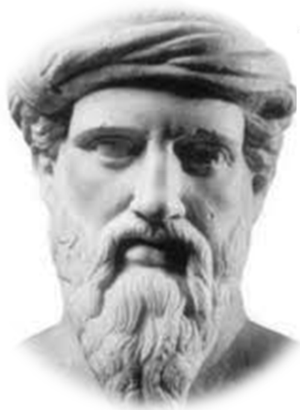
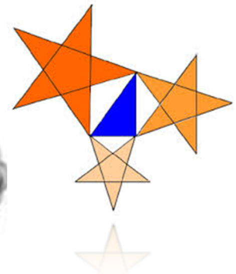
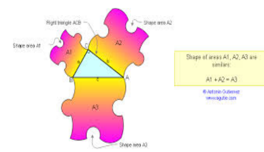
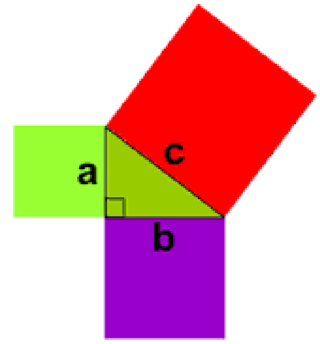






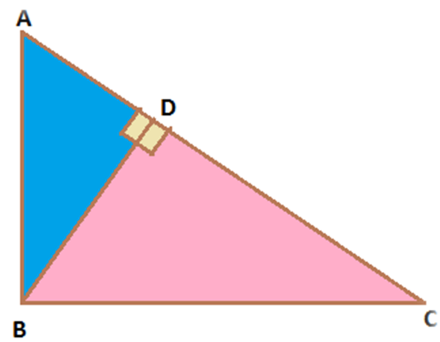


Class Notes on Pythagoras Theorem (Chapter 12)

Chapter – 12 English Version

Pythagoras Theorem

In a right angled triangle, the square on the hypotenuse is equal to the sum of the square on the other two sides.



Data: In $\Delta ABC, \angle ABC = 90^0$

To prove : $AB^2 + BC^2 = CA^2$

Construction : Draw $BD \perp AC$.

Proof

In ΔABC and ΔADB	
$\angle ABC = \angle ADB = 90^0$	Data and construction
$\angle BAD = \angle BAD$	Common angle
$\therefore \Delta ABC \sim \Delta ADB$	Equiangular triangles
$\Rightarrow \frac{AB}{AD} = \frac{AC}{AB}$	
$\Rightarrow AB^2 = AC.AD$.....(1)	
ΔABC ಮತ್ತು ΔBDC ಗಳಲ್ಲಿ	
$\angle ABC = \angle BDC = 90^0$	Data and construction
$\angle ACB = \angle ACB$	Common angle
$\therefore \Delta ABC \sim \Delta BDC$	Equiangular triangles
$\Rightarrow \frac{BC}{DC} = \frac{AC}{BC}$	
$\Rightarrow BC^2 = AC.DC$.....(2)	
$AB^2 + BC^2 = (AC.AD) + (AC.DC)$ [∵(1) + (2)]	
$AB^2 + BC^2 = AC.(AD + DC)$	
$AB^2 + BC^2 = AC.AC$	$AD + DC = AC$
$\mathbf{AB^2 + BC^2 = AC^2}$	

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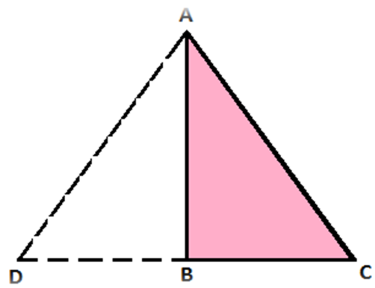
Converse of Pythagoras Theorem

"If the square on the longest side of a triangle is equal to the sum of the squares on the other two sides, then those two sides contain a right angle."



Data: In ΔABC, $AB^2 + BC^2 = AC^2$

To Prove : $\angle ABC = 90^0$

Construction: Drqw perpendicular to AB at B. Select a point D on it such that, DB = BC. Join 'A' and 'D

Proof:

In ΔABD	
$\angle ABC = 90^0$	Construction
$\therefore AD^2 = AB^2 + BC^2$	Pythagoras theorem
But, in	ΔABC
$AC^2 = AB^2 + BC^2$	Given
$\Rightarrow AD^2 = AC^2$	
$\therefore AD = AC$	
In ΔABD and ΔABC,	
AD = AC	Proved
BD = BC	Construction
AB = AB	Common sides
$\Delta ABD \equiv \Delta ABC$	S.S.S.
$\Rightarrow \angle ABD = \angle ABC$	
ಆದರೆ, $\angle ABD + \angle ABC = 180^0$	Complimenotry angles
$\Rightarrow \angle ABD = \angle ABC = 90^0$	

