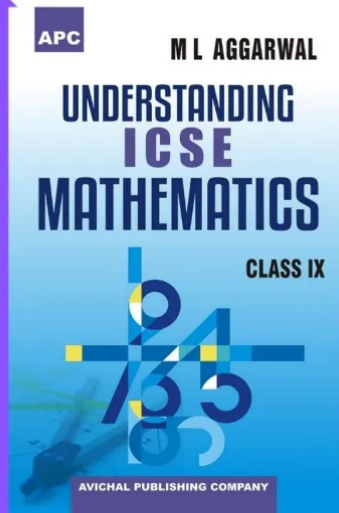


ML Aggarwal Solutions for Class 9 Maths

Chapter 17- Trigonometric Ratios



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ML Agrawal Solutions

CLASS 9 MATHS

Chapter 17: Trigonometric
Ratios

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Chapter 17- Trigonometric Ratios

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ML Aggarwal Solutions for Class 9 Maths Chapter 17- Trigonometric Ratios

ML Aggarwal 9th Maths Chapter 17, Class 9 Maths Chapter 17 solutions

Exercise 17

1. (a) From the figure (1) given below, find the values of:

(i) $\sin \theta$

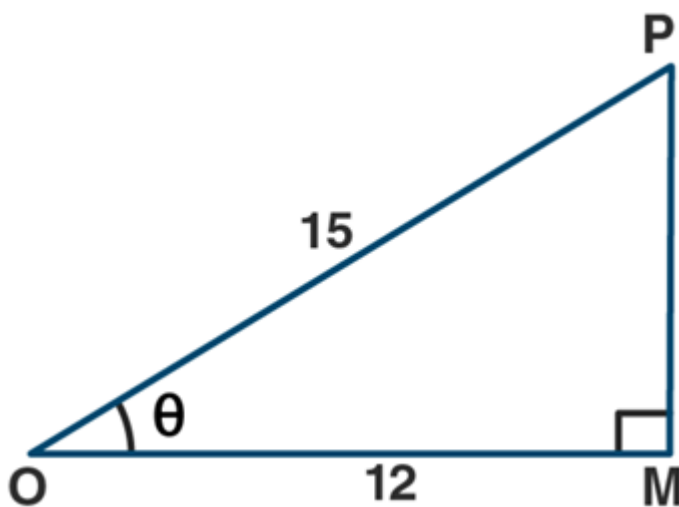
(ii) $\cos \theta$

(iii) $\tan \theta$

(iv) $\cot \theta$

(v) $\sec \theta$

(vi) $\operatorname{cosec} \theta$



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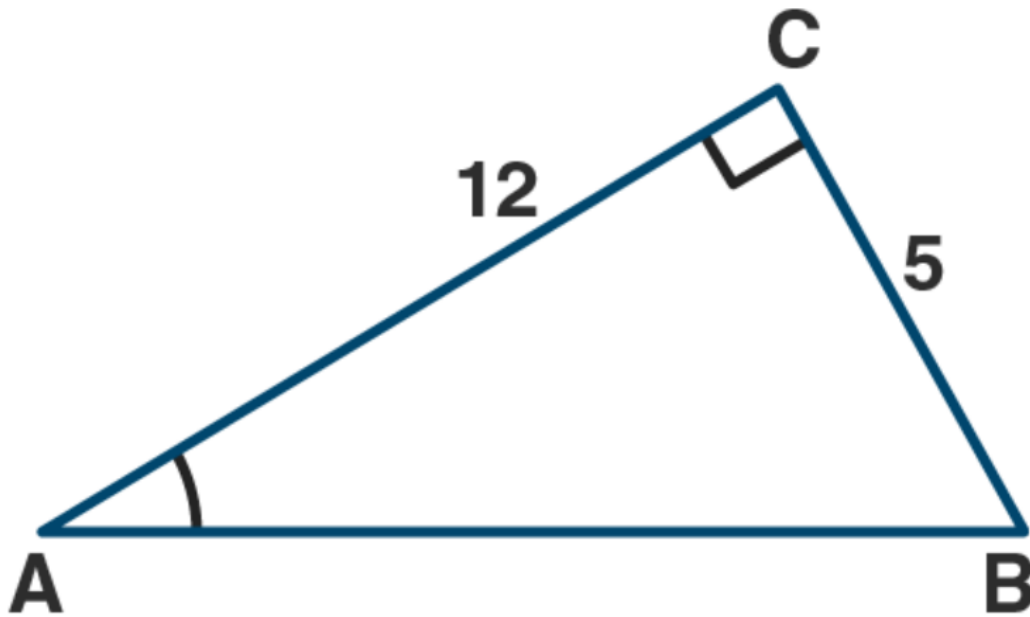
(b) From the figure (2) given below, find the values of:

(i) $\sin A$

(ii) $\cos A$

(iii) $\sin^2 A + \cos^2 A$

(iv) $\sec^2 A - \tan^2 A$.



Solution:

(a) From right angled triangle OMP,

By Pythagoras theorem, we get

$$OP^2 = OM^2 + MP^2$$

$$MP^2 = OP^2 - OM^2$$

$$MP^2 = (15)^2 - (12)^2$$

$$MP^2 = 225 - 144$$

$$MP^2 = 81$$

$$MP^2 = 9^2$$

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$$MP = 9$$

$$(i) \sin \theta = MP/OP$$

$$= 9/15$$

$$= 3/5$$

$$(ii) \cos \theta = OM/OP$$

$$= 12/15$$

$$= 4/5$$

$$(iii) \tan \theta = MP/OM$$

$$= 9/12$$

$$= 3/4$$

$$(iv) \cot \theta = OM/MP$$

$$= 12/9$$

$$= 4/3$$

$$(v) \sec \theta = OP/OM$$

$$= 15/12$$

$$= 5/4$$

$$(vi) \operatorname{cosec} \theta = OP/MP$$

$$= 15/9$$

$$= 5/3$$

(b) From right angled triangle ABC,

By Pythagoras theorem, we get

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

$$AB^2 = (12)^2 + (5)^2$$

$$AB^2 = 144 + 25$$

$$AB^2 = 169$$

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$$AB^2 = 13^2$$

$$AB = 13$$

$$(i) \sin A = BC/AB$$

$$= 5/13$$

$$(ii) \cos A = AC/AB$$

$$= 12/13$$

$$(iii) \sin^2 A + \cos^2 A = (BC/AB)^2 + (AC/AB)^2$$

$$= (5/13)^2 + (12/13)^2$$

$$= (25/169) + (144/169)$$

$$= (25 + 144)/169$$

$$= 169/169$$

$$= 1$$

$$\sin^2 A + \cos^2 A = 1$$

$$(iv) \sec^2 A - \tan^2 A = (AB/AC)^2 - (BC/AC)^2$$

$$= (13/12)^2 - (5/12)^2$$

$$= (169/144) - (25/144)$$

$$= (169 - 25)/144$$

$$= 144/144$$

$$= 1$$

$$\sec^2 A - \tan^2 A = 1$$

2. (a) From the figure (1) given below, find the values of:

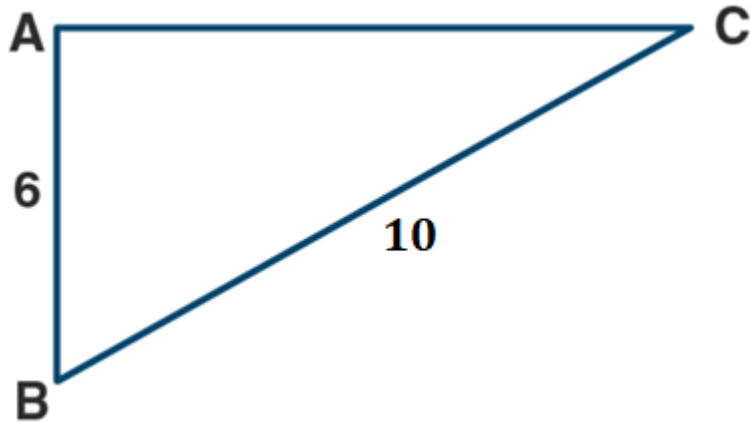
(i) $\sin B$

(i) $\cos C$

(iii) $\sin B + \sin C$

(iv) $\sin B \cos C + \sin C \cos B$.

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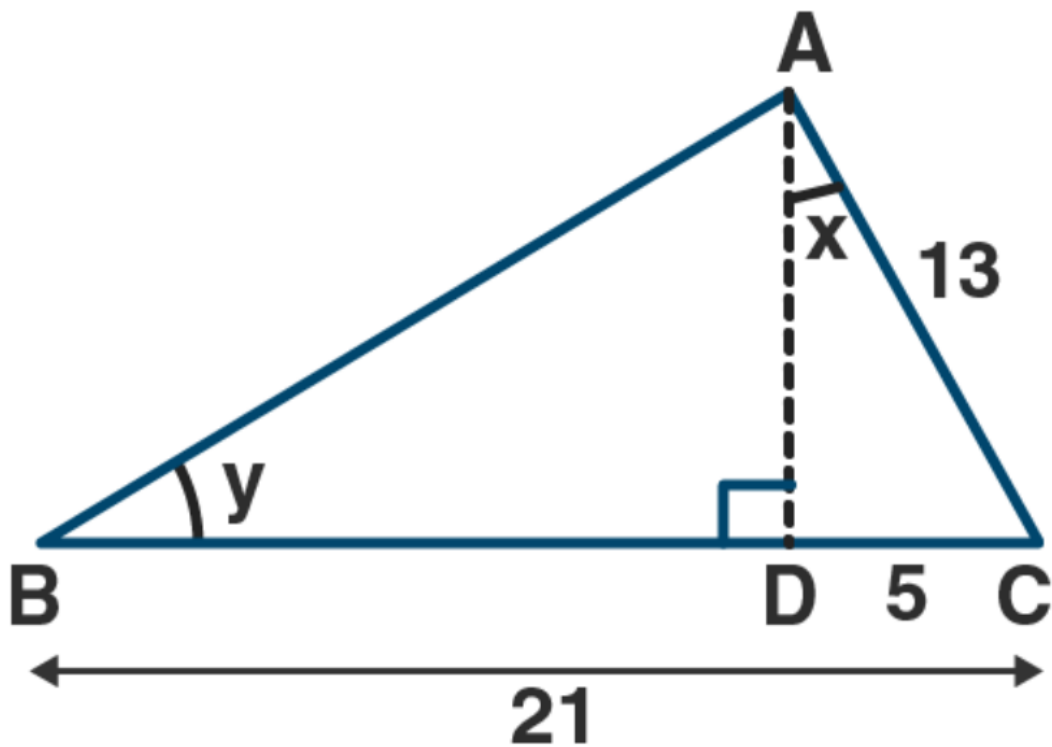
(b) From the figure (2) given below, find the values of:

(i) $\tan x$

(ii) $\cos y$

(iii) $\operatorname{cosec}^2 y - \cot^2 y$

(iv) $5/\sin x + 3/\sin y - 3 \cot y$.



Solution:

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From right angled triangle ABC,

By Pythagoras theorem, we get

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

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

$$AC^2 = (10)^2 - (6)^2$$

$$AC^2 = 100 - 36$$

$$AC^2 = 64$$

$$AC^2 = 8^2$$

$$AC = 8$$

(i) $\sin B = \text{perpendicular/ hypotenuse}$

$$= AC/BC$$

$$= 8/10$$

$$= 4/5$$

(ii) $\cos C = \text{Base/hypotenuse}$

$$= AC/BC$$

$$= 8/10$$

$$= 4/5$$

(iii) $\sin B = \text{Perpendicular/hypotenuse}$

$$= AC/BC$$

$$= 8/10$$

$$= 4/5$$

$\sin C = \text{perpendicular/hypotenuse}$

$$= AB/BC$$

$$= 6/10$$

$$= 3/5$$

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Now,

$$\sin B + \sin C = (4/5) + (3/5)$$

$$= (4 + 3)/5$$

$$= 7/5$$

$$(iv) \sin B = 4/5$$

$$\cos C = 4/5$$

$$\sin C = \text{perpendicular/ hypotenuse}$$

$$= AB/BC$$

$$= 6/10$$

$$= 3/5$$

$$\cos B = \text{Base/Hypotenuse}$$

$$= AB/BC$$

$$= 6/10$$

$$= 3/5$$

$$\sin B \cos C + \sin C \cos B$$

$$= (4/5) \times (4/5) + (3/5) \times (3/5)$$

$$= (16/25) + (9/25)$$

$$= (16+9)/25$$

$$= 25/25$$

$$= 1$$

From Figure

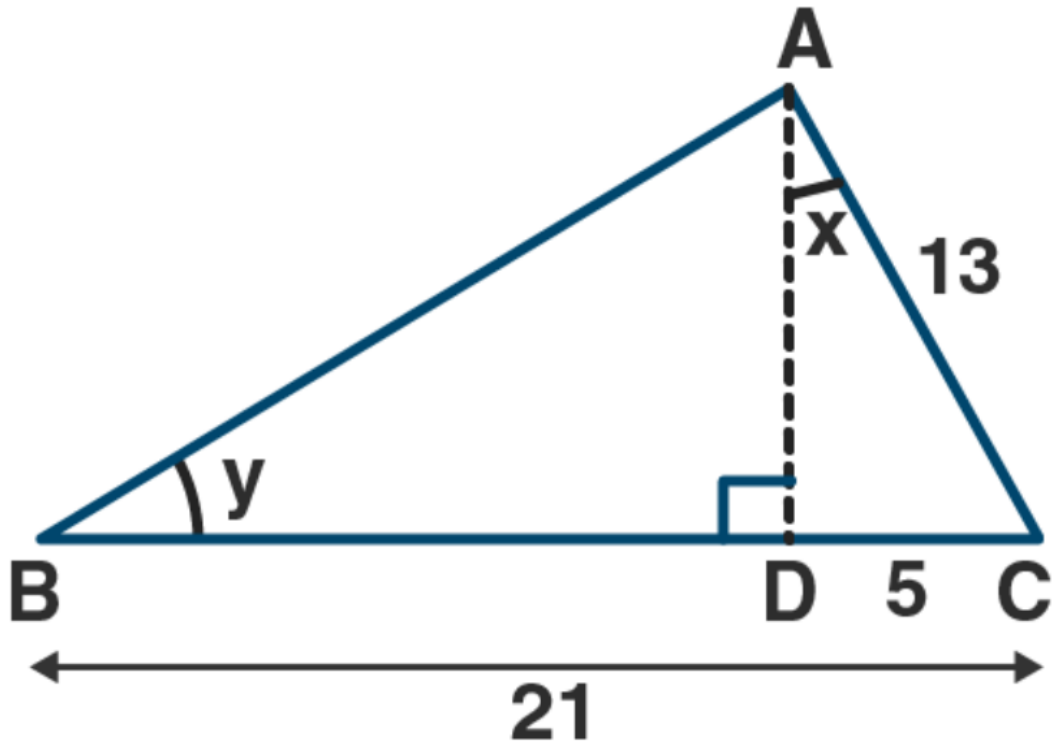
$$AC = 13, CD = 5, BC = 21,$$

$$BD = BC - CD$$

$$= 21 - 5$$

$$= 16$$

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From right angled $\triangle ACD$,

By Pythagoras theorem we get

$$AC^2 = AD^2 + CD^2$$

$$AD^2 = AC^2 - CD^2$$

$$AD^2 = (13)^2 - (5)^2$$

$$AD^2 = 169 - 25$$

$$AD^2 = 144$$

$$AD = 12$$

From right angled $\triangle ABD$,

By Pythagoras theorem in $\triangle ABD$

By Pythagoras theorem we get

$$AB^2 = AD^2 + BD^2$$

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$$AB^2 = 400$$

$$AB^2 = (20)^2$$

$$AB = 20$$

(i) $\tan x = \text{perpendicular/Base}$ (in right angled $\triangle ACD$)

$$= CD/AD$$

$$= 5/12$$

(ii) $\cos y = \text{Base/Hypotenuse}$ (in right angled $\triangle ABD$)

$$= BD/AB$$

$$= (20)/12 = (5/3)$$

$\cot y = \text{Base/Perpendicular}$ (in right $\triangle ABD$)

$$= BD/AB$$

$$= 16/20 = 4/5$$

(iii) $\cos y = \text{Hypotenuse/ perpendicular}$ (in right angled $\triangle ABD$)

$$BD/AB$$

$$= 20/12$$

$$= 5/3$$

$\cot y = \text{Base/Perpendicular}$ (in right $\triangle ABD$)

$$AB/AD$$

$$= 16/12$$

$$= 4/3$$

$$\operatorname{Cosec}^2 y - \cot^2 y = (5/3)^2 - (4/3)^2$$

$$= (25/9) - (16/9)$$

$$= (25-16)/9$$

$$= 9/9$$

$$= 1$$

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$$\text{Hence, } \operatorname{cosec}^2 y - \cot^2 y = 1$$

(iv) $\sin x = \text{Perpendicular/Hypotenuse}$ (in right angled $\triangle ACD$)

$$= AD/AB$$

$$= 12/20$$

$$= 3/5$$

$\cot y = \text{Base/Perpendicular}$ (in right angled $\triangle ABD$)

$$= BD/AD$$

$$= 16/12$$

$$= 4/3$$

$$(5/\sin x) + (3/\sin y) - 3\cot y$$

$$= 5/(5/13) + 3/(3/5) - 3 \times 4/3$$

$$= 5 \times 13/5 + 3 \times 5/3 - 3 \times 4/3$$

$$= 1 \times 13/1 + 1 \times 5/1 - 1 \times 4/1$$

$$= 13 + 5 - 4 = 18 - 4$$

$$= 14$$

$$\text{Hence } 5/\sin x + 3/\sin y - 3\cot y = 14$$

3. (a) From the figure (1) given below, find the value of $\sec \theta$.

