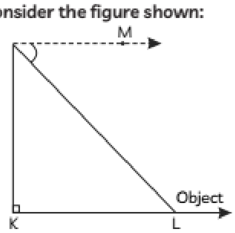
OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Consider the figure shown:

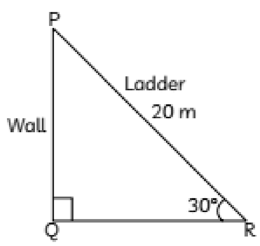


(a) 10 m (b) $10\sqrt{3}$ m

(c) 20 m (d) $\frac{10}{\sqrt{3}}$ m

Ans. *(a) 10 m*

Explanation: Here, PR = 20 m (length of ladder)



In ΔPQR

$$\frac{PQ}{PR} = \sin 30°$$

$$\frac{PQ}{20} = \frac{1}{2}$$

$$PQ = 10 \text{ m}$$

So, the height of the wall is 10 m.

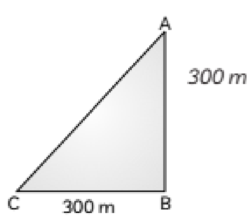
3. If 300 m high pole makes an angle of elevation at a point on ground which is 300 m away from its foot, then the angle of elevation is:

(a) 60° (b) 90°

(c) 30° (d) 45°

Ans. *(d) 45°*

Explanation: Let AB be the tower whose height is 300 m, *i.e.,*



$$AB = 300 \text{ m}$$
$$BC = 300 \text{ m}$$

So, in right-angled ΔABC,

$$\tan\theta = \frac{\text{Perpendicular}}{\text{Base}}$$

$$= \frac{AB}{BC}$$

$$\tan\theta = \frac{300}{300}$$

$$\tan\theta = 1$$

If $\angle LJM$ is the angle of depression, what is the line of sight in the figure shown?

(a) JM (b) JL

(c) JK (d) KL

[CBSE Question Bank 2022]

2. A ladder 20 m long just reaches the top of a wall. If the ladder makes an angle of 30° with the wall, then the height of the wall is:

$$\tan\theta = \tan 45° \quad [\because \tan 45° = 1]$$
$$\theta = 45°$$

Hence, the required angle of elevation is 45°.

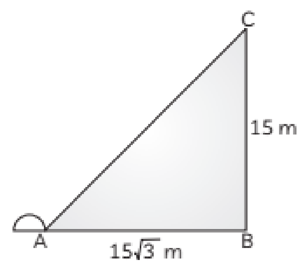
4. A stone is $15\sqrt{3}$ m away from a tower 15 m high, then the angle of elevation of the top of the tower from a stone is:

(a) 45° (b) 60°

(c) 30° (d) 90°

Ans. *(c) 30°*

Explanation: Let BC = 15 m be the height the tower and AB = $15\sqrt{3}$ m be the distance of a stone from the tower.



So, in right-angled ΔABC,

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

$$\tan\theta = \frac{15}{15\sqrt{3}}$$

$$\tan\theta = \frac{1}{\sqrt{3}}$$

$$\tan\theta = \tan 30°$$
$$\theta = 30°$$

Thus, the angle of elevation of the top of the tower from the stone is 30°

5. The tops of the poles of height 16 m and 10 m are connected by a wire of length l meters. If the wire makes an angle of 30° with the horizontal, then l =

(a) 26 m (b) 16 m

(c) 12 m (d) 10 m

[Delhi Gov. QB 2022]

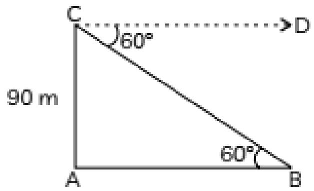
6. The angle of depression of a bike parked on the road from the top of a 90 m high pole is 60 degrees. The distance of the bike from the pole is:

(a) $20\sqrt{3}$ m (b) 90 m

(c) $15\sqrt{3}$ m (d) $30\sqrt{3}$ m

Ans. *(d) $30\sqrt{3}$ m*

Explanation: Let AC = 90 m be the height of the pole. Angle of depression = 60°



We know, $\angle DCB = \angle ABC$ (Alternate angles)

$$\tan 60° = \frac{AC}{AB}$$

$$\sqrt{3} = \frac{90}{AB}$$

$$AB = \frac{90}{\sqrt{3}}$$

$$= \frac{90}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= \frac{90\sqrt{3}}{3}$$

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

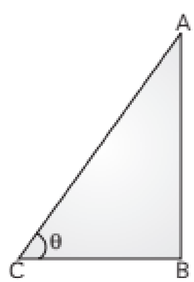
Thus, the distance of the bike from the pole is $30\sqrt{3}m$.

7. The ratio of the length of a tower and its shadow is $\sqrt{3}:1$. The altitude of the sun is:

(a) 0° **(b) 60°**
(c) 30° **(d) 45°**

Ans. *(b) 60°*

Explanation: Let AB be the tower and BC be its shadow.



In ΔABC, $\tan\theta = \frac{AB}{BC}$

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

$$= \tan 60°$$

$\Rightarrow$ $\theta = 60°$

So, the altitude of the sun is 60°

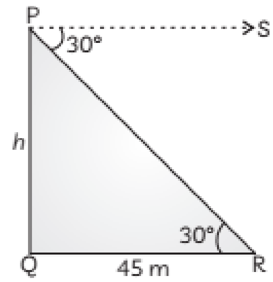
8. If the angle of depression of an object from a temple is 30°, and the distance of the object from the temple is 45 m, then the height of the temple is:

(a) $45\sqrt{3}$ m **(b) $15\sqrt{3}$ m**

(c) 20 m **(d) $20\sqrt{3}$ m**

Ans. *(b) $15\sqrt{3}$ m*

Explanation: Let PQ = hm, be the height of the temple and angle of depression = 30°



We know, $\angle SPR = \angle QRP$ (Alternate angles)

In ΔPQR, $\tan 30° = \frac{PQ}{QR}$

$$\frac{1}{\sqrt{3}} = \frac{h}{45}$$

$$h = \frac{45}{\sqrt{3}}$$

$$= 15\sqrt{3}$$

$$h = 15\sqrt{3} \text{ m}$$

So, the height of the temple is $15\sqrt{3}$ m.

9. From the top of a 15 m high building the angle of elevation of the top of a tower is 30° and the angle of depression of its foot is 45°, then the height of the tower is:

(a) $5(3+\sqrt{3})$ m **(b) $15\sqrt{3}$ m**

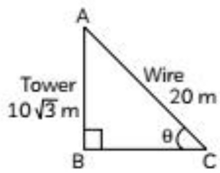
(c) $15(1+\sqrt{3})$ m **(d) $5\sqrt{3}$ m**

10. A 20 m long wire touches the tower at a height of $10\sqrt{3}$ m. The angle which the wire makes with the horizontal is:

(a) 30° **(b) 45°**
(c) 60° **(d) 90°**

Ans. *(c) 60°*

Explanation: Let AB be the tower and AC be the wire.



In ΔABC

$$\sin\theta = \frac{AB}{AC}$$

$$\sin\theta = \frac{10\sqrt{3}}{20}$$

$$\sin\theta = \frac{\sqrt{3}}{2}$$

$$\sin\theta = \sin 60°$$

$$\theta = 60°$$

So, the angle which the wire makes with the horizontal is 60°.

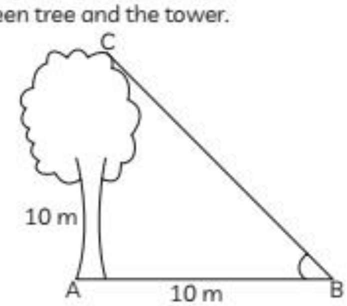
11. The angle of elevation of the top of a 10 m high tree at a point 10 m away from the base of the tower is:

(a) 90° **(b) 60°**

(c) 30° **(d) 45°**

Ans. *(d) 45°*

Explanation: Let AC = 10 m be the height of the tree and AB = 10 m be the distance between tree and the tower.



In ΔABC, $\tan\theta = \frac{AC}{AB}$

$\Rightarrow$ $= \frac{10}{10}$

$\tan\theta = 1$

$\Rightarrow$ $\tan\theta = \tan 45°$

$\theta = 45°$

Hence, the angle of elevation is 45°.

12. The top of two transmission towers of heights 30 m and 24 m are connected by a wire. If the wire makes an angle of 60° with the horizontal, then the length of the wire is:

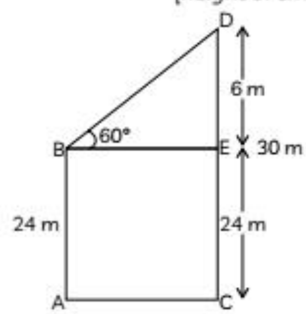
(a) $4\sqrt{3}$ m **(b) $5\sqrt{3}$ m**

(c) $2\sqrt{3}$ m **(d) $6\sqrt{3}$ m**

Ans. *(a) $4\sqrt{3}$ m*

Explanation: Here, CD = 30 m [height of big tower]

AB = 24 m [height of small tower]



$\therefore$ DE = CD − CE

$\Rightarrow$ DE = CD − AB [$\because$ AB = CE]

DE = 30 − 24

DE = 6 m

In ΔBDE, $\sin 60° = \frac{DE}{BD}$

$$\frac{\sqrt{3}}{2} = \frac{6}{BD}$$

$$BD = 4\sqrt{3} \text{ m}$$

$\therefore$ The length of wire is $4\sqrt{3}$ m.

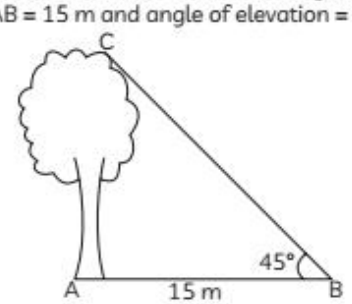
13. If the angle of elevation of the top of a tree at a point 15 m away from the base of tree is 45°, then the height of the tree is:

(a) 15 m **(b) 10 m**

(c) 20 m **(d) 17 m**

Ans. *(a) 15 m*

Explanation: Let AC = x be the height of the tree, AB = 15 m and angle of elevation = 45°



In right ΔABC, we have

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

$$\tan 45° = \frac{x}{15}$$

$$x = 15 \text{ m}$$

$$AC = 15 \text{ m}$$

Hence, the height of the tree is 15 m.

14. **If the height of the tower and the distance from the tower's foot to a point is increased by 10% then the angle of elevation on the top of the tower is:**

(a) decreases
(b) do not change
(c) increase
(d) none of the above

Ans. *(b) do not change*

Explanation: We know, for an angle of elevation θ,

$$\tan\theta = \frac{\text{Height of the tower}}{\text{Distance from the point}}$$

If we increase both the values, there will be no change in the angle of elevation.

15. **A man while walking on a hot day, noticed how the length of his shadow changes with the sun's altitude.**

If the height and the length of the shadow of a man are the same, then the angle of elevation of the sun is:

(a) 45° **(b) 60°**
(c) 90° **(d) 120°** **[Diksha]**

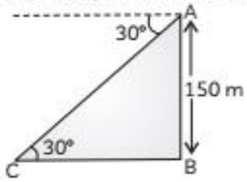
16. **Several cars were parked near a tall tower. Pragya told her friend that she can find out the height of the tower without actually measuring it. She reasoned that she can do it by using her knowledge of trigonometry.**

The angle of depression of a car parked on the road from the top of a 150 m high tower is 30°. The distance of the car from the tower (in metres) is:

(a) $50\sqrt{3}$ **(b)** $150\sqrt{3}$
(c) $150\sqrt{2}$ **(d) 75**

Ans. *(b)* $150\sqrt{3}$

Explanation: Here, AB is a tower of height 150 m.



In ΔABC,

$$\tan 30° = \frac{AB}{BC}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{150}{BC}$$

$$\Rightarrow \quad BC = 150\sqrt{3}\text{ m}$$

Hence, the distance of the car from the tower is $150\sqrt{3}$ m.

