

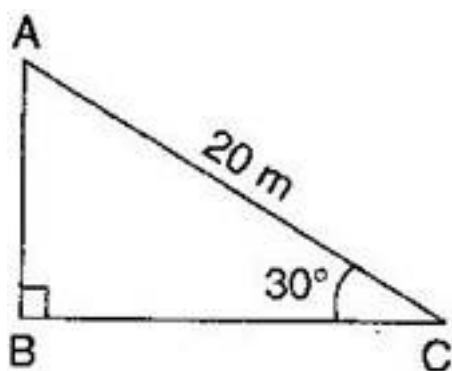
CBSE Class-10 Mathematics

NCERT solution

Chapter - 8

Some Applications of Trigonometry - Exercise 9.1

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 figure).



Ans. In right triangle ABC,

$$\sin 30^\circ = \frac{AB}{AC}$$

$$\Rightarrow \frac{1}{2} = \frac{AB}{20}$$

$$AB = 20/2$$

$$\Rightarrow AB = 10 \text{ m}$$

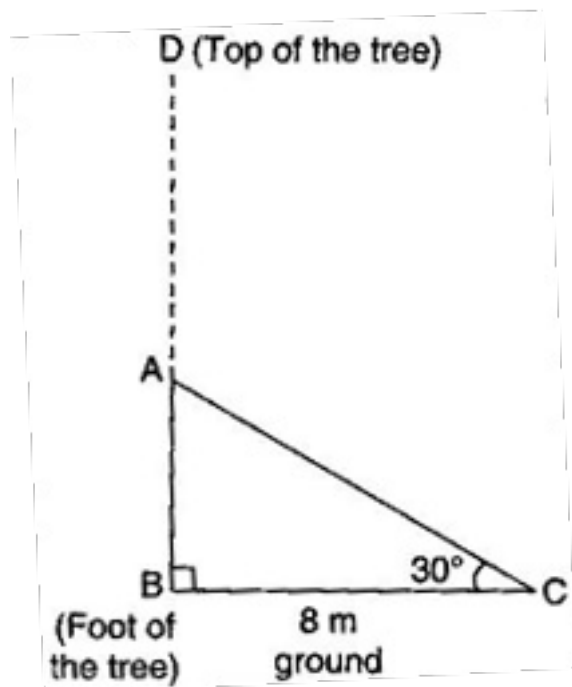
Hence, the height of the pole is 10 m.

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 AC be the broken part of tree

In right triangle ABC,

$$\cos 30^\circ = \frac{BC}{AC}$$



$$\Rightarrow \frac{\sqrt{3}}{2} = \frac{8}{AC}$$

$$\Rightarrow AC = \frac{16}{\sqrt{3}} \text{ m}$$

Again, $\tan 30^\circ = \frac{AB}{BC}$

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

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

\therefore Height of the tree = AB + AD = AB + AC

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

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

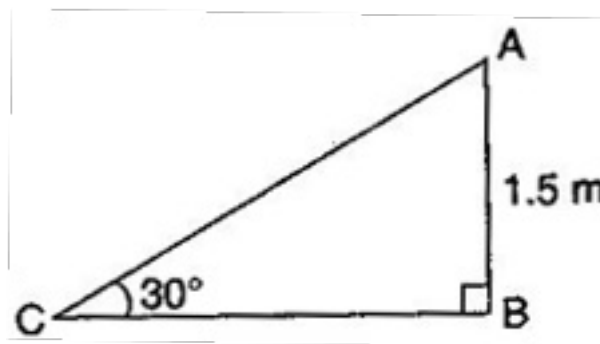
3. A contractor plans to install two slides for the children to play in a park. For the children below the age of 5 years, she prefers to have a slide whose top is at a height of 1.5 m and is inclined at an angle of 30° to the ground, whereas for elder children, she wants to have a steep slide at a height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

Ans. In right triangle ABC,

$$\sin 30^\circ = \frac{AB}{AC}$$

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

$$\Rightarrow AC = 3 \text{ m}$$

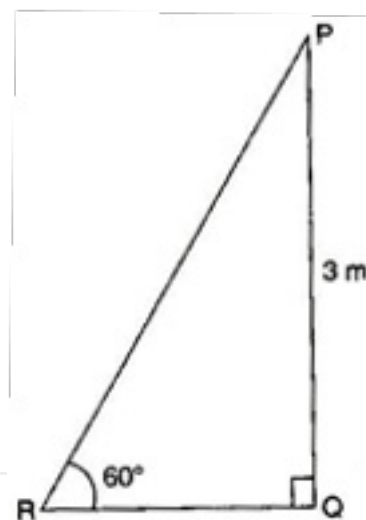


In right triangle PQR,

$$\sin 60^\circ = \frac{PQ}{PR}$$

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

$$\Rightarrow PR = 2\sqrt{3} \text{ m}$$



Hence, the lengths of the slides are 3 m and $2\sqrt{3}$ m respectively.

