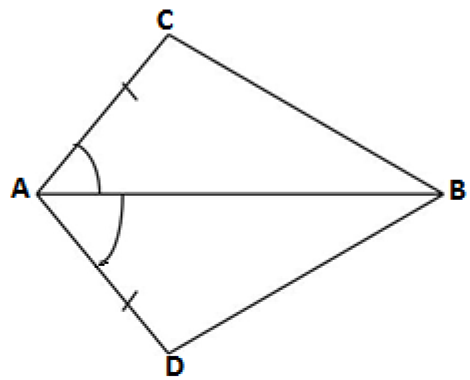
Triangles: NCERT Class 9 CBSE

Exercise 7.1

Q1.In quadrilateral ACBD, AC = AD, and AB bisect ∠A (see the given figure). Show that ΔABC≅ΔABD. What can you say about BC and BD?



Ans.

GIVEN:In quadrilateral ACBD, AC = AD

AB is the bisector of ∠A

So, ∠BAC = ∠DAB

TO PROVE: ΔABC≅ΔABD

PROOF: In ΔABC and ΔABD

We have

AC = AD (given)

AB = AB (common)

∠BAC = ∠DAB (given)

ΔABC≅ΔABD (SAS rule)

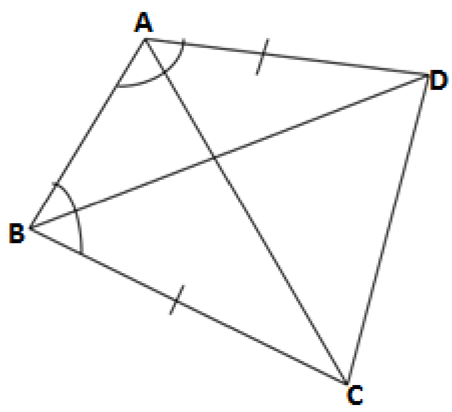
BC = BD (by CPCT)

Q2. ABCD is a quadrilateral in which AD = BC and ∠DAB = ∠CBA (see the given figure).Prove that

(i) ΔABD ≅ΔBAC

(ii) BD = AC

(iii) ∠ABD = ∠BAC



Ans.

(i) **GIVEN:** ABCD is a quadrilateral

AD = BC and ∠DAB = ∠CBA

TO PROVE: ΔABD ≅ΔBAC

PROOF: In ΔABD and ΔBAC

AD = BC (given)

AB = AB (common)

∠DAB = ∠CBA

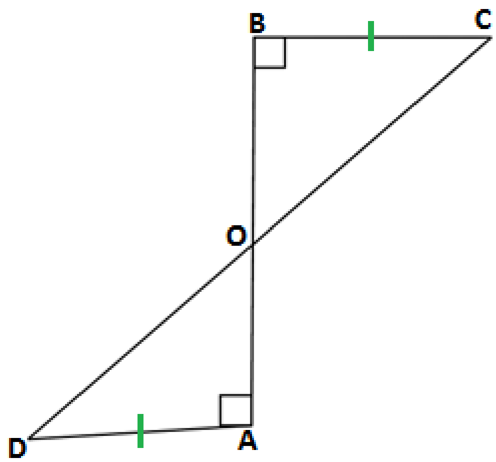
ΔABD ≅ΔBAC (SAS)

Hence proved

(ii) BD = AC (By CPCT)

(iii) ∠ABD = ∠BAC(By CPCT)

Q3. AD and BC are equal perpendiculars to a line segment AB (see the given figure).Show that CD bisects AB.



Ans.

GIVEN: AD = BC

AB ⊥ BC and AB ⊥ BC

∴∠OBC = ∠OAD = 90 °

TO PROVE: CD bisects AB i.e AO = BO

PROOF: In ΔAOD and ΔBOD

Since BOA and COD is a line

∠DOA = ∠BOC (vertically opposite angle)

AD = BC (Given)

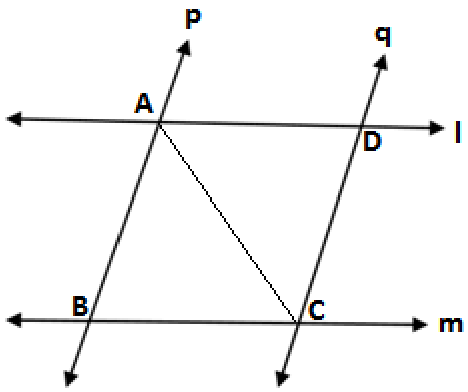
∠OBC = ∠OAD = 90 °(given)

ΔBOC ≅ ΔAOD(AAS)

AO = BO (By CPCT)

Hence Proved

Q4. l and m are two parallel lines intersected by another pair of parallel lines p and q(see the given figure). Show that ΔABC ≅ CDA.



