

# Some Applications of Trigonometry

## Exercise 5.1

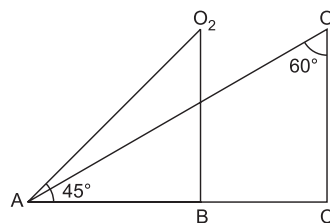
### I. Very Short Answer Type Questions

[1 Mark]

#### 1. Multiple Choice Questions (MCQs)

Choose the correct answer from the given options:

- (1) A pole of 6 m high casts a shadow  $2\sqrt{3}$  m long, then sun's elevation is  
(a)  $60^\circ$  (b)  $45^\circ$  (c)  $30^\circ$  (d)  $90^\circ$
- (2) At some time of the day, the length of the shadow of a tower is equal to height. Then the sun's altitude at that time is  
(a)  $30^\circ$  (b)  $60^\circ$  (c)  $90^\circ$  (d)  $45^\circ$
- (3) The angle of depression of a car standing on the ground, from the top of a 75 m high tower is  $30^\circ$ . The distance of the car from the base of the tower (in m) is:  
(a)  $25\sqrt{3}$  (b)  $50\sqrt{3}$  (c)  $75\sqrt{3}$  (d) 150
- (4) In the given figure, the angles of depressions from the observing positions  $O_1$  and  $O_2$  respectively of the object A respectively are  
(a)  $30^\circ, 45^\circ$   
(b)  $45^\circ, 60^\circ$   
(c)  $60^\circ, 75^\circ$   
(d)  $60^\circ, 30^\circ$



#### 2. Assertion-Reason Type Questions

In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice 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.

- (1) **Assertion (A):** If the angle of elevation of Sun, above a perpendicular line (tower) decreases, then the shadow of tower increases.

**Reason (R):** It is due to decrease in slope of the line of sight.

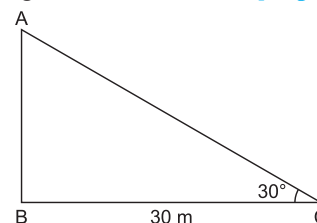
- (2) **Assertion (A):** When we move towards the object, angle of elevation decreases.

**Reason (R):** As we move towards the object, it subtends large angle at our eye than before.

#### 3. Answer the following:

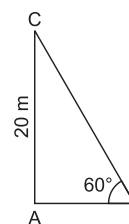
- (1) A kite is attached to a string. Assuming that there is no slack in the string, find the height of the kite above the level of the ground, if the length of the string is 54 m and it makes an angle of  $30^\circ$  with the ground. [Imp.]

- (2) In the given 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  $30^\circ$ . Find the height of the tower. [CBSE Standard 2020]



- (3) 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 Standard 2020]

- (4) In the given figure, the angle of elevation of the top of a tower AC from a point B on the ground is  $60^\circ$ . If the height of the tower is 20 m, find the distance of the point from the foot of the tower.

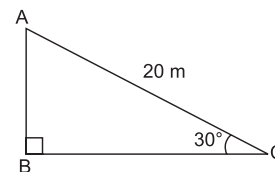


- (5) A tower stands vertically on the ground. From a point on the ground, which is 15m away from the foot of the tower, the angle of elevation of the top of the tower is found to be  $60^\circ$ . Find the height of the tower.

## II. Short Answer Type Questions -I

[2 Marks]

4. 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  $30^\circ$  (see figure given alongside). [NCERT]

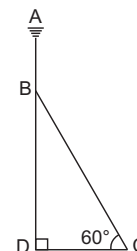


5. From the top of a 60 m high building, the angles of depression of the top and the bottom of a tower are  $45^\circ$  and  $60^\circ$  respectively. Find the height of the tower.

[Take  $\sqrt{3} = 1.73$ ] [AI 2015]

6. The shadow of a tower standing on a level ground is found to be 30 m longer when the sun's altitude is  $30^\circ$  than when it is  $60^\circ$ . Find the height of the tower.

7. An electrician has to repair an electric fault on a pole of height 4 m. He needs to reach a point 1.3 m below the top of the pole to undertake the repair work (see figure given along side). What should be the length of the ladder that he should use which, when inclined at an angle of  $60^\circ$  to the horizontal would enable him to reach the required position? [Imp.]

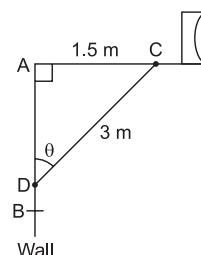


8. The rod AC of a TV disc antenna is fixed at right angles to the wall AB and a rod CD is supporting the disc as shown in the figure. If AC = 1.5 m long and CD = 3 m, find

(a)  $\tan \theta$

(b)  $\sec \theta + \operatorname{cosec} \theta$

[CBSE Standard 2020]



## III. Short Answer Type Questions -II

[3 Marks]

9. The angle of depression of the top and bottom of a tower as seen from the top of a  $60\sqrt{3}$  m high cliff are  $45^\circ$  and  $60^\circ$  respectively. Find the height of the tower. [CBSE 2013]

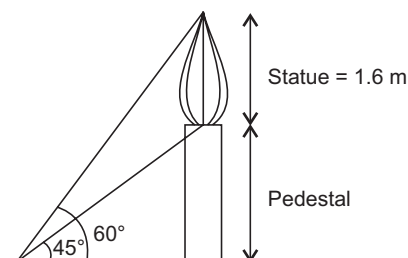
10. The angle of elevation of the top Q of a vertical tower PQ from a point X on the ground is  $60^\circ$ . From a point Y, 40 m vertically above X, the angle of elevation of the top Q of tower PQ is  $45^\circ$ . Find the height of the tower PQ and the distance PX. [Use  $\sqrt{3} = 1.73$ ]

11. From the top of a tower 50 m high, the angle of depression of the top of a pole is  $45^\circ$  and from the foot of the pole, the angle of elevation of the top of the tower is  $60^\circ$ . Find the height of the pole if the pole and tower stand on the same plane. [Foreign 2013]

12. The angle of depression from the top of a tower of a point A on the ground is  $30^\circ$ . On moving a distance of 20 m from the point A towards the foot of the tower to the point B, the angle of elevation of the top of the tower from the point B is  $60^\circ$ . Find the height of the tower and its distance from the point A. [Foreign 2013]

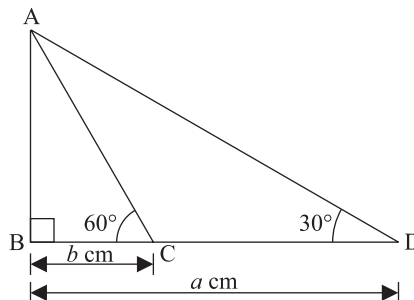
13. A flag-staff stands on the top of a 12 m high tower. From a point on the ground, the angles of elevation of the top and bottom of the flag-staff are observed to be  $45^\circ$  and  $30^\circ$  respectively. Find the height of the flag-staff. [Imp.]

14. The given figure shows a statue, 1.6 m tall, standing on the top of pedestal. From a point on the ground, the angle of elevation of the top of the statue is  $60^\circ$  and from the same point, the angle of elevation of the top of the pedestal is  $45^\circ$ . Find the height of the pedestal. [Imp.]



15. As observed from the top of a 60 m high lighthouse from the sea-level, the angles of depression of the two ships are  $30^\circ$  and  $45^\circ$ . If one ship is exactly behind the other on the same side of the lighthouse, find the distance between the two ships. [Use  $\sqrt{3} = 1.732$ ]

16. The angles of elevation of the top of a tower from two points at a distance of 6 m and 13.5 m from the base of the tower and in the same straight line with it are complementary. Find the height of the tower. [Foreign 2013]
17. Two ships are there in the sea on either side of a lighthouse in such a way that the ships and the lighthouse are in the same straight line. The angles of depression of two ships as observed from the top of the lighthouse are  $60^\circ$  and  $45^\circ$ . If the height of the lighthouse is 200 m, find the distance between the two ships. [Use  $\sqrt{3} = 1.73$ ] [Delhi 2014]
18. The angle of elevation of an aeroplane from a point on the ground is  $60^\circ$ . After a flight of 30 seconds the angle of elevation becomes  $30^\circ$ . If the aeroplane is flying at a constant height of  $3000\sqrt{3}$  m, find the speed of the aeroplane. [AI 2014]
19. From a point P on the ground, the angle of elevation of the top of a 10 m tall building is  $30^\circ$ . A flagstaff is fixed at the top of the building and the angle of elevation of the top of the flagstaff from the point P is  $45^\circ$ . Find the length of the flagstaff and the distance of building from the point P. [Delhi 2013]
20. From the top of a 7 m high building, the angle of elevation of the top of a cable tower is  $60^\circ$  and the angle of depression of its foot is  $30^\circ$ . Determine the height of the tower. [Foreign 2013]
21. A man on the top of a vertical observation tower observes a car moving at a uniform speed coming directly towards him. If it takes 12 minutes for the angle of depression to change from  $30^\circ$  to  $45^\circ$ , how soon after this, will the car reach the observation tower? [CBSE SP 2018-19] [CBSE 2006 (C)]
22. Two men on either side of a 75 m high building and in line with base of building observe the angles of elevation of the top of the building as  $30^\circ$  and  $60^\circ$ . Find the distance between the two men. (Use  $\sqrt{3} = 1.73$ ). [Foreign 2015]
23. As observed from the top of a lighthouse, 100 m high above sea level, the angles of depression of a ship, sailing directly towards it, changes from  $30^\circ$  to  $60^\circ$ . Find the distance travelled by the ship during the period of observation. [Use  $\sqrt{3} = 1.73$ ] [AI 2016]
24. If the angles of elevation of the top of the candle from two coins distant ' $a$ ' cm and ' $b$ ' cm ( $a > b$ ) from its base and in the same straight line from it are  $30^\circ$  and  $60^\circ$ , then find the height of the candle.