4. 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 30° . Find the height of the tower.

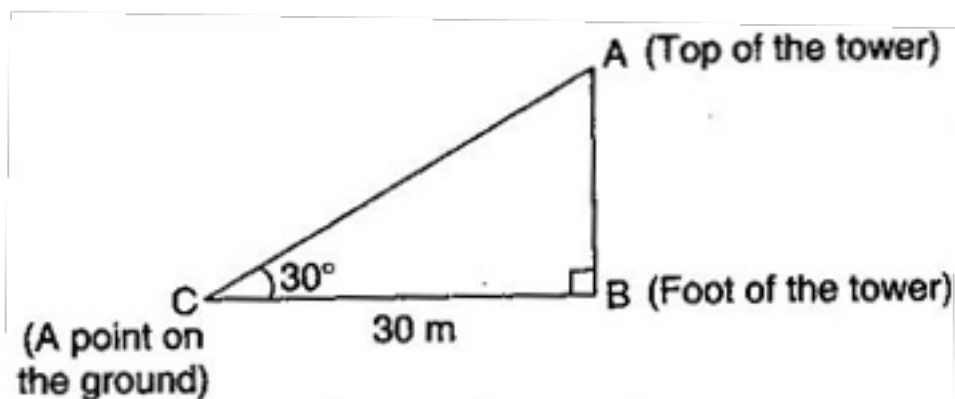
Ans. In right triangle ABC, AB be the height of the tower.

$$\tan 30^\circ = \frac{AB}{BC}$$

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

$$\Rightarrow AB = \frac{30}{\sqrt{3}} \text{ m}$$

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



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.

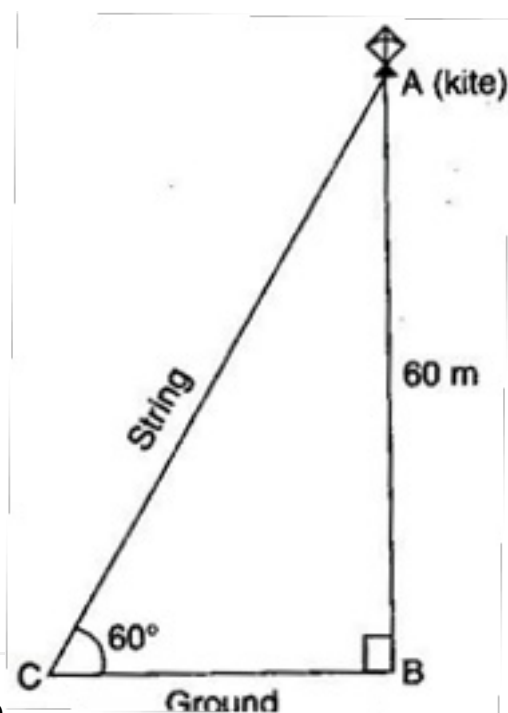
Ans. In right triangle ABC, AC is the length of the string

$$\sin 60^\circ = \frac{AB}{AC}$$

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

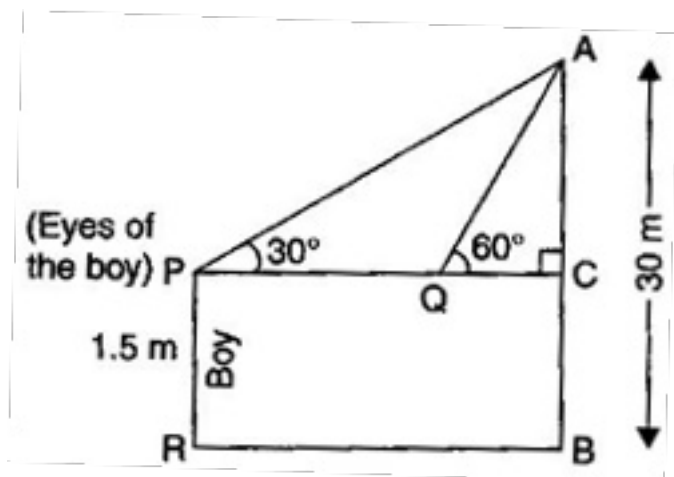
$$\Rightarrow AC = 40\sqrt{3} \text{ m}$$