Ans.

GIVEN: p ∥ q and l∥ m

TO PROVE: ΔABC ≅ ΔCDA

PROOF: In the figure

l∥ m and AC is the transversal(given)

So, ∠DAC = ∠ACB (alternate angles)

p ∥ q and AC is the transversal(given)

∠BAC = ∠ACD(alternate angles)

AC = AC(given)

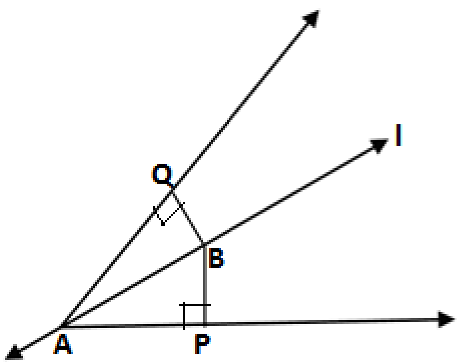
ΔABC ≅ Δ CDA(ASA rule)

Hence proved

Q5.Line l is the bisector of an angle ∠A and B is any point on l ,BP and BQ are perpendiculars from B to the arms of ∠A(see the given figure). Show that

(i) ΔAPB ≅ΔAQB

(ii) BP = BQ or B is equidistant from the arms of ∠A



Ans.

(i) GIVEN: ,BP and BQ are perpendiculars from B to the arms of ∠A

∴∠AQB = ∠APB = 90 °

Line l is the bisector of an angle ∠A and

∴∠QAB = ∠PAB

TO PROVE: ΔAPB ≅ΔAQB

PROOF:∠AQB = ∠APB = 90 °(given)

AB = AB (common)

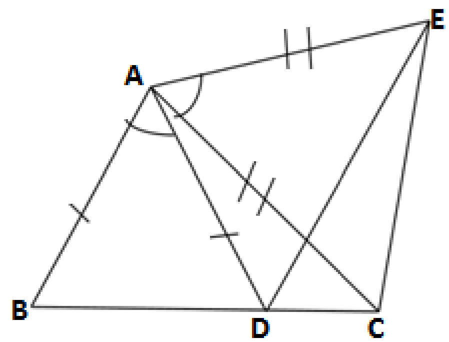
∠QAB = ∠PAB (given)

ΔAPB ≅ΔAQB (AAS rule)

(ii) BP = BQ(by CPCT)

Hence proved

Q6. In the given figure, AC = AE, AB = AD and ∠BAD = ∠EAC. Show that BC =DE.



Ans.

GIVEN: AC = AE

AB = AD

∠BAD = ∠EAC

TO PROVE: BC =DE

PROOF: We have to prove BC =DE, which are sides of the triangle ΔABC and ΔADE

In triangles ΔABC and ΔADE

AB = AD(given)

AC = AE(given)

∠BAD = ∠EAC (given)

Adding both sides ∠DAC

∠BAD + ∠DAC = ∠EAC + ∠DAC

∠BAC = ∠DAE(proved)

ΔABC ≅ ΔADE (SAS rule)

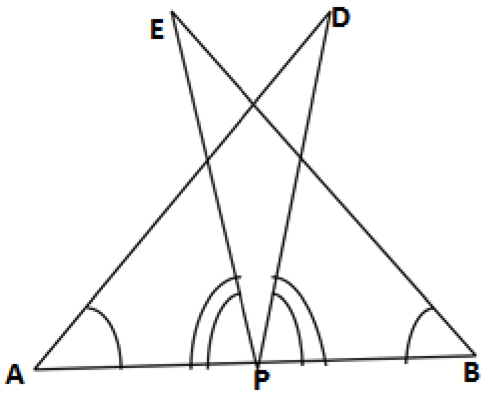
BC = DE (by CPCT)

Hence proved

Q7. AB is a line segment and p is its midpoint. D and E are points on the same sides of AB such that ∠BAD = ∠ABE and ∠EPA=∠DPB(see the given figure). Show that

(i) ΔDAP≅ ΔEBP

(ii) AD = BE



Ans.(i)

GIVEN: ∠DAP = ∠EBP

∠EPA = ∠DPB

P is the mid point of AB

∴AP = BP

TO PROVE:

(i) ΔDAP≅ ΔEBP

(ii) AD = BE

PROOF: In ΔDAP and ΔEBP

∠BAD = ∠ABE(given)

∠EPA=∠DPB(given)

Adding ∠EPD both sides

∠EPA +∠EPD =∠DPB+ ∠EPD

∠APD = ∠EPB

AP = BP(given)

ΔDAP≅ ΔEBP(ASA rule)