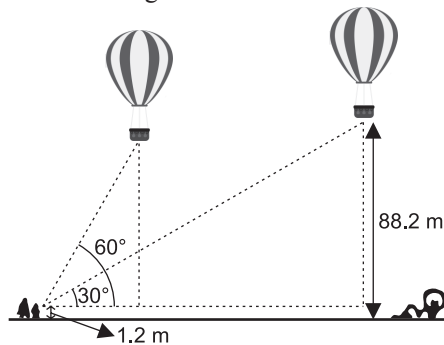
#### IV. Long Answer Type Questions

[5 Marks]

25. As observed from the top of a 100 m high lighthouse from the sea-level, the angles of depression of two ships are  $30^\circ$  and  $45^\circ$ . If one ship is exactly behind the other on the same side of the lighthouse, find the distance between the two ships. [Use  $\sqrt{3} = 1.732$ ] [CBSE 2018]
26. The angles of depression of the top and bottom of a 50 m high building from the top of a tower are  $45^\circ$  and  $60^\circ$  respectively. Find the height of the tower and the horizontal distance between the tower and the building. [Use  $\sqrt{3} = 1.73$ ] [Delhi 2015]
27. A 7 m long flagstaff is fixed on the top of a tower standing on the horizontal plane. From a point on the ground, the angles of elevation of the top and bottom of the flagstaff are  $60^\circ$  and  $45^\circ$  respectively. Find the height of the tower correct to one place of decimal. [Use  $\sqrt{3} = 1.73$ ] [Foreign 2016]
28. An aeroplane, when flying at a height of 4000 m from the ground passes vertically above another aeroplane at an instant when the angles of elevation of the two planes from the same point on the ground are  $60^\circ$  and  $45^\circ$  respectively. Find the vertical distance between the aeroplanes at that instant. [Take  $\sqrt{3} = 1.73$ ] [Foreign 2016]
29. The angle of elevation of a cloud from a point 60 m above a lake is  $30^\circ$  and the angle of depression of the reflection of cloud in the lake is  $60^\circ$ . Find the height of the cloud. [CBSE SP 2018-19, 2008, 2010]
30. A round balloon of radius  $r$  subtends an angle  $\alpha$  at the eye of the observer while the angle of elevation of its centre is  $\beta$ . Prove that the height of the centre of the balloon is  $r \sin \beta \operatorname{cosec} \frac{\alpha}{2}$ . [CBSE 2010]
31. A man in a boat rowing away from a lighthouse 100 m high takes 2 minutes to change the angle of elevation of the top of the lighthouse from  $60^\circ$  to  $30^\circ$ . Find the speed of the boat in metres per minute. [Use  $\sqrt{3} = 1.732$ ] [Delhi 2019]

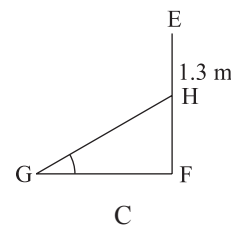
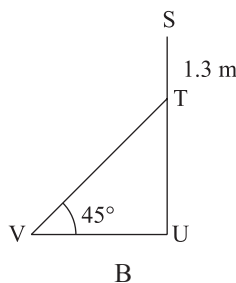
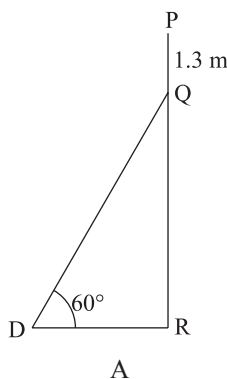
32. Two poles of equal heights are standing opposite to each other on either side of the road, which is 80 m wide. From a point between them on the road, the angles of elevation of the top of the poles are  $60^\circ$  and  $30^\circ$  respectively. Find the height of the poles and the distances of the point from the poles. [Delhi 2019]
33. The shadow of a tower standing on a level ground is found to be 40 m longer when the Sun's altitude is  $30^\circ$  than when it was  $60^\circ$ . Find the height of the tower. [Given  $\sqrt{3} = 1.732$ ] [Delhi 2019]
34. The angles of elevation and depression of the top and bottom of a lighthouse from the top of a 60 m high building are  $30^\circ$  and  $60^\circ$  respectively. Find  
(i) the difference between the heights of the lighthouse and the building.  
(ii) the distance between the lighthouse and the building. [AI 2014]
35. From a point on the ground, the angle of elevation of the top of a tower is observed to be  $60^\circ$ . From a point 40 m vertically above the first point of observation, the angle of elevation of the top of the tower is  $30^\circ$ . Find the height of the tower and its horizontal distance from the point of observation. [AI2016]
36. The angle of elevation of a jet fighter from a point A on the ground is  $60^\circ$ . After a flight of 10 seconds, the angle of elevation changes to  $30^\circ$ . If the jet is flying at a speed of 900 km/hour, find the constant height at which the jet is flying. [Use  $\sqrt{3} = 1.732$ ] [CBSE 2008]
37. The angle of elevation of the top of a tower as observed from a point on the ground is  $\alpha$  and on moving  $a$  metres towards the tower, the angle of elevation is  $\beta$ . Prove that the height of the tower is:  $\frac{a \tan \alpha \tan \beta}{\tan \beta - \tan \alpha}$ . [NCERT] [CBSE 2006]
38. From a window,  $x$  metres high above the ground in a street, the angles of elevation and depression of the top and foot of the other house on the opposite side of the street are  $\alpha$  and  $\beta$  respectively. Show that the height of the opposite house is  $x(1 + \tan \alpha \tan \beta)$  metres. [CBSE 2006]
39. The angle of elevation of the top of a tower at a distance of 120 m from a point A on the ground is  $45^\circ$ . If the angle of elevation of the top of a flagstaff fixed at the top of the tower, at A is  $60^\circ$ , then find the height of the flagstaff. [Use  $\sqrt{3} = 1.73$ ] [AI 2017]
40. At the foot of a mountain, the angle of elevation of its summit is  $45^\circ$ . After ascending 1 km towards the mountain up an incline of  $30^\circ$ , the elevation changes to  $60^\circ$ . Find the height of the mountain. [Use  $\sqrt{3} = 1.732$ ] [CBSE 2010]
41. The angles of depression of the top and bottom of a building 50 metres high as observed from the top of a tower are  $30^\circ$  and  $60^\circ$ , respectively. Find the height of the tower and also the horizontal distance between the building and the tower. [CBSE Standard SP 2020-21, SP 2018]
42. As observed from the top of a 75 m highlight house above the sea level, the angles of depression of two ships are  $30^\circ$  and  $45^\circ$  respectively. If one ship is exactly behind the other on the same side of the lighthouse and in the same straight line, find the distance between the two ships. [Use  $\sqrt{3} = 1.732$ ]
43. 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  $60^\circ$  and from the same point the angle of elevation of the top of the pedestal is  $45^\circ$ . Find the height of the pedestal. [Use  $\sqrt{3} = 1.73$ ] [CBSE Standard 2020]
44. A verticle tower stands on a horizontal plane and is surmounted by a vertical flag-staff of height 6 m. At a point on the plane, the angle of elevation of the bottom and top of the flag-staff are  $30^\circ$  and  $45^\circ$  respectively. Find the height of the tower. [Take  $\sqrt{3} = 1.73$ ] [CBSE Standard 2020]
45. From a point on the ground, the angles of elevation of the bottom and the top of a tower fixed at the top of a 20 m high building are  $45^\circ$  and  $60^\circ$  respectively. Find the height of the tower. [CBSE Standard 2020]
46. From a point on a bridge across a river, the angles of depression of the banks on opposite sides of the river are  $30^\circ$  and  $45^\circ$ , respectively. If the bridge is at a height of 10 m from the banks, then find the width of the river. [Use  $\sqrt{3} = 1.73$ ]
47. The angle of elevation of the top of a building from the foot of a tower is  $30^\circ$ . The angle of elevation of the top of the tower from the foot of the building is  $60^\circ$ . If the tower is 60 m high, find the height of the building.
48. The two palm trees are of equal heights and are standing opposite to each other on either side of the river, which is 80 m wide. From a point O between them on the river, the angles of elevation of the top of the trees are  $60^\circ$  and  $30^\circ$ , respectively. Find the height of the trees and the distances of the point O from the trees. [CBSE Standard SP 2020-21]

49. The angles of depression of the top and bottom of a 8 m tall building from the top of a multi-storied building are  $30^\circ$  and  $45^\circ$ , respectively. Find the height of the multi-storied building and the distance between the two buildings.
50. 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  $60^\circ$ . After sometime, the angle of elevation reduces  $30^\circ$ . Find the distance travelled by the balloon during the interval.



### Case Study Based Questions

- I. **Application of Trigonometry—Height of Tree/Tower:** Mr. Suresh is an electrician. He receives a call regarding a fault on a pole from three different colonies A, B and C. He reaches one-by-one to each colony to repair that fault. He needs to reach a point 1.3 m below the top of each pole to undertake the repair work. Observe the following diagrams.



#### Refer to Diagram A

1. What should be the length of ladder DQ that enable him to reach the required position if the height of the pole is 4 m?