(b) From the figure (2) given below, find the values of:

(i) $\sin x$

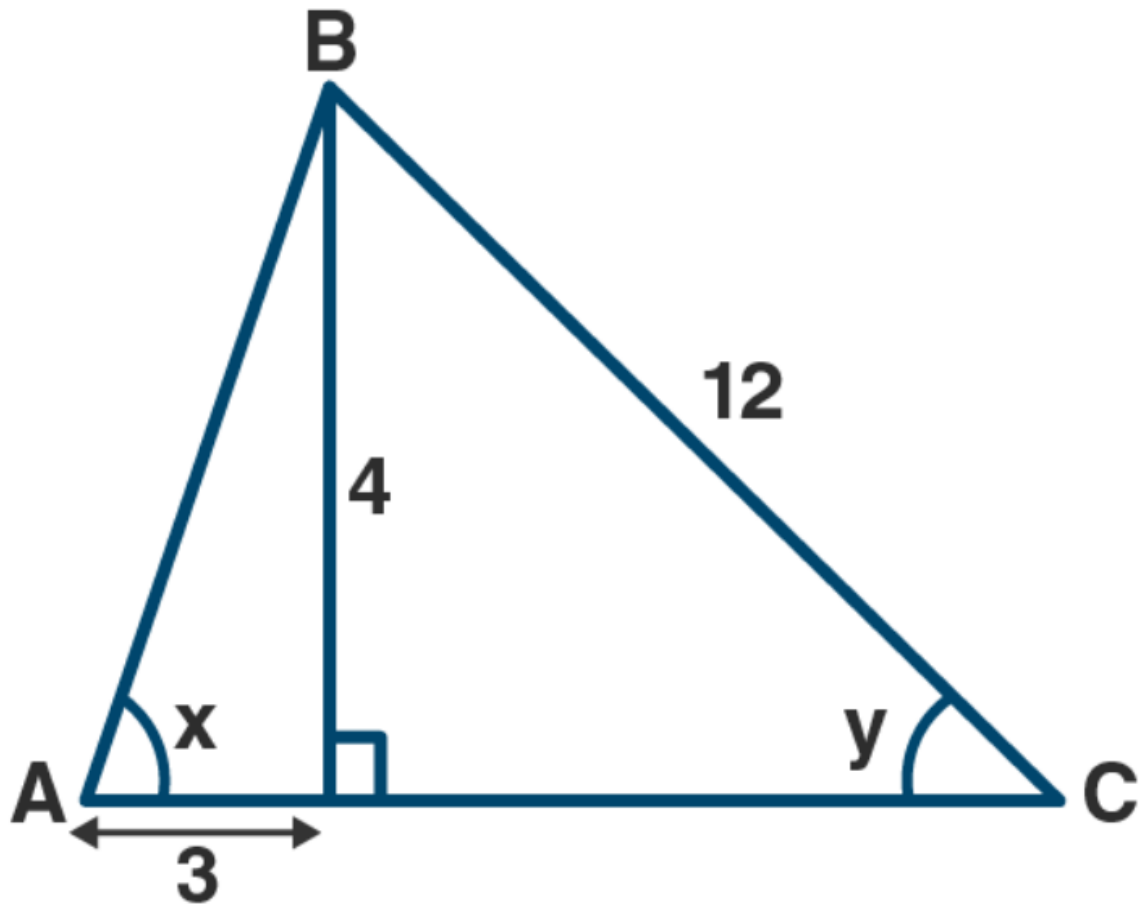
(ii) $\cot x$

(iii) $\cot^2 x - \operatorname{cosec}^2 x$

(iv) $\sec y$

(v) $\tan^2 y - 1/\cos^2 y$.

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Solution:

(a) From the figure, $\sec \theta = AB / BD$

But in $\triangle ADC$, $\angle D = 90^\circ$

$AC^2 = AD^2 + DC^2$ (Pythagoras Theorem)

$$(13)^2 = AD^2 + 25$$

$$AD^2 = 169 - 25$$

$$= 144$$

$$= (12)^2$$

$$AD = 12$$

(in right $\triangle ABD$)

$$AB^2 = AD^2 + BD^2$$

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$$= (12)^2 + (16)^2$$

$$= 144 + 256$$

$$= 400$$

$$= (20)^2$$

$$AB = 20$$

$$\text{Now, Sec } \theta = AB / BD$$

$$= 20/16$$

$$= 5/4$$

(b) let given $\triangle ABC$

$$BD = 3, AC = 12, AD = 4$$

In right angled $\triangle ABD$

By Pythagoras theorem

$$AB^2 = AD^2 + BD^2$$

$$AB^2 = (4)^2 + (3)^2$$

$$AB^2 = 16 + 9$$

$$AB^2 = 25$$

$$AB^2 = (5)^2$$

$$AB = 5$$

In right angled triangle ACD

By Pythagoras theorem,

$$AC^2 = AD^2 + CD^2$$

$$CD^2 = AC^2 - AD^2$$

$$CD^2 = (12)^2 - (4)^2$$

$$CD^2 = 144 - 16$$

$$CD^2 = 128$$

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$$CD = \sqrt{128}$$

$$CD = \sqrt{64 \times 2}$$

$$= 8\sqrt{2}$$

$$(i) \sin x = \text{perpendicular/Hypotenuse}$$

$$= AD/AB$$

$$= 4/5$$

$$(ii) \cot x = \text{Base/Perpendicular}$$

$$= BD/AD$$

$$= 3/4$$

$$(iii) \cot x = \text{Base/ Perpendicular}$$

$$BD/AD$$

$$= 3/4$$

$$(iv) \operatorname{cosec} x = \text{Hypotenuse / Perpendicular}$$

$$AB/BD$$

$$= 5/4$$

$$\cot^2 x - \operatorname{cosec}^2 x$$

$$= (3/4)^2 - (5/4)^2$$

$$= 9/16 - 25/16$$

$$(9 - 25)/16$$

$$= -16/16$$

$$= -1$$

$$\text{Perpendicular} = \text{Hypotenuse/Base (in right angled } \triangle ACD)$$

$$= AD/CD$$

$$= 12/(8\sqrt{2})$$

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

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$$\cot y = \text{Base} / \text{Hypotenuse}$$

$$= AD/CD$$

$$= 4/8 \sqrt{2}$$

$$= 1/2 \sqrt{2}$$

$$\cot y = \text{Base} / \text{Hypotenuse (in right angled } \triangle ACD)$$

$$= CD/AC$$

$$= 8\sqrt{2}/12$$

$$= 2\sqrt{3}$$

$$\text{Now } \tan^2 y = 1/\cos^2 y$$

$$= (1/2\sqrt{2})^2 - 1/(2\sqrt{2}/3)^2$$

$$= \frac{1}{4} \times -\frac{1}{4} \times 2$$

$$= (1/8) - (9/8)$$

$$= (1-9)/8$$

$$= -8/8$$

$$= -1$$

$$\tan^2 y - 1/\cos^2 y = -1.$$

4. (a) From the figure (1) given below, find the values of:

(i) $2 \sin y - \cos y$

(ii) $2 \sin x - \cos x$

(iii) $1 - \sin x + \cos y$

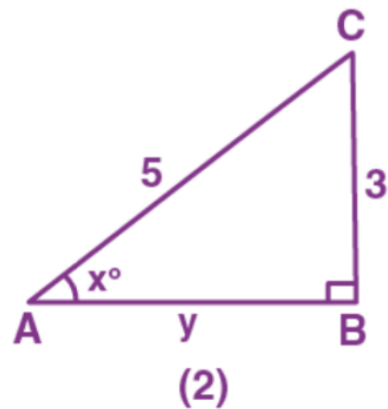
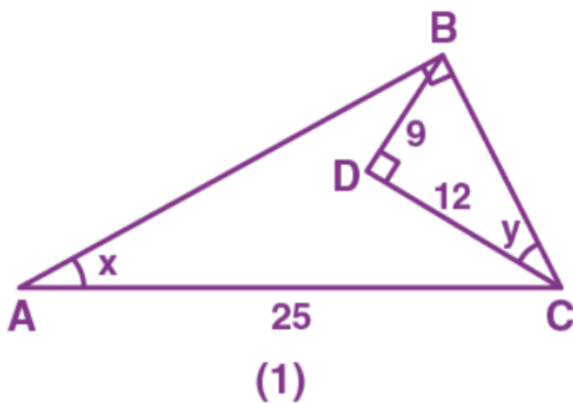
(iv) $2 \cos x - 3 \sin y + 4 \tan x$

(b) In the figure (2) given below, $\triangle ABC$ is right-angled at B. If $AB = y$ units, $BC = 3$ units and $CA = 5$ units, find

(i) $\sin x^\circ$

(ii) y .

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Solution:

(a) In a right angled $\triangle BCD$,

Using Pythagoras theorem

$$BC^2 = BD^2 + CD^2$$

Substituting the values

$$BC^2 = 9^2 + 12^2$$

By further calculation

$$BC^2 = 81 + 144 = 225$$

$$BC^2 = 15^2$$

$$BC = 15$$

In a right angled $\triangle ABC$,

Using Pythagoras theorem

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

We can write it as

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

Substituting the values

$$AB^2 = 25^2 - 15^2$$

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By further calculation

$$AB^2 = 625 - 225 = 400$$

So we get

$$AB^2 = 20^2$$

$$AB = 20$$

(i) We know that

In right angled $\triangle BCD$

$\sin y = \text{perpendicular} / \text{hypotenuse}$

$$\sin y = BD / BC$$

Substituting the values

$$\sin y = 9/15 = 3/5$$

In right angled $\triangle BCD$

$\cos y = \text{base} / \text{hypotenuse}$

$$\cos y = CD / BC$$

Substituting the values

$$\cos y = 12/15 = 4/5$$

Here

$$2\sin y - \cos y = 2 \times 3/5 - 4/5$$

We can write it as

$$= 6/5 - 4/5$$

$$= 2/5$$

Therefore, $2\sin y - \cos y = 2/5$

(ii) In right angled $\triangle ABC$

$\sin x = \text{perpendicular} / \text{hypotenuse}$

$$\sin x = BC / AC$$

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Substituting the values

$$\sin x = 15/25 = 3/5$$

In right angled $\triangle ABC$

$$\cos x = \text{base/hypotenuse}$$

$$\cos x = AB/AC$$

Substituting the values

$$\cos x = 20/25 = 4/5$$

Here

$$2 \sin x - \cos x = 2 \times 3/5 - 4/5$$

We can write it as

$$= 6/5 - 4/5$$

$$= 2/5$$

Therefore, $2 \sin x - \cos x = 2/5$.

(iii) In right angled $\triangle ABC$

$$\sin x = \text{perpendicular/hypotenuse}$$

$$\sin x = BC/AC$$

Substituting the values

$$\sin x = 12/25 = 3/5$$

In right angled $\triangle BCD$

$$\cos y = \text{base/hypotenuse}$$

$$\cos y = CD/BC$$

Substituting the values

$$\cos y = 12/15 = 4/5$$

Here

$$1 - \sin x + \cos y = 1 - 3/5 + 4/5$$

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By further calculation

$$= (5 - 3 + 4) / 5$$

So we get

$$= (9 - 3) / 5$$

$$= 6/5$$

Therefore, $1 - \sin x + \cos y = 6/5$.

(iv) In right angled $\triangle BCD$

$\cos x = \text{base/hypotenuse}$

$$\cos x = AB/AC$$

Substituting the values

$$\cos x = 20/25 = 4/5$$

In right angled $\triangle BCD$

$\sin y = \text{perpendicular/hypotenuse}$

$$\sin y = BD/BC$$

Substituting the values

$$\sin y = 9/15 = 3/5$$

In right angled $\triangle ABC$

$\tan x = \text{perpendicular/base}$

$$\tan x = BC/AB$$

Substituting the values

$$\tan x = 15/20 = 3/4$$

Here

$$2 \cos x - 3 \sin y + 4 \tan x = 2 \times 4/5 - 3 \times 3/5 + 4 \times 3/4$$

By further calculation

$$= 8/5 - 9/5 + 3$$

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Taking LCM

$$= (8 - 9 + 15)/5$$

So we get

$$= (23 - 9)/5$$

$$= 14/5$$

(b) It is given that

AB = y units, BC = 3 units, CA = 5 units

(i) In right angled $\triangle ABC$

$\sin x = \text{perpendicular/hypotenuse}$

$$\sin x = BC/AC$$

Substituting the values

$$\sin x = 3/5$$

(ii) In right angled $\triangle ABC$

Using Pythagoras theorem

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

We can write it as

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

Substituting the values

$$AB^2 = 5^2 - 3^2$$

By further calculation

$$AB^2 = 25 - 9 = 16$$

So we get

$$AB^2 = 4^2$$

$$AB = 4$$

y = 4 units

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Therefore, $y = 4$ units.

5. In a right-angled triangle, it is given that angle A is an acute angle and that $\tan A = 5/12$. Find the values of:

(i) $\cos A$

(ii) $\operatorname{cosec} A - \cot A$.

Solution:

Here, ABC is right angled triangle

$\angle A$ is an acute angle and $\angle C = 90^\circ$

$$\tan A = 5/12$$

$$BC/AC = 5/12$$

$$\text{Let } BC = 5x \text{ and } AC = 12x$$

From right angled $\triangle ABC$

By Pythagoras theorem, we get

$$AB^2 = (5x)^2 + (12x)^2$$

$$AB^2 = 25x^2 + 144x^2$$

$$AB^2 = 169x^2$$

$$(i) \cos A = \text{Base} / \text{Hypotenuse}$$

$$= AC / AB$$

$$= 12x / 13x$$

$$= 12/13$$

$$(ii) \operatorname{cosec} A = \text{Hypotenuse} / \text{perpendicular}$$

$$= AC / BC$$

$$= 13x / 5x$$

$$= 13/5$$

$$\operatorname{cosec} A - \cot A = 13/5 - 12/5$$

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$$= (13-12)/5$$

$$= 1/5$$

6. (a) In $\triangle ABC$, $\angle A = 90^\circ$. If $AB = 7$ cm and $BC - AC = 1$ cm, find:

(i) $\sin C$

(ii) $\tan B$

(b) In $\triangle PQR$, $\angle Q = 90^\circ$. If $PQ = 40$ cm and $PR + QR = 50$ cm, find:

(i) $\sin P$

(ii) $\cos P$

(iii) $\tan R$.

Solution:

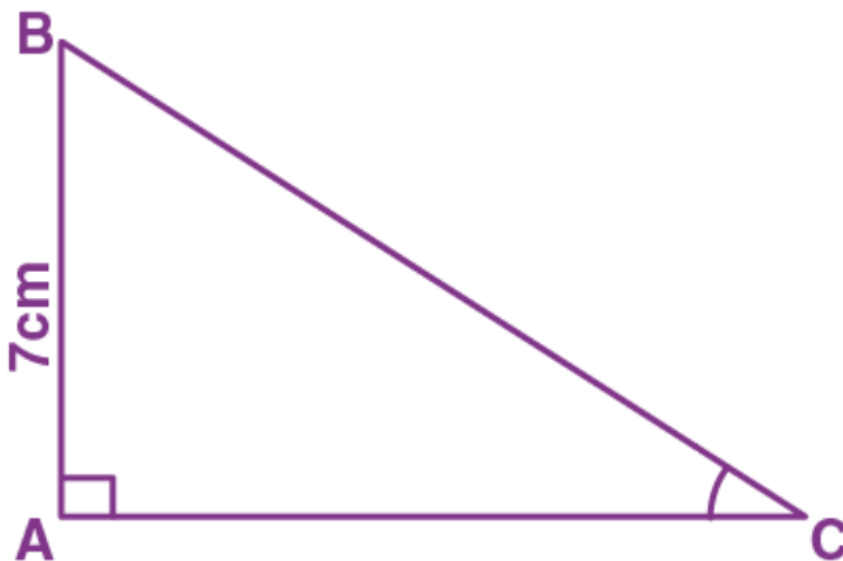
(a) In right $\triangle ABC$

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

$$AB = 7 \text{ cm}$$

$$BC - AC = 1 \text{ cm}$$

$$BC = 1 + AC$$



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We know that

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

Substituting the value of BC

$$(1 + AC)^2 = AB^2 + AC^2$$

$$1 + AC^2 + 2AC = 7^2 + AC^2$$

By further calculation

$$1 + AC^2 + 2AC = 49 AC^2$$

$$2AC = 49 - 1 - 48$$

So we get

$$AC = 48/2 = 24 \text{ cm}$$

Here

$$BC = 1 + AC$$

Substituting the value

$$BC = 1 + 24 = 25 \text{ cm}$$

$$(i) \sin C = AB/BC = 7/25$$

$$(ii) \tan B = AC/AB = 24/7$$

(b) In right $\triangle PQR$

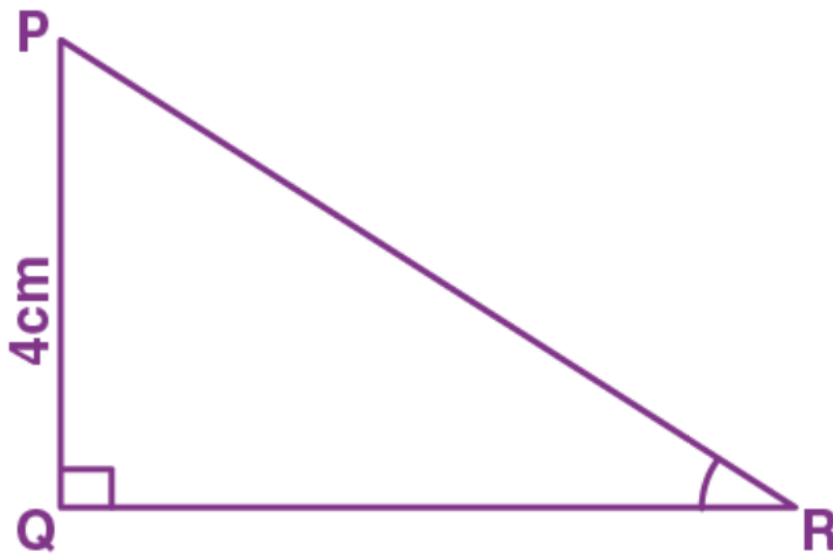
$$\angle Q = 90^\circ$$

$$PQ = 40 \text{ cm}$$

$$PQ + QR = 50 \text{ cm}$$

We can write it as

$$PQ = 50 - QR$$



Using Pythagoras theorem

$$PR^2 = PQ^2 + QR^2$$

$$(50 - QR)^2 = (40)^2 + QR^2$$

By further calculation

$$2500 + QR^2 - 100QR = 1600 + QR^2$$

So we get

$$2500 - 1600 = 100QR$$

$$100QR = 900$$

By division

$$QR = 900/100 = 9$$

We get

$$PR = 50 - 9 = 41$$

$$(i) \sin P = QR/PR = 9/41$$

$$(ii) \cos P = PQ/PR = 40/41$$

$$(iii) \tan R = PQ/QR = 40/9$$

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7. In triangle ABC, AB = 15 cm, AC = 15 cm and BC = 18 cm. Find

(i) $\cos \angle ABC$

(ii) $\sin \angle ACB$.

Solution:

Here ABC is a triangle in which

AB = 15 cm, AC = 15 cm and BC = 18 cm

Draw AD perpendicular to BC, D is mid-point of BC.

