Chapter 9

Some Applications of Trigonometry

In the Chapter

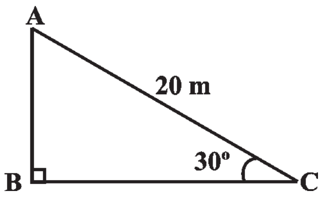
In this chapter, you will be studying the following points:

- (i) The **line of sight** is the line drawn from the eye of an observer to the point in the object viewed by the observer.
  (ii) The **angle of elevation** of an object viewed, is the angle formed by the line of sight with the horizontal level when it is above the horizontal level, i.e., the case when we raise our head to look at the object.
  (iii) The **angle of depression** of an object viewed, is the angle formed by the line of sight with the horizontal level when it is below the horizontal level, i.e., the case when we lower our head to look at the object.
- The height or length of an object or the distance between two distant objects can be determined with the help of trigonometric ratios.

NCERT TEXT BOOK QUESTION (SOLVED)

EXERCISE 9.1

Q.1. A circus artist is climbing a 20 m 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° (see Fig.).



Ans. Let height of the pole AB be h m.

$\therefore \quad \sin 30° = \dfrac{AB}{AC}$

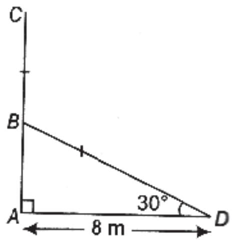
$\Rightarrow \quad \dfrac{1}{2} = \dfrac{h}{20}$

$\Rightarrow \quad h = \dfrac{20}{2} = 10.$

$\therefore$ Height of the pole = 10 m

Q.2. A tree breaks due to storm and the broken part bends so that the top of the tree touches the ground making an angle 30° with it. The distance between the foot of the tree to the point where the top touches the ground is 8 m. Find the height of the tree.

Ans. Let the initial height of the tree be AC. When the storm came, the tree broke from point B. The broken part of the tree BC touches the ground at point D, making an angle 30° on the ground.



Also, given AD = 8 m

In right ΔABD,

$$\tan 30° = \frac{AB}{AD}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{AB}{8}$$

$$\Rightarrow \quad AB = \frac{8}{\sqrt{3}} \text{ m}$$

Again in ΔABD

$$\cos 30° = \frac{AD}{BD} \Rightarrow \frac{\sqrt{3}}{2} = \frac{8}{BD}$$

$\Rightarrow$ $$BD = \frac{16}{\sqrt{3}}$$

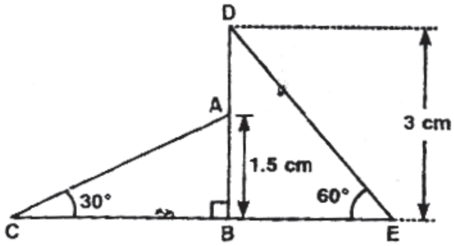
$\therefore$ AC = AB + BC = AB + BD (BC = BD)

$$= \frac{8}{\sqrt{3}} + \frac{16}{\sqrt{3}} = \frac{24}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 8\sqrt{3} \text{ m}$$

Hence, the height of the tree is $8\sqrt{3}$ m.

Q.3. A contractor plans to install two slides for the children to play in a park. For the children below the age of 5 years, she prefers to have a slide whose top is at a height of 1.5 m, and is inclined at an angle of 30° to the ground, whereas for elder children, she wants to have a steep slide at a height of 3m, and inclined at an angle of 60° to the ground. What should be the length of the slide in each case?

Ans.



In case I : From fig., $\sin 30° = \frac{AB}{AC}$, where AC is slide

$\Rightarrow$ $$\frac{1}{2} = \frac{1.5}{AC}$$

$\Rightarrow$ AC = 3 cm

In case II : From fig., $\sin 60° = \frac{BD}{DE}$, where DE is slide

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

$\Rightarrow$ $$DE = \frac{6}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{6\sqrt{3}}{3}$$

$\Rightarrow$ DE = $2\sqrt{3}$ cm.

Q.4. The angle of elevation of the top of a tower from a point on the ground, which is 30 m away from the foot of the tower, is 30°. Find the height of the tower.

Ans. Let height of tower AB be *h* and C be the point which is 30 m away from the foot B.