17. **The kite flying festival in India falls on 14th of January every year, marking the arrival of spring and the transition of the sun into the Makara Rashi (the Capricorn zodiac sign). In quite a few states in India, Makar Sankranti is considered as a major harvest festival. Kite-flying on Independence Day is a tradition in North India, especially in Delhi, Lucknow, Bareilly and Moradabad.**

Ramesh was flying the kite at a height of 30 m from the ground. The length of string from the kite to the ground is 60 m. Assuming that there is no stack in the string, then the angle of elevation of then the kite at ground is:

(a) 45° **(b) 30°**
(c) 60° **(d) 90°**

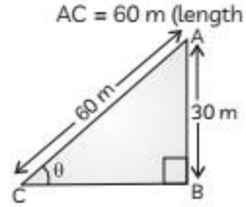
[Mod. CBSE 2012]

Ans. *(b) 30°*

Explanation: Here,

AB = 30 m (height of kite)

AC = 60 m (length of kite string)



In ΔABC, $\sin\theta = \frac{AB}{AC}$

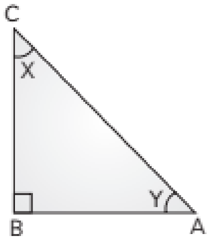
$\Rightarrow \quad \sin\theta = \frac{30}{60} = \frac{1}{2}$

$\Rightarrow \quad \sin\theta = \sin 30° \quad \left[\because \sin 30° = \frac{1}{2}\right]$

$\Rightarrow \quad \theta = 30°$

So, the angle of elevation of the kite at the ground is 30°.

18. In the ΔABC shown below, $\angle X : \angle Y = 1 : 2$.



What is tan X ?

(a) $\frac{1}{\sqrt{3}}$ (b) 1

(c) $\frac{\sqrt{3}}{2}$ (d) $\sqrt{3}$

[CBSE Question Bank 2022]

Ans. *(a)* $\frac{1}{\sqrt{3}}$

Explanation: $\angle B = 90°$

So, $\angle X + \angle Y + \angle B = 180°$

(Angle sum property of triangle)

$\therefore \quad \angle X + \angle Y = 90°$

Let the common measure of angles be Z.

$\therefore \quad 1Z + 2Z = 90°$

[ratio $\angle X : \angle Y = 1 : 2$]

$\therefore \quad 3Z = 90°$

$Z = 30°$

$\therefore \quad X = 1Z = 30°$

and $\quad Y = 2Z = 60°$

$\therefore \quad \tan X = \tan 30°$

$\tan X = \frac{1}{\sqrt{3}}$

Fill in the Blanks

19. .... is the line drawn from the eye of an observer to the point in the object viewed by the observer.

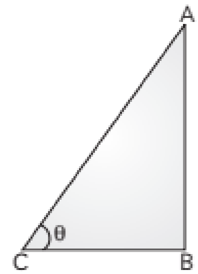
Ans. The line of sight

Explanation: The line of sight is the straight line from the observer's eye to the object.

20. The ratio of the length of a pole and its shadow is 1 : 1. The altitude of the sun is ....

Ans. 45°

Explanation: Let AB be the pole and BC be its shadow.



In ΔABC, $\tan\theta = \frac{AB}{BC} = \frac{1}{1}$

$\tan\theta = \tan 45°$

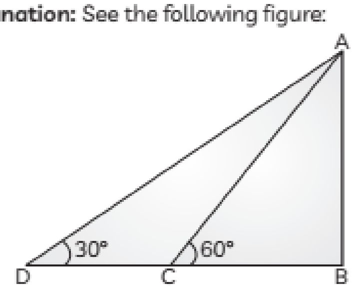
$\theta = 45°$

21. If the angle of elevation of the top of a tower from a point on the ground, which is 60 m away from the foot of the tower, is 45°, then the height of the tower is ....

22. If the length of the shadow of a building is decreasing then the angle of elevation is ....

Ans. increasing

Explanation: See the following figure:



As the shadow reaches from point D to C towards the direction of the building, the angle of elevation increases from 30° to 60°.

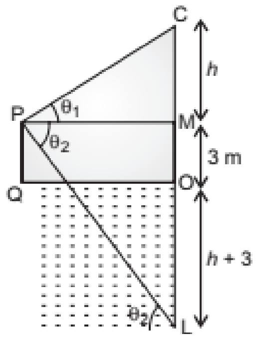
True/False

23. If a man standing on a platform 3 metres 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.

[CBSE 2010]

Ans. False.

Explanation: Let a man be standing on a platform at point P, 3 m above the surface of the lake OQ. A cloud is observed at point C. Let the height of the cloud from the surface of the platform be *h*.



In ΔMPC, $\tan\theta_1 = \dfrac{CM}{PM} = \dfrac{h}{PM}$

$$\Rightarrow \quad PM = \frac{h}{\tan\theta_1} \quad \text{...(i)}$$

In ΔLPM,

$$\tan\theta_2 = \frac{LM}{PM} = \frac{OL+OM}{PM} = \frac{h+6}{PM}$$

$$\Rightarrow \quad PM = \frac{h+6}{\tan\theta_2} \quad \text{...(ii)}$$

From eq. (i) and eq. (ii), we get

$$\frac{h}{\tan\theta_1} = \frac{h+6}{\tan\theta_2}$$

$$\Rightarrow \quad \tan\theta_2 = \left(\frac{h+6}{h}\right)\cdot\tan\theta_1$$

Hence, $\theta_1 \neq \theta_2$.

24. The angle of elevation of the top of a tower is 30°. If the height of the tower is doubled, then the angle of elevation of its top will also be doubled. [NCERT Exemplar]

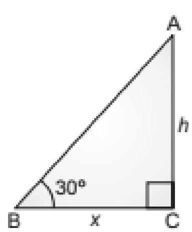
Ans. False.

Explanation: We know that,

$$\tan\theta = \frac{\text{Perpendicular}}{\text{Base}}$$

Let AC be the tower with height h and BC = x.

In ΔABC,



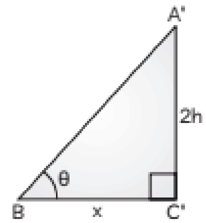
$$\tan 30° = \frac{AC}{BC} = \frac{h}{x}$$

[Here, perpendicular, AC = h and base, BC = x]

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{h}{x} \quad \text{...(i)}$$

When height of the tower is doubled *i.e.,* A'C' = 2h

In $\Delta A'BC'$,



$$\tan\theta = \frac{A'C'}{BC'} = \frac{2h}{x}$$

[Here, perpendicular A'C' = 2h and base BC' = x]

$$\Rightarrow \quad \tan\theta = \frac{2}{x}\times h$$

$$= \frac{2}{x}\times\frac{x}{\sqrt{3}} \quad \text{[Using eq. (i)]}$$

$$\Rightarrow \quad \tan\theta = \frac{2}{\sqrt{3}}$$

But, $\tan 60° = \sqrt{3} \neq \dfrac{2}{\sqrt{3}}$

So, $\theta \neq 60°$

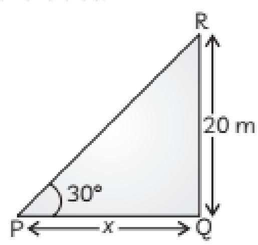
Hence, the required angle is not doubled.

25. If the height 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 remains unchanged. [NCERT Exemplar]

26. The length of the shadow of a tree 20 m long is $20\sqrt{3}$ m, when the sun's angle of elevation is 30°.

Ans. True.

Explanation: Let PQ = x m be the length of the shadow of the tree and QR = 20m be the height of the tree.



In ΔPQR, $\tan 30° = \dfrac{RQ}{PQ}$

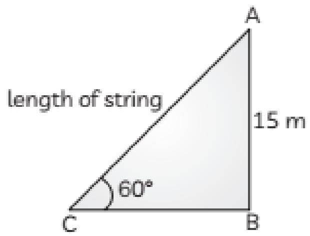
$$\frac{1}{\sqrt{3}} = \frac{20}{PQ}$$

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

27. A kite is flying at a height of 15 m from the ground. The angle of elevation of the kite at the ground is 60°, then the length of the string from the kite to the ground is $10\sqrt{3}$ m.

Ans. True.

Explanation: Let AB = 15 m be the height of the kite from the level of ground and angle of elevation = 60°



In ΔABC, $\sin\theta = \frac{AB}{AC}$

$$\sin 60° = \frac{15}{AC}$$

$$\frac{\sqrt{3}}{2} = \frac{15}{AC}$$

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

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

Assertion Reason

Direction for questions 28 to 31: In question number 28 to 31, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option as:

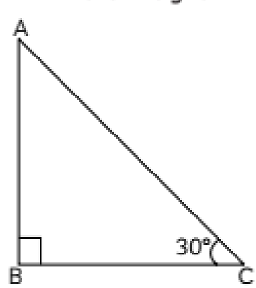
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false.

(d) Assertion (A) is false but reason (R) is true.

28. Assertion (A): In the figure, if BC = 20 m, then height AB is 11.56 m.



Reason (R): $\tan\theta = \frac{AB}{BC} = \frac{\text{perpendicular}}{\text{base}}$

Ans. *(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).*

Explanation:

$$\tan 30° = \frac{AB}{BC} = \frac{AB}{20}$$

$$AB = \frac{1}{\sqrt{3}} \times 20 = \frac{20}{1.73} = 11.56 \text{ m}$$

Hence, both assertion and reason are true and reason is the correct explanation of assertion.

29. Assertion (A): If the length of shadow of a vertical pole is equal to its height, then the angle of elevation of the sun is 45°.

Reason (R): According to Pythagoras theorem, $h^2 = l^2 + b^2$, where h = hypotenuse, l = length and b = base.

30. Assertion (A): The ladder 20 m long makes an angle 60° with the wall, then the height of the point where the ladder touches the wall is 15 m.

Reason (R): For an angle θ,

$$\cos\theta = \frac{\text{base}}{\text{hypotenuse}}$$

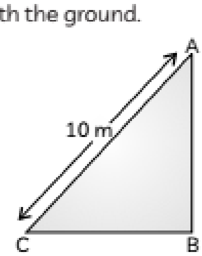
31. Assertion (A): The joker in a circus climb a rope of 10m long which is tied from the top of a vertical pole to the ground. The angle made by the rope with the ground level is 30°, then the height of the pole is 5m.

Reason (R): For an angle θ,

$$\sin\theta = \frac{\text{hypotenuse}}{\text{perpendicular}}$$

Ans. *(c) Assertion (A) is true but reason (R) is false.*

Explanation: Let AB be the vertical pole and AC be the rope of 10 m long, making an angle of 30° with the ground.



In ΔABC,

$$\sin 30° = \frac{AB}{AC}$$

$$\frac{1}{2} = \frac{AB}{10}$$

$$\Rightarrow \quad AB = 5 \text{ m}$$

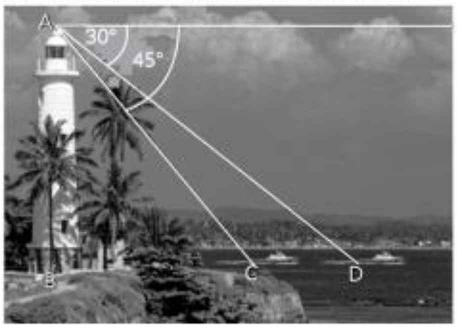
Hence, assertion is true but reason is false.

CASE BASED Questions (CBQs)

[4 & 5 marks]

Read the following passages and answer the questions that follow:

32. *An observer on the top of a 30 m tall light house (including height of the observer) observes a ship at an angle of depression 30° coming towards the base of the lighthouse along a straight line joining the ship and the base of the lighthouse. The angle of depression of the ship changes to 45° after 10 seconds.*



(A) The distance of the ship from the base of the lighthouse when angle of depression is 30°, is:

(a) $30\sqrt{3}$ m (b) $10\sqrt{3}$ m

(c) 30 m (d) $\frac{10}{3}\sqrt{3}$ m

(B) The distance of the ship from the base of the lighthouse after 10 seconds from the initial position when the angle of depression changes to 45° is:

(a) $10\sqrt{3}$ m (b) $30\sqrt{3}$ m

(c) $\frac{10}{3}\sqrt{3}$ m (d) 30 m

(C) The distance between the two positions of ship after 10 seconds is:

(a) 30 m (b) $30(\sqrt{3}-1)$ m

(c) $10(\sqrt{3}+1)$ m (d) $30(\sqrt{3}+1)$ m

(D) The speed of the ship is:

(a) 10 ms^{-1} (b) $30(\sqrt{3}+1)ms^{-1}$

(c) $3(\sqrt{3}-1)$ ms^{-1} (d) $30(\sqrt{3}-1)ms^{-1}$

(E) The time taken by the ship to reach the base of the lighthouse from the instant the angle of depression is 45° is:

(a) $3(\sqrt{3}-1)$s (b) $5(\sqrt{3}-1)$s

(c) $10(\sqrt{3}+1)$s (d) $5(\sqrt{3}+1)$s

Ans. (A) *(a)* $30\sqrt{3}$ *m*

Explanation: As the angle of depression of the ship from the base of the lighthouse = 30°, the angle of elevation from D to the top A of the lighthouse AB is also 30°. We have to find the distance of the ship from the base of the lighthouse i.e., BD.

