXC \cong \triangle AYB$ (S.A.S. axiom)

$\therefore CX = BY$ (c.p.c.t.)

Hence proved.

Question 15.

Solution:

Given : In the figure,

C is mid point of AB

$\angle DCA = \angle ECB$ and

$\angle DBC = \angle EAC$

To Prove : $DC = EC$

Proof : $\angle DCA = \angle FCB$ (given)

Adding $\angle DCE$ both sides,

$\angle DCA + \angle DCE = \angle DCE + \angle ECB$

$\Rightarrow \angle ACE = \angle BCD$

Now, in $\triangle ACE$ and $\triangle BCD$,

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$AC = BC$ (C is mid-point of AB)

$\angle EAC = \angle DBC$ (given)

$\angle ACE = \angle BCD$ (proved)

$\therefore \triangle ACE \cong \triangle BCD$ (ASA axiom)

$\therefore CE = CD$ (c.p.c.t.)

$\Rightarrow EC = DC$

or $DC = EC$

Hence proved.

Question 16.

Solution:

Given : In figure,

$BA \perp AC$, $DE \perp EF$.

$BA = DE$ and $BF = DC$

To Prove : $AC = EF$

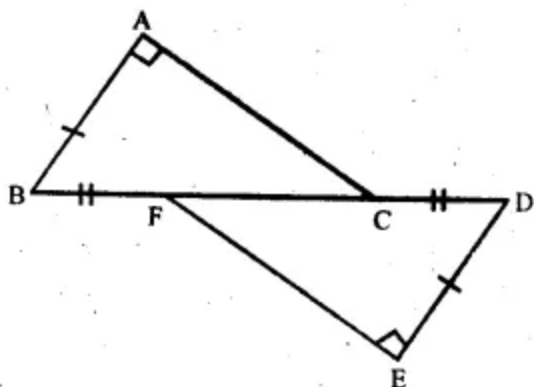
Proof : $BF = DC$ (given)

Adding FC both sides,

$BF + FC = FC + CD$

$\Rightarrow BC = FD$.

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Now, in right-angled $\triangle ABC$ and $\triangle DEF$,

Hyp. $BC =$ Hyp. FD (proved)

Side $AB =$ side DE (given)

$\therefore \triangle ABC \cong \triangle DEF$ (RHS axiom)

$\therefore AC = EF$ (c.p.c.t.)

Hence proved.

Question 17.

Solution:

To prove : $AE = CD$

Proof: $x^\circ + \angle BDC = 180^\circ$ (Linear pair)

Similarly $y^\circ + \angle AEB = 180^\circ$

$\therefore x^\circ + \angle BDC = y^\circ + \angle AEB$

But $x^\circ = y^\circ$ (given)

$\angle BDC = \angle AEB$

Now, in $\triangle AEB$ and $\triangle BCD$,

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$AB = CB$ (given)

$\angle B = \angle B$ (common)

$\angle AEB = \angle BDC$ (proved)

$\therefore \triangle AEB \cong \triangle BCD$ (AAS axiom)

$\therefore AE = CD$. (c.p.c.t.)

Hence proved.

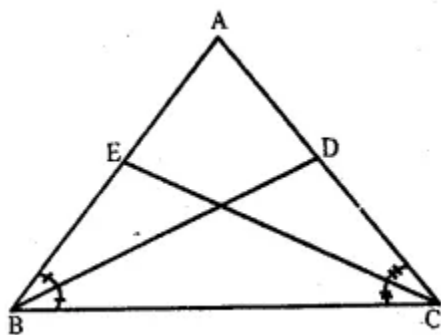
Question 18.

Solution:

Given : In $\triangle ABC$,

$AB = AC$.

Bisectors of $\angle B$ and $\angle C$ meet AC and AB in D and E respectively



To Prove : $BD = CE$

Proof : In $\triangle ABC$,

$AB = AC$

$\angle B = \angle C$ (Angles opposite to equal sides)

Now, in $\triangle ABD$ and $\triangle ACE$,

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$AB = AC$ (given)

$\angle A = \angle A$ (common)

$\angle ABD = \angle ACE$

(Half of equal angles)

$\therefore \triangle ABD \cong \triangle ACE$ (ASA axiom)

$\therefore BD = CE$ (c.p.c.t)

Hence proved.

Question 19.

