CBSE Class–10 Mathematics

NCERT solution

Chapter - 9

Some Applications of Trigonometry - Exercise 9.1

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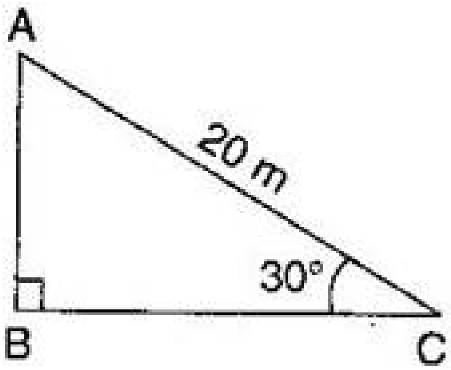
1. A circus artist is climbing a 20 m long rope, which is tightly stretched and tied from the top of a vertical pole to the ground. Find the height of the pole, if the angle made by the rope with the ground level is 30° (see figure).



Ans. In right triangle ABC,

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

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

AB= 20/2

$\Rightarrow$ AB = 10 m

Hence, the height of the pole is 10 m.

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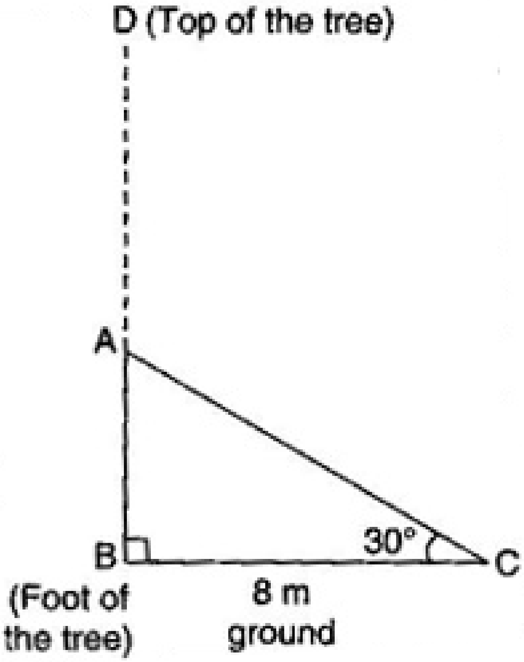
2. A tree breaks due to storm and the broken part bends so that the top of the tree touches the ground making an angle 30° with it. The distance between the foot of the tree to the point where the top touches the ground is 8 m. Find the height of the tree.

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

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

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

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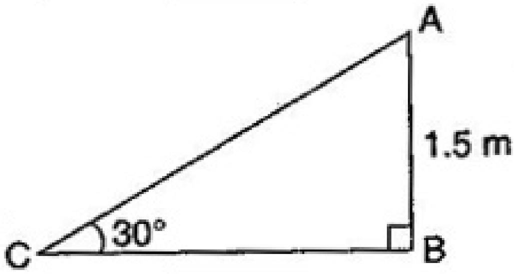
3. A contractor plans to install two slides for the children to play in a park. For the children below the age of 5 years, she prefers to have a slide whose top is at a height of 1.5 m and is inclined at an angle of 30° to the ground, whereas for elder children, she wants to have a steep slide at a height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

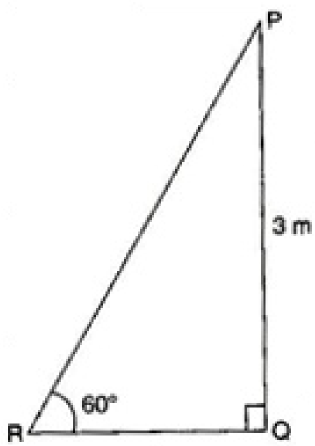


$\sin 30^\circ = \frac{AB}{AC}$

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

$\Rightarrow$ AC = 3 m

In right triangle PQR,



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

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

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

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

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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.