Then, BD = DC = 9 cm

in right angled triangle ABD,

By Pythagoras theorem, we get

$$AB^2 = AD^2 + BD^2$$

$$AD^2 = AB^2 - BD^2$$

$$AD^2 = (15)^2 - (9)^2$$

$$AD^2 = 225 - 81$$

$$AD^2 = 144$$

$$AD = 12 \text{ cm}$$

$$(i) \cos \angle ABC = \text{Base} / \text{Hypotenuse}$$

$$(\text{In right angled } \triangle ABD, \angle ABC = \angle ABD)$$

$$= BD / AB$$

$$= 9/15$$

$$= 3/5$$

$$(ii) \sin \angle ACB = \sin \angle ACD$$

$$= \text{perpendicular} / \text{Hypotenuse}$$

$$= AD/AC$$

$$= 12/15$$

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$$= 4/5$$

8. (a) In the figure (1) given below, $\triangle ABC$ is isosceles with $AB = AC = 5$ cm and $BC = 6$ cm. Find

(i) $\sin C$

(ii) $\tan B$

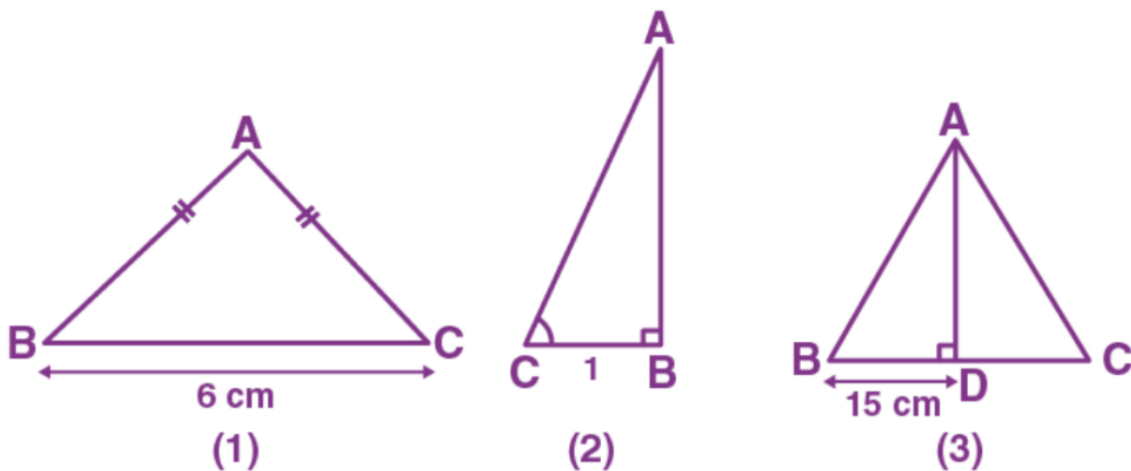
(iii) $\tan C - \cot B$.

(b) In the figure (2) given below, $\triangle ABC$ is right-angled at B. Given that $\angle ACB = \theta$, side $AB = 2$ units and side $BC = 1$ unit, find the value of $\sin^2 \theta + \tan^2 \theta$.

(c) In the figure (3) given below, AD is perpendicular to BC , $BD = 15$ cm, $\sin B = 4/5$ and $\tan C = 1$.

(i) Calculate the lengths of AD , AB , DC and AC .

(ii) Show that $\tan^2 B - 1/\cos^2 B = -1$.



Solution:

(a) It is given that

$\triangle ABC$ is isosceles with $AB = AC = 5$ cm and $BC = 6$ cm

Construct AD perpendicular to BC

D is the mid point of BC

So $BD = CD$

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Here

$$BD = CD = 6/2 = 3 \text{ cm}$$

In right angled $\triangle ABD$

Using Pythagoras theorem

$$AB^2 = AD^2 + BD^2$$

We can write it as

$$AD^2 = AB^2 - BD^2$$

Substituting the values

$$AD^2 = 5^2 - 3^2$$

By further calculation

$$AD^2 = 25 - 9 = 16$$

So we get

$$AD^2 = 4^2$$

$$AD = 4 \text{ cm}$$

(i) In right angled $\triangle ACD$

$\sin C = \text{perpendicular/hypotenuse}$

$$\sin C = AD/AC = 4/5$$

(ii) In right angled $\triangle ABD$

$\tan B = \text{perpendicular/base}$

$$\tan B = AD/BD = 4/3$$

(iii) In right angled $\triangle ACD$

$\tan C = \text{perpendicular/base}$

$$\tan C = AD/CD = 4/3$$

In right angled $\triangle ABD$

$\cot B = \text{base/perpendicular}$

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$$\cot B = BD/AD = \frac{3}{4}$$

Here

$$\tan C - \cot B = \frac{4}{3} - \frac{3}{4}$$

Taking LCM

$$\tan C - \cot B = \frac{(16 - 9)}{12} = \frac{7}{12}$$

(b) It is given that

$\triangle ABC$ is right-angled at B

AB = 2 units and BC = 1 unit

In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = 2^2 + 1^2$$

$$AC^2 = 4 + 1 = 5$$

So we get

$$AC^2 = 5$$

$$AC = \sqrt{5} \text{ units}$$

In right angled $\triangle ABC$

$\sin \theta = \text{perpendicular/hypotenuse}$

$$\sin \theta = AB/AC = 2/\sqrt{5}$$

In right angled $\triangle ABC$

$\tan \theta = \text{perpendicular/base}$

$$\tan \theta = AB/BC = 2/1$$

We know that

$$\sin^2 \theta + \tan^2 \theta = (2/\sqrt{5})^2 + (2/1)^2$$

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By further calculation

$$= \frac{4}{5} + \frac{4}{1}$$

Taking LCM

$$= \frac{(4 + 20)}{5}$$

$$= \frac{24}{5}$$

$$= 4 \frac{4}{5}$$

(c) (i) In $\triangle ABC$

AD is perpendicular to BC

$$BD = 15 \text{ cm}$$

$$\sin B = \frac{4}{5}$$

$$\tan C = 1$$

In $\triangle ABD$

$\sin B = \frac{\text{perpendicular}}{\text{hypotenuse}}$

$$\sin B = \frac{AD}{AB} = \frac{4}{5}$$

Consider $AD = 4x$ and $AB = 5x$

Using Pythagoras theorem

In right angled $\triangle ABD$

$$AB^2 = AD^2 + BD^2$$

We can write it as

$$BD^2 = AB^2 - AD^2$$

Substituting the values

$$(15)^2 = (5x)^2 - (4x)^2$$

$$225 = 25x^2 - 16x^2$$

By further calculation

$$225 = 9x^2$$

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$$x^2 = 225/9 = 25$$

So we get

$$x = \sqrt{25} = 5$$

Here

$$AD = 4 \times 5 = 20$$

$$AB = 5 \times 5 = 25$$

In right angled $\triangle ACD$

$\tan C = \text{perpendicular/base}$

So we get

$$\tan C = AD/CD = 1/1$$

Consider $AD = X$ then $CD = x$

In right angled $\triangle ADC$

Using Pythagoras theorem

$$AC^2 = AD^2 + CD^2$$

Substituting the values

$$AC^2 = x^2 + x^2 \dots\dots(1)$$

So the equation becomes

$$AC^2 = 20^2 + 20^2$$

$$AC^2 = 400 + 400 = 800$$

So we get

$$AC = \sqrt{800} = 20\sqrt{2}$$

Length of $AD = 20$ cm

Length of $AB = 25$ cm

Length of $DC = 20$ cm

Length of $AC = 20\sqrt{2}$ cm

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(ii) In right angled $\triangle ABD$

$\tan B = \text{perpendicular/base}$

So we get

$$\tan B = AD/BD$$

Substituting the values

$$\tan B = 20/15 = 4/3$$

In right angled $\triangle ABD$

$\cos B = \text{base/hypotenuse}$

So we get

$$\cos B = BD/AB$$

Substituting the values

$$\cos B = 15/25 = 3/5$$

Here

$$\text{LHS} = \tan^2 B - 1/\cos^2 B$$

Substituting the values

$$= (4/3)^2 - 1/(3/5)^2$$

By further calculation

$$= (4)^2/(3)^2 - (5)^2/(3)^2$$

$$= 16/9 - 25/9$$

So we get

$$= (16 - 25)/9$$

$$= -9/9$$

$$= -1$$

$$= \text{RHS}$$

Hence, proved.

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9. If $\sin \theta = 3/5$ and θ is acute angle, find

(i) $\cos \theta$

(ii) $\tan \theta$.

Solution:

Let $\triangle ABC$ be a right angled at B

Let $\angle ACB = \theta$

Given that, $\sin \theta = 3/5$

$$AB/AC = 3/5$$

$$\text{Let } AB = 3x$$

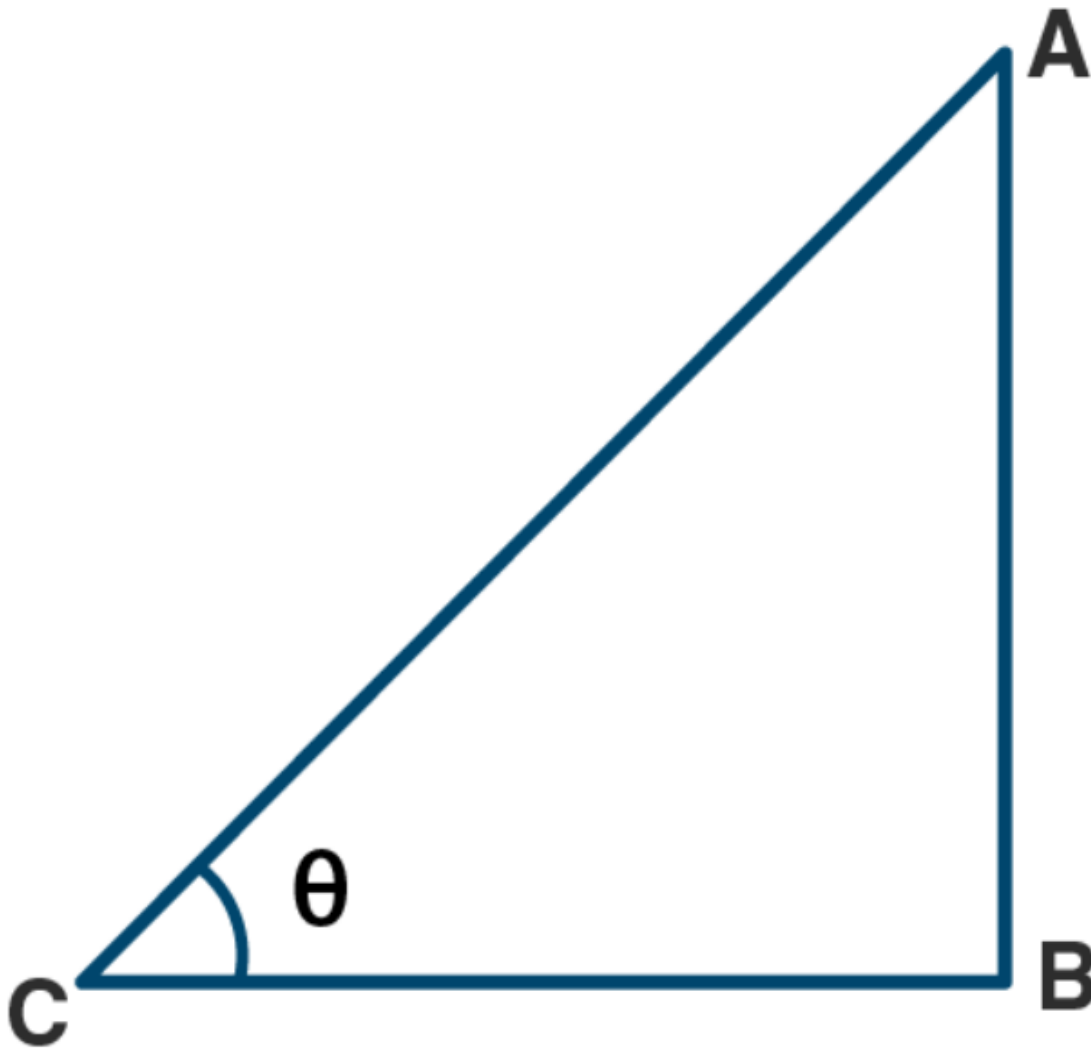
$$\text{then } AC = 5x$$

In right angled $\triangle ABC$,

By Pythagoras theorem,

We get

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$$(5x)^2 = (3x)^2 + BC^2$$

$$BC^2 = (5x)^2 - (3x)^2$$

$$BC^2 = (2x)^2$$

$$BC = 4x$$

$$(i) \cos \theta = \text{Base} / \text{Hypotenuse}$$

$$= BC / AC$$

$$= 4x / 5x$$

$$= 4/5$$

$$(ii) \tan \theta = \text{perpendicular} / \text{Base}$$

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$$= AB/BC$$

$$= 3x/4x$$

$$= \frac{3}{4}$$

10. Given that $\tan \theta = 5/12$ and θ is an acute angle, find $\sin \theta$ and $\cos \theta$.

Solution:

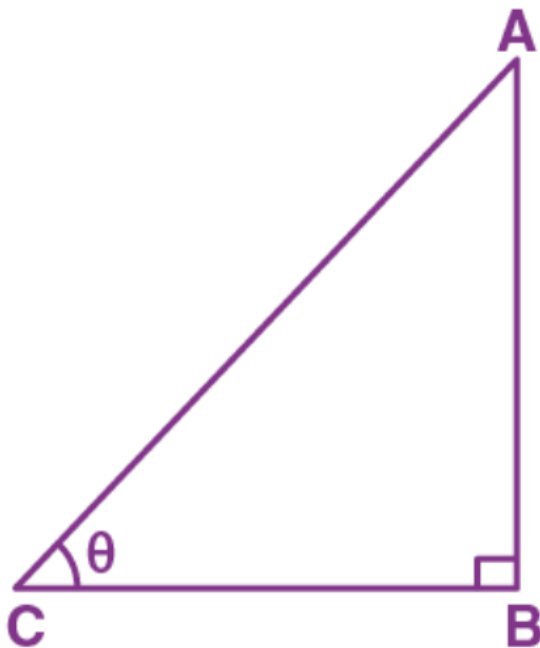
Consider $\triangle ABC$ be right angled at B and $\angle ACB = \theta$

It is given that

$$\tan \theta = 5/12$$

$$AB/BC = 5/12$$

Consider $AB = 5x$ and $BC = 12x$



In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = (5x)^2 + (12x)^2$$

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By further calculation

$$AC^2 = 25x^2 + 144x^2 = 169x^2$$

So we get

$$AC^2 = (13x)^2$$

$$AC = 13x$$

In right angled $\triangle ABC$

$$\sin \theta = \text{perpendicular/hypotenuse}$$

So we get

$$\sin \theta = AB/AC = 5x/13x = 5/13$$

In right angled $\triangle ABC$

$$\cos \theta = \text{base/hypotenuse}$$

So we get

$$\cos \theta = BC/AC$$

Substituting the values

$$\cos \theta = 12x/13x = 12/13$$

11. If $\sin \theta = 6/10$, find the value of $\cos \theta + \tan \theta$.

Solution:

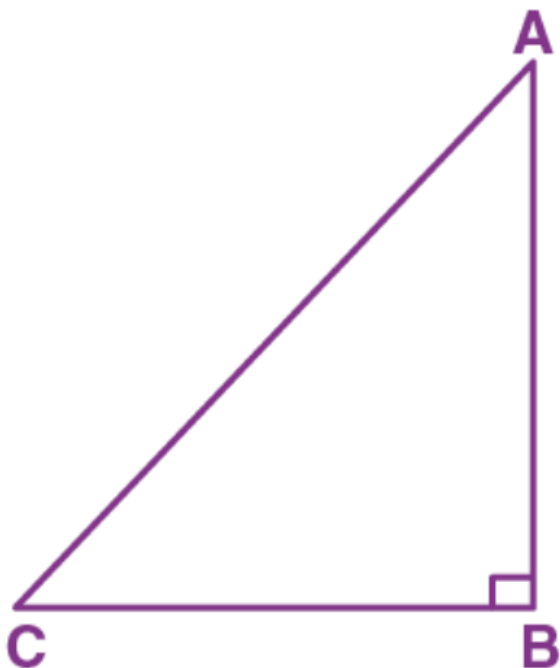
Consider $\triangle ABC$ be right angled at B and $\angle ACB = \theta$

It is given that

$$\sin \theta = AB/AC$$

$$\sin \theta = 6/10$$

Take $AB = 6x$ then $AC = 10x$



In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$(10x)^2 = (6x)^2 + BC^2$$

By further calculation

$$BC^2 = 100x^2 - 36x^2 = 64x^2$$

So we get

$$BC^2 = (8x)^2$$

$$BC = 8x$$

In right angled $\triangle ABC$

$$\cos \theta = \text{base/hypotenuse}$$

$$\cos \theta = BC/AC$$

Substituting the values

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$$\cos \theta = 8x/10x = 4/5$$

In right angled $\triangle ABC$

$$\tan \theta = \text{perpendicular/base}$$

$$\tan \theta = AB/BC$$

Substituting the values

$$\tan \theta = 6x/8x = 3/4$$

Here

$$\cos \theta + \tan \theta = 4/5 + 3/4$$

Taking LCM

$$= (16 + 15)/ 20$$

$$= 31/20$$

$$= 1 \frac{11}{20}$$

12. If $\tan \theta = 4/3$, find the value of $\sin \theta + \cos \theta$ (both $\sin \theta$ and $\cos \theta$ are positive).

