Some Applications of Trigonometry

Case Study Based Questions

Case Study 1

There is fire incident in the house. The house door is locked so, the fireman is trying to enter the house from the window. He places the ladder against the wall such that its top reaches the window as shown in the figure.

Based on the above information, solve the following questions:

Q1. If window is 6 m above the ground and angle made by the foot of ladder to the ground is 30°, then length of the ladder is:

a. 8 m

b. 10 m

c. 12 m

d. 14 m

Q2. If fireman place the ladder 5 m away from the wall and angle of elevation is observed to be 30°, then length of the ladder is:

a. 5 m   b. $\frac{10}{\sqrt{3}}$ m   c. $\frac{15}{\sqrt{2}}$ m   d. 20 m

Q3. If fireman places the ladder 2.5 m away from the wall and angle of elevation is observed to be 60°, then find the height of the window: (Take √3 = 1.73)

a. 4.325 m

b. 5.5 m

c. 6.3 m

d. 2.5 m

Q4. If the height of the window is 8 m above the ground and angle of elevation is observed to be 45°, then horizontal distance between the foot of ladder and wall is:

a. 2 m

b. 4 m

c. 6 m

d. 8 m

Q5. If the fireman gets a 9 m long ladder and window is at 6 m height, then how far should the ladder be placed?

a. 5 m

b. $3\sqrt{5}$m

c. 3m

d. 4 m

Solutions

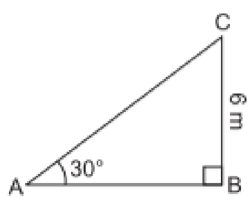
1. Let AC be the length of the ladder

In right-angled ΔABC,

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

$$\Rightarrow \quad \frac{1}{2} = \frac{6}{AC} \quad \Rightarrow AC = 12 \text{ m}$$

So, option (c) is correct.

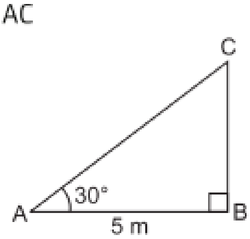


2. In right-angled ΔABC, $\cos 30^\circ = \frac{AB}{AC}$

$$\Rightarrow \quad \frac{\sqrt{3}}{2} = \frac{5}{AC}$$

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

So, option (b) is correct.



3. Let BC be the height of window from ground.

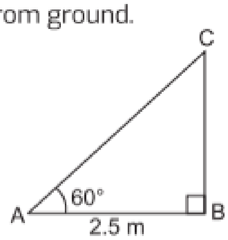
In right-angled ΔABC,

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

$$\Rightarrow \quad \sqrt{3} = \frac{BC}{2.5}$$

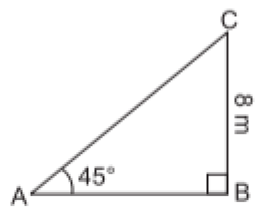
$$\Rightarrow \quad BC = 2.5 \times 1.73 = 4.325 \text{ m}$$

So, option (a) is correct.



4. Let AB be the horizontal distance between the foot of ladder and wall.

In right-angled ΔABC,



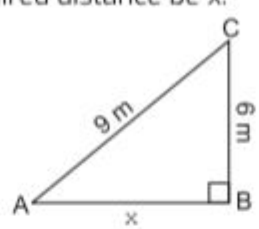
$$\tan 45^\circ = \frac{BC}{AB}$$

$$\Rightarrow \quad 1 = \frac{8}{AB}$$

$$\Rightarrow \quad AB = 8 \text{ m}$$

So, option (d) is correct.

5. Let the required distance be x.



In right-angled ΔABC,

$$(9)^2 = x^2 + (6)^2$$

[By Phthagoras theorem]

$$\Rightarrow \quad 81 - 36 = x^2$$

$$\Rightarrow \quad 45 = x^2$$

$$\Rightarrow \quad x = 3\sqrt{5} \text{ m}$$

So, option (b) is correct.

Case Study 2

A group of students of class-X visited India Gate on an education trip. The teacher and students had interest in history as well. The teacher narrated that India Gate, official name is Delhi Memorial, originally called All-India War Memorial, Monumental Sandstone Arch in New Delhi is 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.

Based on the given information, solve the following questions:

Q1. What is the angle of elevation, if they are standing at a distance of $42\sqrt{3}$ m away from the monument?

a. 0°

b. 30°

c. 45°

d. 60°

Q2. They want to see the tower (monument) at an angle of 60°. So, they want to know the distance where they should stand and hence find the distance. [Use $\sqrt{3} = 1.732$]

a. 24.24 m

b. 20.12 m

c. 42 m

d. 25.64 m

Q3. If the altitude of the Sun is at 30°, then the height of the vertical tower that will cast a shadow of Length 30 m is:

a. $10\sqrt{3}$ m b. $\frac{10}{\sqrt{3}}$ m c. $\frac{20}{\sqrt{3}}$ m d. $20\sqrt{3}$ m

Q4. The ratio of the length of a rod and its shadow is $24:8\sqrt{3}$. The angle of elevation of the Sun is:

a. 30°

b. 60°

c. 45°

d. 90°

Q5. The angle formed by the line of sight with the horizontal when the object viewed is above the horizontal level, is:
a. angle of elevation
b. angle of depression
c. corresponding angle
d. complete angle

Solutions

1. Let the angle of elevation be 0. Given that,
Height of the monument (BC) = 42 m

and $AB = 42\sqrt{3}$ m

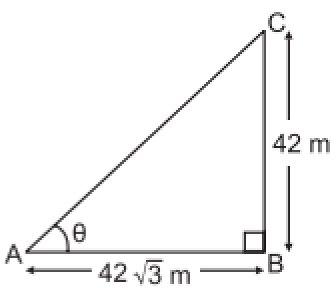
Now, in right-angled ΔABC,

$$\tan\theta = \frac{BC}{AB} = \frac{42}{42\sqrt{3}}$$

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

$$\therefore \quad \theta = 30^\circ$$

So, option (b) is correct.



2. Let the required distance be x m.
Given, angle of elevation (0) = 60°
and height of the monument (BC) = 42 m

Now, in right-angled ΔABC,

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

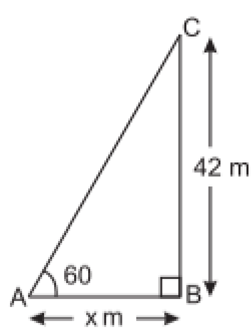
$$\Rightarrow \quad \tan 60^\circ = \frac{42}{x}$$

$$\Rightarrow \quad \sqrt{3} = \frac{42}{x}$$

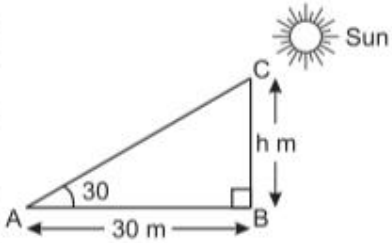
$$\Rightarrow \quad x = \frac{42}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{42\sqrt{3}}{3} = 14\sqrt{3}$$

$$= 14 \times 1.732 = 24.24 \text{ m}$$

So, option (a) is correct.



3. Let the height of the vertical tower be h m.
Given angle of elevation $(\theta) = 30°$ and length of the shadow (AB) = 30 m
Now, In right-angled ΔABC,



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

$$\Rightarrow \quad \tan 30° = \frac{h}{30}$$

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

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

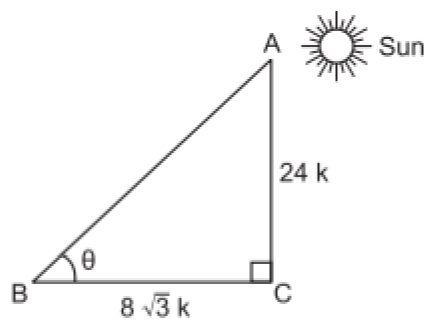
So, option (a) is correct.

4. Given, the ratio of the length of a rod and its shadow is 24:8√3.

Let $AC = 24k$

and $BC = 8\sqrt{3}k$

where k is a positive integer.
Now, let angle of elevation of the Sun is θ.
In right-angled ΔACB;



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

$$= \frac{24k}{8\sqrt{3}k} = \frac{3}{\sqrt{3}}$$

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

$$\Rightarrow \quad \tan\theta = \tan 60°$$

$$\therefore \quad \theta = 60°$$

So, option (b) is correct.

