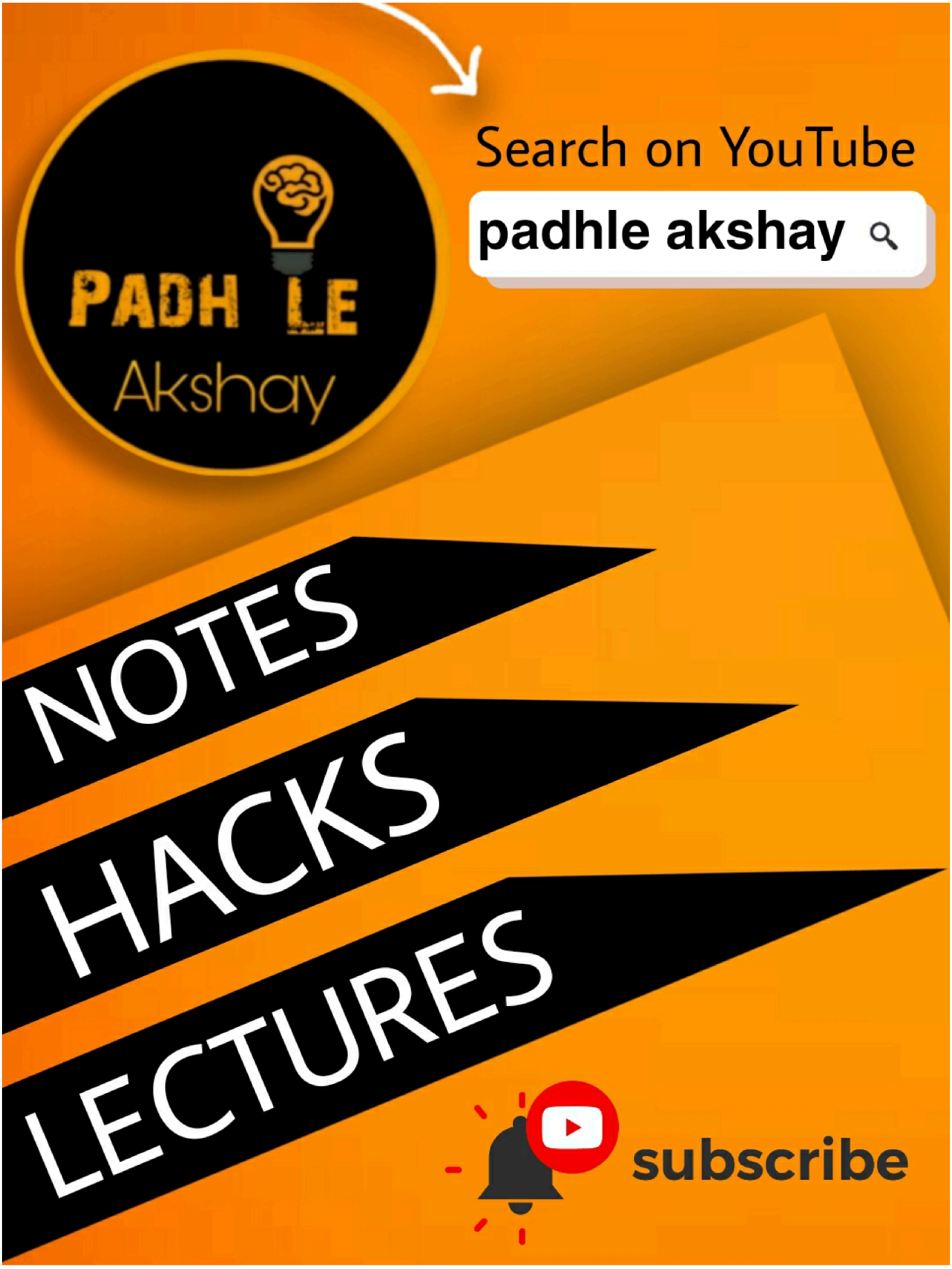
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Chapter-9 Some Application Of Trigonometry