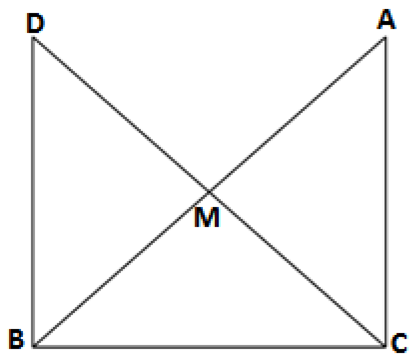
Q8.In right triangle ABC ,right angled at C , M is th mid point of hypotenuse AB, C is joined to M and produced to a point D such that DM = CM . Point D is joined to point B(see the given figure). Show that

(i) ΔAMC ≅ BMD

(ii) ∠DBC is a right angle

(iii) ΔDBC ≅ ΔACB

$$(iv)\ CM = \frac{1}{2}AB$$



Ans.

(i) GIVEN:ΔABC is a right triagle ,∠C = 90 °

M is the midpoint of AB

∴BM = AM

AM = AB/2

DM = CM

TO PROVE: ΔAMC ≅ BMD

PROOF:DM = CM (given)

BM = AM (given)

$\angle BMD = \angle AMC$ (Vertically opposite angle)

$\Delta AMC \cong BMD$(SAS rule)

Hence proved

(ii) Since $\Delta AMC \cong BMD$(proved)

$\angle DBM = \angle CAM$ (By CPCT)

$\angle DBM$ and $\angle CAM$ are alternate angles

$\therefore DB \parallel AC$

$\angle DBC + \angle ACB = 180°$(co-interior angles)

$\angle ACB = 90°$

$\angle DBC + 90° = 180°$

$\angle DBC = 90°$

Hence proved

(iii) Since $\Delta AMC \cong BMD$(proved)

BD = AC (By CPCT)

BC = BC(common)

$\angle DBC = \angle ACB = 90°$(Proved above)

$\Delta DBC \cong \Delta ACB$ (SAS rule)

proved above

(iv) CM = DM(given)

CM + DM = DC

CM + CM = DC

2CM = DC

CM = 1/2 DC

Since we have proved

ΔDBC ≅ ΔACB

So, DC = AB (by CPCT)

Therefore

CM = 1/2 AB

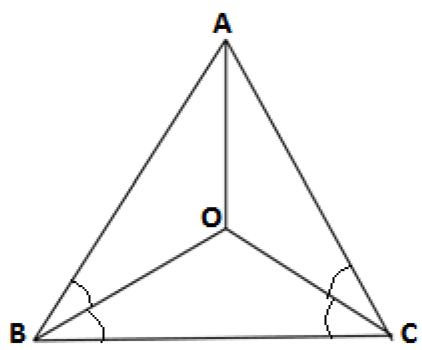
Hence proved

Exercise 7.2

Q1.In an isosceles triangle ABC, with AB = AC, the bisector of angle ∠B and ∠C, intersect each other at O. Join A to O. Show that:

(i) OB = OC (ii) AO bisects ∠A

Ans.



GIVEN: In ΔABC

AB = AC

BO is bisector of ∠B and CO is bisector of ∠C

TO PROVE:(i) OB = OC (ii) AO bisects ∠A

PROOF:In ΔABC

AB = AC (given)

∠ABC = ∠ACB (angles opposite to equal sides)

It is given to us that BO is bisector of ∠B and CO is bisector of ∠C

1/2(∠ABC) = 1/2(∠ACB)

∠OBC = ∠OCB

OB = OC (sides opposite to equal angles)

Hence proved

(ii) OB = OC (proved above)

AO = AO (common)

AB = AC (given)

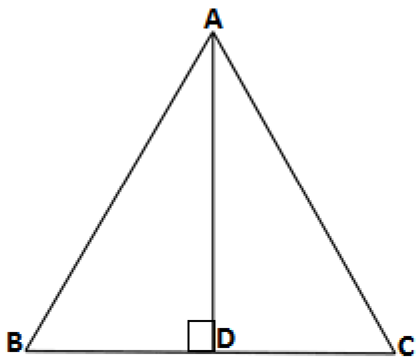
ΔABO ≅ΔACO (SSS rule)

∠OAB = ∠OCA (by CPCT)

Therefore AO is the bisector of ∠A.

Hence proved

Q2. In ΔABC , AD is perpendicular bisector of BC (see the given figure). Show that ΔABC is an isoscles triangle in which AB = AC.



Ans.