5. The angle formed by the line of sight with the horizontal, when the object viewed is above the horizontal level, is angle of elevation. So, option (a) is correct.

Case Study 3

Suppose a straight vertical tree is broken at some point due to storm and the broken part is inclined at a certain distance from the foot of the tree.

Based on the above information, solve the following questions:

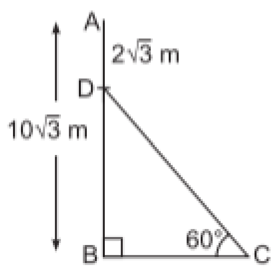
Q1. If the top of upper part of broken tree touches ground at a distance of 30 m (from the foot of the tree) and makes an angle of inclination 30°, then find the height of remaining part of the tree.

Q2. Find the height of the straight vertical tree.

Q3. If the height of a tree is 6 m, which is broken by wind in such a way that its top touches the ground and makes an angle 30° with the ground. Find the length of broken part of the tree.

OR

If AB = 10√√3 m and AD = 2√3 m, then find CD.



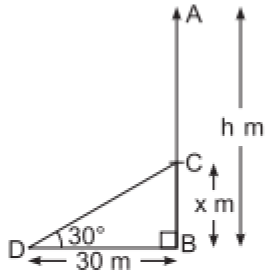
Solutions

1. Let AB be the tree of height h m and let it broken at height of x m, as shown in figure.
Clearly CD = AC = (h-x) m
Now, in right-angled ΔCBD, we have

$$\tan 30^\circ = \frac{BC}{BD} = \frac{x}{30}$$

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

$$\Rightarrow \quad x = \frac{30}{\sqrt{3}}$$



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

Thus, the height of remaining part of the tree is 10√3m.

2. In right-angled ACBD,

$$\cos 30^\circ = \frac{DB}{DC} = \frac{30}{DC}$$

$$\Rightarrow \quad \frac{\sqrt{3}}{2} = \frac{30}{DC}$$

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

$$\Rightarrow \quad DC = 20\sqrt{3}\text{m}$$

from part (1), BC = x = 10√3m

Thus, the height of the straight vertical tree

AB = DC + BC

=20√3+10√3 = 30√3m

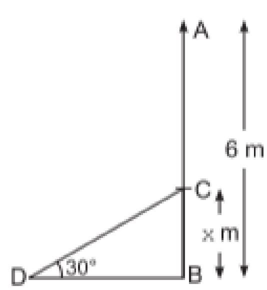
3. Here, h=6 m and 0-30°

:- DC = AC = (6x) m

Now, in right-angled ABCD, we have

$$\sin 30^\circ = \frac{BC}{CD}$$

$$\Rightarrow \quad \frac{1}{2} = \frac{x}{6-x}$$



$$\Rightarrow \quad 6 - x = 2x \quad \Rightarrow \quad 3x = 6 \quad \Rightarrow \quad x = 2$$

So, broken part of tree, $AC = 6 - x = 6 - 2 = 4$ m.

Or

Clearly, $BD = AB - AD$

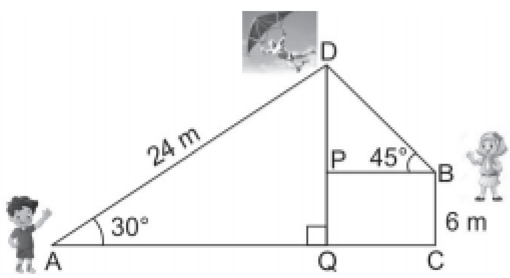
$$= (10\sqrt{3} - 2\sqrt{3})\text{ m} = 8\sqrt{3}\text{ m}$$

Now, in right-angled ΔBCD, we have

$$\sin 60° = \frac{BD}{DC} \Rightarrow \frac{\sqrt{3}}{2} = \frac{8\sqrt{3}}{DC} \Rightarrow DC = 16\text{ m}$$

Case Study 4

Sandeep and his sister Dolly visited at their uncle's place-Birth, Himachal Pradesh. During day time Sandeep, who is standing on the ground spots a paraglider at a distance of 24 m from him at an elevation of 30°. His sister Dolly is also standing on the roof of a 6 m high building, observes the elevation of the same paraglider as 45°. Sandeep and Dolly are on the opposite sides of the paraglider.



Based on the given information, solve the following questions:

Q1. Find the distance of paraglider from the ground.

Q2. Find the value of PD.

Q3. Find the distance between the paraglider and the Dolly.

Or

Find the distance between Sandeep and base of the building.

Solutions

1. In the right–angled ΔAQD, we have

$$\sin 30° = \frac{DQ}{AD} \Rightarrow \frac{1}{2} = \frac{DQ}{24}$$

$\Rightarrow \quad DQ = 12$ m

Thus, distance of paraglider from the ground is 12 m.

2. We have PQ = BC = 6 m

Now, as DQ = 12 m

$\therefore \quad DP = DQ - PQ = 12 - 6 = 6$ m

3. In right–angled ΔBPD, we have

$$\sin 45° = \frac{DP}{BD} \Rightarrow \frac{1}{\sqrt{2}} = \frac{6}{BD} \quad \Rightarrow \quad BD = 6\sqrt{2} \text{ m}$$

Thus, the distance of paraglider from the girl is $6\sqrt{2}$ m.

Or

In right-angled ΔAQD, we have

$$\cos 30° = \frac{AQ}{AD}$$

$$\Rightarrow \quad \frac{\sqrt{3}}{2} = \frac{AQ}{24} \Rightarrow AQ = 12\sqrt{3} \text{ m}$$

In right-angled ΔBPD, we have

$$\cos 45° = \frac{BP}{BD}$$

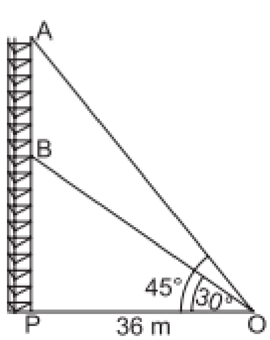
$$\Rightarrow \quad \frac{1}{\sqrt{2}} = \frac{BP}{6\sqrt{2}} \Rightarrow BP = 6\text{m}$$

Thus, the distance between Sandeep and base of the building $= AQ + BP$

$$= 12\sqrt{3} + 6 = 6\,(2\sqrt{3} + 1) \text{ m.}$$

Case Study 5

Radio towers are used for transmitting a range of communication services including radio and television. The tower will either act as an antenna itself or support one or more antennas on its structure. On a similar concept, a radio station tower was built in two Sections A and B. Tower is supported by wires from a point O. Distance between the base of the tower and point O is 36 cm. From point O, the angle of elevation of the top of the Section B is 30° and the angle of elevation of the top of Section A is 45°.



Based on the given information, solve the following questions: [CBSE 2023]

Q1. Find the length of the wire from the point O to the top of Section B.

Q2. Find the height of the Section A from the base of the tower.

Q3. Find the distance AB.

Or

Find the area of AOPB.

Solutions

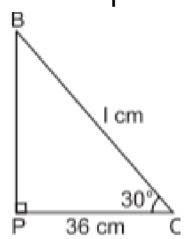
1. Let the length of the wire from the point O to the top of section B, i.e., OB = lm.

Given, OP = 36 cm and $\angle BOP = 30^\circ$

Now in right-angled ΔBPO,

$$\cos 30^\circ = \frac{OP}{OB} \Rightarrow \frac{\sqrt{3}}{2} = \frac{36}{l}$$

$$\Rightarrow l = \frac{72}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{72\sqrt{3}}{3} = 24\sqrt{3}$$



So, required length is $24\sqrt{3}$ cm.

2. Given, $\angle AOP = 45^\circ$ and

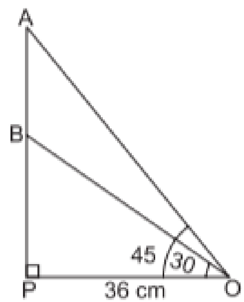
OP = 36 cm

Now in right-angled ΔAPO,

$$\tan 45^\circ = \frac{AP}{OP}$$

$$\Rightarrow \quad 1 = \frac{AP}{36}$$

$$\Rightarrow \quad AP = 36 \text{ cm}$$



$\therefore$ The height of the Section A from the base of the tower = AP = 36 cm.