Solution:

Let $\triangle ABC$ be a right angled

$$\angle ACB = \theta$$

$$\text{Given that, } \tan \theta = 4/3$$

$$(AB/BC = 4/3)$$

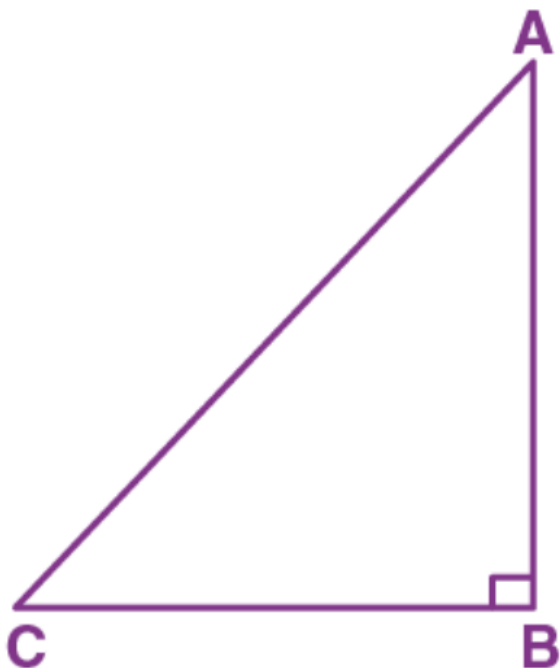
$$\text{Give that, } \tan \theta = 4/3$$

$$(AB/BC = 4/3)$$

$$\text{Let } AB = 4x,$$

$$\text{then } BC = 3x$$

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In right angled $\triangle ABC$

By Pythagoras theorem, we get

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

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

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

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

$$(AC^2 = (4x)^2 + (3x)^2$$

$$AC^2 = 16x^2 + 9x^2$$

$$AC^2 = 25x^2$$

$$AC^2 = (5x)^2$$

$$AC = 5x$$

$\sin \theta = \text{perpendicular/Hypotenuse}$

$$= AB/AC$$

$$= 4x/5x$$

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$$= 4/5$$

$$\cos \theta = \text{Base/Hypotenuse}$$

$$= BC/AC$$

$$= 3x/5x$$

$$= 3/5$$

$$\sin \theta + \cos \theta$$

$$= 4/5 + 3/5$$

$$= (4 + 3)/5$$

$$= 7/5$$

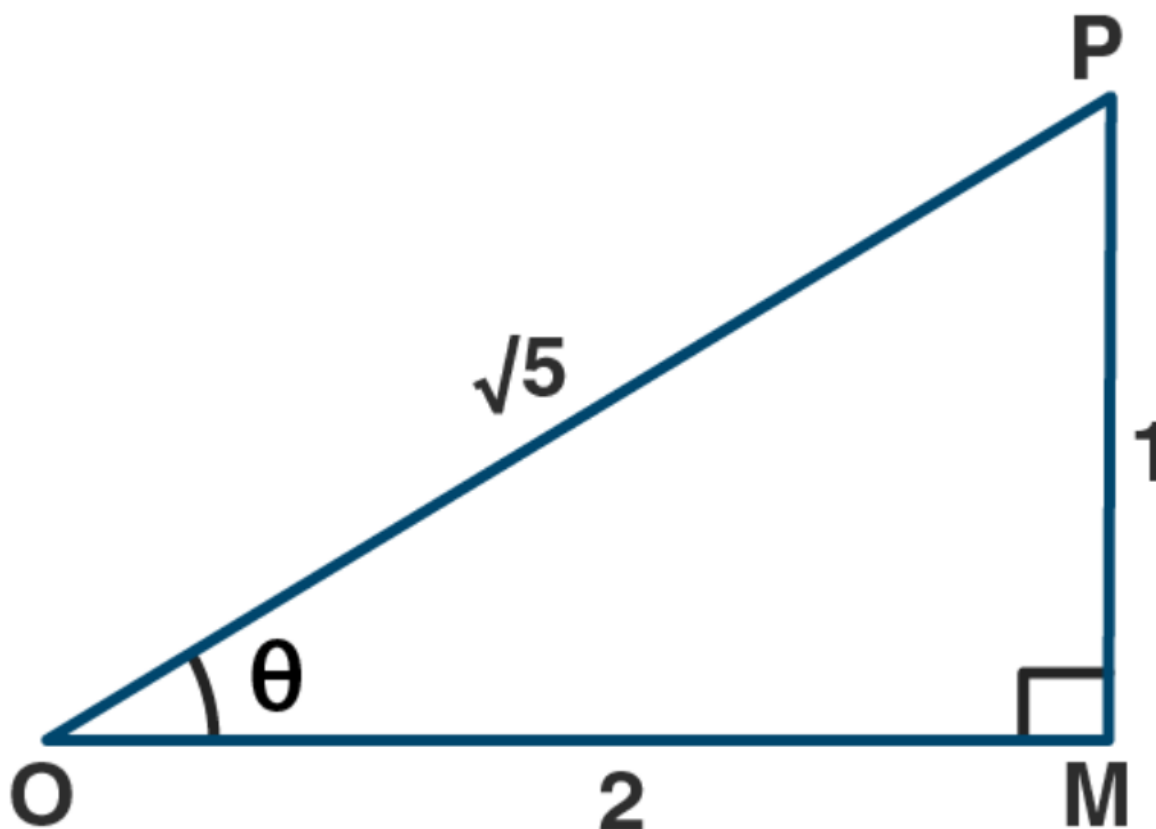
$$\text{Hence, } \sin \theta + \cos \theta = 7/5 = 1 \frac{2}{5}$$

13. If cosec $\theta = \sqrt{5}$ and θ is less than 90° , find the value of $\cot \theta - \cos \theta$.

Solution:

$$\text{Given cosec } \theta = \sqrt{5}/1 = OP/PM$$

$$OP = \sqrt{5} \text{ and } PM = 1$$



Now $OP^2 = OM^2 + PM^2$ using Pythagoras theorem

$$(\sqrt{5})^2 = OM^2 + 1^2$$

$$5 = OM^2 + 1$$

$$OM^2 = 5 - 1$$

$$OM^2 = 4$$

$$OM = 2$$

$$\text{Now } \cot \theta = OM/PM$$

$$= 2/1$$

$$= 2$$

$$\cos \theta = OM/OP$$

$$= 2/\sqrt{5}$$

$$\text{Now } \cot \theta - \cos \theta = 2 - (2/\sqrt{5})$$

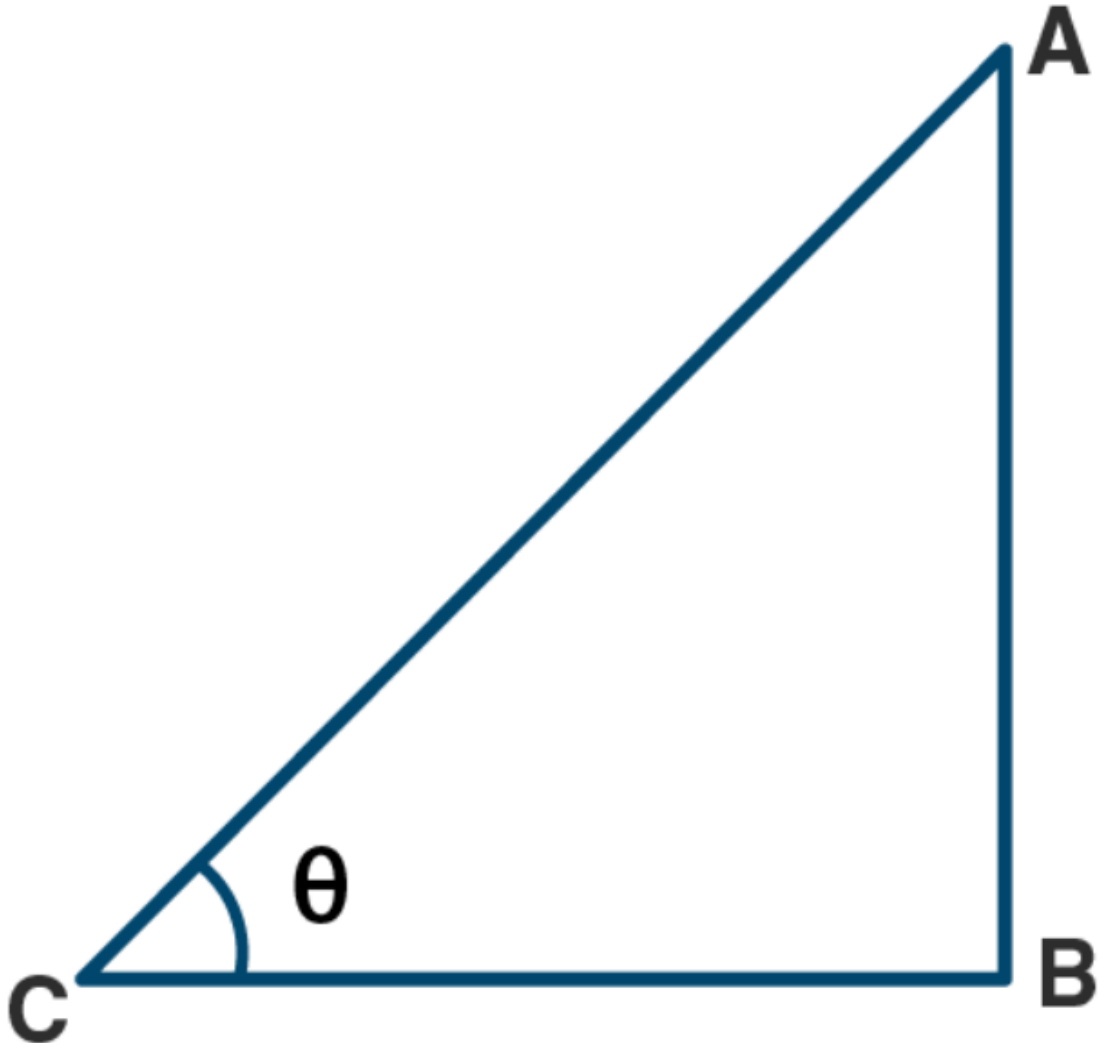
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$$= 2(\sqrt{5} - 1)/\sqrt{5}$$

14. Given $\sin \theta = p/q$, find $\cos \theta + \sin \theta$ in terms of p and q .

Solution:

Given that $\sin \theta = p/q$



Which implies,

$$AB/AC = p/q$$

$$\text{Let } AB = px$$

$$\text{And then } AC = qx$$

In right angled triangle ABC

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By Pythagoras theorem,

We get

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

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

$$BC^2 = q^2x^2 - p^2x^2$$

$$BC^2 = (q^2 - p^2)x^2$$

$$BC = \sqrt{(q^2 - p^2)}x$$

In right angled triangle ABC,

$$\cos \theta = \text{base} / \text{hypotenuse}$$

$$= BC / AC$$

$$= \sqrt{(q^2 - p^2)}x / qx$$

$$= \sqrt{(q^2 - p^2)} / q$$

Now,

$$\sin \theta + \cos \theta = p/q + \sqrt{(q^2 - p^2)} / q$$

$$= [p + \sqrt{(q^2 - p^2)}] / q$$

15. If θ is an acute angle and $\tan \theta = 8/15$, find the value of $\sec \theta + \operatorname{cosec} \theta$.

Solution:

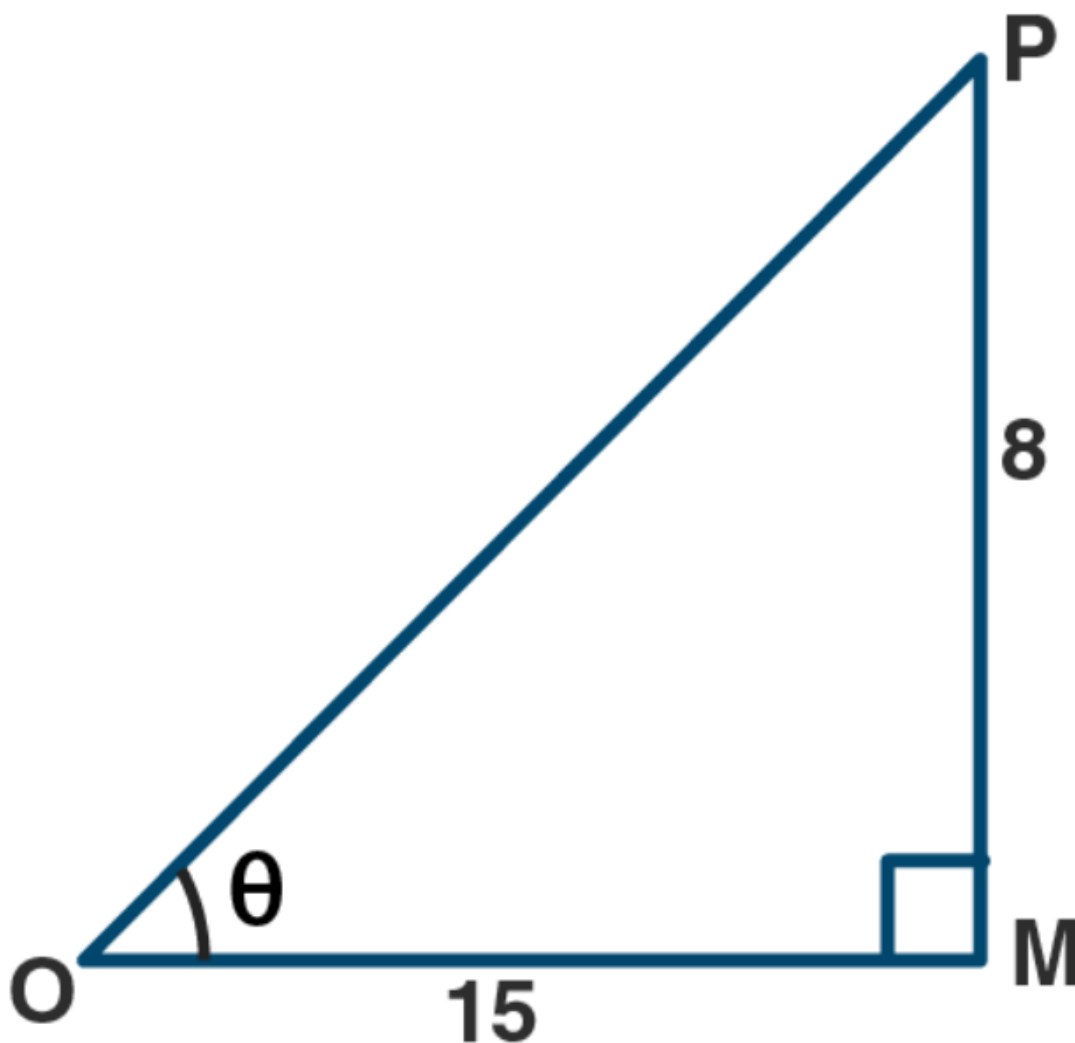
$$\text{Given } \tan \theta = 8/15$$

θ is an acute angle

in the figure triangle OMP is a right angled triangle,

$$\angle M = 90^\circ \text{ and } \angle Q = \theta$$

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$$\tan \theta = PM/OM = 8/15$$

Therefore, PM = 8, OM = 15

But $OP^2 = OM^2 + PM^2$ using Pythagoras theorem,

$$= 15^2 + 8^2$$

$$= 225 + 64$$

$$= 289$$

$$= 17^2$$

Therefore, OP = 17

$$\sec \theta = OP/OM$$

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$$= 17/15$$

$$\operatorname{Cosec} \theta = OP/PM$$

$$= 17/8$$

Now,

$$\sec \theta + \operatorname{cosec} \theta = (17/15) + (17/8)$$

$$= (136 + 255)/120$$

$$= 391/120$$

$$= 3 \frac{31}{120}$$

16. Given A is an acute angle and $13 \sin A = 5$, evaluate:

$$(5 \sin A - 2 \cos A) / \tan A.$$

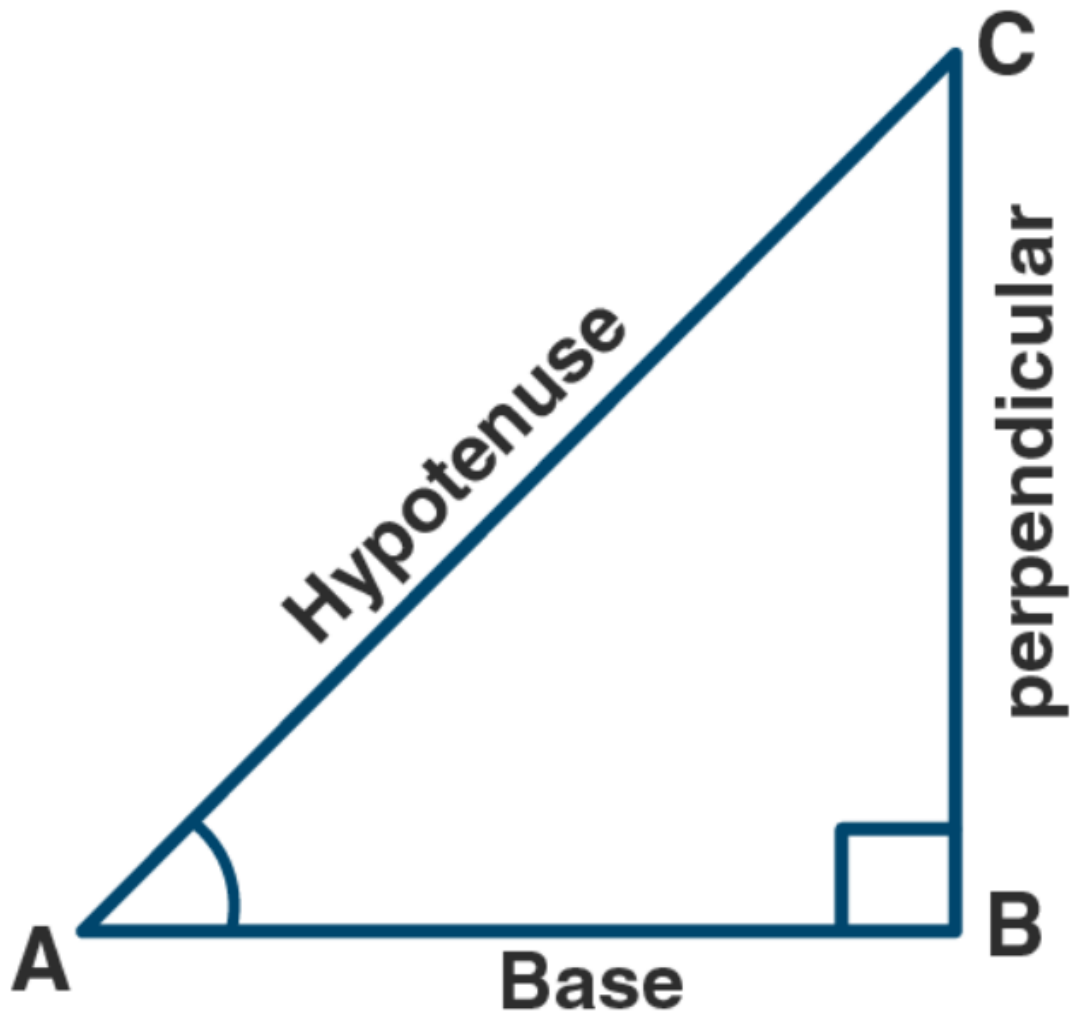
Solution:

Let triangle ABC be a right angled triangle at B and A is an acute angle

$$\text{Given that } 13 \sin A = 5$$

$$\sin A = 5/13$$

$$AB/AC = 5/13$$



Let $AB = 5x$

$AC = 13x$

In right angled triangle ABC,

Using Pythagoras theorem,

We get

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

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

$$BC^2 = (13x)^2 - (5x)^2$$

$$BC^2 = 169x^2 - 25x^2$$

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$$BC^2 = 144x^2$$

$$BC = 12x$$

$$\sin A = 5/13$$

$$\cos A = \text{base} / \text{hypotenuse}$$

$$= BC/AC$$

$$= 12x/13x$$

$$= 12/13$$

$$\tan A = \text{perpendicular} / \text{base}$$

$$= AB/BC$$

$$= 5x/12x$$

$$= 5/12$$

Now,

$$(5 \sin A - 2 \cos A) / \tan A = [(5) (5/13) - (2) (12/13)] / (5/12)$$

$$= (1/13) / (5/12)$$

$$= 12/65$$

$$\text{Hence } (5 \sin A - 2 \cos A) / \tan A = 12/65$$

17. Given A is an acute angle and cosec A = $\sqrt{2}$, find the value of

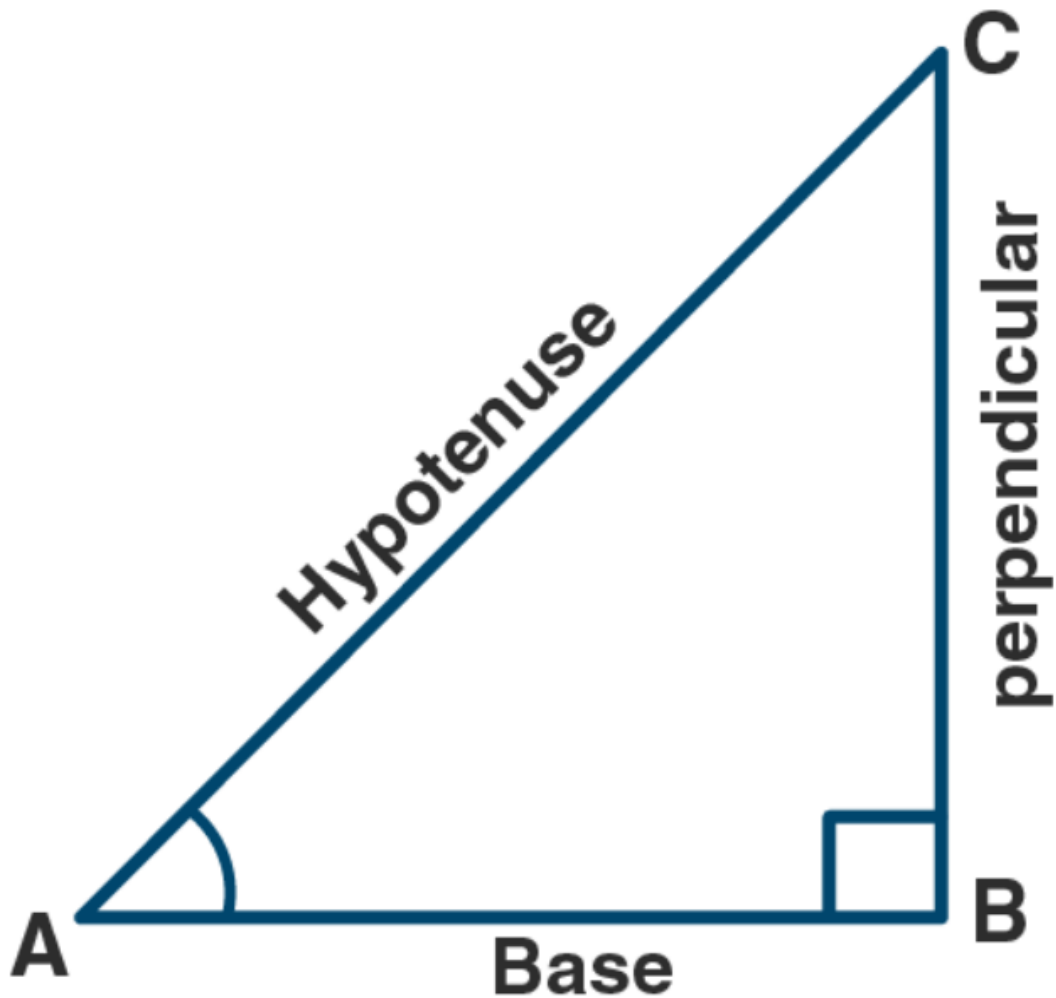
$$(2 \sin^2 A + 3 \cot^2 A) / (\tan^2 A - \cos^2 A).$$

Solution:

Let triangle ABC be a right angled at B and A is a acute angle.

$$\text{Given that cosec A} = \sqrt{2}$$

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Which implies,

$$AC/BC = \sqrt{2}/1$$

$$\text{Let } AC = \sqrt{2}x$$

$$\text{Then } BC = x$$

In right angled triangle ABC

By using Pythagoras theorem,

We get

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

$$(\sqrt{2}x)^2 = AB^2 + x^2$$

$$AB^2 = 2x^2 - x^2$$

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$$AB = x$$

$\sin A = \text{perpendicular} / \text{hypotenuse}$

$$= BC/AC$$

$$= 1/\sqrt{2}$$

$\cot A = \text{base} / \text{perpendicular}$

$$= x/x$$

$$= 1$$

$\tan A = \text{perpendicular} / \text{base}$

$$= BC/AB$$

$$= x/x$$

$$= 1$$

$\cos A = \text{base} / \text{hypotenuse}$

$$= AB/AC$$

$$= x/\sqrt{2}x$$

$$= 1/\sqrt{2}$$

Substituting these values we get

$$2 \sin^2 A + 3 \cot^2 A / (\tan^2 A - \cos^2 A) = 8$$

18. The diagonals AC and BD of a rhombus ABCD meet at O. If AC = 8 cm and BD = 6 cm, find $\sin \angle OCD$.

Solution:

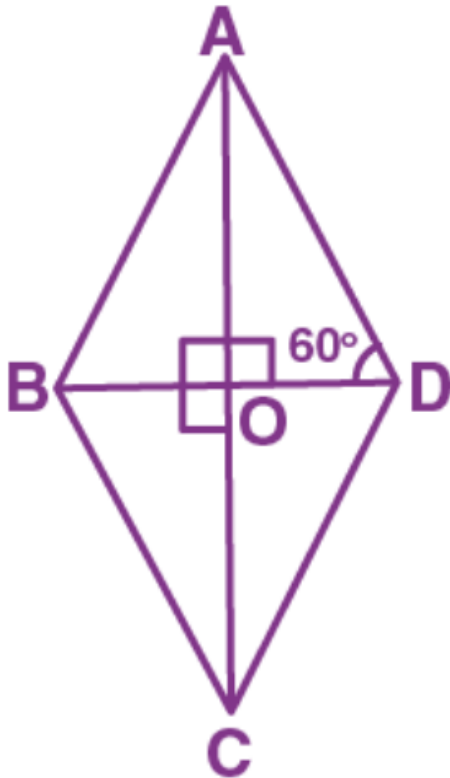
It is given that

Diagonals AC and BD of rhombus ABCD meet at O

AC = 8 cm and BD = 6 cm

O is the mid point of AC

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We know that

$$AO = OC = AC/2 = 8/2 = 4 \text{ cm}$$

O is the mid point of BD

$$BO = OD = BD/2 = 6/2 = 3 \text{ cm}$$

In right angled $\triangle COD$

$$CD^2 = OC^2 + OD^2$$

Substituting the values

$$CD^2 = 4^2 + 3^2$$

So we get

$$CD^2 = 16 + 9 = 25$$

$$CD^2 = 5^2$$

$$CD = 5 \text{ cm}$$

In right angled $\triangle COD$

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$\sin \angle OCD = \text{perpendicular} / \text{hypotenuse}$

So we get

$$\sin \angle OCD = OD/CD = 3/5$$

19. If $\tan \theta = 5/12$, find the value of $(\cos \theta + \sin \theta) / (\cos \theta - \sin \theta)$.

Solution:

Consider $\triangle ABC$ be right angled at B and $\angle ACB = \theta$

It is given that

$$\tan \theta = AB/BC = 5/12$$

Take $AB = 5x$ then $BC = 12x$

In right angled $\triangle ABC$,

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = (5x)^2 + (12x)^2$$

By further calculation

$$AC^2 = 25x^2 + 144x^2 = 169x^2$$

So we get

$$AC^2 = (13x)^2$$

$$AC = 13x$$

In right angled $\triangle ABC$

$\cos \theta = \text{base} / \text{hypotenuse}$

$$\cos \theta = BC/AC$$

Substituting the values

$$\cos \theta = 12x/13x = 12/13$$

In right angled $\triangle ABC$

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$\sin \theta = \text{perpendicular/hypotenuse}$

$$\sin \theta = AB/AC$$

Substituting the values

$$\sin \theta = 5x/13x = 5/13$$

Here

$$(\cos \theta + \sin \theta) / (\cos \theta - \sin \theta) = [12/13 + 5/13] / [12/13 - 5/13]$$

Taking LCM

$$= [(12 + 5)/13] / [(12 - 5)/13]$$

So we get

$$= 17/13 / 7/13$$

$$= 17/13 \times 13/7$$

$$= 17/7$$

Therefore, $(\cos \theta + \sin \theta) / (\cos \theta - \sin \theta) = 17/7 = 2 \frac{3}{7}$.

20. Given $5 \cos A - 12 \sin A = 0$, find the value of $(\sin A + \cos A) / (2 \cos A - \sin A)$.

Solution:

It is given that

$$5 \cos A - 12 \sin A = 0$$

We can write it as

$$5 \cos A = 12 \sin A$$

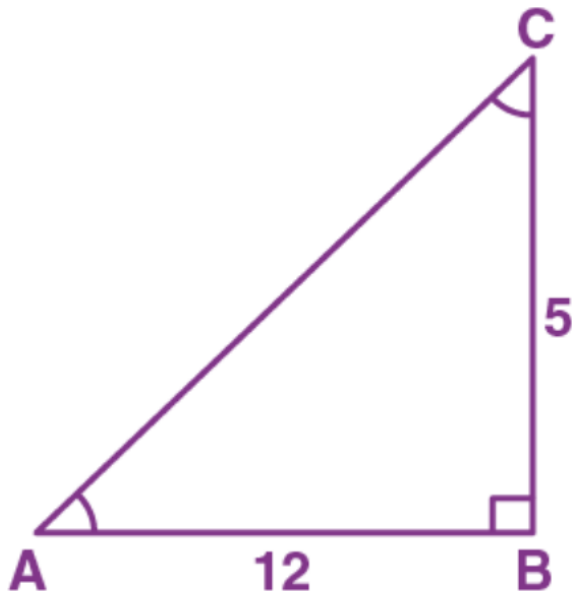
So we get

$$\sin A / \cos A = 5/12$$

We know that $\sin A / \cos A = \tan A$

$$\tan A = 5/12$$

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Consider $\triangle ABC$ right angled at B and $\angle A$ is acute angle

Here

$$\tan A = \frac{BC}{AB} = \frac{5}{12}$$

Take $BC = 5x$ then $AB = 12x$

In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = (5x)^2 + (12x)^2$$

$$AC^2 = 25x^2 + 144x^2 = 169x^2$$

So we get

$$AC^2 = (13x)^2$$

$$AC = 13x$$

In right angled $\triangle ABC$

$\sin A = \frac{\text{perpendicular}}{\text{hypotenuse}}$

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So we get

$$\sin A = BC/AC = 5x/13x = 5/13$$

In right angled $\triangle ABC$

$$\cos A = \text{base/hypotenuse}$$

So we get

$$\cos A = AB/AC = 12x/13x = 12/13$$

Here

$$(\sin A + \cos A) / (2 \cos A - \sin A) = [5/13 + 12/13] / [2 \times 12/13 - 5/13]$$

By further calculation

$$= [(5 + 12)/13] / [24/13 - 5/13]$$

So we get

$$= [(5 + 12)/13] / [(24 - 5)/13]$$

$$= 17/13 / 19/13$$

$$= 17/13 \times 13/19$$

$$= 17/19$$

Therefore, $(\sin A + \cos A) / (2 \cos A - \sin A) = 17/19$

21. If $\tan \theta = p/q$, find the value of $(p \sin \theta - q \cos \theta) / (p \sin \theta + q \cos \theta)$.

Solution:

It is given that

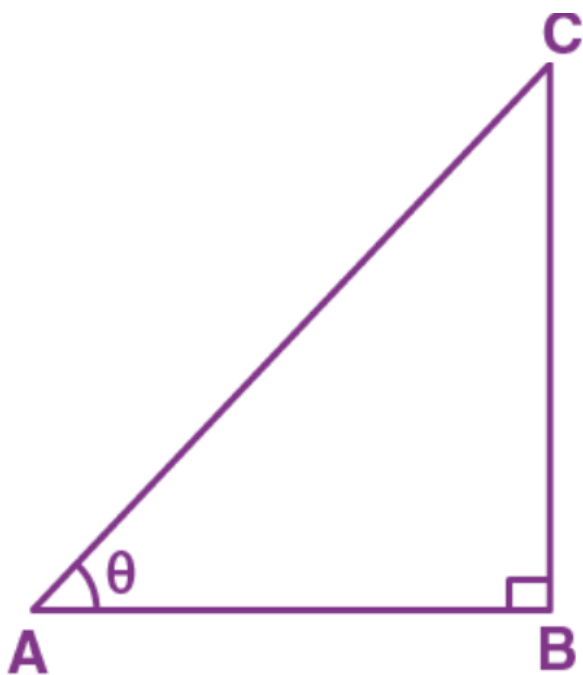
$$\tan \theta = p/q$$

Consider $\triangle ABC$ be right angled at B and $\angle BCA = \theta$

$$\tan \theta = BC/AB = p/q$$

$$BC = px \text{ then } AB = qx$$

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In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = (px)^2 + (qx)^2$$

$$AC^2 = p^2x^2 + q^2x^2$$

$$AC^2 = x^2 (p^2 + q^2)$$

So we get

$$AC = \sqrt{x^2 (p^2 + q^2)}$$

$$AC = x(\sqrt{p^2 + q^2})$$

In right angled $\triangle ABC$

$\sin \theta = \text{perpendicular/hypotenuse}$

$$\sin \theta = BC/AC$$

Substituting the values

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$$\sin \theta = \frac{px}{x(\sqrt{p^2 + q^2})}$$

So we get

$$\sin \theta = \frac{p}{(\sqrt{p^2 + q^2})}$$

In right angled $\triangle ABC$

$$\cos \theta = \frac{\text{base}}{\text{hypotenuse}}$$

$$\cos \theta = \frac{AB}{AC}$$

Substituting the values

$$\cos \theta = \frac{qx}{x(\sqrt{p^2 + q^2})}$$

So we get

$$\cos \theta = \frac{q}{(\sqrt{p^2 + q^2})}$$

Here

$$\frac{p \sin \theta - q \cos \theta}{p \sin \theta + q \cos \theta} = \frac{p\left(\frac{p}{\sqrt{p^2 + q^2}}\right) - q\left(\frac{q}{\sqrt{p^2 + q^2}}\right)}{p\left(\frac{p}{\sqrt{p^2 + q^2}}\right) + q\left(\frac{q}{\sqrt{p^2 + q^2}}\right)}$$

By further calculation

$$\begin{aligned} &= \frac{\frac{p^2}{\sqrt{p^2 + q^2}} - \frac{q^2}{\sqrt{p^2 + q^2}}}{\frac{p^2}{\sqrt{p^2 + q^2}} + \frac{q^2}{\sqrt{p^2 + q^2}}} \\ &= \frac{\frac{p^2 - q^2}{\sqrt{p^2 + q^2}}}{\frac{p^2 + q^2}{\sqrt{p^2 + q^2}}} \end{aligned}$$

So we get

$$\begin{aligned} &= \frac{p^2 - q^2}{\sqrt{p^2 + q^2}} \times \frac{\sqrt{p^2 + q^2}}{p^2 + q^2} \\ &= \frac{p^2 - q^2}{p^2 + q^2} \end{aligned}$$

$$\text{Therefore, } \frac{p \sin \theta - q \cos \theta}{p \sin \theta + q \cos \theta} = \frac{p^2 - q^2}{p^2 + q^2}$$

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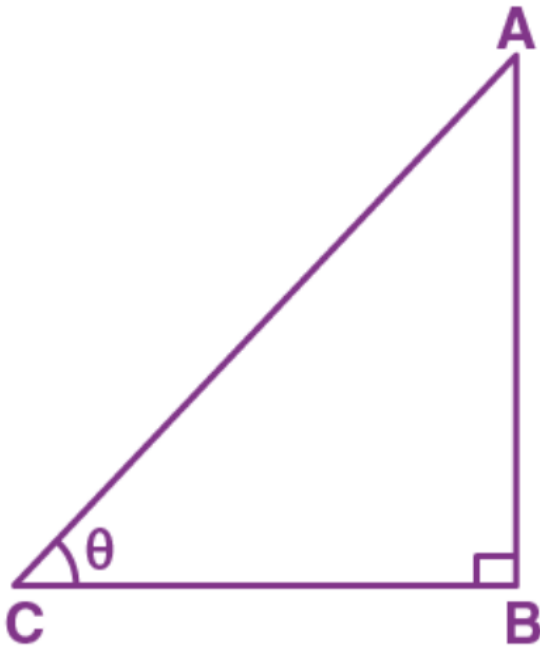
22. If $3 \cot \theta = 4$, find the value of $(5 \sin \theta - 3 \cos \theta) / (5 \sin \theta + 3 \cos \theta)$.

Solution:

It is given that

$$3 \cot \theta = 4$$

$$\cot \theta = 4/3$$



Consider $\triangle ABC$ be right angled at B and $\angle ACB = \theta$

$$\cot \theta = BC/AB = 4/3$$

Take $BC = 4x$ then $AB = 3x$

In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = (3x)^2 + (4x)^2$$

$$AC^2 = 9x^2 + 16x^2 = 25x^2$$

So we get

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$$AC^2 = (5x)^2$$

$$AC = 5x$$

In right angled $\triangle ABC$

$\sin \theta = \text{perpendicular/hypotenuse}$

$$\sin \theta = AB/AC$$

Substituting the values

$$\sin \theta = 3x/5x = 3/5$$

In right angled $\triangle ABC$

$\cos \theta = \text{base/hypotenuse}$

$$\cos \theta = BC/AC$$

Substituting the values

$$\cos \theta = 4x/5x = 4/5$$

$$\frac{5\sin\theta - 3\cos\theta}{5\sin\theta + 3\cos\theta} = \frac{5 \times \frac{3}{5} - 3 \times \frac{4}{5}}{5 \times \frac{3}{5} + 3 \times \frac{4}{5}}$$

By further calculation

$$\begin{aligned} &= \frac{\frac{15}{5} - \frac{12}{5}}{\frac{15}{5} + \frac{12}{5}} \\ &= \frac{\frac{15-12}{5}}{\frac{15+12}{5}} \end{aligned}$$

So we get

$$\begin{aligned} &= \frac{\frac{3}{5}}{\frac{27}{5}} \\ &= \frac{3}{5} \times \frac{5}{27} \\ &= \frac{3}{27} \\ &= \frac{1}{9} \end{aligned}$$

$$\text{Therefore, } \frac{5\sin\theta - 3\cos\theta}{5\sin\theta + 3\cos\theta} = \frac{1}{9}$$

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23. (i) If $5 \cos \theta - 12 \sin \theta = 0$, find the value of $(\sin \theta + \cos \theta)/(2 \cos \theta - \sin \theta)$.

(ii) If $\operatorname{cosec} \theta = 13/12$, find the value of $(2 \sin \theta - 3 \cos \theta)/(4 \sin \theta - 9 \cos \theta)$.