GIVEN: In ΔABC , AD is perpendicular bisector of BC

∴ BD = DC

∠ADB = ∠ADC = 90 °

TO PROVE: AB = AC

PROOF: In ΔABD and ΔACD

∠ADB = ∠ADC = 90 °(given)

AD = AD (common)

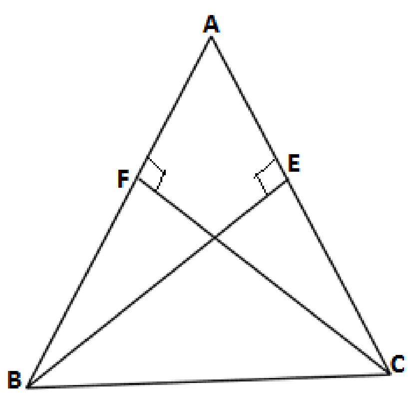
BD = DC(given)

ΔABD ≅ ΔACD (SAS rule)

AB = AC(by CPCT)

Hence ΔABC is an isosceles triangle in which AB = AC

Q3. ABC is an isoscles triangle in which altitudes BE and CF are drawn to equal sides AC and AB respectively (see the given figure).Show that these altitudes are equal.



Ans.

GIVEN: ΔABC in which AC = AB

CF ⊥ AB and CE ⊥ AC

∴∠AFC = ∠AEB = 90 °

TO PROVE: CF = BE

PROOF: AC = AB (given)

∠AFC = ∠AEB = 90 °(given)

∠A = ∠A (common)

ΔAEB ≅ AFC (AAS rule)

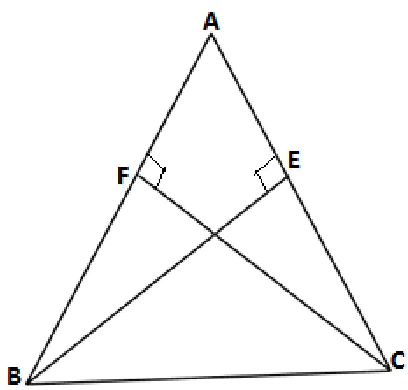
BE = CF(by CPCT)

Hence proved

Q4.ABC is a triangle in which altitudes BE and CF to sides AC and AB are equal (see the given figure). Show that.

(i) ΔABE ≅ ACF

(ii)AB = AC i.e ABC is an isosceles triangle



Ans.

GIVEN: ΔABC in which BE = CF

CF ⊥ AB and CE ⊥ AC

∴∠AFC = ∠AEB = 90 °

TO PROVE: AC = AB

(i) PROOF:BE = CF (given)

∠AFC = ∠AEB = 90 °(given)

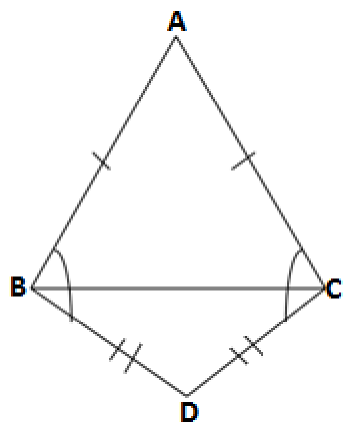
∠A = ∠A (common)

ΔAEB ≅ AFC (AAS rule)

(ii) AC = AB (by CPCT)

Hence proved

Q5. ABC and DBC are two isosceles triangles on the same base BC (see the given figure). Show that ∠ABD = ∠ACD.



Ans.

GIVEN: ΔABC in which AB = AC

ΔDBC in which BD = DC

TO PROVE: ∠ABD = ∠ACD

PROOF: In Δ ABC

AB = AC (given)

∠ABC = ∠ACB ....(i) (angles opposite to equal sides)

BD = DC

∠DBC = ∠DCB....(ii) (angles opposite to equal sides)

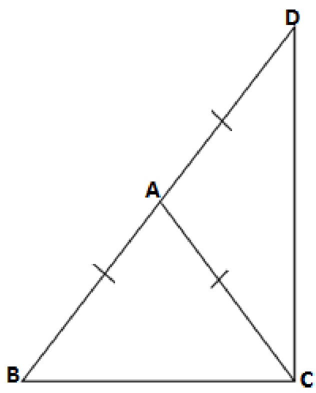
Adding equation (i) and (ii)

∠ABC + ∠DBC = ∠ACB + ∠DCB

∠ABD = ∠ACD

Hence proved

Q6. ΔABC is an isosceles triangle in which AB = AC, side BA is produced to D such that AD = AB(see the given figure). Show that ∠BCD is a right angle.



Ans.