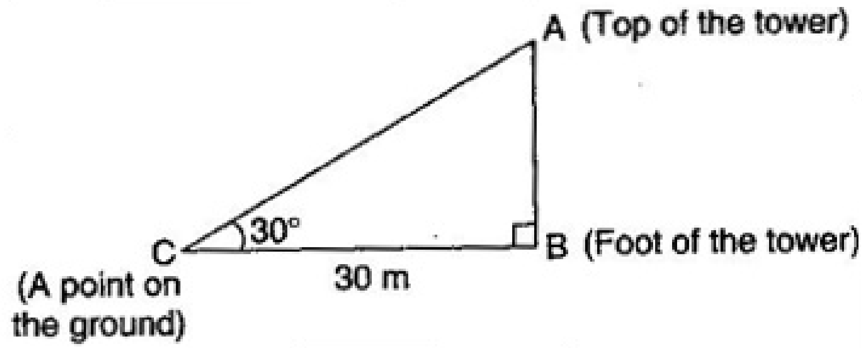
Ans. In right triangle ABC, AB be the height of the tower.

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

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

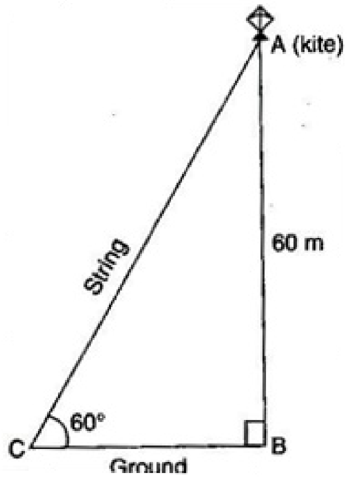
$$\Rightarrow AB = \frac{30}{\sqrt{3}} \text{ m}$$

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



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



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

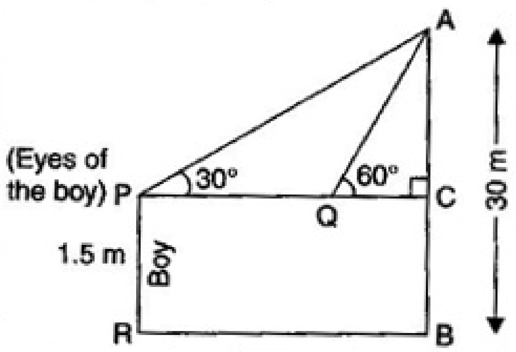
$$\Rightarrow \frac{\sqrt{3}}{2} = \frac{60}{AC}$$

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

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 (As, BC = PR)

= 30 – 1.5

= 28.5 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,

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

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

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

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

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

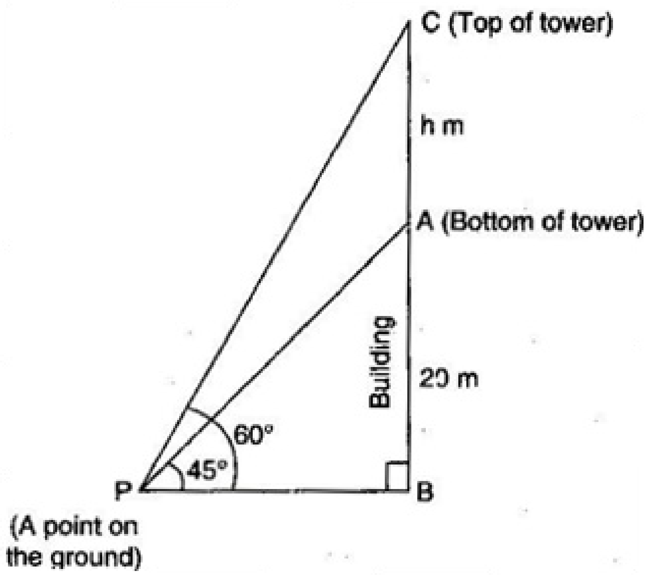
$$\Rightarrow PQ = \frac{57}{\sqrt{3}}$$