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Pythagorean triplets

3	4	5
6	8	10
9	12	15
15	20	25
12	16	20
7	24	25
8	15	17
10	24	26
5	12	13
18	24	30

ILLUSTRATIVE EXAMPLES

Numerical problems based on Pythagoras theorem

Example 1: In a right angled ΔABC, $\angle B = 90°$, $AC = 17cm$ and $AB = 8cm$, find BC

Sol: Given, in ΔABC, $\angle B = 90°$

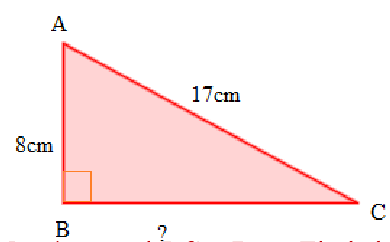
$\therefore AC^2 = AB^2 + BC^2$ [$\because$Pythagoras theorem]

$\Rightarrow BC^2 = AC^2 - AB^2$

$BC^2 = 17^2 - 8^2$

$BC^2 = 289 - 64 = 225$

$\therefore BC = 225$ cm



Example2: In ΔABC, $\angle ABC = 45°$, $AM \perp BC$, $AM = 4cm$ and $BC = 7cm$. Find the length of AC

In ◺AMB, $\angle AMB = 90°, \angle ABM = 45° \therefore \angle BAM = 90°$

◺AMB is an isosceles right angled triangle

$\therefore MA = MB = 4cm$

$MC = BC - MB = 7 - 4 = 3cm$

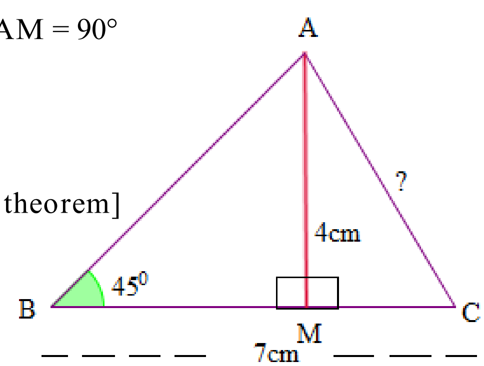
$\therefore MC = 3cm$

In ◺AMC, $AC^2 = AM^2 + MC^2$ [$\because$Pythagoras theorem]

$AC^2 = 4^2 + 3^2$

$AC^2 = 16 + 9$

$AC^2 = 25$



AC = 5cm

Example3:In the rectangle WXYZ, XY + YZ = 17cm and XZ +YW = 26cm. calculate the length and breadth of the rectangle.

Sol:XZ + YW = 26cm

$d_1 + d_2 = 26$cm

2d = 26cm

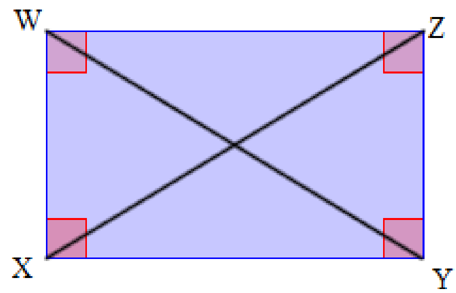
d = 13cm

∴ XZ = YW = 13cm

Let length = XY = x cm ⇒breadth = XW = (17-x)cm

In ⊿WXY,

$WX^2 + XY^2 + WY^2$ [∵ Pythagoras theorem]



$(17 - x)^2 + x^2 = 13^2$

$(289 - 34x + x^2) + x^2 = 169$

$(2x^2 - 34x + 120 = 0)$ □ 2

$x^2 - 17x + 60 = 0$

$x^2 - 12x - 5x + 60 = 0$

$x(x - 12) - 5(x - 12) = 0 \Rightarrow (x - 12)(x - 5) = 0$

$\Rightarrow x - 12 = 0$ or $x - 5 = 0$

$\Rightarrow x = 12$ or $x = 5$

Length = 12cm, breadth = 5cm

Example4: An insect 8 m away from the foot of a lamp post which is 6m tall, crawls towards it. After moving through a distance, its distance from the top of the lamp post is equal to the distance it has moved. How far is the insect away from the foot of the lamp post? [Bhaskaracharya's Leelavathi]

Sol: Distance between the insect and the foot of the lamp post = BD = 8m.

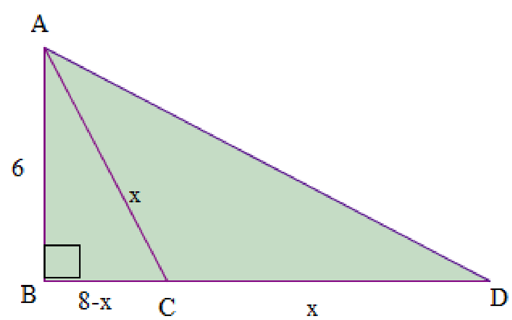
The height of the lamp post = AB = 6m.

After moving a distance, let the insect be at C,

Let AC = CD = x m

∴ BC = (8 - x) m.