$\therefore \angle ACB = 30°$

In ΔABC,

$$\tan 30° = \frac{AB}{BC}$$

$\Rightarrow$ $$\frac{1}{\sqrt{3}} = \frac{h}{30}$$

$\Rightarrow$ $$h = \frac{30}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= \frac{30\sqrt{3}}{3}$$

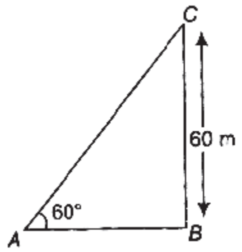
$$= 10\sqrt{3} \text{ m}$$

Height of the tower AB = $10\sqrt{3}$ m.

Q.5. A kite is flying at a height of 60 m above the ground. The string attached to the kite is temporarily tied to a point on the ground. The inclination of the string with the ground is 60°. Find the length of the string, assuming that there is no slack in the string.

Ans. Let C be the portion of the kite. AC be the length of the string which makes, an angle of 60° on the ground. The height of the kite on the ground is BC = 60 m.

In right angled ΔABC



$$\sin 60° = \frac{BC}{AC}$$

$\Rightarrow$ $$\frac{\sqrt{3}}{2} = \frac{60}{AC}$$

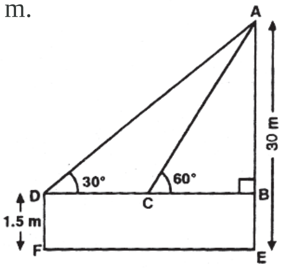
$\Rightarrow$ $$AC = \frac{60 \times 2}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= \frac{120\sqrt{3}}{3} = 40\sqrt{3} \text{ m}$$

Hence, length of the string is $40\sqrt{3}$ m

Q.6. A 1.5 m tall boy is standing at some distance from a 30 m tall building. The angle of elevation from his eyes to the top of the building increases from 30° to 60° as he walks towards the building. Find the distance he walked towards the building.

Ans. Here, AE is a building of height 30 m and FD is a boy of height 1.5 m.



$\therefore$ AB = AE – BE
= AE – DF
= 30 m – 1.5 m
= 28.5 m

Now in ΔABC, $\tan 60° = \frac{AB}{AC}$

$\Rightarrow \quad \sqrt{3} = \frac{28.5}{BC}$

$\Rightarrow \quad BC = \frac{28.5}{\sqrt{3}}$ m

In ΔABD, $\tan 30° = \frac{AB}{BD}$

$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{28.5}{BD}$

$\Rightarrow \quad BD = 28.5\sqrt{3}$ m

$\therefore \quad CD = BD - BC = 28.5\sqrt{3} - \frac{28.5}{\sqrt{3}}$

$= 28.5\left[\frac{3-1}{\sqrt{3}}\right]$

$= \frac{28.5 \times 2}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$

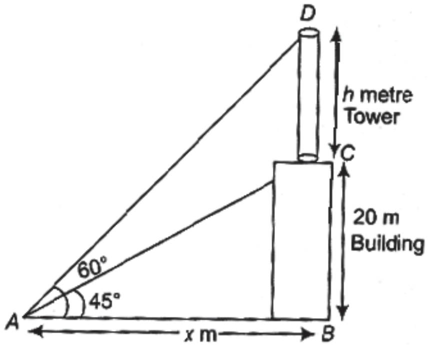
$= 19\sqrt{3}$

He walked $19\sqrt{3}$ m towards the building.

Q.7. From a point on the ground, the angles of elevation of the bottom and the top of a transmission tower fixed at the top of a 20 m high building are 45° and 60° respectively. Find the height of the tower.

Ans. Let BC = 20 m be the height of the building and DC = *h* metre be height of the tower, which is standing on the building. A be a fixed point on the ground. From a fixed point A, the angles of elevation of the bottom and the top of the transmission tower are

$\angle BAC = 45°$ and $\angle BAD = 60°$



Also, let AB = *x* m

In right angled ΔABC,

$\tan 45° = \frac{BC}{AB} \Rightarrow 1 = \frac{20}{x} \Rightarrow x = 20\text{m}$

Again, in right angled ΔABD,

$\tan 60° = \frac{BD}{AB}$

$\Rightarrow \quad \sqrt{3} = \frac{20+h}{x}$

$\Rightarrow \quad \sqrt{3} = \frac{20+h}{20}$ [From Eq. (i), $x = 20$m]

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

Hence, the height of the tower is $20(\sqrt{3} - 1)$m.

