

ML Aggarwal Solutions for Class 9 Maths
Chapter 18: Trigonometric Ratios and Standard Angles

EXERCISE 18.1

1. Find the values of

(i) $7 \sin 30^\circ \cos 60^\circ$

(ii) $3 \sin^2 45^\circ + 2 \cos^2 60^\circ$

(iii) $\cos^2 45^\circ + \sin^2 60^\circ + \sin^2 30^\circ$

(iv) $\cos 90^\circ + \cos^2 45^\circ \sin 30^\circ \tan 45^\circ$.

Solution:

(i) $7 \sin 30^\circ \cos 60^\circ$

Substituting the values

$$= 7 \times \frac{1}{2} \times \frac{1}{2}$$

$$= (7 \times 1 \times 1)/(2 \times 2)$$

$$= 7/4$$

(ii) $3 \sin^2 45^\circ + 2 \cos^2 60^\circ$

Substituting the values

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

By further calculation

$$= 3 \times \frac{1}{2} + 2 \times \frac{1}{4}$$

$$= 3/2 + \frac{1}{2}$$

So we get

$$= (3 + 1)/2$$

$$= 4/2$$

$$= 2$$

(iii) $\cos^2 45^\circ + \sin^2 60^\circ + \sin^2 30^\circ$

Substituting the values

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

By further calculation

$$= \frac{1}{2} + \frac{3}{4} + \frac{1}{4}$$

Taking LCM

$$= (2 + 3 + 1)/4$$

$$= 6/4$$

$$= 3/2$$

(iv) $\cos 90^\circ + \cos^2 45^\circ \sin 30^\circ \tan 45^\circ$

Substituting the values

$$= 0 + (1/\sqrt{2})^2 \times \frac{1}{2} \times 1$$

By further calculation

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

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

2. Find the values of



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$$(i) \frac{\sin^2 45^\circ + \cos^2 45^\circ}{\tan^2 60^\circ}$$

$$(ii) \frac{\sin 30^\circ - \sin 90^\circ + 2\cos 0^\circ}{\tan 30^\circ \times \tan 60^\circ}$$

$$(iii) \frac{4}{3}\tan^2 30^\circ + \sin^2 60^\circ - 3\cos^2 60^\circ + \frac{3}{4}\tan^2 60^\circ - 2\tan^2 45^\circ.$$

Solution:

$$(i) \frac{\sin^2 45^\circ + \cos^2 45^\circ}{\tan^2 60^\circ}$$

Substituting the values

$$= \frac{\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2}{\sqrt{3}^2}$$

By further calculation

$$= \frac{\frac{1}{2} + \frac{1}{2}}{3}$$

$$= \frac{1}{3}$$



$$(ii) \frac{\sin 30^\circ - \sin 90^\circ + 2\cos 0^\circ}{\tan 30^\circ \times \tan 60^\circ}$$

Substituting the values

$$= \frac{\frac{1}{2} - 1 + 2 \times 1}{\frac{1}{\sqrt{3}} \times \sqrt{3}}$$

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

So we get

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

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

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

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

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(iii) $4/3 \tan^2 30^\circ + \sin^2 60^\circ - 3 \cos^2 60^\circ + 3/4 \tan^2 60^\circ - 2 \tan^2 45^\circ$

Substituting the values

$$= 4/3 (1/\sqrt{3})^2 + (\sqrt{3}/2)^2 - 3 (1/2)^2 + 3/4 \times (\sqrt{3})^2 - 2 \times 1^2$$

By further calculation

$$= 4/3 \times 1/3 + 3/4 - 3 \times 1/4 + 3/4 \times 3 - 2 \times 1$$

$$= 4/9 + 3/4 - 3/4 + 9/4 - 2$$

So we get

$$= 4/9 + 9/4 - 2$$

Taking LCM

$$= (16 + 81 - 72)/36$$

$$= (97 - 72)/36$$

$$= 25/36$$

3. Find the values of

(i) $\frac{\sin 60^\circ}{\cos^2 45^\circ} - 3 \tan 30^\circ + 5 \cos 90^\circ$

(ii) $2\sqrt{2} \cos 45^\circ \cos 60^\circ + 2\sqrt{3} \sin 30^\circ \tan 60^\circ - \cos 0^\circ$

(iii) $\frac{4}{5} \tan^2 60^\circ - \frac{2}{\sin^2 30^\circ} - \frac{3}{4} \tan^2 30^\circ$.

Solution:

(i) $\frac{\sin 60^\circ}{\cos^2 45^\circ} - 3 \tan 30^\circ + 5 \cos 90^\circ$

Substituting the values

$$= \frac{(\frac{\sqrt{3}}{2})}{(\frac{1}{\sqrt{2}})^2} - 3 \times \frac{1}{\sqrt{3}} + 5 \times 0$$

$$= \frac{\sqrt{3}}{\frac{1}{2}} - \sqrt{3} - 0$$

So we get

$$= \frac{\sqrt{3}}{2} \times \frac{2}{1} - \sqrt{3}$$

$$= \sqrt{3} - \sqrt{3}$$

$$= 0$$

(ii) $2\sqrt{2} \cos 45^\circ \cos 60^\circ + 2\sqrt{3} \sin 30^\circ \tan 60^\circ - \cos 0^\circ$

Substituting the values

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$$= 2\sqrt{2} \times 1/\sqrt{2} \times 1/2 + 2\sqrt{3} \times 1/2 \times \sqrt{3} - 1$$

By further calculation

$$= 2 \times 1/1 \times 1/2 + 2 \times 3 \times 1/2 - 1$$

$$= 1 + 3 - 1$$

$$= 3$$

$$(iii) \frac{4}{5} \tan^2 60^\circ + \frac{2}{\sin^2 30^\circ} - \frac{3}{4} \tan^2 30^\circ$$

Substituting the values

$$= \frac{4}{5} \times (\sqrt{3})^2 - \frac{2}{(\frac{1}{2})^2} - \frac{3}{4} \left(\frac{1}{\sqrt{3}}\right)^2$$

By further calculation

$$= \frac{4}{5} \times 3 - \frac{2}{\frac{1}{4}} - \frac{3}{4} \times \frac{1}{3}$$

So we get

$$= \frac{12}{5} - \frac{2 \times 4}{1} - \frac{1}{4}$$

$$= \frac{12}{5} - \frac{8}{1} - \frac{1}{4}$$



Taking LCM

$$= \frac{48 - 160 - 5}{20}$$

$$= \frac{43 - 160}{20}$$

$$= \frac{-117}{20}$$

$$= -5\frac{17}{20}$$

4. Prove that

(i) $\cos^2 30^\circ + \sin 30^\circ + \tan^2 45^\circ = 2\frac{1}{4}$

(ii) $4(\sin^4 30^\circ + \cos^4 60^\circ) - 3(\cos^2 45^\circ - \sin^2 90^\circ) = 2$

(iii) $\cos 60^\circ = \cos^2 30^\circ - \sin^2 30^\circ$.

Solution:

(i) $\cos^2 30^\circ + \sin 30^\circ + \tan^2 45^\circ = 2\frac{1}{4}$

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Consider

$$\text{LHS} = \cos^2 30^\circ + \sin 30^\circ + \tan^2 45^\circ$$

Substituting the values

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

By further calculation

$$= \frac{3}{4} + \frac{1}{2} + 1$$

Taking LCM

$$= (3 + 2 + 4)/4$$

$$= 9/4$$

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

$$= \text{RHS}$$

Therefore, LHS = RHS.

$$\text{(ii) } 4(\sin^4 30^\circ + \cos^4 60^\circ) - 3(\cos^2 45^\circ - \sin^2 90^\circ) = 2$$

Consider

$$\text{LHS} = 4(\sin^4 30^\circ + \cos^4 60^\circ) - 3(\cos^2 45^\circ - \sin^2 90^\circ)$$

Substituting the values

$$= 4[(\frac{1}{2})^4 + (\frac{1}{2})^4] - 3[(\frac{1}{\sqrt{2}})^2 - 1^2]$$

It can be written as

$$= 4[\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} + \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}] - 3[\frac{1}{2} - 1]$$

By further calculation

$$= 4[1/16 + 1/16] - 3(-\frac{1}{2})$$

$$= 4[(1 + 1)/16] + 3/2$$

So we get

$$= (4 \times 3)/16 + 3/2$$

$$= 8/16 + 3/2$$

$$= \frac{1}{2} + \frac{3}{2}$$

$$= (1 + 3)/2$$

$$= 4/2$$

$$= 2$$

$$= \text{RHS}$$

Therefore, LHS = RHS.

$$\text{(iii) } \cos 60^\circ = \cos^2 30^\circ - \sin^2 30^\circ$$

Consider

$$\text{LHS} = \cos 60^\circ = \frac{1}{2}$$

$$\text{RHS} = \cos^2 30^\circ - \sin^2 30^\circ$$

Substituting the values

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

By further calculation

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

$$= (3 - 1)/4$$

$$= 2/4$$

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

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= RHS

Therefore, LHS = RHS.

5. (i) If $x = 30^\circ$, verify that $\tan 2x = \frac{2\tan x}{1 - \tan^2 x}$.

(ii) If $x = 15^\circ$, verify that $4 \sin 2x \cos 4x \sin 6x = 1$.

Solution:

(i) It is given that

$$x = 30^\circ$$

Consider LHS = $\tan 2x$

Substituting the value of x

$$= \tan 60^\circ$$

$$= \sqrt{3}$$

$$RHS = \frac{2\tan x}{1 - \tan^2 x}$$

Substituting the value of x

$$= \frac{2\tan 30^\circ}{1 - \tan^2 30^\circ}$$

By further calculation

$$= \frac{2 \times \frac{1}{\sqrt{3}}}{1 - \left(\frac{1}{\sqrt{3}}\right)^2}$$

So we get

$$= \frac{\frac{2}{\sqrt{3}}}{1 - \frac{1}{3}}$$

$$= \frac{\frac{2}{\sqrt{3}}}{\frac{3-1}{3}}$$

$$= \frac{2}{\sqrt{3}} \times \frac{3}{2}$$

$$= \frac{3}{\sqrt{3}}$$

$$= \sqrt{3}$$

Therefore, LHS = RHS.



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(ii) It is given that

$$x = 15^{\circ}$$

$$2x = 15 \times 2 = 30^{\circ}$$

$$4x = 15 \times 4 = 60^{\circ}$$

$$6x = 15 \times 6 = 90^{\circ}$$

Here

$$\text{LHS} = 4 \sin 2x \cos 4x \sin 6x$$

It can be written as

$$= 4 \sin 30^{\circ} \cos 60^{\circ} \sin 90^{\circ}$$

So we get

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

$$= 1$$

$$= \text{RHS}$$

Therefore, LHS = RHS.

6. Find the values of

$$(i) \sqrt{\frac{1 - \cos^2 30^{\circ}}{1 - \sin^2 30^{\circ}}}$$

$$(ii) \frac{\sin 45^{\circ} \cos 45^{\circ} \cos 60^{\circ}}{\sin 60^{\circ} \cos 30^{\circ} \tan 45^{\circ}}$$

Solution:

$$(i) \sqrt{\frac{1 - \cos^2 30^{\circ}}{1 - \sin^2 30^{\circ}}}$$

Substituting the values

$$= \sqrt{\frac{1 - \left(\frac{\sqrt{3}}{2}\right)^2}{1 - \left(\frac{1}{2}\right)^2}}$$

By further calculation

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

Taking LCM

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



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$$= \sqrt{\frac{\frac{1}{4}}{\frac{3}{4}}}$$
$$= \sqrt{\frac{1}{4} \times \frac{4}{3}}$$

So we get

$$= \sqrt{\frac{1}{3}}$$
$$= \frac{1}{\sqrt{3}}$$

$$(ii) \frac{\sin 45^\circ \cos 45^\circ \cos 60^\circ}{\sin 60^\circ \cos 30^\circ \tan 45^\circ}$$

Substituting the values

$$= \frac{\frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}} \times \frac{1}{2}}{\frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2} \times 1}$$

By further calculation

$$= \frac{\frac{1}{2} \times \frac{1}{2}}{\frac{3}{4} \times 1}$$
$$= \frac{\frac{1}{4}}{\frac{3}{4}}$$
$$= \frac{1}{3}$$

7. If $\theta = 30^\circ$, verify that

(i) $\sin 2\theta = 2 \sin \theta \cos \theta$

(ii) $\cos 2\theta = 2 \cos^2 \theta - 1$

(iii) $\sin 3\theta = 3 \sin \theta - 4 \sin^3 \theta$

(iv) $\cos 3\theta = 4 \cos^3 \theta - 3 \cos \theta$.