In ⊿ABC, ∠B = 90^0



∴ $AC^2 = AB^2 + BC^2$ [∵ Pythagoras theorem]

$x^2 = 6^2 + (8 - x)^2$

$x^2 = 36 + 64 - 16x + x^2$

∴ 16x = 100

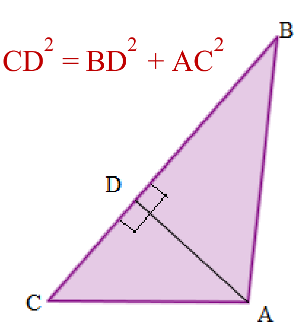
x = 6.25m

∴ BC = 8 – x = 8 – 6.25 = 1.75m

The insect is 1.75m away from the foot of the lamp post

Riders based on Pythagoras Theorem

Example5: In the given figure, AD ⊥BC, Prove that $AB^2 + CD^2 = BD^2 + AC^2$



In ⊿ADC, ∠ADC = 90^0

∴ $AC^2 = AD^2 + CD^2$ [∵ Pythagoras theorem]------(1)

In In ⊿DBA, ∠ADB = 90^0

∴ $AB^2 = AD^2 + BD^2$ [∵ Pythagoras theorem]------(2)

Substracting (1) from (2), we get

$AB^2 - AC^2 = BD^2 - CD^2$

$AB^2 + CD^2 = BD^2 + AC^2$

Example6: In ΔABD, C is the point on BD such that BC:CD = 1:2 and ΔABC is an equilateral triangle. Prove that $AD^2 = 7AC^2$

Sol: Data: In ΔABD, BC:CD = 1:2

In ΔABC, AB = BC = CA

To prove: $AD^2 = 7AC^2$

Construction: Draw $AE \perp BC$

Proof: In ΔABC,

$BE = EC = \frac{a}{2}$ and $AE = \frac{a\sqrt{3}}{2}$

In ΔADE, $\angle AED = 90^0$ [$\because$ construction]

$AD^2 = AE^2 + ED^2$ [$\because$ Pythagoras theorem]

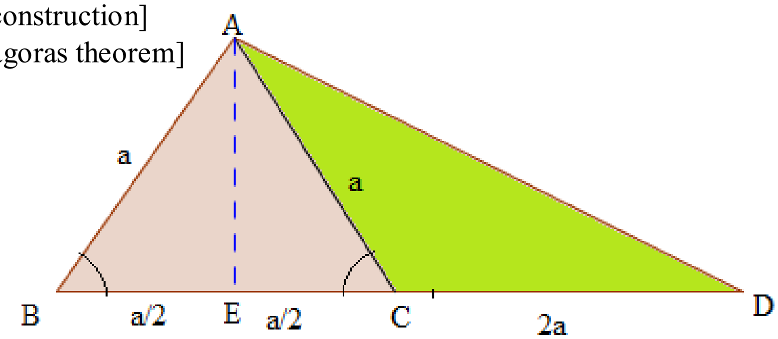
$AD^2 = \left(\frac{a\sqrt{3}}{2}\right)^2 + \left(2a + \frac{a}{2}\right)^2$

$AD^2 = \frac{3a^2}{4} + \left(\frac{5a}{2}\right)^2$

$AD^2 = \frac{3a^2}{4} + \frac{25a^2}{4}$

$AD^2 = \frac{28a^2}{4}$

$AD^2 = 7\,AC^2$



Exercise 12.1

Numerical problems based on Pythagoras theorem

1. The sides of a right angled triangle containing the right angle are 5cm and 12cm, find its hypotenuse .

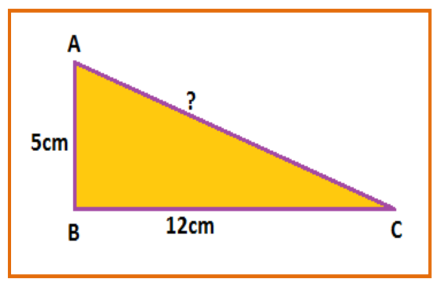
$AC^2 = AB^2 + BC^2$

$AC^2 = 5^2 + 12^2$

$AC^2 = 25 + 144$

$AC^2 = 169$

$AC = 13cm$



2. Find the length of the diagonal of a square of side 12cm.

$AC^2 = AB^2 + BC^2$

$AC^2 = 12^2 + 12^2$

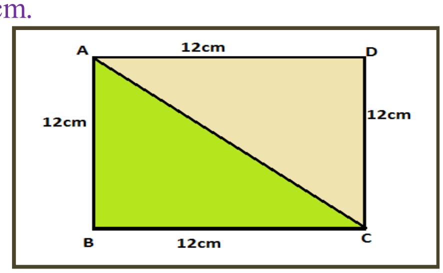
$AC^2 = 144 + 144$

$AC^2 = 288$

$AC = \sqrt{288}$

$AC = \sqrt{2x144}$

$AC = 12\sqrt{2}$ cm



3. The length of the diagonal of a rectangular playground is 125m and the length of one side is 75m. Find the length of the other side .

