EXERCISE 8.1

Choose the correct answer from the given four options:

1. If cos A = 4/5 , then the value of tan A is

(A) 3/5 (B) ¾ (C) 4/3 (D) 5/3

Solution:

(B) 3/4

According to the question,

cos A = 4/5 …(1)

We know,

tan A = sinA/cosA

To find the value of sin A,

We have the equation,

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

So, $\sin \theta = \sqrt{(1-\cos^2 \theta)}$

Then,

$\sin A = \sqrt{(1-\cos^2 A)}$ …(2)

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

$\sin A = \sqrt{(1-\cos^2 A)}$

Substituting equation (1) in (2),

We get,

Sin A $= \sqrt{(1-(4/5)^2)}$

$= \sqrt{(1-(16/25))}$

$= \sqrt{(9/25)}$

= ¾

Therefore,

$$\tan A = \frac{3}{5} \times \frac{5}{4} = \frac{3}{4}$$

2. If sin A = ½ , then the value of cot A is

(A) √3 (B) 1/√3 (C) √3/2 (D) 1

Solution:

(A) √3

According to the question,

Sin A = ½ … (1)

We know that,

$$\cot A = \frac{1}{\tan A} = \frac{\cos A}{\sin A} \text{ … (2)}$$

To find the value of cos A.

We have the equation,

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

So, $\cos \theta = \sqrt{(1-\sin^2 \theta)}$

Then,

$\cos A = \sqrt{(1-\sin^2 A)}$ … (3)

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

$\cos A = \sqrt{(1-\sin^2 A)}$

Substituting equation 1 in 3, we get,

$\cos A = \sqrt{(1-1/4)} = \sqrt{(3/4)} = \sqrt{3}/2$

Substituting values of sin A and cos A in equation 2, we get

$\cot A = (\sqrt{3}/2) \times 2 = \sqrt{3}$

3. The value of the expression [cosec (75° + θ) – sec (15° – θ) – tan (55° + θ) + cot (35° – θ)] is

(A) – 1 (B) 0 (C) 1 (D) 3 2

Solution:

(B) 0

According to the question,

We have to find the value of the equation,

$\text{cosec}(75°+\theta) - \sec(15°-\theta) - \tan(55°+\theta) + \cot(35°-\theta)$

$= \text{cosec}[90°-(15°-\theta)] - \sec(15°-\theta) - \tan(55°+\theta) + \cot[90°-(55°+\theta)]$

Since, $\text{cosec}(90°-\theta) = \sec\theta$

And, $\cot(90°-\theta) = \tan\theta$

We get,

$= \sec(15°-\theta) - \sec(15°-\theta) - \tan(55°+\theta) + \tan(55°+\theta)$

$= 0$

4. Given that sinθ = a b , then cosθ is equal to

(A) $b/\sqrt{(b^2- a^2)}$ (B) b/a (C) $\sqrt{(b^2-a^2)}/b$ (D) $a/\sqrt{(b^2-a^2)}$

Solution:

(C) $\sqrt{(b^2-a^2)}/b$

According to the question,

$\sin\theta = a/b$

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

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

$\sin A = \sqrt{(1-\cos^2 A}$

So, $\cos\theta = \sqrt{(1-a^2/b^2)} = \sqrt{((b^2-a^2)/b^2)} = \sqrt{(b^2-a^2)}/$

b Hence, $\cos\theta = \sqrt{(b^2 - a^2)}/b$

5. If cos (α + β) = 0, then sin (α – β) can be reduced to

(A) cos β (B) cos 2β (C) sin α (D) sin 2α

Solution:

(B) cos 2β

According to the question,

$\cos(\alpha+\beta) = 0$

Since, $\cos 90° = 0$

We can write,

$\cos(\alpha+\beta)= \cos 90°$

By comparing cosine equation on L.H.S and R.H.S,

We get,

$(\alpha+\beta)= 90°$

$\alpha = 90°-\beta$

Now we need to reduce $\sin(\alpha - \beta)$,

So, we take,

$\sin(\alpha-\beta) = \sin(90°-\beta-\beta) = \sin(90°-2\beta)$

$\sin(90°-\theta) = \cos\theta$

So, $\sin(90°-2\beta) = \cos 2\beta$

Therefore, $\sin(\alpha-\beta) = \cos 2\beta$

6. The value of (tan1° tan2° tan3° ... tan89°) is

(A) 0 **(B) 1** **(C) 2** **(D) ½**

Solution:

(B) 1

tan 1°. tan 2°.tan 3° …… tan 89°

= tan1°.tan 2°.tan 3°…tan 43°.tan 44°.tan 45°.tan 46°.tan 47°…tan 87°.tan 88°.tan 89°

Since, tan 45° = 1,

= tan1°.tan 2°.tan 3°…tan 43°.tan 44°.1.tan 46°.tan 47°…tan 87°.tan 88°.tan 89°

= tan1°.tan 2°.tan 3°…tan 43°.tan 44°.1.tan(90°-44°).tan(90°-43°)…tan(90°-3°). tan(90°-2°).tan(90°-1°)

Since, tan(90°-θ) = cot θ,

= tan1°.tan 2°.tan 3°…tan 43°.tan 44°.1.cot 44°.cot 43°…cot 3°.cot 2°.cot 1°

Since, tan θ = (1/cot θ)

= tan1°.tan 2°.tan 3°…tan 43°.tan 44°.1. (1/tan 44°). (1/tan 43°)… (1/tan 3°). (1/tan 2°). (1/tan 1°)

$$= \left(\tan 1° \times \frac{1}{\tan 1°}\right).\left(\tan 2° \times \frac{1}{\tan 2°}\right)\ldots\left(\tan 44° \times \frac{1}{\tan 44°}\right)$$

= 1

Hence, tan 1°.tan 2°.tan 3° …… tan 89° = 1

7. If cos 9α = sinα and 9α < 90° , then the value of tan5α is

(A) 1/√3 **(B) √3** **(C) 1** **(D) 0**

Solution:

(C) 1

According to the question,

cos 9∝ = sin ∝ and 9∝<90°

i.e. 9α is an acute angle

We know that,

sin(90°-θ) = cos θ

So,

cos 9∝ = sin (90°-∝)

Since, cos 9∝ = sin(90°-9∝) and sin(90°-∝) = sin∝

Thus, sin (90°-9∝) = sin∝

90°-9∝ =∝

10∝ = 90°

∝ = 9°

Substituting ∝ = 9° in tan 5∝, we get,

tan 5∝ = tan (5×9) = tan 45° = 1

∴, tan 5∝ = 1

EXERCISE 8.2 PAGE NO: 93

Write 'True' or 'False' and justify your answer in each of the following:

1. $\tan 47^o/\cot 43° = 1$

Solution:

True

<u>Justification:</u>

Since, $\tan(90° - \theta) = \cot\theta$

$\frac{\tan 47°}{\cot 43°} = \frac{\tan(90°-43°)}{\cot 43°}$

$\frac{\tan 47°}{\cot 43°} = \frac{\cot 43°}{\cot 43°} = 1$

$\frac{\tan 47°}{\cot 43°} = 1$

2. The value of the expression $(\cos^2 23° – \sin^2 67°)$ is positive.

Solution:

False

<u>Justification:</u>

Since, $(a^2-b^2) = (a+b)(a-b)$

$\cos^2 23° - \sin^2 67° = (\cos 23°+\sin 67°)(\cos 23°-\sin 67°)$

$= [\cos 23°+\sin(90°-23°)] [\cos 23°-\sin(90°-23°)]$

$= (\cos 23°+\cos 23°)(\cos 23°-\cos 23°)$ $(\because \sin(90°-\theta) = \cos\theta)$

$= (\cos 23°+\cos 23°).0$

$= 0$, which is neither positive nor negative

3. The value of the expression $(\sin 80° – \cos 80°)$ is negative.

Solution:

False

<u>Justification:</u>

We know that,

$\sin\theta$ increases when $0° \leq \theta \leq 90°$

$\cos\theta$ decreases when $0° \leq \theta \leq 90°$

And $(\sin 80°-\cos 80°)$ = (increasing value-decreasing value)

= a positive value.

Therefore, $(\sin 80°-\cos 80°) > 0$.