- (a)  $\frac{5\sqrt{3}}{7}$  m      (b)  $\frac{9\sqrt{3}}{5}$  m      (c)  $\frac{7\sqrt{2}}{5}$  m      (d)  $\frac{4\sqrt{3}}{5}$  m

2. What is the distance of the point where the ladder is placed on the ground if the height of pole is 4 m?

- (a) 2.5 m      (b) 3.8 m      (c) 1.56 m      (d) 5.3 m

#### Refer to Diagram B

3. Given that the length of ladder is  $4\sqrt{2}$  m. What is height of pole?

- (a)  $4\frac{1}{2}$  m      (b)  $4\sqrt{5}$  m      (c)  $5\sqrt{5}$  m      (d) 5.3 m

4. The distance of the point where the ladder lies on the ground is

- (a)  $3\sqrt{5}$  m      (b)  $4\sqrt{2}$  m      (c) 4 m      (d)  $4\sqrt{7}$  m

#### Refer to Diagram C

5. The angle of elevation of reaching point of ladder at pole, i.e., H, if the height of the pole is 8.3 m and the distance GF is  $7\sqrt{3}$  m, is

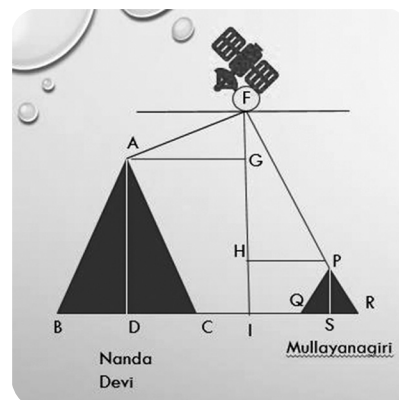
- (a)  $30^\circ$       (b)  $60^\circ$       (c)  $45^\circ$       (d) None of these.



- II. A group of students of class X visited India Gate on an educational trip. The teacher and students had interest in history as well. The teacher narrated that **India Gate**, official name **Delhi Memorial**, originally called **All-India War Memorial**, monumental sandstone arch in New Delhi, dedicated to the troops of British India who died in wars fought between 1914 and 1919. The teacher also said that India Gate, which is located at the eastern end of the Rajpath (formerly called the Kingsway), is about 138 feet (42 metres) in height.



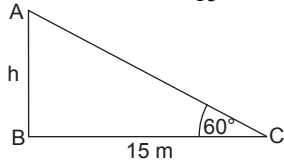
- What is the angle of elevation if they are standing at a distance of 42 m away from the monument?  
(a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $0^\circ$
  - They want to see the tower at an angle of  $60^\circ$ . The distance where they should stand will be  
(a) 25.24 m (b) 20.12 m (c) 42 m (d) 24.25 m
  - If the altitude of the Sun is at  $60^\circ$ , then the height of the vertical tower that will cast a shadow of length 20 m is  
(a)  $20\sqrt{3}$  m (b)  $\frac{20}{\sqrt{3}}$  m (c)  $\frac{15}{\sqrt{3}}$  m (d)  $15\sqrt{3}$  m
  - The ratio of the length of a rod and its shadow is 1:1. The angle of elevation of the Sun is  
(a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $90^\circ$
  - The angle formed by the line of sight with the horizontal when the object viewed is below the horizontal level is  
(a) corresponding angle (b) angle of elevation (c) angle of depression (d) complete angle
- III. A satellite flying at a height  $h$  is watching the top of the two tallest mountains in Uttarakhand and Karnataka, they are being Nanda Devi (height 7,816 m) and Mullayanagiri (height 1,930 m). The angles of depression from the satellite, to the top of Nanda Devi and Mullayanagiri are  $30^\circ$  and  $60^\circ$  respectively. If the distance between the peaks of two mountains is 1937 km, and the satellite is vertically above the mid-point of the distance between the two mountains.
- The distance of the satellite from the top of Nanda Devi is  
(a) 1118.29 km (b) 577.52 km  
(c) 1937 km (d) 1025.36 km
  - The distance of the satellite from the top of Mullayanagiri is  
(a) 1139.4 km (b) 577.52 km  
(c) 1937 km (d) 1025.36 km
  - The distance of the satellite from the ground is  
(a) 1139.4 km (b) 566.96 km  
(c) 1937 km (d) 1025.36 km
  - What is the angle of elevation if a man is standing at a distance of 7816 m away from Nanda Devi?  
(a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $0^\circ$
  - If a mile stone very far away from, makes  $45^\circ$  to the top of Mullayangiri mountain. So, find the distance of this mile stone from the mountain.  
(a) 1118.327 km (b) 566.976 km (c) 1937 km (d) 1025.36 km



## Answers and Hints

1. (1) (a)  $60^\circ$  (1) (2) (d)  $45^\circ$  (1)  
 (3) (c)  $75\sqrt{3}$  (1) (4) (a)  $30^\circ, 45^\circ$  (1)  
 2. (1) (a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A). (1)  
 (2) (d) Assertion (A) is false but reason (R) is true. (1)  
 3. (1) 27 m (1) (2)  $10\sqrt{3}$  m (1)  
 (3)  $30^\circ$  (1) (4)  $\frac{20}{\sqrt{3}}$  m (1)

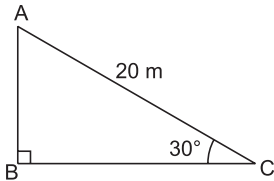
- (5) In right  $\triangle ABC$ ,  $\tan 60^\circ = \frac{h}{15}$



$$\Rightarrow \sqrt{3} = \frac{h}{15} \quad (1/2)$$

$$\therefore h = 15\sqrt{3} \text{ m} \quad (1/2)$$

4. In the given figure, let AC be the rope and AB be the pole.



In right  $\triangle ABC$ , we have:

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

$$\Rightarrow \frac{AB}{20} = \frac{1}{2} \quad [\because AC = 20 \text{ m}] \quad (1)$$

$$\Rightarrow AB = 20 \times \frac{1}{2} = 10 \text{ m}$$

Thus, the required height of the pole is 10 m. (1)

5. Let AB be 60 m high building and CD be the tower of height  $h$ .

$$\therefore \angle ACE = 45^\circ \text{ and } \angle ADB = 60^\circ \quad (\text{using alternate angles})$$

$$\text{Let } BD = CE = x \\ BE = CD = h \Rightarrow AE = 60 - h$$

In right-angled triangle ABD,

$$\frac{BD}{AB} = \cot 60^\circ \Rightarrow \frac{x}{60} = \frac{1}{\sqrt{3}}$$

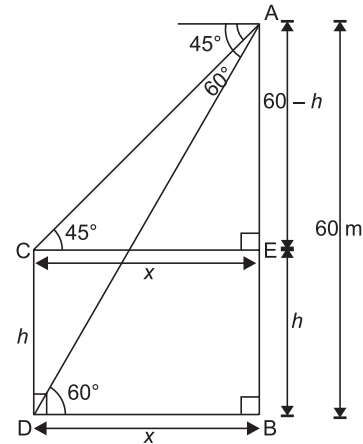
$$x = \frac{60}{\sqrt{3}} = \frac{60}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 20\sqrt{3} \quad \dots(i) \quad (1)$$

In right-angled triangle AEC,

$$\frac{AE}{CE} = \tan 45^\circ$$

$$\Rightarrow \frac{60 - h}{x} = 1 \Rightarrow 60 - h = x$$

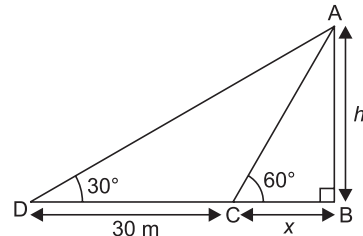
$$\Rightarrow h = 60 - 20\sqrt{3} \quad [\text{using (i)}]$$



$$\Rightarrow h = 20[3 - \sqrt{3}] = 20[3 - 1.73] \\ = 20 \times 1.27 = 25.4 \text{ m}$$

$\therefore$  Height of the tower is 25.4 m. (1)

6. Let AB be the tower of height  $h$ .  
Let BC =  $x$



$$\text{In } \triangle ABC, \frac{AB}{BC} = \tan 60^\circ$$

$$\Rightarrow \frac{h}{x} = \sqrt{3} \Rightarrow x = \frac{h}{\sqrt{3}} \quad \dots(i) \quad (1/2)$$

$$\text{In } \triangle ADB, \frac{AB}{BD} = \tan 30^\circ$$

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

$$\Rightarrow h\sqrt{3} = \frac{h}{\sqrt{3}} + 30 \quad [\text{From (i)}] \quad (1/2)$$

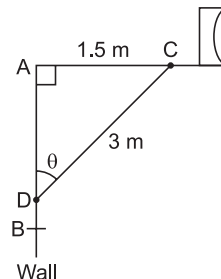
$$\Rightarrow h\sqrt{3} = \frac{h+30\sqrt{3}}{\sqrt{3}} \Rightarrow 3h = h+30\sqrt{3}$$

$$\Rightarrow 2h = 30\sqrt{3} \Rightarrow h = 15\sqrt{3}$$

Hence, the height of the tower is  $15\sqrt{3}$  m. (1)

7.  $\frac{5.4}{\sqrt{3}}$  m (2)

8.  $\triangle ACD$  is a right angled triangle.