Solution:

(i) It is given that

$$5 \cos \theta - 12 \sin \theta = 0$$

We can write it as

$$5 \cos \theta = 12 \sin \theta$$

$$\sin \theta / \cos \theta = 5/12$$

$$\tan \theta = 5/12$$

Dividing both numerator and denominator by $\cos \theta$

$$\frac{\sin \theta + \cos \theta}{2 \cos \theta - \sin \theta} = \frac{\frac{\sin \theta}{\cos \theta} + \frac{\cos \theta}{\cos \theta}}{\frac{2 \cos \theta}{\cos \theta} - \frac{\sin \theta}{\cos \theta}}$$

$$= \frac{\tan \theta + 1}{2 - \tan \theta}$$

Substituting the values

$$= \frac{\frac{5}{12} + 1}{2 - \frac{5}{12}}$$

Taking LCM

$$= \frac{\frac{5+12}{12}}{\frac{24-5}{12}}$$
$$= \frac{17}{19}$$

So we get

$$= \frac{17}{12} \times \frac{12}{19}$$
$$= \frac{17}{19}$$

(ii) It is given that

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$$\operatorname{cosec} \theta = 13/12$$

We know that $\operatorname{cosec} \theta = 1/\sin \theta$

$$1/\sin \theta = 13/12$$

$$\sin \theta = 12/13$$

$$\text{Here } \cos^2 \theta = 1 - \sin^2 \theta$$

Substituting the values

$$= 1 - (12/13)^2$$

By further calculation

$$= 1 - 144/169$$

Taking LCM

$$= (169 - 144)/169$$

$$= 25/169$$

So we get

$$= (5/13)^2$$

$$\cos \theta = 5/13$$

Here

$$\frac{2\sin\theta - 3\cos\theta}{4\sin\theta - 9\cos\theta} = \frac{2(\frac{12}{13}) - 3(\frac{5}{13})}{4(\frac{12}{13}) - 9(\frac{5}{13})}$$

By further calculation

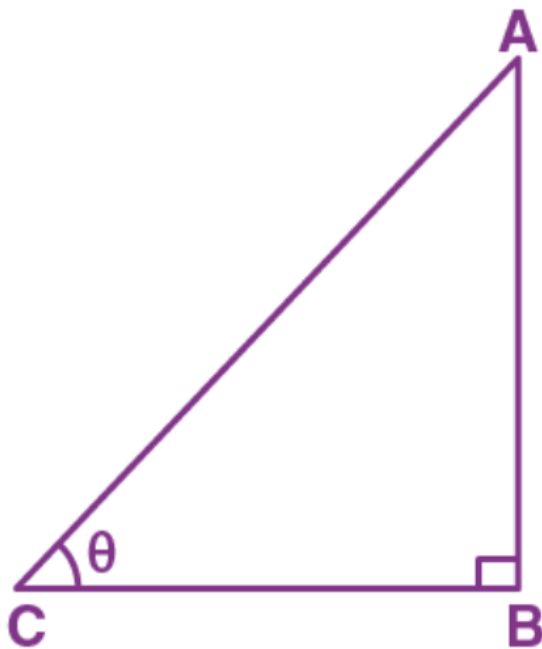
$$= \frac{\frac{24}{13} - \frac{15}{13}}{\frac{48}{13} - \frac{45}{13}}$$

So we get

$$\begin{aligned} &= \frac{\frac{24-15}{13}}{\frac{48-45}{13}} \\ &= \frac{\frac{9}{13}}{\frac{3}{13}} \\ &= \frac{9}{13} \times \frac{13}{3} \\ &= 3 \end{aligned}$$

24. If $5 \sin \theta = 3$, find the value of $(\sec \theta - \tan \theta) / (\sec \theta + \tan \theta)$.

Solution:



Consider $\triangle ABC$ be right angled at B and $\angle ACB = \theta$

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It is given that

$$5 \sin \theta = 3$$

$$\sin \theta = AB/AC = 3/5$$

Take $AB = 3x$ then $AC = 5x$

In right angled $\triangle ABC$

Using Pythagoras theorem

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

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

Substituting the values

$$BC^2 = (5x)^2 - (3x)^2$$

So we get

$$BC^2 = 25x^2 - 9x^2 = 16x^2$$

$$BC^2 = (4x)^2$$

$$BC = 4x$$

In right angled $\triangle ABC$

$\sec \theta = \text{hypotenuse}/\text{base}$

$$\sec \theta = AC/BC = 5x/4x = 5/4$$

In right angled $\triangle ABC$

$\tan \theta = \text{perpendicular}/\text{base}$

$$\tan \theta = AB/BC = 3x/4x = 3/4$$

$$\frac{\sec\theta - \tan\theta}{\sec\theta + \tan\theta} = \frac{\frac{5}{4} - \frac{3}{4}}{\frac{5}{4} + \frac{3}{4}}$$

$$\text{By further calculation} = \frac{2}{4} \times \frac{4}{8}$$

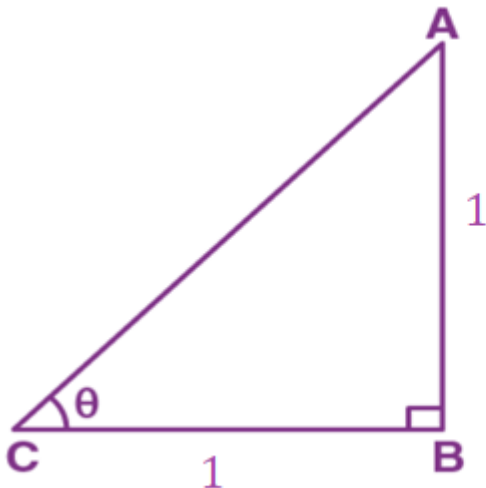
$$= \frac{\frac{5-3}{4}}{\frac{5+3}{4}} = \frac{2}{8}$$

$$\text{So we get} = \frac{1}{4}$$

$$= \frac{2}{8} \quad \text{Therefore, } \frac{\sec\theta - \tan\theta}{\sec\theta + \tan\theta} = \frac{1}{4}$$

25. If θ is an acute angle and $\sin \theta = \cos \theta$, find the value of $2 \tan^2 \theta + \sin^2 \theta - 1$.

Solution:



Consider $\triangle ABC$ be right angled at B and $\angle ACB = \theta$

It is given that

$$\sin \theta = \cos \theta$$

$$\sin \theta / \cos \theta = 1$$

$$\tan \theta = AB/BC = 1$$

Take $AB = x$ then $BC = x$

In right angled $\triangle ABC$

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Using Pythagoras theorem

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

$$AC^2 = x^2 + x^2 = 2x^2$$

So we get

$$AC = \sqrt{2x^2}$$

$$AC = (\sqrt{2})x$$

In right angled $\triangle ABC$

$\sin \theta = \text{perpendicular/hypotenuse}$

$$\sin \theta = AB/AC = x/\sqrt{2}x = 1/\sqrt{2}$$

Here

$$2 \tan^2 \theta + \sin^2 \theta - 1 = 2 \times (1)^2 + (1/\sqrt{2})^2 - 1$$

By further calculation

$$= 2 \times 1 + \frac{1}{2} - 1$$

$$= 2 + \frac{1}{2} - 1$$

$$= 1 + \frac{1}{2}$$

Taking LCM

$$= (2 + 1)/2$$

$$= 3/2$$

Therefore, $2 \tan^2 \theta + \sin^2 \theta - 1 = 3/2$.

26. Prove the following:

(i) $\cos \theta \tan \theta = \sin \theta$

(ii) $\sin \theta \cot \theta = \cos \theta$

(iii) $\sin^2 \theta / \cos \theta + \cos \theta = 1 / \cos \theta$.

Solution:

(i) $\cos \theta \tan \theta = \sin \theta$

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$$\text{LHS} = \cos \theta \tan \theta$$

We know that $\tan \theta = \sin \theta / \cos \theta$

$$= \cos \theta (\sin \theta / \cos \theta)$$

So we get

$$= 1 \times \sin \theta / 1$$

$$= \sin \theta$$

$$= \text{RHS}$$

Therefore, $\text{LHS} = \text{RHS}$.

$$\text{(ii) } \sin \theta \cot \theta = \cos \theta$$

$$\text{LHS} = \sin \theta \cot \theta$$

We know that $\cot \theta = \cos \theta / \sin \theta$

$$= \sin \theta (\cos \theta / \sin \theta)$$

$$= 1 \times \cos \theta / 1$$

$$= \cos \theta$$

$$= \text{RHS}$$

Therefore, $\text{LHS} = \text{RHS}$.

$$\text{(iii) } \sin^2 \theta / \cos \theta + \cos \theta = 1 / \cos \theta$$

$$\text{LHS} = \sin^2 \theta / \cos \theta + \cos \theta / 1$$

Taking LCM

$$= (\sin^2 \theta + \cos^2 \theta) / \cos \theta$$

We know that $\sin^2 \theta + \cos^2 \theta = 1$

$$= 1 / \cos \theta$$

$$= \text{RHS}$$

Therefore, $\text{LHS} = \text{RHS}$.

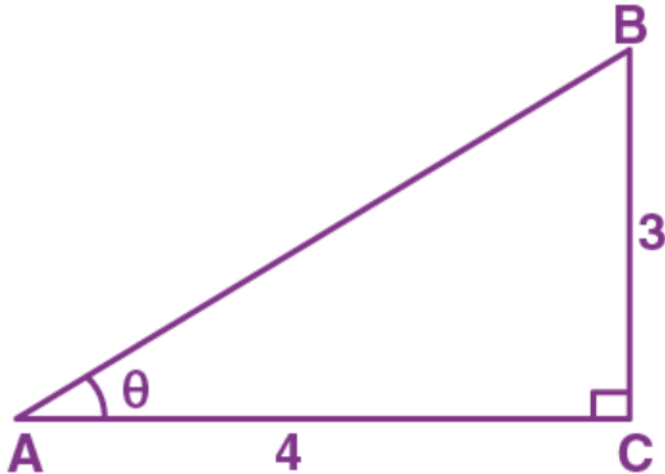
27. If in $\triangle ABC$, $\angle C = 90^\circ$ and $\tan A = \frac{3}{4}$, prove that $\sin A \cos B + \cos A \sin B = 1$.

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Solution:

It is given that

$$\tan A = BC/AC = \frac{3}{4}$$



Using Pythagoras theorem

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

Substituting the values

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

$$= 16 + 9$$

$$= 25$$

$$= 5^2$$

So we get $AB = 5$

Here

$$\sin A = BC/AB = \frac{3}{5}$$

$$\cos A = AC/AB = \frac{4}{5}$$

$$\cos B = BC/AB = \frac{3}{5}$$

$$\sin B = AC/AB = \frac{4}{5}$$

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$$\text{LHS} = \sin A \cos B + \cos A \sin B$$

Substituting the values

$$= \frac{3}{5} \times \frac{3}{5} + \frac{4}{5} \times \frac{4}{5}$$

By further calculation

$$= \frac{9}{25} + \frac{16}{25}$$

$$= \frac{(9 + 16)}{25}$$

$$= \frac{25}{25}$$

$$= 1$$

$$= \text{RHS}$$

Therefore, LHS = RHS.

28. (a) In figure (1) given below, $\triangle ABC$ is right-angled at B and $\triangle BRS$ is right-angled at R. If $AB = 18$ cm, $BC = 7.5$ cm, $RS = 5$ cm, $\angle BSR = x^\circ$ and $\angle SAB = y^\circ$, then find:

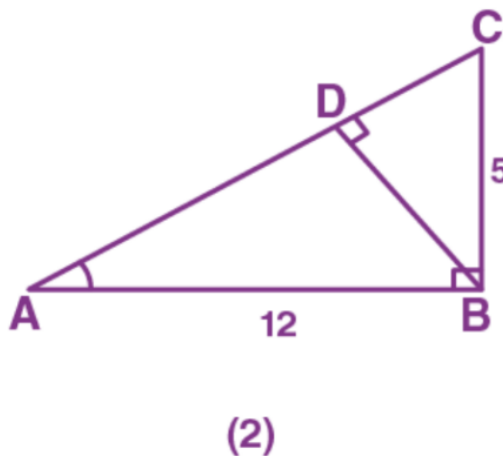
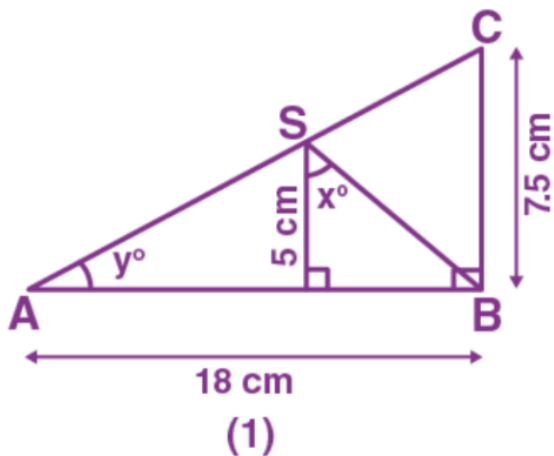
(i) $\tan x^\circ$

(ii) $\sin y^\circ$.

(b) In the figure (2) given below, $\triangle ABC$ is right angled at B and BD is perpendicular to AC. Find

(i) $\cos \angle CBD$

(ii) $\cot \angle ABD$.



Solution:

(a) $\triangle ABC$ is right-angled at B, $\triangle BSC$ is right-angled at S and $\triangle BRS$ is right-angled at R

It is given that

$AB = 18$ cm, $BC = 7.5$ cm, $RS = 5$ cm, $\angle BSR = x^\circ$ and $\angle SAB = y^\circ$

By Geometry $\triangle ARS$ and $\triangle ABC$ are similar

$$AR/AB = RS/BC$$

Substituting the values

$$AR/18 = 5/7.5$$

By further calculation

$$AR = (5 \times 18)/7.5 = (1 \times 18)/1.5$$

Multiply both numerator and denominator by 10

$$AR = (18 \times 10)/15$$

$$AR = (10 \times 6)/5$$

$$AR = (2 \times 6)/1 = 12$$

So we get

$$RB = AB - AR$$

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$$RB = 18 - 12 = 6$$

In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = 18^2 + 7.5^2$$

By further calculation

$$AC^2 = 324 + 56.25 = 380.25$$

$$AC = \sqrt{380.25} = 19.5 \text{ cm}$$

(i) In right angled $\triangle BSR$

$$\tan x^\circ = \text{perpendicular/base}$$

$$\tan x^\circ = RB/RS = 6/5$$

(ii) In right angled $\triangle ASR$

$$\sin y^\circ = \text{perpendicular/hypotenuse}$$

Using Pythagoras theorem

$$AS^2 = 12^2 + 5^2$$

By further calculation

$$AS^2 = 144 + 25 = 169$$

$$AS = \sqrt{169} = 13 \text{ cm}$$

So we get

$$\sin y^\circ = RS/AS = 5/13$$

(b) We know that

$\triangle ABC$ is right angled at B and BD is perpendicular to AC

In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

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

By further calculation

$$AC^2 = 144 + 25 = 169$$

So we get

$$AC^2 = (13)^2$$

$$AC = 13$$

By Geometry $\angle CBD = \angle A$ and $\angle ABD = \angle C$

(i) $\cos \angle CBD = \cos \angle A = \text{base/hypotenuse}$

In right angled $\triangle ABC$

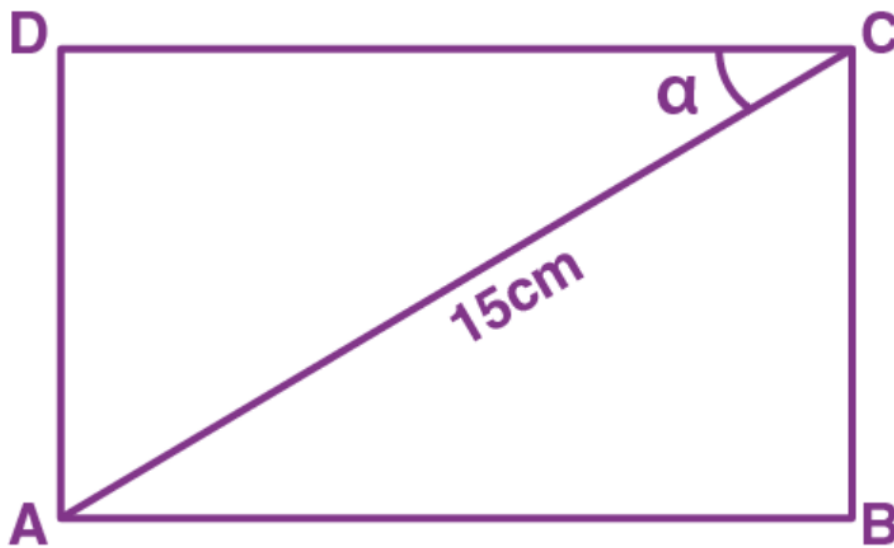
$$\cos \angle CBD = \cos \angle A = AB/AC = 12/13$$

(ii) $\cos \angle ABD = \cos \angle C = \text{base/perpendicular}$

In right angled $\triangle ABC$

$$\cos \angle ABD = \cos \angle C = BC/AB = 5/12$$

29. In the adjoining figure, ABCD is a rectangle. Its diagonal AC = 15 cm and $\angle ACD = \alpha$. If $\cot \alpha = 3/2$, find the perimeter and the area of the rectangle.

**Solution:**

In right $\triangle ADC$

$$\cot \alpha = CD/AD = 3/2$$

Take $CD = 3x$ then $AD = 2x$

Using Pythagoras theorem

$$AC^2 = CD^2 + AD^2$$

Substituting the values

$$(15)^2 = (3x)^2 + (2x)^2$$

By further calculation

$$13x^2 = 225$$

$$x^2 = 225/13$$

So we get

$$x = \sqrt{225/13} = 15/\sqrt{13}$$

$$\text{Length of rectangle (l)} = 3x = (3 \times 15)/\sqrt{13} = 45/\sqrt{13} \text{ cm}$$

$$\text{Breadth of rectangle (b)} = 2x = (2 \times 15)/\sqrt{13} = 30/\sqrt{13} \text{ cm}$$

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(i) Perimeter of rectangle = $2(l + b)$

Substituting the values of l and b

$$= 2(45/\sqrt{13} + 30/\sqrt{13})$$

So we get

$$= 2 \times 75/\sqrt{13}$$

$$= 150/\sqrt{13} \text{ cm}$$

(ii) Area of rectangle = $l \times b$

Substituting the values of l and b

$$= 45/\sqrt{13} \times 30/\sqrt{13}$$

So we get

$$= 1350/13$$

$$= 103 \frac{11}{13} \text{ cm}^2$$

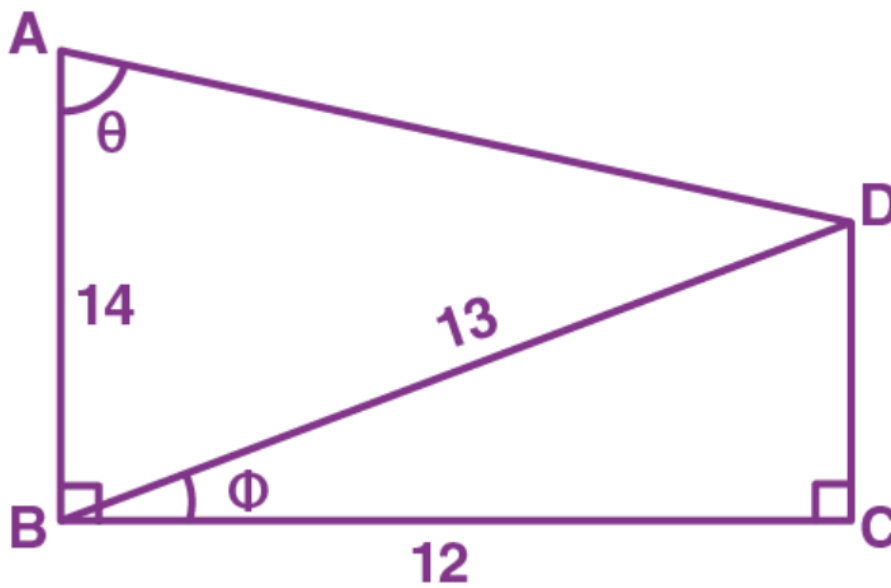
30. Using the measurements given in the figure alongside,

(a) Find the values of:

(i) $\sin \phi$

(ii) $\tan \theta$.