As ΔABD is a right triangle, right angled at B,

$$\therefore \quad \tan 30° = \frac{AB}{BD}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{30}{BD}$$

$$\Rightarrow \quad BD = 30\sqrt{3} \text{ m}$$

(C) *(b)* $30(\sqrt{3}-1)$ *m*

Explanation: The distance between the ships after 10 seconds

$$= CD = BD - BC = 30\sqrt{3} - 30$$

$$= 30(\sqrt{3}-1) \text{ m}$$

(D) *(c)* $3(\sqrt{3}-1)$ ms^{-1}

Explanation: Speed of the ship

$$= \frac{\text{Distance travelled by the ship in 10s}}{10}$$

$$= \frac{CD}{10} = \frac{30(\sqrt{3}-1)}{10} = 3(\sqrt{3}-1)ms^{-1}$$

33. *Trigonometry in the form of triangulation forms the basis of navigation, whether it is by land, sea or air. GPS a radio navigation system helps to locate our position on earth with the help of satellites.*

A guard, stationed at the top of a 240 m tower, observed an unidentified boat coming towards it. A clinometer or inclinometer is an instrument used for measuring angles or slopes(tilt). The guard used the clinometer to measure the angle of depression of the boat coming towards the lighthouse and found it to be 30°.

(Lighthouse of Mumbai Harbour. Picture credits - Times of India Travel)

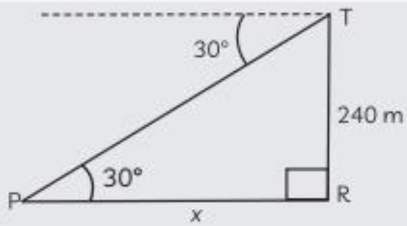
(A) Draw a labelled figure on the basis of the given information.

(B) Calculate the distance of the boat from the foot of the observation tower.

(C) After 10 minutes, the guard observed that the boat was approaching the tower and its distance from tower is reduced by $240(\sqrt{3}-1)$m. He immediately raised the alarm. What was the new angle of depression of the boat from the top of the observation tower?

[Mod. CBSE Term-2 SQP 2022]

Ans. (A)

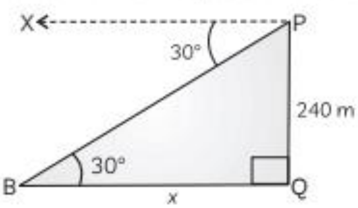


(B) In ΔPTR, $\tan 30° = \dfrac{240}{x}$

$\Rightarrow \quad x = 240\sqrt{3}$ m

[CBSE Marking Scheme Term-2 SQP 2022]

Explanation: Let PQ be the 240 m high tower and B be the position of boat.



$\therefore \quad \angle XPB = \angle PBQ = 30°$

and $\quad PQ = 240$ m

So, in ΔPBQ,

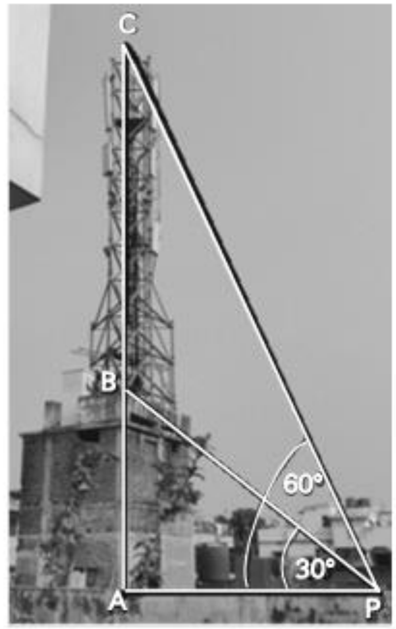
$$\tan 30° = \frac{PQ}{BQ}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{240}{BQ}$$

$$\Rightarrow \quad BQ = 240\sqrt{3}$$

Hence, distance of the boat from the foot of observation tower is $240\sqrt{3}$ m.

34. *Consider a telecom tower BC fixed on top of a building AB. The distance between the base of the building and point P on the ground is 48 m. From the point P, the angle of elevation of the top of the building B is 30° and the angle of elevation of the top of the tower C is 60°.*



(A) The height of the building, AB is:

(a) $32\sqrt{3}$ m (b) $16\sqrt{3}$ m
(c) $48\sqrt{3}$ m (d) $24\sqrt{3}$ m

(B) The angle of depression from the top of the tower to the point P is:

(a) 30° (b) 45°
(c) 75° (d) 60°

(C) Distance of the top B of the building AB from the point P is:

(a) $32\sqrt{3}$ m (b) $16\sqrt{3}$ m
(c) $48\sqrt{3}$ m (d) 96 m

(D) Height of the telecom tower BC is:

(a) $48\sqrt{3}$ m (b) $16\sqrt{3}$ m
(c) $32\sqrt{3}$ m (d) 48 m

(E) Distance of the top C of the telecom tower BC from the point P is:

(a) 96 m (b) $32\sqrt{3}$ m
(c) 48 m (d) 24 m

Ans. (A) *(b) $16\sqrt{3}$ m*

Explanation: As ABP is a right triangle right- angled at A,

$$\therefore \tan 30° = \frac{AB}{AP}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{AB}{48}$$

$$\Rightarrow \quad AB = \frac{48}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= 16\sqrt{3} \text{ m}$$

(B) *(d) 60°*

Explanation: As the angle of elevation of the top C of the tower BC from the point P is 60°, the angle of depression from the top of the tower to the point P is also 60°.

(D) *(c)* $32\sqrt{3}$ *m*

Explanation: Height of the telecom tower = BC.

$\therefore$ In ΔAPC,

$$\tan 60° = \frac{AC}{AP}$$

$$\Rightarrow \quad \sqrt{3} = \frac{AC}{48}$$

$$\Rightarrow \quad AC = 48\sqrt{3}$$

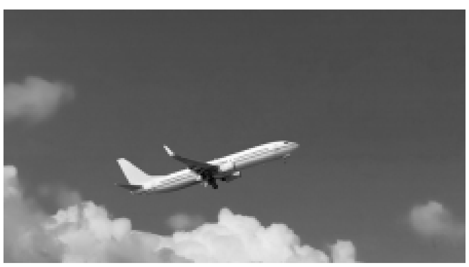
So, $BC = AC - AB$

$$= 48\sqrt{3} - 16\sqrt{3}$$

$$= 32\sqrt{3} \text{ m}$$

35. *An inclinometer is an instrument which is used for measuring angles of slope, elevation or depression of an object, with respect to gravity's direction.*

The angle of elevation of an aeroplane from a point P on the ground is 45°. After flying for 15 seconds, the angle of elevation changes to 30°. If the aeroplane is flying at a constant height of 2500 m, then answer the following questions:



(A) Draw a labelled figure on the basis of the given information.

(B) Calculate the distance covered by the plane during the period of observation.

(C) What is the average speed of the aeroplane? [Use $\sqrt{3} = 1.73$]

Ans. *(C) We have,*

Distance AA' $= 2500(\sqrt{3} - 1)$ m

and Time taken = 15 sec

$\therefore$ Speed of the plane

$$= \frac{\text{Distance covered}}{\text{Time taken}}$$

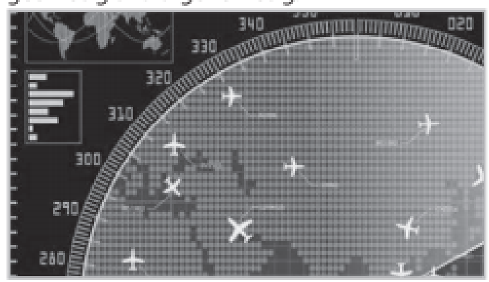
$$= \frac{2500(\sqrt{3} - 1)}{15}$$

$$= \frac{2500(1.73 - 1)}{15}$$

$$= 121.67 \text{ m/sec}$$

Hence, the average speed of the aeroplane is 121.67 m/sec.

36. *We all have seen the airplanes flying in the sky but might have not thought of how they actually reach the correct destination. Air Traffic Control (ATC) is a service provided by ground-based air traffic controllers who direct aircraft on the ground and through a given section of controlled airspace, and can provide advisory services to aircraft in non-controlled airspace. Actually, all this air traffic is managed and regulated by using various concepts based on coordinate geometry and trigonometry.*



At a given instance, ATC finds that the angle of elevation of an airplane from a point on the ground is 60°. After a flight of 30 seconds, it is observed that the angle of elevation changes to 30°. The height of the plane remains constantly as $3000\sqrt{2}$ *m. Use the above information to answer the questions that follow:*

(A) Draw a neat labelled figure to show the above situation diagrammatically.

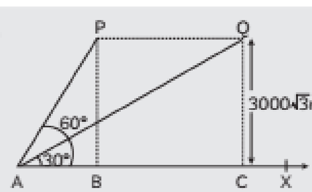
(B) What is the distance travelled by the plane in 30 seconds?

OR

Keeping the height constant, during the above flight, it was observed that after $15(\sqrt{3} - 1)$ seconds, the angle of elevation changed to 45°. How much is the distance travelled in that duration?

(C) What is the speed of the plane in km/hr?
[CBSE SQP Std. 2022]

Ans. (A)



P and Q are the two positions of the plane flying at a height of $3000\sqrt{3}$ m. A is the point of observation.

(B) In ΔPAB, $\tan 60° = \frac{PB}{AB}$

Or $\sqrt{3} = \frac{3000\sqrt{3}}{AB}$

So $AB = 3000m$

$\tan 30° = \frac{QC}{AC}$

$\frac{1}{\sqrt{3}} = \frac{3000\sqrt{3}}{AC}$

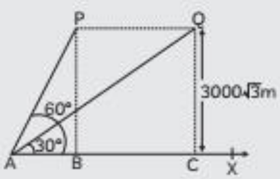
$AC = 9000$ m

distance covered

$= 9000 - 3000$

$= 6000$ m

OR



In ΔPAB, $\tan 60° = \frac{PB}{AB}$

Or $\sqrt{3} = \frac{3000\sqrt{3}}{AB}$

So $AB = 3000m$

$\tan 45° = \frac{RD}{AD}$

$1 = \frac{3000\sqrt{3}}{AD}$

$AD = 3000\sqrt{3}$ m

distance covered

$= 3000\sqrt{3} - 3000$

$= (3000\sqrt{3} - 1)$ m

[CBSE Marking Scheme SQP Std. 2022]

37. *Lakshaman Jhula is located 5 kilometers north-east of the city of Rishikesh in the Indian state of Uttarakhand. The bridge connects the villages of Tapovan to Jonk. Tapovan is in Tehri Garhwal district, on the west bank of the river, while Jonk is in Pauri Garhwal district, on the east bank. Lakshman Jhula is a pedestrian bridge also used by motorbikes. It is a landmark of Rishikesh. A group of Class X students visited Rishikesh in Uttarakhand on a trip. They observed from a point (P) on a river bridge that the angles of depression of opposite banks of the river are 60° and 30° respectively. The height of the bridge is about 18 meters from the river.*

Based on the above information answer the following questions.

(A) Find the distance PA.

(B) Find the distance PB.

(C) Find the width AB of the river.

OR

Find the height BQ if the angle of the elevation from P to Q be 30°.

[CBSE SQP Basic 2022]

Ans.