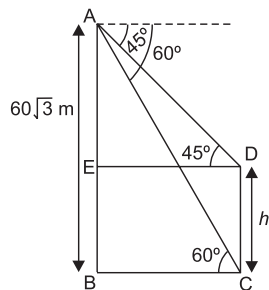
$$\begin{aligned}
 \text{So, } CD^2 &= AC^2 + AD^2 \\
 \Rightarrow (3)^2 &= (1.5)^2 + AD^2 \\
 \Rightarrow AD^2 &= 9 - 2.25 = 6.75 \\
 \Rightarrow AD &= \sqrt{\frac{6.75 \times 4}{4}} = \sqrt{\frac{27}{4}} = \frac{3\sqrt{3}}{2} \\
 (a) \quad \tan \theta &= \frac{AC}{AD} = \frac{1.5}{\frac{3\sqrt{3}}{2}} = \frac{1.5 \times 2}{3\sqrt{3}} = \frac{1}{\sqrt{3}} \\
 (b) \quad \sec \theta &= \frac{CD}{AD} = \frac{3}{\frac{3\sqrt{3}}{2}} = \frac{2}{\sqrt{3}} \\
 \operatorname{cosec} \theta &= \frac{CD}{AC} = \frac{3}{1.5} = \frac{30}{15} = 2 \\
 \therefore \sec \theta + \operatorname{cosec} \theta &= \frac{2}{\sqrt{3}} + 2 \\
 &= \frac{2 + 2\sqrt{3}}{\sqrt{3}} \quad (1)
 \end{aligned}$$

9. In  $\triangle ABC$ ,

$$\begin{aligned}
 \frac{AB}{BC} &= \tan 60^\circ \Rightarrow \frac{60\sqrt{3}}{BC} = \sqrt{3} \\
 BC &= 60 \text{ m} \quad \dots(i) (1)
 \end{aligned}$$

Now, in  $\triangle AED$ ,

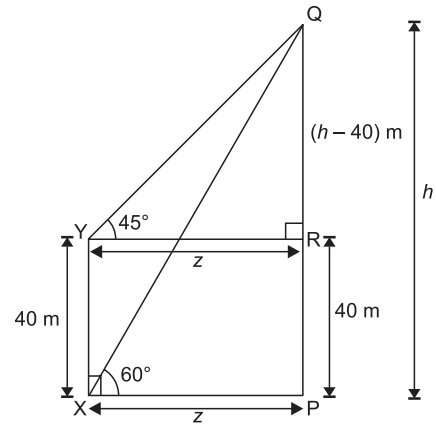
$$\begin{aligned}
 \frac{AE}{ED} &= \tan 45^\circ \\
 \Rightarrow \frac{60\sqrt{3} - h}{BC} &= 1 \quad [\because AE = AB - BE \text{ and } ED = BC] \\
 \Rightarrow 60\sqrt{3} - h &= 60 \quad [\text{From (i)}] (1)
 \end{aligned}$$



$$\begin{aligned}
 h &= 60\sqrt{3} - 60 \Rightarrow h = 60(\sqrt{3} - 1) \\
 h &= 60(1.73 - 1) \\
 &= 60 \times 0.73 = 43.8 \text{ m} \quad (1)
 \end{aligned}$$

10. In  $\triangle QPX$ ,  $\frac{PQ}{PX} = \tan 60^\circ \Rightarrow \frac{h}{z} = \sqrt{3}$

$$\Rightarrow \frac{h}{\sqrt{3}} = z \quad \dots(i)$$



In  $\triangle QRY$ ,

$$\begin{aligned}
 \frac{QR}{YR} &= \tan 45^\circ \Rightarrow \frac{h - 40}{z} = 1 \\
 \Rightarrow h - 40 &= z \quad \dots(ii) (1)
 \end{aligned}$$

From (i) and (ii), we get

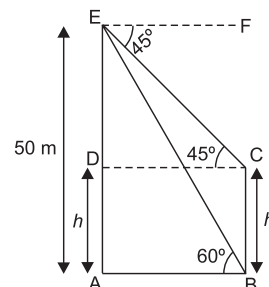
$$\begin{aligned}
 \frac{h}{\sqrt{3}} &= h - 40 \Rightarrow h = h\sqrt{3} - 40\sqrt{3} \\
 \Rightarrow h\sqrt{3} - h &= 40\sqrt{3} \Rightarrow h = \frac{40\sqrt{3}}{\sqrt{3} - 1} \quad (1) \\
 \Rightarrow h &= \frac{40\sqrt{3}(\sqrt{3} + 1)}{2} \\
 &= 20(3 + \sqrt{3}) = 20(3 + 1.73) \\
 \Rightarrow h &= 20 \times 4.73 = 94.6 \text{ m} \quad \dots(iii)
 \end{aligned}$$

So, height of the tower  $PQ = 94.6$  m and the distance  $PX = 94.6 - 40 = 54.6$  m. [From (ii) and (iii)] (1)

11. Let the height of the pole is  $h$ .

In right  $\triangle EDC$ ,

$$\begin{aligned}
 \tan 45^\circ &= \frac{ED}{DC} \Rightarrow 1 = \frac{50 - h}{DC} \\
 DC &= 50 - h = AB \quad \dots(i) (1)
 \end{aligned}$$



In right  $\triangle EAB$ ,

$$\begin{aligned}
 \tan 60^\circ &= \frac{EA}{AB} \Rightarrow \sqrt{3} = \frac{50}{AB} \\
 \Rightarrow \sqrt{3} &= \frac{50}{50 - h} \quad [\text{From (i)}] (1) \\
 \Rightarrow 50 - h &= \frac{50}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} \\
 \Rightarrow (50 - h) &= \frac{50 \times 1.73}{3} \\
 \Rightarrow 3(50 - h) &= 86.50 \Rightarrow 150 - 3h = 86.50
 \end{aligned}$$



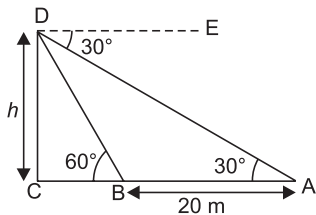
$$\Rightarrow 150 - 86.50 = 3h \Rightarrow 63.50 = 3h$$

$$\Rightarrow h = \frac{63.50}{3} \Rightarrow h = 21.16 \text{ m} \quad (1)$$

12. In right  $\triangle DCB$ ,

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

$$\Rightarrow BC = \frac{h}{\sqrt{3}} \quad \dots(i) (1)$$



In right  $\triangle DCA$ ,

$$\tan 30^\circ = \frac{DC}{AC} \Rightarrow \frac{1}{\sqrt{3}} = \frac{h}{BC+AB}$$

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

$$\Rightarrow \frac{h}{\sqrt{3}} + 20 = \sqrt{3}h \quad [\text{From (i)}] (1)$$

$$\Rightarrow h \left( \frac{3-1}{\sqrt{3}} \right) = 20 \Rightarrow h = 10\sqrt{3} = 17.30 \text{ m}$$

On putting  $h = 10\sqrt{3}$  in equation (i), we get

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

So, the height of the tower is 17.30 m and its distance from point A = 20 + 10 = 30 m. (1)

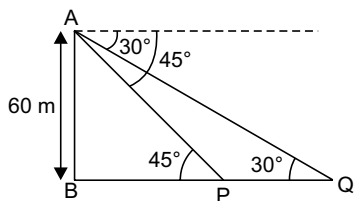
13.  $12(\sqrt{3} - 1) \text{ m}$  (3)

14.  $(0.8)(\sqrt{3} + 1) \text{ m}$  (3)

15. In  $\triangle ABP$ ,

$$\tan 45^\circ = \frac{AB}{BP} \Rightarrow 1 = \frac{60}{BP}$$

$$\Rightarrow BP = 60 \text{ m} \quad (1)$$



In  $\triangle ABQ$ ,

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

$$\Rightarrow BQ = AB\sqrt{3} = 60(\sqrt{3})$$

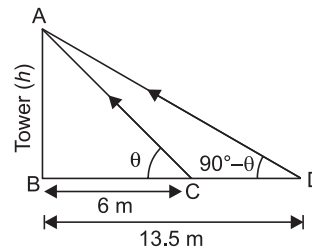
$$= 103.92 \text{ m} \quad (1)$$

Distance between two ships

$$= BQ - BP = 103.92 - 60$$

$$= 43.92 \text{ m.} \quad (1)$$

16. In  $\triangle ABC$ ,  $\tan \theta = \frac{h}{6} \quad \dots(i) (1)$



In  $\triangle ABD$ ,

$$\tan (90^\circ - \theta) = \frac{h}{13.5} \Rightarrow \cot \theta = \frac{h}{13.5}$$

$$\Rightarrow \tan \theta = \frac{13.5}{h} \quad \dots(ii) (1)$$

$$\therefore \frac{h}{6} = \frac{13.5}{h} \quad [\text{From (i) and (ii)}]$$

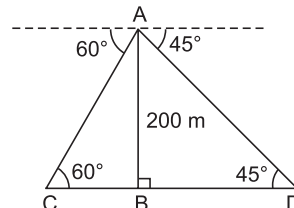
$$h^2 = 13.5 \times 6 = 81.0$$

$$\Rightarrow h = 9 \text{ m} \quad (1)$$

17. In  $\triangle ABD$ ,

$$\frac{AB}{BD} = \tan 45^\circ \Rightarrow \frac{200}{BD} = 1$$

$$\Rightarrow BD = 200 \text{ m} \quad \dots(i) (1)$$



Now, in  $\triangle ABC$

$$\frac{AB}{BC} = \tan 60^\circ \Rightarrow \frac{200}{BC} = \sqrt{3}$$

$$\Rightarrow BC = \frac{200}{\sqrt{3}} \text{ m} \quad \dots(ii) (1)$$

$\therefore$  Distance between the ships

$$= BC + BD = \frac{200}{\sqrt{3}} + 200$$

[From (i) and (ii)]

$$= \frac{200\sqrt{3}}{3} + 200$$

$$= \frac{200 \times 1.73}{3} + 200 = \frac{346}{3} + 200$$

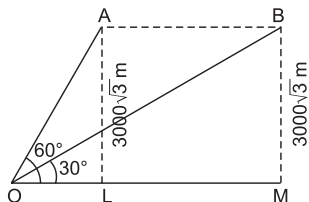
$$= 115.33 + 200 = 315.33 \text{ m} \quad (1)$$

18. In right-angled triangle OLA,

$$\frac{OL}{AL} = \cot 60^\circ$$

$$\Rightarrow OL = 3000\sqrt{3} \times \frac{1}{\sqrt{3}}$$

$$= 3000 \text{ m} \quad \dots(i) (1)$$



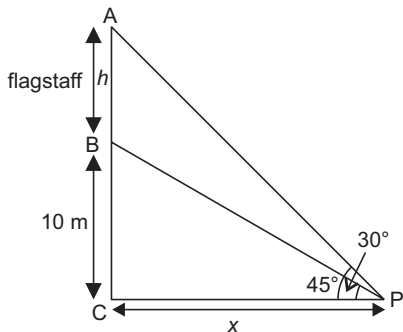
In right-angled triangle OMB,

$$\begin{aligned}\frac{OM}{BM} &= \cot 30^\circ \\ \Rightarrow OM &= 3000\sqrt{3} \times \sqrt{3} = 9000 \text{ m} \quad \dots(ii) \\ \therefore AB &= LM = OM - OL \\ &= (9000 - 3000) \\ &= 6000 \text{ m} \quad (\text{From (i) and (ii)}) \quad (1)\end{aligned}$$