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

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,



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

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

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

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,

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

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

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

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

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

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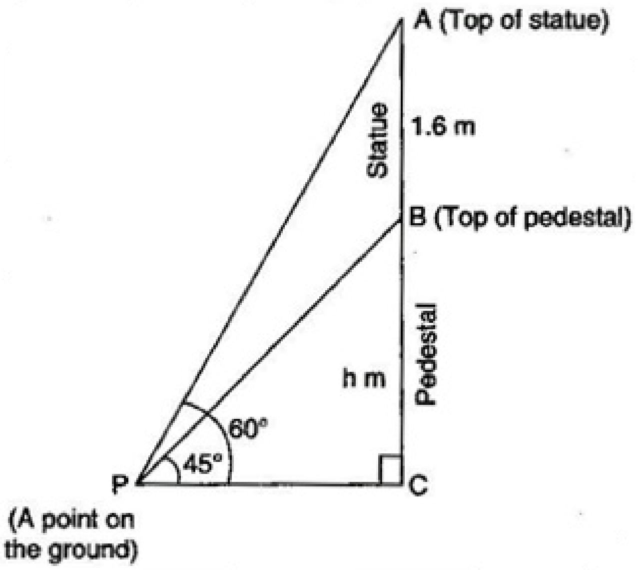
8. A statue, 1.6 m tall, stands on the top of a pedestal. From a point on the ground, the angle of elevation of the top of the statue is 60° and from the same point the angle of elevation of the top of the pedestal is 45°. Find the height of the pedestal.

Ans. Let the height of the pedestal be h m.

$\therefore$ BC = h m

In right triangle ACP,



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

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

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

In right triangle BCP,

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

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

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

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

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

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

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

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

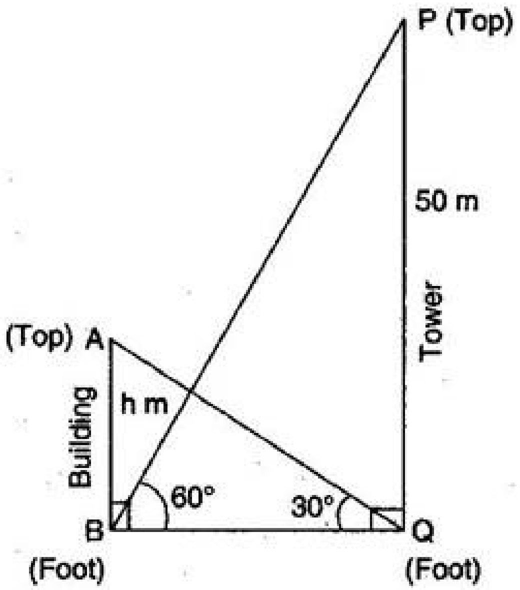
$$\Rightarrow h = \frac{1.6\left(\sqrt{3} + 1\right)}{2}$$

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

Hence, the height of the pedestal is $0.8\left(\sqrt{3} + 1\right)$ 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 = $\frac{50}{\sqrt{3}}$ m..........(i)

In right triangle ABQ,

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

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

From eq. (i) and (ii),

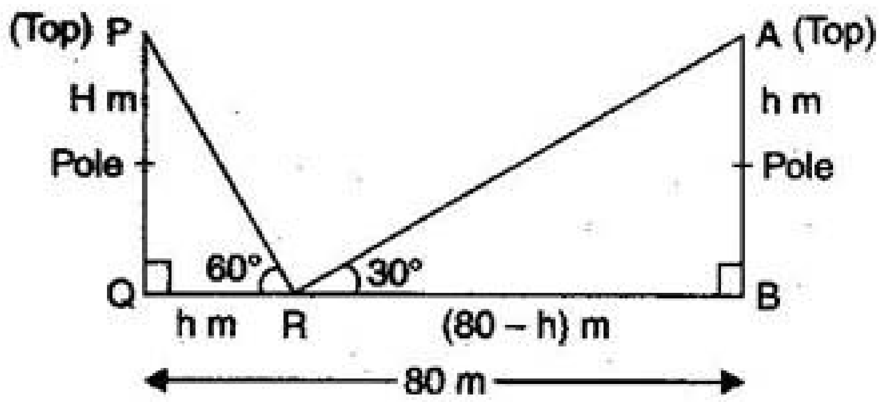
$$h\sqrt{3} = \frac{50}{\sqrt{3}} \Rightarrow h = \frac{50}{3} = 16\frac{2}{3} \text{ m}$$

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 = $h\sqrt{3}$ m..........(i)

In right triangle ABR,

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

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

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

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

$\Rightarrow 4h = 80$

$\Rightarrow h = 20$ m

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

Also, BR = $80 - h$ = 80 – 20 = 60 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.