3. Now, in right–angled ΔBPO,

$$\tan 30^\circ = \frac{BP}{OP} \Rightarrow \frac{1}{\sqrt{3}} = \frac{BP}{36}$$

$$\Rightarrow \quad BP = \frac{36}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{36\sqrt{3}}{3} = 12\sqrt{3} \text{ cm}$$

$$\therefore \quad AB = AP - BP \quad [\because AP = 36 \text{ cm}]$$

$$= 36 - 12\sqrt{3} = 12(3 - \sqrt{3}) \text{ cm}$$

So, required distance AB is $12(3 - \sqrt{3})$ cm.

Or

Since, ΔBPO is a right-angled triangle.

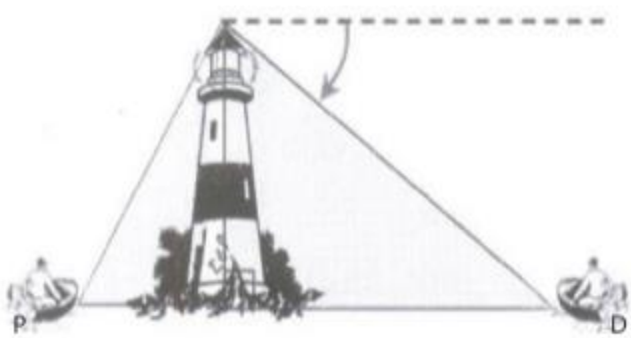
$$\therefore \text{ Area of } \Delta OPB = \frac{1}{2} \times \text{base} \times \text{height}$$

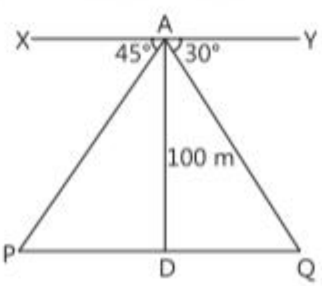
$$= \frac{1}{2} \times OP \times BP = \frac{1}{2} \times 36 \times 12\sqrt{3}$$

$$= 216\sqrt{3} \text{ cm}^2.$$

Case Study 6

A boy is standing on the top of light house. He observed that boat P and boat Q are approaching the light house from opposite directions. He finds that angle of depression of boat P is 45° and angle of depression of boat Q is 30°. He also knows that height of the light house is 100 m.





Based on the above information, answer the following questions.

Q1. What is the measure of APD?

Q2. If ZYAQ = 30°, then ZAQD is also 30°, why?

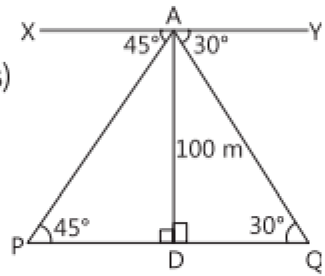
Q3. Find length of PD.

Or

Find length of QD.

Solutions

1. Let a boy is standing on the top (A) of light house (AD).
Here XYII PQ and AP is traversal.



$\therefore \quad \angle APD = \angle PAX$
(Alternative interior angles)

$\Rightarrow \quad \angle APD = 45°$.

2. Given, $\angle YAQ = 30°$

$\Rightarrow \quad \angle AQD = 30°$

Because, XY||PQ and AQ is a traversal.
So, alternate interior angles are equal.

$\therefore \quad \angle YAO = \angle AOD.$

3. In right–angled ΔADP,

$$\tan 45° = \frac{AD}{PD}$$

$$\Rightarrow \quad 1 = \frac{100}{PD}$$

$$\Rightarrow \quad PD = 100 \text{ m.}$$

$\therefore$ Boat P is 100 m from the light house.

Or

In right–angled ΔADQ,

$$\tan 30° = \frac{AD}{DQ}$$

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

$$\Rightarrow \quad QD = 100\sqrt{3} \text{m}$$

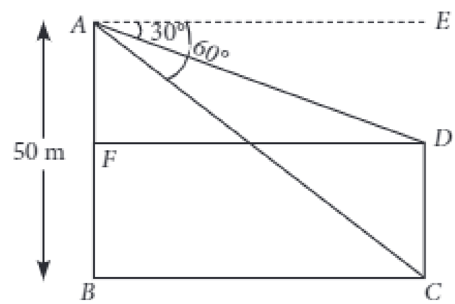
$\therefore$ Boat Q is $100\sqrt{3}$ m from the light house.

Solutions for Questions 7 to 21 are Given Below

Case Study 7

Visit to Temple

There are two temples on each bank of a river. One temple is 50 m high. A man, who is standing on the top of 50 m high temple, observed from the top that angle of depression of the top and foot of other temple are 30° and 60° respectively. (Take $\sqrt{3} = 1.73$)



Based on the above information, answer the following questions.

(i) Measure of $\angle ADF$ is equal to

(a) 45° (b) 60° (c) 30° (d) 90°

(ii) Measure of $\angle ACB$ is equal to

(a) 45° (b) 60° (c) 30° (d) 90°

(iii) Width of the river is

(a) 28.90 m (b) 26.75 m

(c) 25 m (d) 27 m

(iv) Height of the other temple is

(a) 32.5 m (b) 35 m

(c) 33.33 m (d) 40 m

(v) Angle of depression is always

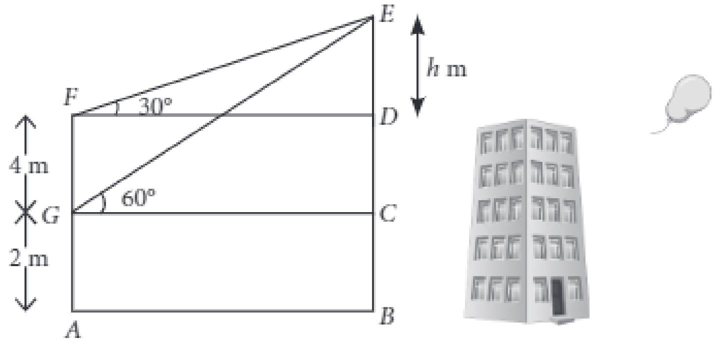
(a) reflex angle (b) straight

(c) an obtuse angle (d) an acute angle

Case Study 8

Observation of a Balloon

There are two windows in a house. First window is at the height of 2 m above the ground and other window is 4 m vertically above the lower window. Ankit and Radha are sitting inside the two windows at points G and F respectively. At an instant, the angles of elevation of a balloon from these windows are observed to be 60° and 30° as shown belc···



Based on the above information, answer the following questions.

(i) Who is more closer to the balloon?

(a) Ankit (b) Radha

(c) Both are at equal distance (d) Can't be determined

(ii) Value of DF is equal to

(a) $\frac{h}{\sqrt{3}}$ m (b) $h\sqrt{3}$ m (c) $\frac{h}{2}$ m (d) $2h$ m

(iii) Value of h is

(a) 2 (b) 3 (c) 4 (d) 5

(iv) Height of the balloon from the ground is

(a) 4 m (b) 6 m (c) 8 m (d) 10 m

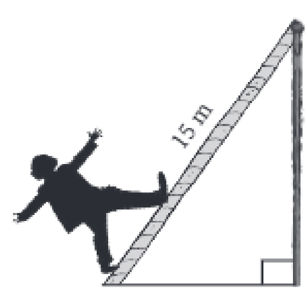
(v) If the balloon is moving towards the building, then both angle of elevation will

(a) remain same (b) increases (c) decreases (d) can't be determined

Case Study 9

Stunt by Circus Artist

A circus artist is climbing through a 15 m long rope which is highly stretched and tied from the top of a vertical pole to the ground as shown below.
Based on the above information, answer the following questions.



(i) Find the height of the pole, if angle made by rope to the ground level is 45°.

(a) 15 m (b) $15\sqrt{2}$ m

(c) $\frac{15}{\sqrt{3}}$ m (d) $\frac{15}{\sqrt{2}}$ m

(ii) If the angle made by the rope to the ground level is 45°, then find the distance between artist and pole at ground level.

(a) $\frac{15}{\sqrt{2}}$ m (b) $15\sqrt{2}$ m (c) 15 m (d) $15\sqrt{3}$ m

(iii) Find the height of the pole if the angle made by the rope to the ground level is 30°.

(a) 2.5 m (b) 5 m (c) 7.5 m (d) 10 m

(iv) If the angle made by the rope to the ground level is 30° and 3 m rope is broken, then find the height of the pole.

(a) 2 m (b) 4 m (c) 5 m (d) 6 m

(v) Which mathematical concept is used here?