Solution:

It is given that $\theta = 30^\circ$

(i) $\sin 2\theta = 2 \sin \theta \cos \theta$

Consider

LHS = $\sin 2\theta$



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Substituting the value of θ

$$\begin{aligned} &= \sin 2 \times 30^\circ \\ &= \sin 60^\circ \\ &= \sqrt{3}/2 \end{aligned}$$

RHS = $2 \sin \theta \cos \theta$

Substituting the value of θ

$$\begin{aligned} &= 2 \sin 30^\circ \cos 30^\circ \\ \text{So we get} \\ &= 2 \times \frac{1}{2} \times \frac{\sqrt{3}}{2} \\ &= 1 \times \frac{\sqrt{3}}{2} \\ &= \frac{\sqrt{3}}{2} \end{aligned}$$

Therefore, LHS = RHS.

(ii) $\cos 2\theta = 2 \cos^2 \theta - 1$

Consider

LHS = $\cos 2\theta$

Substituting the value of θ

$$\begin{aligned} &= \cos 2 \times 30^\circ \\ &= \cos 60^\circ \\ &= \frac{1}{2} \end{aligned}$$

RHS = $2 \cos^2 \theta - 1$

Substituting the value of θ

$$\begin{aligned} &= 2 \cos^2 30^\circ - 1 \\ \text{So we get} \\ &= 2 \left(\frac{\sqrt{3}}{2}\right)^2 - 1 \\ &= 2 \times \frac{3}{4} - 1 \\ &= \frac{3}{2} - 1 \\ &= \frac{(3 - 2)}{2} \\ &= \frac{1}{2} \end{aligned}$$

Therefore, LHS = RHS.

(iii) $\sin 3\theta = 3 \sin \theta - 4 \sin^3 \theta$

Consider

LHS = $\sin 3\theta$

Substituting the value of θ

$$\begin{aligned} &= \sin 3 \times 30^\circ \\ &= \sin 90^\circ \\ &= 1 \end{aligned}$$

RHS = $3 \sin \theta - 4 \sin^3 \theta$

Substituting the value of θ

$$\begin{aligned} &= 3 \sin 30^\circ - 4 \sin^3 30^\circ \end{aligned}$$



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So we get

$$= 3 \times \frac{1}{2} - 4 \times \left(\frac{1}{2}\right)^3$$

$$= \frac{3}{2} - 4 \times \frac{1}{8}$$

$$= \frac{3}{2} - \frac{1}{2}$$

Taking LCM

$$= \frac{(3 - 1)}{2}$$

$$= \frac{2}{2}$$

$$= 1$$

Therefore, LHS = RHS.

$$(iv) \cos 3\theta = 4 \cos^3 \theta - 3 \cos \theta$$

Consider

$$\text{LHS} = \cos 3\theta$$

Substituting the value of θ

$$= \cos 3 \times 30^\circ$$

$$= \cos 90^\circ$$

$$= 0$$

$$\text{RHS} = 4 \cos^3 \theta - 3 \cos \theta$$

Substituting the value of θ

$$= 4 \cos^3 30^\circ - 3 \cos 30^\circ$$

So we get

$$= 4 \times \left(\frac{\sqrt{3}}{2}\right)^3 - 3 \times \left(\frac{\sqrt{3}}{2}\right)$$

By further calculation

$$= 4 \times \frac{3\sqrt{3}}{8} - 3\frac{\sqrt{3}}{2}$$

$$= 3\frac{\sqrt{3}}{2} - 3\frac{\sqrt{3}}{2}$$

$$= 0$$

Therefore, LHS = RHS.

8. If $\theta = 30^\circ$, find the ratio $2 \sin \theta : \sin 2\theta$.

Solution:

It is given that $\theta = 30^\circ$

We know that

$$2 \sin \theta : \sin 2\theta = 2 \sin 30^\circ : \sin 2 \times 30^\circ$$

So we get

$$= 2 \sin 30^\circ : \sin 60^\circ$$

$$= 2 \sin 30^\circ / \sin 60^\circ$$

Substituting the values



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$$= \frac{2 \times \frac{1}{2}}{\frac{\sqrt{3}}{2}}$$

By further simplification

$$\begin{aligned} &= \frac{1}{\frac{\sqrt{3}}{2}} \\ &= \frac{1 \times 2}{\sqrt{3}} \\ &= \frac{2}{\sqrt{3}} \\ &= 2 : \sqrt{3} \end{aligned}$$

Therefore, $2 \sin \theta : \sin 2\theta = 2 : \sqrt{3}$.

9. By means of an example, show that $\sin(A + B) \neq \sin A + \sin B$.

Solution:

Consider $A = 30^\circ$ and $B = 60^\circ$

LHS = $\sin(A + B)$

Substituting the values of A and B

$$= \sin(30^\circ + 60^\circ)$$

$$= \sin 90^\circ$$

$$= 1$$

RHS = $\sin A + \sin B$

Substituting the values

$$= \sin 30^\circ + \sin 60^\circ$$

So we get

$$= \frac{1}{2} + \frac{\sqrt{3}}{2}$$

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

Therefore, LHS \neq RHS i.e. $\sin(A + B) \neq \sin A + \sin B$.

10. If $A = 60^\circ$ and $B = 30^\circ$, verify that

(i) $\sin(A + B) = \sin A \cos B + \cos A \sin B$

(ii) $\cos(A + B) = \cos A \cos B - \sin A \sin B$

(iii) $\sin(A - B) = \sin A \cos B - \cos A \sin B$

(iv) $\tan(A - B) = \frac{\tan A - \tan B}{1 + \tan A \tan B}$.

Solution:

It is given that $A = 60^\circ$ and $B = 30^\circ$

(i) $\sin(A + B) = \sin A \cos B + \cos A \sin B$

Here

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$$\text{LHS} = \sin (A + B)$$

Substituting the values of A and B

$$= \sin (60^{\circ} + 30^{\circ})$$

$$= \sin 90^{\circ}$$

$$= 1$$

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

Substituting the values of A and B

$$= \sin 60^{\circ} \cos 30^{\circ} + \cos 60^{\circ} \sin 30^{\circ}$$

So we get

$$= \frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2} + \frac{1}{2} \times \frac{1}{2}$$

By further calculation

$$= \frac{3}{4} + \frac{1}{4}$$

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

$$= 1$$

Therefore, LHS = RHS.

$$\text{(ii) } \cos (A + B) = \cos A \cos B - \sin A \sin B$$

Here

$$\text{LHS} = \cos (A + B)$$

Substituting the value of A and B

$$= \cos (60^{\circ} + 30^{\circ})$$

$$= \cos 90^{\circ}$$

$$= 0$$

$$\text{RHS} = \cos A \cos B - \sin A \sin B$$

Substituting the value of A and B

$$= \cos 60^{\circ} \cos 30^{\circ} - \sin 60^{\circ} \sin 30^{\circ}$$

So we get

$$= \frac{1}{2} \times \frac{\sqrt{3}}{2} - \frac{\sqrt{3}}{2} \times \frac{1}{2}$$

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

$$= 0$$

Therefore, LHS = RHS.

$$\text{(iii) } \sin (A - B) = \sin A \cos B - \cos A \sin B$$

Here

$$\text{LHS} = \sin (A - B)$$

Substituting the values of A and B

$$= \sin (60^{\circ} - 30^{\circ})$$

$$= \sin 30^{\circ}$$

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

$$\text{RHS} = \sin A \cos B - \cos A \sin B$$

Substituting the values of A and B



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$$= \sin 60^\circ \cos 30^\circ - \cos 60^\circ \sin 30^\circ$$

So we get

$$= \sqrt{3}/2 \times \sqrt{3}/2 - 1/2 \times 1/2$$

$$= 3/4 - 1/4$$

$$= (3 - 1)/4$$

$$= 2/4$$

$$= 1/2$$

Therefore, LHS = RHS.

$$(iv) \tan(A - B) = (\tan A - \tan B) / (1 + \tan A \tan B)$$

Here

$$\text{LHS} = \tan(A - B)$$

Substituting the values of A and B

$$= \tan(60^\circ - 30^\circ)$$

$$= \tan 30^\circ$$

$$= 1/\sqrt{3}$$

$$\text{RHS} = (\tan A - \tan B) / (1 + \tan A \tan B)$$

Substituting the values of A and B

$$= (\tan 60^\circ - \tan 30^\circ) / (1 + \tan 60^\circ \tan 30^\circ)$$

So we get

$$= \frac{\sqrt{3} - \frac{1}{\sqrt{3}}}{1 + \sqrt{3} \times \frac{1}{\sqrt{3}}}$$



By further simplification

$$= \frac{3 - 1}{\frac{\sqrt{3}}{1+1}}$$

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

We get

$$= 2/\sqrt{3} \times 1/2$$

$$= 1/\sqrt{3}$$

Therefore, LHS = RHS.

11. (i) If 2θ is an acute angle and $2 \sin 2\theta = \sqrt{3}$, find the value of θ .

(ii) If $20^\circ + x$ is an acute angle and $\cos(20^\circ + x) = \sin 60^\circ$, then find the value of x .

(iii) If $3 \sin^2 \theta = 2 \frac{1}{4}$ and θ is less than 90° , find the value of θ .

Solution:

(i) It is given that

2θ is an acute angle

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$$2 \sin 2\theta = \sqrt{3}$$

It can be written as

$$\sin 2\theta = \sqrt{3}/2 = \sin 60^\circ$$

By comparing

$$2\theta = 60^\circ$$

So we get

$$\theta = 60^\circ/2 = 30^\circ$$

Therefore, $\theta = 30^\circ$.

(ii) It is given that

$20^\circ + x$ is an acute angle

$$\cos (20^\circ + x) = \sin 60^\circ$$

It can be written as

$$\cos (20^\circ + x) = \sin 60^\circ = \cos (90^\circ - 60^\circ)$$

$$= \cos 30^\circ$$

By comparing

$$20^\circ + x = 30^\circ$$

$$x = 30^\circ - 20^\circ = 10^\circ$$

Therefore, $x = 10^\circ$.

(iii) It is given that

$$3 \sin^2 \theta = 2 \frac{1}{4}$$

θ is less than 90°

We can write it as

$$\sin^2 \theta = 9/(4 \times 3) = \frac{3}{4}$$

So we get

$$\sin \theta = \sqrt{3}/2 = \sin 60^\circ$$

By comparing

$$\theta = 60^\circ$$

Therefore, $\theta = 60^\circ$.



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

Solution:

It is given that

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

We can write it as

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

$$\tan \theta = 1$$

We know that $\tan 45^\circ = 1$

$$\tan \theta = \tan 45^\circ$$

So we get

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$$\theta = 45^\circ$$

We know that

$$2 \tan^2 \theta + \sin^2 \theta - 1 = 2 \tan^2 45^\circ + \sin^2 45^\circ - 1$$

Substituting the values

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

By further calculation

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

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

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

Taking LCM

$$= \frac{(5 - 2)}{2}$$

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

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

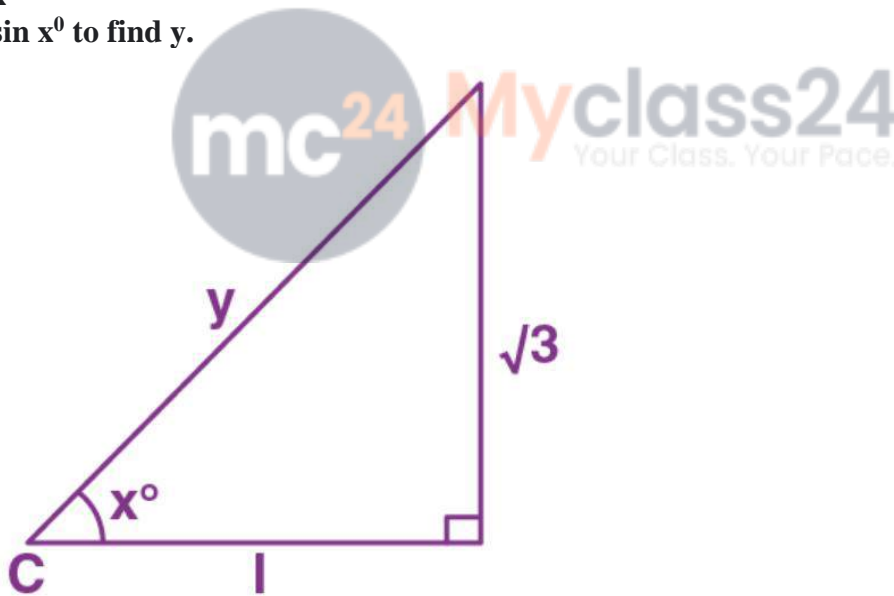
13. From the adjoining figure, find

(i) $\tan x^\circ$

(ii) x

(iii) $\cos x^\circ$

(iv) use $\sin x^\circ$ to find y .