Solution:

Given : In $\triangle ABC$,

AD is median. BL and CM are perpendiculars on AD and AD is produced to E

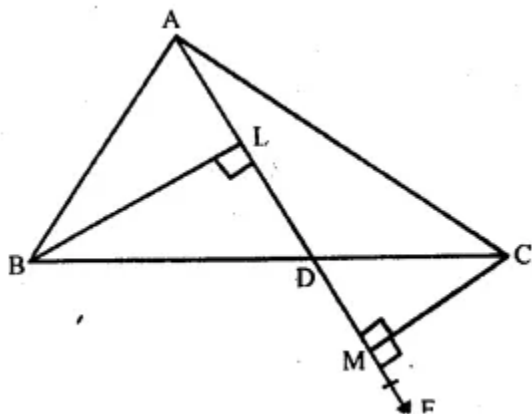
To prove : $BL = CM$.

Proof : In $\triangle BLD$ and $\triangle CMD$,

$BD = DC$ (D is mid-point of BC)

$\angle LDB = \angle CDM$

(Vertically opposite angles)



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$$\angle L = \angle M \text{ (each } 90^\circ)$$

$$\therefore \triangle BLD \cong \triangle CMD \text{ (A.A.S. axiom)}$$

$$\text{Hence, } BL = CM \text{ (c.p.c.t)}$$

Hence proved.

Question 20.

Solution:

Given : In $\triangle ABC$, D is mid-point of BC. $DL \perp AB$ and $DM \perp AC$ and $DL = DM$

To prove : $AB = AC$

Proof: In right angled $\triangle BLD$ and $\triangle CMD$

Hyp. $DL = DM$ (given)

Side $BD = DC$ (D is mid-point of BC)

$$\therefore \triangle BLD \cong \triangle CMD \text{ (R.H.S. axiom)}$$

$$\therefore \angle B = \angle C \text{ (c.p.c.t.)}$$

$$\therefore AC = AB$$

(sides opposite to equal angles)

Hence $AB = AC$

Hence proved.

Question 21.

Solution:

Given : In $\triangle ABC$, $AB = AC$ and bisectors of $\angle B$ and $\angle C$ meet at a point O. OA is joined.

To Prove : $BO = CO$ and Ray AO is the bisector of $\angle A$

Proof : $AB = AC$ (given)

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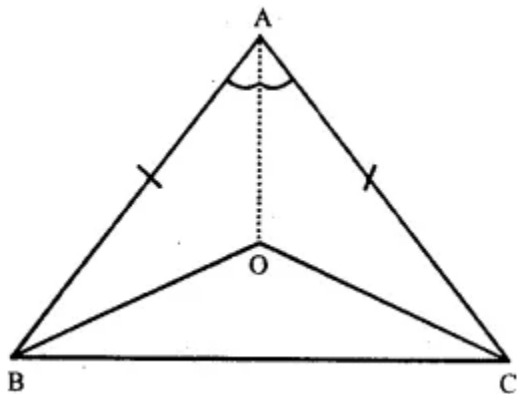
$$\therefore \angle C = \angle B$$

(Angles opposite to equal sides)

$$\Rightarrow 12 \angle C = 12 \angle B$$

$$\Rightarrow \angle OBC = \angle OCB$$

$\therefore$ in $\triangle OBC$,



$OB = OC$ (Sides opposite to equal angles)

Now in $\triangle OAB$ and $\triangle OCA$

$OB = OC$ (proved)

$OA = OA$ (common)

$AB = AC$ (given)

$\therefore \triangle OAB \cong \triangle OCA$ (S.S.S. axiom)

$\therefore \angle OAB = \angle OAC$ (c.p.c.t.)

Hence OA is the bisector of $\angle A$.

Hence proved.

Question 22.

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Solution:

Given : $\triangle PQR$ is an equilateral triangle and $QRST$ is a square. PT and PS are joined.