(a) Similar Triangles (b) Pythagoras Theorem
(c) Application of Trigonometry (d) None of these

Case Study 10

Fire Incident

There is fire incident in the house. The house door is locked so, the fireman is trying to enter the house from the window. He places the ladder against the wall such that its top reaches the window as shown in the figure.

Based on the above information, answer the following questions.

(i) If window is 6 m above the ground and angle made by the foot of ladder to the ground is 30°, then length of the ladder is

(a) 8 m (b) 10 m (c) 12 m (d) 14 m

(ii) If fireman place the ladder 5 m away from the wall and angle of elevation is observed to be 30°, then length of the ladder is

(a) 5 m (b) $\frac{10}{\sqrt{3}}$ m (c) $\frac{15}{\sqrt{2}}$ m (d) 20 m

(iii) If fireman places the ladder 2.5 m away from the wall and angle of elevation is observed to be 60°, then find the height of the window. (Take $\sqrt{3} = 1.73$)

(a) 4.325 m (b) 5.5 m (c) 6.3 m (d) 2.5 m

(iv) If the height of the window is 8 m above the ground and angle of elevation is observed to be 45°, then horizontal distance between the foot of ladder and wall is

(a) 2 m (b) 4 m (c) 6 m (d) 8 m

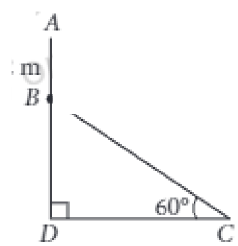
(v) If the fireman gets a 9 m long ladder and window is at 6 m height, then how far should the ladder be placed?

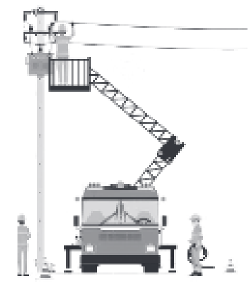
(a) 5 m (b) $3\sqrt{5}$ m (c) 3 m (d) 4 m

Case Study 11

Repairing of Electric Fault

An electrician has to repair an electric fault on the pole of height of 8 m. He needs to reach a point 2 m below the top of the pole to undertake the repair work.





Based on the above information, answer the following questions.

(i) Length of BD is

(a) 10 m (b) 6 m (c) 4 m (d) 4 m

(ii) What should be the length of ladder, so that it makes an angle of 60° with the ground?

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

(iii) The distance between the foot of ladder and pole is

(a) $6\sqrt{3}$ m (b) $4\sqrt{3}$ m (c) $3\sqrt{3}$ m (d) $2\sqrt{3}$ m

(iv) What will be the measure of $\angle BCD$ when BD and CD are equal?

(a) 30° (b) 45° (c) 60° (d) 75°

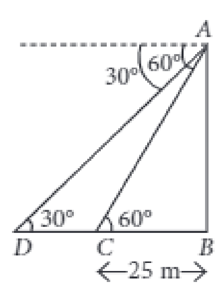
(v) Find the measure of $\angle DBC$.

(a) 15° (b) 60° (c) 30° (d) 45°

Case Study 12

Application of Trigonometry for Moving Car

Rohit is standing at the top of the building observes a car at an angle of 30°, which is approaching the foot of the building with a uniform speed. 6 seconds later, angle of depression of car formed to be 60°, whose distance at that instant from the building is 25 m.



Based on the above information, answer the following questions.

(i) Height of the building is

(a) $25\sqrt{2}$ m (b) 50 m (c) $25\sqrt{3}$ m (d) 25 m

(ii) Distance between two positions of the car is

(a) 40 m (b) 50 m (c) 60 m (d) 75 m

(iii) Total time taken by the car to reach the foot of the building from starting point is

(a) 4 sec. (b) 3 sec. (c) 6 sec. (d) 9 sec.

(iv) The distance of the observer from the car when it makes an angle of 60° is

(a) 25 m (b) 45 m (c) 50 m (d) 75 m

(v) The angle of elevation increases

(a) when point of observation moves towards the object

(b) when point of observation moves away from the object

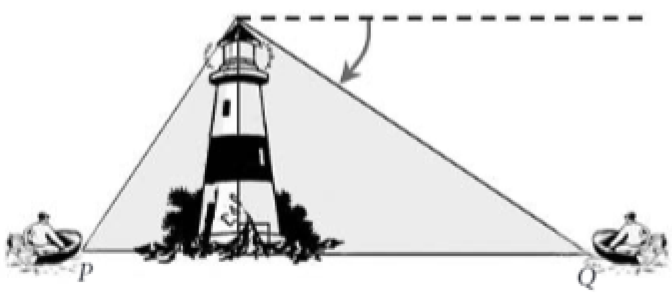
(c) when object moves away from the observer

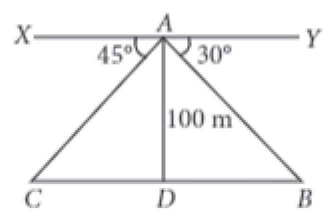
(d) None of these

Case Study 13

Light House

A boy is standing on the top of light house. He observed that boat P and boat Q are approaching to light house from opposite directions. He finds that angle of depression of boat P is 45° and angle of depression of boat Q is 30°. He also knows that height of the light house is 100 m.





Based on the above information, answer the following questions.

(i) Measure of $\angle ACD$ is equal to

(a) 30° (b) 45° (c) 60° (d) 90°

(ii) If $\angle YAB = 30°$, then $\angle ABD$ is also 30°, Why?

(a) vertically opposite angles (b) alternate interior angles

(c) alternate exterior angles (d) corresponding angles

(iii) Length of CD is equal to

(a) 90 m (b) 60 m (c) 100 m (d) 80 m

(iv) Length of BD is equal to

(a) 50 m (b) 100 m

(c) $100\sqrt{2}$ m (d) $100\sqrt{3}$ m

(v) Length of AC is equal to

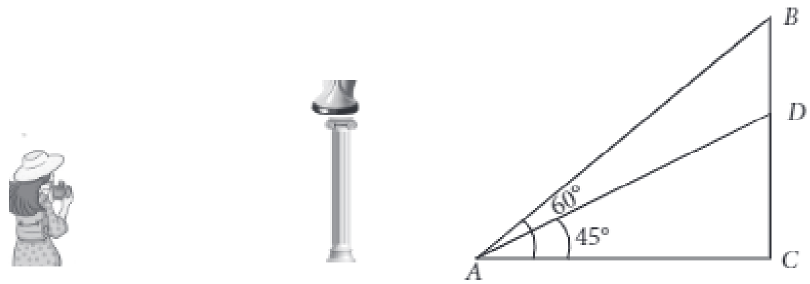
(a) $100\sqrt{2}$ m (b) $100\sqrt{3}$ m

(c) 50 m (d) 100 m

Case Study 14

Visit to Exhibition

In an exhibition, a statue stands on the top of a pedestal. From the point on ground where a girl is clicking the photograph of the statue 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 pedestal is 45°.



Based on the above information, answer the following questions.

(i) If the height of the pedestal is 20 m, then the distance between girl and the foot of the pedestal is

(a) 20 m (b) 40 m (c) 60 m (d) 80 m

(ii) If the height of the pedestal is 20 m, then the height of the statue is

(a) $20\sqrt{3}$ m (b) $20(\sqrt{3}-1)$ m (c) $20(\sqrt{3}+1)$ m (d) $10(\sqrt{3}-1)$ m

(iii) If the height of the statue is 1.6 m, then height of the pedestal is

(a) $0.8(\sqrt{3}-1)$ m (b) $1.6(\sqrt{3}+1)$ m (c) $0.8(\sqrt{3})$ m (d) $0.8(\sqrt{3}+1)$ m

(iv) If the total height of the statue and pedestal is 39 m, then find the length of AC.