Solution:

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

It can be written as

$$= \frac{AB}{BC}$$

$$= \frac{\sqrt{3}}{1}$$

$$= \sqrt{3}$$

(ii) $\tan x^\circ = \sqrt{3}$

We know that $\tan 60^\circ = \sqrt{3}$

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$$\tan x^\circ = \tan 60^\circ$$
$$x = 60$$

(iii) We know that

$$\cos x^\circ = \cos 60^\circ$$

So we get

$$\cos x^\circ = \frac{1}{2}$$

(iv) $\sin x^\circ = \frac{\text{perpendicular}}{\text{hypotenuse}} = \frac{AB}{AC}$

Substitute $x = 60$ from (ii)

$$\sin 60^\circ = \frac{\sqrt{3}}{y}$$

We know that $\sin 60^\circ = \frac{\sqrt{3}}{2}$

$$\frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{y}$$

By further calculation

$$y = \frac{(\sqrt{3} \times 2)}{\sqrt{3}}$$

$$y = \frac{(2 \times 1)}{1} = 2$$

Therefore, $y = 2$.

14. If 3θ is an acute angle, solve the following equations for θ :

(i) $2 \sin 3\theta = \sqrt{3}$

(ii) $\tan 3\theta = 1$.

Solution:

(i) $2 \sin 3\theta = \sqrt{3}$

It can be written as

$$\sin 3\theta = \frac{\sqrt{3}}{2}$$

We know that $\sin 60^\circ = \frac{\sqrt{3}}{2}$

$$\sin 3\theta = \sin 60^\circ$$

$$3\theta = 60^\circ$$

So we get

$$\theta = \frac{60}{3} = 20^\circ$$

(ii) $\tan 3\theta = 1$

We know that $\tan 45^\circ = 1$

$$\tan 3\theta = \tan 45^\circ$$

So we get

$$3\theta = 45^\circ$$

$$\theta = 15^\circ$$

15. If $\tan 3x = \sin 45^\circ \cos 45^\circ + \sin 30^\circ$, find the value of x .

Solution:

We know that

$$\tan 3x = \sin 45^\circ \cos 45^\circ + \sin 30^\circ$$

Substituting the values



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$$\begin{aligned} &= 1/\sqrt{2} \times 1/\sqrt{2} + 1/2 \\ &= 1/2 + 1/2 \\ &= 1 \end{aligned}$$

We know that
 $\tan 3x = \tan 45^\circ$
By comparing
 $3x = 45^\circ$
 $x = 45/3 = 15^\circ$

Therefore, the value of x is 15° .

16. If $4 \cos^2 x^\circ - 1 = 0$ and $0 \leq x \leq 90$, find

- (i) x
(ii) $\sin^2 x^\circ + \cos^2 x^\circ$
(iii) $\cos^2 x^\circ - \sin^2 x^\circ$.

Solution:

It is given that
 $4 \cos^2 x^\circ - 1 = 0$
 $4 \cos^2 x^\circ = 1$

It can be written as

$$\begin{aligned} \cos^2 x^\circ &= 1/4 \\ \cos x^\circ &= \pm \sqrt{1/4} \\ \cos x^\circ &= + \sqrt{1/4} \quad [0 \leq x \leq 90^\circ, \text{ then } \cos x^\circ \text{ is positive}] \\ \cos x^\circ &= 1/2 \end{aligned}$$

We know that $\cos 60^\circ = 1/2$

$$\cos x^\circ = \cos 60^\circ$$

By comparing

$$x = 60$$

$$(ii) \sin^2 x^\circ + \cos^2 x^\circ = \sin^2 60^\circ + \cos^2 60^\circ$$

Substituting the values

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

By further calculation

$$\begin{aligned} &= 3/4 + 1/4 \\ &= (3 + 1)/4 \\ &= 4/4 \\ &= 1 \end{aligned}$$

Therefore, $\sin^2 x^\circ + \cos^2 x^\circ = 1$.

$$(iii) \cos^2 x^\circ - \sin^2 x^\circ = \cos^2 60^\circ - \sin^2 60^\circ$$

Substituting the values

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

By further calculation

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$$\begin{aligned} &= \frac{1}{4} - \frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2} \\ &= \frac{1}{4} - \frac{3}{4} \\ &= \frac{(1 - 3)}{4} \\ &= \frac{-2}{4} \\ &= -\frac{1}{2} \end{aligned}$$

Therefore, $\cos^2 x^\circ - \sin^2 x^\circ = -\frac{1}{2}$.

17. (i) If $\sec \theta = \operatorname{cosec} \theta$ and $0^\circ \leq \theta \leq 90^\circ$, find the value of θ .

(ii) If $\tan \theta = \cot \theta$ and $0^\circ \leq \theta \leq 90^\circ$, find the value of θ

Solution:

(i) It is given that

$$\sec \theta = \operatorname{cosec} \theta$$

We know that

$$\sec \theta = \frac{1}{\cos \theta}$$

$$\operatorname{cosec} \theta = \frac{1}{\sin \theta}$$

So we get

$$\frac{1}{\cos \theta} = \frac{1}{\sin \theta}$$

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

$$\tan \theta = 1$$

$$\text{Here } \tan 45^\circ = 1$$

$$\tan \theta = \tan 45^\circ$$

$$\theta = 45^\circ$$



(ii) It is given that

$$\tan \theta = \cot \theta$$

We know that $\cot \theta = 1/\tan \theta$

$$\tan \theta = 1/\tan \theta$$

So we get

$$\tan^2 \theta = 1$$

$$\tan \theta = \pm \sqrt{1}$$

$$\tan \theta = +1 \quad [0^\circ \leq \theta \leq 90^\circ, \tan \theta \text{ is positive}]$$

$$\tan \theta = \tan 45^\circ$$

By comparing

$$\theta = 45^\circ$$

18. If $\sin 3x = 1$ and $0^\circ \leq 3x \leq 90^\circ$, find the values of

(i) $\sin x$

(ii) $\cos 2x$

(iii) $\tan^2 x - \sec^2 x$.

Solution:

It is given that

$$\sin 3x = 1$$

We know that $\sin 90^\circ = 1$

$$\sin 3x = \sin 90^\circ$$

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By comparing

$$3x = 90$$

$$x = 90/3$$

$$x = 30^0$$

$$(i) \sin x = \sin 30^0 = 1/2$$

$$(ii) \cos 2x = \cos 2 \times 30 = \cos 60^0 = 1/2$$

$$(iii) \tan^2 x - \sec^2 x = \tan^2 30^0 - \sec^2 30^0$$

Substituting the values

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

By further calculation

$$= 1/3 - 4/3$$

$$= (1 - 4)/3$$

$$= - 3/3$$

$$= -1$$

Therefore, $\tan^2 x - \sec^2 x = - 1$.

19. If $3 \tan^2 \theta - 1 = 0$, find $\cos 2\theta$, given that θ is acute.

Solution:

It is given that

$$3 \tan^2 \theta - 1 = 0$$

We can write it as

$$3 \tan^2 \theta = 1$$

$$\tan^2 \theta = 1/3$$

$$\tan \theta = 1/\sqrt{3} \text{ } [\theta \text{ is acute so } \tan \theta \text{ is positive}]$$

$$\theta = 30^0$$

So we get

$$\cos 2\theta = \cos 2 \times 30^0 = \cos 60^0 = 1/2$$

20. If $\sin x + \cos y = 1$, $x = 30^0$ and y is acute angle, find the value of y .

Solution:

It is given that

$$\sin x + \cos y = 1$$

$$x = 30^0$$

Substituting the values

$$\sin 30^0 + \cos y = 1$$

$$1/2 + \cos y = 1$$

It can be written as

$$\cos y = 1 - 1/2$$

Taking LCM

$$\cos y = (2 - 1)/2 = 1/2$$



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We know that $\cos 60^\circ = \frac{1}{2}$

$$\cos y = \cos 60^\circ$$

So we get

$$y = 60^\circ$$

21. If $\sin(A + B) = \frac{\sqrt{3}}{2} = \cos(A - B)$, $0^\circ < A + B \leq 90^\circ$ ($A > B$), find the values of A and B.

Solution:

It is given that

$$\sin(A + B) = \frac{\sqrt{3}}{2} = \cos(A - B)$$

Consider

$$\sin(A + B) = \frac{\sqrt{3}}{2}$$

We know that $\sin 60^\circ = \frac{\sqrt{3}}{2}$

$$\sin(A + B) = \sin 60^\circ$$

$$A + B = 60^\circ \dots\dots (1)$$

Similarly

$$\cos(A - B) = \frac{\sqrt{3}}{2}$$

We know that $\cos 30^\circ = \frac{\sqrt{3}}{2}$

$$\cos(A - B) = \cos 30^\circ$$

$$A - B = 30^\circ \dots\dots (2)$$

By adding both the equations

$$A + B + A - B = 60^\circ + 30^\circ$$

So we get

$$2A = 90^\circ$$

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

Now substitute the value of A in equation (1)

$$45^\circ + B = 60^\circ$$

By further calculation

$$B = 60^\circ - 45^\circ = 15^\circ$$

Therefore, $A = 45^\circ$ and $B = 15^\circ$.

22. If the length of each side of a rhombus is 8 cm and its one angle is 60° , then find the lengths of the diagonals of the rhombus.

Solution:

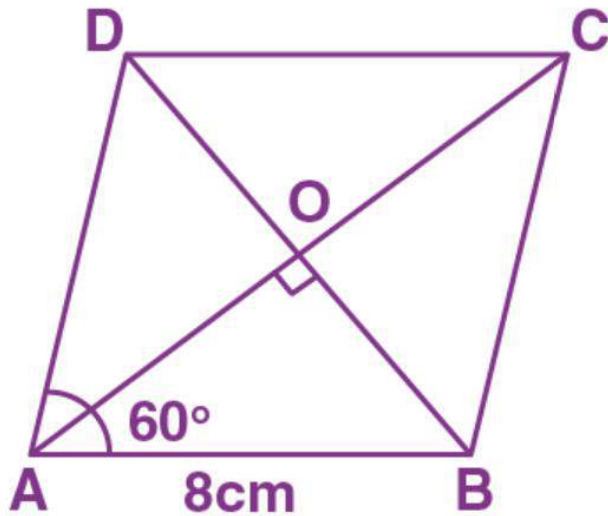
It is given that

Each side of a rhombus = 8 cm

One angle = 60°



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We know that the diagonals bisect the opposite angles
 $\angle OAB = 60^\circ/2 = 30^\circ$

In right $\triangle AOB$
 $\sin 30^\circ = OB/AB$

So we get
 $\frac{1}{2} = OB/8$

By further calculation

$$OB = 8/2 = 4 \text{ cm}$$

$$BD = 2OB = 2 \times 4 = 8 \text{ cm}$$

$$\cos 30^\circ = AO/AB$$

Substituting the values

$$\frac{\sqrt{3}}{2} = AO/8$$

By further calculation

$$AO = 8\sqrt{3}/2 = 4\sqrt{3}$$

Here

$$AC = 4\sqrt{3} \times 2 = 8\sqrt{3} \text{ cm}$$

Therefore, the length of the diagonals of the rhombus are 8 cm and $8\sqrt{3}$ cm.

23. In the right-angled triangle ABC, $\angle C = 90^\circ$ and $\angle B = 60^\circ$. If AC = 6 cm, find the lengths of the sides BC and AB.