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



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. AB = 30 m and PR = 1.5 m



$$AC = AB - BC$$

$$= AB - PR \quad (\text{As, } BC = PR)$$

$$= 30 - 1.5$$

$$= 28.5 \text{ m}$$

In right triangle ACQ,

$$\tan 60^\circ = \frac{AC}{QC}$$

$$\Rightarrow \sqrt{3} = \frac{28.5}{QC} \Rightarrow QC = \frac{28.5}{\sqrt{3}} \text{ m}$$

In right triangle ACP,

$$\tan 30^\circ = \frac{AC}{PC} \Rightarrow \frac{1}{\sqrt{3}} = \frac{28.5}{PQ + QC}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{28.5}{PQ + \frac{28.5}{\sqrt{3}}}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{28.5 \times \sqrt{3}}{PQ\sqrt{3} + 28.5}$$

$$\Rightarrow PQ\sqrt{3} + 28.5 = 85.5$$

$$\Rightarrow PQ\sqrt{3} = 57$$

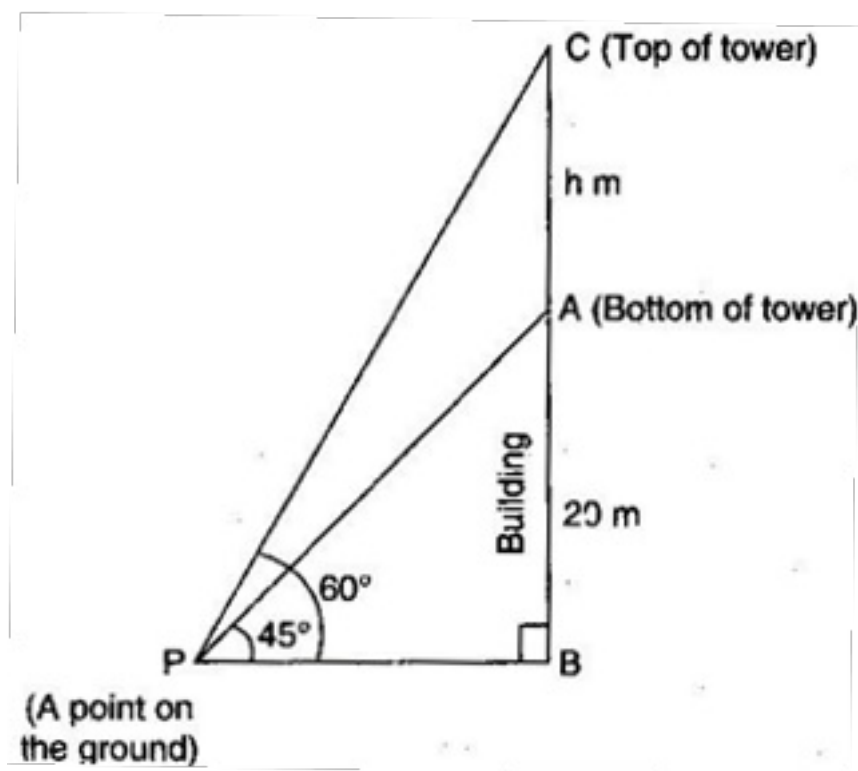
$$\Rightarrow PQ = \frac{57}{\sqrt{3}}$$

$$\Rightarrow PQ = \frac{57}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 19\sqrt{3} \text{ m}$$

Hence, the distance the boy walked towards the building is $19\sqrt{3}$ m.

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 the height of the tower be h m. Then, in right triangle CBP,



