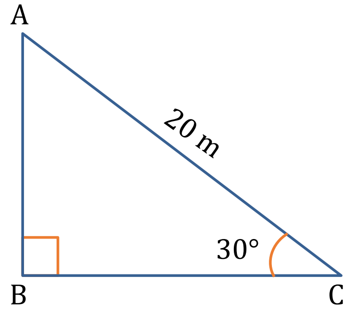
# NCERT QUESTIONS WITH SOLUTIONS

## EXERCISE : 9.1

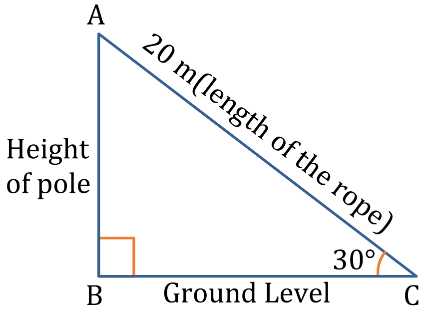
**1.** A circus artist is climbing a 20 m long rope, which is tightly stretched and tied from the top of a vertical pole to the ground. Find the height of the pole if the angle made by the rope with the ground level is 30° (see fig.).




**Sol.** AC = 20 m is the length of the rope.

Let AB = h metres be the height of the pole

$\angle ACB = 30°$ (Given)




Now,

$$\frac{AB}{AC} = \sin 30° = \frac{1}{2}$$

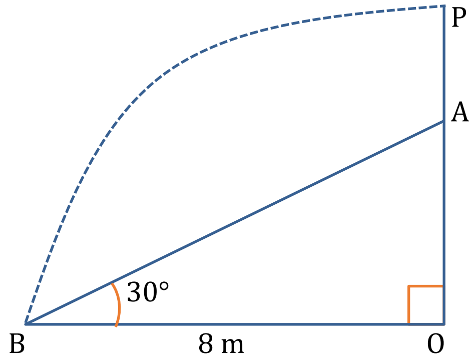
$$\Rightarrow \quad \frac{h}{20} = \frac{1}{2}$$

$\Rightarrow$ h = 10 m

$\therefore$ 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 of 30° with the ground. 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.

**Sol.**




Let tree is broken at A and its top is touching the ground at B.

Now, in right $\Delta AOB$, we have

$$\frac{AO}{OB} = \tan 30°$$

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

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

Also, $\frac{AB}{OB} = \sec 30°$

$$\Rightarrow \quad \frac{AB}{8} = \frac{2}{\sqrt{3}}$$

$$\Rightarrow \quad AB = \frac{2 \times 8}{\sqrt{3}} = \frac{16}{\sqrt{3}} \text{ m}$$

Now, height of the tree OP = OA + AP

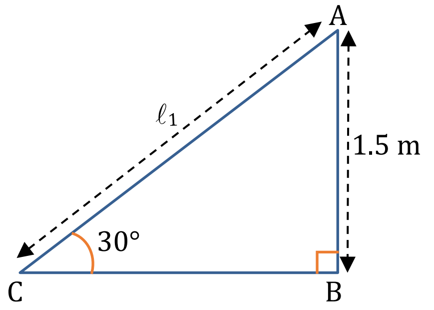
= OA + AB

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

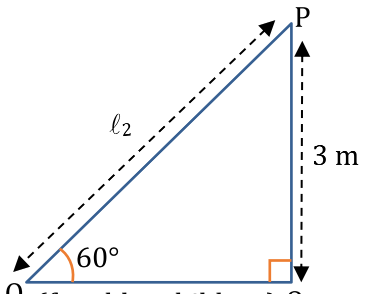
$\therefore$ the height of the tree is $8\sqrt{3}$ m

**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 is inclined at an angle of 60° to the ground. What should be the length of the slide in each case?

**Sol.** In figure, $\ell_1$ is the length of the slide made for children below the age of 5 years and $\ell_2$ is the length of the slide made for elder children.