Solution:

In the right-angled triangle ABC, $\angle C = 90^\circ$ and $\angle B = 60^\circ$

$$AC = 6 \text{ cm}$$

We know that



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$$\tan B = AC/BC$$

Substituting the values

$$\tan 60^\circ = 6/BC$$

So we get

$$\sqrt{3} = 6/BC$$

$$BC = 6/\sqrt{3}$$

It can be written as

$$= 6\sqrt{3}/(\sqrt{3} + \sqrt{3})$$

$$= 6\sqrt{3}/3$$

$$= 2\sqrt{3} \text{ cm}$$

$$\sin 60^\circ = AC/AB$$

Substituting the values

$$\sqrt{3}/2 = 6/AB$$

By further calculation

$$AB = (6 \times 2)/\sqrt{3}$$

So we get

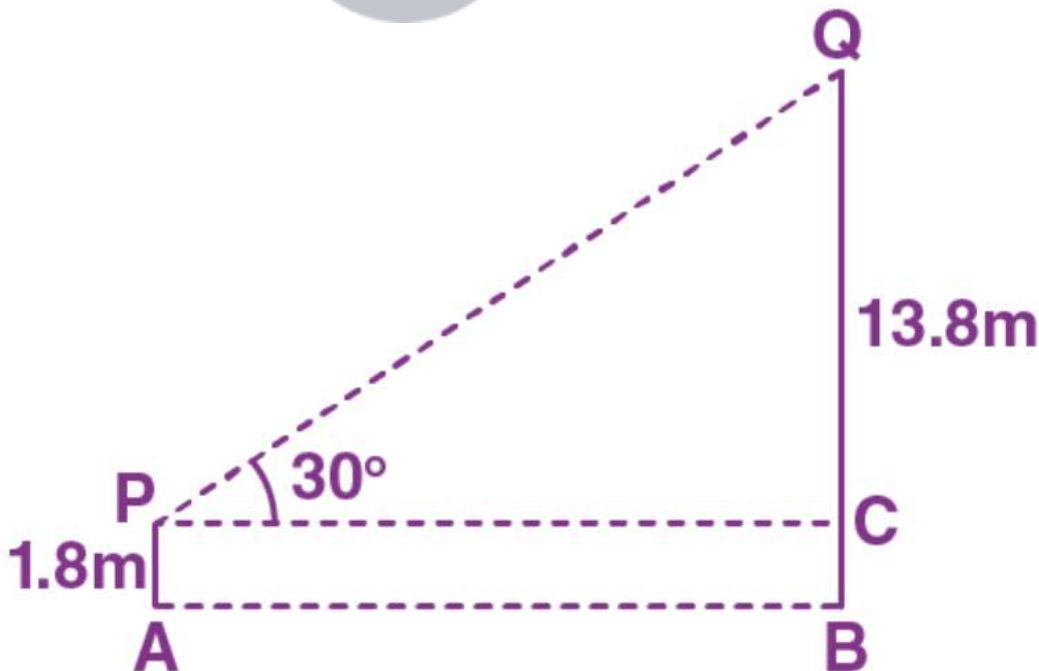
$$AB = (12 \times \sqrt{3})/(\sqrt{3} \times \sqrt{3})$$

$$= 12\sqrt{3}/3$$

$$= 4\sqrt{3} \text{ cm}$$

Therefore, the lengths of the sides $BC = 2\sqrt{3} \text{ cm}$ and $AB = 4\sqrt{3} \text{ cm}$.

24. In the adjoining figure, AP is a man of height 1.8 m and BQ is a building 13.8 m high. If the man sees the top of the building by focusing his binoculars at an angle of 30° to the horizontal, find the distance of the man from the building.



Solution:

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It is given that

Height of man AP = 1.8 m

Height of building BQ = 13.8 m

Angle of elevation from the top of the building to the man = 30°

Consider AB as the distance of the man from the building

AB = x then PC = x

QC = 13.8 - 1.8 = 12 m

In right $\triangle PQC$

$\tan \theta = QC/PC$

Substituting the values

$\tan 30^\circ = 12/x$

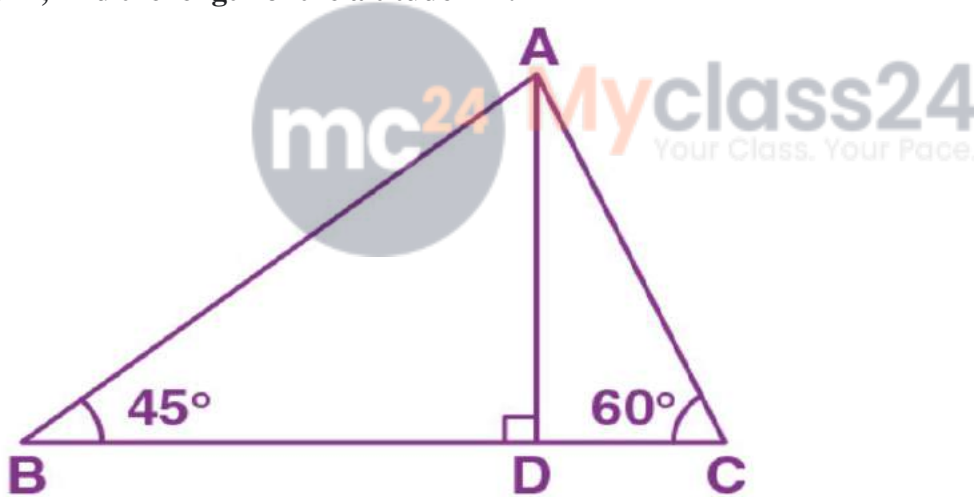
By further calculation

$1/\sqrt{3} = 12/x$

$x = 12\sqrt{3}$ m

Therefore, the distance of the man from the building is $12\sqrt{3}$ m.

25. In the adjoining figure, ABC is a triangle in which $\angle B = 45^\circ$ and $\angle C = 60^\circ$. If AD \perp BC and BC = 8 m, find the length of the altitude AD.



Solution:

In triangle ABC

$\angle B = 45^\circ$ and $\angle C = 60^\circ$

AD \perp BC and BC = 8 m

In right $\triangle ABD$

$\tan 45^\circ = AD/BD$

So we get

$1 = AD/BD$

AD = BD

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In right $\triangle ACD$
 $\tan 60^\circ = AD/DC$
So we get
 $\sqrt{3} = AD/DC$
 $DC = AD/\sqrt{3}$

Here
 $BD + DC = AD + AD/\sqrt{3}$
Taking LCM
 $BC = (\sqrt{3}AD + AD)/\sqrt{3}$
 $8 = [AD(\sqrt{3} + 1)]/\sqrt{3}$
By further calculation
 $AD = 8\sqrt{3}/(\sqrt{3} + 1)$
It can be written as
$$= \frac{8\sqrt{3}(\sqrt{3} - 1)}{(\sqrt{3} + 1)(\sqrt{3} - 1)}$$

So we get

$$\begin{aligned} &= \frac{8(3 - \sqrt{3})}{3 - 1} \\ &= \frac{8(3 - \sqrt{3})}{2} \\ &= 4(3 - \sqrt{3}) \text{ m} \end{aligned}$$



Therefore, the length of the altitude AD is $4(3 - \sqrt{3})$ m.

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EXERCISE 18.2

Without using trigonometric tables, evaluate the following (1 to 5):

1. (i) $\cos 18^\circ/\sin 72^\circ$

(ii) $\tan 41^\circ/\cot 49^\circ$

(iii) $\operatorname{cosec} 17^\circ 30'/\sec 72^\circ 30'$

Solution:

(i) $\cos 18^\circ/\sin 72^\circ$

It can be written as

$$= \cos 18^\circ/\sin (90^\circ - 18^\circ)$$

So we get

$$= \cos 18^\circ/\cos 18^\circ$$

$$= 1$$

(ii) $\tan 41^\circ/\cot 49^\circ$

It can be written as

$$= \tan 41^\circ/\cot (90^\circ - 41^\circ)$$

So we get

$$= \tan 41^\circ/\tan 41^\circ$$

$$= 1$$

(iii) $\operatorname{cosec} 17^\circ 30'/\sec 72^\circ 30'$

It can be written as

$$= \operatorname{cosec} 17^\circ 30'/\sec (90^\circ - 17^\circ 30')$$

So we get

$$= \operatorname{cosec} 17^\circ 30'/\operatorname{cosec} 17^\circ 30'$$

$$= 1$$

2. (i) $\cot 40^\circ/\tan 50^\circ - \frac{1}{2} (\cos 35^\circ/\sin 55^\circ)$

(ii) $(\sin 49^\circ/\cos 41^\circ)^2 + (\cos 41^\circ/\sin 49^\circ)^2$

(iii) $\sin 72^\circ/\cos 18^\circ - \sec 32^\circ/\operatorname{cosec} 58^\circ$

(iv) $\cos 75^\circ/\sin 15^\circ + \sin 12^\circ/\cos 78^\circ - \cos 18^\circ/\sin 72^\circ$

(v) $\sin 25^\circ/\sec 65^\circ + \cos 25^\circ/\operatorname{cosec} 65^\circ$.

Solution:

(i) $\cot 40^\circ/\tan 50^\circ - \frac{1}{2} (\cos 35^\circ/\sin 55^\circ)$

It can be written as



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$$= \frac{\cot 40^\circ}{\tan(90^\circ - 40^\circ)} - \frac{1}{2} \frac{\cos 35^\circ}{\sin(90^\circ - 35^\circ)}$$

By further calculation

$$= \frac{\cot 40^\circ}{\cot 40^\circ} - \frac{1}{2} \frac{\cos 35^\circ}{\cos 35^\circ}$$

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

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

(ii) $(\sin 49^\circ / \cos 41^\circ)^2 + (\cos 41^\circ / \sin 49^\circ)^2$

It can be written as

$$= \left[\frac{\sin 49^\circ}{\cos(90^\circ - 49^\circ)} \right]^2 + \left[\frac{\cos 41^\circ}{\sin(90^\circ - 41^\circ)} \right]^2$$

By further calculation

$$= \left(\frac{\sin 49^\circ}{\sin 49^\circ} \right)^2 + \left(\frac{\cos 41^\circ}{\cos 41^\circ} \right)^2$$

So we get

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

$$= 1 + 1$$

$$= 2$$

(iii) $\sin 72^\circ / \cos 18^\circ - \sec 32^\circ / \operatorname{cosec} 58^\circ$

It can be written as

$$= \frac{\sin 72^\circ}{\cos(90^\circ - 72^\circ)} - \frac{\sec 32^\circ}{\operatorname{cosec}(90^\circ - 32^\circ)}$$

By further calculation

$$= \frac{\sin 72^\circ}{\sin 72^\circ} - \frac{\sec 32^\circ}{\sec 32^\circ}$$

$$= 1 - 1$$

$$= 0$$

(iv) $\cos 75^\circ / \sin 15^\circ + \sin 12^\circ / \cos 78^\circ - \cos 18^\circ / \sin 72^\circ$

It can be written as



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$$= \frac{\cos 75^\circ}{\sin(90^\circ - 75^\circ)} + \frac{\sin 12^\circ}{\cos(90^\circ - 12^\circ)} - \frac{\cos 18^\circ}{\sin(90^\circ - 18^\circ)}$$

By further calculation

$$= \frac{\cos 75^\circ}{\cos 75^\circ} + \frac{\sin 12^\circ}{\sin 12^\circ} - \frac{\cos 18^\circ}{\cos 18^\circ}$$

So we get

$$= 1 + 1 - 1$$
$$= 1$$

(v) $\sin 25^\circ / \sec 65^\circ + \cos 25^\circ / \operatorname{cosec} 65^\circ$

It can be written as

$$= (\sin 25^\circ \times \cos 65^\circ) + (\cos 25^\circ \times \sin 65^\circ)$$

By further calculation

$$= [\sin 25^\circ \times \cos(90^\circ - 25^\circ)] + [\cos 25^\circ \times \sin(90^\circ - 25^\circ)]$$

So we get

$$= (\sin 25^\circ \times \sin 25^\circ) + (\cos 25^\circ \times \cos 25^\circ)$$

$$= \sin^2 25^\circ + \cos^2 25^\circ$$

$$= 1$$

3. (i) $\sin 62^\circ - \cos 28^\circ$

(ii) $\operatorname{cosec} 35^\circ - \sec 55^\circ$.

Solution:

(i) $\sin 62^\circ - \cos 28^\circ$

It can be written as

$$= \sin(90^\circ - 28^\circ) - \cos 28^\circ$$

So we get

$$= \cos 28^\circ - \cos 28^\circ$$

$$= 0$$

(ii) $\operatorname{cosec} 35^\circ - \sec 55^\circ$

It can be written as

$$= \operatorname{cosec} 35^\circ - \sec(90^\circ - 35^\circ)$$

So we get

$$= \operatorname{cosec} 35^\circ - \operatorname{cosec} 35^\circ$$

$$= 0$$

4. (i) $\cos^2 26^\circ + \cos 64^\circ \sin 26^\circ + \tan 36^\circ / \cot 54^\circ$

(ii) $\sec 17^\circ / \operatorname{cosec} 73^\circ + \tan 68^\circ / \cot 22^\circ + \cos^2 44^\circ + \cos^2 46^\circ$.