(B) $\sin 30° = \frac{PC}{PB}$

$\Rightarrow \frac{1}{2} = \frac{18}{PB}$

$\Rightarrow PB = 36$ m

(C) $\tan 60° = \frac{PC}{AC}$

$\Rightarrow \sqrt{3} = \frac{18}{AC}$

$\Rightarrow AC = 6\sqrt{3}$ m

$\tan 30° = 6\sqrt{3}$

$\Rightarrow \frac{1}{\sqrt{3}} = \frac{18}{CB}$

$\Rightarrow CB = 18\sqrt{3}$ m

Width $AB = AC + CB$

$= 6\sqrt{3} + 18\sqrt{3} = 24\sqrt{3}$ m

OR

RB = PC = 18 m and PR = CB = $18\sqrt{3}$ m

$$\tan 30° = \frac{QR}{PR}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{QR}{18\sqrt{3}}$$

$$\Rightarrow \quad QR = 18 \text{ m}$$

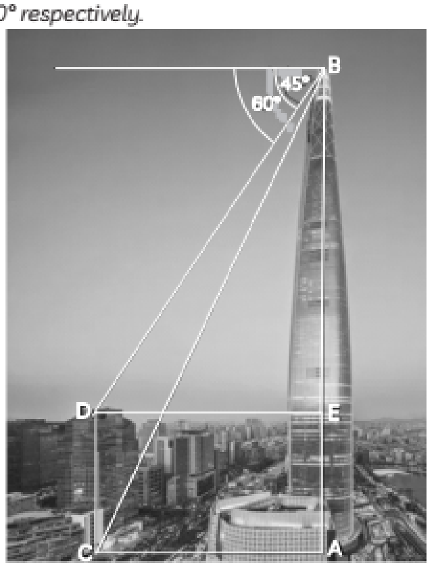
$$QB = QR + RB = 18 + 18$$

$$= 36 \text{ m.}$$

Hence, height BQ is 36 m.

[CBSE Marking Scheme SQP Basic 2022]

38. *The horizontal distance between a towers AB and a building CD is 120 m. The angle of elevation of the top of the tower AB from the top and bottom of the building CD are 45° and 60° respectively.*



(A) **The angle of depression of the bottom of the building CD as seen from the top of the tower AB is:**

(a) 30° (b) 60°
(c) 45° (d) 15°

(B) **The height of the tower AB is:**

(a) $40\sqrt{3}$ m (b) $60\sqrt{3}$ m
(c) $120\sqrt{3}$ m (d) 120 m

(C) **The height of the building CD is:**

(a) $120\sqrt{3}$ m (b) $120(\sqrt{3} - 1)$ m
(c) $120(\sqrt{3} + 1)$ m (d) $60(\sqrt{3} - 1)$ m

(D) **Difference in height of the tower AB and building CD is:**

(a) $120(\sqrt{3} - 1)$ m (b) $120\sqrt{3}$ m
(c) 60 m (d) 120 m

(E) **The distance of the straight line joining the top of the tower AB and the bottom of the building CD is:**

(a) 240 m (b) 120 m
(c) 60 m (d) $120\sqrt{3}$ m

Ans. (A) *(b) 60°*

Explanation: The angle of depression of the bottom of the building CD as seen from the top of the tower AB is equal to the angle of elevation of the top of the tower AB as seen from the bottom of the building CD *i.e.* 60°.

(B) *(c) $120\sqrt{3}$ m.*

Explanation: Height of the tower = AB.

In ΔABC,

$$\tan 60° = \frac{AB}{AC}$$

$$\Rightarrow \quad \sqrt{3} = \frac{AB}{120}$$

$$\Rightarrow \quad AB = 120\sqrt{3} \text{ m}$$

(D) *(d) 120 m*

Explanation: Difference in height of tower AB and building CD = AB – CD

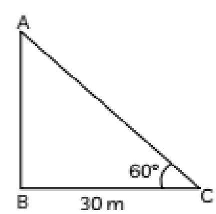
= AB – AE = EB = 120 m

[Using part (C)]

VERY SHORT ANSWER Type Questions (VSA)

[1 mark]

39. **In the figure, the angle of elevation of the top of a tower from a point C on the ground, which is 30 m away from the foot of the tower, is 60°. Find the height of the tower.**



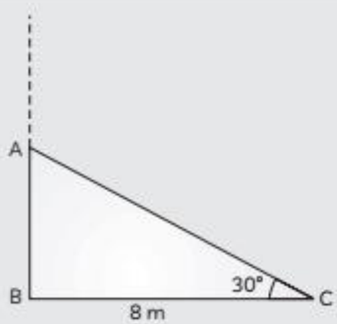
[CBSE 2020]

40. A pole casts a shadow of length $2\sqrt{3}$ m on ground, when the sun's elevation is 60°. Find the height of the pole. **[CBSE 2015]**

41. India is one of the most vulnerable countries to getting hit by tropical cyclones in the basin, from the east or from the west. On average, 2–3 tropical cyclones make landfall in India each year, with about one being a severe tropical cyclone or greater.

A tree breaks due to storm and the broken part bends so, that the top of the tree touches the ground where it makes an angle 30°. 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 from where it is broken. **[CBSE SQP 2020]**

Ans.



$$\tan 30° = \frac{AB}{BC}$$

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

$$AB = \frac{8}{\sqrt{3}} \text{ metres}$$

Height from where it is broken is $\frac{8}{\sqrt{3}}$ metres.

[CBSE Marking Scheme SQP 2020]

42. Raju, a painter, has to use a ladder to paint the high walls and ceiling of homes. When Raghu was observing Raju paint his house, he told his friend that he can calculate the height of the wall upto the point where the ladder reaches by using his knowledge of trigonometry.

Raju used the ladder 15 m long that makes an angle of 60° with the wall. Find the height of the point where the ladder touches the wall.

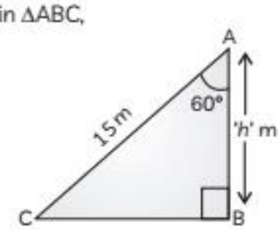
[CBSE 2017]

Ans. Let AC be the ladder of length 15 m, which is at the height AB *i.e.*, 'h' m from the ground.

The ladder makes an angle of 60° with the wall.

$\therefore \angle CAB = 60°$

Now, in ΔABC,



$$\cos 60° = \frac{AB}{AC}$$

$$\Rightarrow \quad \frac{1}{2} = \frac{h}{15}$$

$$\Rightarrow \quad h = 7.5 \text{ m}$$

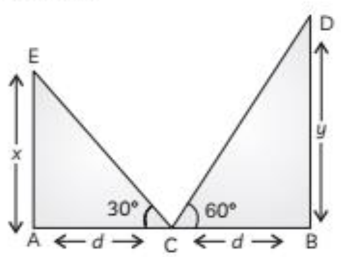
Hence, the height of the point where the ladder touches the wall is 7.5 m.

43. Two friends Ajay and Pranjay were discussing how it is possible to find out the heights of the tall towers or buildings by using their knowledge of trigonometry.

The tops of two towers of heights *x* and *y*, standing on level ground, subtend angles of 30° and 60° respectively at the centre of the line joining their feet, then find *x*: *y*.

[Delhi Gov. QB 2022, CBSE 2015]

Ans. Let EA and DB be the two towers of heights *x* and *y* respectively and C be the point of observation.



Since, point C lies at centre of the line joining the base of two towers.

$\therefore$ AC = CB = *d* (say)

In ΔACE,

$$\tan 30° = \frac{AE}{AC}$$

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

$$\Rightarrow \quad x = \frac{d}{\sqrt{3}} \quad \text{...(i)}$$

In ΔDCB,

$$\tan 60° = \frac{BD}{BC}$$

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

$$\Rightarrow \quad \sqrt{3}d = y \quad \text{...(ii)}$$

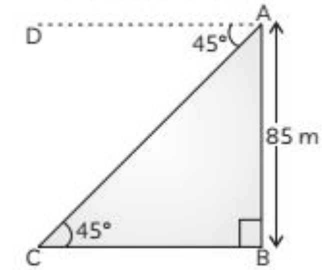
Now, $x : y = \dfrac{\frac{d}{\sqrt{3}}}{\sqrt{3}d}$

$= \dfrac{1}{3}$ [Using (i) and (ii)]

Thus, $x : y = \dfrac{1}{3}$

44. The angle of depression of a car standing on the ground, from the top of a 85 m high tower is 45°. Find the distance of the car from the base of the tower.

Ans.



Let AB = 85 m be the height of the tower and angle of depression is $\angle$DAC = 45°.

Then, $\angle$ACB = $\angle$DAC = 45° [alternate angles]

Now, in right-angled ΔABC,

$$\tan 45° = \frac{AB}{BC}$$

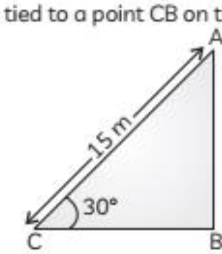
$$1 = \frac{85}{BC}$$

BC = 85 m

Hence, the distance of the car from the base of the tower is 85 m .

45. A circus artist is climbing a 15 m long rope, which is lightly stretched and tied from the top of a vertical pole to the ground, then find the height of pole, if the angle made by the rope with the ground level is 30°.

Ans. Let AB be the vertical pole and CA be the 15 m long rope such that its one end A is tied from the top of the vertical pole AB and the other end C is tied to a point CB on the ground.



In ΔABC, $\sin 30° = \dfrac{AB}{AC}$

$$\frac{1}{2} = \frac{AB}{15}$$

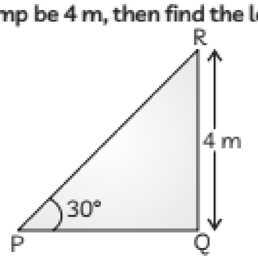
$$AB = \frac{15}{2}$$

$$AB = 7.5 \text{ m}$$

Hence, the height of the pole is 7.5 m.

46. **A ramp for disabled people in a hospital have slope not more than 30°. If the height of the ramp be 4 m, then find the length of ramp.**

Ans.



Let PR be the length and RQ be the height of the ramp.

Then, $\angle RPQ = 30°$ and RQ = 4 m

In right-angled ΔPQR,

$$\sin 30° = \frac{RQ}{PR}$$

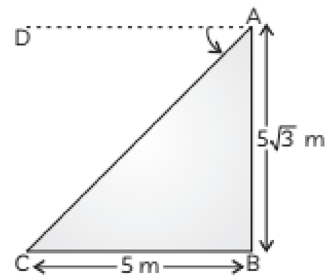
$$\frac{1}{2} = \frac{RQ}{PR}$$

$$\frac{1}{2} = \frac{4}{PR}$$

$$PR = 8 \text{ m}$$

Hence, the length of the rope is 8 m.

47. **The figure shows the observation of point C from point A. Find the angle of depression from A.**



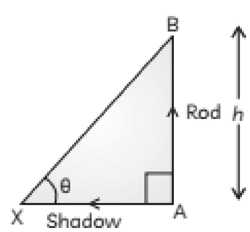
SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

48. **The ratio of the length of a vertical rod and the length of its shadow is $1:\sqrt{3}$. Find the angle of elevation of the sun at that moment.** **[CBSE 2020]**

Ans. Let AB be the rod and AX be its shadow when the angle of elevation of the sun is θ.

Let h be the length of the rod.



Then, its shadow is $\sqrt{3}h$.

Now, in ΔABX

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

$$\Rightarrow \quad \tan\theta = \frac{1}{\sqrt{3}}$$

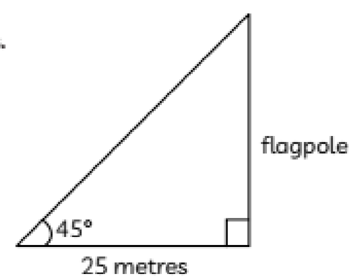
$$\Rightarrow \quad \tan\theta = \tan 30°$$

$$\Rightarrow \quad \theta = 30°.$$

Hence, the angle of elevation of the sun is 30°.

49. **A flagpole casts its shadow that is 25 m long, on the ground. The angle made by the tip of the flagpole and the tip of its shadow on the ground is 45°. Find the height of the flagpole.** **[British Council 2022]**

Ans.



$$\text{Tan } 45° = \frac{\text{Opposite side}}{\text{Adjacent side}}$$

$$= \frac{\text{Height of the flagpole}}{25}$$

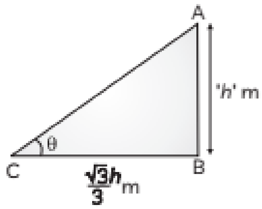
$$1 = \frac{\text{Height of the flagpole}}{25}$$

Height of the flagpole = 25 m.

50. **When the shadow of a pole 'h' metres high is $\frac{\sqrt{3}\,h}{3}$ metres, what is the angle of elevation of the sun at that time?** **[CBSE 2014]**

Ans. Let AB be the pole of height 'h' metres and BC be its shadow of length $\frac{\sqrt{3}h}{3}$ m.

