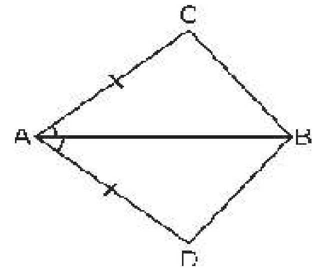
7 TRIANGLES

EXERCISE 7.1

Q.1. *In quadrilateral ACBD, AC = AD and AB bisects ∠A (see Fig.). Show that ΔABC ≅ ΔABD. What can you say about BC and BD?*



Sol. In ΔABC and ΔABD, we have

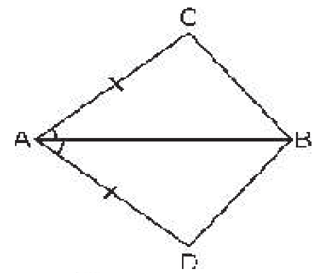
AC = AD [Given]

∠CAB = ∠DAB [Q AB bisects ∠A]

AB = AB [Common]

∴ ΔABC ≅ ΔABD. [By SAS congruence] **Proved.**

Therefore, BC = BD. (CPCT). **Ans.**

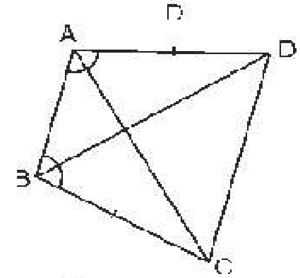


Q.2. *ABCD is a quadrilateral in which AD = BC and ∠DAB = ∠CBA (see Fig.). Prove that*

(i) Δ ABD ≅ Δ BAC

(ii) BD = AC

(iii) ∠ ABD = ∠ BAC



Sol. In the given figure, ABCD is a quadrilateral in which AD = BC and ∠DAB = ∠CBA.

In ΔABD and ΔBAC, we have

AD = BC [Given]

∠DAB = ∠CBA [Given]

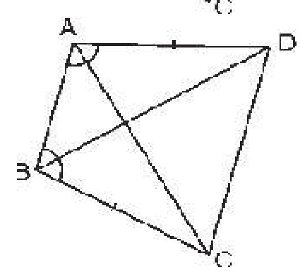
AB = AB [Common]

∴ ΔABD ≅ ΔBAC [By SAS congruence]

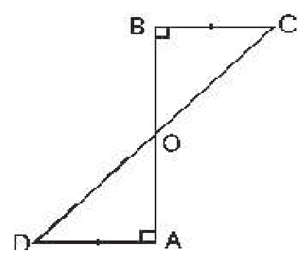
∴ BD = AC [CPCT]

and ∠ABD = ∠BAC [CPCT]

Proved



Q.3. *AD and BC are equal perpendiculars to a line segment AB (see Fig.). Show that CD bisects AB.*



Sol. In ΔAOD and ΔBOC, we have,

∠AOD = ∠BOC [Vertically opposite angles)

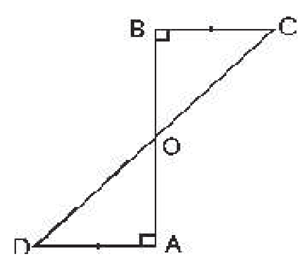
∠CBO = ∠DAO [Each = 90°]

and AD = BC [Given]

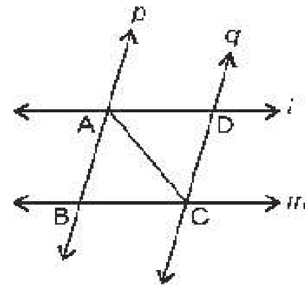
∴ ΔAOD ≅ ΔBOC [By AAS congruence]

Also, AO = BO [CPCT]

Hence, CD bisects AB **Proved.**



Q.4. *l and m are two parallel lines intersected by another pair of parallel lines p and q (see Fig.). Show that $\Delta ABC \cong \Delta CDA$.*



Sol. In the given figure, ABCD is a parallelogram in which AC is a diagonal, i.e., AB || DC and BC || AD.