GIVEN:AB = AC

AD = AB

TO PROVE: ∠BCD = 90 °

PROOF : AB = AC (given)

∠ABC = ∠ACB (angles opposite to equal sides)

Applying the angle sum property in ΔABC

∠ABC + ∠BAC + ∠ACB = 180 °

∠BAC = 180 °- (∠ABC + ∠ACB)

∠BAC and ∠DAC are lienear pair

So, ∠BAC + ∠DAC = 180 °

180 °- (∠ABC + ∠ACB) + ∠DAC = 180 °

∠DAC = ∠ABC + ∠ACB =∠ACB + ∠ACB =2∠ACB

∠ACB = 1/2 ∠DAC.....(i)

AD = AC (given)

∠ADC = ∠ACD (angles opposite to equal sides)

Applying the angle sum property in ΔABC

$\angle ADC + \angle ACD + \angle DAC = 180°$

$\angle ACD + \angle ACD + \angle DAC = 180°$

$2\angle ACD + \angle DAC = 180°$

$\angle DAC = 180° - 2\angle ACD$

$\angle ACD = 90° - 1/2\ \angle DAC$........(ii)

Adding equation (i) and (ii)

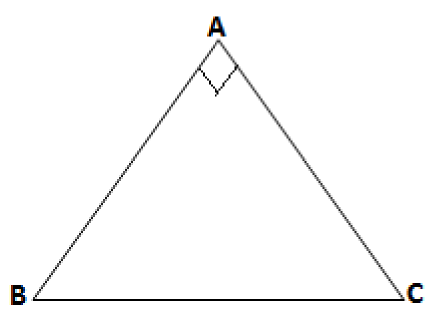
$\angle ACB + \angle ACD = 1/2\ \angle DAC + 90° - 1/2\ \angle DAC$

$\angle BCD = 90°$

Hence ΔBCD is right triangle

Q7. ABC is a right triangle in which ∠A = 90 °and AB = AC. Find ∠B and ∠C.

Ans.



We are given triagle ABC in which

$\angle A = 90°$

AB = AC

∠B = ∠C (angles opposite to equal sides)

∠B + ∠C + ∠A = 180°

∠B + ∠B +90°= 180°

2∠B + 90°= 180°

2∠B = 90°

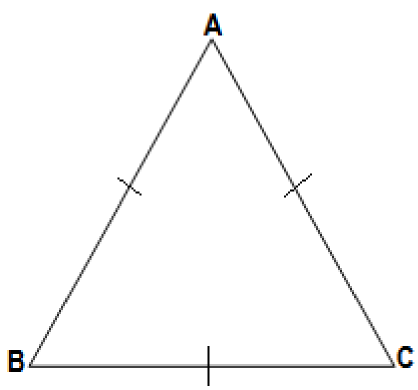
∠B = 45°

∠C = 45°

Hence both of the angles ∠B and ∠C are of 45°

Q8. Show that the angles of an equilateral triangle are 60°each.

Ans.



We are given that ΔABC is an equilateral triangle

AB = AC (sides of equilateral triangle)

∠C = ∠B .....(i)(angles opposite to equal sides)

BC = AC (sides of equilateral triangle)

∠B = ∠A .....(ii)(angles opposite to equal sides)

From equation (i) and (ii)

$\angle A = \angle B = \angle C$

Applying angle sum property of the triangle in ΔABC

$\angle A + \angle B + \angle C = 180°$

$\angle A + \angle A + \angle A = 180°$

$3\angle A = 180°$

$\angle A = 180°/3$

$\angle A = 60°$

$\therefore \angle A = \angle B = \angle C = 60°$

Therefore angles of an equilateral triangle are 60° each.

Exercise 7.3

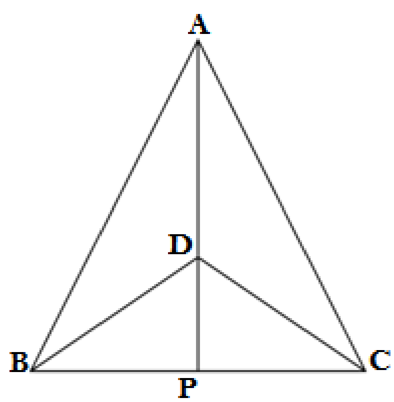
Q1. ΔABC and ΔDBC are two isosceles on the same base BC and vertices A and D are on the same side of BC (see the given figure). If AD is extended to intersect BC at P, show that

(i) ΔABD ≅ ACD

(ii)ΔABP ≅ ACP

(iii)AP bisects ∠A and as well as ∠D

(iv) AP is the perpendicular bisector of BC



Ans.