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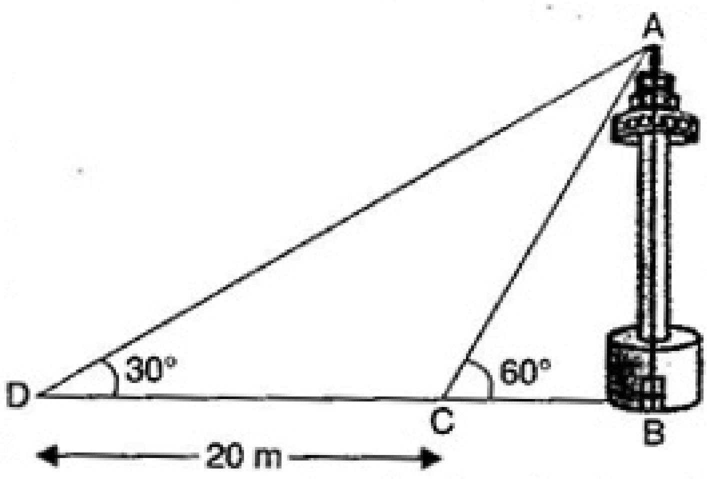
11. A TV tower stands vertically on a bank of a canal. From a point on the other bank directly opposite the tower, the angle of elevation of the top of the tower is 60°. From another point 20 m away from this point on the line joining this point to the foot of the tower, the angle of elevation of the 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 = $BC\sqrt{3}$ m……….(i)

In right triangle ABD,

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

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

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

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

From eq. (i) and (ii),

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

$\Rightarrow$ 3BC = BC + 20

$\Rightarrow$ BC = 10 m

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

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

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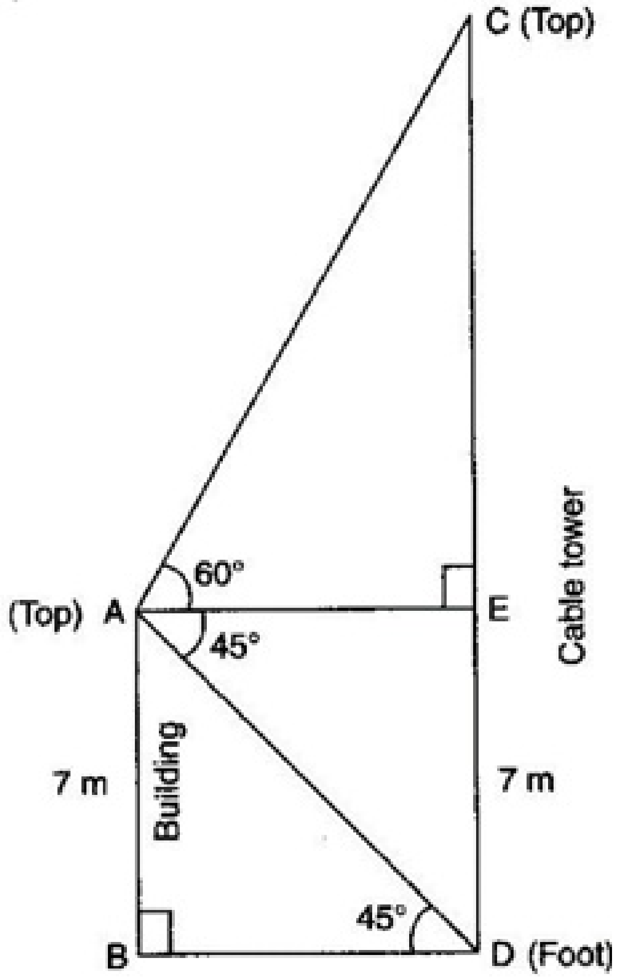
12. From the top of a 7 m high building, the angle of elevation of the top of a cable tower is 60° and the angle of depression of its foot is 45°. Determine the height of the tower.