Also, let angle of elevation of the sun at that time be θ.



Now, in Δ ABC,

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

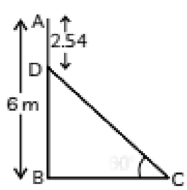
$$\Rightarrow \quad \tan\theta = \frac{h}{\frac{\sqrt{3}h}{3}} = \frac{3h}{\sqrt{3}h} = \sqrt{3}$$

$$\Rightarrow \quad \tan\theta = \tan 60° \; [\because \tan 60° = \sqrt{3}]$$

$$\Rightarrow \quad \theta = 60°$$

Hence, the angle of elevation of the sun at that time is 60°.

51. **In the figure, AB is a 6 m high pole and CD is a ladder inclined at an angle of 60° to the horizontal and reaches up to a point D of pole. If AD = 2.54 m, find the length of the ladder. (Use $\sqrt{3}$ = 1.73)**

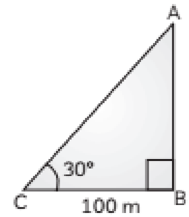


[CBSE 2016]

52. **A ladder is placed along a wall of a house such that its upper end is touching the top of the wall. The foot of the ladder is 2 m away from the wall and the ladder makes an angle of 60° with the level of the ground. Find the height of the wall. [CBSE 2017]**

53. **A vertical flagstaff stands on a horizontal tower. From a point 100 m from its foot, the angle of elevation of its top is 30°. Find the height of the flagstaff. [CBSE 2016]**

Ans. Let AB be the vertical flagstaff, point C be the point of observation at the distance of 100 m from the foot of the tower of flagstaff.



∴ ∠ACB = 30° and BC = 100 m

In Δ ABC,

$$\tan 30° = \frac{AB}{BC}$$

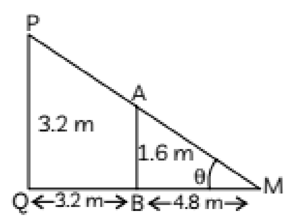
$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{AB}{100}$$

$$\Rightarrow \quad AB = \frac{100}{\sqrt{3}} = \frac{100}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{100\sqrt{3}}{3}$$

Hence, the height of the flagstaff is $\frac{100\sqrt{3}}{3}$ m.

54. **A 1.6 m tall girl stands at a distance of 3.2 m from a lamppost and casts a shadow of 4.8 m on the ground. Find the height of the lamppost.**

Ans. Let AB be the girl and BM be her shadow. Similarly, let PQ be the lamppost and QM be its shadow. Also, let θ be the angle of elevation of the Sun.



$$\therefore \quad AB = 1.6\text{ m}, BM = 4.8\text{ m}, QB = 3.2\text{ m}$$

$$\text{and} \quad \angle M = \theta$$

$$\text{So,} \quad QM = QB + BM = 3.2 + 4.8 = 8\text{ m}$$

Now in ΔABM,

$$\tan\theta = \frac{AB}{BM} = \frac{1.6}{4.8} = \frac{1}{3} \qquad ...(i)$$

Also, in ΔPQM,

$$\tan\theta = \frac{PQ}{QM} = \frac{PQ}{8}$$

$$\Rightarrow \quad \frac{1}{3} = \frac{PQ}{8} \qquad \text{[From (i)]}$$

$$\Rightarrow \quad PQ = \frac{8}{3} = 2.67\text{ m}$$

Hence, the height of the lamppost is 2.67 m.

55. The shadow of a 5 m long stick is 2 m long. At the same time, find the length of the shadow of a 12.5 m high tree.

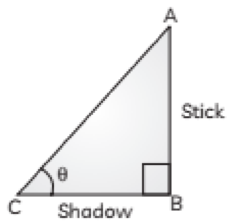
Ans. Let AB be the stick and BC be its shadow.

$\therefore$ AB = 5 m and BC = 2m

Let angle of elevation of the sun at that moment be θ.

$\therefore$ In ΔABC,

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

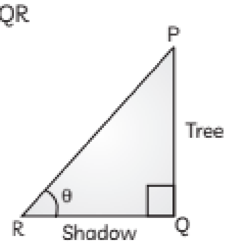


$$\Rightarrow \quad \tan\theta = \frac{5}{2} \quad ...(i)$$

Now, let PQ be the tree, 12.5 m high and QR be its shadow, x m long.

Since, angle of elevation of sun in both the cases is some (as both shadows form at the same time),

So, in ΔPQR



$$\tan\theta = \frac{PQ}{QR}$$

$$\Rightarrow \quad \frac{5}{2} = \frac{12.5}{QR}$$

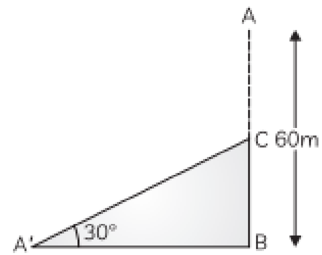
$$\Rightarrow \quad QR = \frac{2 \times 12.5}{5}$$

$$= 5 \text{ m}$$

Hence, the length of the shadow of the tree is 5 m.

56. A portion of 60 m long tree is broken by a tornado and the top struck up the ground making an angle of 30° with the ground level. Find the height of the broken part of the tree.

Ans. Let AB be the tree and C be the point on it, from where it is broken, so that the top A of the tree touches the ground at point A'.



$\therefore$ AB = 60 m, $\angle$CA'B = 30°

Let BC = x

Then, AC = AB – BC = 60 – x

$\therefore$ A'C = AC = 60 – x

Now, in ΔA'BC

$$\sin 30° = \frac{BC}{A'C}$$

$$\Rightarrow \quad \frac{1}{2} = \frac{x}{60 - x}$$

$$\Rightarrow \quad 2x = 60 - x$$

$$\Rightarrow \quad 3x = 60$$

$$\Rightarrow \quad x = 20$$

So, AC = 60 – x

$$= 60 - 20 = 40 \text{ m}$$

Hence, the height of the broken part of the tree is 40 m.

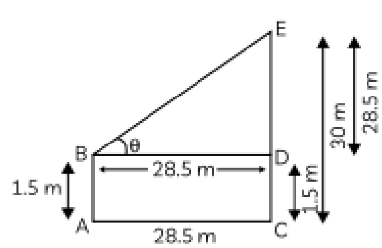
57. The ratio of the height of a tower and the length of its shadow on the ground is $\sqrt{3}:1$. What is the angle of elevation of the sun? **[Diksha]**

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

58. An observer, 1.5 m tall, is 28.5 m away from a 30 m high tower. Determine the angle of elevation of the top of the tower from the eye of the observer. **[CBSE 2017]**

Ans. Let, the angle of elevation be θ, AB be the observer, EC be the tower and AC be the distance between the tower and the observer.



So, AB = 1.5 m, EC = 30 m and AC = 28.5 m.

Then, $ED = EC - DC$

$= 30 - 1.5$ [$\because AB = CD$]

$= 28.5$ m

and $BD = AC = 28.5$ m

Now, in ΔBDE

$$\tan\theta = \frac{ED}{BD} = \frac{28.5}{28.5} = 1$$

$$\tan\theta = \tan 45° \; [\because \tan 45° = 1]$$

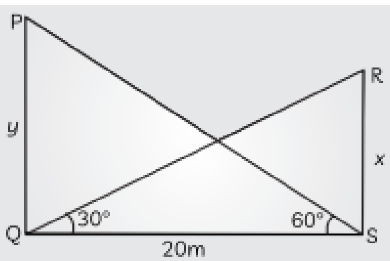
$\Rightarrow$ $\theta = 45°$

Hence, the angle of elevation is 45°.

59. Two vertical poles of different heights are standing 20 m away from each other on the level ground. The angle of elevation of the top of the first pole from the foot of the second pole is 60° and angle of elevation of the top of the second pole from the foot of the first pole is 30°. Find the difference between the heights of two poles. (Take $\sqrt{3} = 1.73$)

[CBSE Term-2 SQP 2022]

Ans.



In ΔPQS, $\tan 60° = \frac{y}{20}$

$\Rightarrow$ $y = 20\sqrt{3}$ m

In ΔRSQ, $\tan 30° = \frac{x}{20}$

$\Rightarrow$ $x = \frac{20}{\sqrt{3}}$ m

$$y - x = 20\sqrt{3} - \frac{20}{\sqrt{3}}$$

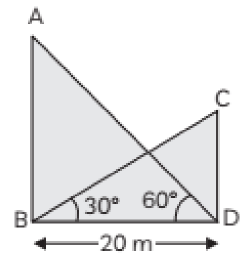
$$= \frac{40}{\sqrt{3}} = \frac{40\sqrt{3}}{3}$$

$= 23.06$ m

[CBSE Marking Scheme Term-2 SQP 2022]

Explanation: Let AB and CD be the two poles with AB > CD.

$\therefore \angle ADB = 60°, \angle CBD = 30°$ and BD = 20 m



Now, in ΔADB,

$$\tan 60° = \frac{AB}{BD}$$

$\Rightarrow$ $\sqrt{3} = \frac{AB}{20}$

$\Rightarrow$ $AB = 20\sqrt{3}$ m

Similarly, in ΔBCD,

$$\tan 30° = \frac{CD}{BD}$$

$\Rightarrow$ $\frac{1}{\sqrt{3}} = \frac{CD}{20}$

$\Rightarrow$ $CD = \frac{20}{\sqrt{3}}$ m

Now, difference in heights of two poles

$= AB - CD$

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

$$= \frac{60 - 20}{\sqrt{3}}$$

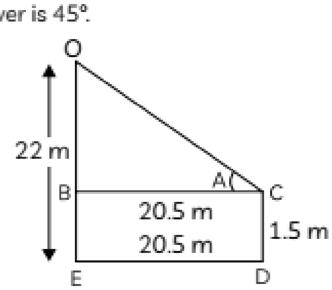
$$= \frac{40}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{40\sqrt{3}}{3}$$

$$= \frac{40 \times 1.73}{3}$$

$= 23.06$ m

60. A 1.5 m tall observer is looking at the tower at a distance 20.5 away from the tower. The angle of elevation between the sight of observer and top of the tower is 45°. Find the height of the tower. [Delhi Gov. SQP 2022]

Ans. Let CD be the observer of 1.5 m tall. And OE be the tower of 22 m, and the angle of elevation between the sight of observer and top of the tower is 45°.



We know that

$$\text{Tan A} = \frac{\text{Opposite side to angle A}}{\text{Adjacent side}}$$

$$\tan A = \frac{OB}{BC}$$

From the figure,

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

So, we get

$$\tan A = \frac{20.5}{20.5}$$

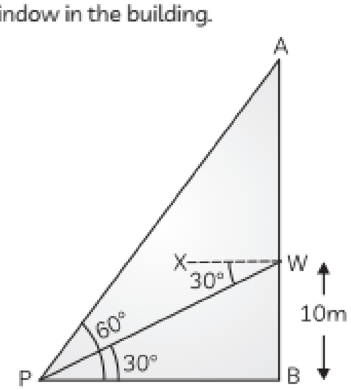
$$\tan A = \tan 45°$$

$$\Rightarrow \quad A = 45°$$

Therefore, the angle of elevation is 45°.

61. A window in the building is at a height of 10 m from the ground. The angle of depression of a point P on the ground from the window is 30°. If the angle of elevation of the top of the building from the point P is 60°, find the height of the building.

Ans. Let AB be the building and W be the position of window in the building.



$\therefore$ WB = 10 m, $\angle XWP = \angle WPB = 30°$, $\angle APB = 60°$.

So, in ΔWPB

$$\tan 30° = \frac{WB}{PB}$$

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

$$\Rightarrow \quad PB = 10\sqrt{3} \text{m}$$

Similarly, in ΔAPB

$$\tan 60° = \frac{AB}{PB}$$

$$\Rightarrow \quad \sqrt{3} = \frac{AB}{10\sqrt{3}}$$

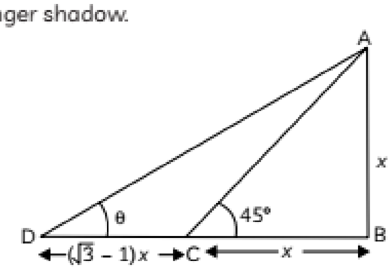
$$\Rightarrow \quad AB = 30 \text{ m}$$

Hence, the height of the building is 30 m.