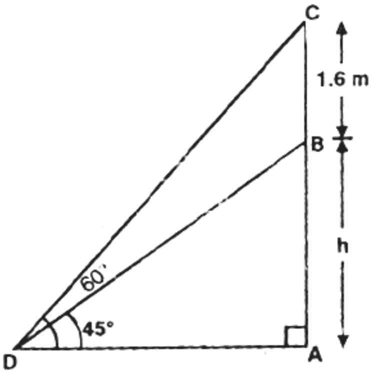
Q.8. A statue, 1.6 m tall, stands on the top of a pedestal. From a point on the ground, the angle of elevation of the top of the statue is 60° and from the same point the angle of elevation of the top of the pedestal is 45°. Find the height of the pedestal.

Ans. Let AB be the pedestal of height *h*, BC be the statue of height 1.6 m.

$\angle ADB = 45°$ and $\angle ADC = 60°$

In ΔDAB,

$\tan 45° = \frac{AB}{AD}$



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

$\Rightarrow \quad h = AD$

In ΔCAD,

$$\tan 60° = \frac{h+1.6}{AD}$$

$\Rightarrow \quad \sqrt{3} = \frac{h+1.6}{h}$

$\Rightarrow \quad \sqrt{3}\ h = h + 1.6$

$\Rightarrow \quad h(\sqrt{3} - 1) = 1.5$

$$h = \frac{1.6}{\sqrt{3}-1} \times \frac{\sqrt{3}+1}{\sqrt{3}+1}$$

$$= \frac{1.6(\sqrt{3}+1)}{3-1} = 0.8 \times (\sqrt{3}+1)$$

$\therefore$ Height of pedestal = 0.8 $(\sqrt{3}+1)$ m.

Q.9. The angle of elevation of the top of a building from the foot of the tower is 30° and the angle of elevation of the top of the tower from the foot of the building is 60°. If the tower is 50 m high, find the height of the building.

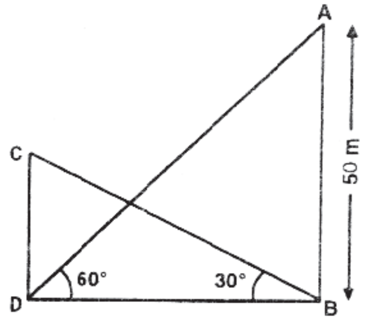
Ans. Let AB is tower of height 50 m and CD be a building.

In ΔABD, $\tan 60° = \frac{AB}{BD}$

$$\sqrt{3} = \frac{50}{BD} \Rightarrow \quad = BD = \frac{50}{\sqrt{3}} \text{ m}$$

Now, in ΔBDC,

$$\tan 30° = \frac{CD}{BD}$$



$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{CD}{\frac{50}{\sqrt{3}}}$

$\Rightarrow \quad CD = \frac{50}{3} = 16\frac{2}{3}$ m

$\therefore$ Height of building = $16\frac{2}{3}$ m

Q.10. Two poles of equal heights are standing opposite each other on either side of the road, which is 80 m wide. From a point between them on the road, the angles of elevation of the top of the poles are 60° and 30°, respectively. Find the height of the poles and the distances of the point from the poles.

Ans. Let AB = 80m be the width of the road. On both sides of the road poles AE = BD = h metre are standing. Let C be any point on AB such that point C makes an elevation and ∠BCD = 60° and ∠ACE = 30°

Let BC = x, then AC = AB – BC = (80 – x) m

In right angled ΔACE,

$$\tan 30° = \frac{AE}{AC}$$

$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{h}{80-x}$

$\Rightarrow \quad 80 - x = h\sqrt{3}$

$\Rightarrow \quad h\sqrt{3} + x = 80$

Again, in right angled ΔBCD,

$$\tan 60° = \frac{BD}{BC}$$

$\Rightarrow \quad \sqrt{3} = \frac{h}{x} \Rightarrow h = \sqrt{3}\,x \qquad ...(ii)$

Putting $h = \sqrt{3}$ in Eq. (i), we get

$$\sqrt{3}\,x \times (\sqrt{3}) + x = 80$$

$\Rightarrow$ $3x + x = 80$

$\Rightarrow$ $4x = 80$

$\Rightarrow$ $x = 20\text{m}$

Putting $x = 20$ m in Eq. (ii), we get

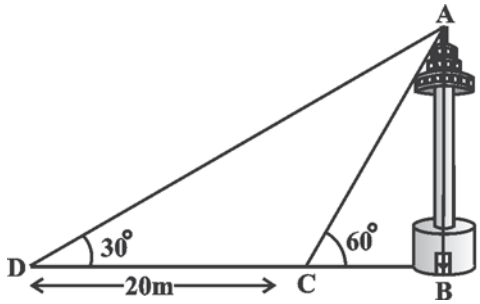
$$h = 20\sqrt{3} \text{ m}$$

Also, AC $= 80 - x$

$= 80 - 20 = 60$ m

Hence, height of the poles be $20\sqrt{3}$ m and the distances of the point from the poles are 60 m and 20 m.