(for children below 5 years)



(for elder children)

In figure, AB = 1.5 m, AC = $\ell_1$ m and ∠ACB = 30°, PQ = 3 m, OP = $\ell_2$ m and ∠POQ = 60°

$$\frac{AB}{AC} = \sin 30° \text{ and } \frac{PQ}{OP} = \sin 60°$$

$$\Rightarrow \frac{1.5}{\ell_1} = \frac{1}{2} \text{ and } \frac{3}{\ell_2} = \frac{\sqrt{3}}{2}$$

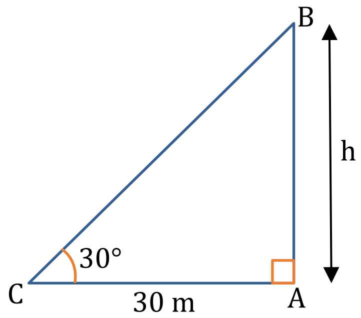
$$\Rightarrow \ell_1 = 2 \times 1.5 \text{ m and } \ell_2 = \frac{3 \times 2}{\sqrt{3}} \text{ m}$$

$$\Rightarrow \ell_1 = 3 \text{ m and } \ell_2 = 2\sqrt{3} \text{ m}$$

∴ the length of the slides are 3m 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 30 m away from the foot of the tower, is 30°. Find the height of the tower.

**Sol.** In right ΔABC, AB = h height of the tower and point C is 30m away from the foot of the tower,




∴ AC = 30 m

Now, $\frac{AB}{AC} = \tan 30°$

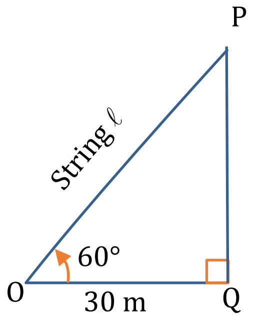
$$\Rightarrow \frac{h}{30} = \frac{1}{\sqrt{3}}$$

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

Thus, the required height of the tower is $10\sqrt{3}$ 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.

**Sol.** P is the position of the kite. Its height from the point Q (on the ground) = PQ = 60 m




Let OP = $\ell$ be the length of the string.

$\angle POQ = 60°$ (Given)

Now, $\frac{PQ}{OP} = \sin 60°$

$\Rightarrow \frac{60}{\ell} = \sin 60° = \frac{\sqrt{3}}{2}$

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

$\Rightarrow \ell = 40\sqrt{3}$ m

$\therefore$ 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.

**Sol.** PQ = 30 m is the height of the building.

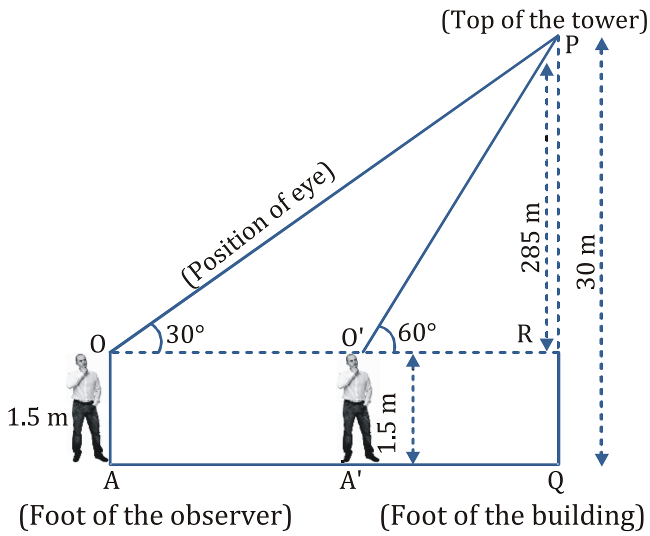
OA = 1.5 m is the height of the boy. Its first position is at OA. OR is horizontal line through the position of the eye at O.

$\angle POR = 30°$ (Given)

The second position of the boy is at O'A' and $\angle PO'R = 60°$.

Here, RQ = OA = O'A' =1.5 m

and PR = 30 m – 1.5 m = 28.5 m




In $\Delta POR$,

$\frac{PR}{OR} = \tan 30°$

$\Rightarrow \frac{28.5}{OR} = \frac{1}{\sqrt{3}}$

In $\Delta PO'R$,

$\frac{PR}{O'R} = \tan 60°$

$\Rightarrow \frac{28.5}{O'R} = \sqrt{3}$

$\Rightarrow OR = 28.5\sqrt{3}$ m ... (i)

$\Rightarrow O'R = \frac{28.5}{\sqrt{3}}$ m ... (ii)

The distance walked by the boy towards the building = OO' = OR – O'R

[From (i) and (ii)]

$= 28.5 \times \sqrt{3}\,\text{m} - \dfrac{28.5}{\sqrt{3}}\,\text{m}$

$= 28.5 \times \left\{\sqrt{3} - \dfrac{1}{\sqrt{3}}\right\}\,\text{m}$

$= 28.5 \times \dfrac{(3-1)}{\sqrt{3}}\,\text{m} = 28.5 \times \dfrac{2}{\sqrt{3}}\,\text{m}$

$= \dfrac{57}{\sqrt{3}}\,\text{m} = 19\sqrt{3}\,\text{m}$

$\therefore$ the boy walks $19\sqrt{3}$ m towards the building.