4. $\sqrt{(1– \cos^2\theta) \sec^2\theta} = \tan\theta$

Solution:

True

<u>Justification:</u>

LHS: $\sqrt{((1-\cos^2\theta)\sec^2\theta)}$

$= \sqrt{\sin^2\theta\sec^2\theta}$

$(\because \sin^2\theta + \cos^2\theta = 1 \Rightarrow \sin^2\theta = 1-\cos^2\theta)$

$= \sqrt{\frac{\sin^2\theta}{\cos^2\theta}}$ (Since, $\sec^2\theta = \frac{1}{\cos^2\theta}$)

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

$= \tan\theta$

= RHS

5. If $\cos A + \cos^2 A = 1$, then $\sin^2 A + \sin^4 A = 1$.

Solution:

True

Justification:

According to the question,

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

i.e., $\cos A = 1 - \cos^2 A$

Since,

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

$\sin^2\theta = 1 - \cos^2\theta)$

We get,

$\cos A = \sin^2 A$ …(1)

Squaring L.H.S and R.H.S,

$\cos^2 A = \sin^4 A$ …(2)

To find $\sin^2 A + \sin^4 A = 1$

Adding equations (1) and (2),

We get

$\sin^2 A + \sin^4 A = \cos A + \cos^2 A$

Therefore, $\sin^2 A + \sin^4 A = 1$

6. $(\tan\theta + 2)(2\tan\theta + 1) = 5\tan\theta + \sec^2\theta$.

Solution:

False

Justification:

L.H.S $= (\tan\theta+2)(2\tan\theta+1)$

$= 2\tan^2\theta + \tan\theta + 4\tan\theta + 2$

$= 2\tan^2\theta + 5\tan\theta + 2$

Since, $\sec^2\theta - \tan^2\theta = 1$, we get, $\tan^2\theta = \sec^2\theta - 1$

$= 2(\sec^2\theta - 1) + 5\tan\theta + 2$

$= 2\sec^2\theta - 2 + 5\tan\theta + 2$

$= 5\tan\theta + 2\sec^2\theta \neq$ R.H.S

$\therefore$, L.H.S $\neq$ R.H.S

EXERCISE 8.3

Prove the following (from Q.1 to Q.7):

1. sin θ/(1+cos θ) + (1+ cos θ)/sin θ = 2cosec θ

Solution:

L.H.S=

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

Taking the L.C.M of the denominators,

We get,

$$= \frac{\sin^2\theta+(1+\cos\theta)^2}{(1+\cos\theta).\sin\theta}$$

$$= \frac{\sin^2\theta+1+\cos^2\theta+2\cos\theta}{(1+\cos\theta).\sin\theta}$$

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

$$= \frac{1+1+2\cos\theta}{(1+\cos\theta).\sin\theta}$$

$$= \frac{2+2\cos\theta}{(1+\cos\theta).\sin\theta}$$

$$= \frac{2(1+\cos\theta)}{(1+\cos\theta).\sin\theta}$$

Since, $1/\sin\theta = \text{cosec}\,\theta$

$$= \frac{2}{\sin\theta} = 2\,\text{cosec}\,\theta$$

R.H.S

Hence proved.

2. tan A/(1+secA) - tan A/(1-secA) = 2cosec A

Solution:

L.H.S:

$$\frac{\tan A}{1+\sec A} - \frac{\tan A}{1-\sec A}$$

Taking LCM of the denominators,

$$= \frac{\tan A(1-\sec A)-\tan A(1+\sec A)}{(1+\sec A)(1-\sec A)}$$

Since, $(1 + \sec A)(1 - \sec A) = 1 - \sec^2 A)$

$$= \frac{\tan A(1-\sec A-1-\sec A)}{1-\sec^2 A}$$

$$= \frac{\tan A(-2\sec A)}{1-\sec^2 A}$$

$$= \frac{2\tan A.\sec A}{\sec^2 A-1}$$

Since,

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

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

$= \frac{2 \tan A . \sec A}{\tan^2 A}$

Since, sec A = (1/cos A) and tan A = (sin A/ cos A)

$= \frac{2 \sec A}{\tan A} = \frac{2 \cos A}{\cos A \sin A}$

$= \frac{2}{\sin A}$

$= 2 \operatorname{cosec} A \ (\because \frac{1}{\sin A} = \operatorname{cosec} A)$

= R.H.S

Hence proved.

3. If tan A = ¾, then sinA cosA = 12/25

Solution:

According to the question,

tan A = ¾

We know,

tan A = perpendicular/ base

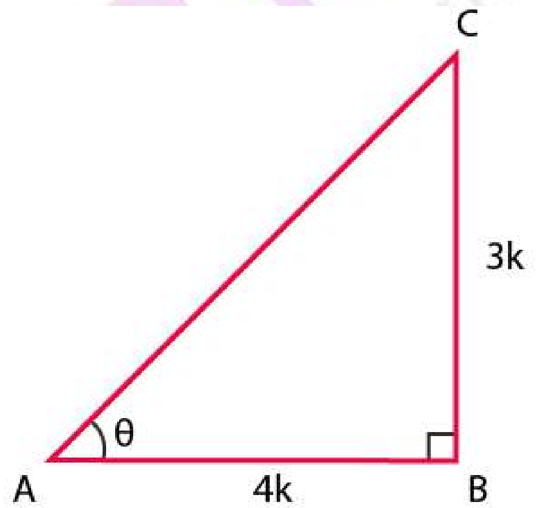
So,

tan A = 3k/4k

Where,

Perpendicular = 3k

Base = 4k



Using Pythagoras Theorem,

$(\text{hypotenuse})^2 = (\text{perpendicular})^2 + (\text{base})^2$

$(\text{hypotenuse})^2 = (3k)^2 + (4k)^2 = 9k^2+16k^2 = 25k^2$

hypotenuse = 5k

To find sin A and cos A,

$$\sin A = \frac{\text{perpendicular}}{\text{hypotenuse}} = \frac{3k}{5k} = \frac{3}{5}$$

$$\cos A = \frac{\text{base}}{\text{hypotenuse}} = \frac{4k}{5k} = \frac{4}{5}$$

Multiplying sin A and cos A,

$$\sin A \cos A = \frac{3}{5} \times \frac{4}{5} = \frac{12}{25}$$

Hence, proved.

4. (sin α + cos α) (tan α + cot α) = sec α + cosec α

Solution:

L.H.S:

(sin α + cos α) (tan α + cot α)

As we know,

$$\tan A = \frac{\sin A}{\cos A}$$

$$\cot A = \frac{\cos A}{\sin A}$$

$$= (\sin\alpha + \cos\alpha)\left(\frac{\sin\alpha}{\cos\alpha} + \frac{\cos\alpha}{\sin\alpha}\right)$$

$$= (\sin\alpha + \cos\alpha)\left(\frac{\sin^2\alpha + \cos^2\alpha}{\sin\alpha\cos\alpha}\right)$$

$$[\because \sin^2\alpha + \cos^2\alpha = 1]$$

$$= (\sin\alpha + \cos\alpha)\left(\frac{1}{\sin\alpha\cos\alpha}\right)$$

$$= \frac{\sin\alpha}{\sin\alpha\cos\alpha} + \frac{\cos\alpha}{\sin\alpha\cos\alpha}$$

$$= \frac{1}{\cos\alpha} + \frac{1}{\sin\alpha}$$

$$= \sec\alpha + \operatorname{cosec}\alpha \left[\because \frac{1}{\cos\alpha} = \sec\alpha \text{ and } \frac{1}{\sin\alpha} = \operatorname{cosec}\alpha\right]$$

= R.H.S

Hence, proved.

5. (√3+1) (3 – cot 30°) = $\tan^3 60°$ – 2 sin 60°

Solution:

L.H.S: (√3 + 1) (3 – cot 30°)

= (√3 + 1) (3 – √3) [∵cos 30° = √3]

= (√3 + 1) √3 (√3 - 1) [∵(3 – √3) = √3 (√3 - 1)]

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

= (3-1) √3

= 2√3

Similarly solving R.H.S: $\tan^3 60°$ - 2 sin 60°

Since, tan 60° = √3 and sin 60° = √3/2,

We get,

$(\sqrt{3})^3 - 2.(\sqrt{3}/2) = 3\sqrt{3} - \sqrt{3}$
$= 2\sqrt{3}$
Therefore, L.H.S = R.H.S
Hence, proved.

6. 1 + ($\cot^2 \alpha$/1+cosec α) = cosec α
Solution:

L.H.S:
Since,

$$\cot^2\alpha = \frac{\cos^2\alpha}{\sin^2\alpha} \text{ and } \operatorname{cosec}\alpha = \frac{1}{\sin\alpha}]$$

We get,

$$1+\frac{\cot^2\alpha}{1+\operatorname{cosec}\alpha} = 1+\frac{\cos^2\alpha/\sin^2\alpha}{1+1/\sin\alpha}$$

$$= 1+\frac{\cos^2\alpha/\sin^2\alpha}{\frac{\sin\alpha+1}{\sin\alpha}}$$

$$= 1+\frac{\cos^2\alpha}{\sin\alpha(1+\sin\alpha)}$$

$$= \frac{\sin\alpha+\sin^2\alpha+\cos^2\alpha}{\sin\alpha+\sin^2\alpha}$$

And, we know that,

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

$$= \frac{1+\sin\alpha}{\sin\alpha(1+\sin\alpha)}$$

Since,

$$\frac{1}{\sin\alpha} = \operatorname{cosec}\alpha]$$

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

= R.H.S

7. tan θ + tan (90° – θ) = sec θ sec (90° – θ)
Solution:

L.H.S=
Since, tan (90° - θ) = cot θ
tan θ + tan (90° - θ)= tan θ + cot θ

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

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

Since,

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

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

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

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

Since,

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

$= \sec\theta \sec(90° - \theta)$

= R.H.S

Hence, proved.