$AC^2 = AB^2 + BC^2$

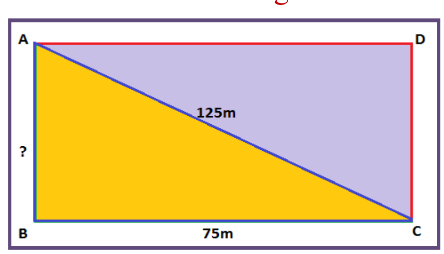
$125^2 = AB^2 + 75^2$

$15625 = AB^2 + 5625$

$AB^2 = 15625 - 5625$

$AB^2 = 10000$

$AB = 100$



4. In ⊿LAW, $\angle LAW = 90^0$, $\angle LNA = 90^0$ LW = 26cm,LN = 6cm ಮತ್ತು AN = 8cm, Calculate the length of WA.

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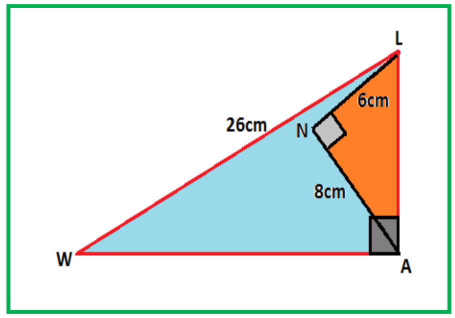
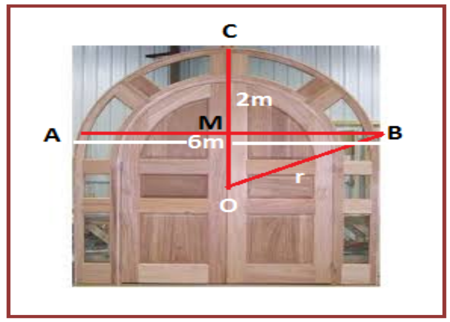


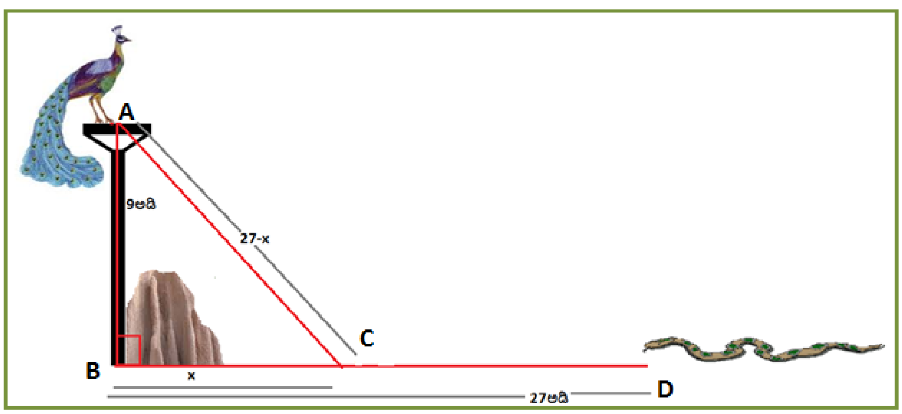
ΔLNA ಯಲ್ಲಿ , $\angle LNA = 90^0$
$\therefore LA^2 = LN^2 + NA^2$
$\therefore LA^2 = 6^2 + 8^2$
$\therefore LA^2 = 36 + 64 = 100$
$\therefore LA = 10cm$
ΔLAW ನಲ್ಲಿ, $\angle LAW = 90^0$
$\therefore WA^2 = LW^2 + LA^2$
$\therefore WA^2 = 26^2 - 10^2$
$\therefore WA^2 = 676 + 100$
$\therefore WA^2 = 576$
$\therefore$ **WA = 24cm**

5. A door of width 6 meter has an arch above it having a height of 2 meter. Find the radius of the arch .



In the figure, OC = OB = ತ್ರಿಜ್ಯ = r
OC = r - 2
In ΔOMB , $\angle OMB = 90^0$
$\therefore$ Radius $OB^2 = OM^2 + MB^2$
$\therefore r^2 = (r-2)^2 + 3^2$
$\therefore r^2 = r^2 - 4r + 4 + 9$
$\therefore 4r = 4 + 9$
$\therefore r = \frac{13}{4}$
$\therefore r = 3.25m$

6. A peacock on a pillar of 9 feet height on seeing a snake coming towards its hole situated just below the pillar from a distance of 27 feet away from the pillar will fly to catch it. If both posess the same speed, how far from the pillar they are going to meet?