Short Question

Q. 3. From a point *P* on the ground the angle of elevation of the top of a 10 m tall building is 30°. A flag is hosted at the top of the building and the angle of elevation of the top of the flagstaff from *P* is 45°. Find the length of the flagstaff and distance of building from point *P*. [Take $\sqrt{3} = 1.732$]

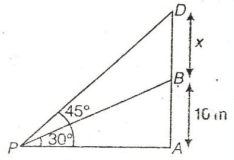
[NCERT, CBSE (AI) 2011, 12, 13]

Sol. In ΔAPB,

$$\tan\theta = \frac{AB}{AP}$$

$$\Rightarrow \quad \tan 30° = \frac{10}{AP}$$

$$\Rightarrow \quad AP = 10\sqrt{3}$$



Distance of the building,

$$AP = 10 \times 1.732$$

$$= 17.32 \text{ m}$$

In ΔAPD, $\quad \tan 45° = \frac{AD}{AP}$

$$\Rightarrow \quad 1 = \frac{10 + x}{10\sqrt{3}}$$

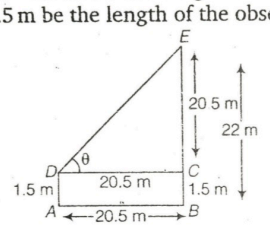
$$\Rightarrow \quad x = 7.32 \text{ m}$$

Hence, the length of the flagstaff and distance of building from point *P* are 7.32 m and 17.32 m, respectively.

Q. 5. An observer 1.5 m tall is 20.5 m away from a tower 22 m high. Determine the angle of elevation of the top of the tower from the eye of the observer.

[NCERT Exemplar, CBSE 2012]

Sol. Let $BE = 22$ m be the height of the tower and $AD = 1.5$ m be the length of the observer.



Also, $AB = 20.5$ m $= DC$

Let θ be the angle make by observer's eye to the top of the tower *i.e.*, $\angle EDC = \theta$

Now, $\quad EC = BE - BC$

$$= BE - AD$$

$$= 22 - 1.5 = 20.5 \text{ m}$$

In right ΔDCE,

$$\tan\theta = \frac{CE}{DC} = \frac{20.5}{20.5} = 1 = \tan 45°$$

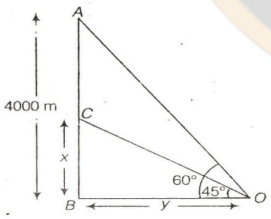
$$\Rightarrow \quad \theta = 45°$$

Hence, the angle of the top of the tower from the eye of the observer is 45°.

Q. 8. An aeroplane, when flying at a height of 4000 m from the ground passes vertically above another aeroplane at an instant when the angles of elevation of the two planes from the same point on the ground are 60° and 45° respectively. Find the vertical distance between the aeroplanes at that instant. (Take $\sqrt{3} = 1.73$)

[CBSE (F) 2016]

Sol. Let *A* and *B* be the position of two aeroplanes, when *C* is vertically below *A* and $B = 4000$ m. Let the angle of elevation of *A* and *C* from a point *O* on the ground 60° and 45°, respectively.



In ΔOBC, $\quad \tan 45° = \frac{BC}{BO}$

$$\Rightarrow \quad 1 = \frac{x}{y} \quad \Rightarrow \quad x = y \quad \ldots(1)$$

Now, in ΔABO, $\quad \tan 60° = \frac{AB}{BO}$

$$\Rightarrow \quad \sqrt{3} = \frac{4000}{y}$$

$$\Rightarrow \quad y = \frac{4000}{\sqrt{3}}$$

$$\Rightarrow \quad y = \frac{4000\sqrt{3}}{\sqrt{3} \times \sqrt{3}} = \frac{4000\sqrt{3}}{3}$$

$$y = \frac{4000 \times 1.73}{3} = \frac{6920}{3}$$

$$= 2306.67 \text{ m}$$

$\therefore \quad x = 2306.67$ m [using eq. (1)]