GIVEN: ΔABC and ΔDBC are two isosceles with a common base BC

In which AB = AC and AD = DC

(i) TO PROVE: ΔABD ≅ ACD

PROOF:AB = AC (given)

BD = CD (given)

AD = AD (common)

ΔABD ≅ ACD (SSS rule)

Hence proved

(ii) TO PROVE:ΔABP ≅ ACP

PROOF: AB = AC (given)

AP = AP(common)

Since we have already proved ΔABD ≅ ACD

∴∠BAP = ∠PAC (By CPCT)

ΔABP ≅ ACP(SAS rule)

Hence proved

(iii TO PROVE: AP bisects ∠A and as well as ∠D

PROOF: In ΔDPB and ΔDPC

Since we have proved ΔABD ≅ ACD and ΔABP ≅ ACP

∴ BD = DC (By CPCT) and BP = PC (CPCT)

DP = DP (common)

ΔDPB ≅ΔDPC

∠DPB =∠DPC (By CPCT)...(i)

And it is already proved ΔABD ≅ ACD

∠BAD=∠DAC (By CPCT)....(*ii)

From (i) and (ii) it is clear that AP bisects ∠A and as well as ∠D

Hence proved

(iv) TO PROVE: AP is the perpendicular bisector of BC

PROOF: Since we have proved ΔABP ≅ ACP

Therefore ∠APB = ∠APC (By CPCT)

BP = PC(By CPCT).....(i)

∠APB + ∠APC = 180 °

∠APB +∠APB = 180 °

2 ∠APB = 180 °

∠APB = 90 °

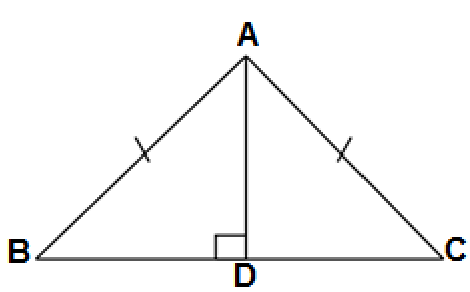
∴ AP ⊥ BC......(ii)

From (i) and (ii), it is cleared that AP is a perpendicular bisector of BC

Hence proved

Q2.AD is an altitude of an isosceles triangle ABC in which AB = AC. Show that (i) AD bisects BC (ii) AD bisects ∠A.

Ans.



GIVEN: An isosceles triangle ΔABC in which AB = AC

AD is the altitude of the isosceles triangle

∴ ∠ADC = ∠ADB = 90 °

TO PROVE: (i) AD bisects BC

In ΔABD and ΔACD

AD = AD (common)

AB = AC (given)

∠ADC = ∠ADB = 90 °(AD ⊥ BC)

ΔABD ≅ ΔACD(RHS rule)

BD = DC (By CPCT)

Hence AD bisects BC

(ii) TO PROVE: AD bisects ∠A.

Since we have proved ΔABD ≅ ΔACD

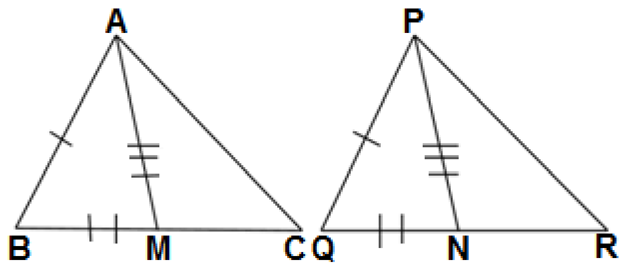
∴∠BAD = ∠DAC (By CPCT)

Therefore AD bisects ∠A

Q3. Two sides AB and BC and median AM of one triangle ABC are respectively equal to sides PQ and QR and median PN of ΔPQR see the given figure. Show that.

(i) ΔABM ≅Δ PQN

(ii)ΔABC ≅ ΔPQR



Ans.

GIVEN: In ΔABC and ΔPQR

AB = PQ

BC = QR

AM = PN

TO PROVE: (i) ΔABM ≅Δ PQN

PROOF: AB = PQ (given)

AM = PN (given)

BC = QR (given)

Since AM is the median of the triangle ΔABC and PN is the median of the triangle ΔPQR

∴BC/2 = QR/2

BM = QN

ΔABM ≅Δ PQN (SSS rule)

Hence proved

TO PROVE (ii)ΔABC ≅ ΔPQR

PROOF: Since we have already proved ΔABM ≅Δ PQN

∴∠ABM = ∠PQN (by CPCT)

AB = PQ (given)

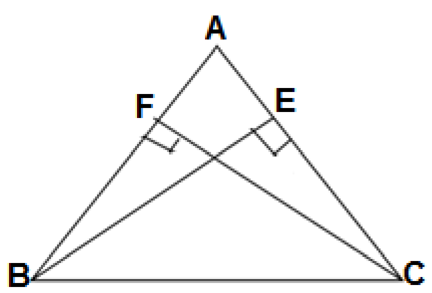
BC = QR(given)

ΔABM ≅Δ PQN (SAS rule)

Hence proved

Q4. BE and CF are two equal altitudes of a triangle ABC. Using the RHS congruence rule, prove that the triangle ABC is isosceles.

Ans.