Now, distance covered in 30 s = 6000 m

$$\begin{aligned}\therefore \text{Distance covered in 1 hour (3600 s)} &= \frac{6000}{30} \times \frac{3600}{1000} \text{ km} = 720 \text{ km} \\ \therefore \text{Speed of the aeroplane is } 720 \text{ km/h.} &\quad (1)\end{aligned}$$

19. Let height of flagstaff be  $h$  and the distance of the building from the point P be  $x$ .



$$\begin{aligned}\text{In } \triangle BCP, \quad \frac{BC}{CP} &= \tan 30^\circ = \frac{1}{\sqrt{3}} \Rightarrow \frac{10}{x} = \frac{1}{\sqrt{3}} \\ \Rightarrow x &= 10\sqrt{3} \text{ m} \quad \dots(i) \quad (1)\end{aligned}$$

$$\begin{aligned}\text{In } \triangle ACP, \quad \frac{AC}{PC} &= \tan 45^\circ \Rightarrow \frac{h+10}{x} = 1 \\ \Rightarrow h+10 &= x \\ \Rightarrow h+10 &= 10\sqrt{3} \quad [\text{From (i)}] \quad (1) \\ \Rightarrow h &= 10(\sqrt{3}-1) = 10(1.73-1) \\ &= 10 \times (0.73) = 7.3 \text{ m}\end{aligned}$$

$\therefore$  Height of the flagstaff is 7.3 m.

$$\begin{aligned}\text{The distance of the building from the point P} &= 10\sqrt{3} = 10 \times 1.73 = 17.3 \text{ m} \quad (1)\end{aligned}$$

20. In  $\triangle ADC$ ,

$$\begin{aligned}\tan 60^\circ &= \frac{CD}{AD} \\ \Rightarrow \sqrt{3} &= \frac{CD}{AD}\end{aligned}$$

$$\Rightarrow AD = \frac{CD}{\sqrt{3}} \quad \dots(i) \quad (1)$$

In  $\triangle ADE$ ,

$$\tan 30^\circ = \frac{DE}{AD}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{DE}{AD}$$

$$\Rightarrow AD = DE(\sqrt{3}) \quad \dots(ii) \quad (1)$$

From (i) and (ii), we get

$$\begin{aligned}\frac{CD}{\sqrt{3}} &= DE(\sqrt{3}) \\ \Rightarrow \frac{CD}{\sqrt{3}} &= 7(\sqrt{3}) \quad [\because DE = AB = 7 \text{ m}]\end{aligned}$$

$$\Rightarrow CD = 21 \text{ m}$$

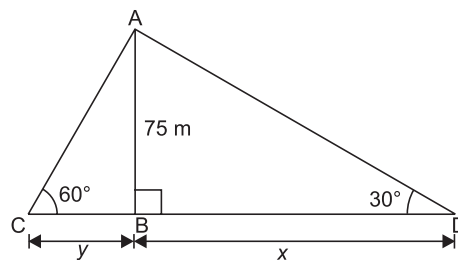
Total height of the cable tower

$$= CD + DE = 21 + 7 = 28 \text{ m} \quad (1)$$

21. 16.39 mins.

22. Let C and D be the positions of two men.

Let  $CB = y$  and  $BD = x$



$$\begin{aligned}\text{In } \triangle ABC, \quad \frac{AB}{BC} &= \tan 60^\circ \Rightarrow \frac{75}{y} = \sqrt{3} \quad (1)\end{aligned}$$

$$\Rightarrow y = \frac{75}{\sqrt{3}} = \frac{75\sqrt{3}}{3} = 25\sqrt{3} \text{ m} \quad (1)$$

Now, in  $\triangle ABD$ ,

$$\tan 30^\circ = \frac{75}{x} \Rightarrow \frac{1}{\sqrt{3}} = \frac{75}{x}$$

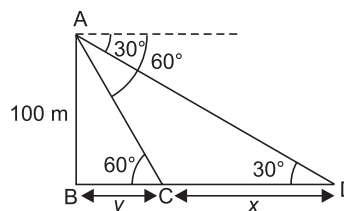
$$\Rightarrow x = 75\sqrt{3}$$

Hence, distance between two men is  $x + y$

$$\begin{aligned}&= 25\sqrt{3} + 75\sqrt{3} = 100\sqrt{3} \\ &= 100 \times 1.732 = 173.20 \text{ m} \quad (1)\end{aligned}$$

23. In  $\triangle ABC$ ,  $\frac{AB}{BC} = \tan 60^\circ$

$$\Rightarrow \frac{100}{y} = \sqrt{3} \Rightarrow y = \frac{100}{\sqrt{3}} \quad \dots(i) \quad (1)$$



In  $\triangle ABD$ ,

$$\frac{AB}{BD} = \tan 30^\circ \Rightarrow \frac{100}{y+x} = \frac{1}{\sqrt{3}}$$

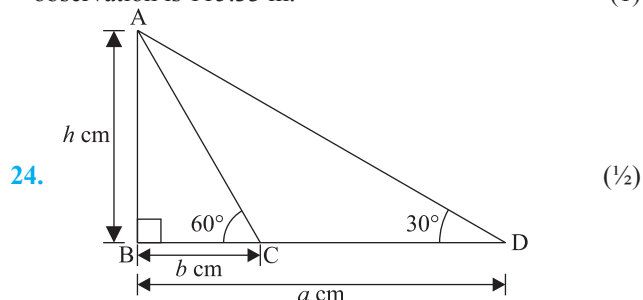
$$\Rightarrow x+y = 100\sqrt{3} \Rightarrow x = 100\sqrt{3} - y$$

$$\Rightarrow x = 100\sqrt{3} - \frac{100}{\sqrt{3}} = \frac{300-100}{\sqrt{3}} = \frac{200}{\sqrt{3}}$$

[From (i)] (1)

$$\Rightarrow x = \frac{200\sqrt{3}}{3} = \frac{200 \times 1.73}{3} = 115.33 \text{ m}$$

The distance travelled by the ship during the period of observation is 115.33 m. (1)



Let AB = candle  
C and D are two coins

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

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

$$h = b\sqrt{3} \quad \dots(i) \quad (\frac{1}{2})$$

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

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

$$h = \frac{a}{\sqrt{3}} \quad \dots(ii) \quad (\frac{1}{2})$$

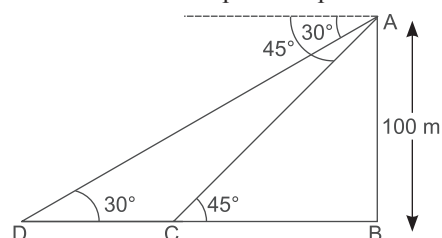
Multiplying (i) and (ii), we get

$$h^2 = b\sqrt{3} \times \frac{a}{\sqrt{3}} \quad (\frac{1}{2})$$

$$h^2 = ba$$

$$h = \sqrt{ab} \text{ m} \quad (\frac{1}{2})$$

25. Let AB be the tower and ships are at points C and D.



$$\tan 45^\circ = \frac{AB}{BC} \quad (1)$$

$$\Rightarrow \frac{AB}{BC} = 1 \Rightarrow AB = BC \quad (1)$$

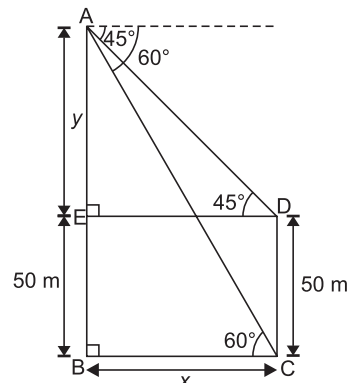
$$\text{Also } \tan 30^\circ = \frac{1}{\sqrt{3}} = \frac{AB}{BC+CD}$$

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{AB+CD} \quad (1)$$

$$\Rightarrow AB+CD = \sqrt{3} AB \quad (1)$$

$$\Rightarrow CD = AB(\sqrt{3}-1) = 100 \times (1.732-1) = 73.2 \text{ m} \quad (1)$$

26. In  $\triangle AED$ ,  $\frac{y}{x} = \tan 45^\circ \Rightarrow \frac{y}{x} = 1$



$$\Rightarrow y = x \quad \dots(i) \quad (1)$$

In  $\triangle ABC$ ,  $\frac{AB}{BC} = \tan 60^\circ$

$$\Rightarrow \frac{AE+EB}{BC} = \sqrt{3} \Rightarrow \frac{y+50}{x} = \sqrt{3}$$

$$\Rightarrow x+50 = \sqrt{3}x \quad [\because y=x, \text{ using (i)}] \quad (1)$$

$$\Rightarrow \sqrt{3}x - x = 50 \Rightarrow (\sqrt{3}-1)x = 50$$

$$x = \frac{50}{\sqrt{3}-1} = \frac{50(\sqrt{3}+1)}{(\sqrt{3}-1)(\sqrt{3}+1)} = \frac{50(1.732+1)}{2} \quad (1)$$

$$x = 68.49 \text{ m} \quad (1)$$

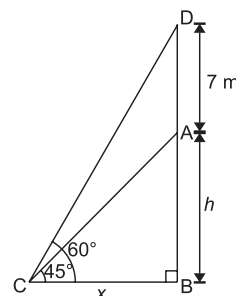
$$\text{Height of the tower} = 50 + y = 50 + 68.49 \quad (\because x=y)$$

$$= 118.49 \text{ m}$$

$$\text{Horizontal distance between the tower and the building} = x = 68.49 \text{ m.} \quad (1)$$