$$\tan 60^\circ = \frac{BC}{BP}$$

$$\Rightarrow \sqrt{3} = \frac{AB + AC}{BP}$$

$$\Rightarrow \sqrt{3} = \frac{20+h}{BP} \dots\dots\dots(i)$$

In right triangle ABP,

$$\tan 45^\circ = \frac{AB}{BP}$$

$$\Rightarrow 1 = \frac{20}{BP} \Rightarrow BP = 20 \text{ m}$$

Putting this value in eq. (i), we get,

$$\sqrt{3} = \frac{20+h}{20}$$

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

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

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

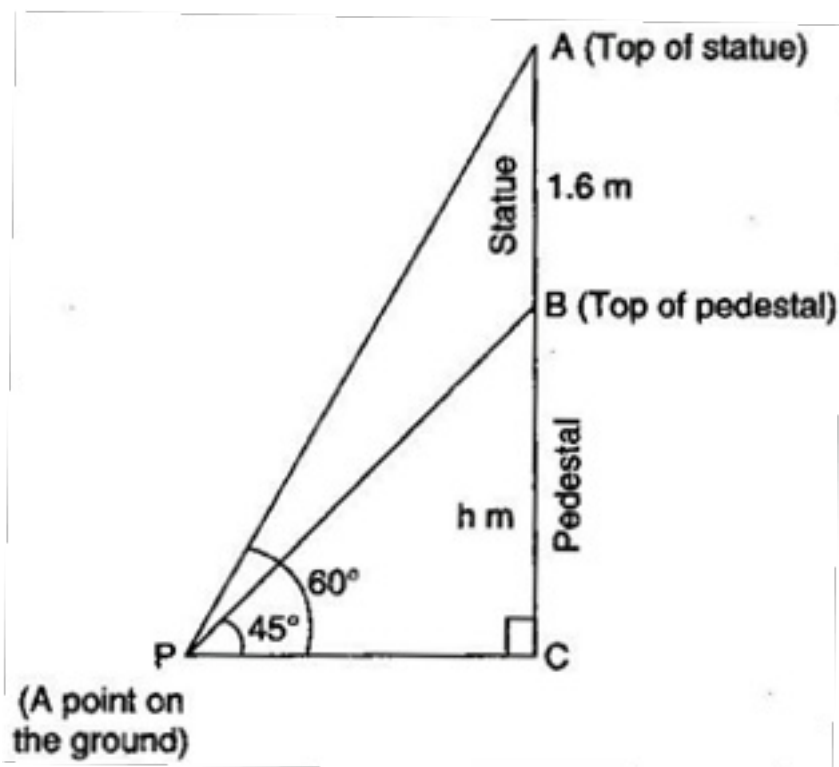
\therefore The height of the tower is $20(\sqrt{3} - 1) \text{ m}$.

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 the height of the pedestal be $h \text{ m}$.

$$\therefore BC = h \text{ m}$$

In right triangle ACP,



$$\tan 60^\circ = \frac{AC}{PC}$$

$$\Rightarrow \sqrt{3} = \frac{AB + BC}{PC}$$

$$\Rightarrow \sqrt{3} = \frac{1.6 + h}{PC} \dots\dots\dots(i)$$

In right triangle BCP,

$$\tan 45^\circ = \frac{BC}{PC}$$

$$\Rightarrow 1 = \frac{h}{PC} \Rightarrow PC = h$$

$$\therefore \sqrt{3} = \frac{1.6 + h}{h} \text{ [From eq. (i)]}$$

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

$$\Rightarrow h(\sqrt{3} - 1) = 1.6$$

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

$$\Rightarrow h = \frac{1.6(\sqrt{3}+1)}{(\sqrt{3}-1)(\sqrt{3}+1)}$$

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

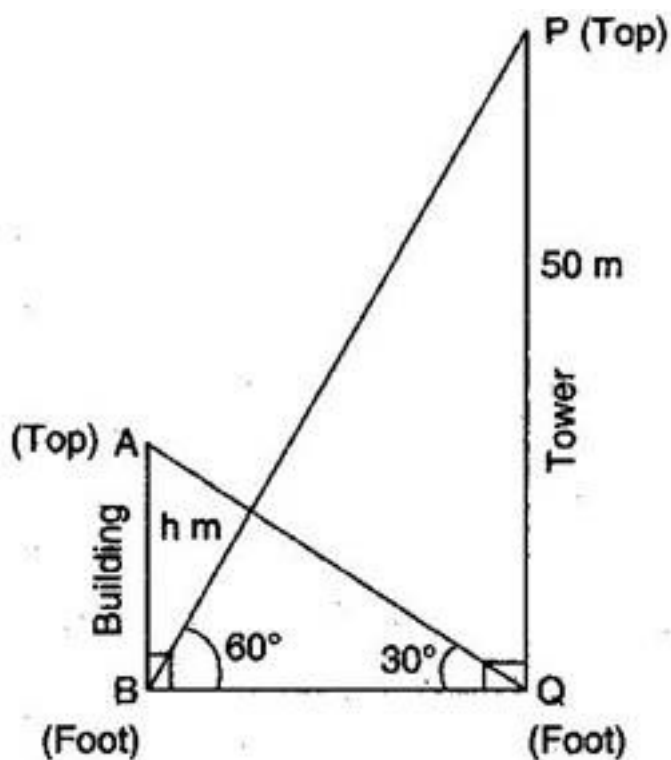
$$\Rightarrow h = \frac{1.6(\sqrt{3}+1)}{2}$$

$$\Rightarrow h = 0.8(\sqrt{3}+1) \text{ m}$$

Hence, the height of the pedestal is $0.8(\sqrt{3}+1)$ m.