EXERCISE 8.4 PAGE NO: 99

1. If cosecθ + cotθ = p, then prove that $\cos\theta = (p^2 - 1)/(p^2 + 1)$.

Solution:

According to the question,

cosec θ + cot θ = p

Since,

$$\operatorname{cosec}\theta = \frac{1}{\sin\theta} \text{ \& } \cot\theta = \frac{\cos\theta}{\sin\theta}$$

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

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

Squaring on L.H.S and R.H.S,

$$\left(\frac{1+\cos\theta}{\sin\theta}\right)^2 = p^2$$

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

Applying component and dividend rule,

$$\frac{(1+\cos^2\theta+2\cos\theta)-\sin^2\theta}{(1+\cos^2\theta+2\cos\theta)+\sin^2\theta} = \frac{p^2-1}{p^2+1}$$

$$\frac{(1-\sin^2\theta)+\cos^2\theta+2\cos\theta}{\sin^2\theta+\cos^2\theta+1+2\cos\theta} = \frac{p^2-1}{p^2+1}$$

Since,

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

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

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

$$\frac{2\cos\theta\,(\cos\theta+1)}{2\,(\cos\theta+1)} = \frac{p^2-1}{p^2+1}$$

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

Hence, proved.

2. Prove that $\sqrt{\sec^2\theta + \operatorname{cosec}^2\theta} = \tan\theta + \cot\theta$

Solution:

L.H.S=

$\sqrt{(\sec^2\theta + \operatorname{cosec}^2\theta)}$

Since,

$\sec^2\theta = \frac{1}{\cos^2\theta}$ & $\text{cosec}^2\theta = \frac{1}{\sin^2\theta}$

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

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

Since,

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

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

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

Since,

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

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

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

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

Since,

$\frac{\sin\theta}{\cos\theta} = \tan\theta$ & $\frac{\cos\theta}{\sin\theta} = \cot\theta$

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

= R.H.S

Hence, proved.

3. The angle of elevation of the top of a tower from certain point is 30°. If the observer moves 20 metres towards the tower, the angle of elevation of the top increases by 15°. Find the height of the tower.

Solution:

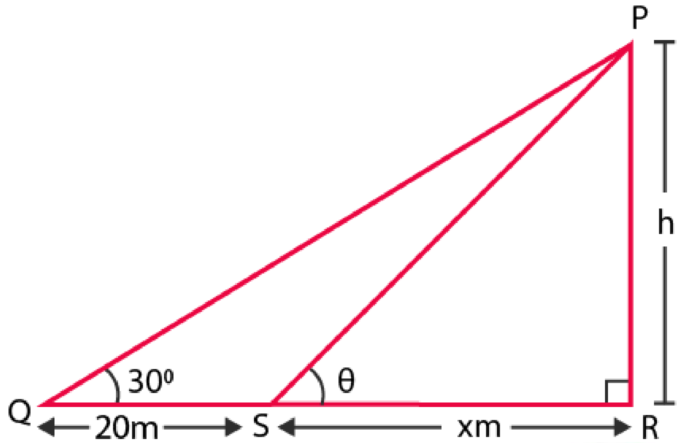
Let PR = h meter, be the height of the tower.

The observer is standing at point Q such that, the distance between the observer and tower is QR = (20+x) m, where

QR = QS + SR = 20 + x

∠PQR = 30°

∠ PSR = θ



In ΔPQR,

$$\tan 30° = \frac{h}{20+x} \left[\because, \tan\theta = \frac{\text{perpendicular}}{\text{base}}\right]$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{h}{20+x} \left[\because, \tan 30° = \frac{1}{\sqrt{3}}\right]$$