$\therefore$ Vertical distance between the aeroplane at that instant

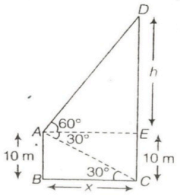
$$= 4000 - x$$

$$= 4000 - 2306.67 = 1693.33 \text{ m}$$

Q. 9. A man standing on the deck of a ship, which is 10 m above water level, observes the angle of elevation of the top of a hill as 60° and the angle of depression of the base of hill as 30°. Find the distance of the hill from the ship and the height of the hill.

[CBSE (AI) 2016]

Sol. Let a man is standing on the deck of a ship at point *A* such that $AB = 10$ m and *CD* be the hill.



Given, the angle of depression of the base *C* of the hill *CD* observed from *A* is 30° and the angle of elevation of top *D* of the hill *CD* observed from *A* is 60°.

Then $\quad \angle EAD = 60°$

and $\quad \angle CAE = \angle BCA = 30°$ [alternate angles]

Let $\quad BC = x = AE$

$\quad DE = h$

and $\quad CE = AB = 10$ m

In ΔAED, $\quad \tan 60° = \frac{DE}{EA}$

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

$$\Rightarrow \quad h = \sqrt{3}x \quad \ldots(1)$$

In ΔABC $\quad \tan 30° = \frac{AB}{BC}$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{10}{x}$$

$$\Rightarrow \quad x = 10\sqrt{3} \quad \ldots(2)$$

On putting $x = 10\sqrt{3}$ in eq. (1), we get

$$h = \sqrt{3} \times 10\sqrt{3} = 30 \text{ m}$$

Now, $\quad CD = CE + DE = 10 + 30 = 40$ m

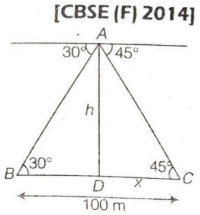
Hence, the distance of the hill from the ship is $10\sqrt{3}$ m and height of the hill is 40 m.

Q.10. Two ships are approaching a light house from opposite directions. The angle of depression of two ships from top of the light house are 30° and 45°. If the distance between two ships is 100 m. Find the height of lighthouse. [CBSE (F) 2014]

Sol. Let AD be the height (h) of the lighthouse and BC is the distance between the ships.

Given, $BC = 100$ m

In ΔACD,



$$\tan 45° = \frac{h}{DC}$$

$$\Rightarrow \quad 1 = \frac{h}{x}$$

$$\Rightarrow \quad x = h \qquad \ldots(1)$$

In ΔABD, $\quad \tan 30° = \dfrac{h}{100 - DC}$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{h}{100 - x}$$

$$\therefore \quad 100 - x = h\sqrt{3}$$

$$100 - h = h\sqrt{3} \qquad \text{[from eq. (1)]}$$

$$100 = h + h\sqrt{3}$$

$$100 = h(1 + \sqrt{3})$$

$$\Rightarrow \quad h = \frac{100}{1 + \sqrt{3}} = \frac{100}{2.732} = 36.60$$

$\therefore$ Hence the height of tower = 36.60 m

Q.11. The angles of depression of the top and bottom of an 8m tall building from top of a multistoreyed building are 30° and 45°, respectively. Find the height of multistoreyed building and distance between two buildings. [CBSE 2014]

Sol. Let h be the height of multistoreyed building and x be the distance between two buildings.