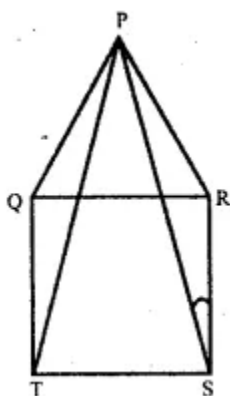
To Prove : (i) $PT = PS$

(ii) $\angle PSR = 15^\circ$

Proof : In $\triangle PQT$ and $\triangle PRS$,

$PQ = PR$ (Sides of equilateral $\triangle PQR$)

$QT = RS$ (sides of in square $PRST$) .



$$\angle PQT = \angle PRS$$

(each angle = $90^\circ + 60^\circ = 150^\circ$)

$\therefore \triangle PQT \cong \triangle PRS$ (S.A.S. axiom)

$\therefore PT = PS$ (c.p.c.t)

In $\triangle PRS$, $\angle PRS = 60^\circ + 90^\circ = 150^\circ$

$$\angle RPS + \angle PSR = 180^\circ - 150^\circ = 30^\circ$$

But $\angle RPS = \angle PSR$ ($\because PR = RS$)

$$\therefore \angle PSR + \angle PSR = 30^\circ$$

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$$\Rightarrow 2\angle PSR = 30^\circ$$

$$\therefore \angle PSR = 30 \div 2 = 15^\circ$$

Hence proved.

Question 23.

Solution:

Given : In right angle $\triangle ABC$, $\angle B$ is right angle. BCDE is square on side BC and ACFG is also a square on AC.

AD and BF are joined.

To Prove : $AD = BF$

Proof : $\angle ACF = \angle BCD$ (Each 90°)

Adding $\angle ACB$ both sides,

$$\angle ACF + \angle ACB = \angle BCD + \angle ACB$$

$$\Rightarrow \angle BCF = \angle ACD$$

Now in $\triangle ACD$ and $\triangle BCF$,

$AC = CF$ (sides of a squares)

$CD = BC$ (sides of a square)

$\therefore \angle ACD = \angle BCF$ (proved)

$\therefore \triangle ACD \cong \triangle BCF$ (S.A.S. axiom)

$AD = BF$ (c.p.c.t)

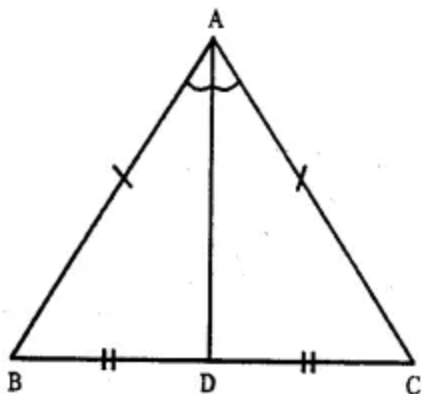
Hence proved.

Question 24.

Solution:

Given : $\triangle ABC$ is an isosceles in which $AB = AC$. and AD is the median which meets BC at D.

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To Prove : AD is the bisector of $\angle A$

Proof : In $\triangle ABD$ and $\triangle ACD$,

AD = AD (Common)

AB = AC (Given)

BD = CD (D is mid-point of BC)

$\therefore \triangle ABD \cong \triangle ACD$ (S.S.S. axiom)

$\angle BAD = \angle CAD$ (c.p.c.t.)

Hence, AD is the bisector of $\angle A$.

Question 25.

Solution:

Given : ABCD is a quadrilateral in which $AB \parallel DC$. P is mid-point of BC. AP and DC are produced to meet at Q.

To Prove : (i) $AB = CQ$.

(ii) $DQ = DC + AB$

Proof:

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(i) In $\triangle ABP$ and $\triangle CPQ$,

$BP = PC$ (P is mid-point of BC)

$\angle BAP = \angle PQC$ (Alternate angles)

$\angle APB = \angle CPQ$

(Vertically opposite angles)

$\therefore \triangle ABP \cong \triangle CPQ$ (A.A.S. axiom)

$\therefore AB = CQ$. (c.p.c.t.)

(ii) Now $DQ = DC + CQ$

$\Rightarrow DQ = DC + AB$ ($CQ = AB$ proved)

Hence proved.

Question 26.

Solution:

Given : In figure,

$OA = OB$ and $OP = OQ$.

To Prove : (i) $PX = QX$ (ii) $AX = BX$

Proof : In $\triangle OAQ$ and $\triangle OBP$,

$OA = OB$. (Given)

$OQ = OP$ (Given)

$\angle O = \angle O$ (Common)

$\therefore \triangle OAQ \cong \triangle OBP$ (SAS axiom)

$\therefore \angle A = \angle B$ (c.p.c.t)

Now $OA = OB$ and $OP = OQ$

Subtracting

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$$OA - OP = OB - OQ$$

$$\Rightarrow PA = QB$$

Now, in $\triangle XPA$ and $\triangle XQB$,

$$PA = QB \text{ (Proved)}$$

$$\angle AXP = \angle BXQ$$

(Vertically opposite angles)

$$\angle A = \angle B \text{ (Proved)}$$

$$\therefore \triangle XPA \cong \triangle XQB \text{ (A.A.S. axiom)}$$

$$\therefore AX = BX \text{ (c.p.c.t.) and } PX = QX \text{ (c.p.c.t.)}$$

Hence proved.