Q.11. A TV tower stands vertically on a bank of a canal. From a point on the other bank directly opposite the tower, the angle of elevation of the top of the tower is 60°. From another point 20 m away from this point on the line joing this point to the foot of the tower, the angle of elevation of the top of the tower is 30° (see Fig.). Find the height of the tower and the width of the canal.



Ans. Let AB be the tower of height *h* metres standing on a bank of a canal. Let C be a point on the opposite bank of a canal, such that BC = *x* metres.

Let D be the new position after changing the elevation. It is given that CD = 20m

The angle of elevation of the top of the tower at C and D are respectiely 60° and 30°.

i.e., $\angle ACB = 60°$ and $\angle ADB = 30°$

In right triangle ABC, we have

$$\tan 60° = \frac{AB}{BC}$$

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

$\Rightarrow$ $x = \frac{h}{\sqrt{3}}$ ...(i)

In right triangle ABD, we have

$$\tan 30° = \frac{AB}{BD}$$

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

$\Rightarrow$ $x + 20 = \sqrt{3}\,h$

$\Rightarrow$ $x = \sqrt{3}\,h - 20$ ...(ii)

Comparing (i) and (ii), we get

$$\frac{h}{\sqrt{3}} = \sqrt{3}\,h - 20$$

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

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

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

$\Rightarrow$ $-2h = -20\sqrt{3}$

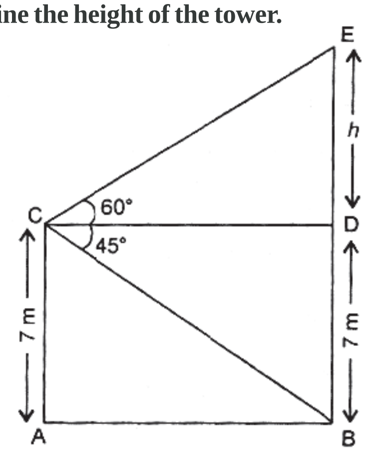
$\Rightarrow$ $h = 10\sqrt{3}$

Putting this value in (i), we get

$$x = \frac{h}{\sqrt{3}} = \frac{10\sqrt{3}}{\sqrt{3}} = 10 \text{ m.}$$

Hence, the height of tower = $10\sqrt{3}$ metre and width of the canal = 10.

Q.12. From the top of a 7 m high building, the angle of elevation of the top of a cable tower is 60° and the angle of depression of its foot is 45°. Determine the height of the tower.



Ans. Let AC be the building whose height is 7 m and BE be the cable tower.

It is given that the angle of elevation of the top E of the cable tower from C and the angle of depression of its foot from C be 60° and 45° respectively.

i.e., $\angle DCE = 60°$ and $\angle BCD = 45°$

Also, $AC = BD = 7$ m

Let $DE = h$ m

In right triangle DCE, we have

$$\tan 60° = \frac{DE}{CD}$$

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

$$\Rightarrow CD = \frac{h}{\sqrt{3}} \quad ...(i)$$

Now, in right triangle BCD, we have

$$\tan 45° = \frac{BD}{CD}$$

$$\Rightarrow 1 = \frac{7}{CD}$$

$$\Rightarrow CD = 7 \quad ...(ii)$$

Comparing (i) and (ii), we get

$$\frac{h}{\sqrt{3}} = 7$$

Hence, $h = 7\sqrt{3}$ m

Total height of the cable tower (BE)

$= BD + DE = 7 \text{ m} + \mathbf{7}\sqrt{3} \text{ m} = 7(1+\sqrt{3}) \text{ m}$

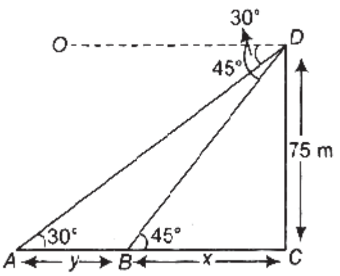
Q.13. As observed from the top of a 75 m high lighthouse from the sea-level, the angles of depression of two ships are 30° and 45°. If one ship is exactly behind the other on the same side of the lighthouse, find the distance between the two ships.

Ans. Let CD = 75m be the height of the lighthouse from the sea level AC. Let A and B be the position of two ships on the sea-level.