27. In  $\triangle ABC$ ,  $\frac{AB}{BC} = \tan 45^\circ$

$$\frac{h}{x} = 1 \Rightarrow h = x \quad \dots(i) \quad (1)$$



Now, in  $\triangle BDC$ ,

$$\frac{DB}{BC} = \tan 60^\circ \Rightarrow \frac{h+7}{x} = \sqrt{3} \quad (1)$$

$$\Rightarrow h + 7 = \sqrt{3}h \quad [\because h = x, \text{ using (i)}] \quad (1)$$

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

$$= \frac{7(\sqrt{3} + 1)}{(\sqrt{3} - 1)(\sqrt{3} + 1)} \quad (1)$$

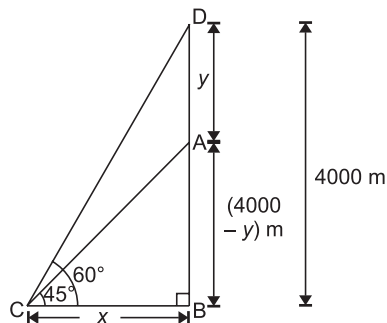
$$= \frac{7(1.732 + 1)}{2} = \frac{7 \times 2.732}{2}$$

$$= 9.5 \text{ m}$$

So, height of the tower is 9.5 m. (1)

28. In  $\triangle ABC$ ,  $\frac{AB}{BC} = \tan 45^\circ \Rightarrow \frac{4000 - y}{x} = 1$

$$\Rightarrow x = (4000 - y) \text{ m} \quad \dots(i) \quad (1)$$



Now, in  $\triangle DBC$

$$\frac{DB}{BC} = \tan 60^\circ \Rightarrow \frac{4000}{x} = \sqrt{3} \quad (1)$$

$$x = \frac{4000}{\sqrt{3}} \quad \dots(ii) \quad (1)$$

From (i) and (ii),

$$4000 - y = \frac{4000}{\sqrt{3}} \Rightarrow y = 4000 - \frac{4000}{\sqrt{3}} \quad (1)$$

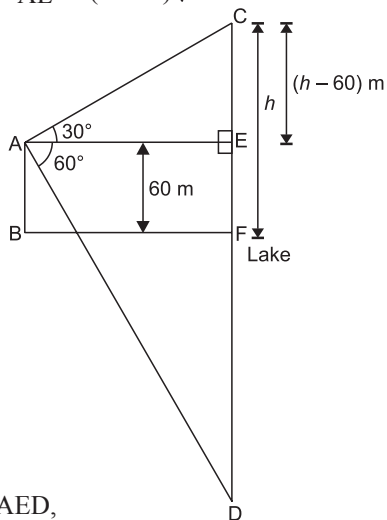
$$\Rightarrow y = 4000 - 2312.14 = 1687.86 \text{ m}$$

So, distance between the aeroplanes is 1687.86 m. (1)

29. In right  $\triangle AEC$ ,

$$\frac{AE}{EC} = \cot 30^\circ$$

$$\Rightarrow AE = (h - 60)\sqrt{3} \quad \dots(i) \quad (1)$$



In right  $\triangle AED$ ,

$$\frac{AE}{ED} = \cot 60^\circ$$

$$\Rightarrow AE = \frac{h + 60}{\sqrt{3}} \quad \dots(ii) \quad (1)$$

From (i) and (ii), we get

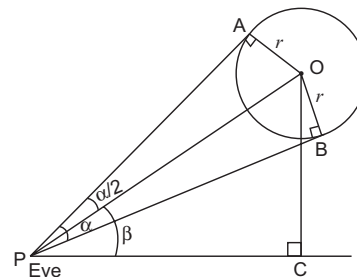
$$(h - 60)\sqrt{3} = \frac{h + 60}{\sqrt{3}} \quad (1)$$

$$\Rightarrow 3h - 180 = h + 60 \quad (1)$$

$$\Rightarrow 2h = 240 \Rightarrow h = 120 \text{ m}$$

$\therefore$  Height of the cloud above the lake is 120 m. (1)

30. According to the given statement, the diagram will be as shown:



In the diagram, O is the centre of the balloon, P is the eye of the observer. If PA and PB are tangents, angle APB =  $\alpha$  and  $\angle APO = \angle BPO = \frac{\alpha}{2}$ . (1)

$$\angle APO = \angle BPO = \frac{\alpha}{2} \quad (1)$$

Since the angle of elevation of the centre is  $\beta$

$$\Rightarrow \angle OPC = \beta$$

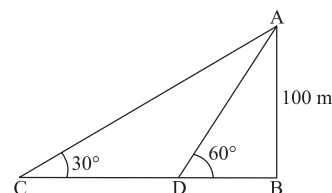
$$\text{Required to prove: } OC = r \sin \beta \operatorname{cosec} \frac{\alpha}{2} \quad (1)$$

$$\text{In } \triangle OAP, \operatorname{cosec} \frac{\alpha}{2} = \frac{OP}{OA} \Rightarrow OP = r \operatorname{cosec} \frac{\alpha}{2} \quad (\because OA = r) \quad (1)$$

$$\text{In } \triangle OPC, \sin \beta = \frac{OC}{OP} \Rightarrow OC = OP \sin \beta$$

$$\text{i.e., } OC = r \operatorname{cosec} \frac{\alpha}{2} \sin \beta = r \sin \beta \operatorname{cosec} \frac{\alpha}{2} \quad (1)$$

31. Let BD = x m and CD = y m



$$AB = 100 \text{ m}$$

In triangle ABD,

$$\tan 60^\circ = \frac{100}{x}$$

$$\Rightarrow \sqrt{3} = \frac{100}{x} \Rightarrow x = \frac{100}{\sqrt{3}} \quad (1)$$

In triangle ABC,

$$\tan 30^\circ = \frac{AB}{x + y} \Rightarrow \frac{1}{\sqrt{3}} = \frac{100}{x + y}$$

$$\Rightarrow x + y = 100\sqrt{3} \quad (1)$$

$$\Rightarrow y = 100\sqrt{3} - x = 100\sqrt{3} - \frac{100}{\sqrt{3}}$$

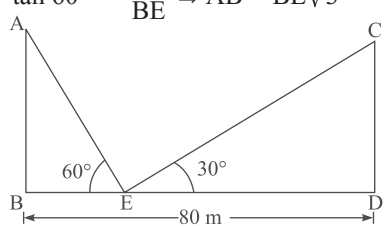
$$\Rightarrow y = \frac{200}{\sqrt{3}} \quad (1)$$

$$\begin{aligned}\text{Now, speed} &= \frac{\text{Distance}}{\text{Time}} = \frac{\frac{200}{\sqrt{3}}}{2} \\ &= \frac{200}{2\sqrt{3}} = \frac{100}{\sqrt{3}} = \frac{100\sqrt{3}}{3} \\ \Rightarrow \text{speed of boat} &= \frac{100 \times 1.732}{3} = \frac{173.2}{3} \\ &= 57.7 \text{ m/min}\end{aligned}\quad (1)$$

32. Let AB and CD be the two poles of equal height standing on the opposite sides of the road BD.

$$\therefore AB = CD$$

From figure in right  $\triangle ABE$

$$\tan 60^\circ = \frac{AB}{BE} \Rightarrow AB = BE\sqrt{3} \quad \dots(i) \quad (1)$$


Also, in right  $\triangle CDE$ ,

$$\begin{aligned}\tan 30^\circ &= \frac{CD}{ED} \Rightarrow \frac{AB}{80 - BE} = \frac{1}{\sqrt{3}} \\ \Rightarrow AB &= \frac{80 - BE}{\sqrt{3}} \\ BE &= 80 - \sqrt{3} AB \quad \dots(ii) \quad (1)\end{aligned}$$

Using (ii) in (i),

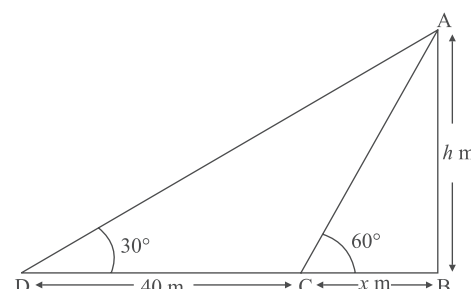
$$\begin{aligned}AB &= (80 - \sqrt{3} AB) \sqrt{3} \\ &= 80\sqrt{3} - 3 AB \\ \Rightarrow 4 AB &= 80\sqrt{3} \Rightarrow AB = 20\sqrt{3} \text{ m} \\ \therefore \text{Height of poles} &= 20\sqrt{3} \text{ m}\end{aligned}\quad (1)$$

$$\begin{aligned}\text{Now, } BE &= 80 - \sqrt{3} AB \\ &= 80 - \sqrt{3} \times 20\sqrt{3} \\ &= 80 - 60 = 20 \text{ m}\end{aligned}$$

$$ED = 80 - BE = 80 - 20 = 60 \text{ m}$$

- $\therefore$  Point E is 20 m and 60 m away from both the poles. (1)

33. Let AB be a tower of height  $h$  m, and BC its shadow when sun's altitude is  $60^\circ$  and BD also its shadow when sun's altitude is  $30^\circ$ .



$$\begin{aligned}\text{Let } BC &= x \text{ m} \\ \text{Then, } BD &= (x + 40) \text{ m} \quad [\because CD = 40 \text{ m, given}] \\ \text{In right } \triangle ABC, &\end{aligned}\quad (1)$$

$$\text{Let } BC = x \text{ m}$$

$$\text{Then, } BD = (x + 40) \text{ m} \quad [\because CD = 40 \text{ m, given}]$$