In the figure,Piller AB =9 feet, BD = 27feet, The distance travelled by (Peacock) snake DC (AC) = 27-x
BC = x feet
In ΔABC , $\angle ABC = 90^0$
$\therefore AC^2 = AB^2 + BC^2$
$\therefore (27-x)^2 = 9^2 + x^2$
$\therefore 729 - 54x + x^2 = 81 + x^2$
$\therefore 729 - 54x = 81$
$\therefore 729 - 81 = 54x$

$\therefore 648 = 54x$

$\therefore x = \frac{648}{54}$

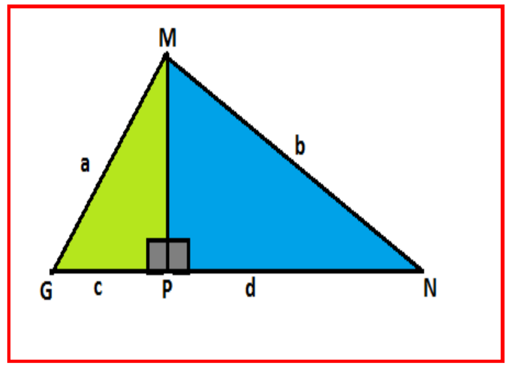
$\therefore x = 12$ feet

$\therefore$ Peacock and snake meet 12 feet away from the piller.

Riders based on Pythagoras theorem

1. ΔMGN ನಲ್ಲಿ MP⊥GN. If MG = 'a' units, MN = 'b' units, GP = 'c' units, PN = 'd' units But,

Prove that (a + b)(a – b) = (c + d)(c – d).



ΔMPG ಯಲ್ಲಿ, $\angle MPG = 90^0$,

$\therefore MP^2 = a^2 - c^2$--------(1)

ΔMPN ಯಲ್ಲಿ, $\angle MPN = 90^0$,

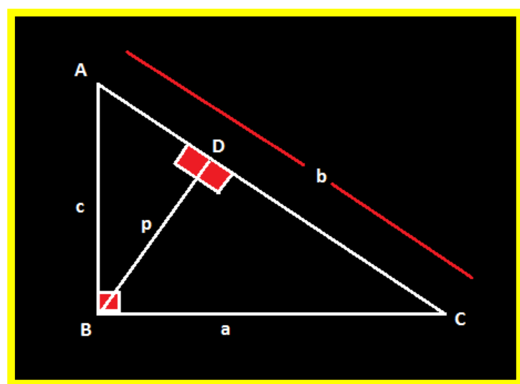
$\therefore MP^2 = b^2 - d^2$--------(2)

$\therefore a^2 - c^2 = b^2 - d^2$ [From 1 and 2]

$\therefore a^2 - b^2 = c^2 - d^2$

$\therefore$ **(a + b)(a – b) = (c + dc)(c – d)**

2. In ◺ABC, $\angle ABC = 90^0$, BD⊥AC. If AB = 'c' units, BC = 'a' units, BD = 'p' units, CA = 'b' units. Prove that $\frac{1}{a^2} + \frac{1}{c^2} = \frac{1}{p^2}$



Area ΔABC = $\frac{1}{2}$xBCxAB

Area ΔABC = $\frac{ac}{2}$ -----(1)

Area ΔABC = $\frac{1}{2}$xACxBD

Area ΔABC = $\frac{bp}{2}$ ------(2)

$\therefore \frac{ac}{2} = \frac{bp}{2}$ [From 1 and 2]

$\Rightarrow ac = bp \Rightarrow p = \frac{ac}{b} \Rightarrow \frac{1}{p} = \frac{b}{ac}$ ----(3)

Area ΔABC , $\angle ABC = 90^0$

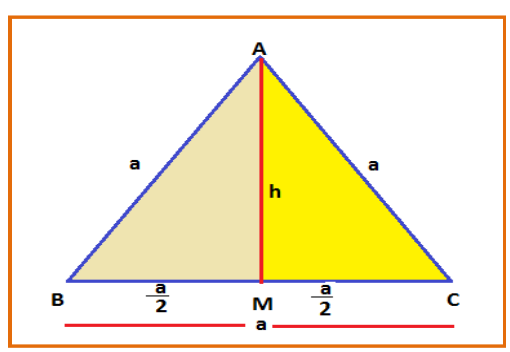
$\therefore b^2 = a^2 + c^2$

$\therefore \frac{b^2}{a^2c^2} = \frac{a^2}{a^2c^2} + \frac{c^2}{a^2c^2}$

$\therefore \mathbf{\frac{1}{p^2} = \frac{1}{c^2} + \frac{1}{a^2}}$

3. Derive the formula to find the height and area of an equilateral triangles.

In equilateral ΔABC, AM⊥BC



ΔAMC ಯಲ್ಲಿ, $\angle AMC = 90^0$,

$\therefore AM^2 = AC^2 - MC^2$--------(1)

$\Rightarrow h^2 = a^2 - \left(\frac{a}{2}\right)^2$ [∵AD⊥BC]

$\Rightarrow h^2 = a^2 - \frac{a^2}{4}$

$\Rightarrow h^2 = \frac{4a^2 - a2}{4}$

$\Rightarrow h^2 = \frac{3a2}{4}$

$\Rightarrow h = \frac{\sqrt{3}a}{2}$

Area of $\Delta ABC = \frac{1}{2} x BC x AM$

$\Rightarrow$ Area of $\Delta ABC = \frac{1}{2} xa\ x \frac{\sqrt{3}a}{2}$

$\Rightarrow$ Area of $\Delta ABC = \frac{\sqrt{3}a^2}{4}$

ILLUSTRATIVE EXAMPLES

Example1: Verify whether the following measures represent the sides of a right angled triangle.