From point D of a lighthouse the angle of depression of two ships A and B are

$\angle ODA = 30°$ and $\angle ODB = 45°$

$\Rightarrow \angle CAD = 30°$ and $\angle CBD = 45°$ (Alternate angle)



Let distance between two ships AB = y metre and BC = x metre

In right angle DACD

$$\tan 30° = \frac{CD}{AC} \Rightarrow \frac{1}{\sqrt{3}} = \frac{75}{AB+BC}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{75}{y+x} \Rightarrow x+y = 75\sqrt{3}$$

In right angled ΔDBC

$$\tan 45° = \frac{CD}{BC}$$

$$\Rightarrow 1 = \frac{75}{x}$$

$$\Rightarrow x = 75 \text{ m}$$

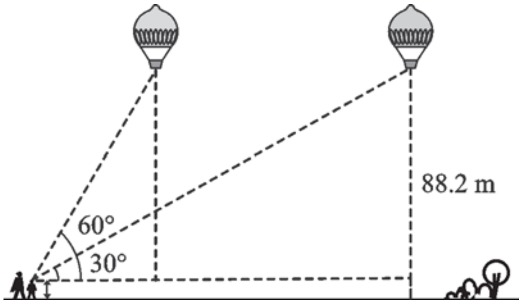
Putting $x = 75$ m in Eq. (i), we get

$$75 + y = 75\sqrt{3}$$

$$\Rightarrow y = 75(\sqrt{3} - 1) \text{ m}$$

Hence, the distance between two ships is 75 $(\sqrt{3}-1)$m

Q.14. A 1.2 m tall girl spots a balloon moving with the wind in a horizontal line at a height of 88.2 m from the ground. The angle of elevation of the balloon from the eyes of the girl at any instant is 60°. After some time, the angle of elevation reduces to 30° (see Fig.). Find the distance travelled by the balloon during the interval.



Ans. Let AB be the girl (AB = 1.2m) and E and F be the two positions of the balloon.

Clearly,

$EH = 88.2 \text{ m} = FD$

and $EG = (88.2 - 1.2)$ m
$= 87$ m $=$ FC

In right triangle EAG, we have

$$\tan 60° = \frac{EG}{AG}$$

$$\Rightarrow \quad \sqrt{3} = \frac{87}{AG}$$

$$\Rightarrow \quad AG = \frac{87}{\sqrt{3}},$$

$$= \frac{87}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{87\sqrt{3}}{3} \text{m}$$

$$= \frac{87 \times 1.732}{3} \text{m} = 50.23 \text{ metres}$$

In right triangle FAC, we have

$$\tan 30° = \frac{FC}{AC}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{87}{AC}$$

$$\Rightarrow \quad AC = 87\sqrt{3}$$

$$\Rightarrow \quad AC = (87 \times 1.732) \text{ metres}$$
$$= 150.68 \text{ m}$$

$\Rightarrow$ Distance travelled by the baloon

$$EF = GC = AC - AG$$
$$= (150.68 - 50.23) \text{m}$$
$$= 100.45 \text{ metres}$$

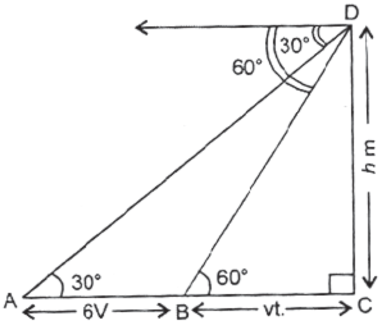
Q.15. A straight highway leads to the foot of a tower. A man standing at the top of the tower observes a car at an angle of depression of 30°, which is approaching the foot of the tower with a uniform speed. Six seconds later, the angle of depression of the car is found to be 60°. Find the time taken by the car to reach the foot of the tower from this point.

Ans. Let CD be the tower of height h m. Let A be the initial position of the car and after 6 sec. the car is found to be at B.

It is given that the angle of depression at A and B from the top of a tower be 30° and 60° respectively.

Let the speed of the car be v second per minute. Then,

AB = distance tavelled by the car in 6s.
$= (6 \times v)$ sec. (Dist = speed × time)
$= 6v$ sec.



Let the car takes t minutes to reach the tower CD from B.

Then,

BC = distance travelled by car in t minutes
$= (v \times t)$ metres $= vt$ sec.