$AE = CD = 8$ m (given)

$BE = AB - AE = (h - 8)$ m

and $\quad AC = DE = x$ m (given)

Also, $\quad \angle FBD = \angle BDE = 30°$ [alternate angles]

$\angle FBC = \angle BCA = 45°$ [alternate angles]

In ΔACB, $\quad \tan 45° = \dfrac{AB}{AC}$

$$\Rightarrow \quad x = h \qquad \ldots(1)$$

In ΔBDE, $\quad \tan 30° = \dfrac{BE}{ED}$

$$\Rightarrow \quad x = \sqrt{3}(h - 8) \qquad \ldots(2)$$

From eq. (1) and (2), we get

$$h = \sqrt{3}h - 8\sqrt{3}$$

$$h = \frac{8\sqrt{3}}{\sqrt{3} - 1} \times \frac{\sqrt{3} + 1}{\sqrt{3} + 1}$$

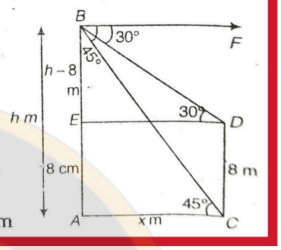
$$= 4\sqrt{3}(\sqrt{3} + 1)$$

$$= (4\sqrt{3} + 12) \text{ m}$$

From eq. (1)

$$x = h$$

Distance $= (4\sqrt{3} + 12)$ m

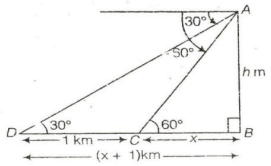


Long Question

Q. 8. From the top of a hill the angles of depression of two consecutive kilometer stones due east are found to be 30° and 60°. Find the height of the hill. [CBSE 2011]

Sol. Let $AB = h$ m be height of the hill.

Let C and D be two consecutive stones, $BC = x$ km and $BD = (x + 1)$ km



As $\angle ACB = 60°$ and $\angle ADB = 30°$

In ΔABC, we have

$$\frac{AB}{BC} = \tan 60°$$

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

$$\Rightarrow \quad h = \sqrt{3}x \qquad \ldots(1)$$

In ΔABD, we have

$$\frac{AB}{BD} = \tan 30°$$

$$\frac{h}{x + 1} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad \sqrt{3}h = x + 1$$

$$\Rightarrow \quad \sqrt{3} \times \sqrt{3}x = x + 1 \qquad \text{[Using eq. (1)]}$$

$$\Rightarrow \quad 3x = x + 1$$

$$\Rightarrow \quad 2x = 1$$

$$\Rightarrow \quad x = \frac{1}{2}$$

Putting the value of x in eq. (1), we have

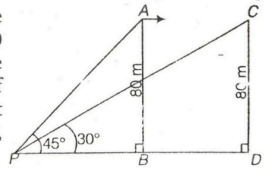
$$h = \sqrt{3} \times \frac{1}{2} = \frac{1.732}{2} = 0.866 \text{ km}$$

$$= 866 \text{ m}$$

$\therefore$ Hence, height of the hill is 866 m.

Q.11. A bird is sitting on the top of a 80 m high tree. From a point on the ground, the angle of elevation of the bird is 45°. The bird flies away horizontally in such a way that it remained at a constant height from the ground. After 2 seconds, the angle of elevation of the bird from the same point is 30°. Find the speed of flying of the bird. (Take $\sqrt{3} = 1.732$) [CBSE 2016]

Sol. Let AB be the tree of height 80 m. A and C be the two positions of the bird, such that : $\angle APB = 45°$, $\angle CPD = 30°$



$AB = CD = 80$ m and time taken by the bird to move from A and C is 2 s.