(a) 13 m (b) $12\sqrt{3}$ m (c) $13\sqrt{3}$ m (d) $15\sqrt{3}$ m

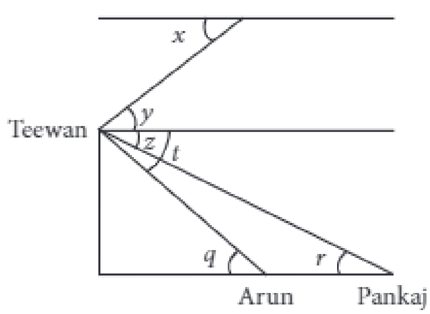
(v) If the height of the pedestal is 35 m, then length of AD is

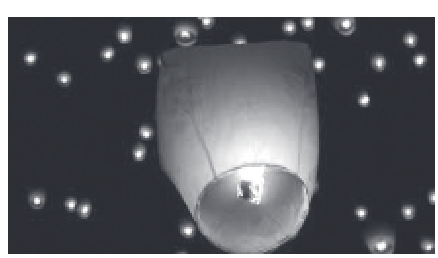
(a) $35\sqrt{2}$ m (b) $40\sqrt{2}$ m (c) $35(\sqrt{2}+1)$ m (d) $35(\sqrt{2}-1)$ m

Case Study 15

Diwali Celebration

Teewan, Arun and Pankaj were celebrating the festival of Diwali in open ground with firecrackers. There is a pedestal in the ground. All of sudden Teewan stands on pedestal and release sky lantern from the top of pedestal.





Based on the above information answer the following questions. (Take $\sqrt{3} = 1.73$)

(i) Which one is a pair of angle of depression?

(a) $(\angle x, \angle y)$ (b) $(\angle y, \angle z)$ (c) $(\angle z, \angle t)$ (d) $(\angle r, \angle q)$

(ii) If the position of Pankaj is 25 m away from the base of pedestal and $\angle r = 30°$, then find the height of pedestal.

(a) 14.45 m (b) 15.5 m (c) 16.36 m (d) 17.36 m

(iii) If the height of pedestal is 30 m, $\angle t = 45°$ and $\angle z = 30°$, then the horizontal distance between Arun and Pankaj is

(a) 24.5 m (b) 19.5 m (c) 20 m (d) 21.9 m

(iv) If the vertical height of sky lantern from the top of pedestal is 12 m and $\angle y = 30°$, then distance between Teewan and sky lantern is

(a) 20 m (b) 16.97 m (c) 24 m (d) 19.86 m

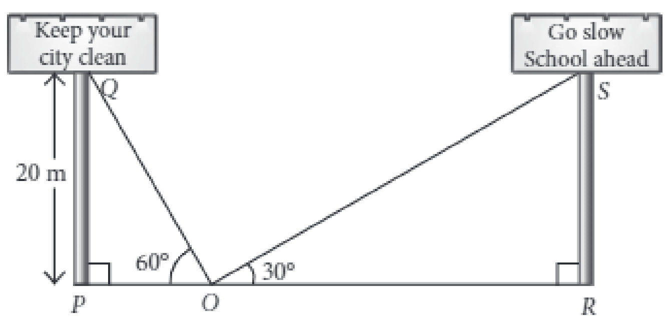
(v) If $\angle q = 60°$ and position of Arun is 15 m away from the base of pedestal, then find the height of pedestal.

(a) 16.25 m (b) 25 m (c) 25.95 m (d) 26 m

Case Study 16

Hoardings on the Road

Two hoardings are put on two poles of equal heights standing on either side of the road. From a point between them on the road the angle of elevation of the top of poles are 60° and 30° respectively. Height of the each pole is 20 m



Based on the above information, answer the following questions. (Take $\sqrt{3} = 1.73$).

(i) Find the length of *PO*.

(a) 20 m (b) $20\sqrt{3}$ m (c) $\frac{20}{\sqrt{3}}$ m (d) None of these

(ii) Find the length of *RO*.

(a) 20 m (b) $20\sqrt{3}$ m (c) $\frac{20}{\sqrt{3}}$ m (d) None of these

(iii) The width of the road is

(a) 31.23 m (b) 35.68 m (c) 39.73 m (d) 46.24 m

(iv) If the angle of elevation made by pole *PQ* is 45°, then the length of *PO* =

(a) 20 m (b) $20\sqrt{3}$ m (c) $\frac{20}{\sqrt{3}}$ m (d) None of these

(v) Angle formed by the line of sight with the horizontal when the point being viewed is above the horizontal level is known as

(a) angle of depression (b) angle of elevation (c) right Angle (d) reflex angle

Case Study 17

Applications of Trigonometry - Broken Tree

Suppose a straight vertical tree is broken at some point due to storm and the broken part is inclined at a certain distant from the foot of the tree.
Based on the above information, answer the following questions.

(i) If the top of upper part of broken tree touches ground at a distance of 30 m (from the foot of the tree) and makes an angle of inclination 30°, then the height of remaining part of the tree is

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

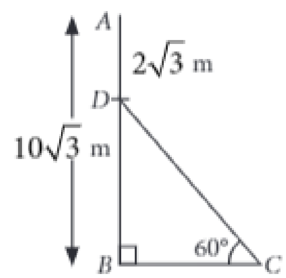
(ii) If the top of broken part of a tree touches the ground at a point whose distance from foot of the tree is equal to height of remaining part, then its angle of inclination is

(a) 30° (b) 60° (c) 45° (d) None of these

(iii) The angle of elevation are always

(a) obtuse angle (b) acute angle (c) right angle (d) reflex angle

(iv) If $AB = 10\sqrt{3}$ m, $AD = 2\sqrt{3}$ m, then $CD =$



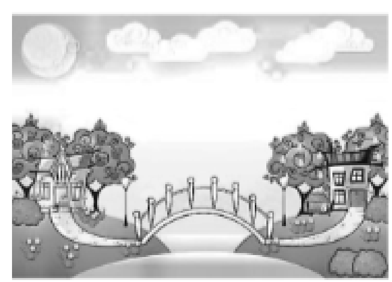
(a) 9 m (b) 11 m (c) 14 m (d) 16 m

(v) If the height of a tree is 6 m, which is broken by wind in such a way that its top touches the ground and makes an angles 30° with the ground. At what height from the bottom of the tree is broken by the wind?

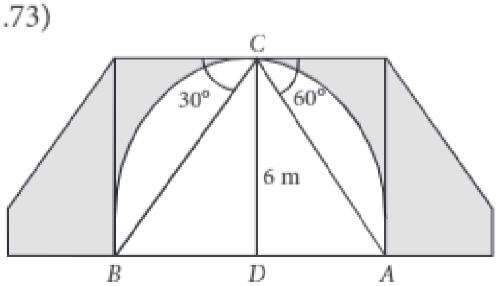
(a) 2 m (b) 4 m (c) 8 m (d) 10 m

Case Study 18

Trigonometry in Bridge Design



One day while sitting on the bridge across a river Arun observes the angles of depression of the banks on opposite sides of the river are 30° and 60° respectively as shown in the figure. (Take $\sqrt{3} = 1.73$)



Based on the above information, answer the following questions.

(i) If the bridge is at a height of 6 m, then $AD =$

(a) 6 m (b) $\frac{\sqrt{3}}{6}$ m (c) $6\sqrt{3}$ m (d) $\frac{6}{\sqrt{3}}$ m

(ii) $BD =$

(a) 6 m (b) $6\sqrt{3}$ m (c) $\sqrt{3}$ m (d) $10\sqrt{3}$ m

(iii) Width of the river is

(a) 10.85 m (b) 13.87 m (c) 15.85 m (d) 19.85 m

(iv) The angles of elevation and depression are always

(a) acute angles (b) obtuse angles (c) right angles (d) straight angles

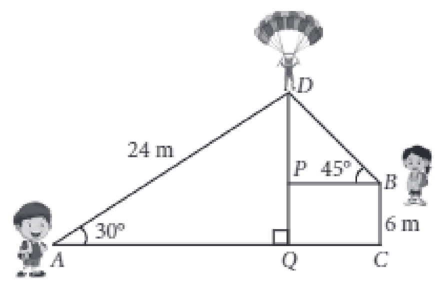
(v) If $BD = 21$ m, then height of the bridge is

(a) 7 m (b) 21 m (c) $7\sqrt{3}$ m (d) $\frac{7}{\sqrt{3}}$ m

Case Study 19

Hot Air Balloon

Karan and his sister Riddhima visited at their uncle's place-Bir, Himachal Pradesh. During day time Karan, who is standing on the ground spots a paraglider at a distance of 24 m from him at an elevation of 30°. His sister Riddhima is also standing on the roof of a 6 m high building, observes the elevation of the same paraglider as 45°. Karan and Riddhima are on the opposite sides of the paraglider.



Based on the above information, answer the following questions.