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 the height of the building be h m.



In right triangle PQB,

$$\tan 60^\circ = \frac{PQ}{BQ} \Rightarrow \sqrt{3} = \frac{50}{BQ}$$

$$\Rightarrow BQ = \frac{50}{\sqrt{3}} \text{ m} \dots\dots\dots(i)$$

In right triangle ABQ,

$$\tan 30^\circ = \frac{AB}{BQ} \Rightarrow \frac{1}{\sqrt{3}} = \frac{h}{BQ}$$

$$\Rightarrow BQ = h\sqrt{3} \text{ m} \dots\dots\dots(ii)$$

From eq. (i) and (ii),

$$h\sqrt{3} = \frac{50}{\sqrt{3}} \Rightarrow h = \frac{50}{3} = 16\frac{2}{3} \text{ m}$$

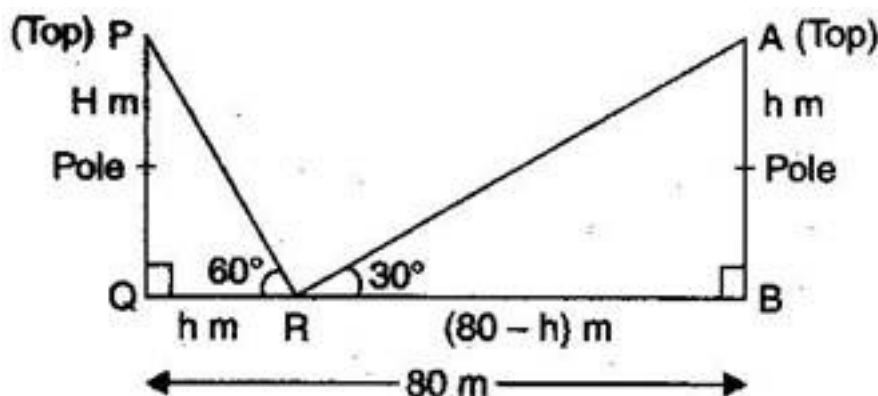
10. Two poles of equal heights are standing opposite each other on either side of the road, which is 80 m wide. From a point between them on the road, the angles of

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 the height of each poles be H m

$$AB = PQ = H$$

In right triangle PRQ,



(in figure change $AB = H$ m rather than h m)

$$\tan 60^\circ = \frac{PQ}{QR} \Rightarrow \sqrt{3} = \frac{H}{h}$$

$$\Rightarrow H = h\sqrt{3} \text{ m} \dots\dots\dots(i)$$

In right triangle ABR,

$$\tan 30^\circ = \frac{AB}{BR}$$

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

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{h\sqrt{3}}{80 - h} \text{ [From eq. (i)]}$$

$$\Rightarrow 80 - h = 3h$$

$$\Rightarrow 4h = 80$$

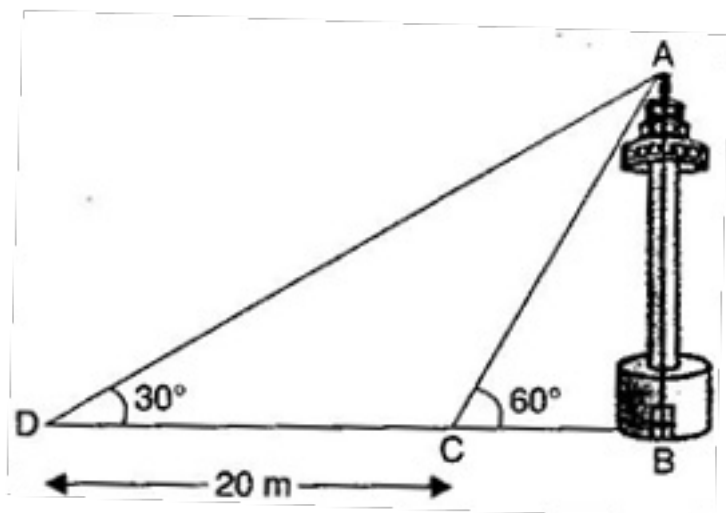
$$\Rightarrow h = 20 \text{ m}$$

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

$$\text{Also, } BR = 80 - h = 80 - 20 = 60 \text{ m}$$

Hence the heights of the poles are $20\sqrt{3}$ m each and the distances of the point from poles are 20 m and 60 m respectively.

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 joining this point to the foot of the tower, the angle of elevation of the top of the tower is 30° (see figure). Find the height of the tower and the width of the canal.



Ans. Let AB be the TV tower .