In ΔPBA, $\quad \dfrac{AB}{PB} = \tan 45°$

$$\frac{80}{PB} = 1$$

$$\Rightarrow \quad PB = 80 \text{ m} \qquad \ldots(1)$$

In ΔPDC, $\quad \dfrac{CD}{PD} = \tan 30°$

$$\frac{80}{PB + BD} = \frac{1}{\sqrt{3}}$$

$$\frac{80}{80 + BD} = \frac{1}{\sqrt{3}} \qquad \text{[Using eq. (1)]}$$

$$BD = 80\sqrt{3} - 80$$

$$= 80(1.732 - 1)$$

$$= 80\ (0.732) = 58.56 \text{ m}$$

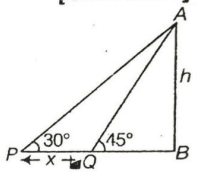
Distance covered by the bird in 2 s = 58.56 m

Now, the speed of flying of the bird

$$= \frac{58.56}{2} = 29.28 \text{ m/s.}$$

Q.13. A man on the top of a vertical tower observes a car moving at a uniform speed towards him. If it takes 12 min for the angle of depression to change from 30° to 45°, how soon after this, the car will reach the tower? **[CBSE 2014]**

Sol. Let AB be the tower of height h.



$$\angle AQB = 45°$$

Now, in ΔABQ,

$$\tan 45° = AB / BQ = h/BQ$$

$$\Rightarrow \quad BQ = h$$

In ΔAPB, $\quad \tan 30° = \frac{AB}{BP} = \frac{1}{\sqrt{3}} = \frac{h}{h+x}$

$$\Rightarrow \quad x + h = h\sqrt{3} \quad \Rightarrow \quad x = h(\sqrt{3} - 1)$$

Thus, $\quad \text{Speed} = \frac{h(\sqrt{3}-1)}{12}$

$$\Rightarrow \quad \text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Time for remaining distance, $= \frac{h}{\frac{h(\sqrt{3}-1)}{12}}$

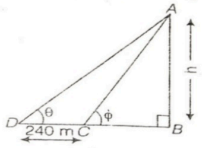
$$= \frac{12(\sqrt{3}+1)}{3-1} = \frac{12}{2}(\sqrt{3}+1)$$

$$= 6(\sqrt{3}+1) = 6(1.73+1)$$

Time $= 16.38$ minutes

Q.18. The angle of elevation θ of the top of a light house as seen by a person on the ground is such that $\tan\theta = \frac{5}{12}$. When the person moves a distance of 240 m towards the light house, the angle of elevation becomes ϕ, such that $\tan\phi = \frac{3}{4}$. Find the height of the light house. *HOTS* **[CBSE 2013]**

Sol. Let us assume that the height of light house AB be h m and C, D be two points of observation, such that $DC = 240$ m.



In ΔABC, $\quad \tan\phi = \frac{AB}{BC}$

$$\Rightarrow \quad \frac{3}{4} = \frac{AB}{BC} \qquad \left[\because \tan\phi = \frac{3}{4}, \text{ given}\right]$$

$$\Rightarrow \quad AB = \frac{3}{4} \times BC \qquad \ldots(1)$$

Again, in ΔABD,

$$\tan\theta = \frac{AB}{BD}$$

$$\Rightarrow \quad \frac{5}{12} = \frac{AB}{DC + CB} \qquad \left[\because \tan\theta = \frac{5}{12}, \text{ given}\right]$$

$$\Rightarrow \quad \frac{5}{12} = \frac{AB}{240 + CB} \qquad \ldots(2)$$

On putting the value of AB in eq. (2), we get

$$\frac{5}{12} = \frac{\frac{3}{4}BC}{240 + BC}$$

$$\Rightarrow \quad 5(240 + BC) = 12\left(\frac{3}{4}BC\right)$$

$$\Rightarrow \quad 5 \times 240 + 5BC = 9BC$$

$$\Rightarrow \quad 5 \times 240 = 4BC$$

$$\therefore \quad BC = \frac{5 \times 240}{4} = 300 \text{ m}$$

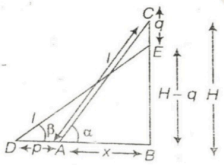
From eq. (1), we get

$$AB = \frac{3}{4} \times 300 = 225 \text{ m}$$

Hence, the height of the light house is 225 m.