In Δ ABC and Δ CDA, we have,

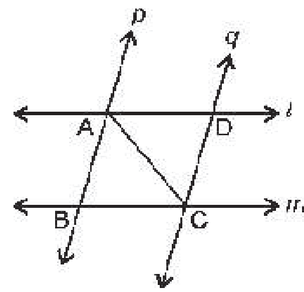
$\angle BAC = \angle DCA$ [Alternate angles]

$\angle BCA = \angle DAC$ [Alternate angles]

AC = AC [Common]

$\therefore$ $\Delta ABC \cong \Delta CDA$ [By ASA congruence]

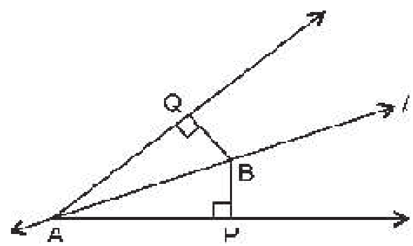
Proved.



Q.5. *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 $\angle A$ (see Fig.). Show that :*

(i) $\Delta APB \cong \Delta AQB$

(ii) BP = BQ or B is equidistant from the arms of $\angle A$.



Sol. In Δ APB and Δ AQB, we have

$\angle PAB = \angle QAB$ [l is the bisector of $\angle A$]

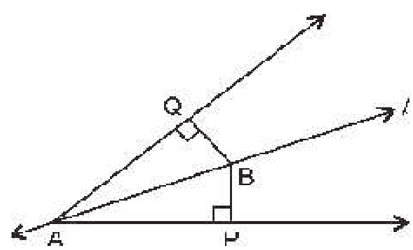
$\angle APB = \angle AQB$ [Each = 90°]

AB = AB [Common]

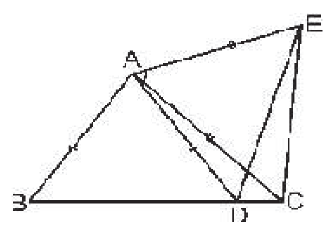
$\therefore$ $\Delta APB \cong \Delta AQB$ [By AAS congruence]

Also, BP = BQ [By CPCT]

i.e., B is equidistant from the arms of $\angle A$. **Proved**



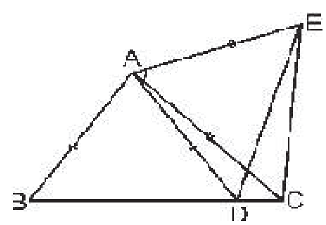
Q.6. *In the figure, AC = AE, AB = AD and $\angle BAD = \angle EAC$. Show that BC = DE.*



Sol. $\angle BAD = \angle EAC$ [Given]

$\Rightarrow \angle BAD + \angle DAC = \angle EAC + \angle DAC$ [Adding $\angle DAC$ to both sides]

$\Rightarrow \angle BAC = \angle EAC$ ... (i)



Now, in ΔABC and ΔADE, we have

AB = AD [Given]

AC = AE [Given)

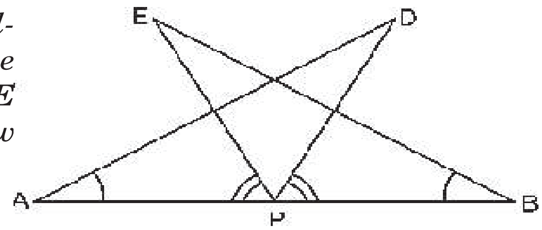
$\Rightarrow \angle BAC = \angle DAE$ [From (i)]

$\therefore \Delta ABC \cong \Delta ADE$ [By SAS congruence]

$\Rightarrow$ BC = DE. [CPCT] **Proved.**

Q.7. *AB is a line segment and P is its mid-point. D and E are points on the same side of AB such that ∠BAD = ∠ABE and ∠EPA = ∠DPB (see Fig.). Show that*

(i) *ΔDAP ≅ ΔEBP* (ii) *AD = BE*



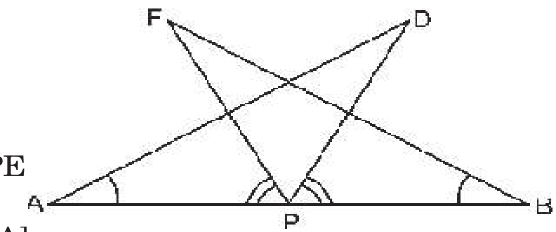
Sol. In ΔDAP and ΔEBP, we have

AP = BP [∵ P is the mid-point of line segment AB]

∠BAD = ∠ABE [Given]

∠EPB = ∠DPA

[∵ ∠EPA = ∠DPB ⇒ ∠EPA + ∠DPE = ∠DPB + ∠DPE]