Solution:

(i) $\cos^2 26^\circ + \cos 64^\circ \sin 26^\circ + \tan 36^\circ / \cot 54^\circ$

It can be written as

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$$= \cos^2 26^\circ + \cos (90^\circ - 26^\circ) \sin 26^\circ + \tan 36^\circ / \cot (90^\circ - 36^\circ)$$

We know that

$$\cos (90^\circ - \theta) = \sin \theta$$

$$\cot (90^\circ - \theta) = \tan \theta$$

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

So we get

$$= \cos^2 26^\circ + \sin^2 26^\circ + \tan 36^\circ / \tan 36^\circ$$

$$= 1 + 1$$

$$= 2$$

$$(ii) \sec 17^\circ / \operatorname{cosec} 73^\circ + \tan 68^\circ / \cot 22^\circ + \cos^2 44^\circ + \cos^2 46^\circ$$

It can be written as

$$= \sec (90^\circ - 73^\circ) / \operatorname{cosec} 73^\circ + \tan (90^\circ - 22^\circ) / \cot 22^\circ + \cos^2 (90^\circ - 46^\circ) + \cos^2 46^\circ$$

By further calculation

$$= \operatorname{cosec} 73^\circ / \operatorname{cosec} 73^\circ + \cot 22^\circ / \cot 22^\circ + \sin^2 46^\circ + \cos^2 46^\circ$$

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

So we get

$$= 1 + 1 + 1$$

$$= 3$$

$$5. (i) \cos 65^\circ / \sin 25^\circ + \cos 32^\circ / \sin 58^\circ - \sin 28^\circ \sec 62^\circ + \operatorname{cosec}^2 30^\circ$$

$$(ii) \sec 29^\circ / \operatorname{cosec} 61^\circ + 2 \cot 8^\circ \cot 17^\circ \cot 45^\circ \cot 73^\circ \cot 82^\circ - 3 (\sin^2 38^\circ + \sin^2 52^\circ).$$

Solution:

$$(i) \cos 65^\circ / \sin 25^\circ + \cos 32^\circ / \sin 58^\circ - \sin 28^\circ \sec 62^\circ + \operatorname{cosec}^2 30^\circ$$

It can be written as

$$= \cos 65^\circ / \sin (90^\circ - 65^\circ) + \cos 32^\circ / \sin (90^\circ - 32^\circ) - \sin 28^\circ \sec (90^\circ - 28^\circ) + \operatorname{cosec}^2 30^\circ$$

By further calculation

$$= \cos 65^\circ / \cos 65^\circ + \cos 32^\circ / \cos 32^\circ - \sin 28^\circ \operatorname{cosec} 28^\circ + \operatorname{cosec}^2 30^\circ$$

We know that $\operatorname{cosec} 30^\circ = 2$

$$= 1 + 1 - 1 + 4$$

$$= 5$$

$$(ii) \sec 29^\circ / \operatorname{cosec} 61^\circ + 2 \cot 8^\circ \cot 17^\circ \cot 45^\circ \cot 73^\circ \cot 82^\circ - 3 (\sin^2 38^\circ + \sin^2 52^\circ)$$

It can be written as

$$= \sec 29^\circ / \operatorname{cosec} (90^\circ - 29^\circ) + 2 \cot 8^\circ \cot 17^\circ \cot 45^\circ \cot (90^\circ - 17^\circ) \cot (90^\circ - 8^\circ) - 3 [\sin^2 38^\circ + \sin^2 (90^\circ - 38^\circ)]$$

By further calculation

$$= \sec 29^\circ / \sec 29^\circ + 2 \cot 8^\circ \cot 17^\circ \times 1 \times \tan 17^\circ \tan 8^\circ - 3 (\sin^2 38^\circ + \cos^2 38^\circ)$$

So we get

$$= 1 + 2 \cot 8^\circ \tan 8^\circ \cot 17^\circ \tan 17^\circ \times 1 - 3 \times 1$$

We know that

$$\operatorname{cosec} (90^\circ - \theta) = \sec \theta$$

$$\cot (90^\circ - \theta) = \tan \theta$$

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

Here

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$$\begin{aligned} &= 1 + 2 \times 1 \times 1 \times 1 - 3 \\ &= 1 + 2 - 3 \\ &= 0 \end{aligned}$$

6. Express each of the following in terms of trigonometric ratios of angles between 0° to 45° :

(i) $\tan 81^\circ + \cos 72^\circ$

(ii) $\cot 49^\circ + \operatorname{cosec} 87^\circ$.

Solution:

(i) $\tan 81^\circ + \cos 72^\circ$

It can be written as

$$= \tan (90^\circ - 9^\circ) + \cos (90^\circ - 18^\circ)$$

So we get

$$= \cot 9^\circ + \sin 18^\circ$$

(ii) $\cot 49^\circ + \operatorname{cosec} 87^\circ$

It can be written as

$$= \cot (90^\circ - 41^\circ) + \operatorname{cosec} (90^\circ - 3^\circ)$$

So we get

$$= \tan 41^\circ + \sec 3^\circ$$

Without using trigonometric tables, prove that (7 to 11):

7. (i) $\sin^2 28^\circ - \cos^2 62^\circ = 0$

(ii) $\cos^2 25^\circ + \cos^2 65^\circ = 1$

(iii) $\operatorname{cosec}^2 67^\circ - \tan^2 23^\circ = 1$

(iv) $\sec^2 22^\circ - \cot^2 68^\circ = 1$.

Solution:

(i) $\sin^2 28^\circ - \cos^2 62^\circ = 0$

Consider

$$\text{LHS} = \sin^2 28^\circ - \cos^2 62^\circ$$

It can be written as

$$= \sin^2 28^\circ - \cos^2 (90^\circ - 28^\circ)$$

So we get

$$= \sin^2 28^\circ - \sin^2 28^\circ$$

$$= 0$$

$$= \text{RHS}$$

(ii) $\cos^2 25^\circ + \cos^2 65^\circ = 1$

Consider

$$\text{LHS} = \cos^2 25^\circ + \cos^2 65^\circ$$

It can be written as

$$= \cos^2 25^\circ + \cos^2 (90^\circ - 25^\circ)$$

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

So we get

$$= \cos^2 25^\circ + \sin^2 25^\circ$$

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$$= 1$$

$$(iii) \operatorname{cosec}^2 67^\circ - \tan^2 23^\circ = 1$$

Consider

$$\text{LHS} = \operatorname{cosec}^2 67^\circ - \tan^2 23^\circ$$

It can be written as

$$= \operatorname{cosec}^2 67^\circ - \tan^2 (90^\circ - 67^\circ)$$

We know that $\operatorname{cosec}^2 \theta - \cot^2 \theta = 1$

So we get

$$= \operatorname{cosec}^2 67^\circ - \cot^2 67^\circ$$

$$= 1$$

$$(iv) \sec^2 22^\circ - \cot^2 68^\circ = 1$$

Consider

$$\text{LHS} = \sec^2 22^\circ - \cot^2 68^\circ$$

It can be written as

$$= \sec^2 22^\circ - \cot^2 (90^\circ - 22^\circ)$$

We know that $\sec^2 \theta - \tan^2 \theta = 1$

So we get

$$= \sec^2 22^\circ - \tan^2 22^\circ$$

$$= 1$$

8. (i) $\sin 63^\circ \cos 27^\circ + \cos 63^\circ \sin 27^\circ = 1$
(ii) $\sec 31^\circ \sin 59^\circ + \cos 31^\circ \operatorname{cosec} 59^\circ = 2$.

Solution:

$$(i) \sin 63^\circ \cos 27^\circ + \cos 63^\circ \sin 27^\circ = 1$$

Consider

$$\text{LHS} = \sin 63^\circ \cos 27^\circ + \cos 63^\circ \sin 27^\circ$$

It can be written as

$$= \sin 63^\circ \cos (90^\circ - 63^\circ) + \cos 63^\circ \sin (90^\circ - 63^\circ)$$

$$= \sin 63^\circ \sin 63^\circ + \cos 63^\circ \cos 63^\circ$$

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

So we get

$$= \sin^2 63^\circ + \cos^2 63^\circ$$

$$= 1$$

$$(ii) \sec 31^\circ \sin 59^\circ + \cos 31^\circ \operatorname{cosec} 59^\circ = 2$$

Consider

$$\text{LHS} = \sec 31^\circ \sin 59^\circ + \cos 31^\circ \operatorname{cosec} 59^\circ$$

It can be written as

$$= 1/\cos 31^\circ \times \sin 59^\circ + \cos 31^\circ \times 1/\sin 59^\circ$$

By further calculation

$$= \sin 59^\circ/\cos (90^\circ - 59^\circ) + \cos 31^\circ/\sin (90^\circ - 31^\circ)$$

So we get

$$= \sin 59^\circ/\sin 59^\circ + \cos 31^\circ/\cos 31^\circ$$

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$$\begin{aligned} &= 1 + 1 \\ &= 2 \\ &= \text{RHS} \end{aligned}$$

9. (i) $\sec 70^\circ \sin 20^\circ - \cos 20^\circ \operatorname{cosec} 70^\circ = 0$

(ii) $\sin^2 20^\circ + \sin^2 70^\circ - \tan^2 45^\circ = 0$.

Solution:

(i) $\sec 70^\circ \sin 20^\circ - \cos 20^\circ \operatorname{cosec} 70^\circ = 0$

Consider

$$\text{LHS} = \sec 70^\circ \sin 20^\circ - \cos 20^\circ \operatorname{cosec} 70^\circ$$

By further simplification

$$= \sin 20^\circ / \cos 70^\circ - \cos 20^\circ / \sin 70^\circ$$

It can be written as

$$= \sin 20^\circ / \cos (90^\circ - 20^\circ) - \cos 20^\circ / \sin (90^\circ - 20^\circ)$$

So we get

$$= \sin 20^\circ / \sin 20^\circ - \cos 20^\circ / \cos 20^\circ$$

$$= 1 - 1$$

$$= 0$$

$$= \text{RHS}$$

(ii) $\sin^2 20^\circ + \sin^2 70^\circ - \tan^2 45^\circ = 0$

Consider

$$\text{LHS} = \sin^2 20^\circ + \sin^2 70^\circ - \tan^2 45^\circ$$

It can be written as

$$= \sin^2 20^\circ + \sin^2 (90^\circ - 20^\circ) - \tan^2 45^\circ$$

By further calculation

$$= \sin^2 20^\circ + \cos^2 20^\circ - \tan^2 45^\circ$$

We know that $\sin^2 \theta + \cos^2 \theta = 1$ and $\tan 45^\circ = 1$

So we get

$$= 1 - 1$$

$$= 0$$

$$= \text{RHS}$$

10. (i) $\cot 54^\circ / \tan 36^\circ + \tan 20^\circ / \cot 70^\circ - 2 = 0$

(ii) $\sin 50^\circ / \cos 40^\circ + \operatorname{cosec} 40^\circ / \sec 50^\circ - 4 \cos 50^\circ \operatorname{cosec} 40^\circ + 2 = 0$.

Solution:

(i) $\cot 54^\circ / \tan 36^\circ + \tan 20^\circ / \cot 70^\circ - 2 = 0$

Consider

$$\text{LHS} = \cot 54^\circ / \tan 36^\circ + \tan 20^\circ / \cot 70^\circ - 2$$

It can be written as

$$= \cot 54^\circ / \tan (90^\circ - 54^\circ) + \tan 20^\circ / \cot (90^\circ - 20^\circ) - 2$$

By further calculation

$$= \cot 54^\circ / \cot 54^\circ + \tan 20^\circ / \tan 20^\circ - 2$$

So we get

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$$\begin{aligned} &= 1 + 1 - 2 \\ &= 0 \\ &= \text{RHS} \end{aligned}$$

$$(ii) \sin 50^\circ / \cos 40^\circ + \operatorname{cosec} 40^\circ / \sec 50^\circ - 4 \cos 50^\circ \operatorname{cosec} 40^\circ + 2 = 0$$

Consider

$$\text{LHS} = \sin 50^\circ / \cos 40^\circ + \operatorname{cosec} 40^\circ / \sec 50^\circ - 4 \cos 50^\circ \operatorname{cosec} 40^\circ + 2$$

It can be written as

$$= \sin 50^\circ / \cos (90^\circ - 50^\circ) + \operatorname{cosec} 40^\circ / \sec (90^\circ - 40^\circ) - 4 \cos 50^\circ \operatorname{cosec} (90^\circ - 50^\circ) + 2$$

By further calculation

$$= \sin 50^\circ / \sin 50^\circ + \operatorname{cosec} 40^\circ / \operatorname{cosec} 40^\circ - \cos 50^\circ \sec 50^\circ + 2$$

So we get

$$= 1 + 1 - 4 \cos 50^\circ / \cos 50^\circ + 2$$

$$= 1 + 1 - 4 + 2$$

$$= 4 - 4$$

$$= 0$$

$$= \text{RHS}$$

$$11. (i) \cos 70^\circ / \sin 20^\circ + \cos 59^\circ / \sin 31^\circ - 8 \sin^2 30^\circ = 0$$

$$(ii) \cos 80^\circ / \sin 10^\circ + \cos 59^\circ \operatorname{cosec} 31^\circ = 2.$$