In right triangle ABC,

$$\tan 60^\circ = \frac{AB}{BC} \Rightarrow \sqrt{3} = \frac{AB}{BC}$$

$$\Rightarrow AB = BC\sqrt{3} \text{ m} \dots\dots\dots(i)$$

In right triangle ABD,

$$\tan 30^\circ = \frac{AB}{BD}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{BC + CD}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{BC + 20}$$

$$\Rightarrow AB = \frac{BC + 20}{\sqrt{3}} \text{ m} \dots\dots\dots(ii)$$

From eq. (i) and (ii),

$$BC\sqrt{3} = \frac{BC + 20}{\sqrt{3}}$$

$$\Rightarrow 3BC = BC + 20$$

$$\Rightarrow BC = 10 \text{ m}$$

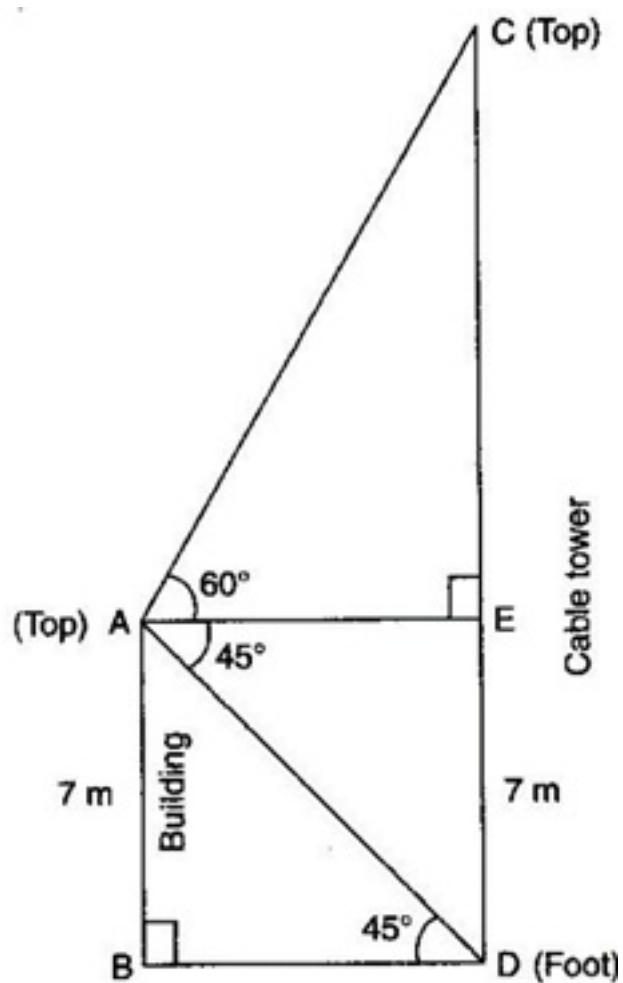
From eq. (i), $AB = 10\sqrt{3} \text{ m}$

Hence height of the tower is $10\sqrt{3} \text{ m}$ and the width of the canal is 10 m.

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. In right triangle ABD,

$$\tan 45^\circ = \frac{AB}{BD}$$



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

$$\Rightarrow BD = 7 \text{ m}$$

$$\Rightarrow AE = 7 \text{ m}$$

In right triangle AEC,

$$\tan 60^\circ = \frac{CE}{AE}$$

$$\Rightarrow \sqrt{3} = \frac{CE}{7}$$

$$\Rightarrow CE = 7\sqrt{3} \text{ m}$$

$$\therefore CD = CE + ED$$

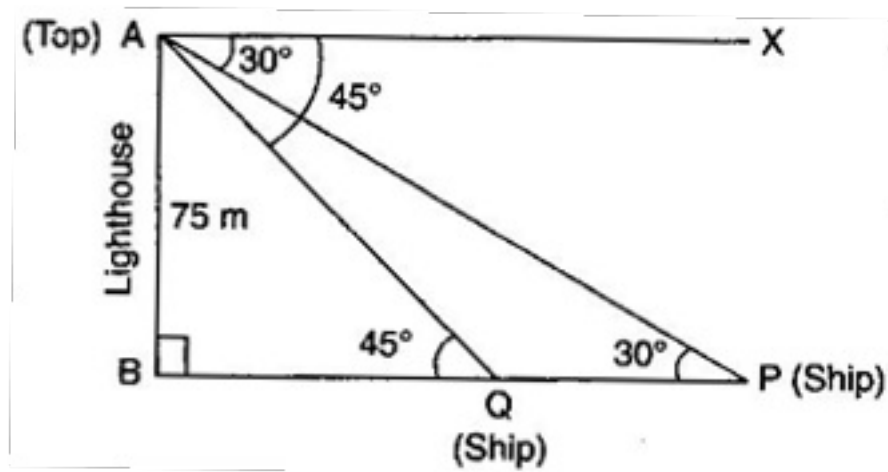
$$= CE + AB \text{ (As } AB = ED\text{)}$$

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

Hence height of the tower is $7(\sqrt{3} + 1) \text{ m}$.