GIVEN: In ΔABC, in which two altitudes BE and CF are equal

BE = CF

∠CFB = ∠CEB = 90 °

TO PROVE: triangle ABC is isosceles

In ΔCFB and ΔBEC

The hypotenuse of both right triangles is common

BC = BC (common)

∠CFB = ∠CEB = 90 °(BE and CF are altitudes of both triangles)

BE = CF (equal)

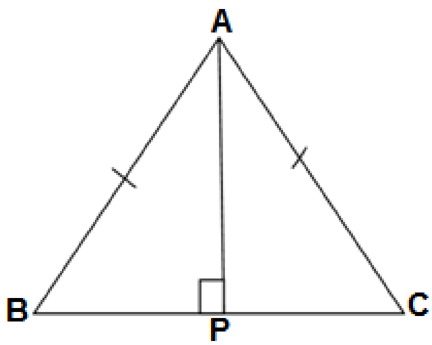
ΔΔCFB≅ ΔBEC (RHS rule)

∠B = ∠C (by CPCT)

AB = AC (opposite sides of equal triangles)

Q5. ABC is an isoscles triangle with AB = AC . Draw AP⊥ BC to show that ∠B = ∠C.

Ans.



GIVEN: In triangle ABP and triangle ACP

AB = AC

∠APB = ∠APC = 90 °(AP ⊥ BC)

TO PROVE:∠B = ∠C

PROOF: In ΔABP and ΔACP

AB = AC (given)

AP = AP (common)

∠APB = ∠APC = 90 °(given)

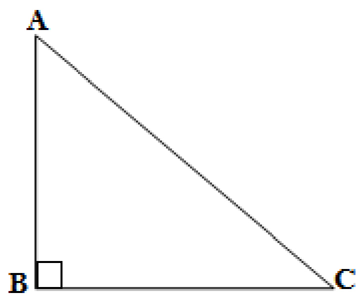
ΔABP ≅ ΔACP (RHS rule)

∠B = ∠C (by CPCT)

Hence proved

Q1.Show that in a right-angled triangle, the hypotenuse is the longest triangle.

Ans.



GIVEN: ΔABC is a right triangle,let ∠B =$90°$

TO PROVE: Hypotenuse is the largest side in a right triangle

PROOF: ∠B = $90°$(given)

∠A + ∠B + ∠C = $180°$(angle sum property of the triangle)

∠A + $90°$+ ∠C = $180°$

∠A + ∠C = $180° - 90° = 90°$

∠A and ∠C must be acute angle

∴∠A < $90°$and ∠C < $90°$

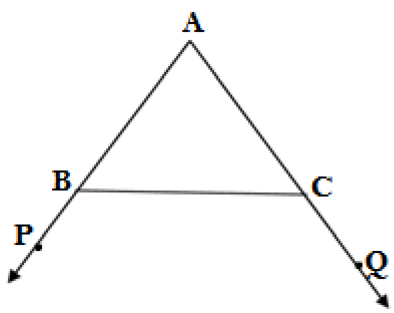
Therefore ∠B is the largest angle

So, ∠B >∠A and ∠B>∠C

AC> BC and AC > AB (in a triangle side opposite to larger angle is longer)

Hence AC(hypotenuse) is the largest side in a right triangle

Q2.In the given figure sides AB and AC of ΔABC are extended to points P and Q respectively .Also ∠PBC < ∠QCB. Show that AC > AB.



Ans.

GIVEN: In the fig. ∠PBC < ∠QCB

TO PROVE:AC > AB

PROOF: ∠PBC < ∠QCB(given)

∠ABC + ∠PBC = 180 °(linear pair)

∠PBC = 180 °- ∠ABC ....(i)

∠ACB + ∠QCB = 180 °(linear pair)

∠QCB = 180 °- ∠ACB ....(ii)

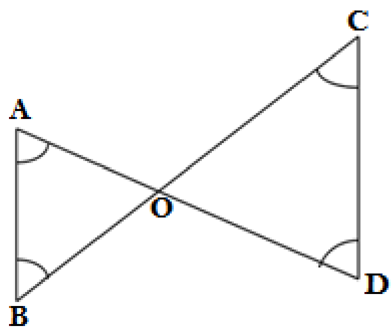
From equation (i) and equation (ii)

180 °- ∠ABC < 180 °- ∠ACB

∠ABC >∠ ACB

AC > AB (side opposite to larger angle is greater)

Q3.In the given figure , ∠B < ∠A, and ∠C < ∠D. Show that AD < BC.



Ans.