In right  $\triangle ABC$ ,

$$\begin{aligned}\tan 60^\circ &= \frac{AB}{BC} \Rightarrow \sqrt{3} = \frac{h}{x} \\ \Rightarrow h &= x\sqrt{3} \quad \dots(i) \quad (1)\end{aligned}$$

In right  $\triangle ABD$ ,

$$\tan 30^\circ = \frac{AB}{BD} \Rightarrow \frac{1}{\sqrt{3}} = \frac{h}{x + 40} \quad \dots(ii) \quad (1)$$

Using (i) in (ii), we get

$$\begin{aligned}\frac{1}{\sqrt{3}} &= \frac{x\sqrt{3}}{x + 40} \Rightarrow (x\sqrt{3})\sqrt{3} = x + 40 \\ \Rightarrow 3x - x &= 40 \\ \Rightarrow 2x &= 40 \Rightarrow x = 20\end{aligned}\quad (1)$$

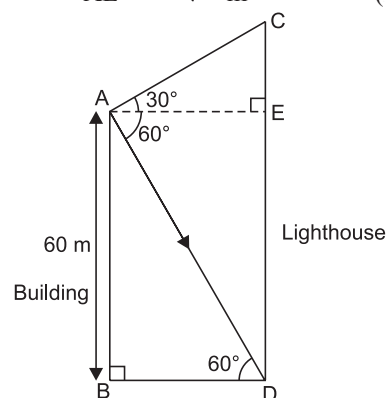
$$\text{So, } h = 20\sqrt{3} \quad [\text{From (i)}]$$

$$\Rightarrow h = 20 \times 1.732 \Rightarrow h = 34.64$$

Therefore, the height of the tower is 34.64 m. (1)

34. In right  $\triangle ABD$ ,

$$\begin{aligned}\frac{BD}{AB} &= \cot 60^\circ \Rightarrow \frac{BD}{60} = \frac{1}{\sqrt{3}} \\ \Rightarrow BD &= \frac{60}{\sqrt{3}} = \frac{60}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 20\sqrt{3} \text{ m} \\ \therefore AE &= 20\sqrt{3} \text{ m} \quad (\because BD = AE) \quad (1)\end{aligned}$$



Now, in right  $\triangle CEA$ ,

$$\begin{aligned}\tan 30^\circ &= \frac{CE}{AE} \\ \Rightarrow \frac{1}{\sqrt{3}} &= \frac{CE}{20\sqrt{3}} \Rightarrow CE = 20 \text{ m}\end{aligned}\quad (1)$$

(i) Difference between the heights of the lighthouse and the building =  $CE = 20$  m

(ii) The distance between the lighthouse and the building =  $BD = 20\sqrt{3}$  m. (1)

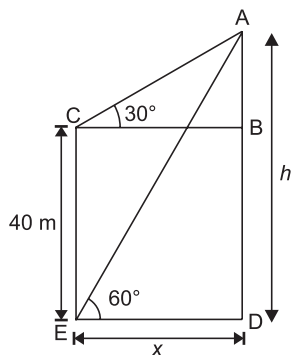
35. Let  $h$  be the height of the tower and  $x$  be the horizontal distance from the point of observation.

$$\therefore CB = ED = x \text{ and } CE = BD = 40 \text{ m}$$

In right  $\triangle ABC$ ,

$$\tan 30^\circ = \frac{AB}{BC} \Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{x}$$

$$\Rightarrow x = AB\sqrt{3} \quad \dots(i) (1)$$



Now, in right  $\triangle AED$

$$\tan 60^\circ = \frac{AD}{DE}$$

$$\Rightarrow \sqrt{3} = \frac{h}{x} \Rightarrow x = \frac{h}{\sqrt{3}} \quad \dots(ii)(1)$$

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

$$AB\sqrt{3} = \frac{h}{\sqrt{3}} \Rightarrow \sqrt{3}(h-40) = \frac{h}{\sqrt{3}} \\ [\because AB + 40 = h \Rightarrow AB = h - 40]$$

$$3(h-40) = h \\ \Rightarrow 2h = 120 \Rightarrow h = 60 \text{ m} \quad (1)$$

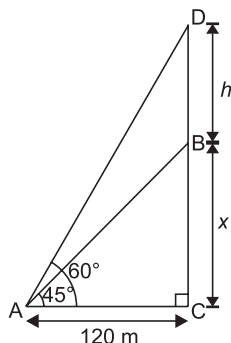
$$\text{From (ii), } x = \frac{60}{\sqrt{3}} = 20\sqrt{3}$$

$$\Rightarrow x = 34.641 \text{ m} \quad (1)$$

36. 2165 m

39. Let  $BC = x$  be the tower and  $BD$  be the flagstaff of height  $h$ .

$AC = 120 \text{ m}$ ,  $\angle BAC = 45^\circ$  and  $\angle DAC = 60^\circ$



In right-angled triangle  $ACB$ ,

$$\frac{AC}{BC} = \cot 45^\circ \Rightarrow \frac{120}{x} = 1$$

$$\Rightarrow x = 120 \quad \dots(i) (1)$$

In right-angled triangle  $ACD$ ,

$$\frac{CD}{AC} = \tan 60^\circ \Rightarrow \frac{h+x}{120} = \sqrt{3}$$

$$\Rightarrow h+x = 120\sqrt{3} \quad (1)$$

$$\Rightarrow h = 120\sqrt{3} - 120 \quad [\text{using (i) } x = 120]$$

$$\Rightarrow h = 120[\sqrt{3} - 1] \quad (1)$$

$$\Rightarrow h = 120[1.73 - 1] \text{ m}$$

$$\Rightarrow h = 120 \times 0.73 = 87.6 \text{ m}$$

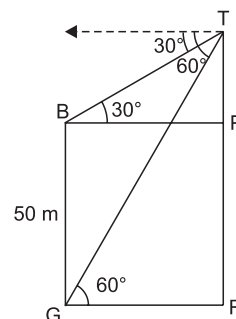
$\therefore$  Height of the flagstaff is 87.6 m. (1)

40. 1.366 km

41. In right  $\triangle BTP$ ,

$$\Rightarrow \tan 30^\circ = \frac{TP}{BP} \Rightarrow \frac{1}{\sqrt{3}} = \frac{TP}{BP}$$

$$BP = TP\sqrt{3} \quad \dots(ii) (1)$$



In right  $\triangle GRT$ ,

$$\tan 60^\circ = \frac{TR}{GR} \Rightarrow \sqrt{3} = \frac{TR}{GR}$$

$$\Rightarrow GR = \frac{TR}{\sqrt{3}} \quad \dots(ii) (1)$$

$$\text{Now, } TP\sqrt{3} = \frac{TR}{\sqrt{3}} \quad (\because BP = GR)$$

$$\Rightarrow 3TP = TP + PR \Rightarrow 2TP = BG$$

$$\Rightarrow TP = \frac{50}{2} \text{ m} = 25 \text{ m} \quad (1)$$

$$\text{Now, } TR = TP + PR = (25 + 50) \text{ m}$$

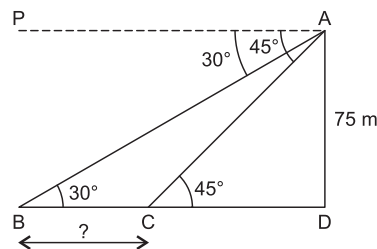
Height of tower =  $TR = 75 \text{ m}$

Distance between building and tower

$$= GR = \frac{TR}{\sqrt{3}}$$

$$\Rightarrow GR = \frac{75}{\sqrt{3}} \text{ m} = 25\sqrt{3} \text{ m} \quad (1)$$

42.



In right  $\triangle ADC$ ,

$$\tan 45^\circ = \frac{75}{CD} \Rightarrow 1 = \frac{75}{CD}$$

$$\Rightarrow CD = 75 \quad (1\frac{1}{2})$$



In right  $\triangle ADB$ ,

$$\tan 30^\circ = \frac{75}{BD} \Rightarrow \frac{1}{\sqrt{3}} = \frac{75}{BD}$$

$$\Rightarrow BD = 75\sqrt{3} \quad (1\frac{1}{2})$$

$$\Rightarrow \text{Distance between two ships} \\ = BC = 75(\sqrt{3} - 1) \text{ m} = 54.9 \text{ m} \quad (1)$$

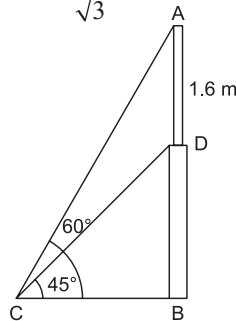
43. Let AD be 1.6 m tall statue, BD the pedestal and C the point of observation such that  $\angle ACB = 60^\circ$  and  $\angle DCB = 45^\circ$

In right  $\triangle ABC$ ,

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

$$\Rightarrow \sqrt{3} = \frac{AD + BD}{BC} = \frac{1.6 + BD}{BC}$$

$$\Rightarrow BC = \frac{1.6 + BD}{\sqrt{3}} \quad \dots(i) \quad (1)$$



In right  $\triangle DCB$ ,

$$\tan 45^\circ = \frac{BD}{BC} \Rightarrow 1 = \frac{BD}{BC}$$

$$\Rightarrow BC = BD \quad \dots(ii) \quad (1)$$

From (i) and (ii),

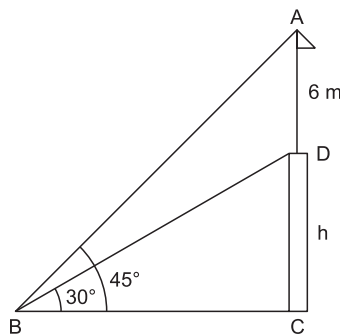
$$\frac{1.6 + BD}{\sqrt{3}} = BD$$

$$\Rightarrow 1.6 + BD = \sqrt{3} BD \quad (1)$$

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

$$\Rightarrow BD = \frac{1.6}{\sqrt{3} - 1} \times \frac{\sqrt{3} + 1}{\sqrt{3} + 1} \\ = \frac{1.6(1.732 + 1)}{2} = 0.8 \times 2.732 \\ = 2.1856 \approx 2.19 \text{ m} \quad (1)$$