Solution:

$$(i) \cos 70^\circ / \sin 20^\circ + \cos 59^\circ / \sin 31^\circ - 8 \sin^2 30^\circ = 0$$

Consider

$$\text{LHS} = \cos 70^\circ / \sin 20^\circ + \cos 59^\circ / \sin 31^\circ - 8 \sin^2 30^\circ$$

It can be written as

$$= \cos 70^\circ / \sin (90^\circ - 70^\circ) + \cos 59^\circ / \sin (90^\circ - 59^\circ) - 8 \sin^2 30^\circ$$

We know that $\sin 30^\circ = \frac{1}{2}$

$$= \cos 70^\circ / \cos 70^\circ + \cos 59^\circ / \cos 59^\circ - 8 \left(\frac{1}{2}\right)^2$$

By further calculation

$$= 1 + 1 - 8 \times \frac{1}{4}$$

So we get

$$= 2 - 2$$

$$= 0$$

$$= \text{RHS}$$

$$(ii) \cos 80^\circ / \sin 10^\circ + \cos 59^\circ \operatorname{cosec} 31^\circ = 2$$

Consider

$$\text{LHS} = \cos 80^\circ / \sin 10^\circ + \cos 59^\circ \operatorname{cosec} 31^\circ$$

It can be written as

$$= \cos 80^\circ / \sin (90^\circ - 80^\circ) + \cos 59^\circ / \sin 31^\circ$$

By further simplification

$$= \cos 80^\circ / \cos 80^\circ + \cos 59^\circ / \sin (90^\circ - 59^\circ)$$

So we get

$$= 1 + \cos 59^\circ / \cos 59^\circ$$

$$= 1 + 1$$

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$$= 2$$
$$= \text{RHS}$$

12. Without using trigonometrical tables, evaluate:

$$(i) 2\left(\frac{\tan 35^\circ}{\cot 55^\circ}\right)^2 + \left(\frac{\cot 55^\circ}{\tan 35^\circ}\right) - 3\left(\frac{\sec 40^\circ}{\operatorname{cosec} 50^\circ}\right)$$

$$(ii) \frac{\sin 35^\circ \cos 55^\circ + \cos 35^\circ \sin 55^\circ}{\operatorname{cosec}^2 10^\circ - \tan^2 80^\circ}$$

$$(iii) \sin^2 34^\circ + \sin^2 56^\circ + 2 \tan 18^\circ \tan 72^\circ - \cot^2 30^\circ.$$

Solution:

$$(i) 2\left(\frac{\tan 35^\circ}{\cot 55^\circ}\right)^2 + \left(\frac{\cot 55^\circ}{\tan 35^\circ}\right) - 3\left(\frac{\sec 40^\circ}{\operatorname{cosec} 50^\circ}\right)$$

It can be written as

$$= 2\left[\frac{\tan(90^\circ - 55^\circ)}{\cot 55^\circ}\right] + \left[\frac{\cot(90^\circ - 35^\circ)}{\tan 35^\circ}\right] - 3\left[\frac{\sec(90^\circ - 50^\circ)}{\operatorname{cosec} 50^\circ}\right]$$

By further calculation

$$= 2\left(\frac{\cot 55^\circ}{\cot 55^\circ}\right)^2 + \left(\frac{\tan 35^\circ}{\tan 35^\circ}\right) - 3\left(\frac{\operatorname{cosec} 50^\circ}{\operatorname{cosec} 50^\circ}\right)$$

So we get

$$= 2 + 1 - 3$$
$$= 0$$

$$(ii) \frac{\sin 35^\circ \cos 55^\circ + \cos 35^\circ \sin 55^\circ}{\operatorname{cosec}^2 10^\circ - \tan^2 80^\circ}$$

It can be written as

$$= \frac{\sin 35^\circ \cos(90^\circ - 35^\circ) + \cos 35^\circ \sin(90^\circ - 35^\circ)}{\operatorname{cosec}^2 10^\circ - \tan^2(90^\circ - 10^\circ)}$$

By further calculation

$$= \frac{\sin 35^\circ \cdot \sin 35^\circ + \cos 35^\circ \cdot \cos 35^\circ}{\operatorname{cosec}^2 10^\circ - \cot^2 10^\circ}$$

So we get

$$= \frac{\sin^2 35^\circ + \cos^2 35^\circ}{\operatorname{cosec}^2 10^\circ - \cot^2 10^\circ}$$

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We know that $\sin^2 \theta + \cos^2 \theta = 1$ and $\operatorname{cosec}^2 \theta - \cot^2 \theta = 1$
 $= 1/1$
 $= 1$

(iii) $\sin^2 34^\circ + \sin^2 56^\circ + 2 \tan 18^\circ \tan 72^\circ - \cot^2 30^\circ$
 It can be written as
 $= \sin^2 34^\circ + [\sin(90^\circ - 34^\circ)]^2 + 2 \tan 18^\circ \tan(90^\circ - 18^\circ) - \cot^2 30^\circ$
 By further simplification
 $= \sin^2 34^\circ + \cos^2 34^\circ + 2 \tan 18^\circ \cot 18^\circ - (\sqrt{3})^2$
 So we get
 $= 1 + 2 \tan 18^\circ \times 1/\tan 18^\circ - 3$
 $= 1 + 2 - 3$
 $= 0$

13. Prove the following:

$$(i) \frac{\cos \theta}{\sin(90^\circ - \theta)} + \frac{\sin \theta}{\cos(90^\circ - \theta)} = 2$$

$$(ii) \cos \theta \sin(90^\circ - \theta) + \sin \theta \cos(90^\circ - \theta) = 1$$

$$(iii) \frac{\tan \theta}{\tan(90^\circ - \theta)} + \frac{\sin(90^\circ - \theta)}{\cos \theta} = \sec^2 \theta.$$

Solution:

$$(i) \frac{\cos \theta}{\sin(90^\circ - \theta)} + \frac{\sin \theta}{\cos(90^\circ - \theta)} = 2$$

We know that

$$\text{LHS} = \frac{\cos \theta}{\sin(90^\circ - \theta)} + \frac{\sin \theta}{\cos(90^\circ - \theta)}$$

So we get

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

$$= 1 + 1$$

$$= 2$$

$$= \text{RHS}$$

$$(ii) \cos \theta \sin(90^\circ - \theta) + \sin \theta \cos(90^\circ - \theta) = 1$$

Consider

$$\text{LHS} = \cos \theta \sin(90^\circ - \theta) + \sin \theta \cos(90^\circ - \theta)$$

It can be written as

$$= \cos \theta \cdot \cos \theta + \sin \theta \cdot \sin \theta$$

So we get

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

$$= 1$$

$$= \text{RHS}$$

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$$(iii) \frac{\tan \Theta}{\tan(90^\circ - \Theta)} + \frac{\sin(90^\circ - \Theta)}{\cos \Theta} = \sec^2 \Theta$$

Consider

$$\text{LHS} = \frac{\tan \Theta}{\tan(90^\circ - \Theta)} + \frac{\sin(90^\circ - \Theta)}{\cos \Theta}$$

By further calculation

$$= \tan \theta / \cot \theta + \cos \theta / \cos \theta$$

So we get

$$= \tan \theta \times \tan \theta + 1$$

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

$$= \sec^2 \theta$$

$$= \text{RHS}$$

14. Prove the following:

$$(i) \frac{\cos(90^\circ - A) \sin(90^\circ - A)}{\tan(90^\circ - A)} = 1 - \cos^2 A$$

$$(ii) \frac{\sin(90^\circ - A)}{\operatorname{cosec}(90^\circ - A)} + \frac{\cos(90^\circ - A)}{\sec(90^\circ - A)} = 1.$$

Solution:

$$(i) \frac{\cos(90^\circ - A) \sin(90^\circ - A)}{\tan(90^\circ - A)} = 1 - \cos^2 A$$

Consider

$$\text{LHS} = \frac{\cos(90^\circ - A) \sin(90^\circ - A)}{\tan(90^\circ - A)}$$

It can be written as

$$= \sin A \cos A / \cot A$$

So we get

$$= (\sin A \cos A \times \sin A) / \cos A$$

$$= \sin^2 A$$

$$= 1 - \cos^2 A$$

$$= \text{RHS}$$

$$(ii) \frac{\sin(90^\circ - A)}{\operatorname{cosec}(90^\circ - A)} + \frac{\cos(90^\circ - A)}{\sec(90^\circ - A)} = 1$$

Consider

$$\text{LHS} = \frac{\sin(90^\circ - A)}{\operatorname{cosec}(90^\circ - A)} + \frac{\cos(90^\circ - A)}{\sec(90^\circ - A)}$$

It can be written as

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$$= \cos A / \sec A + \sin A / \operatorname{cosec} A$$

So we get

$$= \cos A \times \cos A + \sin A \times \sin A$$

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

$$= 1$$

$$= \text{RHS}$$

15. Simplify the following:

$$(i) \frac{\cos \theta}{\sin(90^\circ - \theta)} + \frac{\cos(90^\circ - \theta)}{\sec(90^\circ - \theta)} - 3 \tan^2 30^\circ$$

$$(ii) \frac{\operatorname{cosec}(90^\circ - \theta) \sin(90^\circ - \theta) \cot(90^\circ - \theta)}{\cos(90^\circ - \theta) \sec(90^\circ - \theta) \tan \theta} + \frac{\cot \theta}{\tan(90^\circ - \theta)}$$

Solution:

$$(i) \frac{\cos \theta}{\sin(90^\circ - \theta)} + \frac{\cos(90^\circ - \theta)}{\sec(90^\circ - \theta)} - 3 \tan^2 30^\circ$$

It can be written as

$$= \cos \theta / \cos \theta + \sin \theta / \operatorname{cosec} \theta - 3 \tan^2 30^\circ$$

By further calculation

$$= 1 + \sin \theta \times \sin \theta - 3 (1/\sqrt{3})^2$$

So we get

$$= \sin^2 \theta + 1 - 3 \times 1/3$$

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

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

$$(ii) \frac{\operatorname{cosec}(90^\circ - \theta) \sin(90^\circ - \theta) \cot(90^\circ - \theta)}{\cos(90^\circ - \theta) \sec(90^\circ - \theta) \tan \theta} + \frac{\cot \theta}{\tan(90^\circ - \theta)}$$

It can be written as

$$= (\sec \theta \cos \theta \tan \theta) / (\sin \theta \operatorname{cosec} \theta \tan \theta) + \cot \theta / \cot \theta$$

So we get

$$= \sec \theta \cos \theta / \sin \theta \operatorname{cosec} \theta + 1$$

$$= 1/1 + 1$$

$$= 1 + 1$$

$$= 2$$

16. Show that

$$\frac{\cos^2(45^\circ + \theta) + \cos^2(45^\circ - \theta)}{\tan(60^\circ + \theta) \tan(30^\circ - \theta)} = 1.$$

Solution:

Consider

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$$LHS = \frac{\cos^2(45^\circ + \Theta) + \cos^2(45^\circ - \Theta)}{\tan(60^\circ + \Theta)\tan(30^\circ - \Theta)}$$

It can be written as

$$= \frac{\cos^2(45^\circ + \Theta) + \cos^2[90^\circ - (45^\circ - \Theta)]}{\tan(60^\circ + \Theta)\tan[90^\circ - (60^\circ - \Theta)]}$$

By further calculation

$$= \frac{\cos^2(45^\circ + \Theta) + \sin^2(45^\circ - \Theta)}{\tan(60^\circ + \Theta)\cot(60^\circ - \Theta)}$$

We know that $\cos(90^\circ - \theta) = \sin \theta$, $\tan(90^\circ - \theta) = \cot \theta$ and $\tan \theta \cot \theta = 1$

So we get

$$= 1/1$$

$$= 1$$

$$= \text{RHS}$$

17. Find the value of A if

(i) $\sin 3A = \cos(A - 6^\circ)$, where $3A$ and $A - 6^\circ$ are acute angles

(ii) $\tan 2A = \cot(A - 18^\circ)$, where $2A$ and $A - 18^\circ$ are acute angles

(iii) If $\sec 2A = \operatorname{cosec}(A - 27^\circ)$ where $2A$ is an acute angle, find the measure of $\angle A$.

Solution:

(i) $\sin 3A = \cos(A - 6^\circ)$, where $3A$ and $A - 6^\circ$ are acute angles

It is given that

$$\sin 3A = \cos(A - 6^\circ)$$

We know that $\cos(90^\circ - \theta) = \sin \theta$

$$\cos(90^\circ - 3A) = \cos(A - 6^\circ)$$

By comparing both

$$90^\circ - 3A = A - 6^\circ$$

By further calculation

$$90^\circ + 6^\circ = A + 3A$$

$$96^\circ = 4A$$

So we get

$$A = 96^\circ/4 = 24^\circ$$

Hence, the value of A is 24° .