(a) 6, 8, 10

Sol: Sides are : 6, 8, 10

Consider the areas of square on the sides : $6^2, 8^2, 10^2$

i.e., 36, 64, 100

Consider the sum of areas of squares on the two smaller sides : 36 + 64 = 100

$6^2 + 8^2 = 10^2$

We observe that, square on the longest side of the triangle is equal to the sum of squares on the other two sides.

By converse of Pythagoras theorem, those two smaller sides must contain a right angle.

Conclusion: The sides 6, 8 and 10 form the sides of a right angled triangle with hypotenuse 10 units and 6 and 8 units as the sides containing the right angle.

Note: Without actually constructing the triangle for the given measurements of sides it is now possible to say whether the sides represent the sides of a right angled triangle using converse of Pythagoras theorem

(b) 4, 5, 6

Sides are	:	4, 5, 6
Areas of squares on the sides	:	$4^2, 5^2, 6^2$
i.e.	:	16, 25, 36

Sum of areas of squares on the two smaller sides: 16 + 25 = 41

$\Rightarrow 4^2 + 5^2$ □ 6^2

We observe that the square on the longest side of the triangle is not equal to the sum of the squares on the other two sides.

By converse of Pythagoras theorem, these two sides cannot contain a right angle. Hence, 4, 5, and 6 cannot form the sides of right angled triangle

Example2: In the quadrilateral ABCD, $\angle ABC = 90^0$ and $AD^2 = (AB^2 + BC^2 + CD^2)$. Prove that $\angle ACD = 90^0$

Sol; in $\triangle ABC$, $\angle ABC = 90^0$ [∵ data]

$AC^2 = AB^2 + BC^2$ [∵ Pythagoras theorem]

But, $AD^2 = (BD^2 + BC^2) + CD^2$ [∵ data]

$\therefore AD^2 = AC^2 + CD^2$ [∵ by data $AB^2 + BC^2 = AC^2$]

$\therefore \angle ACD = 90^0$ [∵ Converse of Pythagoras theorem]

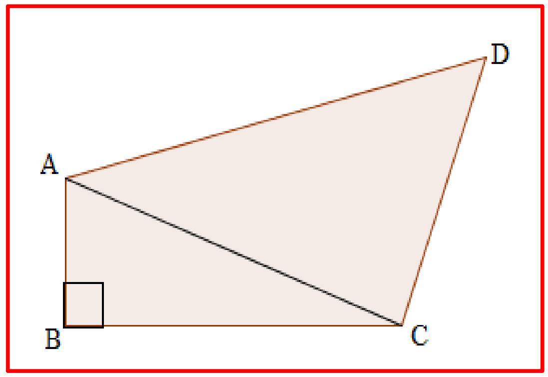
Exercise 12.2

1. Verify whether the following measures represent the sides of a right angled triangle .

(i) 1, 2 , $\sqrt{3}$ (ii) $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$ (iii) $6\sqrt{3}$, 12, 6(iv). $m^2 - n^2$, $2mn$, $m^2 + n^2$

(i) 1, 2 , $\sqrt{3}$

$1^2 = 1; 2^2 = 4; (\sqrt{3})^2 = 3$



$\therefore 2^2 = 1^2 + (\sqrt{3})^2$

$\therefore$ Not a right angled triangle.

(ii) $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$

$(\sqrt{2})^2 = 2$

$(\sqrt{3})^2 = 3$

$(\sqrt{5})^2 = 5$

$\therefore (\sqrt{5})^2 = (\sqrt{3})^2 + (\sqrt{2})^2$

$\therefore$ This is right angled triangle

(iii) $6\sqrt{3}$, 12, 6

$(6\sqrt{3})^2 = 36\text{x}3 = 108$

$12^2 = 144$

$6^2 = 36$

$\therefore 12^2 = (6\sqrt{3})^2 + 6^2$

$\therefore$ This is right angled triangle.