Rearranging the terms,
We get $20 + x = \sqrt{3}h$
$\Rightarrow x = \sqrt{3}h - 20$ …eq.1
In ΔPSR,
$\tan\theta = h/x$
Since, angle of elevation increases by 15^o when the observer moves 20 m towards the tower.
We have,
$\theta = 30° + 15° = 45°$
So,
$\tan 45^o = h/x$
$\Rightarrow 1 = h/x$
$\Rightarrow h = x$
Substituting x=h in eq. 1, we get
$h = \sqrt{3}\,h - 20$
$\Rightarrow \sqrt{3}\,h - h = 20$
$\Rightarrow h(\sqrt{3} - 1) = 20$

$$\Rightarrow h = \frac{20}{\sqrt{3}-1}$$

Rationalizing the denominator, we have

$$\Rightarrow h = \frac{20}{\sqrt{3}-1} \times \frac{\sqrt{3}+1}{\sqrt{3}+1}$$

$$\Rightarrow h = \frac{20(\sqrt{3}+1)}{(\sqrt{3}-1)(\sqrt{3}+1)}$$

$$= \frac{20(\sqrt{3}+1)}{3-1}$$

$$= \frac{20(\sqrt{3}+1)}{2}$$

$= 10(\sqrt{3} + 1)$
Hence, the required height of the tower is $10(\sqrt{3} + 1)$ meter.

4. If $1 + \sin^2\theta = 3\sin\theta \cos\theta$, then prove that $\tan\theta = 1$ or ½.
Solution:

Given: $1+\sin^2 \theta = 3 \sin \theta \cos \theta$
Dividing L.H.S and R.H.S equations with $\sin^2 \theta$,
We get,

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

$$\Rightarrow \frac{1}{\sin^2\theta} + 1 = \frac{3\cos\theta}{\sin\theta}$$

$\operatorname{cosec}^2 \theta + 1 = 3 \cot \theta$
Since,
$\operatorname{cosec}^2 \theta - \cot^2 \theta = 1 \Rightarrow \operatorname{cosec}^2 \theta = \cot^2 \theta +1$
$\Rightarrow \cot^2 \theta +1+1 = 3 \cot \theta$
$\Rightarrow \cot^2 \theta +2 = 3 \cot \theta$
$\Rightarrow \cot^2 \theta -3 \cot \theta +2 = 0$
Splitting the middle term and then solving the equation,
$\Rightarrow \cot^2 \theta - \cot \theta -2 \cot \theta +2 = 0$
$\Rightarrow \cot \theta(\cot \theta -1)-2(\cot \theta +1) = 0$
$\Rightarrow (\cot \theta - 1)(\cot \theta - 2) = 0$
$\Rightarrow \cot \theta = 1, 2$
Since,
$\tan \theta = 1/\cot \theta$
$\tan \theta = 1$, ½
Hence, proved.

5. Given that $\sin\theta + 2\cos\theta = 1$, then prove that $2\sin\theta - \cos\theta = 2$.
Solution:

Given: $\sin \theta +2 \cos \theta = 1$
Squaring on both sides,
$(\sin \theta +2 \cos \theta)^2 = 1$
$\Rightarrow \sin^2 \theta + 4 \cos^2 \theta + 4\sin \theta\cos \theta = 1$
Since, $\sin^2 \theta = 1 - \cos^2 \theta$ and $\cos^2 \theta = 1 - \sin^2 \theta$
$\Rightarrow (1 - \cos^2 \theta) + 4(1 - \sin^2 \theta) + 4\sin \theta\cos \theta = 1$
$\Rightarrow 1 - \cos^2 \theta + 4 - 4 \sin^2 \theta + 4\sin \theta\cos \theta = 1$
$\Rightarrow - 4 \sin^2 \theta - \cos^2 \theta + 4\sin \theta\cos \theta = - 4$
$\Rightarrow 4 \sin^2 \theta + \cos^2 \theta - 4\sin \theta\cos \theta = 4$
We know that,
$a^2+ b^2 - 2ab = (a - b)^2$
So, we get,
$(2\sin \theta - \cos \theta)^2 = 4$
$\Rightarrow 2\sin \theta - \cos \theta = 2$
Hence proved.

6. The angle of elevation of the top of a tower from two points distant s and t from its foot are complementary. Prove that the height of the tower is $\sqrt{st}$.