(ii) $\tan 2A = \cot(A - 18^\circ)$

We know that $\cot(90^\circ - \theta) = \tan \theta$

$$\cot(90^\circ - 2A) = \cot(A - 18^\circ)$$

By comparing both

$$90^\circ - 2A = A - 18^\circ$$

By further calculation

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$$90^\circ + 18^\circ = A + 2A$$

So we get

$$3A = 108^\circ$$

$$A = 108^\circ/3 = 36^\circ$$

Hence, the value of A is 36° .

$$(iii) \sec 2A = \operatorname{cosec} (A - 27^\circ)$$

We know that $\operatorname{cosec} (90^\circ - \theta) = \sec \theta$

$$\operatorname{cosec} (90^\circ - 2A) = \cos (A - 27^\circ)$$

By comparing both

$$90^\circ - 2A = A - 27^\circ$$

By further calculation

$$90^\circ + 27^\circ = A + 2A$$

So we get

$$3A = 117^\circ$$

$$A = 117^\circ/3 = 39^\circ$$

Hence, the value of A is 39° .

18. Find the value of θ ($0^\circ < \theta < 90^\circ$) if:

(i) $\cos 63^\circ \sec (90^\circ - \theta) = 1$

(ii) $\tan 35^\circ \cot (90^\circ - \theta) = 1$.

Solution:

(i) $\cos 63^\circ \sec (90^\circ - \theta) = 1$

It can be written as

$$\cos 63^\circ = 1/\sec (90^\circ - \theta)$$

We know that $1/\sec \theta = \cos \theta$

$$\cos 63^\circ = \cos (90^\circ - \theta)$$

By comparing both

$$90^\circ - \theta = 63^\circ$$

By further calculation

$$\theta = 90^\circ - 63^\circ = 27^\circ$$

(ii) $\tan 35^\circ \cot (90^\circ - \theta) = 1$

It can be written as

$$\tan 35^\circ = 1/\cot (90^\circ - \theta)$$

We know that $1/\cot \theta = \tan \theta$

$$\tan 35^\circ = \tan (90^\circ - \theta)$$

By comparing both

$$35^\circ = 90^\circ - \theta$$

By further calculation

$$\theta = 90^\circ - 35^\circ = 55^\circ$$

19. If A, B and C are the interior angles of a ΔABC , show that



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- (i) $\cos (A + B)/2 = \sin C/2$
(ii) $\tan (C + A)/2 = \cot B/2$.

Solution:

A, B and C are the interior angles of a $\triangle ABC$

It can be written as

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

Dividing both sides by 2

$$(\angle A + \angle B + \angle C)/2 = 180^\circ/2$$

$$A/2 + B/2 + C/2 = 90^\circ$$

- (i) $\cos (A + B)/2 = \sin C/2$

We can write it as

$$(A + B)/2 = 90^\circ - C/2$$

We know that

$$\cos (90^\circ - C/2) = \sin C/2$$

Here $\cos (90^\circ - \theta) = \sin \theta$

$$\sin C/2 = \sin C/2$$

- (ii) $\tan (C + A)/2 = \cot B/2$

We know that $(A + C)/2 = 90^\circ - B/2$

$$= \tan (90^\circ - B/2)$$

So we get

$$= \cot B/2$$

$$= \text{RHS}$$



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CHAPTER TEST

1. Find the values of:

(i) $\sin^2 60^\circ - \cos^2 45^\circ + 3\tan^2 30^\circ$

$$\frac{2 \cos^2 45^\circ + 3 \tan^2 30^\circ}{\sqrt{3} \cos 30^\circ + \sin 30^\circ}$$

(ii) $\sqrt{3} \cos 30^\circ + \sin 30^\circ$

(iii) $\sec 30^\circ \tan 60^\circ + \sin 45^\circ \operatorname{cosec} 45^\circ + \cos 30^\circ \cot 60^\circ$

Solution:

(i) $\sin^2 60^\circ - \cos^2 45^\circ + 3\tan^2 30^\circ$

$$\begin{aligned} &= \left(\frac{\sqrt{3}}{2}\right)^2 - \left(\frac{1}{\sqrt{2}}\right)^2 + 3\left(\frac{1}{\sqrt{3}}\right)^2 \\ &= \frac{3}{4} - \frac{1}{2} + 3 \times \frac{1}{3} = \frac{3}{4} - \frac{1}{2} + \frac{1}{1} \\ &= \frac{3-2+4}{4} = \frac{7-2}{4} = \frac{5}{4} = 1\frac{1}{4} \end{aligned}$$

Therefore, $\sin^2 60^\circ - \cos^2 45^\circ + 3\tan^2 30^\circ = 1\frac{1}{4}$

(ii) $\frac{2 \cos^2 45^\circ + 3 \tan^2 30^\circ}{\sqrt{3} \cos 45^\circ + \sin 30^\circ}$

$$\begin{aligned} &= \frac{2\left(\frac{1}{\sqrt{2}}\right)^2 + 3 \times \left(\frac{1}{\sqrt{3}}\right)^2}{\sqrt{3} \times \left(\frac{\sqrt{3}}{2}\right) + \frac{1}{2}} \\ &= \frac{2 \times \frac{1}{2} + 3 \times \frac{1}{3}}{\frac{3}{2} + \frac{1}{2}} = \frac{1+1}{\frac{3+1}{2}} = \frac{2}{\frac{4}{2}} = \frac{2}{2} = 1 \end{aligned}$$

Hence, $\frac{2 \cos^2 45^\circ + 3 \tan^2 30^\circ}{\sqrt{3} \cos 30^\circ + \sin 30^\circ} = 1$

(iii) $\sec 30^\circ \tan 60^\circ + \sin 45^\circ \operatorname{cosec} 45^\circ + \cos 30^\circ \cot 60^\circ$

$$\begin{aligned} &= \frac{2}{\sqrt{3}} \times \sqrt{3} + \frac{1}{\sqrt{2}} \times \sqrt{2} + \frac{\sqrt{3}}{2} \times \frac{1}{\sqrt{3}} = \frac{2}{1} + \frac{1}{1} + \frac{1}{2} \\ &= 2 + 1 + \frac{1}{2} = 3 + \frac{1}{2} = (6 + 1)/2 \end{aligned}$$

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$$= 7/2 = 3\frac{1}{2}$$

$$\text{Thus, } \sec 30^\circ \tan 60^\circ + \sin 45^\circ \operatorname{cosec} 45^\circ + \cos 30^\circ \cot 60^\circ = 3\frac{1}{2}$$

2. Taking $A = 30^\circ$, verify that

(i) $\cos^4 A - \sin^4 A = \cos 2A$

(ii) $4\cos A \cos (60^\circ - A) \cos (60^\circ + A) = \cos 3A$.

Solution:

(i) $\cos^4 A - \sin^4 A = \cos 2A$

Let's take $A = 30^\circ$

so, we have

$$\text{L.H.S.} = \cos^4 A - \sin^4 A = \cos^4 30^\circ - \sin^4 30^\circ$$

$$\begin{aligned} &= \left(\frac{\sqrt{3}}{2}\right)^4 - \left(\frac{1}{2}\right)^4 \\ &= \frac{\sqrt{3} \times \sqrt{3} \times \sqrt{3} \times \sqrt{3}}{2 \times 2 \times 2 \times 2} - \frac{1 \times 1 \times 1 \times 1}{2 \times 2 \times 2 \times 2} = \frac{9}{16} - \frac{1}{16} \\ &= \frac{9-1}{16} = \frac{8}{16} = \frac{1}{2} \end{aligned}$$

Now,

$$\text{R.H.S.} = \cos 2A = \cos 2(30^\circ) = \frac{1}{2}$$

Therefore, L.H.S. = R.H.S. hence verified.

(ii) $4 \cos A \cos (60^\circ - A) \cos (60^\circ + A) = \cos 3A$

Let's take $A = 30^\circ$

$$\text{L.H.S.} = 4 \cos A \cos (60^\circ - A) \cos (60^\circ + A)$$

$$= 4 \cos 30^\circ \cos (60^\circ - 30^\circ) \cos (60^\circ + 30^\circ)$$

$$= 4 \cos 30^\circ \cos 30^\circ \cos 90^\circ$$

$$= 4 \times (\sqrt{3}/2) \times (\sqrt{3}/2) \times 0$$

$$= 0$$

Now,

$$\text{R.H.S.} = \cos 3A$$

$$= \cos (3 \times 30^\circ) = \cos 90^\circ = 0$$

Hence, L.H.S. = R.H.S. hence verified.

3. If $A = 45^\circ$ and $B = 30^\circ$, verify that $\sin A / (\cos A + \sin A + \sin B) = 2/3$

Solution:

Taking,

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$$\begin{aligned}
 \text{L.H.S.} &= \frac{\sin A}{\cos A + \sin A \sin B} \\
 &= \frac{\sin 45^\circ}{\cos 45^\circ + \sin 45^\circ \sin 30^\circ} \\
 &= \frac{\frac{\sqrt{2}}{2}}{\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2} \times \frac{1}{2}} = \frac{\frac{\sqrt{2}}{2}}{\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{4}} \\
 &= \frac{\frac{\sqrt{2}}{2}}{\frac{2\sqrt{2} + \sqrt{2}}{4}} = \frac{\frac{\sqrt{2}}{2}}{\frac{3\sqrt{2}}{4}} \\
 &= \frac{\sqrt{2}}{2} \times \frac{4}{3\sqrt{2}} = \frac{2}{3} = \text{R.H.S.}
 \end{aligned}$$

Hence verified.

4. Taking A = 60° and B = 30°, verify that

(i) $\frac{\sin(A+B)}{\cos A \cos B} = \tan A + \tan B$

(ii) $\frac{\sin(A-B)}{\sin A \sin B} = \cot B - \cot A$

Solution:

(i) Here, A = 60° and B = 30°

$$\begin{aligned}
 \text{LHS} &= \frac{\sin(A+B)}{\cos A \cos B} = \frac{\sin(60^\circ + 30^\circ)}{\cos 60^\circ \cos 30^\circ} \\
 &= \frac{\sin 90^\circ}{\cos 60^\circ \cos 30^\circ} = \frac{1}{\frac{1}{2} \times \frac{\sqrt{3}}{2}} \\
 &= \frac{1}{\frac{\sqrt{3}}{4}} = \frac{4}{\sqrt{3}}
 \end{aligned}$$

Now,

$$\begin{aligned}
 \text{R.H.S.} &= \tan A + \tan B \\
 &= \tan 60^\circ + \tan 30^\circ \\
 &= \sqrt{3} + \frac{1}{\sqrt{3}} \\
 &= \frac{3+1}{\sqrt{3}} = \frac{4}{\sqrt{3}}
 \end{aligned}$$

∴ L.H.S. = R.H.S.

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(ii) $A = 60^\circ$, $B = 30^\circ$

$$\begin{aligned} \text{L.H.S.} &= \frac{\sin(A - B)}{\sin A \sin B} = \frac{\sin(60^\circ - 30^\circ)}{\sin 60^\circ \sin 30^\circ} \\ &= \frac{\sin 30^\circ}{\sin 60^\circ \sin 30^\circ} = \frac{1}{\sin 60^\circ} = \frac{1}{\frac{\sqrt{3}}{2}} \\ &= \frac{2}{\sqrt{3}} \end{aligned}$$

$$\begin{aligned} \text{R.H.S.} &= \cot B - \cot A \\ &= \cot 30^\circ - \cot 60^\circ \\ &= \sqrt{3} - \frac{1}{\sqrt{3}} = \frac{3-1}{\sqrt{3}} = \frac{2}{\sqrt{3}} \end{aligned}$$

$\therefore \text{L.H.S.} = \text{R.H.S.}$

5. If $\sqrt{2} \tan 2\theta = \sqrt{6}$ and $0^\circ < 2\theta < 90^\circ$, find the value of $\sin \theta + \sqrt{3} \cos \theta - 2 \tan^2 \theta$.