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 two ships.

Ans. In right triangle ABQ,



$$\tan 45^\circ = \frac{AB}{BQ}$$

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

$$\Rightarrow BQ = 75 \text{ m} \dots \dots \dots (i)$$

In right triangle ABP,

$$\tan 30^\circ = \frac{AB}{BP}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{BQ + QP}$$

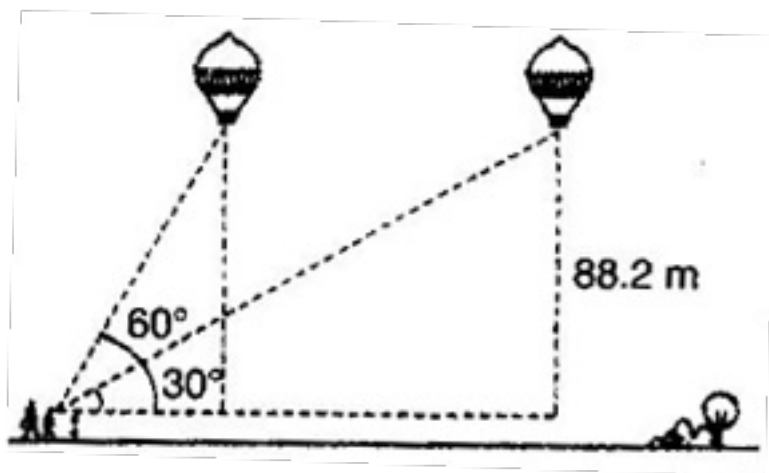
$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{75 + QP} \quad [\text{From eq. (i)}]$$

$$\Rightarrow 75 + QP = 75\sqrt{3}$$

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

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

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 distant is 60° . After some time, the angle of elevation reduces to 30° (see figure). Find the distance travelled by the balloon during the interval.

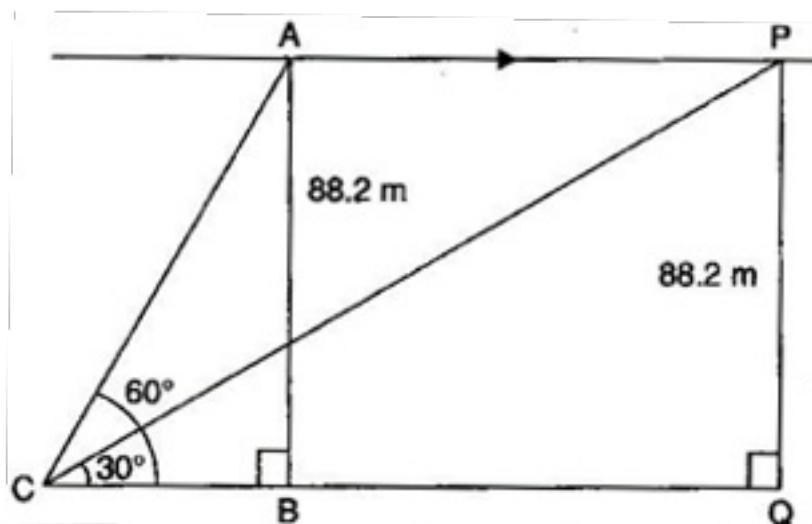


Ans. As, per question;

$$AB = PQ = 88.2 - 1.2 = 87 \text{ m}$$

In right triangle ABC,

$$\tan 60^\circ = \frac{AB}{BC}$$



$$\Rightarrow \sqrt{3} = \frac{87}{BC}$$

$$\Rightarrow BC = \frac{87}{\sqrt{3}} = 29\sqrt{3} \text{ m}$$

In right triangle PQC,

$$\tan 30^\circ = \frac{PQ}{CQ}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{87}{29\sqrt{3} + BQ}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{88.2}{\frac{88.2}{\sqrt{3}} + BQ}$$