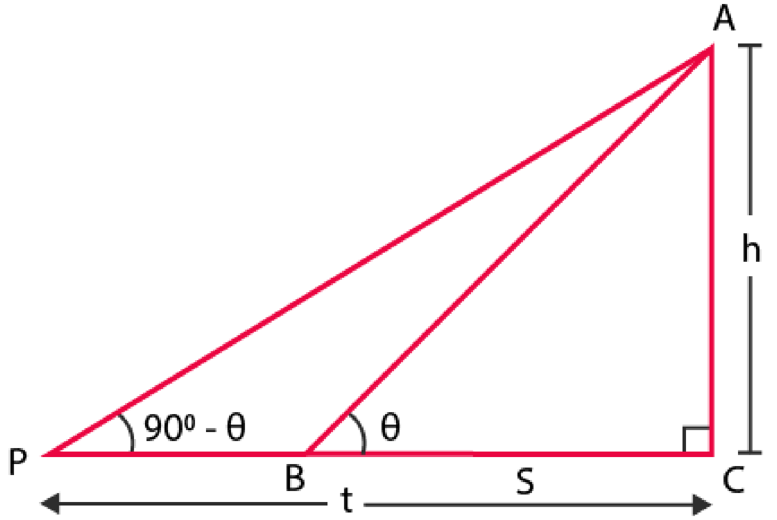
Solution:

Let BC = s; PC = t

Let height of the tower be AB = h.

$\angle ABC = \theta$ and $\angle APC = 90° - \theta$

($\because$ the angle of elevation of the top of the tower from two points P and B are complementary)



In $\Delta ABC, \tan\theta = \frac{AC}{BC} = \frac{h}{s}$ ... eq. 1 $[\because, \tan\theta = \frac{\text{perpendicular}}{\text{base}}]$

In $\Delta APC, \tan(90° - \theta) = \frac{AC}{PC} = \frac{h}{t}$

$\Rightarrow \cot\theta = \frac{h}{t}$ ... eq. 2

Multiplying eq. 1 and eq. 2, we get

$\tan\theta \times \cot\theta = \frac{h}{s} \times \frac{h}{t}$

$\Rightarrow 1 = \frac{h^2}{st}$ $[\because \tan\theta \times \cot\theta = 1 \text{ as } \cot\theta = \frac{1}{\tan\theta}]$

$\Rightarrow h^2 = st$

$\Rightarrow h = \sqrt{st}$

Hence the height of the tower is $\sqrt{st}$.

7. The shadow of a tower standing on a level plane is found to be 50 m longer when Sun's elevation is 30° than when it is 60°. Find the height of the tower.

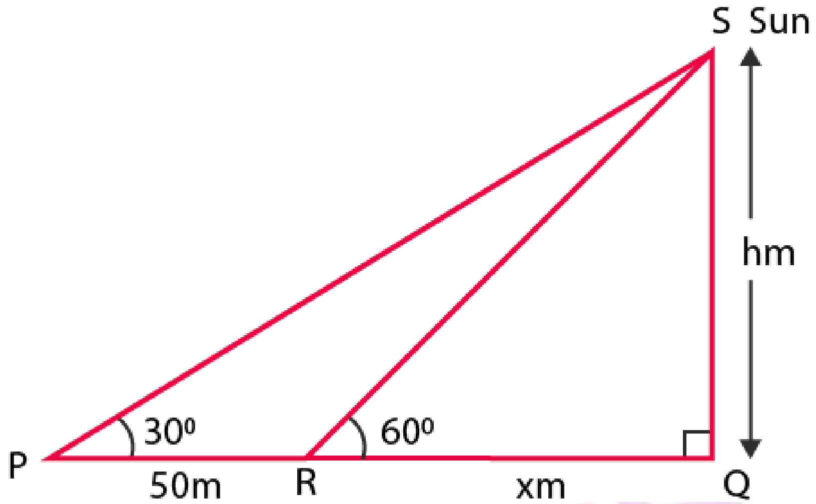
Solution:

Let SQ = h be the tower.

$\angle SPQ = 30°$ and $\angle SRQ = 60°$

According to the question, the length of shadow is 50 m long hen angle of elevation of the sun is 30° than when it was 60°. So,

PR = 50 m and RQ = x m



So in ΔSRQ, we have

$\tan 60° = \frac{h}{x}$

$[\because \tan\theta = \frac{\text{perpendicular}}{\text{base}}$

$\Rightarrow \tan 60° = \frac{SQ}{RQ}]$

$\Rightarrow \sqrt{3} = \frac{h}{x}$ $[\because \tan 60° = \sqrt{3}]$

$\Rightarrow x = \frac{h}{\sqrt{3}}$

In ΔSPQ,

$\tan 30° = \frac{h}{50+x}$

$[\because \tan 30° = \frac{SQ}{PQ} = \frac{SQ}{PR+PQ}]$

$\Rightarrow \frac{1}{\sqrt{3}} = \frac{h}{50+x}$ $[\because, \tan 30° = \frac{1}{\sqrt{3}}]$