(b) Write an expression for AD in terms of θ .

**Solution:**

From the figure

$$BC = 12, BD = 13$$

In right angled $\triangle BCD$

Using Pythagoras theorem

$$BD^2 = BC^2 + CD^2$$

It can be written as

$$CD^2 = BD^2 - BC^2$$

Substituting the values

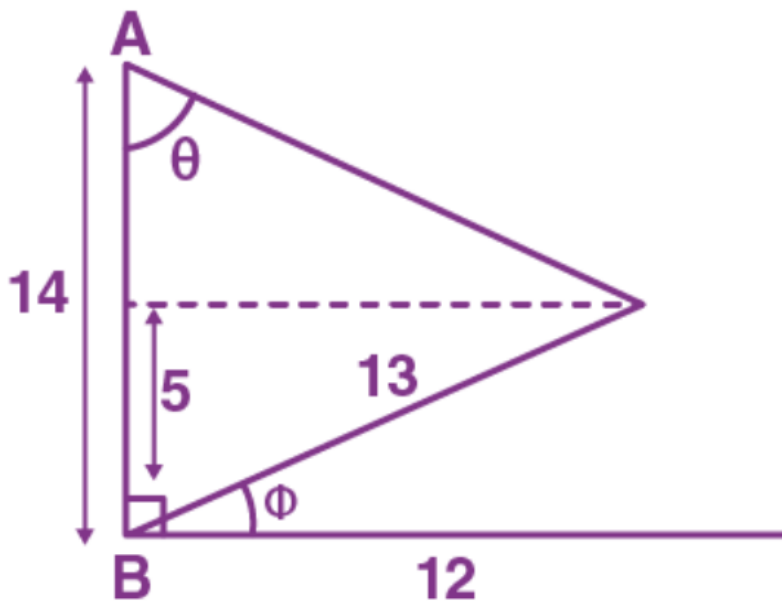
$$CD^2 = (13)^2 - (12)^2$$

$$CD^2 = 169 - 144 = 25$$

So we get

$$CD = \sqrt{25} = 5$$

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Construct BE perpendicular to AB

$CD = BE = 5$ and $EA = AE = 14 - 5 = 9$

(a) (i) $\sin \phi = \text{perpendicular/hypotenuse}$

In right angled $\triangle BCD$

$$\sin \phi = CD/BD = 5/13$$

(ii) $\tan \theta = \text{perpendicular/hypotenuse}$

In right angled $\triangle AED$

$$\tan \theta = ED/AE = BC/AE = 12/9 = 4/3 \text{ (Since } ED = BC \text{)}$$

(b) In right angled $\triangle AED$

$$\sin \theta = \text{perpendicular/hypotenuse}$$

$$\cos \theta = \text{base/perpendicular}$$

We can write it as

$$\sin \theta = ED/AD \text{ or } \cos \theta = AE/AD$$

$$AD = ED/\sin \theta \text{ or } AD = AE/\cos \theta$$

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Substituting the values

$$AD = 12/\sin \theta \text{ or } AD = 9/\cos \theta$$

Therefore, $AD = 12/\sin \theta$ or $AD = 9/\cos \theta$.

31. Prove the following:

(i) $(\sin A + \cos A)^2 + (\sin A - \cos A)^2 = 2$

(ii) $\cot^2 A - 1/\sin^2 A + 1 = 0$

(iii) $1/(1 + \tan^2 A) + 1/(1 + \cot^2 A) = 1$

Solution:

(i) $(\sin A + \cos A)^2 + (\sin A - \cos A)^2 = 2$

$$\text{LHS} = (\sin A + \cos A)^2 + (\sin A - \cos A)^2$$

Using the formula

$$(a + b)^2 = a^2 + b^2 + 2ab \text{ and } (a - b)^2 = a^2 + b^2 - 2ab$$

$$= [(\sin A)^2 + (\cos A)^2 + 2 \sin A \cos A] + [(\sin A)^2 + (\cos A)^2 - 2 \sin A \cos A]$$

By further calculation

$$= \sin^2 A + \cos^2 A + 2 \sin A \cos A + \sin^2 A + \cos^2 A - 2 \sin A \cos A$$

$$= \sin^2 A + \cos^2 A + \sin^2 A + \cos^2 A$$

$$= 2 \sin^2 A + 2 \cos^2 A$$

$$\text{We know that } \sin^2 A + \cos^2 A = 1$$

$$= 2 (\sin^2 A + \cos^2 A)$$

$$= 2 (1)$$

$$= 2$$

$$= \text{RHS}$$

Therefore, LHS = RHS.

(ii) $\cot^2 A - 1/\sin^2 A + 1 = 0$

$$\text{LHS} = \cot^2 A - 1/\sin^2 A + 1$$

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We know that

$$1/\sin A = \operatorname{cosec} A$$

$$= \cot^2 A - \operatorname{cosec}^2 A + 1$$

$$= (1 + \cot^2 A) - \operatorname{cosec}^2 A$$

$$\text{We know that } 1 + \cot^2 A = \operatorname{cosec}^2 A$$

$$= \operatorname{cosec}^2 A - \operatorname{cosec}^2 A$$

$$= 0$$

$$= \text{RHS}$$

Therefore, LHS = RHS.

$$\text{(iii) } 1/(1 + \tan^2 A) + 1/(1 + \cot^2 A) = 1$$

$$\text{LHS} = 1/(1 + \tan^2 A) + 1/(1 + \cot^2 A)$$

We know that

$$\sec^2 A - \tan^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A - \cot^2 A = 1$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

So we get

$$= 1/\sec^2 A + 1/\operatorname{cosec}^2 A$$

$$\text{Here } 1/\sec A = \cos A \text{ and } 1/\operatorname{cosec} A = \sin A$$

$$= \cos^2 A + \sin^2 A$$

$$= 1$$

$$= \text{RHS}$$

Therefore, LHS = RHS.

32. Simplify

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$$\sqrt{\frac{1 - \sin^2 \theta}{1 - \cos^2 \theta}}$$

Solution:

$$\sqrt{\frac{1 - \sin^2 \theta}{1 - \cos^2 \theta}} = \sqrt{\frac{\sin^2 \theta + \cos^2 \theta - \sin^2 \theta}{\sin^2 \theta + \cos^2 \theta - \cos^2 \theta}}$$

We know that $1 = \sin^2 \theta + \cos^2 \theta$

$$= \sqrt{\cos^2 \theta / \sin^2 \theta}$$

$$= \cos \theta / \sin \theta$$

Here $\cos \theta / \sin \theta = \cot \theta$

$$= \cot \theta$$

Therefore,

$$\sqrt{\frac{1 - \sin^2 \theta}{1 - \cos^2 \theta}} = \cot \theta.$$

33. If $\sin \theta + \operatorname{cosec} \theta = 2$, find the value of $\sin^2 \theta + \operatorname{cosec}^2 \theta$.

Solution:

It is given that

$$\sin \theta + \operatorname{cosec} \theta = 2$$

$$\sin \theta + 1/\sin \theta = 2$$

By further calculation

$$\sin^2 \theta + 1 = 2 \sin \theta$$

$$\sin^2 \theta - 2 \sin \theta + 1 = 0$$

So we get

$$(\sin \theta - 1)^2 = 0$$

$$\sin \theta - 1 = 0$$

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$$\sin \theta = 1$$

Here

$$\sin^2 \theta + \operatorname{cosec}^2 \theta = \sin^2 \theta + 1/\sin^2 \theta$$

Substituting the values

$$= 1^2 + 1/1^2$$

$$= 1 + 1/1$$

$$= 1 + 1$$

$$= 2$$

34. If $x = a \cos \theta + b \sin \theta$ and $y = a \sin \theta - b \cos \theta$, prove that $x^2 + y^2 = a^2 + b^2$.

Solution:

It is given that

$$x = a \cos \theta + b \sin \theta \dots (1)$$

$$y = a \sin \theta - b \cos \theta \dots (2)$$

By squaring and adding both the equations

$$x^2 + y^2 = (a \cos \theta + b \sin \theta)^2 + (a \sin \theta - b \cos \theta)^2$$

Using the formula

$$(a + b)^2 = a^2 + b^2 + 2ab \text{ and } (a - b)^2 = a^2 + b^2 - 2ab$$

$$= [(a \cos \theta)^2 + (b \sin \theta)^2 + 2(a \cos \theta)(b \sin \theta)] + [(a \sin \theta)^2 + (b \cos \theta)^2 - 2(a \sin \theta)(b \cos \theta)]$$

By further calculation

$$= a^2 \cos^2 \theta + b^2 \sin^2 \theta + 2ab \sin \theta \cos \theta + a^2 \sin^2 \theta + b^2 \cos^2 \theta - 2ab \sin \theta \cos \theta$$

$$= a^2 \cos^2 \theta + b^2 \sin^2 \theta + a^2 \sin^2 \theta + b^2 \cos^2 \theta$$

So we get

$$= a^2 (\cos^2 \theta + \sin^2 \theta) + b^2 (\sin^2 \theta + \cos^2 \theta)$$

$$\text{Here } \sin^2 \theta + \cos^2 \theta = 1$$

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$$= a^2 (1) + b^2 (1)$$

$$= a^2 + b^2$$

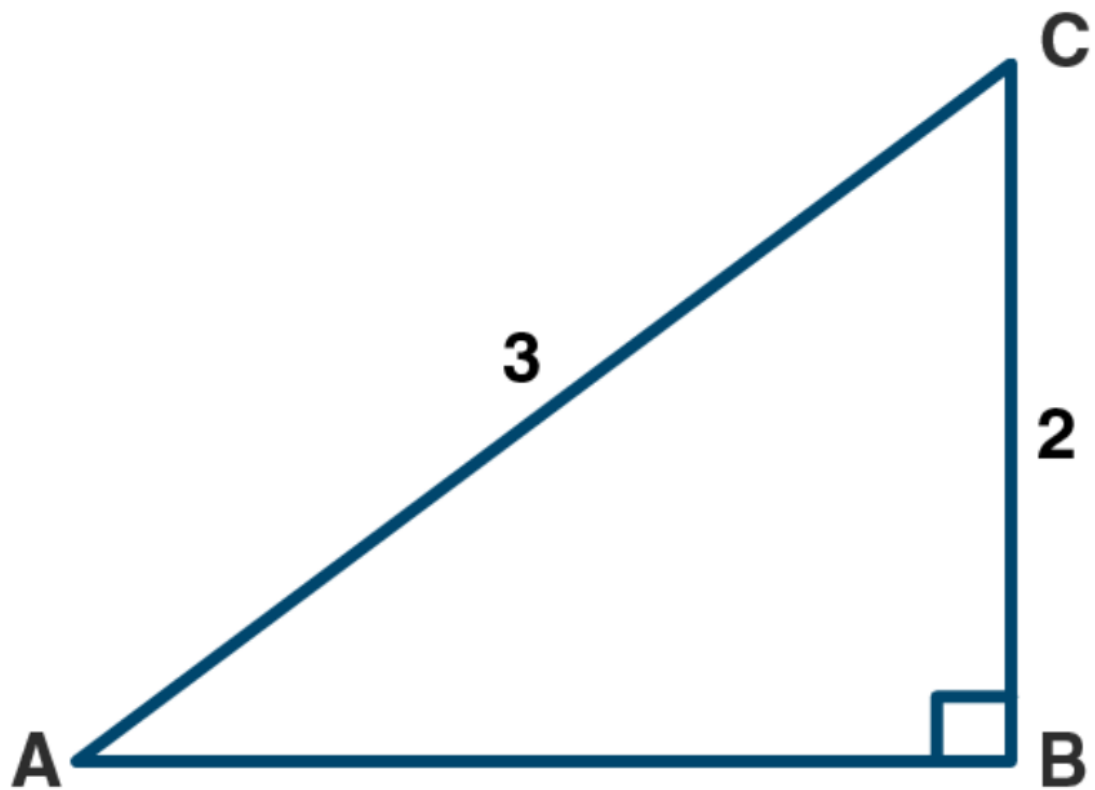
Therefore, $x^2 + y^2 = a^2 + b^2$.

Chapter test

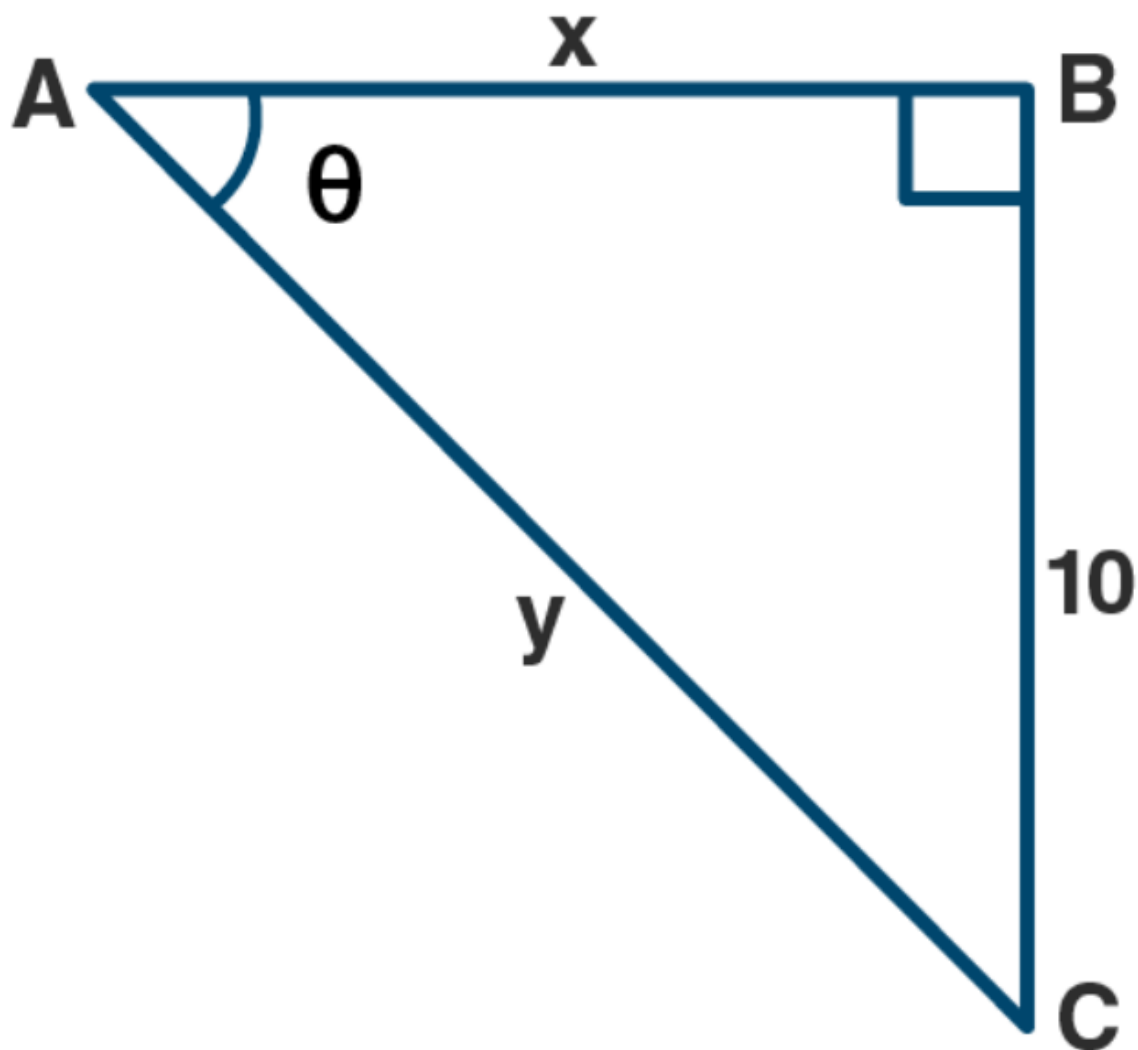
1. (a) From the figure (i) given below, calculate all the six t-ratios for both acute.....

(b) From the figure (ii) given below, find the values of x and y in terms of t-ratios

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Solution:

(a) From right angled triangle ABC,

By Pythagoras theorem, we get

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

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

$$AB^2 = (3)^2 - (2)^2$$

$$AB^2 = 9 - 4$$

$$AB^2 = 5$$

$$AB = \sqrt{5}$$

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(i) $\sin A = \text{perpendicular} / \text{hypotenuse}$

$$= BC/AC$$

$$= 2/3$$

(ii) $\cos A = \text{base} / \text{hypotenuse}$

$$= AB/AC$$

$$= \sqrt{5}/3$$

(iii) $\tan A = \text{perpendicular} / \text{base}$

$$= BC/AB$$

$$= 2/ \sqrt{5}$$

(iv) $\cot A = \text{base} / \text{perpendicular}$

$$= AB/ BC$$

$$= \sqrt{5}/2$$

(v) $\sec A = \text{hypotenuse} / \text{base}$

$$= AC/AB$$

$$= 3/ \sqrt{5}$$

(vi) $\operatorname{cosec} A = \text{hypotenuse} / \text{perpendicular}$

$$= AC/BC$$

$$= 3/2$$

(b) From right angled triangle ABC,

$$\angle BAC = \theta$$

Then we know that,

$$\cot \theta = \text{base} / \text{perpendicular}$$

$$= AB/ BC$$

$$= x/ 10$$

$$x = 10 \cot \theta$$

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also, $\operatorname{cosec} \theta = \text{hypotenuse} / \text{perpendicular}$

$$= AC / BC$$

$$= y / 10$$

$$y = 10 \operatorname{cosec} \theta$$

Therefore, $x = 10 \cot \theta$ and $y = 10 \operatorname{cosec} \theta$.

2. (a) From the figure (1) given below, find the values of:

(i) $\sin \angle ABC$

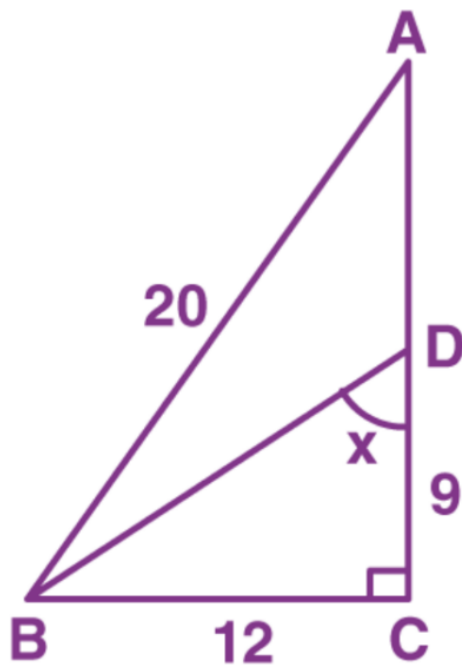
(ii) $\tan x - \cos x + 3 \sin x$.