Question 27.

Solution:

Given : ABCD is a square in which a point P is inside it. Such that $PB = PD$.

To prove : CPA is a straight line.

Proof : In $\triangle APB$ and $\triangle ADP$,

$$AB = AD \text{ (Sides of a square)}$$

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

$$PB = PD \text{ (Given)}$$

$$\therefore \triangle APB \cong \triangle ADP \text{ (S.S.S. axiom)}$$

$$\angle APD = \angle APB \text{ (c.p.c.t.) ... (i)}$$

Similarly, in $\triangle CBP$ and $\triangle CPD$,

$$CB = CD \text{ (Sides of a square)}$$

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

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PB = PD (Given)

$\therefore \triangle CBP \cong \triangle CPD$ (S.S.S. axiom)

$\therefore \angle BPC = \angle CPD$ (c.p.c.t.) ... (i)

Adding (i) and (ii),

$\therefore \angle APD + \angle CPD = \angle APB + \angle BPC$

$\angle APC = \angle APC$

$\angle APC = 180^\circ$

($\because$ sum of angles at a point is 360°)

APC or CPA is a straight line.

Hence proved.

Question 28.

Solution:

Given : $\triangle ABC$ is an equilateral triangle PQ $\parallel$ AC and AC is produced to R such that CR = BP

To prove : QR bisects PC

Proof : $\therefore$ PQ $\parallel$ AC

$\therefore \angle BPQ = \angle BCA$

(Corresponding angles)

But $\angle BCA = 60^\circ$

(Each angle of the equilateral triangle)

and $\angle ABC$ or $\angle QBP = 60^\circ$

$\therefore \triangle BPQ$ is also an equilateral triangle.

$\therefore BP = PQ$

But BP = CR (Given)

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$$\therefore PQ = CR$$

Now in $\triangle PQM$ and $\triangle RMC$,

$$PQ = CR \text{ (proved)}$$

$$\angle QMP = \angle RMC$$

(vertically opposite angles)

$$\angle PQM = \angle MRC \text{ (alternate angles)}$$

$$\therefore \triangle PQM \cong \triangle RMC \text{ (AAS axiom)}$$

$$\therefore PM = MC \text{ (c.p.c.t.)}$$

Hence, QR bisects PC.

Hence proved

Question 29.

Solution:

Given : In quadrilateral ABCD,

$$AB = AD \text{ and } BC = DC$$

AC and BD are joined.

To prove : (i) AC bisects $\angle A$ and $\angle C$

(ii) AC is perpendicular bisector of BD.

Proof : In $\triangle ABC$ and $\triangle ADC$,

$$AB = AD \text{ (given)}$$

$$BC = DC \text{ (given)}$$

$$AC = AC \text{ (common)}$$

$$\therefore \triangle ABC \cong \triangle ADC \text{ (S.S.S. axiom)}$$

$$\therefore \angle BCA = \angle DCA \text{ (c.p.c.t.)}$$

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and $\angle BCA = \angle DAC$ (c.p.c.t.)

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

(ii) In $\triangle ABO$ and $\triangle ADO$,

$AB = AD$ (given)

$AO = AO$ (common)

$\angle BAO = \angle DAO$

(proved that AC bisects $\angle A$)

$\therefore \triangle ABO \cong \triangle ADO$ (SAS axiom)

$\therefore BO = OD$ and $\angle AOB = \angle AOD$ (c.p.c.t.)

But $\angle AOB + \angle AOD = 180^\circ$ (linear pair)

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

Hence AC is perpendicular bisector of BD. Hence proved.

Question 30.

Solution:

Given : In $\triangle ABC$,

Bisectors of $\angle B$ and $\angle C$ meet at I

From I, $IP \perp BC$, $IQ \perp AC$ and $IR \perp AB$.

IA is joined.