∴ Δ DPA ≅ Δ EPB [ASA]

⇒ AD = BE [By CPCT] **Proved.**

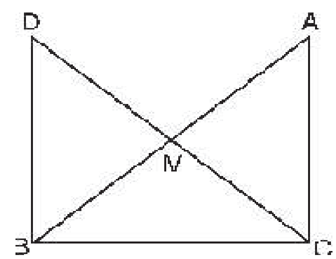
Q.8. *In right triangle ABC, right angled at C, M is the mid-point of hypotenuse AB. C is joined to M and produced to a point D such that DM = CM. Point D is joined to point B (see Fig.). Show that :*

(i) ΔAMC ≅ ΔBMD

(ii) ∠DBC is a right angle.

(iii) ΔDBC ≅ ΔACB

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



Sol. In ΔBMB and ΔDMC, we have

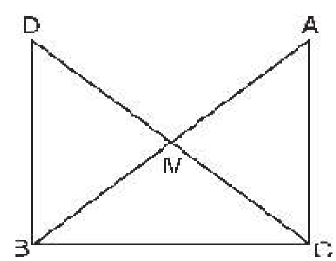
(i) DM = CM [Given]

BM = AM [∵ M is the mid-point of AB]

∠DMB = ∠AMC [Vertically opposite angles]

∴ ΔAMC ≅ ΔBMD [By SAS]

Proved.



(ii) AC || BD [∵ ∠DBM and ∠CAM are alternate angles]

⇒ ∠DBC + ∠ACB = 180° [Sum of co-interior angles]

[∵ ∠ACB = 90°] **Proved.**

⇒ ∠DBC = 90° **Proved.**

(iii) In ΔDBC and ΔACB, we have

DB = AC [CPCT]

BC = BC [Common]

∠DBC = ∠ACB [Each = 90°]

∴ ΔDBC ≅ ΔACB [By SAS] **Proved.**

(iv) ∴ AB = CD [CPCT]

⇒ $\frac{1}{2}AB = \frac{1}{2}CD$

Hence, $\frac{1}{2}AB = CM$ [$CM = \frac{1}{2}CD$] **Proved.**

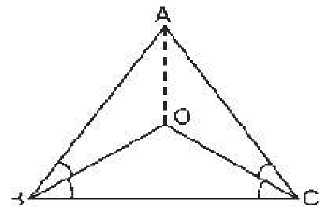
7 | TRIANGLES

EXERCISE 7.2

Q.1. *In an isosceles triangle ABC, with AB = AC, the bisectors of ∠B and ∠C intersect each other at O. Join A to O. Show that :*
(i) OB = OC (ii) AO bisects ∠A.

Sol. (i) AB = AC ⇒ ∠ABC = ∠ACB [Angles opposite to equal sides are equal]

$\frac{1}{2}\angle ABC = \frac{1}{2}\angle ACB$



⇒ ∠CBO = ∠BCO [OB and OC are bisectors of ∠B and ∠C respectively]

⇒ OB = OC [Sides opposite to equal angles are equal]

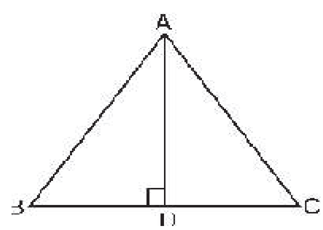
Again, $\angle\frac{1}{2}ABC = \frac{1}{2}\angle ACB$

⇒∠ABO = ∠ACO [∴ OB and OC are bisectors of ∠B and ∠C respectively]

In ∆ABO and ∆ACO, we have

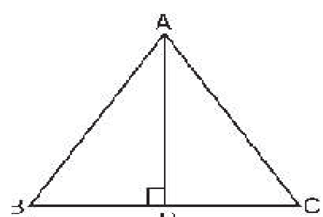
AB = AC [Given]
OB = OC [Proved above]
∠ABO = ∠ACO [Proved above]
∴ ∆ABO ≅ ∆ACO [SAS congruence]
⇒ ∆ABO = ∠CAO [CPCT]
⇒ AO bisects ∠A **Proved.**

Q.2. *In ∆ABC, AD is the perpendicular bisector of BC (see Fig.). Show that ∆ABC is an isosceles triangle in which AB = AC.*