(b) From the figure (2) given below, find the values of:

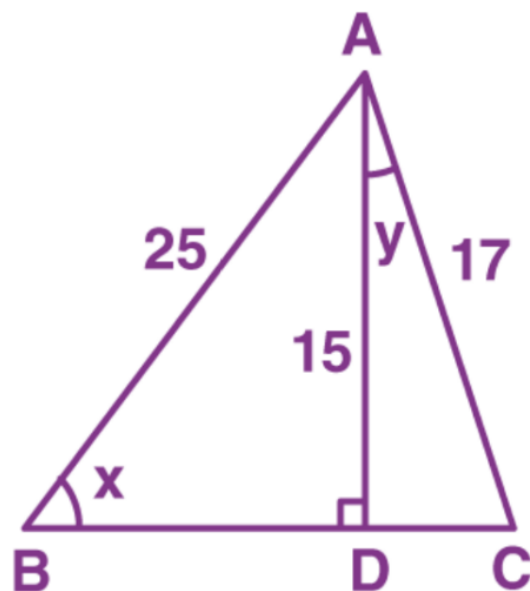
(i) $5 \sin x$

(ii) $7 \tan x$

(iii) $5 \cos x - 17 \sin y - \tan x$.



(i)



(ii)

Solution:

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(a) From the figure

BC = 12, CD = 9 and AC = 20

In right angled $\triangle ABC$,

Using Pythagoras theorem

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

It can be written as

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

Substituting the values

$$AC^2 = (20)^2 - (12)^2$$

By further calculation

$$AC^2 = 400 - 144 = 256$$

So we get

$$AC^2 = (16)^2$$

$$AC = 16$$

In right angled $\triangle BCD$

Using Pythagoras theorem

$$BD^2 = BC^2 + CD^2$$

Substituting the values

$$BD^2 = 12^2 + 9^2$$

By further calculation

$$BD^2 = 144 + 81 = 225$$

So we get

$$BD^2 = (15)^2$$

$$BD = 15$$

(i) In right angled $\triangle BCD$

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$$\sin \angle ABC = \text{perpendicular/hypotenuse}$$

So we get

$$\sin \angle ABC = AC/AB = 16/20 = 4/5$$

(ii) In right angled $\triangle BCD$

$$\tan x = \text{perpendicular/base}$$

So we get

$$\tan x = BC/CD = 12/9 = 4/3$$

In right angled $\triangle BCD$

$$\cos x = \text{base/hypotenuse}$$

So we get

$$\cos x = CD/BD = 9/15 = 3/5$$

In right angled $\triangle BCD$

$$\sin x = \text{perpendicular/hypotenuse}$$

So we get

$$\sin x = BC/BD = 12/15 = 4/5$$

$$\tan x - \cos x + 3 \sin x = 4/3 - 3/5 + 3 \times 4/5$$

By further calculation

$$= 4/3 - 3/5 + 12/5$$

Taking LCM

$$= (4 \times 5 - 3 \times 3 + 12 \times 3)/ 15$$

So we get

$$= (20 - 9 + 36)/ 15$$

$$= (56 - 9)/ 15$$

$$= 27/15$$

$$= 3 \frac{2}{5}$$

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Therefore, $\tan x - \cos x + 3 \sin x = 3 \frac{2}{15}$.

(b) In the figure

$$AC = 17, AB = 25, AD = 15$$

In right angled $\triangle ACD$

Using Pythagoras theorem

$$AC^2 = AD^2 + CD^2$$

Substituting the values

$$(17)^2 = (15)^2 + (CD)^2$$

By further calculation

$$CD^2 = (17)^2 - (15)^2$$

$$CD^2 = 289 - 225 = 64$$

So we get

$$CD^2 = 8^2$$

$$CD = 8$$

In right angled $\triangle ABD$

Using Pythagoras theorem

$$AB^2 = AD^2 + BD^2$$

Substituting the values

$$(25)^2 = (15)^2 + BD^2$$

By further calculation

$$BD^2 = (25)^2 - (15)^2$$

$$BD^2 = 625 - 225 = 400$$

So we get

$$BD^2 = (20)^2$$

$$BD = 20$$

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(i) In right angled $\triangle ABD$

$$5 \sin x = 5 \text{ (perpendicular/hypotenuse)}$$

So we get

$$= 5 (AD/AB)$$

$$= 5 \times 15/25$$

$$= 15/5$$

$$= 3$$

(ii) In right angled $\triangle ABD$

$$7 \tan x = 7 \text{ (perpendicular/base)}$$

So we get

$$= 7 (AD/AB)$$

$$= 7 \times 15/20$$

$$= 7 \times \frac{3}{4}$$

$$= 21/4$$

$$= 5 \frac{1}{4}$$

(iii) In right angled $\triangle ABD$

$$\cos x = \text{base/hypotenuse}$$

So we get

$$\cos x = BD/AB = 20/25 = 4/5$$

In right angled $\triangle ACD$

$$\sin y = \text{perpendicular/hypotenuse}$$

So we get

$$\sin y = CD/AC = 8/17$$

In right angled $\triangle ABD$

$$\tan x = \text{perpendicular/base}$$

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So we get

$$\tan x = AD/BD = 15/20 = \frac{3}{4}$$

$$5 \cos x - 17 \sin y - \tan x = 5 \times \frac{4}{5} - 17 \times \frac{8}{17} - \frac{3}{4}$$

It can be written as

$$= \frac{4}{1} - \frac{8}{1} - \frac{3}{4}$$

Taking LCM

$$= \frac{(16 - 32 - 3)}{4}$$

$$= \frac{(16 - 35)}{4}$$

So we get

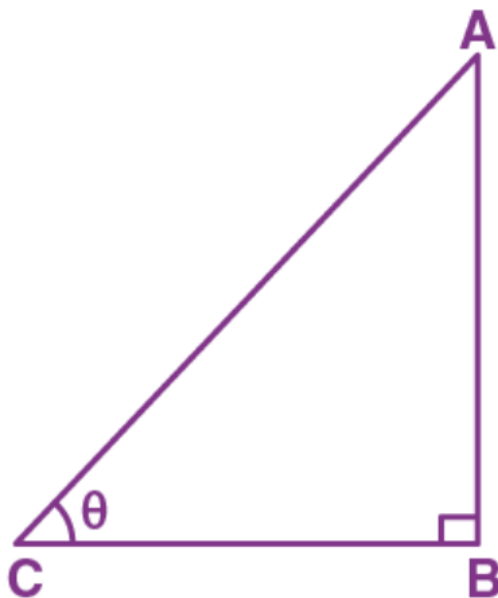
$$= -\frac{19}{4}$$

$$= -4\frac{3}{4}$$

Therefore, $5 \cos x - 17 \sin y - \tan x = -4\frac{3}{4}$.

3. If $q \cos \theta = p$, find $\tan \theta - \cot \theta$ in terms of p and q .

Solution:



Consider ABC as a triangle right angled at B and $\angle ACB = \theta$

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It is given that

$$q \cos \theta = p$$

$$\cos \theta = BC/AC = p/q$$

Take $BC = px$ then $AC = qx$

In right angled $\triangle ABC$

Using Pythagoras theorem

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

It can be written as

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

Substituting the values

$$AB^2 = (qx)^2 - (px)^2$$

$$AB^2 = q^2x^2 - p^2x^2$$

Taking out the common terms

$$AB^2 = (q^2 - p^2)x^2$$

So we get

$$AB = \sqrt{(q^2 - p^2)} x$$

$$AB = (\sqrt{q^2 - p^2})x$$

In right angled $\triangle ABC$

$$\tan \theta = \text{perpendicular/base}$$

So we get

$$\tan \theta = AB/BC = [(\sqrt{q^2 - p^2})x]/px$$

$$\tan \theta = (\sqrt{q^2 - p^2})/p$$

In right angled $\triangle ABC$

$$\cot \theta = \text{base/perpendicular}$$

So we get

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$$\cot \theta = BC/AB = px/[(\sqrt{q^2 - p^2})x]$$

$$\cot [(\sqrt{q^2 - p^2})x] = p/(\sqrt{q^2 - p^2})$$

$$\tan \theta - \cot \theta = \frac{\sqrt{q^2 - p^2}}{p} - \frac{p}{\sqrt{q^2 - p^2}}$$

Taking LCM

$$= \frac{\sqrt{q^2 - p^2}(q^2 - p^2) - p \times p}{p(\sqrt{q^2 - p^2})}$$

So we get

$$\begin{aligned} &= \frac{q^2 - p^2 - p^2}{p(\sqrt{q^2 - p^2})} \\ &= \frac{q^2 - 2p^2}{p\sqrt{q^2 - p^2}} \end{aligned}$$

$$\text{Therefore, } \tan \theta - \cot \theta = \frac{q^2 - 2p^2}{p\sqrt{q^2 - p^2}}.$$

4. Given $4 \sin \theta = 3 \cos \theta$, find the values of:

(i) $\sin \theta$

(ii) $\cos \theta$

(iii) $\cot^2 \theta - \operatorname{cosec}^2 \theta$.

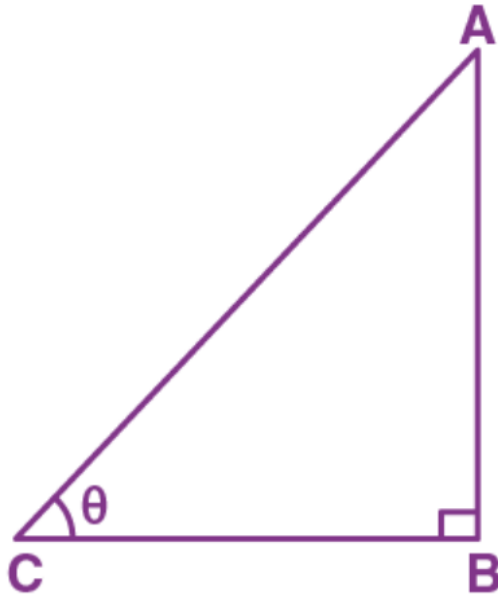
Solution:

It is given that

$$4 \sin \theta = 3 \cos \theta$$

$$\sin \theta / \cos \theta = 3/4$$

$$\tan \theta = 3/4$$



Consider $\triangle ABC$ right angled at B and $\angle ACB = \theta$

$\tan \theta = \text{perpendicular/base}$

Substituting the values

$$\frac{3}{4} = AB/BC$$

$$AB/BC = \frac{3}{4}$$

Take $AB = 3x$ then $BC = 4x$

In right angled $\triangle ABC$

Using Pythagoras theorem

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

Substituting the values

$$AC^2 = (3x)^2 + (4x)^2$$

By further calculation

$$AC^2 = 9x^2 + 16x^2 = 25x^2$$

So we get

$$AC^2 = (5x)^2$$

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$$AC = 5x$$

(i) In right angled $\triangle ABC$

$$\sin \theta = \text{perpendicular/hypotenuse}$$

So we get

$$\sin \theta = AB/AC = 3x/5x = 3/5$$

(ii) In right angled $\triangle ABC$

$$\cos \theta = \text{base/hypotenuse}$$

So we get

$$\cos \theta = BC/AC = 4x/5x = 4/5$$

(iii) In right angled $\triangle ABC$

$$\cot \theta = \text{base/perpendicular}$$

So we get

$$\cot \theta = BC/AB = 4x/3x = 4/3$$

In right angled $\triangle ABC$

$$\operatorname{cosec} \theta = \text{hypotenuse/perpendicular}$$

So we get

$$\operatorname{cosec} \theta = AC/AB = 5x/3x = 5/3$$

Here

$$\cot^2 \theta - \operatorname{cosec}^2 \theta = (4/3)^2 - (5/3)^2$$

By further calculation

$$= 16/9 - 25/9$$

$$= (16 - 25)/9$$

$$= -9/9$$

$$= -1$$

Therefore, $\cot^2 \theta - \operatorname{cosec}^2 \theta = -1$.

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5. If $2 \cos \theta = \sqrt{3}$, prove that $3 \sin \theta - 4 \sin^3 \theta = 1$.

Solution:

It is given that

$$2 \cos \theta = \sqrt{3}$$

$$\cos \theta = \sqrt{3}/2$$

We know that

$$\sin^2 \theta = 1 - \cos^2 \theta$$

Substituting the values

$$= 1 - (\sqrt{3}/2)^2$$

$$= 1 - 3/4$$

$$= 1/4$$

$$\sin \theta = \sqrt{1/4} = 1/2$$

Consider

$$\text{LHS} = 3 \sin \theta - 4 \sin^3 \theta$$

It can be written as

$$= \sin \theta (3 - 4 \sin^2 \theta)$$

Substituting the values

$$= 1/2 (3 - 4 \times 1/4)$$

$$= 1/2 (3 - 1)$$

$$= 1/2 \times 2$$

$$= 1$$

$$= \text{RHS}$$

Therefore, proved.

6. If $(\sec \theta - \tan \theta) / (\sec \theta + \tan \theta) = 1/4$, find $\sin \theta$.

Solution:

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We know that

$$\frac{\sec\theta - \tan\theta}{\sec\theta + \tan\theta} = \frac{\frac{1}{\cos\theta} - \frac{\sin\theta}{\cos\theta}}{\frac{1}{\cos\theta} + \frac{\sin\theta}{\cos\theta}}$$

Taking LCM

$$= \frac{\frac{1 - \sin\theta}{\cos\theta}}{\frac{1 + \sin\theta}{\cos\theta}}$$

So we get

$$= \frac{1 - \sin\theta}{\cos\theta} \times \frac{\cos\theta}{1 + \sin\theta}$$
$$= \frac{1 - \sin\theta}{1 + \sin\theta}$$

Here

$$\frac{1 - \sin\theta}{1 + \sin\theta} = \frac{1}{4}$$

By cross multiplication

$$4 - 4 \sin \theta = 1 + \sin \theta$$

We get

$$4 - 1 = \sin \theta + 4 \sin \theta$$

$$3 = 5 \sin \theta$$

$$\sin \theta = 3/5$$

7. If $\sin \theta + \operatorname{cosec} \theta = 3 \frac{1}{3}$, find the value of $\sin^2 \theta + \operatorname{cosec}^2 \theta$.

Solution:

It is given that

$$\sin \theta + \operatorname{cosec} \theta = 3 \frac{1}{3} = 10/3$$

By squaring on both sides

$$(\sin \theta + \operatorname{cosec} \theta)^2 = (10/3)^2$$

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Expanding using formula $(a + b)^2 = a^2 + b^2 + 2ab$

$$\sin^2 \theta + \operatorname{cosec}^2 \theta + 2 \sin \theta \operatorname{cosec} \theta = 100/9$$

We know that $\sin \theta = 1/\operatorname{cosec} \theta$

$$\sin^2 \theta + \operatorname{cosec}^2 \theta + 2 \sin \theta \times 1/\sin \theta = 100/9$$

By further calculation

$$\sin^2 \theta + \operatorname{cosec}^2 \theta + 2 = 100/9$$

$$\sin^2 \theta + \operatorname{cosec}^2 \theta = 100/9 - 2$$

Taking LCM

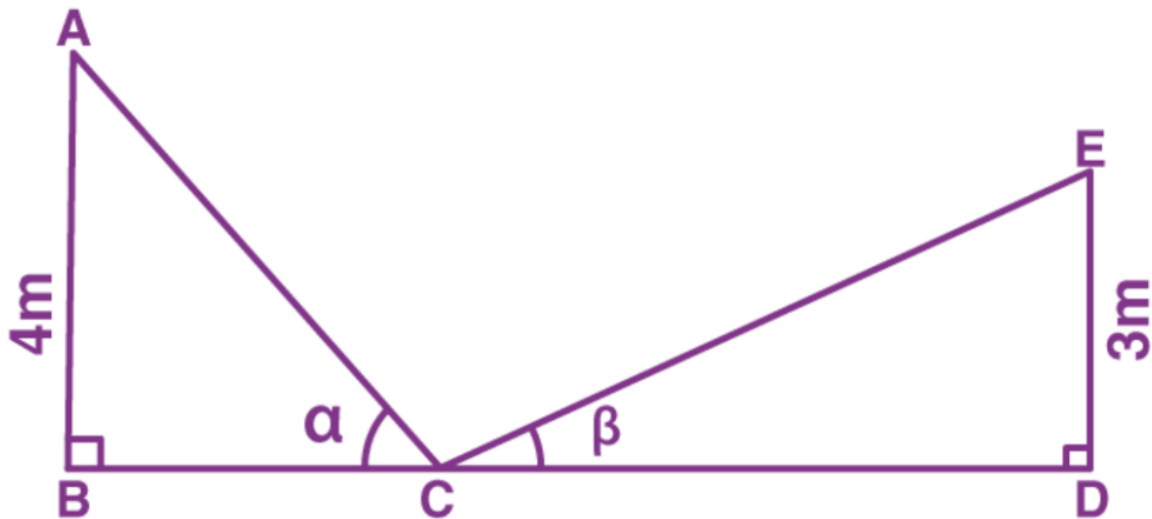
$$\sin^2 \theta + \operatorname{cosec}^2 \theta = (100 - 18)/9 = 82/9$$

So we get

$$\sin^2 \theta + \operatorname{cosec}^2 \theta = 9 \frac{1}{9}$$

8. In the adjoining figure, $AB = 4$ m and $ED = 3$ m.

If $\sin \alpha = 3/5$ and $\cos \beta = 12/13$, find the length of BD .



Solution:

It is given that

$$\sin \alpha = AB/AC = 3/5$$

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$$AB = 3 \text{ and } AC = 5$$

Using Pythagoras theorem

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

Substituting the values

$$5^2 = 3^2 + BC^2$$

By further calculation

$$25 = 9 + BC^2$$

$$BC^2 = 25 - 9 = 16$$

So we get

$$BC^2 = 4^2$$

$$BC = 4$$

We know that

$$\tan \alpha = AB/BC = 4/5$$

$$\cos \beta = CD/CE = 12/13$$

$$CD = 12 \text{ and } CE = 13$$

Using Pythagoras theorem

$$CE^2 = CD^2 + ED^2$$

Substituting the values

$$13^2 = 12^2 + ED^2$$

By further calculation

$$ED^2 = 13^2 - 12^2$$

$$ED^2 = 169 - 144 = 25$$

So we get

$$ED^2 = (5)^2$$

$$ED = 5$$

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$$\tan \beta = ED/CD = 5/12$$

From the figure

$$\tan \alpha = AB/BC = 4/BC$$

So we get

$$\frac{3}{4} = 4/BC$$

$$BC = (4 \times 4)/3 = 16/3 \text{ m}$$

$$\tan \beta = ED/CD = 3/CD$$

$$5/12 = 3/CD$$

So we get

$$CD = (12 \times 3)/5 = 36/5 \text{ m}$$

Here

$$BD = BC + CD$$

Substituting the values

$$= 16/3 + 36/5$$

Taking LCM

$$= (80 + 108)/15$$

$$= 188/15 \text{ m}$$

$$= 12 \frac{8}{15} \text{ m}$$



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About ML Aggarwal

M. L. Aggarwal, is an Indian mechanical engineer, educator. His achievements include research in solutions of industrial problems related to fatigue design. Recipient Best Paper award, Manipal Institute of Technology, 2004. Member of TSTE.

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