In right triangle BCD, we have

$$\tan 60° = \frac{CD}{BC}$$

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

$$\Rightarrow \quad h = \sqrt{3}\, vt \qquad \text{...(i)}$$

In right triangle ACD, we have

$$\tan 30° = \frac{CD}{AC}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{h}{6v + vt}$$

$$\Rightarrow \quad 6v + vt = \sqrt{3}\, h$$

$$\Rightarrow \quad h = \frac{6v + vt}{\sqrt{3}} \qquad \text{...(ii)}$$

Comparing (i) and (ii), we get

$$\sqrt{3}\, vt = \frac{6v + vt}{\sqrt{3}}$$

$$\Rightarrow \quad \sqrt{3} \times \sqrt{3}\, vt = 6v + vt$$

$$\Rightarrow \quad 3vt = 6v + vt$$

$$\Rightarrow \quad 3vt - vt = 6v$$

$$\Rightarrow \quad vt(3 - 1) = 6v$$

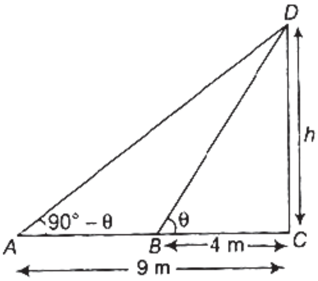
$$\Rightarrow \quad t \times 2 = 6$$

$$\Rightarrow \quad t = 3 \text{ seconds.}$$

Hence, the time taken by the car to reach the foot of the tower in 3 seconds.

Q.16. 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. Prove that the height of the tower is 6 m.

Ans. Let CD = h metre be the height of the tower. AC be a horizontal line on a ground. A and B be the two points on the line at a distance of 9 m and 4 m from the base of the tower.



Let $\angle CBD = \theta$, then $\angle CAD = 90° - \theta$

(The complementary means the sum of two angles are 90°)

In right angled ΔCAD,

$$\tan(90° - \theta) = \frac{CD}{AC}$$

$$\Rightarrow \quad \cot\theta = \frac{h}{9} \quad \text{...(i)}$$

And in right angled ΔCBD,

$$\tan\theta = \frac{CD}{BC}$$

$$\Rightarrow \quad \tan\theta = \frac{h}{4} \quad \text{...(ii)}$$

On multiplying Eqs. (i) and (ii), we get

$$\cot\theta \times \tan\theta = \frac{h}{9} \times \frac{h}{4}$$

$$\Rightarrow \quad 1 = \frac{h^2}{36}$$

$$\Rightarrow \quad h^2 = 36 \Rightarrow h = 6\text{m}$$

Hence, the height of the tower is 6 m.
Hence proved.

Additional Questions

Q.1. If a man standing on a platform, 3m above the surface of a lake observes a cloud and its reflection in the lake, then the angle of elevation of the cloud is equal to the angle of depression of its reflection.

Ans. We know, if P is a point above the lake at a distance d, then the reflection of the point in the lake would be at the same distance d. Also the angle of elevation and depression from the surface of the lake is same.

Here, the man is standing on a platform 3 m above the surface, so its angle of elevation to the cloud and angle of depression to the reflection of the cloud is not same.

So, the statement is false.

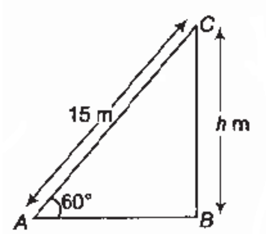
Q.2. If the length of the shadow of a tower is increasing, then the angle of elevation of a sun is also increasing.

Ans. We know, if the elevation moves towards the tower, it increase and if its elevation moves away the tower, it decreases. Hence, if the shadow of a tower is increasing, then the angle of elevation of a Sun is not increasing.

So, the statement is false.

Q.3. A ladder 15 m long just reaches the top of a certical wall. If the ladder makes an angle of 60° with the wall, find the height of the wall.

Ans. Let BC = h metre be the height of the wall and AC = 15 m be the length of the ladder. The ladder AC makes an angle of elevation $\angle BAC = 60°$. In right angled ΔABC,



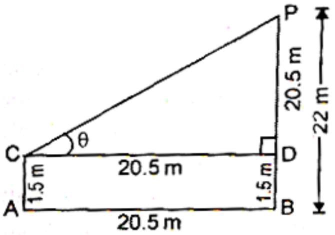
$$\sin 60° = \frac{BC}{AC}$$

$$\Rightarrow \quad \frac{\sqrt{3}}{2} = \frac{h}{15}$$

$$\Rightarrow \quad h = \frac{15\sqrt{3}}{2}\text{ m}$$

Q.4. An observer 1.5 metre tall is 20.5 metre away from a tower 22 metres high. Determine the angle of elevation of the top of the tower from the eye of the observer.