(i) The distance of paraglider from the ground is

(a) 10 m (b) 12 m (c) 18 m (d) 22 m

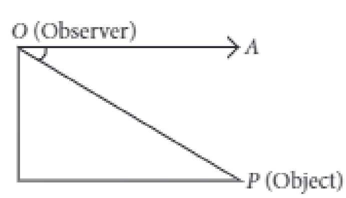
(ii) The value of PD is

(a) 6 m (b) 7 m (c) 8 m (d) 9 m

(iii) The distance between the paraglider and the Riddhima is

(a) $\sqrt{2}$ m (b) 6 m (c) $6\sqrt{2}$ m (d) $\frac{6}{\sqrt{2}}$ m

(iv) In the given figure, $\angle AOP$ is



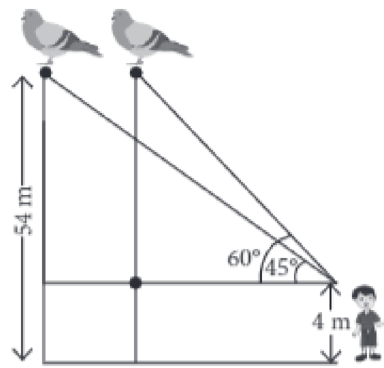
(a) Reflex angle (b) Angle of elevation
(c) Straight angle (d) Angle of depression

(v) If A and B are two objects and the eye of an observer is at point O, then the line of sight will be

(a) OA (b) OB
(c) Both (a) and (b) (d) None of these

Case Study 20

Flying Pigeon



A boy 4 m tall spots a pigeon sitting on the top of a pole of height 54 m from the ground. The angle of elevation of the pigeon from the eyes of boy at any instant is 60°. The pigeon flies away horizontally in such a way that it remained at a constant height from the ground. After 8 seconds, the angle of elevation of the pigeon from the same point is 45°

Based on the above information, answer the following questions. (Take $\sqrt{3}=1.73$)

(i) Find the distance of first position of the pigeon from the eyes of the boy.
 (a) 54 m (b) 100 m
 (c) $\frac{100}{\sqrt{3}}$ m (d) $100\sqrt{3}$

(ii) If the distance between the position of pigeon increases, then the angle of elevation
 (a) Increases (b) decreases (c) remains unchanged (d) can't say

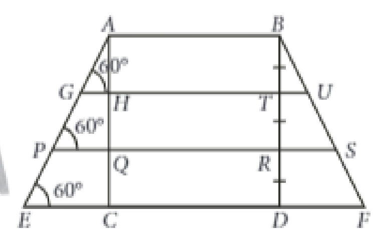
(iii) Find the distance between the boy and the pole.
 (a) 50 m (b) $\frac{50}{\sqrt{3}}$ m (c) $50\sqrt{3}$ m (d) $60\sqrt{3}$ m

(iv) How much distance the pigeon covers in 8 seconds?
 (a) 12.13 m (b) 19.60 m (c) 21.09 m (d) 26.32 m

(v) Find the speed of the pigeon.
 (a) 2.63 m/sec (b) 3.88 m/sec (c) 6.7 m/sec (d) 9.3 m/sec

Case Study 21

Wooden Stool



Aditi purchase a wooden bar stool for her living room with square top of side 2 m and having height of 6 m above the ground. Also each leg is inclined at an angle of 60° to the ground as shown in the figure (not drawn to scale).

Based on the above information, answer the following questions. (Take $\sqrt{3}$ = 1.73)

(i) Find the length of the each leg.
 (a) 5.9 m (b) 6.93 m (c) 7.3 m (d) 8.2 m

(ii) Find the length of GH.
 (a) 0.53 m (b) 1 m (c) 1.15 m (d) 2.73 m

(iii) The length of second step is
 (a) 4.3 m (b) 4.99 m (c) 5.68 m (d) 6.78 m

(iv) The length of PQ =
 (a) 1.56 m (b) 2.31 m (c) 3.34 m (d) 5.68 m

(v) The length of first step is
 (a) 4.78 m (b) 5.34 m (c) 6.62 m (d) 7.82 m

HINTS & EXPLANATIONS

7. **(i) (c) :** Since, $AE \parallel FD$

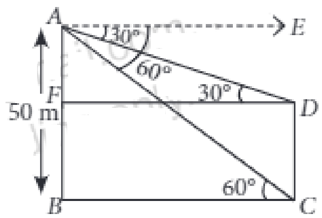
$\therefore \quad \angle EAD = \angle ADF = 30^\circ$

[Alternate interior angles]

(ii) (b): Since, $AE \parallel BC$

$\therefore \quad \angle EAC = \angle ACB = 60^\circ$

[Alternate interior angles]



(iii) (a): In ΔABC,

$$\tan 60^\circ = \frac{AB}{BC} \Rightarrow \sqrt{3} = \frac{50}{BC}$$

$$\Rightarrow \quad BC = \frac{50}{\sqrt{3}} = 28.90 \text{ m}$$

(iv) (c) : In ΔADF, $\tan 30^\circ = \dfrac{AF}{FD}$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{AB - BF}{FD} \Rightarrow \frac{1}{\sqrt{3}} = \frac{50 - CD}{\frac{50}{\sqrt{3}}}$$

$$\left[\because FD = BC = \frac{50}{\sqrt{3}}\right]$$

$$\Rightarrow \quad \frac{50}{3} = 50 - CD \Rightarrow CD = 50 - \frac{50}{3} = \frac{100}{3} = 33.33 \text{ m}$$

(v) (d)

8. **(i) (b):** The person who makes small angle of elevation is more closer to the balloon.

$\therefore$ Radha is more closer to the balloon.

(ii) (b): In ΔEFD, $\tan 30^\circ = \dfrac{ED}{DF}$

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

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

(iii) (a): In ΔGCE,

$$\tan 60^\circ = \frac{EC}{GC} = \frac{h+4}{DF}$$

$$\Rightarrow \quad \sqrt{3} = \frac{h+4}{\sqrt{3}h} \Rightarrow 3h = h + 4 \Rightarrow h = 2$$

(iv) (c) : Height of the balloon from the ground = BE

$= BC + CD + DE = 2 + 4 + 2 = 8$ m

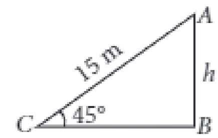
(v) (b)

9. **(i) (d):** Let h be the height of the pole.

In ΔABC,

$$\frac{h}{15} = \sin 45^\circ \Rightarrow \frac{h}{15} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad h = \frac{15}{\sqrt{2}} \text{ m}$$

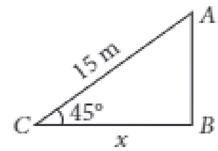


(ii) (a): Let x be the required distance.

In ΔABC,

$$\frac{x}{15} = \cos 45^\circ = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad x = \frac{15}{\sqrt{2}} \text{ m}$$

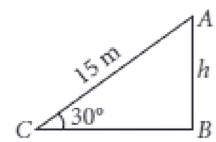


(iii) (c) : Let h be the height of the pole.

In right triangle ABC,

$$\frac{h}{15} = \sin 30^\circ = \frac{1}{2}$$

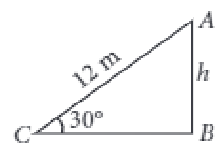
$$\Rightarrow \quad h = \frac{15}{2} = 7.5 \text{ m}$$



(iv) (d): If 3 m rope is broken, then the length of the rope is 12 m.

In ΔABC, $\dfrac{h}{12} = \sin 30^\circ = \dfrac{1}{2}$

$$\Rightarrow \quad h = \frac{12}{2} = 6 \text{ m}$$

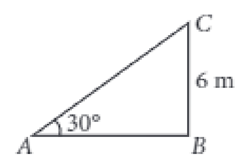


(v) (c)

10. **(i) (c) :** Let AC be the length of the ladder.

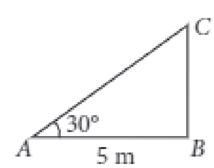
In ΔABC, $\dfrac{BC}{AC} = \sin 30^\circ$

$$\Rightarrow \quad \frac{6}{AC} = \frac{1}{2} \Rightarrow AC = 12 \text{ m}$$



(ii) (b): In ΔABC, $\dfrac{AB}{AC} = \cos 30^\circ$

$$\Rightarrow \quad \frac{5}{AC} = \frac{\sqrt{3}}{2} \Rightarrow AC = \frac{10}{\sqrt{3}} \text{ m}$$

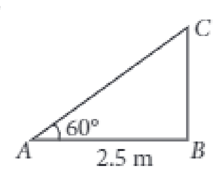


(iii) (a): Let BC be the height of window from ground.