44. Let AD be a flagstaff of height 6 m, CD = h be the tower and B be the point of observation.



In right  $\triangle ABC$ ,

$$\tan 45^\circ = \frac{AC}{BC} \Rightarrow 1 = \frac{AD + CD}{BC}$$

$$\Rightarrow BC = 6 + h \quad \dots(i) \quad (1)$$

In right  $\triangle BCD$ ,

$$\tan 30^\circ = \frac{CD}{BC} \Rightarrow \frac{1}{\sqrt{3}} = \frac{h}{BC}$$

$$\Rightarrow BC = h\sqrt{3} \quad \dots(ii) \quad (1)$$

From equations (i) and (ii)

$$6 + h = h\sqrt{3} \Rightarrow h\sqrt{3} - h = 6$$

$$\Rightarrow h(\sqrt{3} - 1) = 6 \Rightarrow h = \frac{6}{\sqrt{3} - 1}$$

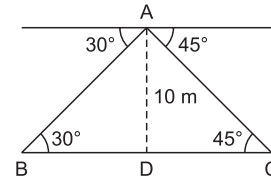
$$\Rightarrow h = \frac{6(\sqrt{3} + 1)}{3 - 1} = 3(1.732 + 1) \quad (1)$$

$$\Rightarrow h = 3 \times 2.732 \Rightarrow h = 8.196$$

$$\Rightarrow h = 8.2 \text{ m} \quad (1)$$

$$45. 14.64 \text{ m} \quad (5)$$

46. Let BC be the river and AD = 10 m be the height of bridge,



In right  $\triangle ABD$ ,

$$\tan 30^\circ = \frac{AD}{BD} \Rightarrow \frac{1}{\sqrt{3}} = \frac{10}{BD}$$

$$\Rightarrow BD = 10\sqrt{3} \text{ m} \quad \dots(i) \quad (1)$$

In right  $\triangle ADC$ ,

$$\tan 45^\circ = \frac{AD}{CD} \Rightarrow 1 = \frac{10}{CD}$$

$$\Rightarrow CD = 10 \text{ m} \quad \dots(ii) \quad (1)$$

From (i) and (ii),

$$BC = BD + CD = 10\sqrt{3} + 10 \quad (1)$$

$$= 10 \times 1.732 + 10 \\ = 17.32 + 10 = 27.32 \text{ m}$$

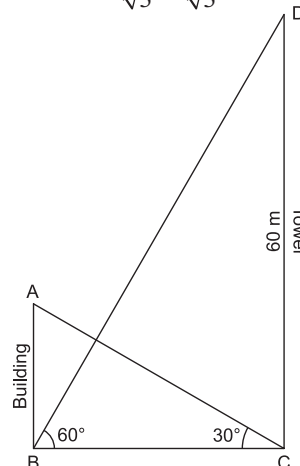
$$\text{So, the width of the river is } 27.32 \text{ m.} \quad (1)$$

47. Let AB be the building and CD be the tower of height 60 m.

In right  $\triangle BCD$ ,

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

$$BC = \frac{60}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 20\sqrt{3} \text{ m} \quad \dots(i) \quad (1)$$



In right  $\triangle ABC$ ,

$$(1)$$

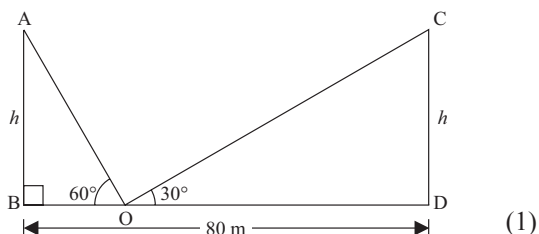
$$\tan 30^\circ = \frac{AB}{BC} \Rightarrow \frac{1}{\sqrt{3}} = \frac{AB}{BC} \quad (1)$$

$$\Rightarrow AB = \frac{BC}{\sqrt{3}} = \frac{20\sqrt{3}}{\sqrt{3}} \quad [\text{From (i)}] \quad (1)$$

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

So, the height of building = 20 m (1)

48.



Let BD = river (1/2)

$$AB = CD = \text{palm trees} = h$$

$$BO = x \quad (1/2)$$

$$OD = 80 - x$$

In  $\triangle ABO$ ,  $\tan 60^\circ = \frac{h}{x} \quad (1/2)$

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

$$h = \sqrt{3}x \quad \dots(i) \quad (1/2)$$

In  $\triangle CDO$ ,  $\tan 30^\circ = \frac{h}{(80 - x)}$

$$\frac{1}{\sqrt{3}} = \frac{h}{(80 - x)} \quad \dots(ii) \quad (1/2)$$

Solving (i) and (ii), we get  
 $x = 20$

$$h = \sqrt{3}x = 34.6 \quad (1/2)$$

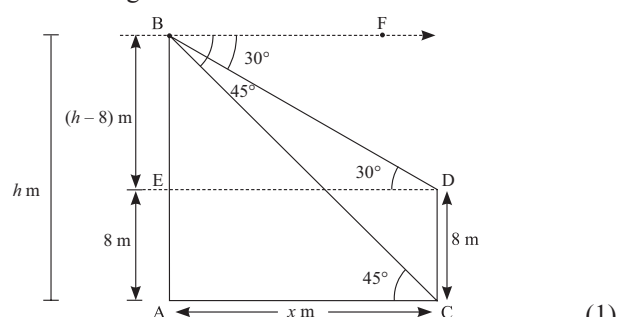
The height of the trees =  $h = 34.6 \text{ m}$

$$BO = x = 20 \text{ m} \quad (1/2)$$

$$DO = 80 - x$$

$$= 80 - 20 = 60 \text{ m} \quad (1/2)$$

49. Let AB be the multi-storied building of height  $h \text{ m}$  and CD the building at a distance  $x \text{ m}$ .



$$AE = CD = 8 \text{ m} \quad [\text{Given}] \quad (1)$$

$$BE = AB - AE = (h - 8) \text{ m}$$

and  $AC = DE = x \text{ m} \quad [\text{Given}]$

Also,  $\angle FBD = \angle BDE = 30^\circ$  (Alternate angles)

$$\angle FBC = \angle BCA = 45^\circ \quad (\text{Alternate angles}) \quad (1/2)$$

Now,

In right  $\triangle ACB$ ,

$$\Rightarrow \tan 45^\circ = \frac{AB}{AC} \quad \left[ \because \tan \theta = \frac{\text{Perpendicular}}{\text{Base}} \right]$$

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

$$\Rightarrow x = h \quad \dots(i) \quad (1)$$

In right  $\triangle BDE$ ,

$$\Rightarrow \tan 30^\circ = \frac{BE}{ED}$$

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

$$\Rightarrow x = \sqrt{3}(h - 8) \quad \dots(ii) \quad (1)$$

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

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

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

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

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

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

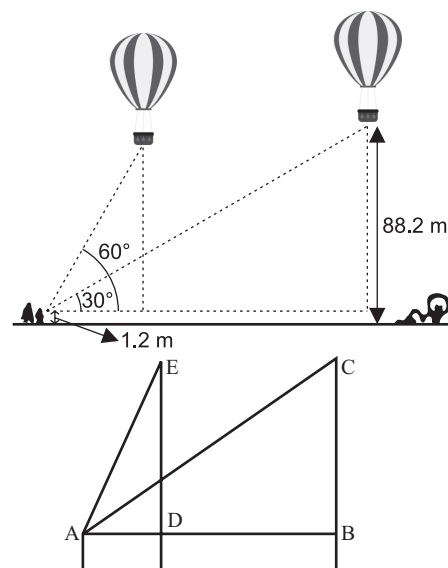
$$h = 4\sqrt{3}(\sqrt{3} + 1)$$

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

Distance between the two building

$$x = (12 + 4\sqrt{3}) \text{ m} \quad [\text{From (i)}] \quad (1/2)$$

50.



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

$$ED = CB = 88.2 - 1.2 = 87 \text{ m}. \quad (1)$$

Let  $AD = x \text{ m}$  and  $AB = y \text{ m}$

Then in right  $\triangle ADE$ ,  $\tan 60^\circ = \frac{DE}{AD}$

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

$$\therefore x = \frac{87}{\sqrt{3}} \quad \dots (i) (1)$$

In right  $\triangle ABC$ ,  $\tan 30^\circ = \frac{BC}{AB}$

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

$$\therefore y = 87\sqrt{3} \quad \dots(ii) (1)$$

Subtracting (i) from (ii), we get

$$y - x = 87\sqrt{3} - \frac{87}{\sqrt{3}} \quad (1)$$

$$\Rightarrow y - x = \frac{87\sqrt{3} \times \sqrt{3} - 87}{\sqrt{3}} = \frac{87 \times 2}{\sqrt{3}}$$

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

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

Hence, the distance travelled by the balloon

$$= BD = y - x$$

$$= 58\sqrt{3} \text{ m} \quad (1)$$

### Case Study Based Questions

I. 1. (b)  $\frac{9\sqrt{3}}{5}$  m      2. (c) 1.56 m

3. (d) 5.3 m      4. (c) 4 m

5. (a)  $30^\circ$

II. 1. (b)  $45^\circ$       2. (d) 24.25 m

3. (a)  $20\sqrt{3}$  m      4. (b)  $45^\circ$

5. (c) angle of depression

III. 1. (a) 1118.29 km      2. (c) 1937 km

3. (b) 566.96 km      4. (b)  $45^\circ$

5. (c) 1937 km