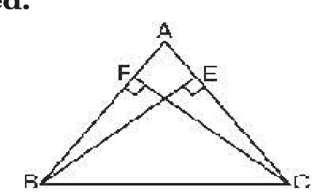
Sol. In ∆ABD and ∆ACD, we have

∠ADB = ∠ADC [Each = 90°]
BD = CD [∵ AD bisects BC]
AD = AD [Common]
∴ ∆ABD ≅ ∆ACD [SAS]
∴ AB = AC [CPCT]



Hence, ∆ABC is an isosceles triangle. **Proved.**

Q.3. *ABC is an isosceles triangle in which altitudes BE and CF are drawn to equal sides AC and AB respectively (see Fig.). Show that these altitudes are equal.*

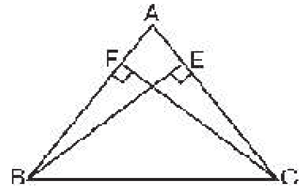


Sol. In ∆ABC,

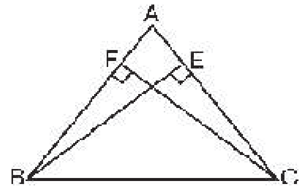
AB = AC [Given]

⇒ ∠B = ∠C [Angles opposite to equal sides of a triangle are equal]

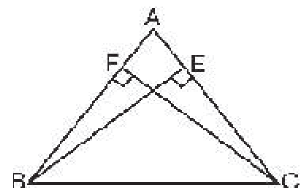
Now, in right triangles BFC and CEB,



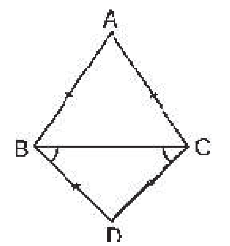
$\angle BFC = \angle CEB$ [Each = 90°]
$\angle FBC = \angle ECB$ [Pproved above]
$BC = BC$ [Common]
$\therefore$ $\Delta BFC \cong \Delta CEB$ [AAS]
Hence, BE = CF [CPCT] **Proved.**



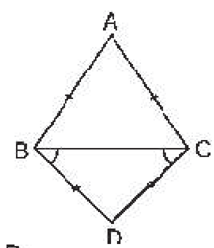
Q.4. *ABC is a triangle in which altitudes BE and CF to sides AC and AB are equal (see Fig.). Show that*
(i) $\Delta ABE \cong \Delta ACF$
(ii) AB = AC, i.e., ABC is an isosceles triangle.



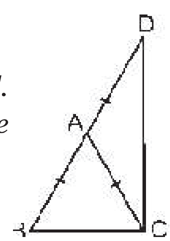
Sol. (i) In Δ ABE and ACF, we have
$BE = CF$ [Given]
$\angle BAE = \angle CAF$ [Common]
$\angle BEA = \angle CFA$ [Each = 90°]
So, $\Delta ABE \cong \angle ACF$ [AAS] **Proved.**
(ii) Also, AB = AC [CPCT]
i.e., ABC is an isosceles triangle **Proved.**



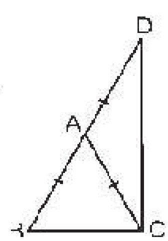
Q.5. *ABC and DBC are two isosceles triangles on the same base BC (see Fig.). Show that $\angle ABD = \angle ACD$.*



Sol. In isosceles ΔABC, we have
$AB = AC$
$\angle ABC = \angle ACB$ ...(i)
[Angles opposite to equal sides are equal]
Now, in isosceles ΔDCB, we have
$BD = CD$
$\angle DBC = \angle DCB$ ...(ii)
[Angles opposite to equal sides are equal]
Adding (i) and (ii), we have
$\angle ABC + \angle DBC = \angle ACB + \angle DCB$
$\Rightarrow$ $\angle ABD = \angle ACD$ **Proved.**



Q.6. *ΔABC is an isosceles triangle in which AB = AC. Side BA is produced to D such that AD = AB (see Fig.). Show that $\angle BCD$ is a right angle.*



Sol. $AB = AC$ [Given]
$\angle ACB = \angle ABC$ ...(i)
[Angles opposite to equal sides are equal]
$AB = AD$ [Given]
$\therefore$ $AD = AC$ [$\because$ AB = AC]
$\therefore$ $\angle ACD = \angle ADC$ ...(ii) [Angles opposite to equal sides are equal]
Adding (i) and (ii)
$\angle ACB + \angle ACD = \angle ABC + \angle ADC$
$\Rightarrow$ $\angle BCD = \angle ABC + \angle ADC$ ...(iii)
Now, in ΔBCD, we have
$\angle BCD + \angle DBC + \angle BDC = 180°$ [Angle sum property of a triangle]