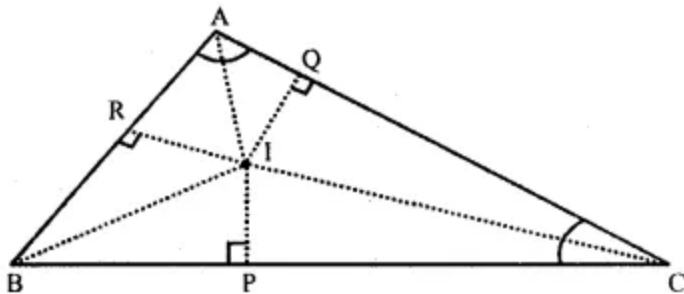
To prove : (i) $IP = IQ = IR$

(ii) IA bisects $\angle A$.

Proof : (i) In $\triangle BIP$ and $\triangle BIR$

$BI = BI$ (Common)

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and $\angle P = \angle R$ (Each 90°)

$\therefore \angle IBP \cong \angle IBR$

($\therefore$ IB is bisector of $\angle B$)

$\therefore \triangle BIP \cong \triangle BIR$ (A.A.S. axiom)

$\therefore IP = IR$ (c.p.c.t) ... (i)

Similarly, in $\triangle CIP$ and $\triangle CIQ$,

CI = CI (Common)

$\angle P = \angle Q$ (each = 90°) and $\angle ICP = \angle ICR$

(IC is bisector of $\angle C$)

$\therefore \triangle CIP \cong \triangle CIQ$ (A.A.S. axiom)

$\therefore IP = IQ$ (c.p.c.t.) ... (ii)

From (i) and (ii),

$IP = IQ = IR$.

(i) In right angled $\triangle IRA$ and $\triangle IQA$,

Hyp. IA = IA (Common)

side IR = IQ (Proved)

$\therefore \triangle IRA \cong \triangle IQA$ (R.H.S. axiom)

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$\therefore \angle IAR = \angle IRQ$ (c.p.c.t.)

Hence IA is the bisector of $\angle A$

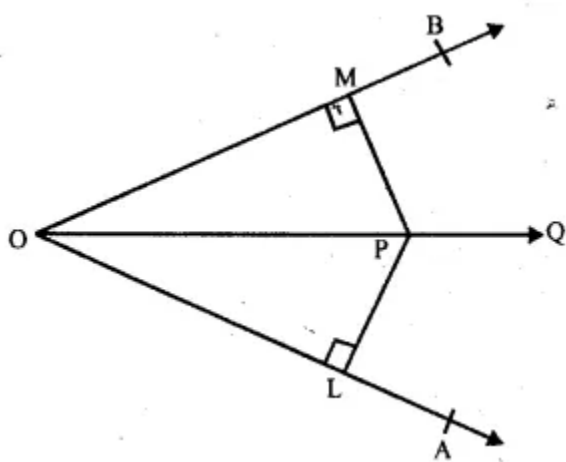
Hence proved.

Question 31.

Solution:

Given. P is a point in the interior of $\angle AOB$

$PL \perp OA$ and $PM \perp OB$ are drawn and $PL = PM$.



To prove : OP is the bisector of $\angle AOB$

Proof: In right angled $\triangle OPL$ and $\triangle OPM$,

Hyp. $OP = OP$ (Common)

Side $PL = PM$ (Given)

$\therefore \triangle OPL \cong \triangle OPM$ (R.H.S. axiom)

$\therefore \angle POL = \angle POM$ (c.p.c.t.)

Hence, OP is the bisector of $\angle AOB$.

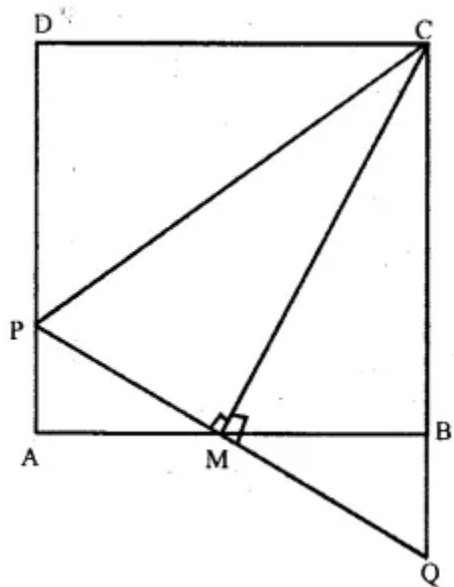
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[Hence proved.

Question 32.

Solution:

Given : ABCD is a square, M is midpoint of AB.



PQ is perpendicular to MC which meets CB produced at Q. CP is joined.