GIVEN: ∠B < ∠A, and ∠C < ∠D

TO PROVE:AD < BC

PROOF: ∠B < ∠A (given)

OA < OB....(i) (side opposite to larger angle is grater)

∠C < ∠D

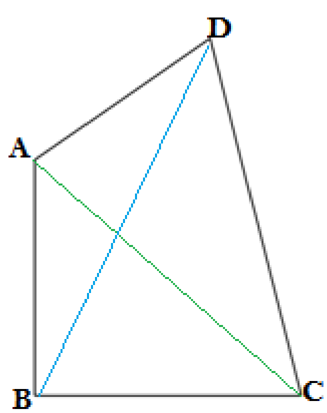
OD < OC...(ii) (side opposite to larger angle is grater)

From equation (i) and equation (ii)

OA + OD < OB + OC

AD < BC (from figure), Hence proved

Q4.AB and CD are respectively smallest and the longest side of quadrilateral ABCD(see the given figure). Show that ∠A > ∠C and ∠B > ∠D.



Ans.

GIVEN: AB and CD are respectively smallest and the longest side of quadrilateral ABCD

COSTRUCTION: Joining A to C and B to D

TO PROVE: (i) $\angle A > \angle C$ (ii) $\angle B > \angle D$.

(i) PROOF: In ΔABC

BC> AB (AB is the smallest side in ABCD)

$\angle BAC > \angle ACB$ ....(i) (side opposite to larger angle is grater)

In ΔADC

CD > AD (CD is the largest side in ABCD)

$\angle DAC > \angle ACD$....(ii)

Adding equation (i) and (ii)

$\angle BAC + \angle DAC > \angle ACB + \angle ACD$

$\angle A > \angle C$, Hence proved

PROOF: (ii) $\angle B > \angle D$

In ΔABD

AD> AB (AB is the smallest side in ABCD)

$\angle ABD > \angle ADB$ ....(i) (side opposite to larger angle is grater)

In ΔADC

CD > BC (CD is the largest side in ABCD)

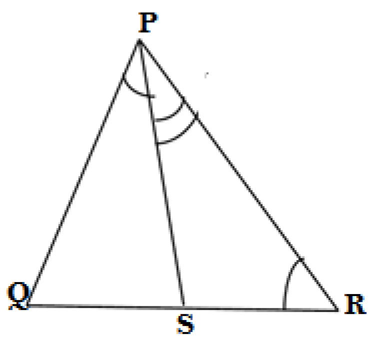
∠DBC > ∠BDC....(ii)

Adding equation (i) and (ii)

∠ABD +∠DBC > ∠ADB + ∠BDC

∠B > ∠D, Hence proved

Q5.In the given figure , PR > PQ and PS bisects ∠QPR , prove that ∠PSR > PSQ.



Ans.

GIVEN:PR > PQ

PS bisects ∠QPR

∠QPS = ∠SPR

TO PROVE: ∠PSR >∠ PSQ

PROOF: PR > PQ (given)

$\angle Q > \angle R$ (side opposite to larger angle is grater)

In ΔPQS

$\angle Q + \angle QPS + \angle PSQ = 180^\circ$ (angle sum property of the triangle)

$\angle Q = 180^\circ - (\angle QPS + \angle PSQ)$.....(i)

In ΔPSR

$\angle R + \angle SPR + \angle PSR = 180^\circ$ (angle sum property of the triangle)

$\angle R = 180^\circ - (\angle SPR + \angle PSR)$.....(ii)

From (i) and (ii)

$180^\circ - (\angle QPS + \angle PSQ) > 180^\circ - (\angle SPR + \angle PSR)$

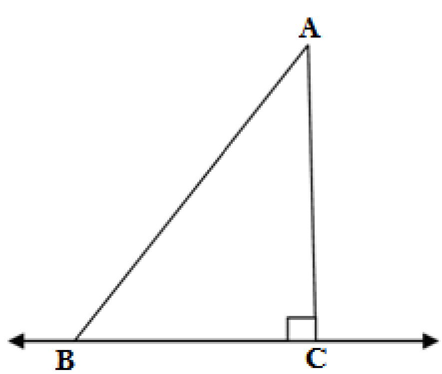
$\angle SPR + \angle PSR > \angle QPS + \angle PSQ$

Since PS bisects $\angle P$, $\angle QPS = \angle SPR$

$\angle SPR + \angle PSR > \angle SPR + \angle PSQ$

$\angle PSR > \angle PSQ$, Hence proved

Q6. Show that of all line segments drawn from a given point not on it, the perpendicular line segment is the shortest.



Ans. Let A is an external point out of the line and AC⊥ BC

Let BC is a line and AB is a line segment drawn from the point A on the line BC

In triangle ΔABC

∠B <∠C (since ∠B is acute angle and ∠C =90 °)

AC < AB (side opposite to larger angle is grater)

Similarly all line segments drawn from A on the line BC are larger than AC

Therefore AC is the shortest side drawn from A on BC, Hence proved

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