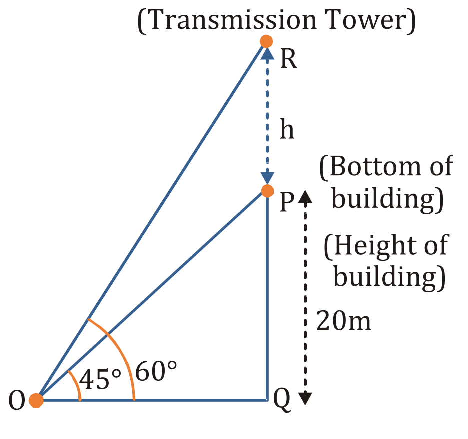
**7.** From a point on the ground, the angles of elevation of the bottom and the top of a transmission tower fixed at the top of a 20m high building are 45° and 60° respectively. Find the height of the tower.

**Sol.** PQ = 20 m is the height of the building.

Let PR = h metres be the height of the transmission tower. P is the bottom and R is the top of the transmission tower.

$\angle POQ = 45°$ and $\angle ROQ = 60°$

In $\Delta OPQ$,




$\dfrac{PQ}{OQ} = \tan 45°$

$\Rightarrow \dfrac{20}{OQ} = 1$

$\Rightarrow OQ = 20$ m

In $\Delta ORQ$,

$\dfrac{RQ}{OQ} = \tan 60°$

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

($\because$ RQ = PQ + PR = 20 + h metres and OQ = 20 metres)

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

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

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

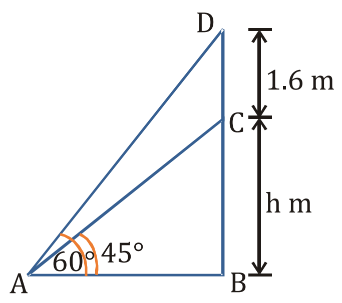
$\therefore$ the height of the tower is $20(\sqrt{3}-1)$ m.

**8.** A statue, 1.6 m tall, stands on the top of 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.

**Sol.** In the figure, DC represents the statue and BC represents the pedestal.

Let the height of pedestal is 'h'

Now, in right $\Delta ABC$, we have




$\dfrac{AB}{BC} = \cot 45° = 1$

$\Rightarrow \dfrac{AB}{h} = 1$

$\Rightarrow AB = h$ metres ... (i)

Now in right $\Delta ABD$, we have

$$\frac{BD}{AB} = \tan 60° = \sqrt{3}$$

$\Rightarrow$ $BD = \sqrt{3} \times AB = \sqrt{3} \times h$ [from (i)]

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

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

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

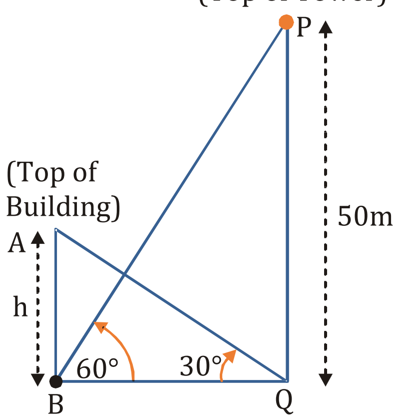
$$\Rightarrow \quad h = \frac{1.6}{3-1} \times \left(\sqrt{3}+1\right) = \frac{1.6}{2} \times \left(\sqrt{3}+1\right)$$

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

Thus, 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.

**Sol.** PQ = 50 metres is the height of the tower. Let AB = h metres be the height of the building. Angle of elevation of the top of the building from the foot of the tower = 30°, i.e., $\angle AQB = 30°$.




Angle of elevation of the top of the tower from the foot of the building = 60°, i.e., $\angle PBQ = 60°$.