62. The window of a house is h m above the ground. From the window, the angles of elevation and depression of the top and bottom of another house situated on the opposite side of the lane, are found to be α and β, respectively. Prove that the height of the other house is $h(1 + \tan \alpha \cot \beta)$.

63. The length of shadow of a person is x m long when the angle of elevation of the Sun is 45°. If the length of the shadow increases by $(\sqrt{3}-1)m$, then find the new angle of elevation of the Sun.

Ans. Let AB be the person, BC be its shadow when angle of elevation of Sun is 45° and BD be its longer shadow.



Also, let the new angle of elevation of the Sun be θ.

$\therefore \angle ACB = 45°, \angle ADB = \theta, BC = x, DC = (\sqrt{3}-1)x$.

Now, in ΔABC

$$\tan 45° = \frac{AB}{BC}$$

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

$$\Rightarrow \quad AB = x \qquad \text{...(i)}$$

and, in ΔADB

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

$$= \frac{AB}{BC + CD}$$

$$= \frac{x}{x + (\sqrt{3}-1)x} \qquad \text{[From (i)]}$$

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

$$= \tan 30°$$

$$\Rightarrow \quad \theta = 30°$$

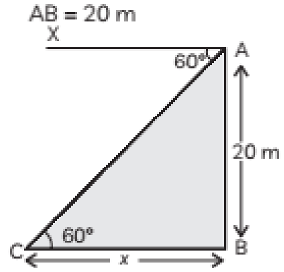
Hence, the new angle of elevation of the Sun is 30°.

64. A player sitting on the top of a tower of height 20 m observes the angle of depression of a ball lying on the ground as 60°. Find the distance between the foot of the tower and the ball. Take $\sqrt{3} = 1.732$.

[Diksha]

Ans. Let AB be the tower and C be the position of the ball on the ground.

$\therefore$ AB = 20 m



In this figure,
Due to property of alternate angles, we obtain,

$$\angle XAC = \angle ACB = 60°$$

Let BC = x m.
Now, in ΔABC,

$$\tan 60° = \frac{AB}{BC}$$

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

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

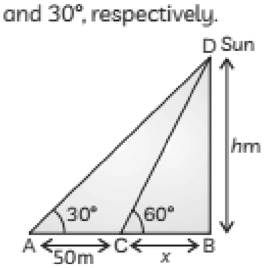
$$\Rightarrow \quad = 20 \times \frac{1.732}{3} = 11.55 \text{ m}$$

Hence, the distance between the ball and the foot of the tower is 11.55 m.

65. The shadow of a tower standing on a level plane is found to be 50 m longer when the Sun's elevation is 30° than when it is 60°. Find the height of the tower.

[CBSE 2012, 11]

Ans. Let DB be the tower with height h m, BC and BA be its shadows when angle of elevation of sun is 60° and 30°, respectively.



Let x be the length of the shadow when angle of elevation is 60°.

i.e., BC = x m

Given that AC = 50 m

and $\angle DCB = 60°$ and $\angle DAB = 30°$

In ΔDCB,

$$\tan 60° = \frac{DB}{BC} = \frac{h}{x}$$

$$\Rightarrow \quad x = \frac{h}{\tan 60°} = \frac{h}{\sqrt{3}} \quad ...(i)$$

$$[\because \tan 60° = \sqrt{3}]$$

In ΔABD,

$$\tan 30° = \frac{BD}{AB} = \frac{h}{50+x}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{h}{50+x}$$

$$\Rightarrow \quad \sqrt{3}\,h = 50 + x$$

$$\Rightarrow \quad \sqrt{3}\,h = 50 + \frac{h}{\sqrt{3}} \quad \text{[Using eqn (i)]}$$

$$\Rightarrow \quad \left(\sqrt{3} - \frac{1}{\sqrt{3}}\right)h = 50$$

$$\Rightarrow \quad \left(\frac{3-1}{\sqrt{3}}\right)h = 50$$

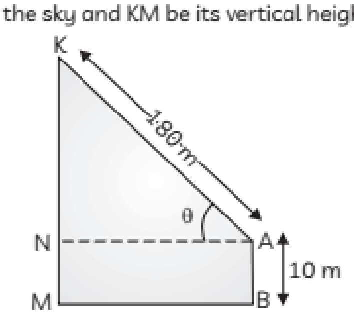
$$\Rightarrow \quad h = \frac{50\sqrt{3}}{2}$$

$$\Rightarrow \quad h = 25\sqrt{3} \text{ m}$$

Hence, the height of the tower is $25\sqrt{3}$ m

66. The length of a string between a kite and a point on the roof of a building 10 m high, is 180 m. If the string makes an angle θ with the horizontal level, such that $\tan\theta = \frac{4}{3}$, how high is the kite from the ground?

Ans. Let AB be the building K be the position of kite in the sky and KM be its vertical height.



$\therefore$ AB = 10 m, KA = 180 m, $\angle KAN = \theta$

Given, $\tan\theta = \frac{4}{3}$

$\therefore$ In ΔAKN,

$$\tan\theta = \frac{KN}{AN} = \frac{4}{3}$$

So, let KN = $4x$ and AN = $3x$

Applying Pythagoras theorem in ΔAKN, we have

$$(AK)^2 = (KN)^2 + (AN)^2$$

$$\Rightarrow \quad (180)^2 = (4x)^2 + (3x)^2$$

$$\Rightarrow \quad 32400 = 25x^2$$

$$\Rightarrow \quad x^2 = \frac{32400}{25}$$

$$\Rightarrow \quad x = \sqrt{324 \times 4}$$

$$= \sqrt{(18)^2 \times (2)^2}$$

$$= 18 \times 2 = 36$$

So, KN = $4x = 4 \times 36 = 144$ m

$\therefore$ Vertical height of kite

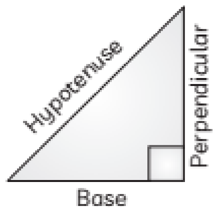
KM = KN + NM

= KN + AB [$\because$ NM = AB]

= 144 + 10 = 154 m

Concept Applied

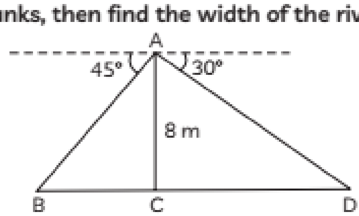
In a right-angled triangle,



(Hypotenuse)^2 = (Perpendicular)^2 + (Base)^2

67. **A person standing on the bank of a river observes that the angle of elevation of the top of a tree, standing on opposite bank of the river, is 60°. When he moves 40 m away from the bank, he finds angle of elevation to be 30°. Find the width of the river and the height of the tree.**

68. **From a point on a bridge across a river, the angles of depression of the banks on opposite sides of the river are 30° and 45°. If the bridge is at a height of 8 m from the banks, then find the width of the river.**



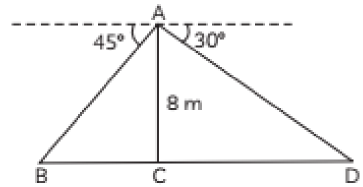
Ans. Let the width of the river = BD

And the bridge is at a height of 8m from the banks.

So, CA = 8m

$\angle$EAB = 45°

$\angle$FAD = 30°



Since, AC height is perpendicular to BD.

$\angle$ACB = $\angle$ACD = 90°

and line EF is parallel to BD

$\angle$EAB = $\angle$ABC = 45° (alternate angle)

$\angle$FAD = $\angle$ADC = 30° (alternate angle)

Now, in triangle ABC

$$\tan 45° = \frac{AC}{BC}$$

$$1 = \frac{8}{BC}$$

BC = 8m

In triangle ADC

$$\tan 30° = \frac{AC}{CD}$$

$$\frac{1}{\sqrt{3}} = \frac{8}{CD}$$

$$CD = 8\sqrt{3}$$

$$BD = BC + CD$$

$$= 8 + 8\sqrt{3}$$

$$BD = 8(1+\sqrt{3})m$$

Hence, width of river is $8(1+\sqrt{3})m$.

LONG ANSWER Type Questions (LA)

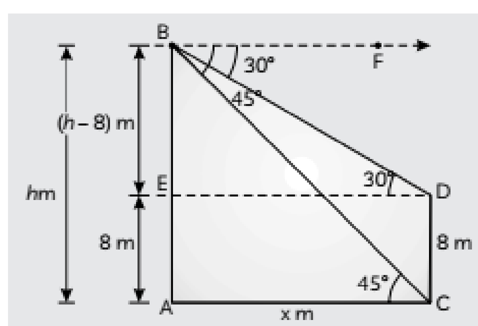
[**4** & **5** marks]

69. **The angles of depression of the top and bottom of a 8 m tall building from the top of a multi storied building are 30° and 45°, respectively. Find the height of the multi-storied building and the distance between the two buildings.** **[CBSE SQP 2020]**

Ans.

BE = AB − AE = $(h - 8)$ m

and AC = DE = x m [Given]



Also,

$$\angle FBD = \angle BDE = 30°$$ (Alternate angles)

$$\angle FBC = \angle BCA = 45°$$ (Alternate angles)

Now, in ΔACB,

$$\Rightarrow \tan 45° = \frac{AB}{AC}$$

$$\left[\because \tan\theta = \frac{\text{Perpendicular}}{\text{Base}}\right]$$

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

$$\Rightarrow x = h \quad ...(i)$$

In ΔBDE,

$$\Rightarrow \tan 30° = \frac{BE}{ED}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{h-8}{x}$$

$$\Rightarrow x = \sqrt{3}(h-8) \quad ...(ii)$$

From (i) and (ii), we get

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

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

$$h(\sqrt{3}-1) = 8\sqrt{3}$$

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

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

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

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

Distance between the two building

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

[From (i)]

[CBSE Marking Scheme SQP 2020]

70. From a window, 15 m high above the ground, the angles of elevation and depression of the top and the foot of a house on the opposite side of the street are 30° and 45°, respectively. Find the height of the opposite house. (Use $\sqrt{3}$ = 1.732)

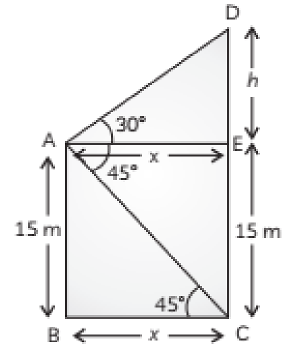
[CBSE 2017]

Ans. Let, AB be the window, 15 m above the ground and CD be the house on the opposite side of the street at a distance BC.

$\therefore$ AB = 15 m,

$\angle DAE = 30°$

and $\angle EAC = \angle ACB = 45°$.



Let the length of DE = 'h' m

Then, the height of house,

$$DC = (h + 15) \text{ m}$$

[$\because$ AB = EC = 15 m]

and BC = AE = x m (say)

Now, in ΔABC

$$\tan 45° = \frac{AB}{BC}$$

$$\Rightarrow 1 = \frac{15}{x}$$

$$\Rightarrow x = 15$$

In ΔDEA

$$\tan 30° = \frac{DE}{EA}$$

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

$$\Rightarrow h = \frac{x}{\sqrt{3}} = \frac{15}{\sqrt{3}}$$

$$= \frac{15}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 5\sqrt{3}$$

Then, $DC = DE + EC$

$= h + 15$

$= 5\sqrt{3} + 15$

$= 5(\sqrt{3} + 3)$ m

$= 5 \times 4.732 = 23.66$

Hence, the height of the opposite house is 23.66 m.

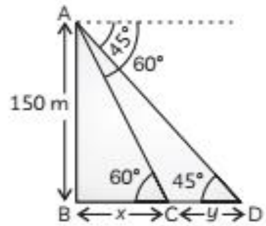
71. A moving boat is observed from the top of a 150 m high cliff, moving away from the cliff. The angle of depression of the boat changes from 60° to 45° in 2 minutes. Find the speed of the boat in m/hr. [CBSE 2019, 17]

Ans. Here, AB is the cliff of height 150 m, C and D are the two positions of a boat.