To prove : (i) $PA = BQ$

(ii) $CP = AB + PA$

Proof : (i) In $\triangle PAM$ and $\triangle QBM$,

$AM = MB$ (M is midpoint of AB)

$\angle AMP = \angle BMQ$

(vertically opposite angles)

$\angle PAM = \angle QBM$

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(Each = 90° angles of a square)

$\therefore \triangle PAM \cong \triangle QBM$ (A.S.A. axiom)

$\therefore AP = BQ$

$\Rightarrow PA = BQ$ (c.p.c.t.)

and $PM = QM$ (c.p.c.t.)

Now, in $\triangle CPM$ and $\triangle CQM$,

$CM = CM$ (Common)

$PM = QM$ (Proved)

$\angle CMP = \angle CMQ$ (Each 90° as $PQ \perp MC$)

$\therefore \triangle CPM \cong \triangle CQM$ (SAS axiom)

$\therefore CP = CQ$ (c.p.c.t.)

$= CB + BQ$

$= AB + PA$

($CB = AB$ sides of squares and $BQ = PA$ proved)

Hence, $CP = AB + PA$.

Question 33.

Solution:

Construction. Let AB be the breadth of the river. Mark any point M on the bank on which B is situated. Let O be the midpoint of BM . From M move along the path MN perpendicular to BM to a point N such that A, O, N are on the same straight line. Then MN is the required breadth of the river.

Proof : In $\triangle ABO$ and $\triangle MNO$,

$BO = OM$ (const.)

$\angle AOB = \angle MON$ (vertically opposite angle)

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$$\angle B = \angle M \text{ (each } 90^\circ)$$

$$\therefore \triangle ABO \cong \triangle MNO \text{ (A.S.A. axiom)}$$

$$\therefore AB = MN. \text{ (c.p.c.t.)}$$

Hence, MN is the required breadth of the river.

Question 34.

Solution:

In $\triangle ABC$,

$$\angle A = 36^\circ, \angle B = 64^\circ$$

$$\text{But } \angle A + \angle B + \angle C = 180^\circ$$

(Sum of angles of a triangle)

$$\Rightarrow 36^\circ + 64^\circ + \angle C = 180^\circ$$

$$\Rightarrow 100^\circ + \angle C = 180^\circ$$

$$\Rightarrow \angle C = 180^\circ - 100^\circ = 80^\circ$$

$\therefore \angle C = 80^\circ$ which is the greatest angle.

$\therefore$ The side AB, opposite to it is the longest side.

$\therefore \angle A$ is the shortest angle

$\therefore$ BC is the shortest side.

Question 35.

Solution:

In $\triangle ABC$,

$$\therefore \angle A = 90^\circ$$

$$\therefore \angle B + \angle C = 180^\circ - 90^\circ = 90^\circ$$

Hence, $\angle A$ is the greatest angle of the triangle.

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Side BC, opposite to this angle be the longest side.

Question 36.

Solution:

In $\triangle ABC$,

$$\angle A = \angle B = 45^\circ$$

$$\therefore \angle A + \angle B = 45^\circ + 45^\circ = 90^\circ$$

$$\text{and } \angle C = 180^\circ - 90^\circ = 90^\circ$$

$\therefore \angle C$ is the greatest angle.

$\therefore$ Side AB, opposite to $\angle C$ will be the longest side of the triangle.

Question 37.

Solution:

Given : In $\triangle ABC$, side AB is produced to D such that $BD = BC$.

$$\angle B = 60^\circ, \angle A = 70^\circ$$

To Prove : (i) $AD > CD$ (ii) $AD > AC$

Proof : In $\triangle BCD$,

$$\text{Ext. } \angle B = 60^\circ$$

$$\therefore \angle CBD = 180^\circ - 60^\circ = 120^\circ$$

$$\text{and } \angle BCD + \angle BDC = \text{Ext. } \angle CBA = 60^\circ$$

$$\text{But } \angle BCD = \angle BDC \text{ (} BC = BD \text{)}$$

$$\therefore \angle BCD = \angle BDC = 60^\circ / 2 = 30^\circ.$$

$$\therefore \angle ACD = 50^\circ + 30^\circ = 80^\circ$$

(i) Now in $\triangle ACD$,

$$\therefore \angle ACD > \angle CAD \text{ (} 80^\circ > 70^\circ \text{)}$$

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$AD > CD$.