In $\Delta AQB$, $\frac{AB}{BQ} = \tan 30°$

$$\frac{h}{BQ} = \frac{1}{\sqrt{3}}$$

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

In $\Delta PBQ$

$$\frac{50}{BQ} = \tan 60° = \sqrt{3}$$

$\Rightarrow$ $BQ = \frac{50}{\sqrt{3}}$ ... (ii)

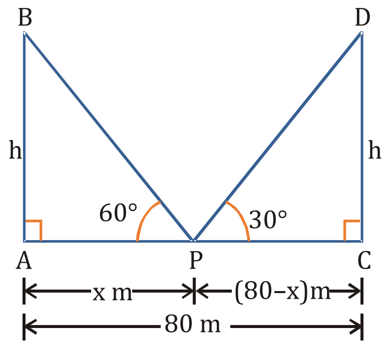
From (i) and (ii), we have $h\sqrt{3} = \frac{50}{\sqrt{3}}$

$\Rightarrow$ $h = \frac{50}{3}$m i.e., $h = 16\frac{2}{3}$m

$\therefore$ the height of building is $16\frac{2}{3}$m .

**10.** Two poles of equal heights are standing opposite to 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 distance of the point from the poles.

**Sol.** Let AB and CD be two poles and P is the point in between them.



AB = h metres

$\Rightarrow$ CD = h metres

AP = x m

$\Rightarrow$ CP = (80 – x) m

Now, in right ΔAPB, we have

$\frac{AB}{AP} = \tan 60° \quad \Rightarrow \frac{h}{x} = \sqrt{3}$

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

Again, in right ΔCPD, we have

$\frac{CD}{CP} = \tan 30°$

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

$\Rightarrow h = \frac{80-x}{\sqrt{3}}$ ... (ii)

From (i) and (ii), we get

$\sqrt{3}x = \frac{80-x}{\sqrt{3}}$

$\Rightarrow \sqrt{3} \times \sqrt{3} \times x = 80 - x \Rightarrow 3x = 80 - x$

$\Rightarrow 3x + x = 80 \Rightarrow 4x = 80 \Rightarrow x = \frac{80}{4} = 20$

$\therefore$ CP = 80 – x = 80 – 20 = 60 m

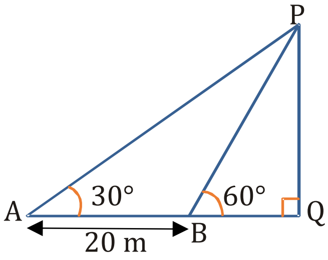
Now, from (i), we have

$h = \sqrt{3} \times 20 = 1.732 \times 20 = 34.64$

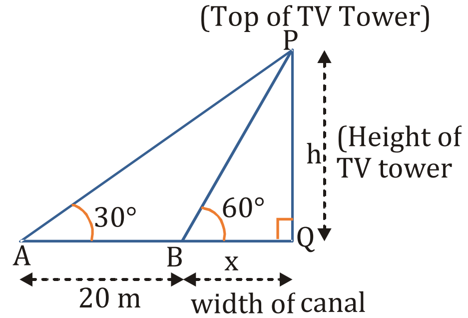
Thus, the required point is 20 m away from the first pole and 60 m away from the second pole.

Height of each pole = 34.64 m.

**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 fig.). Find the height of the tower and the width of the canal.




**Sol.** Let PQ = h metres be the height of the tower and BQ = x metres be the width of the canal ∠PBQ = 60°




Now, the angle of elevation of the top of the tower from the point A is 30°.

i.e., ∠PAQ = 30° where AB = 20 metres.

In ΔPBQ,

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

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

In ΔPAQ,

$\frac{h}{20+x} = \tan 30° = \frac{1}{\sqrt{3}}$

$\Rightarrow h = \frac{20+x}{\sqrt{3}}$ ... (ii)

From (i) and (ii), we have $\sqrt{3}x = \frac{20+x}{\sqrt{3}}$

$\Rightarrow$ 3x = 20 + x

$\Rightarrow$ $2x = 20 \Rightarrow x = 10$

From (i), $h = 10\sqrt{3}$ m

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

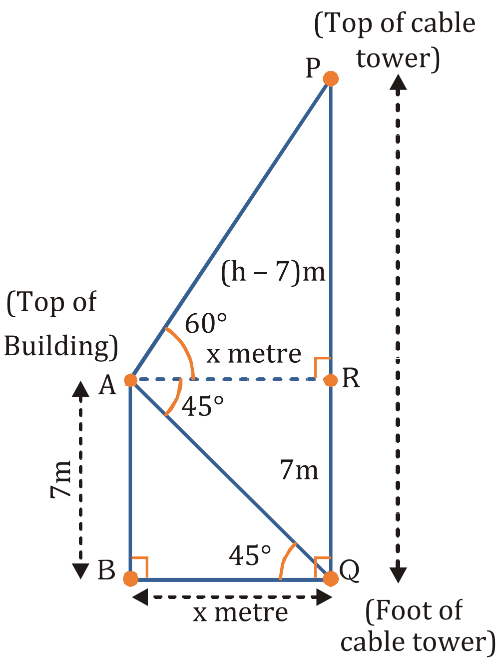
**12.** From the top of a 7 m high building, the angle of elevation of the top of a cable tower is 60° and the angle of depression of its foot is 45°. Determine the height of the tower.