Solution:

Given,

$$\begin{aligned} \sqrt{2} \tan 2\theta &= \sqrt{6} \\ \tan 2\theta &= \frac{\sqrt{6}}{\sqrt{2}} \\ &= \sqrt{3} \\ &= \tan 60^\circ \end{aligned}$$

$$\Rightarrow 2\theta = 60^\circ$$

$$\theta = 30^\circ$$

Now,

$$\begin{aligned} &\sin \theta + \sqrt{3} \cos \theta - 2 \tan^2 \theta \\ &= \sin 30^\circ + \sqrt{3} \cos 30^\circ - 2 \tan^2 30^\circ \\ &= \frac{1}{2} + \sqrt{3} \times \frac{\sqrt{3}}{2} - 2 \left(\frac{1}{\sqrt{3}}\right)^2 \\ &= \frac{1}{2} + \frac{3}{2} - \frac{2}{3} \\ &= \frac{4}{2} - \frac{2}{3} \\ &= \frac{(12 - 4)}{6} \\ &= \frac{8}{6} \\ &= \frac{4}{3} \end{aligned}$$

6. If 3θ is an acute angle, solve the following equations for θ :

(i) $(\operatorname{cosec} 3\theta - 2)(\cot 2\theta - 1) = 0$

(ii) $(\tan \theta - 1)(\operatorname{cosec} 3\theta - 1) = 0$

Solution:

(i) $(\operatorname{cosec} 3\theta - 2)(\cot 2\theta - 1) = 0$

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Now, either

$$\operatorname{cosec} 3\theta - 2 \text{ or } \cot 2\theta - 1 = 0$$

$$\Rightarrow \operatorname{cosec} 3\theta = 2 \text{ or } \cot 2\theta = 1$$

So,

$$\operatorname{cosec} 3\theta = \operatorname{cosec} 3\theta^\circ \text{ or } \cot 2\theta = \cot 45^\circ$$

$$\Rightarrow 3\theta = 30^\circ \text{ or } 2\theta = 45^\circ$$

$$\text{Thus, } \theta = 30^\circ \text{ or } 45^\circ.$$

$$(ii) (\tan \theta - 1) (\operatorname{cosec} 3\theta - 1) = 0$$

Now, either

$$\tan \theta - 1 = 0 \text{ or } \operatorname{cosec} 3\theta - 1 = 0$$

$$\Rightarrow \tan \theta = 1 \text{ or } \operatorname{cosec} 3\theta = 1$$

So,

$$\tan \theta = \tan 45^\circ \text{ or } \operatorname{cosec} 3\theta = \operatorname{cosec} 90^\circ$$

$$\Rightarrow \theta = 45^\circ \text{ or } 3\theta = 90^\circ \text{ i.e. } \theta = 30^\circ$$

$$\text{Thus, } \theta = 45^\circ \text{ or } 30^\circ.$$

7. If $\tan (A + B) = \sqrt{3}$ and $\tan (A - B) = 1$ and A, B ($B < A$) are acute angles, find the values of A and B .

Solution:

Given, $\tan (A + B) = \sqrt{3}$

So, $\tan (A + B) = \tan 60^\circ$ [Since, $\tan 60^\circ = \sqrt{3}$]

$$\Rightarrow A + B = 60^\circ \dots\dots\dots (i)$$

Also, given

$$\tan (A - B) = 1$$

So, $\tan (A - B) = \tan 45^\circ$ [$\tan 45^\circ = 1$]

$$\Rightarrow A - B = 45^\circ \dots\dots\dots (ii)$$

From equation (1) and (2), we get

$$A + B = 60^\circ$$

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

$$2A = 105^\circ$$

$$A = 52\frac{1}{2}^\circ$$

Now, on substituting the value of A in equation (i), we get

$$52\frac{1}{2}^\circ + B = 60^\circ$$

$$B = 60^\circ - 52\frac{1}{2}^\circ = 7\frac{1}{2}^\circ$$

Therefore, the value of $A = 52\frac{1}{2}^\circ$ and $B = 7\frac{1}{2}^\circ$

8. Without using trigonometrical tables, evaluate the following:

(i) $\sin^2 28^\circ + \sin^2 62^\circ - \tan^2 45^\circ$

(ii) $2 \frac{\cos 27^\circ}{\sin 63^\circ} + \frac{\tan 27^\circ}{\cot 63^\circ} + \cos 0^\circ$

(iii) $\cos 18^\circ \sin 72^\circ + \sin 18^\circ \cos 72^\circ$

(iv) $5 \sin 50^\circ \sec 40^\circ - 3 \cos 59^\circ \operatorname{cosec} 31^\circ$

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Solution:

$$\begin{aligned} \text{(i)} \quad & \sin^2 28^\circ + \sin^2 62^\circ - \tan^2 45^\circ \\ &= \sin^2 28^\circ + \sin^2 (90^\circ - 28^\circ) - \tan^2 45^\circ \\ &= \sin^2 28^\circ + \cos^2 28^\circ - \tan^2 45^\circ \\ &= 1 - (1)^2 \quad (\because \sin^2 \theta + \cos^2 \theta = 1 \text{ and } \tan 45^\circ = 1) \\ &= 1 - 1 \\ &= 0 \end{aligned}$$

$$\begin{aligned} \text{(ii)} \quad & 2 \frac{\cos 27^\circ}{\sin 63^\circ} + \frac{\tan 27^\circ}{\cot 63^\circ} + \cos 0^\circ \\ &= 2 \frac{\cos 27^\circ}{\sin (90^\circ - 27^\circ)} + \frac{\tan 27^\circ}{\cot (90^\circ - 27^\circ)} + \cos 0^\circ \\ &= 2 \frac{\cos 27^\circ}{\cos 27^\circ} + \frac{\tan 27^\circ}{\tan 27^\circ} + 1 \quad (\because \cos 0^\circ = 1) \\ &= 2 \times 1 + 1 + 1 \\ &= 2 + 1 + 1 \\ &= 4 \end{aligned}$$

$$\begin{aligned} \text{(iii)} \quad & \cos 18^\circ \sin 12^\circ + \sin 18^\circ \cos 12^\circ \\ &= \cos (90^\circ - 12^\circ) \sin 12^\circ + \sin (90^\circ - 12^\circ) \cos 12^\circ \\ &= \sin 72^\circ \sin 12^\circ + \cos 12^\circ \cos 12^\circ \\ &= \sin^2 12^\circ + \cos^2 12^\circ \\ &= 1 \quad (\because \sin^2 \theta + \cos^2 \theta = 1) \end{aligned}$$

$$\begin{aligned} \text{(iv)} \quad & 5 \sin 50^\circ \sec 40^\circ - 3 \cos 59^\circ \operatorname{cosec} 31^\circ \\ &= 5 \frac{\sin 50^\circ}{\cos 40^\circ} - 3 \frac{\cos 59^\circ}{\sin 31^\circ} \\ &= 5 \frac{\sin 50^\circ}{\cos (90^\circ - 50^\circ)} - 3 \frac{\cos 59^\circ}{\sin (90^\circ - 59^\circ)} \\ &= 5 \frac{\sin 50^\circ}{\sin 50^\circ} - 3 \frac{\cos 59^\circ}{\cos 59^\circ} = 5 \times 1 - 3 \times 1 \\ &= 5 - 3 \\ &= 2 \end{aligned}$$

9. Prove that:

$$\frac{\cos (90^\circ - \theta) \sec (90^\circ - \theta) \tan \theta}{\operatorname{cosec} (90^\circ - \theta) \sin (90^\circ - \theta) \cot (90^\circ - \theta)} + \frac{\tan (90^\circ - \theta)}{\cot \theta} = 2$$

Solution:

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$$\begin{aligned} \text{L.H.S.} &= \frac{\cos(90^\circ - \theta) \sec(90^\circ - \theta) \tan \theta}{\operatorname{cosec}(90^\circ - \theta) \sin(90^\circ - \theta) \cot(90^\circ - \theta)} + \frac{\tan(90^\circ - \theta)}{\cot \theta} \\ &= \frac{\sin \theta \operatorname{cosec} \theta \tan \theta}{\sec \theta \cos \theta \tan \theta} + \frac{\cot \theta}{\cot \theta} \\ &= \frac{1 \times \tan \theta}{1 \times \tan \theta} + 1 = 1 + 1 = 2 = \text{R.H.S.} \end{aligned}$$

Thus, L.H.S. = R.H.S.

Hence proved.

10. When $0^\circ < A < 90^\circ$, solve the following equations:

(i) $\sin 3A = \cos 2A$

(ii) $\tan 5A = \cot A$

Solution:

(i) $\sin 3A = \cos 2A$

$\Rightarrow \sin 3A = \sin(90^\circ - 2A)$

So,

$3A = 90^\circ - 2A$

$3A + 2A = 90^\circ$

$5A = 90^\circ$

$\therefore A = 90^\circ/5 = 18^\circ$

(ii) $\tan 5A = \cot A$

$\Rightarrow \tan 5A = \tan(90^\circ - A)$

So,

$5A = 90^\circ - A$

$5A + A = 90^\circ$

$6A = 90^\circ$

$\therefore A = 90^\circ/6 = 15^\circ$



11. Find the value of θ if

(i) $\sin(\theta + 36^\circ) = \cos \theta$, where θ and $\theta + 36^\circ$ are acute angles.

(ii) $\sec 4\theta = \operatorname{cosec}(\theta - 20^\circ)$, where 4θ and $\theta - 20^\circ$ are acute angles.

Solution:

(i) Given, θ and $(\theta + 36^\circ)$ are acute angles

And,

$\sin(\theta + 36^\circ) = \cos \theta = \sin(90^\circ - \theta)$ [As, $\sin(90^\circ - \theta) = \cos \theta$]

On comparing, we get

$\theta + 36^\circ = 90^\circ - \theta$

$\theta + \theta = 90^\circ - 36^\circ$

$2\theta = 54^\circ$

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$$\theta = 54^\circ/2$$

$$\therefore \theta = 27^\circ$$

(ii) Given, θ and $(\theta - 20^\circ)$ are acute angles

And,

$$\sec 4\theta = \operatorname{cosec}(\theta - 20^\circ)$$

$$\operatorname{cosec}(90^\circ - 4\theta) = \operatorname{cosec}(\theta - 20^\circ)$$

$$[\text{Since, } \operatorname{cosec}(90^\circ - \theta) = \sec \theta]$$

On comparing, we get

$$90^\circ - 4\theta = \theta - 20^\circ$$

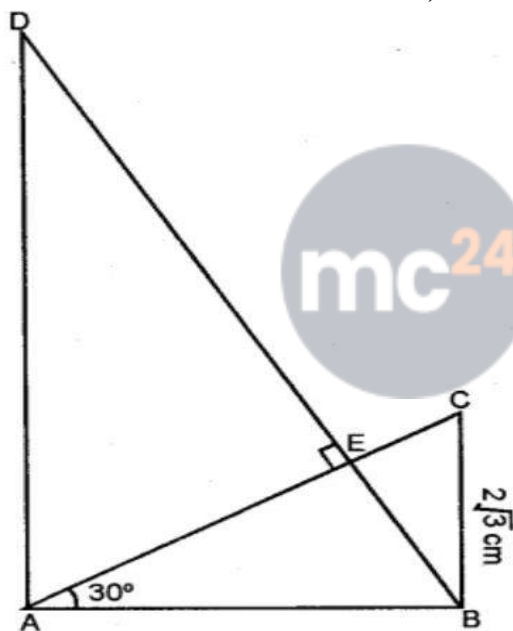
$$90^\circ + 20^\circ = \theta + 4\theta$$

$$5\theta = 110^\circ$$

$$\theta = 110^\circ/5$$

$$\therefore \theta = 22^\circ$$

12. In the adjoining figure, $\triangle ABC$ is right-angled triangle at B and $\triangle ABD$ is right angled triangle at A . If $BD \perp AC$ and $BC = 2\sqrt{3}\text{cm}$, find the length of AD .



Solution:

Given, $\triangle ABC$ and $\triangle ABD$ are right angled triangles in which $\angle A = 90^\circ$ and $\angle B = 90^\circ$

And,

$BC = 2\sqrt{3}$ cm. AC and BD intersect each other at E at right angle and $\angle CAB = 30^\circ$.

Now in right $\triangle ABC$, we have

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

$$\Rightarrow \tan 30^\circ = 2\sqrt{3}/AB$$

$$\Rightarrow 1/\sqrt{3} = 2\sqrt{3}/AB$$

$$\Rightarrow AB = 2\sqrt{3} \times \sqrt{3} = 2 \times 3 = 6 \text{ cm.}$$

In $\triangle ABE$, $\angle EAB = 30^\circ$ and $\angle AEB = 90^\circ$

Hence,

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$$\begin{aligned}\angle ABE \text{ or } \angle ABD &= 180^\circ - 90^\circ - 30^\circ \\ &= 60^\circ\end{aligned}$$

Now in right $\triangle ABD$, we have

$$\tan 60^\circ = AD/AB$$

$$\Rightarrow \sqrt{3} = AD/6$$

Thus, $AD = 6\sqrt{3}$ cm.