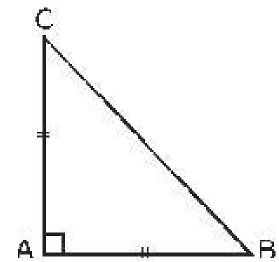
$\therefore \quad \angle BCD + \angle BCD = 180°$

$\Rightarrow \quad 2\angle BCD = 180°$

$\Rightarrow \quad \angle BCD = 90°$

Hence, $\angle BCD = 90°$ or a right angle **Proved.**

Q.7. *ABC is a right angled triangle in which $\angle A = 90°$ and AB = AC. Find $\angle B$ and $\angle C$.*



Sol. In ΔABC, we have

$\angle A = 90°$
and AB = AC } [Given]

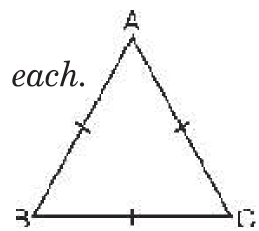
We know that angles opposite to equal sides of an isosceles triangle are equal.

So, $\angle B = \angle C$

Since, $\angle A = 90°$, therefore sum of remaining two angles = 90°.

Hence, **$\angle B = \angle C = 45°$ Answer.**

Q.8. *Show that the angles of an equilateral triangle are 60° each.*



Sol. As ΔABC is an equilateral.

So, AB = BC = AC

Now, AB = AC

$\Rightarrow \angle ACB = \angle ABC$ ...(i)

[Angles opposite to equal sides of a triangle are equal]

Again, BC = AC

$\Rightarrow \angle BAC = \angle ABC$ ...(ii) [same reason]

Now, in ΔABC,

$\angle ABC + \angle ACB + \angle BAC = 180°$ [Angle sum property of a triangle]

$\Rightarrow \angle ABC + \angle ABC + \angle ABC = 180°$ [From (i) and (ii)]

$\Rightarrow 3\angle ABC = 180°$

$$\Rightarrow \angle ABC = \frac{180°}{3} = 60°$$

Also, from (i) and (ii)

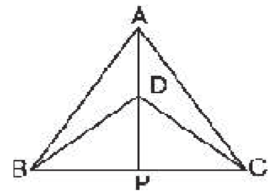
$\angle ACB = 60°$ and $\angle BAC = 60°$

Hence, each angle of an equilateral triangle is 60° **Proved.**

7 TRIANGLES

EXERCISE 7.3

Q.1. *ΔABC and ΔDBC are two isosceles triangles on the same base BC and vertices A and D are on the same side of BC (see Fig.). If AD is extended to intersect BC at P, show that*



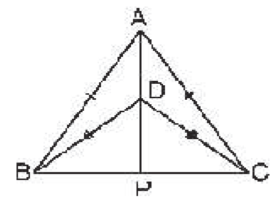
(i) $\Delta ABD \cong \Delta ACD$

(ii) $\Delta ABP \cong \Delta ACP$

(iii) AP bisects $\angle A$ as well as $\angle D$.

(iv) AP is the perpendicular bisector of BC.

Sol. (i) In Δ ABD and Δ ACD, we have



AB = AC [Given]

BD = CD [Given]

AD = AD [Common]

$\therefore$ $\Delta ABD \cong \Delta ACD$ [SSS congruence] **Proved.**

(ii) In ΔABP and ΔACP, we have

AB = AC [Given]

$\angle BAP = \angle CAP$ [Q $\angle BAD = \angle CAD$, by CPCT]

AP = AP [Common]

$\therefore$ $\Delta ABP \cong \Delta ACP$ [SAS congruence] **Proved.**

(iii) $\Delta ABD \cong \Delta ADC$ [From part (i)]

$\Rightarrow$ $\angle ADB = \angle ADC$ (CPCT)

$\Rightarrow$ $180° - \angle ADB = 180° - \angle ADC$

$\Rightarrow$ Also, from part (ii), $\angle BAPD = \angle CAP$ [CPCT]

$\therefore$ AP bisects ÐA as well as $\angle D$. **Proved.**

(iv) Now, BP = CP

and $\angle BPA = \angle CPA$ [By CPCT]

But $\angle BPA + \angle CPA = 180°$ [Linear pair]

So, $2\angle BPA = 180°$

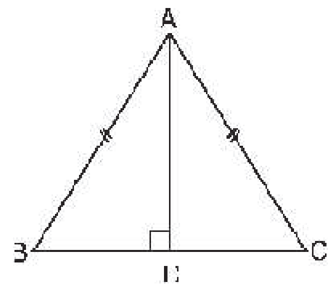
Or, $\angle BPA = 90°$

Since BP = CP, therefore AP is perpendicular bisector of BC.