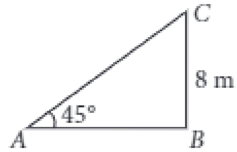
In ΔABC, $\dfrac{BC}{AB} = \tan 60^\circ$

$$\Rightarrow \quad \frac{BC}{2.5} = \sqrt{3}$$

$$\Rightarrow \quad BC = 2.5 \times 1.73 = 4.325 \text{ m}$$



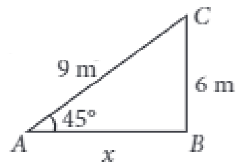
(iv) (d): Let AB be the horizontal distance between the foot of ladder and wall.



In ΔABC, $\frac{BC}{AB} = \tan 45°$

$\Rightarrow \quad \frac{8}{AB} = 1 \Rightarrow AB = 8\text{ m}$

(v) (b): Let the required distance be x.



In ΔABC, $(9)^2 = x^2 + (6)^2$

[By Pythagoras theorem]

$\Rightarrow \quad 81 - 36 = x^2 \Rightarrow 45 = x^2$

$\Rightarrow \quad x = 3\sqrt{5}$ m

11. (i) (b): Total height of pole = 8 m

$\therefore \quad BD = AD - AB = (8 - 2)\text{m} = 6$ m

(ii) (a): In ΔBDC, $\frac{BD}{BC} = \sin 60°$

$\Rightarrow \quad \frac{6}{BC} = \frac{\sqrt{3}}{2}$

$\Rightarrow \quad BC = \frac{12}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 4\sqrt{3}$ m

(iii) (d): In ΔBDC,

$\frac{BD}{CD} = \tan 60° \Rightarrow \frac{6}{CD} = \sqrt{3} \Rightarrow CD = \frac{6}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 2\sqrt{3}\text{m}$

(iv) (b): If ΔBCD,

$\frac{BD}{CD} = \tan\theta \Rightarrow 1 = \tan\theta \qquad [\because BD = CD]$

$\Rightarrow \quad \theta = 45°$

(v) (c): In ΔBDC, $\angle B + \angle D + \angle C = 180°$

$\therefore \quad \angle B = 180° - 60° - 90° = 30°$

12. (i) (c): In ΔABC, $\frac{AB}{BC} = \tan 60°$

$\Rightarrow \quad AB = 25 \times \sqrt{3}$

$\therefore$ Height of building is $25\sqrt{3}$ m.

(ii) (b): In ΔABD, $\frac{AB}{BD} = \tan 30°$

$\Rightarrow \quad \frac{25\sqrt{3}}{BD} = \frac{1}{\sqrt{3}} \Rightarrow BD = 75\text{ m}$

$\therefore$ Distance between two positions of car = (75 – 25) m = 50 m.

(iii) (d): Time taken to cover 50 m distance = 6 sec.

$\therefore$ Time taken to cover 25 m distance = 3 sec.

$\therefore$ Total time taken by car = 6 sec + 3 sec = 9 sec

(iv) (c): In ΔABC, $\frac{BC}{AC} = \cos 60°$

$\Rightarrow \quad \frac{25}{AC} = \frac{1}{2}$

$\Rightarrow \quad AC = 50$ m

(v) (a)

13. (i) (b): $\angle XAC = 45°$ (Given)

$\therefore \quad \angle ACD = 45°$ [Alternate interior angles]

(ii) (b)

(iii) (c): In $\Delta\ ACD$,

$\frac{AD}{DC} = \tan 45°$

$\Rightarrow \quad \frac{100}{DC} = 1 \Rightarrow DC = 100\text{ m}$

(iv) (d): In ΔABD, $\frac{AD}{BD} = \tan 30°$

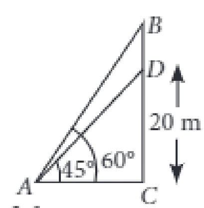
$\Rightarrow \quad \frac{100}{BD} = \frac{1}{\sqrt{3}}$

$\Rightarrow \quad BD = 100\sqrt{3}$ m

(v) (a): In ΔADC,

$\frac{AD}{AC} = \sin 45° \Rightarrow \frac{100}{AC} = \frac{1}{\sqrt{2}} \Rightarrow AC = 100\sqrt{2}\text{ m}$

14. (i) (a): In ΔACD,



$\tan 45° = \frac{CD}{AC} = 1$

$\therefore \quad AC = CD = 20$ m ...(i)

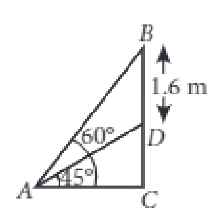
(ii) (b): Let, $BD = h$ m be the height of the statue.

In ΔABC, $\tan 60° = \frac{BC}{AC} \Rightarrow \frac{BD + CD}{AC} = \sqrt{3}$

$\Rightarrow \quad \frac{20 + h}{20} = \sqrt{3}$ [using (i)] $\Rightarrow h = 20\,(\sqrt{3} - 1)$ m.

(iii) (d): Since, in $\Delta\ ACD$, $\angle DAC = 45°$

$\therefore \quad AC = CD$ (say x)



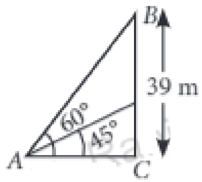
In $\Delta\ BAC$, $\tan 60° = \frac{BC}{AC}$

$\Rightarrow \quad \frac{1.6 + x}{x} = \sqrt{3}$

$\Rightarrow \quad 1.6 = x\,(\sqrt{3} - 1)$

$$\Rightarrow \quad x = \frac{1.6}{\sqrt{3}-1} \times \frac{\sqrt{3}+1}{\sqrt{3}+1} = 0.8\,(\sqrt{3}+1)\text{ m}$$

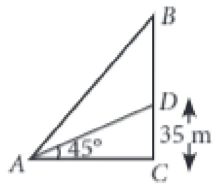
(iv) (c) : In ΔABC,



$$\tan 60° = \frac{BC}{AC} \Rightarrow \frac{39}{AC} = \sqrt{3}$$

$$\Rightarrow AC = \frac{39}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 13\sqrt{3}\text{ m}$$

(v) (a) : In ΔACD, $\sin 45° = \dfrac{CD}{AD}$



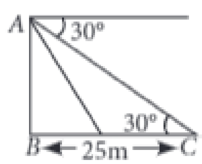
$$\Rightarrow \quad \frac{35}{AD} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad AD = 35\sqrt{2}\text{ m}$$

15. **(i) (c)**

(ii) (a) : Let AB be the height of pedestal.

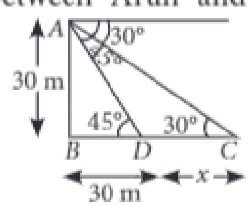
In $\Delta\, ABC$,



$$\tan 30° = \frac{AB}{BC}$$

$$\Rightarrow \quad AB = \frac{25}{\sqrt{3}} = \frac{25}{1.73} = 14.45\text{ m}$$

(iii) (d): Let x be the distance between Arun and Pankaj.



In ΔABD, $\tan 45° = \dfrac{AB}{BD}$

$\Rightarrow \quad BD = 30$ m

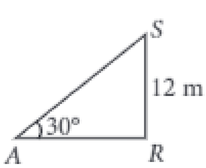
Now, in $\Delta\, ABC$,

$$\tan 30° = \frac{AB}{BC}$$

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

$$\Rightarrow \quad x = 30\ (\sqrt{3}-1) = 30 \times 0.73 = 21.9\text{ m}$$

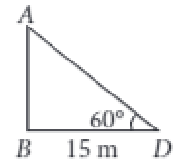
(iv) (c) : In ΔARS,



$$\sin 30° = \frac{RS}{AS}$$

$$\Rightarrow \quad \frac{12}{AS} = \frac{1}{2} \Rightarrow AS = 12 \times 2 = 24\text{ m}$$

(v) (c) : In ΔABD, $\dfrac{AB}{BD} = \tan 60°$



$$\Rightarrow \quad \frac{AB}{15} = \sqrt{3}$$

$\Rightarrow \quad AB = 15 \times 1.73 = 25.95$ m

16. **(i) (c) :** In ΔOPQ, we have

$$\tan 60° = \frac{PQ}{PO}$$

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

$$\Rightarrow \quad PO = \frac{20}{\sqrt{3}}\text{ m}$$

(ii) (b): In ΔORS, we have

$$\tan 30° = \frac{RS}{OR} \quad \Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{20}{OR} \quad \Rightarrow \quad OR = 20\sqrt{3}\text{ m}$$

(iii) (d): Clearly, width of the road $= PR$

$$= PO + OR = \left(\frac{20}{\sqrt{3}} + 20\sqrt{3}\right)\text{m}$$

$$= 20\left(\frac{4}{\sqrt{3}}\right)\text{m} = \frac{80}{\sqrt{3}}\text{ m} = 46.24\text{ m}$$

(iv) (a) : In ΔOPQ, if $\angle POQ = 45°$, then

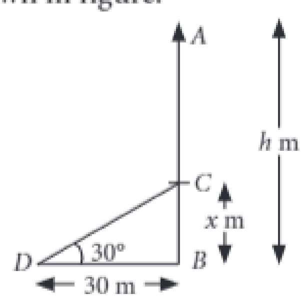
$$\tan 45° = \frac{PQ}{PO} \quad \Rightarrow 1 = \frac{20}{PO} \quad \Rightarrow \quad PO = 20\text{ m}$$

(v) (b)

17. **(i) (c) :** Let AB be the tree of height h m and let it broken at height of x m, as shown in figure.