$\Rightarrow 50 + x = \sqrt{3}h$

Substituting the value of x in the above equation, we get

$\Rightarrow 50 + \frac{h}{\sqrt{3}} = \sqrt{3}h$

$\Rightarrow \frac{50\sqrt{3}+h}{\sqrt{3}} = \sqrt{3}h$

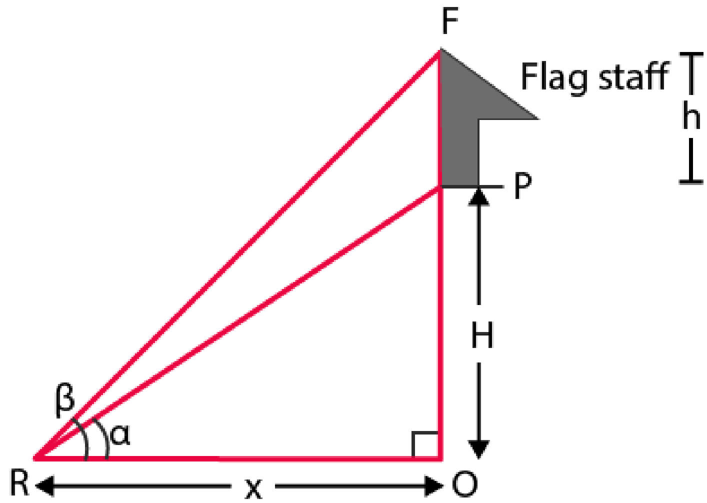
$\Rightarrow 50\sqrt{3}+h = 3h$
$\Rightarrow 50\sqrt{3} = 3h – h$
$\Rightarrow 3h - h = 50\sqrt{3}$
$\Rightarrow 2h = 50\sqrt{3}$
$\Rightarrow h = (50\sqrt{3})/2$
$\Rightarrow h = 25\sqrt{3}$
Hence, the required height is $25\sqrt{3}$ m.

8. A vertical tower stands on a horizontal plane and is surmounted by a vertical flag staff of height

h. At a point on the plane, the angles of elevation of the bottom and the top of the flag staff are α and β, respectively. Prove that the height of the tower is [h tan α/(tan β – tan α)].
Solution:

Given that a vertical flag staff of height h is surmounted on a vertical tower of height H(say), such that FP = h and FO = H.

The angle of elevation of the bottom and top of the flag staff on the plane is ∠PRO = α and ∠FRO = β respectively



In ΔPRO, we have

$$\tan\alpha = \frac{PO}{RO} = \frac{H}{x}$$

$$[\because \tan\theta = \frac{\text{perpendicular}}{\text{base}}]$$

$$\Rightarrow x = \frac{H}{\tan\alpha} \text{ ... eq. 1}$$

And in ΔFRO, we have

$$\tan\beta = \frac{FO}{RO} = \frac{FP+PO}{RO} = \frac{h+H}{x}$$

$$\Rightarrow x = \frac{h+H}{\tan\beta} \text{ ... eq. 2}$$

Comparing eq. 1 and eq. 2,

$$\Rightarrow \frac{H}{\tan\alpha} = \frac{h+H}{\tan\beta}$$

Solving for H,

$\Rightarrow$ H tan β = (h+H) tan α

$\Rightarrow$ H tan β – H tan α = h tan α

$\Rightarrow$ H (tan β – tan α) = h tan α

$$\Rightarrow H = \frac{h\tan\alpha}{\tan\beta - \tan\alpha}$$

Hence, proved.

9. If tanθ + secθ = l, then prove that secθ = (l^2 + 1)/2l.
Solution:

Given: tan θ+ sec θ = l …eq. 1

Multiplying and dividing by (sec θ – tan θ) on numerator and denominator of L.H.S,

$$\frac{(\sec\theta+\tan\theta)(\sec\theta-\tan\theta)}{\sec\theta-\tan\theta} = l$$

$$\Rightarrow \frac{\sec^2\theta-\tan^2\theta}{\sec\theta-\tan\theta} = l$$

Since, $\sec^2\theta - \tan^2\theta = 1$

$$\Rightarrow \frac{1}{\sec\theta-\tan\theta} = l$$

So, sec θ – tan θ = 1 …eq.2

Adding eq. 1and eq. 2, we get

(tan θ + sec θ) + (sec θ – tan θ) = 1

$$\Rightarrow 2\sec\theta = \frac{l^2+1}{l}$$

$$\Rightarrow \sec\theta = \frac{l^2+1}{2l}$$

Hence, proved.