$$\Rightarrow 29\sqrt{3} + BQ = 87\sqrt{3}$$

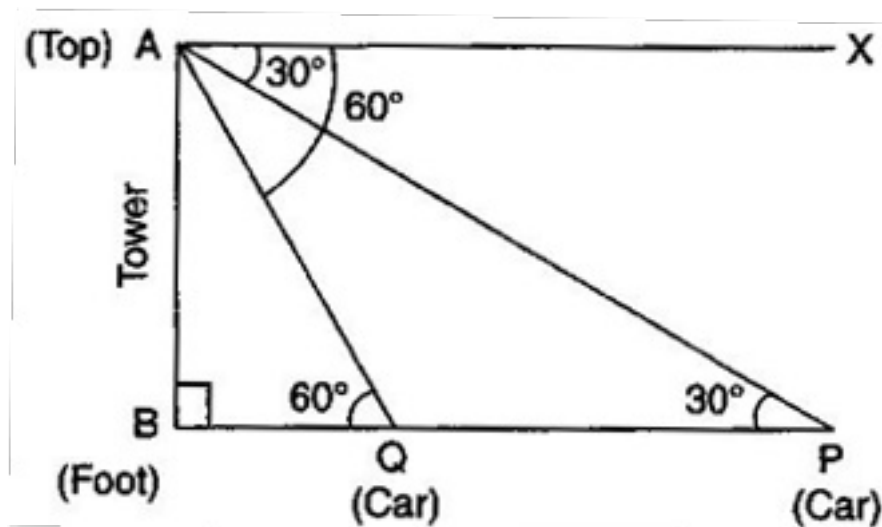
$$\Rightarrow BQ = 58\sqrt{3} \text{ m}$$

Hence the distance travelled by the balloon during the interval is $58\sqrt{3}$ m.

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. In right triangle ABP,

$$\tan 30^\circ = \frac{AB}{BP}$$



$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{BP}$$

$$\Rightarrow BP = AB \sqrt{3} \dots\dots\dots(i)$$

In right triangle ABQ,

$$\tan 60^\circ = \frac{AB}{BQ}$$

$$\Rightarrow \sqrt{3} = \frac{AB}{BQ}$$

$$\Rightarrow BQ = \frac{AB}{\sqrt{3}} \dots\dots\dots(ii)$$

$$\therefore PQ = BP - BQ$$

$$\therefore PQ = AB \sqrt{3} - \frac{AB}{\sqrt{3}}$$

$$= \frac{3AB - AB}{\sqrt{3}} = \frac{2AB}{\sqrt{3}} = 2BQ \text{ [From eq. (ii)]}$$

$$\Rightarrow BQ = \frac{1}{2} PQ$$

\therefore Time taken by the car to travel a distance PQ = 6 seconds.

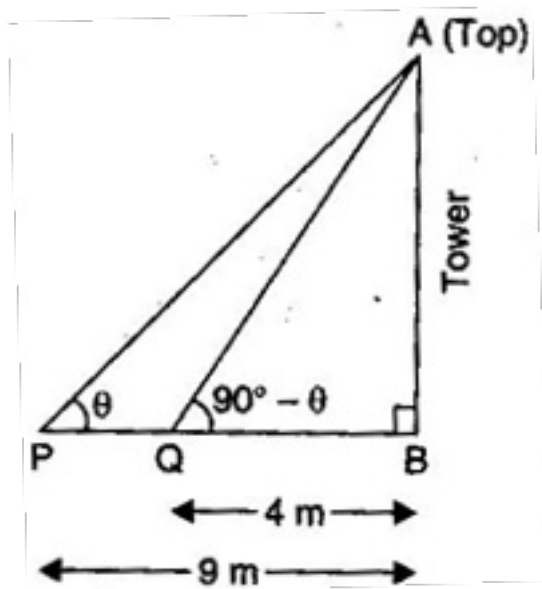
\therefore Time taken by the car to travel a distance BQ, i.e. $\frac{1}{2} PQ = \frac{1}{2} \times 6 = 3$ seconds.

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

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 $\angle APB = \theta$

Then, $\angle AQB = (90^\circ - \theta)$



[$\angle APB$ and $\angle AQB$ are complementary]

In right triangle ABP,

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

$$\Rightarrow \tan \theta = \frac{AB}{9} \dots\dots\dots(i)$$

In right triangle ABQ,

$$\tan (90^\circ - \theta) = \frac{AB}{QB}$$

$$\Rightarrow \cot \theta = \frac{AB}{4} \dots\dots\dots(ii)$$

Multiplying eq. (i) and eq. (ii),

$$\frac{AB}{9} \cdot \frac{AB}{4} = \tan \theta \cdot \cot \theta$$

$$\Rightarrow \frac{AB^2}{36} = 1 \Rightarrow AB^2 = 36$$

$$\Rightarrow AB = 6 \text{ m}$$

Hence, the height of the tower is 6 m.

Proved.