Ans. In right triangle ABD,

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



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

$\Rightarrow$ BD = 7 m

$\Rightarrow$ AE = 7 m

In right triangle AEC,

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

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

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

$\therefore$ CD = CE + ED

= CE + AB (As AB = ED)

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

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

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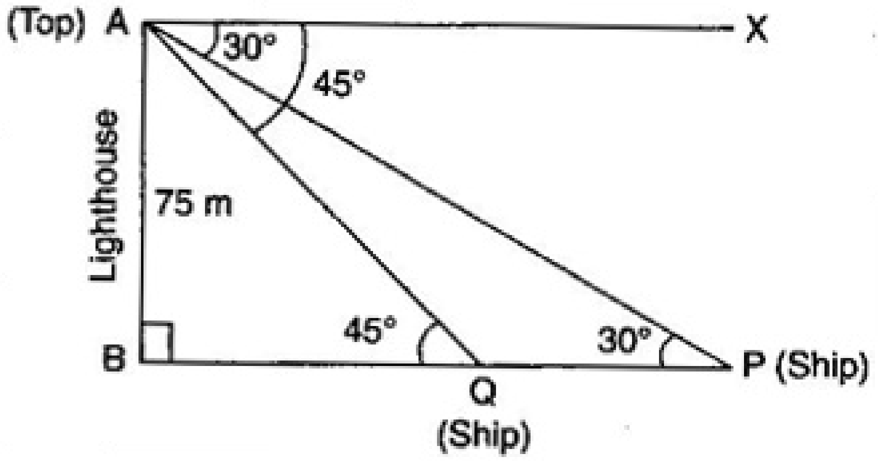
13. As observed from the top of a 75 m high lighthouse from the sea-level, the angles of depression of two ships are 30° and 45°. If one ship is exactly behind the other on the same side of the lighthouse, find the distance between two ships.

Ans. In right triangle ABQ,



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

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

$\Rightarrow$ BQ = 75 m..........(i)

In right triangle ABP,

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

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

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

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

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

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

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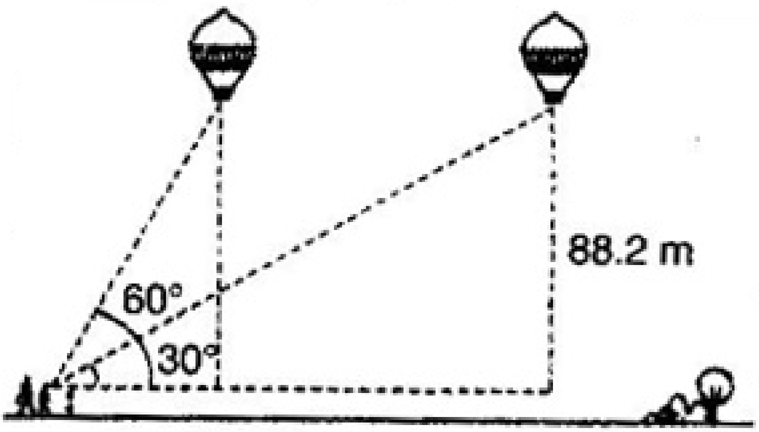
14. A 1.2 m tall girl spots a balloon moving with the wind in a horizontal line at a height of 88.2 m from the ground. The angle of elevation of the balloon from the eyes of the girl at any distant is 60^0 After some time, the angle of elevation reduces to 30^0 (see figure). Find the distance travelled by the balloon during the interval.

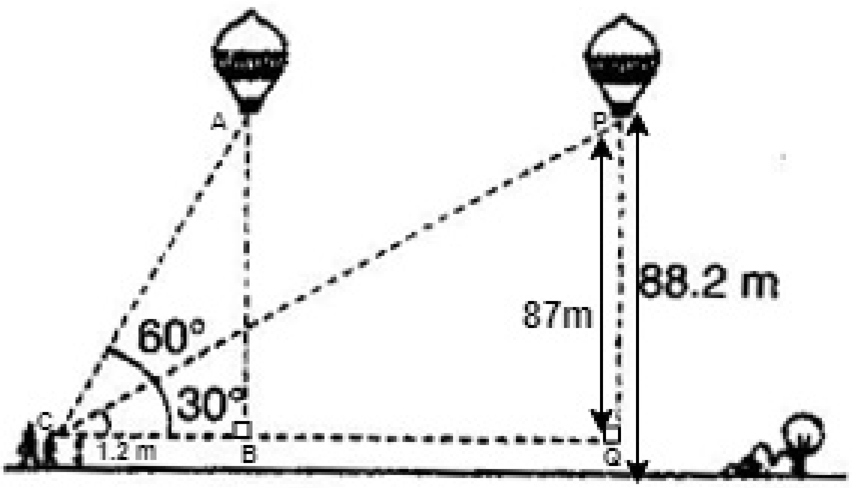


Ans. As, per question;