**Sol.** Let PQ = h metres be the height of the cable tower.

AB = 7 metres is the height of the building

$\angle PAR = 60°$ is the angle of elevation of the top of the cable tower from the top of the building.

$\angle RAQ = 45°$ is the angle of depression of the foot of the cable tower from the top of the building. Then $\angle AQB = 45°$.




Now, BQ = AR = x metres (say)

In $\Delta AQB$, $\frac{AB}{BQ} = \tan 45° \Rightarrow \frac{7}{x} = 1 \Rightarrow x = 7$ m

Now, in $\Delta PAR$,

$$\frac{PR}{AR} = \tan 60°$$

$$\Rightarrow \frac{PQ - QR}{x} = \sqrt{3}$$

$$\Rightarrow \frac{h-7}{x} = \sqrt{3}$$

$$\Rightarrow \frac{h-7}{x} = \sqrt{3}$$

$$\Rightarrow h = 7(\sqrt{3}+1)$$

Hence, the height of the cable tower is $7(\sqrt{3}+1)$ metre.

**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.

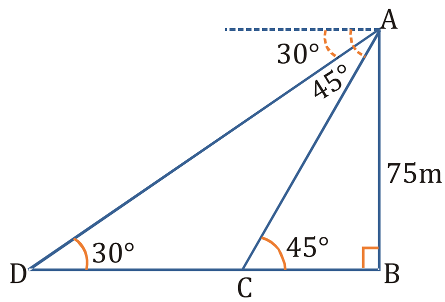
**Sol.** In the figure, let AB represent the lighthouse.

$\therefore$ AB = 75 m

Let the two ships be C and D such that angle of depression from A are 45° and 30° respectively.

Now, in right $\Delta ABC$, we have

$$\frac{AB}{BC} = \tan 45°$$




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

$\Rightarrow$ BC = 75 m

Again, in right $\Delta ABD$, we have

$$\frac{AB}{BD} = \tan 30°$$

$$\Rightarrow \quad \frac{75}{BD} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad BD = 75\sqrt{3}\,m$$

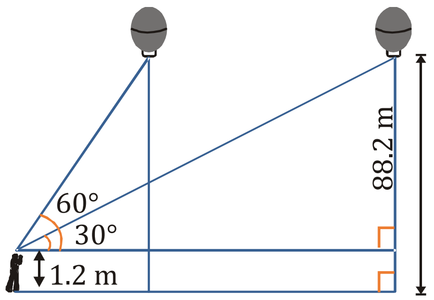
Since the distance between the two ships

$= CD = BD - BC = 75\sqrt{3} - 75 = 75(\sqrt{3} - 1)$

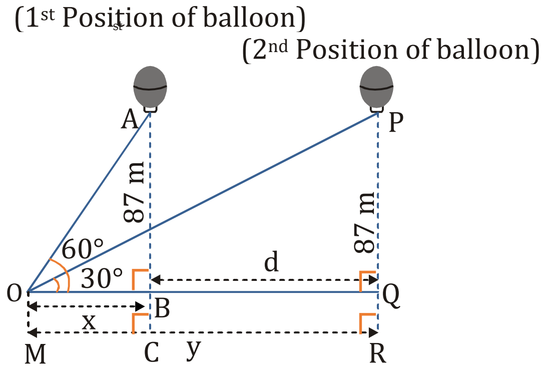
$= 75(1.732 - 1) = 75 \times 0.732 = 54.9m$

Thus, the required distance between the ships is 54.9 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 instant is 60°. After some time, the angle of elevation reduces to 30° (see figure). Find the distance travelled by the balloon during the interval.