Q.19. A ladder rests against a vertical wall at an inclination α to the horizontal. Its foot is pulled away from the wall through a distance p, so that its upper end slides a distance q down the wall and then the ladder makes an angle β to the horizontal. Show that $\frac{p}{q} = \frac{\cos\beta - \cos\alpha}{\sin\alpha - \sin\beta}$. *HOTS* **[NCERT Exemplar]**

Sol. Let $BC = H$ be the height of the wall and $AC = l$ m be the length of the ladder which rests against a vertical wall at an $\angle BAC = \alpha$



When the ladder pulled away from wall, its new position will be $DE = l$ m and $AD = p$ m.

Let $\quad AB = x \quad$ and $\quad EC = q$

In right angled ΔABC,

$$\sin\alpha = \frac{BC}{AC} = \frac{H}{l}$$

and $\quad \cos\alpha = \frac{AB}{AC} = \frac{x}{l}$

In right angles ΔEBD,

$$\sin\beta = \frac{BE}{DE} = \frac{BC - EC}{DE} = \frac{H - q}{l}$$

and $\quad \cos\beta = \frac{BD}{DE} = \frac{AB + DA}{DE} = \frac{p + x}{l}$

Now, $\quad \text{RHS} = \frac{\cos\beta - \cos\alpha}{\sin\alpha - \sin\beta}$

$$= \frac{\frac{p+x}{l} - \frac{x}{l}}{\frac{H}{l} - \frac{H-q}{l}}$$

$$= \frac{p + x - x}{H - (H - q)} = \frac{p}{q} = \text{LHS}$$

$\therefore \quad \text{LHS} = \text{RHS}$ **Hence proved**

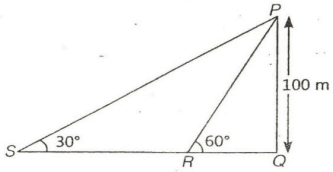
Q. 21. A man in a boat rowing away from a light house 100 m high takes 2 minutes to change the angle of elevation of the top of the light house from 60° to 30°. Find the speed of the boat in metres per minutes. **[Use $\sqrt{3} = 1.732$]** **[CBSE 2019]**

Sol. Let the tower be PQ and the boat changes its position from R to S.

Here, $PQ = 100$ m, $\angle PRQ = 60°$ and $\angle PSR = 30°$

In ΔPQR, $\quad \tan 60° = \frac{PQ}{QR} = \frac{100}{QR}$

$$\Rightarrow \quad QR = \frac{100\sqrt{3}}{3} \text{ m} \qquad \ldots(i)$$



In ΔPQS, $\quad \tan 30° = \frac{PQ}{QS}$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{100}{QS}$$

$$\Rightarrow \quad QS = 100\sqrt{3} \text{ m}$$

$$\therefore \quad RS = QS - QR$$

$$= 100\sqrt{3} - \frac{100\sqrt{3}}{3} = \frac{200\sqrt{3}}{3}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{200\sqrt{3}}{3 \times 2} = \frac{100\sqrt{3}}{3}$$

$= 57.73$ (approx). (using $\sqrt{3} = 1.732$)

$= 57.73$ m/min

Question. The angle of elevation of the top of a tower from a point on the ground, which is 20m away from the foot of the tower is 60^0. Find the height of the tower.

(a) 10 √3 m
(b) 30 √3 m
(c) 20 √3 m
(d) none of these

Question. The height of a tower is 10m. What is the length of its shadow when Sun's altitude is 45^0?

(a) 10 m
(b) 30 m
(c) 20 m
(d) none of these

Question. The angle of elevation of a ladder leaning against a wall is 60^0 and the foot of the ladder is 9.5 m away from the wall. Find the length of the ladder.

(a) 10 m
(b) 19 m
(c) 20 m
(d) none of these

Question. If the ratio of the height of a tower and the length of its shadow is √3 : 1, what is the angle of elevation of the Sun?