(iv). $m^2 - n^2$, $2mn$, $m^2 + n^2$

$(m^2 - n^2)^2 = (m^2)^2 + (n^2)^2 - 2m^2n^2$

$(m^2 - n^2)^2 = m^4 + n^4 - 2m^2n^2$

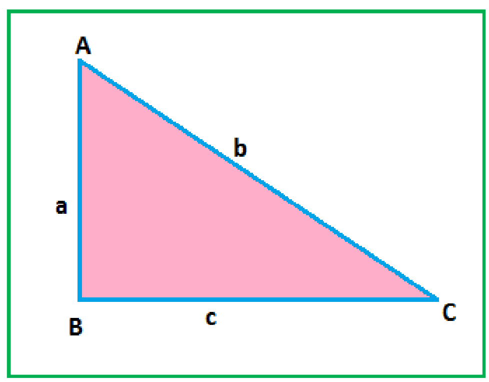
$(m^2 + n^2)^2 = (m^2)^2 + (n^2)^2 + 2m^2n^2$

$(m^2 + n^2)^2 = m^4 + n^4 + 2m^2n^2$

$(2mn)^2 = 4m^2n^2$

$\therefore (m^2 + n^2)^2 = (m^2 - n^2)^2 + (2mn)^2$

2. In ΔABC, $a + b = 18$units, $b + c = 25$units and $c + a = 17$ units . what type of ΔABC? Give reason.



$a + b = 18$

$b + c = 25$

$c + a = 17$

$\Rightarrow 2a + 2b + 2c = 60$

$\Rightarrow 2(a + b + c) = 60$

$\Rightarrow (a + b + c) = 30$

$\therefore 18 + c = 30 \Rightarrow c = 12$

$a + 25 = 30 \Rightarrow a = 5$

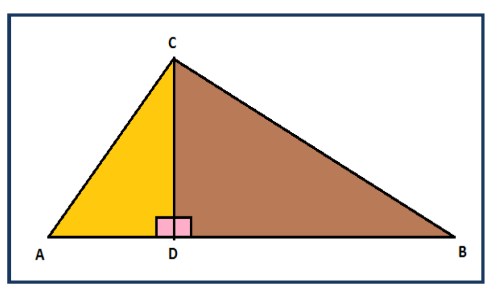
$b + 17 = 30 \Rightarrow b = 13$

$\therefore$ ABC ಯಲ್ಲಿ,

$13^2 = 5^2 + 12^2 \Rightarrow b^2 = a^2 + c^2$

$\therefore$ This is right angled triangle [Converse of Pythagoras theorem]

3. In ΔABC, If $CD \perp AB$, $CA = 2AD$ and $BD = 3AD$,Prove that $\angle \mathbf{BCA} = 90^0$.



ΔCDA ಯಲ್ಲಿ, $\angle CDA = 90^0$,

$\therefore CD^2 = CA^2 - AD^2$

$\Rightarrow CD^2 = (2AD)^2 - AD^2$

$\Rightarrow CD^2 = 4AD^2 - AD^2$

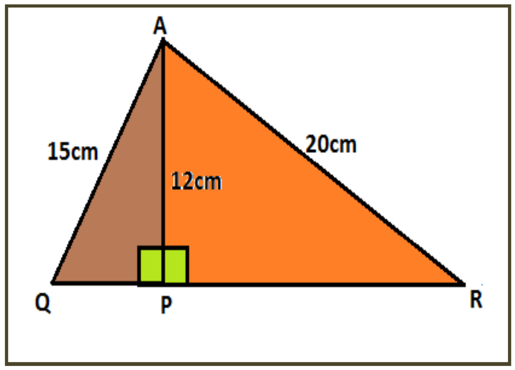
$\Rightarrow CD^2 = 3AD^2$ -------------(1)

ΔCDB ಯಲ್ಲಿ, $\angle CDB = 90^0$,

$\therefore CD^2 = CB^2 - BD^2$

$\therefore CD^2 = CB^2 - (3AD)^2$
$\therefore CD^2 = CB^2 - 9AD^2$-----(2)
$\therefore 3AD^2 = CB^2 - 9AD^2$ [∵(1) ಮತ್ತು (2)]
$\therefore CB^2 = 12AD^2$ --------------(3)
$CA^2 = (2AD)^2$
$\Rightarrow CA^2 = 4AD^2$----------------(4)
$AB^2 = (AD + BD)^2$
$\Rightarrow AB^2 = (AD + 3AD)^2$
$\Rightarrow AB^2 = (4AD)^2$
$\Rightarrow AB^2 = 16AD^2$ ------- (5)
$\therefore AB^2 = CB^2 + CA^2$ [∵From (3), (4) and (5)]
$\therefore$ **∠BCA = 90⁰**

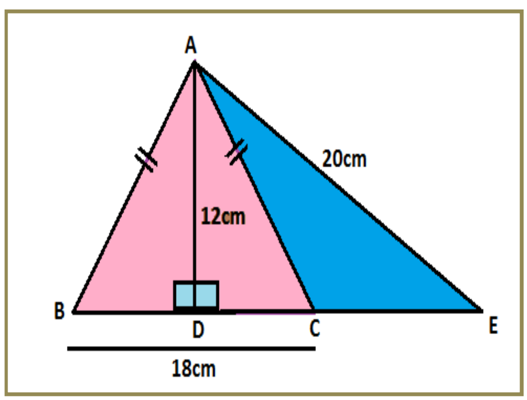
4. The shortest distance AP from a point A to QR is 12cm. 'Q' and 'R' are respect tively 15cm and 20cm from 'A' and on opposite side of AP. Prove that ∠**QAR** = 90^0