(ii) and $\angle ACD > \angle D$ ($80^\circ > 30^\circ$)

$\therefore AD > AC$

Hence proved.

Question 38.

Solution:

Given : In $\triangle ABC$, $\angle B = 35^\circ$ and $\angle C = 65^\circ$

AX is the bisector of $\angle BAC$ meeting BC in X

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

(Sum of angles of a triangle)

$$\Rightarrow \angle A + 35^\circ + 65^\circ = 180^\circ$$

$$\Rightarrow \angle A + 100^\circ = 180^\circ$$

$$\Rightarrow \angle A = 180^\circ - 100^\circ = 80^\circ$$

$\therefore$ AX is the bisector of $\angle BAC$

$$\therefore \angle BAX = \angle CAX = 40^\circ$$

In $\triangle ABX$,

$$\angle BAX = 40^\circ \text{ and } \angle B = 35^\circ$$

$$\therefore \angle BAX > \angle B$$

$$\therefore BX > AX \dots (i)$$

and in $\triangle AXC$,

$$\angle C = 65^\circ \text{ and } \angle CAX = 40^\circ$$

$$\therefore \angle C > \angle CAX$$

$$\therefore AX > XC \dots (ii)$$

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From (i) and (ii),

$$BX > AX > XC$$

$$\text{or } BX > AX > CX$$

Question 39.

Solution:

Given : In $\triangle ABC$,

AD is the bisector of $\angle A$

To prove : (i) $AB > BD$ and

(ii) $AC > DC$

Proof : (i) In $\triangle ADC$,

$$\text{Ext. } \angle ADB > \angle CAD$$

$$\Rightarrow \angle ADB > \angle BAD ,$$

(AD is bisector of $\angle A$)

In $\triangle ABD$,

$$AB > BD.$$

(ii) Again, in $\triangle ADB$,

$$\text{Ext. } \angle ADC > \angle BAD$$

$$\Rightarrow \angle ADC > \angle CAD$$

($\angle CAD = \angle BAD$)

Now in $\triangle ACD$.

$$AC > DC.$$

Hence proved

Question 40.

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Solution:

Given : In $\triangle ABC$, $AB = AC$

BC is produced to D and AD is joined.

To Prove : $AD > AC$

Proof : In $\triangle ABC$,

$AB = AC$ (given)

$\therefore \angle B = \angle C$ (Angles opposite to equal sides)

Ext. $\angle ACD > \angle ABC$

$\angle ACB = \angle ABC$

$\therefore \angle ABC > \angle ADC$

Now, in $\triangle ABD$,

$\therefore \angle ABC > \angle ADC$ or $\angle ADB$

$\therefore AD > AC$

Hence proved.

Question 41.**Solution:**

Given : In $\triangle ABC$,

$AC > AB$ and AD is the bisector of $\angle A$ which meets BC in D.

To Prove : $\angle ADC > \angle ADB$

Proof : In $\triangle ABC$,

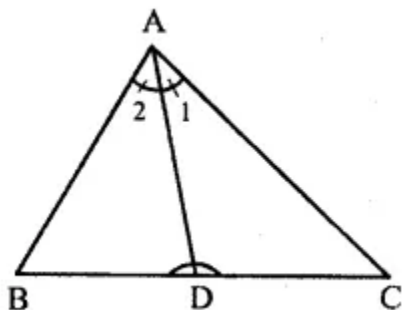
$AC > AB$

$\therefore \angle B > \angle C$

$\therefore \angle 1 = \angle 2$ (AD is the bisector of $\angle A$)

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$$\therefore \angle B + \angle 2 = \angle C + \angle 1$$



But in $\triangle ADB$

$$\text{Ext. } \angle ADC = \angle B + \angle 2$$

and in $\triangle ADC$,

$$\text{Ext. } \angle ADB > \angle C + \angle 1$$

$$\therefore \angle B + \angle 2 > \angle C + \angle 1 \text{ (Proved)}$$

$$\therefore \angle ADC > \angle ADB \text{ Hence proved.}$$

Question 42.

Solution:

Given : In $\triangle PQR$,

S is any point on QR and PS is joined

To Prove : $PQ + QR + RP > 2PS$

Proof : In $\triangle PQS$,

$$PQ + QS > PS$$

(Sum of two sides of a triangle is greater than the third side) ... (i)

Similarly, in $\triangle PRS$.