$\therefore$ AB = 150 m,

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

Let, the distance BC be 'x' m and CD be 'y' m.
Now, in ΔABC,



$$\tan 60° = \frac{AB}{BC}$$

$$\Rightarrow \quad \sqrt{3} = \frac{150}{x}$$

$$\Rightarrow \quad x = \frac{150}{\sqrt{3}} \quad ...(i)$$

and in ΔABD,

$$\tan 45° = \frac{AB}{BD}$$

$$\Rightarrow \quad 1 = \frac{150}{x+y}$$

$[\because BD = BC + CD]$

$$\Rightarrow \quad 150 = x + y$$

$$\Rightarrow \quad y = 150 - x$$

Using (i), we get

$$y = 150 - \frac{150}{\sqrt{3}}$$

$$= \frac{150(\sqrt{3}-1)}{\sqrt{3}}$$

But, the time taken to cover distance 'y' or CD is 2 minutes *i.e.* $\frac{2}{60}$ hr or, $\frac{1}{30}$ hr

Then, $$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{\frac{150(\sqrt{3}-1)}{\sqrt{3}}}{\frac{1}{30}}$$

$$= 150 \times 30 \frac{(\sqrt{3}-1)}{\sqrt{3}}$$

$$= 4500 \times \frac{(\sqrt{3}-1)}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= 1500\sqrt{3}(\sqrt{3}-1)$$

Hence, the speed of the boat is $1500\sqrt{3}(\sqrt{3}-1)$ m/hr.

72. **An observer 1.5 m tall is $20\sqrt{3}$ m away from a chimney. The angle of elevation of the top of the chimney from his eyes is 30°. Find the height of the chimney. [CBSE 2016]**

73. **Two men on either side of a 75 m high building and in line with the base of the building, observe the angles of elevation of the top of the building as 30° and 60°. Find the distance between the two men. (Use $\sqrt{3}$ = 1.73) [CBSE 2016]**

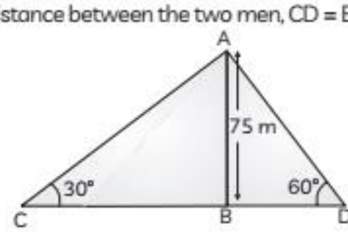
Ans. Here, AB is a building of height 75 m. Two men on either side of it are at the positions C and D.

$\therefore$ AB = 75 m,

$\angle ACB = 30°$

and $\angle ADB = 60°$.

The distance between the two men, CD = BC + BD



In ΔABC,

$$\tan 30° = \frac{AB}{BC}$$

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

$$\Rightarrow \quad BC = 75\sqrt{3}$$

In ΔABD,

$$\tan 60° = \frac{AB}{BD}$$

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

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

$$= 25\sqrt{3}$$

Now, $$CD = BC + BD$$

$$= 75\sqrt{3} + 25\sqrt{3}$$

$$= 100 \times \sqrt{3}$$

$$= 100 \times 1.73$$

$$= 173$$

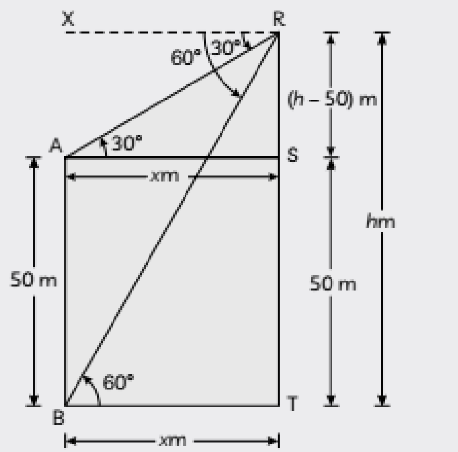
Hence, the distance between the two men is 173 m.

74. **The angles of depression of the top and bottom of a 50 m high building from the top of a tower are 45° and 60°, respectively. Find the height of the tower and the horizontal distance between the tower and the building. (Use $\sqrt{3} = 1.73$) [CBSE 2016]**

75. **The angles of depression of the top and bottom of a building 50 meters high as observed from the top of a tower are 30° and 60° respectively. Find the height of the tower, and also the horizontal distance between the building and the tower.**

[CBSE SQP 2019]

Ans.



Let AB = Building of height = 50 m

RT = tower of height = h m

BT = AS = x m

AB = ST = 50 m

RS = TR – TS = (h – 50) m

In ΔARS,

$$\tan 30° = \frac{RS}{AS}$$

$$\frac{1}{\sqrt{3}} = \frac{(h-50)}{x} \quad ...(1)$$

In ΔRBT,

$$\tan 60° = \frac{RT}{BT}$$

$$\sqrt{3} = \frac{h}{x} \quad ...(2)$$

Solving (1) and (2), we get

$h = 75$ from (2)

$$x = \frac{h}{\sqrt{3}} = \frac{75}{\sqrt{3}} = 25\sqrt{3}$$

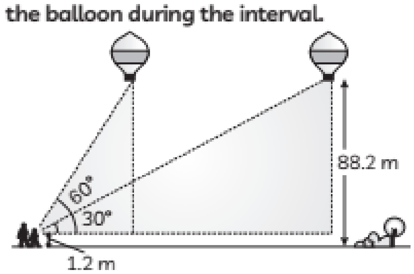
Hence, height of the tower = h = 75 m

Distance between the building and the tower = $25\sqrt{3}$ = 43.25 m

[CBSE Marking Scheme SQP 2019]

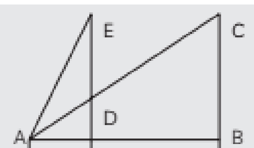
76. **A statue 1.6 m tall, stands on the top of a pedestal. From a point on the ground, the angle of elevation of the top of the statue is 60° and from the same point, the angle of elevation of the top of the pedestal is 45°. Find the height of the pedestal. (Use $\sqrt{3}$ = 1.73).** **[CBSE 2020]**

77. **A 1.2 m tall girl spots a balloon moving with the wind in a horizontal line at a height 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 sometime, the angle of elevation reduces to 30°. Find the distance travelled by the balloon during the interval.**



[CBSE SQP 2020]

Ans.



From the figure, the angle of elevation for the first position of the balloon $\angle EAD = 60°$ and for second position $\angle BAC = 30°$. The vertical distance

ED = CB = 88.2 – 1.2

= 87 m.

Let AD = x m and AB = y m.

Then in right Δ ADE,

$$\tan 60° = \frac{DE}{AD}$$

$$\sqrt{3} = \frac{87}{x}$$

$$x = \frac{87}{\sqrt{3}} \quad ...(i)$$

In right ΔABC,

$$\tan 30° = \frac{BC}{AB}$$

$$\frac{1}{\sqrt{3}} = \frac{87}{y}$$

$$y = 87\sqrt{3} \quad ...(ii)$$

Subtracting (i) and (ii)

$$y - x = 87\sqrt{3} - \frac{87}{\sqrt{3}}$$

$$y - x = \frac{174\sqrt{3}}{\sqrt{3}.\sqrt{3}}$$

$$y - x = 58\sqrt{3}\text{ m}$$

Hence, the distance travelled by the balloon is equal to BD

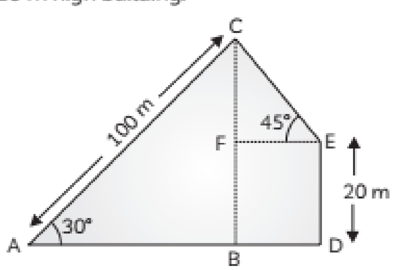
$$y - x = 58\sqrt{3}\text{ m.}$$

[CBSE Marking Scheme SQP 2020]

78. **The angle of elevation of an aeroplane from a point A on the ground is 60°. After a flight of 15 seconds, the angle of elevation changes to 30°. If the aeroplane is flying at a constant height of $1500\sqrt{3}$ m, find the speed of the plane in km/hr. [CBSE SQP 2015]**

79. **A boy standing on a horizontal plane finds a bird flying at a distance of 100 m from him at an elevation of 30°. A girl standing on the roof of a 20 m high building, find the elevation of the same bird to be 45°. The boy and the girl are on the opposite sides of the bird. Find the distance of the bird from the girl. (Given $\sqrt{2} = 1.414$) [CBSE 2019]**

Ans. Let C be the position of the bird, A be the position of boy and girl be at position E on a 20 m high building.



Then, AC = 100 m, ∠CAB = 30°, ED = 20 m, ∠CEF = 45°.

From right ΔCBA,

$$\sin 30° = \frac{BC}{AC}$$

$$\Rightarrow \quad \frac{1}{2} = \frac{BC}{100}$$

$$\Rightarrow \quad BC = 50\text{ m}$$

Now, CF = BC – BF
= BC – ED
= 50 – 20
= 30 m

From right ΔCFE,

$$\sin 45° = \frac{CF}{CE}$$

$$\Rightarrow \quad \frac{1}{\sqrt{2}} = \frac{30}{CE}$$

$$\Rightarrow \quad CE = 30\sqrt{2}$$

$$\Rightarrow \quad CE = 30 \times 1.414 = 42.42\text{ m}$$

Hence, the distance of the bird from the girl is 42.42 m.

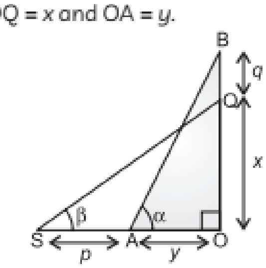
80. **The angle of elevation of an aeroplane from a point A on the ground is 60°. After a flight of 30 seconds, the angle of elevation changes to 30°. If the plane is flying at a constant height of $3600\sqrt{3}$ metres, find the speed of the aeroplane. [CBSE 2019]**

81. **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 $\frac{p}{q} = \frac{\cos\beta - \cos\alpha}{\sin\alpha - \sin\beta}$. [NCERT Exemplar]**

Ans. Let AB be the ladder at an inclination α to the horizontal and SQ be its position when it makes an angle β to the horizontal.

So, SA = *p*, BQ = *q*, ∠BAO = α, ∠QSO = β.

Let, OQ = *x* and OA = *y*.



In ΔBAO,

$$\cos\alpha = \frac{OA}{AB}$$

$$\Rightarrow \quad OA = AB\cos\alpha \quad \text{...(i)}$$

and

$$\sin\alpha = \frac{OB}{AB}$$

$$\Rightarrow \quad OB = AB\sin\alpha \quad \text{...(ii)}$$

In ΔQSO,

$$\cos\beta = \frac{OS}{SQ}$$

$$\Rightarrow \quad OS = SQ\cos\beta = AB\cos\beta \quad \text{...(iii)}$$

and

$$\sin\beta = \frac{OQ}{SQ}$$

$\Rightarrow \quad OQ = SQ \sin\beta = AB \sin\beta \quad$ ...(iv)

Now, $\quad SA = OS - AO$

$\Rightarrow \quad = AB\cos\beta - AB\cos\alpha$

$p = AB(\cos\beta - \cos\alpha) \quad$ ...(v)

and $\quad BQ = BO - QO$

$= AB\sin\alpha - AB\sin\beta$

$\Rightarrow \quad q = AB(\sin\alpha - \sin\beta) \quad$ ...(vi)

Dividing eq^n (v) by eq^n (vi), we get

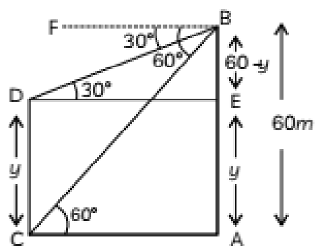
$$\frac{p}{q} = \frac{AB(\cos\beta - \cos\alpha)}{AB(\sin\alpha - \sin\beta)}$$

$$\therefore \quad \frac{p}{q} = \frac{\cos\beta - \cos\alpha}{\sin\alpha - \sin\beta}$$

Hence, proved.

82. There are two poles, one each on either bank of a river just opposite to each other. One pole is 60 m high. From the top of this pole, the angles of depression of the top and foot of the other pole are 30° and 60° respectively. Find the width of the river and the height of the other pole. [CBSE 2019]

Ans. Here, AB and CD are two poles on the either bank of the river. AC is the width of the river.



$\therefore \quad AB = 60$ m,

$\angle FBD = \angle BDE = 30°$,

and $\quad \angle FBC = \angle BCA = 60°$

Let the height of other pole be y m.