Ans. From the figure.



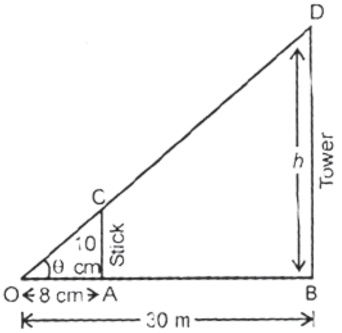
$AB = CD = 20.5$ m
$AC = BD = 1.5$ m
$\therefore \quad PD = 20.5$ m

Now $\tan\theta = \dfrac{20.5}{20.5} = 1 \Rightarrow \theta = 45°$.

Hence angle of elevation = 45°.

Q.5. A vertical stick 10 cm long casts a shadow 8 cm long. At the same time, a tower casts a shadow 30m long. Determine the height of the tower.

Ans. As shown in the figure AC is the stick and AC = 10 cm. Its shadow OA = 8 cm.



Now, $\tan\theta = \dfrac{10}{8} = \dfrac{5}{4}$ ...(i)

Again let BD be the tower and let BD = h m and it shadow OB = 30 m.

$\therefore \quad \tan\theta = \dfrac{h}{30}$ ...(ii)

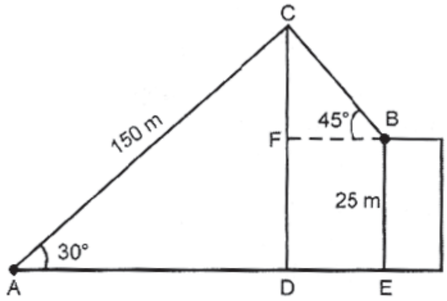
From (i) and (ii), we get

$$\frac{5}{4} = \frac{h}{30}$$

$$\Rightarrow \quad h = \frac{5}{4} \times 30 = \frac{150}{4} = 36.5 \text{ m}$$

Hence height of tower = 37.5 m.

Q.6. A boy is standing on ground and flying a kite with 150 m of string at an elevation of 30°. Another boy is standing on the roof of a 25m high building and flying a kite at an elevation of 45°. Find the length of string required by the second boy so that the two kites just meet, if both the boys are on opposite side of the kites.



Ans. Now, $\dfrac{CD}{150} = \sin 30°$

$\Rightarrow \quad \dfrac{CD}{150} = \dfrac{1}{2}$

$\Rightarrow \quad CD = 75$

$\therefore \quad CD = 75 - 25 = 50$ m

Now, $\dfrac{CF}{BC} = \sin 45°$

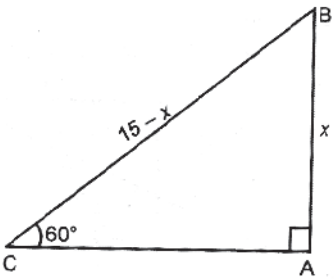
$\dfrac{50}{BC} = \dfrac{1}{\sqrt{2}}$

$BC = 50\sqrt{2}$
$= 50 \times 1.4142 = 70.71$

Hence required length of string = 70.71 m.

Q.7. A vertically straight tree, 15 m high is broken by the wind in such a way that its top just touches the ground and makes and angle of 60° with the ground, at which height from the groun did the tree break?

Ans. Let the tree is broken at B and C is the top of it and after breakage it is as shown in figure.



$\therefore \quad \sin 60° = \dfrac{x}{15 - x}$

$\Rightarrow \quad \frac{\sqrt{3}}{2} = \frac{x}{15-x}$

$\Rightarrow \quad 15\sqrt{3} - \sqrt{3}x = 2x$

$\Rightarrow \quad (2+\sqrt{3})x = 15\sqrt{3}$

$$\Rightarrow \quad x = \frac{15\sqrt{3}}{(2+\sqrt{3})} \times \frac{(2-\sqrt{3})}{(2-\sqrt{3})}$$

$$= \frac{15\sqrt{3}(2-\sqrt{3})}{4-3}$$

$\Rightarrow \quad x = 15\sqrt{3}(2-1.732)$

$= 15 \times 1.732 \times 0.268$

$\Rightarrow \quad x = 6.96$ m

Q.8. If the length of a tower and the distance of the point of observation from its foot, both, are increased by 10%, then the angle of elevation of its top remain unchanged.

Ans. When both length of the tower and distance of observation from its foot, are increased by 10%, then we get the adjacent figure.