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$$PQ + SR > PS \dots(ii)$$

Adding (i), and (ii),

$$PQ + QS + PR + SR > PS + PS$$

$$\Rightarrow PQ + QS + SR + PR > 2PS$$

$$\Rightarrow PQ + QR + RP > 2PS$$

Hence proved.

Question 43.

Solution:

Given : O is the centre of the circle and XOY is its diameter.

XZ is the chord of this circle

To Prove : $XY > XZ$

Const. Join OZ

Proof : OX, OZ and OY are the radii of the circle

$$\therefore OX = OZ = OY$$

In $\triangle XOZ$,

$OX + OZ > XZ$ (Sum of two sides of a triangle is greater than its third side)

$$\Rightarrow OX + OY > XZ \text{ (}\therefore OZ = OY\text{)}$$

$$\Rightarrow OXY > XZ$$

Hence proved.

Question 44.

Solution:

Given : In $\triangle ABC$, O is any point within it OA, OB and OC are joined.

To Prove : (i) $AB + AC > OB + OC$

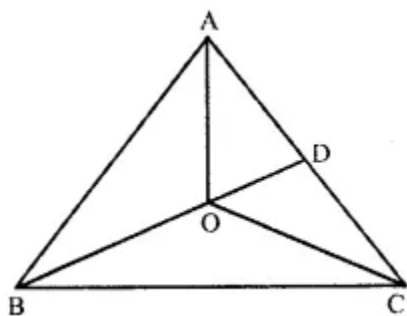
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(ii) $AB + BC + CA > OA + OB + OC$

(iii) $OA + OB + OC > 12$

$(AB + BC + CA)$

Const. Produce BO to meet AC in D.



Proof : (i) In $\triangle ABD$,

$$AB + AD > BD \dots(i)$$

(Sum of two sides of a triangle is greater than its third side)

$$\Rightarrow AB + AD > BO + OD \dots(i)$$

Similarly in $\triangle ODC$

$$OD + DC > OC. \dots(ii)$$

Adding (i) and (ii)

$$AB + AD + OD + DC > OB + OD + OC$$

$$\Rightarrow AB + AD + DC > OB + OC$$

$$AB + AC > OB + OC.$$

(ii) In (i) we have proved that

$$AB + AC > OB + OC$$

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Similarly, we can prove that

$$AC + BC > OC + OA$$

$$\text{and } BC + AB > OA + OB$$

Adding, we get:

$$AB + AC + AC + BC + B + AB > OB + OC + OC + OA + OA + OB$$

$$\Rightarrow 2(AB + BC + CA) > 2(OA + OB + OC)$$

$$\Rightarrow AB + BC + CA > OA + OB + OC.$$

(iii) In $\triangle AOB$,

$$OA + OB > AB$$

Similarly, in $\triangle BOC$

$$OB + OC > BC$$

and in $\triangle COA$

$$OC + OA > CA$$

adding we get:

$$OA + OB + OB + OC + OC + OA > AB + BC + CA$$

$$\Rightarrow 2(OA + OB + OC) > (AB + BC + CA)$$

$$\Rightarrow OA + OB + OC > \frac{1}{2} (AB + BC + CA)$$

Hence proved.

Question 45.

Solution:

Sides of $\triangle ABC$ are $AB = 3\text{cm}$, $BC = 3.5\text{cm}$ and $CA = 6.5\text{cm}$

We know that sum of any two sides of a triangle is greater than its third side.

Here, $AB = 3\text{ cm}$ and $BC = 3.5\text{ cm}$

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$\therefore AB + BC = 3\text{ cm} + 3.5\text{ cm} = 6.5\text{ cm}$ and $CA = 6.5\text{ cm}$

$\therefore AB + BC = CA$

Which is not possible to draw the triangle.

Hence, we cannot draw the triangle with the given data.



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He was born on January 2, 1946 in a village of Delhi. He graduated from Kirori Mal College, University of Delhi. After completing his M.Sc. in Mathematics in 1969, he joined N.A.S. College, Meerut, as a lecturer. In 1976, he was awarded a fellowship for 3 years and joined the University of Delhi for his Ph.D. Thereafter, he was promoted as a reader in N.A.S. College, Meerut. In 1999, he joined M.M.H. College, Ghaziabad, as a reader and took voluntary retirement in 2003. He has authored more than 75 titles ranging from Nursery to M. Sc. He has also written books for competitive examinations right from the clerical grade to the I.A.S. level.

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