Then, $\quad CD = AE = y$

$\therefore \quad BE = AB - AE = (60 - y)$ m

Now, in ΔABC,

$$\tan 60° = \frac{AB}{AC}$$

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

$$\Rightarrow \quad AC = \frac{60}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 20\sqrt{3}$$

And, in ΔBED,

$$\tan 30° = \frac{BE}{DE}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{60 - y}{20\sqrt{3}}$$

$[\because AC = DE = 20\sqrt{3}]$

$\Rightarrow \quad 20 = 60 - y$

$\Rightarrow \quad y = 40$

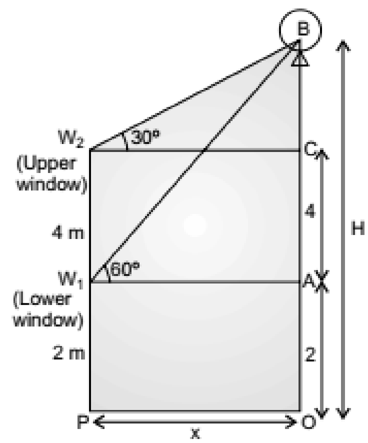
Hence, the width of the river is $20\sqrt{3}$ m and the height of the other pole is 40 m.

83. The lower window of a house is at a height of 2 m above the ground and its upper window is 4 m vertically above the lower window. At certain distance the angles of elevation of a balloon from these windows are observed to be 60° and 30°, respectively. Find the height of the balloon above the ground.

[NCERT Exemplar]

Ans. Let B be a balloon at a height of H metres from the ground, W_1 be the lower window and W_2 be the upper window.

$\therefore PW_1 = 2$ m, $PW_2 = 4$ m, $\angle AW_1B = 60°$ and $\angle CW_2B = 30°$.



So, $\quad OA = PW_1 = 2$m

and $\quad AC = PW_2 = 4$m

$\therefore \quad BC = OB - (AC + AO)$

$= H - (4 + 2)$

$= H - 6$

Let $\quad OP = AW_1 = CW_2 = x$ m.

In ΔBW_1A,

$$\tan 60° = \frac{BA}{W_1A} = \frac{BC + CA}{W_1A}$$

$$\Rightarrow \quad \sqrt{3} = \frac{(H-6)+4}{x}$$

$$\Rightarrow \quad x = \frac{H-2}{\sqrt{3}} \quad \text{...(i)}$$

In ΔBW_2C,

$$\tan 30° = \frac{BC}{W_1C}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{H-6}{x}$$

$$\Rightarrow \quad x = \sqrt{3}(H-6) \quad \text{...(ii)}$$

From eqn (i) and (ii), we get

$$\sqrt{3}(H-6) = \frac{(H-2)}{\sqrt{3}}$$

$\Rightarrow \quad 3(H-6) = (H-2)$

$\Rightarrow \quad 3H-18 = H-2$

$\Rightarrow \quad 2H = 16$

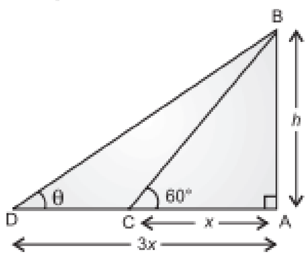
$\Rightarrow \quad H = 8$

Hence, the height of the balloon is 8 m from the ground.

84. **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 meters per minute. [Use $\sqrt{3}$ = 1.732] [CBSE 2019]**

85. **The shadow of a tower at a time is three times as long as its shadow when the angle of elevation of the sun is 60°. Find the angle of elevation of the sun of the longer shadow. [Diksha]**

Ans. Let AB be the tower of height h m, AC be its shadow at elevation of the sun of 60° and AD be its shadow, which is three times of shadow AC.



Let $\quad AC = x$ m and $\angle ADB = \theta$.

Then, $\quad AD = 3x$

In ΔBAC,

$$\frac{AB}{AC} = \tan 60°$$

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

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

In ΔBAD,

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

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

$$\frac{x\sqrt{3}}{3x} = \tan\theta \quad \text{[using (i)]}$$

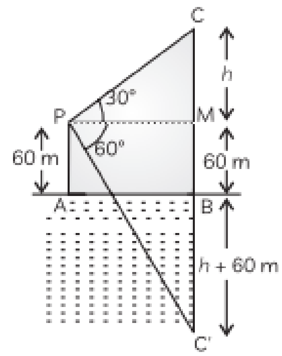
$$\Rightarrow \quad \tan\theta = \frac{1}{\sqrt{3}} = \tan 30°$$

Thus, $\quad \theta = 30°$

Hence, the angle of elevation of the sun of the longer shadow is 30°.

86. **The angle of elevation of a cloud from a point 60 m above the surface of the water of a lake is 30° and the angle of depression of its shadow in water of lake is 60°. Find the height of the cloud from the surface of water. [CBSE 2017]**

Ans. Let AB be the surface of the lake and P be the point of observation such that AP = 60 m.



Let C be the position of the cloud and C' be its reflection in the lake.

Let, $\quad CM = h$ m.

Draw, $\quad PM \perp CC'$.

Then, $\quad CB = (h + 60)$ m

and $\quad C'B = (h + 60)$ m

[$\because$ CB = C'B, as reflection of C is C']

Now, in ΔCPM

$$\tan 30° = \frac{CM}{PM}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{h}{PM}$$

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

Similarly, in ΔPMC'

$$\tan 60° = \frac{CM}{PM} = \frac{C'B + BM}{PM}$$

$$\Rightarrow \quad \sqrt{3} = \frac{(h+60)+60}{PM}$$

$$\Rightarrow \quad PM = \frac{h+120}{\sqrt{3}} \quad ...(ii)$$

From (i) and (ii), we get

$$\sqrt{3}h = \frac{h+120}{\sqrt{3}}$$

$\Rightarrow \quad 3h = h + 120$ m

$\Rightarrow \quad 2h = 120$

$\Rightarrow \quad h = 60$

So, $\quad CB = h + 60 = 60 + 60$

$\quad = 120$ m

Hence, the height of the cloud from the surface of the lake is 120 m.

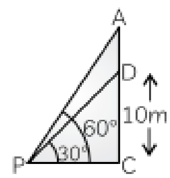
87. From a point P on the ground, the angles of elevation of the top of a 10 m tall building and a helicopter, at some height vertically over the top the building are 30° and 60° respectively. Find the height of the helicopter above the ground. [CBSE 2017]

Ans. Let CD be a building, A be the position of the helicopter above the building and P be the point of observation on the ground.

$\therefore$ CD = 10 m, $\angle DPC = 30°$ and $\angle APC = 60°$.

Let the height of helicopter above the ground be h m.

Now, in ΔPDC,



$$\tan 30° = \frac{CD}{PC}$$

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

$$\Rightarrow \quad PC = 10\sqrt{3} \quad \text{...(i)}$$

and in ΔPAC

$$\tan 60° = \frac{AC}{PC}$$

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

$[\because PC = 10\sqrt{3}$ from (i)$]$

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

Hence, the height of the helicopter above the ground is 30 m.

88. A 1.6m tall boy is standing at some distance from a 40m 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. [CBSE 2016]

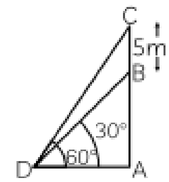
89. From the top of a 120 m high tower, a man observes two cars on the opposite sides of the tower and in straight line with the base of tower with angles of depression as 60° and 45°. Find the distance between two cars. [Diksha]

90. A vertical tower stands on a horizontal plane and is surmounted by a flagstaff of height 5 m. From a point on the ground, the angles of elevation of the top and bottom of the flagstaff are 60° and 30°, respectively. Find the height of the tower and the distance of the point from the tower. (Take $\sqrt{3}$ = 1.732) [CBSE 2016]

Ans. Let AB be a vertical tower on which a flagstaff BC of height 5m is surmounted. Also, let D be the point of observation on the ground.

$\therefore$ BC = 5 m, $\angle ADC = 60°$ and $\angle ADB = 30°$.

In the right-angled ΔBAD,



$$\tan 30° = \frac{AB}{AD}$$

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

$$\Rightarrow \quad AD = \sqrt{3}\,AB \quad \text{...(i)}$$

Similarly, in right-angled ΔCAD,

$$\tan 60° = \frac{AC}{AD}$$

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

$$\Rightarrow \quad \sqrt{3} = \frac{AB + 5}{AD}$$

$$\Rightarrow \quad \sqrt{3}\,AD = AB + 5$$

$$\Rightarrow \quad \sqrt{3}\,(\sqrt{3}\,AB) = AB + 5 \quad \text{[From (i)]}$$

$$\Rightarrow \quad 2AB = 5$$

$$\Rightarrow \quad AB = 2.5 \text{ m}$$

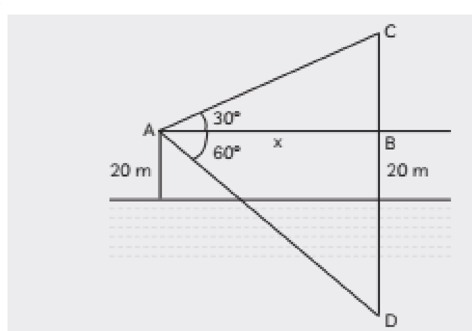
and $\quad AD = \sqrt{3} \times 2.5 = 2.5 \times 1.732$

$= 4.33$ m

Hence, the height of the tower is 2.5 m and distance of the point from the tower is 4.33 m.

91. At a point A, 20 metres above the level of water in a lake, the angle of elevation of a cloud is 30°. The angle of depression of the reflection of the cloud in the lake, at A is 60°. Find the distance of the cloud from A. [CBSE SQP 2015]

Ans.



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

$\Rightarrow \quad x = \sqrt{3}\,h.$

$$= \tan 60° = \sqrt{3}$$

$\Rightarrow \quad x = \dfrac{40+h}{\sqrt{3}}$

$\therefore \quad \sqrt{3}\,h = \dfrac{40+h}{\sqrt{3}}$

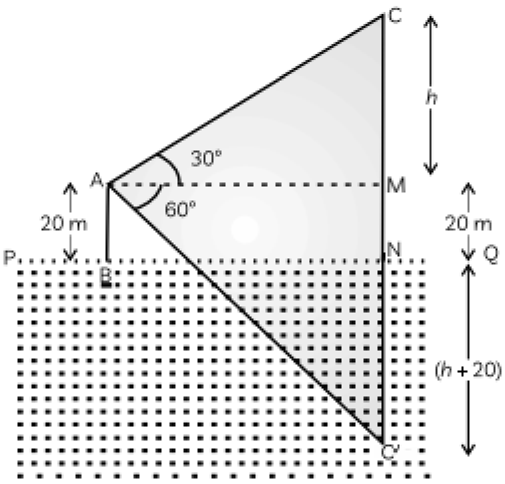
$\Rightarrow \quad h = 20$ m.

$\therefore \quad x = 20\sqrt{3}$ m

$\therefore$ AC $= \sqrt{(20)^2+(20\sqrt{3})^2} = 40$ m.

[CBSE Marking Scheme SQP 2015]

Explanation: Let BN be the surface of lake, C be the cloud and C' be its reflection in the lake.



It is given that point A is 20 m above the surface of lake.

Draw AM ⊥ CC'.

$\therefore \quad$ AB = MN = 20 m,

$\angle$CAM = 30° and $\angle$MAC' = 60°.

Let $\quad$ CM = h m

Then, $\quad$ CN = CM + MN

$= (h + 20)$ m

and $\quad$ C'N = CN = $(h + 20)$ m

Now, in ΔAMC,

$$\tan 30° = \frac{CM}{AM}$$

$\Rightarrow \quad \dfrac{1}{\sqrt{3}} = \dfrac{h}{AM}$

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

And, in ΔAMC',

$$\tan 60° = \frac{C'M}{AM}$$

$\Rightarrow \quad \sqrt{3} = \dfrac{(h+20)+20}{h\sqrt{3}} \quad$ [using (i)]

$\Rightarrow \quad 3h = h + 40$

$\Rightarrow \quad 2h = 40$

$\Rightarrow \quad h = 20$

So, $\quad AM = h\sqrt{3} = 20\sqrt{3}$

Again, in ΔAMC, using Pythagoras theorem, we have

$$AC^2 = CM^2 + AM^2$$

$$= (20)^2 + (20\sqrt{3})^2$$

$$= 400 + 1200$$

$\Rightarrow \quad AC^2 = 1600$

$\Rightarrow \quad AC = 40$

Hence, the distance of the cloud from the point A is 40 m.

92. **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 the bird. (Take $\sqrt{3}$ = 1.732) [CBSE 2016]**

93. **If the angle of elevation of a cloud from a point 10 metres above a lake is 30° and the angle of depression of its reflection in the lake is 60°, find the height of the cloud from the surface of lake. [CBSE 2020]**