(a) 30^0
(b) 60^0
(c) 45^0
(d) none of these

Question. What is the angle of elevation of the Sun when the length of the shadow of a vertical pole is equal to its height?

(a) 30^0
(b) 60^0
(c) 45^0
(d) none of these

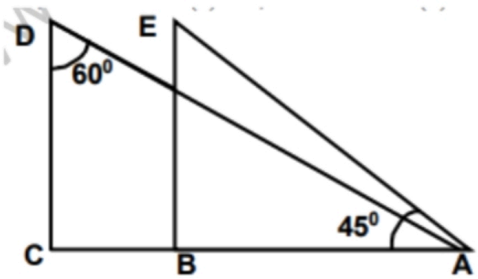
Question. From a point on the ground, 20 m away from the foot of a vertical tower, the angle of elevation of the top of the tower is 600, what is the height of the tower?

(a) 10 √3 m
(b) 30 √3 m
(c) 20 √3 m
(d) none of these

Question. If the angles of elevation of the top of a tower from two points at a distance of 4 m and 9 m from the base of the tower and in the same straight line with it are complementary, find the height of the tower.

(a) 10 m
(b) 6 m
(c) 8 m
(d) none of these

Question. In the below fig. what are the angles of depression from the observing positions D and E of the object A?



(a) $30^0, 45^0$
(b) $60^0, 45^0$
(c) $45^0, 60^0$
(d) none of these

Question : A tower is 100 3 m high. Find the angle of elevation if its top from a point 100 m away from its foot.
(a) 30^0
(b) 60^0
(c) 45^0
(d) none of these

Question : The angle of elevation of the top of a tower from a point on the ground, which is 30m away from the foot of the tower is 300. Find the height of the tower.
(a) 10 √3 m
(b) 30 √3 m
(c) 20√ 3 m
(d) none of these

Question : The string of a kite is 100m long and it makes an angle of 60^0 with the horizontal. Find the height of the kite, assuming that there is no slack in the string.
(a) 100 √3 m
(b) 200 √3 m
(c) 50 √3 m
(d) 100 √3 m

Question : A kite is flying at a height of 60m above the ground. The inclination of the string with the ground is 60^0. Find the length of the string, assuming that there is no slack in the string.
(a) 40 √3 m
(b) 30 √3 m
(c) 20 √3 m
(d) none of these

Question : A circus artist is climbing a 20m long rope, which is tightly stretched and tied from the top of a vertical pole to the ground. Find the height of the pole if the angle made by the rope with the ground level is 30^0.
(a) 10 m
(b) 30 m
(c) 20 m
(d) none of these

Question : A tower is 50m high, Its shadow ix 'x' metres shorter when the sun's altitude is 45^0 than when it is 30^0. Find the value of 'x'
(a) 100 √3 m
(b) 200 √3 m
(c) 50 √3 m
(d) none of these

Question : Find the angular elevation of the sun when the shadow of a 10m long pole is 10 √3 m.
(a) 30^0
(b) 60^0
(c) 45^0
(d) none of these

Question : A vertical pole stands on the level ground. From a point on the ground 25m away from the foot of the pole, the angle of elevation of its top is found to be 600. Find the height of the pole.
(a) 25 √3 m
(b) 25 √3 m
(c) 50 √3 m
(d) none of these

Question : A kite is flying at a height of 75m above the ground. The inclination of the string with the ground is 60^0. Find the length of the string, assuming that there is no slack in the string.
(a) 40 √3 m
(b) 30√ 3 m
(c) 50 √3 m
(d) none of these

Question : The angle of elevation of the tope of a tree from a point A on the ground is 60^0. On walking 20m away from its base, to a point B, the angle of elevation changes to 30^0. Find the height of the tree.
(a) 10 √3 m
(b) 30 √3 m
(c) 20 √3 m
(d) none of these