AB = PQ = 88.2 - 1.2 = 87 m

In right triangle ABC,

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



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

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

In right triangle PQC,

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

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

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

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

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

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

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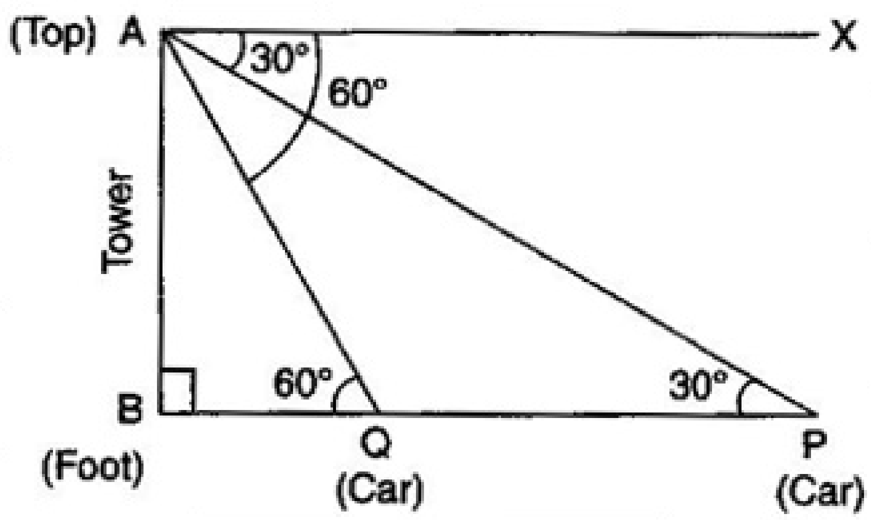
15. A straight highway leads to the foot of a tower. A man standing at the top of the tower observes a car at an angle of depression of 30°, which is approaching the foot of the tower with a uniform speed. Six seconds later, the angle of depression of the car is found to be 60°. Find the time taken by 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 $\sqrt{3}$ ....(i)

In right triangle ABQ,

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

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

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

$\because$ PQ = BP – BQ

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

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

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

$\because$ 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 = $\frac{1}{2}$ x 6 = 3 seconds.

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

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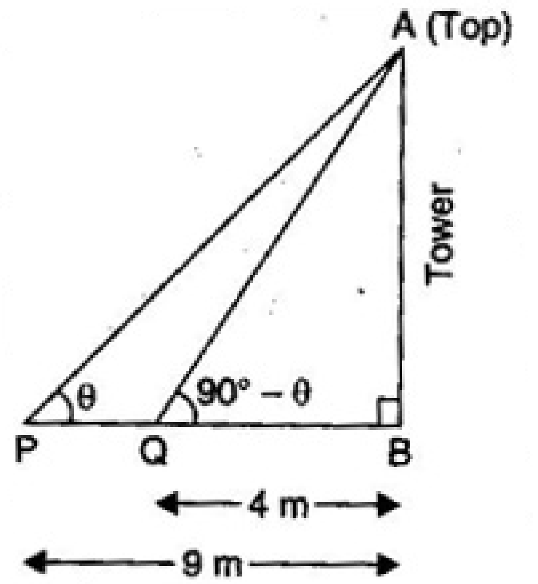
16. The angles of elevation of the top of a tower from two points at a distance of 4 m and 9 m from the base of the tower and in the same straight line with it are complementary. Prove that the height of the tower is 6 m.

Ans. Let $\angle$ APB = θ

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



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

In right triangle ABP,

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

$$\Rightarrow \tan\theta = \frac{AB}{9} \quad \text{..........(i)}$$

In right triangle ABQ,

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

$$\Rightarrow \cot\theta = \frac{AB}{4} \quad \text{..........(ii)}$$

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

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

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

$\Rightarrow$ AB = 6 m

Hence, the height of the tower is 6 m.

Proved.