Clearly $CD = AC = (h - x)$ m

Now, in ΔCBD, we have



$$\tan 30° = \frac{x}{30}$$

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

Thus, the height of remaining part of the tree is $\dfrac{30}{\sqrt{3}}$ m.

(ii) (c) : In this case, $BD = BC = x$ m

$\therefore$ If θ be the angle of inclination, then

$$\tan\theta = \frac{BC}{BD} = 1$$

$\Rightarrow \quad \tan\theta = \tan 45°$

$\Rightarrow \quad \theta = 45°$

(iii) (b): The angle of elevation and depression are always acute angles.

(iv) (d): Clearly, $BD = AB - AD$

$= \left(10\sqrt{3} - 2\sqrt{3}\right) \text{m} = 8\sqrt{3}\text{ m}$

Now, in ΔBCD, we have

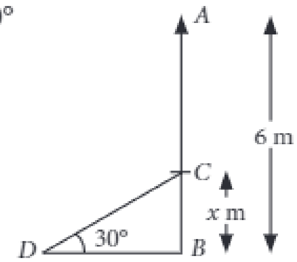
$$\sin 60^\circ = \frac{BD}{DC}$$

$$\Rightarrow \frac{\sqrt{3}}{2} = \frac{8\sqrt{3}}{DC} \Rightarrow DC = 16\text{ m}$$

(v) (a): Here, $h = 6$ m, $\theta = 30^\circ$

$\therefore \quad DC = AC = (6 - x)$ m

Now, in ΔBCD, we have



$$\sin 30^\circ = \frac{BC}{CD}$$

$$\Rightarrow \frac{1}{2} = \frac{x}{6-x}$$

$$\Rightarrow 6 - x = 2x$$

$$\Rightarrow 3x = 6 \Rightarrow x = 2$$

18. (i) **(d):** Clearly, $\angle DAC = 60^\circ$

So, in ΔADC, we have

$$\tan 60^\circ = \frac{CD}{AD} \Rightarrow \sqrt{3} = \frac{6}{AD}$$

$$\Rightarrow AD = \frac{6}{\sqrt{3}}\text{m}$$

(ii) (b): Clearly, $\angle DBC = 30^\circ$

So, in ΔBDC, we have

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

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{6}{BD}$$

$$\Rightarrow BD = 6\sqrt{3}\text{ m}$$

(iii) (b): Width of the river $= AB = AD + BD$

$$= \frac{6}{\sqrt{3}} + 6\sqrt{3}$$

$$= 6\left(\frac{1}{\sqrt{3}} + \sqrt{3}\right) = 6\left(\frac{4}{\sqrt{3}}\right) = \frac{24}{\sqrt{3}}\text{ m} = 13.87\text{ m}$$

(iv) (a): The angle of elevation and angle of depression are always acute angles.

(v) (c): In ΔBCD, if $BD = 21$m, then

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

$$\Rightarrow \frac{1}{\sqrt{3}} = \frac{CD}{21} \Rightarrow CD = \frac{21\sqrt{3}}{3} = 7\sqrt{3}\text{ m}$$

19. (i) **(b):** In the right ΔADQ, we have

$$\sin 30^\circ = \frac{DQ}{AD} \Rightarrow \frac{1}{2} = \frac{DQ}{24}$$

$$\Rightarrow DQ = 12\text{ m}$$

Thus, distance of paraglider from the ground is 12 m.

(ii) (a): We have $PQ = BC = 6$ m

Now, as $DQ = 12$ m

$\therefore \quad DP = DQ - PQ = 12 - 6 = 6$ m

(iii) (c): In right ΔBDP, we have

$$\sin 45^\circ = \frac{DP}{BD} \Rightarrow \frac{1}{\sqrt{2}} = \frac{6}{BD}$$

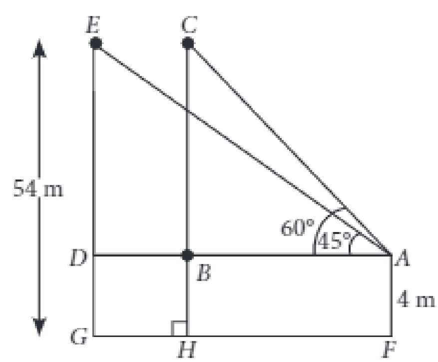
$$\Rightarrow BD = 6\sqrt{2}\text{ m}$$

Thus, the distance of paraglider from the girl is $6\sqrt{2}$ m.

(iv) (d): $\angle AOP$ given in figure, is the angle of depression.

(v) (c): If A and B are two objects and the eye of an observer is at point O, then line of sight will be both OA and OB.

20. (i) **(c):** Distance of first position of pigeon from the eyes of boy $= AC$



In ΔABC,

$$\sin 60^\circ = \frac{BC}{AC} \Rightarrow AC = \frac{CH - BH}{\sin 60^\circ} = \frac{54-4}{\sqrt{3}/2} = \frac{100}{\sqrt{3}}\text{ m}$$

(ii) (b): If the distance increases, then the angle of elevation decreases.

(iii) (b): Distance between boy and pole $= AB$

Now, in ΔABC,

$$\tan 60^\circ = \frac{BC}{AB} \Rightarrow \sqrt{3}\, AB = 50 \Rightarrow AB = \frac{50}{\sqrt{3}} \text{ m}$$

(iv) **(c)** : In ΔAED, $\tan 45^\circ = \frac{ED}{AD}$

$\Rightarrow \quad AD = BC = 50$ m $\qquad (\because ED = BC)$

Now, distance between two positions of pigeon = EC

$= BD = AD - AB$

$$= \left(50 - \frac{50}{\sqrt{3}}\right)\text{m} = \frac{50(1.73-1)}{1.73} = 21.09 \text{ m}$$

(v) **(a)**: Speed of pigeon $= \frac{\text{Distance covered}}{\text{Time taken}}$

$$= \left(\frac{21.09}{8}\right)\text{m/sec} = 2.63 \text{ m/sec}$$

21. Given, side of square top = 2 m

$\therefore \quad AB = HT = QR = CD = 2$ m

Also, AC and BD are perpendicular to the ground.

So, $AH = HQ = QC$. (By B.P.T. Theorem)

(i) **(b)**: In ΔAEC,

$$\sin 60^\circ = \frac{AC}{AE} \Rightarrow \frac{\sqrt{3}}{2} = \frac{6}{AE} \Rightarrow AE = 6.93 \text{ m}$$

$\therefore \quad$ Length of each leg *i.e.*, $AE = BF = 6.93$ m.

(ii) **(c)** : In ΔAGH, $\tan 60^\circ = \frac{AH}{GH} \Rightarrow \sqrt{3} = \frac{2}{GH}$

$\Rightarrow \quad GH = 1.15$ m

(iii) **(a)** : Length of second step = $GH + HT + TU$

$= 1.15 + 2 + 1.15 = 4.3$ m

(iv) **(b)**: In ΔAPQ,

$$\tan 60^\circ = \frac{AQ}{PQ} \Rightarrow \sqrt{3} = \frac{4}{PQ} \Rightarrow PQ = \frac{4}{\sqrt{3}} \text{ m} = 2.31 \text{ m}$$

(v) **(c)** : Length of first step = $PQ + QR + RS$

$= 2.31 + 2 + 2.31 = 6.62$ m