**Sol.** From figure, we have ∠AOB = 60° is the angle of elevation for the first position of the balloon. Let OB = x m.




We are given that

AC = 88.2 m, AB = 88.2 – 1.2 = 87 m

For the second position of the balloon, we have

∠POQ = 30°. Let OQ = y

We have to find distance d = BQ = (y – x)

$$\frac{AB}{OB} = \tan 60° \text{ and } \frac{PQ}{OQ} = \tan 30°$$

$$\Rightarrow \quad \frac{87}{x} = \sqrt{3} \text{ and } \frac{87}{y} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad x = \frac{87}{\sqrt{3}} m \text{ and } y = 87\sqrt{3}\ m$$

$$\text{Now, } d = y - x = \left\{87\sqrt{3} - \frac{87}{\sqrt{3}}\right\} m$$

$$= 87 \times \left\{\sqrt{3} - \frac{1}{\sqrt{3}}\right\} m$$

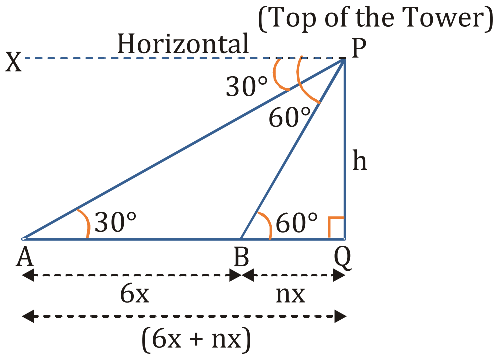
$$= 87 \times \frac{2}{\sqrt{3}}\ m = 87 \times \frac{2}{3} \times \sqrt{3}\ m$$

$$= \frac{174}{3}\sqrt{3}m = 58\sqrt{3}\ m$$

∴ A distance travelled by the balloon during 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.

**Sol.** Let PQ = h metres be the height of the tower. P is the top of the tower. PX is horizontal line through P. The first and second positions of the car are at A and B respectively.




$\angle APX = 30°$

Angles of depression of the car when observed at A and B are $\angle APX = 30°$ and $\angle BPX = 60°$ respectively.

Then, $\angle PAQ = 30°$ and $\angle PBQ = 60°$

Let the speed of the car be x m/sec

Then, distance AB = 6x m

Let the time taken from B to Q be n seconds.

Then distance BQ = nx m

| In right $\Delta PAQ$ | In right $\Delta PBQ$ |
|---|---|
| $\frac{h}{6x+nx} = \tan 30° = \frac{1}{\sqrt{3}}$ | $\frac{h}{nx} = \tan 60° = \sqrt{3}$ |
| $\Rightarrow h = \frac{(n+6)x}{\sqrt{3}}$ ...(i) | $\Rightarrow h = nx\sqrt{3}$ ...(ii) |

From (i) and (ii), we have

$$\frac{(n+6)x}{\sqrt{3}} = nx\sqrt{3}$$

$\Rightarrow$ $n + 6 = n\sqrt{3}\times\sqrt{3}$

$\Rightarrow$ $3n = n + 6$

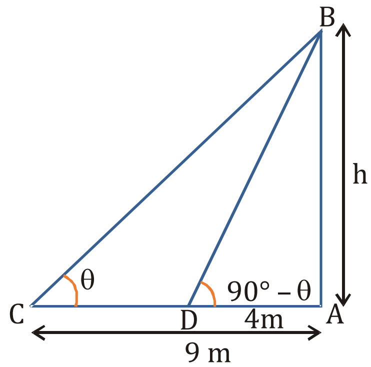
$\Rightarrow$ $2n = 6$

$\Rightarrow$ $n = 3$

Hence, the time taken to travel from B to Q = 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.

**Sol.** Let the tower be represented by AB in the figure.




Let AB = h metres.

$\therefore$ In right $\Delta$ ABC, we have $\frac{AB}{AC} = \tan\theta$

$\Rightarrow$ $\frac{h}{9} = \tan\theta$ ...(i)

In right $\Delta ABD$, we have

$\frac{AB}{AD} = \tan(90° - \theta) = \cot\theta$

$\Rightarrow$ $\frac{h}{4} = \cot\theta$ ...(ii)

Multiplying (i) and (ii), we get

$\frac{h}{9}\times\frac{h}{4} = \tan\theta \times \cot\theta = 1$

$(\because \tan\theta \times \cot\theta = 1)$

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

$\Rightarrow$ $h = \pm 6$ m

$\therefore$ $h = 6$ m $(\because$ Height is positive only)

Thus, the height of the tower is 6 m.

**Note : (**) marked question are deleted from NCERT.**