Proved.

Q.2. *AD is an altitude of an isosceles triangle ABC in which AB = AC. Show that*

(i) AD bisects BC (ii) AD bisects ∠A.



Sol. (i) In ΔABD and ΔACD, we have

∠ADB = ∠ADC [Each = 90°]

AB = AC [Given]

AD = AD [Common]

∴ ΔABD ≅ ΔACD [RHS congruence]

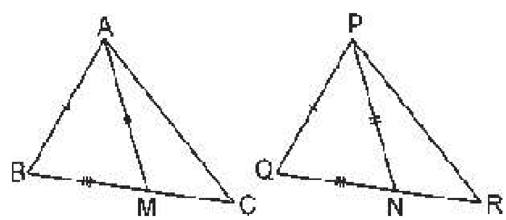
∴ BD = CD [CPCT]

Hence, AD bisects BC.

(ii) Also, ∠BAD = ∠CAD

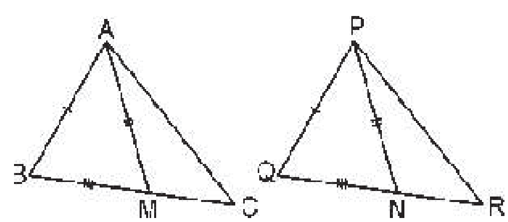
Hence AD bisects ∠A **Proved**

Q.3. *Two sides AB and BC and median AM of one triangle ABC are respectively equal to sides PQ and QR and median PN of Δ PQR (see Fig.). Show that :*



(i) Δ *ABM* ≅ Δ*PQN* (ii) Δ *ABC* ≅ Δ*PQR*

Sol. (i) In ΔABM and ΔPQN, we have



BM = QN

[Q BC = QR

$\Rightarrow \frac{1}{2}BC = \frac{1}{2}QR$]

AB = PQ [Given]

AM = PN [Given]

∴ ΔABM ≅ ΔPQN [SSS congruence] **Proved.**

⇒ ∠ABM = ∠PQN [CPCT]

(ii) Now, in ΔABC and ΔPQR, we have

AB = PQ [Given]

∠ABC = ∠PQR [Proved above]

BC = QR [Given]

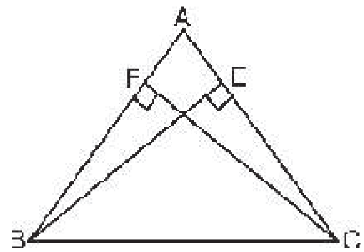
∴ ΔABC ≅ ΔPQR [SAS congruence] **Proved.**

Q.4. *BE and CF are two equal altitudes of a triangle ABC. Using RHS congruence rule, prove that the triangle ABC is isosceles.*

Sol. BE and CF are altitudes of a ΔABC.

∴ ∠BEC = ∠CFB = 90°

Now, in right triangles BEB and CFB, we have



Hyp. BC = Hyp. BC [Common]

Side BE= Side CF [Given]

∴ ΔBEC ≅ ΔCFB [By RHS congruence rule]

∴ ∠BCE = ∠CBF [CPCT]

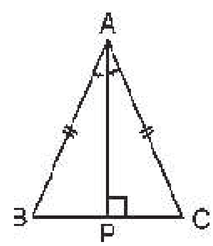
Now, in ΔABC, ∠B = ∠C

∴ AB = AC [Sides opposite to equal angles are equal]

Hence, ΔABC is an isosceles triangle. **Proved.**

Q.5. *ABC is an isosceles triangle with AB = AC. Draw AP ⊥ BC to show that ∠B = ∠C.*

Sol. Draw AP ⊥ BC.



In ΔABP and ΔACP, we have

AB = AC [Given]

∠APB = ∠APC [Each = 90°]

AB = AP [Common]

∴ ΔABP ≅ ΔACP [By RHS congruence rule]

Also, ∠B = ∠C **Proved.** [CPCT]