$\tan\theta_1 = \frac{h}{x}$

$\tan\theta_2 = \frac{h}{x}$

$\therefore \quad \theta_1 = \theta_2$

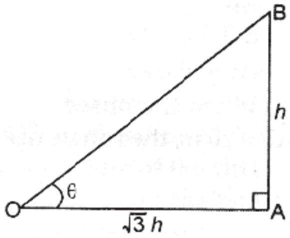
which shows that AD || BC and angle of elevations are equal.

Hence the statement is true.

Q.9. Find the the angle of elevation of the sun when the shadow of a pole *h* metres high is $\sqrt{3}h$ metres long.

Ans. In right angled ΔOAB,

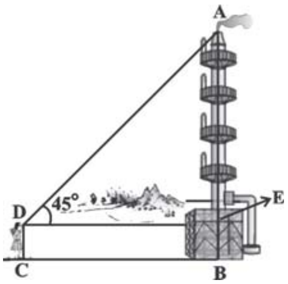
$\tan\theta = \frac{h}{\sqrt{3}h} = \frac{h}{\sqrt{3}}$



$\therefore \quad \theta = 30°$

Hence angle of elevation = 30°

Q.10. An observer 1.5 m tall is 28.5 m away from a chimney. The angle of elevation of the top of the chimney from her eyes is 45°. What is the height of the chimney?



Ans. Here, AB is the chimney, CD the observer and ∠ADE the angle of elevation (see Fig.). In this case, ADE is a triangle, right-angled at E and we are required to find the height of the chimney.

We have AB = AE + BE = AE + 1.5

and DE = CB = 28.5 m

To determine AE, we choose a trigonometric ratio, which involves both AE and DE. Let us choose the tangent of the angle of elevation.

Now, $\tan 45° = \frac{AE}{DE}$

i.e., $1 = \frac{AE}{28.5}$

Therefore, AE = 28.5

So the height of the chimney

(AB) = (28.5 + 1.5) m = 30 m.

Multiple Choice Questions

Q.1. The angle of elevation of the top of a 15*m* high tower at a point 15*m* away from the base of the tower is :

(a) 30° (b) 60°
(c) 45° (d) 75°

Ans. (c)

Q.2. At an instant, the length of the shadow of a pole is $\sqrt{3}$ times the height of the pole then, the angle of elevation of the sun is :

(a) 30° (b) 60°
(c) 45° (d) 75°

Ans. (a)

Q.3. A ladder 10 m in length touches a wall at height of 5 m. The angle made by the ladder with the horizontal is :

(a) 30° (b) 90°
(c) 45° (d) 75°

Ans. (a)

Q.4. If the length of the shadow of a pole is equal to the height of pole, then the elevation of sun is :

(a) 0° (b) 60°
(c) 45° (d) 75°

Ans. (c)

Q.5. A pole 6 m high casts a shadow $2\sqrt{3}$ m long on the ground , the the sun's elevation is :

(a) 30° (b) 60°
(c) 45° (d) 75°

Ans. (b)

Q.6. If two towers of height h_1 and h_2 subtends angle of 60° and 30° respectively at the mid-point of the line joining their feet, then $h_1 : h_2$ is :

(a) 3:1 (b) $\sqrt{3} : 1$
(b) $1 : \sqrt{3}$ (d) 1 : 3

Ans. (a)

Q.7. The height of a tower is 50 m.When the sun's altitude change from 30° to 45°, the shadow of the tower becomes *x* metres less. The value of *x* is :

(a) 50 m (b) $50\sqrt{3}$ m
(c) $50(\sqrt{3}-1)$m (d) $50/\sqrt{3}$m

Ans. (c)

Q.8. A pole subtends an angle of 30° at a point on the same level as its foot. At a second point *h* metres above the first, the depression of the foot of the pole is 60°. The height of the pole is :

(a) h/2m (b) $\sqrt{3}$m
(c) h/3 m (d) $h/\sqrt{3}$m

Ans. (c)

Q.9. The angle of elevation of the top of a tower from a point on the ground, which is 30 m away from the foot of the tower is 45°. The height of the tower (in metres) is :

(a) 15 (b) 30
(c) $30\sqrt{3}$ (d) $10\sqrt{3}$

Ans. (b)

Q.10. The height of a tower is 200m. When the altitude of the sun is 30°, the length of its shadow is :

(a) $100\sqrt{3}$m (b) $200\sqrt{3}$m
(c) $300\sqrt{3}$m (d) 200m

Ans. (b)