ΔAPQ ನಲ್ಲಿ, $\angle APQ = 90^0$ [∵Shortest distance =⊥]
$\therefore QP^2 = AQ^2 - AP^2$ [∵Pythagoras theorem]
$\therefore QP^2 = 15^2 - 12^2$
$\therefore QP^2 = 225 - 144$
$\therefore QP^2 = 81$-------(1)
ΔAPQ ನಲ್ಲಿ, $\angle APR = 90^0$ [∵Shortest distance =⊥]
$\therefore PR^2 = AR^2 - AP^2$ [∵Pythagoras theorem]
$\therefore PR^2 = 20^2 - 12^2$
$\therefore PR^2 = 400 - 144$
$\therefore PR^2 = 256$-----(2)
$AQ^2 = 15^2 = 225$-------(3)
$AB^2 = 20^2 = 400$-------(4)
$QR^2 = (QP + PR)^2$
$QR^2 = QP^2 + PR^2 + 2QP.PR$
$\therefore QR^2 = 81 + 256 + 2 \times 9 \times 16$
$\therefore QR^2 = 81 + 256 + 288$
$\therefore QR^2 = 625$----------------(5)
$\therefore QR^2 = AQ^2 + AB^2$ [∵From (3),(4)and (5)]

5. In the isosceles ΔABC, AB = AC, BC = 18cm, AD = 12cm, BC is produced to 'E' and AE = 20cm. Prove that ∠**BAE** = 90^0.

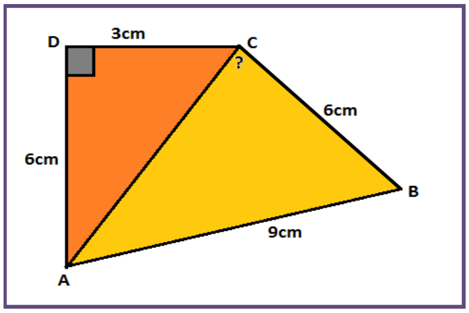
ΔABC ಯಲ್ಲಿ , AB = AC, BC⊥AD
$\therefore BD = CD = 9cm$



In ΔADC , ∠**ADC** = 90^0
$\therefore AC^2 = AD^2 + CD^2$ [∵Pythagoras theorem]
$\therefore AC^2 = 12^2 + 9^2 = 144 + 81$
$\therefore AC^2 = 225$
$\therefore AB^2 = 225$ ---------------------(1)
$AE^2 = 20^2$
$AE^2 = 400$ ----------------------(2)
$\therefore 20^2 = 12^2 + DE^2$ [∵Pythagoras theorem]
$\therefore 400 = 144 + DE^2$
$\therefore DE^2 = 256$
$\therefore DE = 16cm$

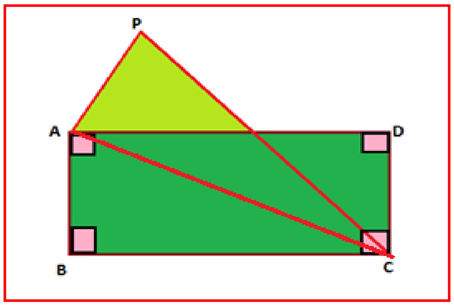
$\therefore$ BE = BD +DE
$\therefore$ BE = 9 + 16 = 25cm
$\therefore BE^2 = 625$ ----------------(3)
In ΔABC ,
$\therefore BE^2 = AB^2 + AE^2$ [$\because$ From (1), (2) and (3)]
$\therefore \angle$**BAE** = 90^0 [$\because$Converse of Pythagoras theorem.]

6. In the quadrilateral ABCD, $\angle ADC = 90^0$, AB = 9cm,, AB= 9cm, BC = AD = 6cm and CD = 3cm, Prove that $\angle ACB = 90^0$.



Δ**ADC** ಯಲ್ಲಿ, $\angle$**ADC** = 90^0
$\therefore AC^2 = AD^2 + CD^2$ [$\because$Pythagoras theorem.]
$\therefore AC^2 = 6^2 + 3^2$
$\therefore AC^2 = 36 + 9 = 45$ -----------(1)
$AB^2 = 9^2 = 81$ -----(2)
$BC^2 = 6^2 = 36$ -----(3)
$\therefore AB^2 = AC^2 + BC^2$[$\because$ From (1), (2) and (3)]
$\therefore \angle ACB = 90^0$ [$\because$Converse of Pythagoras theorem]

7 .ABCD is a rectangle. 'P' is any point outside it such that $PA^2 + PC^2 = BA^2 + AD^2$. Prove that $\angle APC = 90^0$.



ABCD is a rectangle
$\therefore AC^2 = DC^2 + AD^2$
$\Rightarrow AC^2 = BA^2 + AD^2$ [$\because$BA = DC]
But, $PA^2 + PC^2 = BA^2 + AD^2$
$\therefore PA^2 + PC^2 = AC^2$
$\therefore \angle APC = 90^0$ [$\because$Converse of Pythagoras theorem]