Some Applications
of Trigonometry

Multiple Choice Questions

Q: 1 Shown below is The Louvre Museum, the world's most visited museum. In the shape of a square pyramid, it is 21.6 m high and has a base of edge 34 m.

(Note: The image is for representation purpose only)

Which of these angles is closest to the angle of elevation of the top of the museum from the mid-point of its 34 m edge?
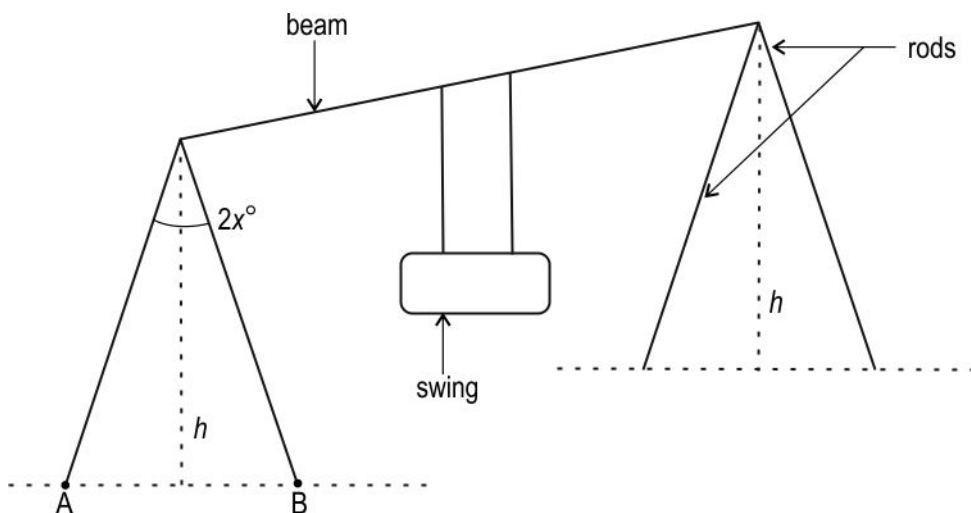
1 30°   **2** 50°   **3** 60°   **4** 75°

Q: 2 A park has a swing which is suspended to a beam. The beam is supported by a pair of identical rods on either side as shown in the figure below.

The height of the beam from the ground is *h* metres and the angle between the rods on each side is 2 *x°*.

Which of the following is an appropriate expression for the distance AB, in terms of *h* and *x* ?

1 *h* tan 2 *x*

2 2 *h* cot *x*

3 2 *h* tan *x*

4 2 *h* tan 2 *x*

Q: 3 Ananya, Suman and Dipti see a crane lifting a metal rod, as shown in the following figure. They notice that more precision must be required in operating the crane as the rod gets closer to the base of the crane, since the rod could hit the crane if it tilts.
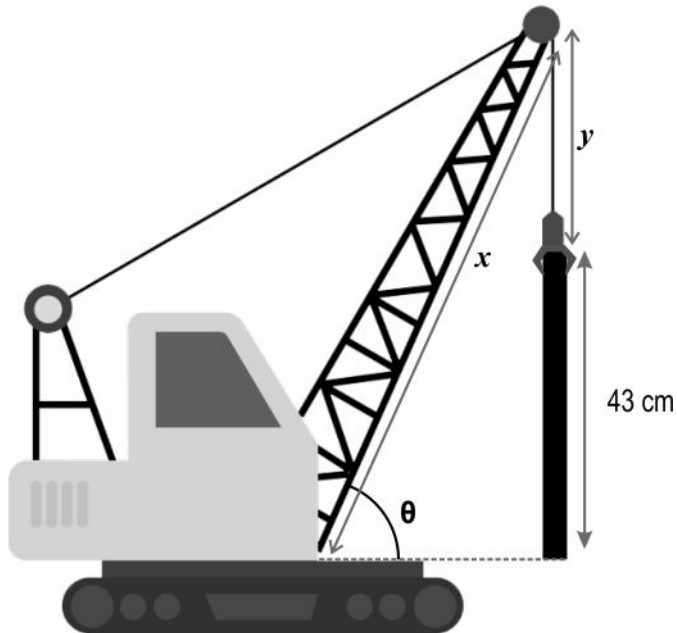
(Note: The figure is not to scale.)

Taking the length of the crane's arm as *x* metres, and the length of the hanging line as *y* metres, they find the approximate horizontal distance between the end of the rod and the base of the crane's arm as follows:

Ananya: $\frac{\tan\theta}{(y+43)}$ m
Suman: *x* cos θ m
Dipti: *x* cosec θ m

Who is/are correct?

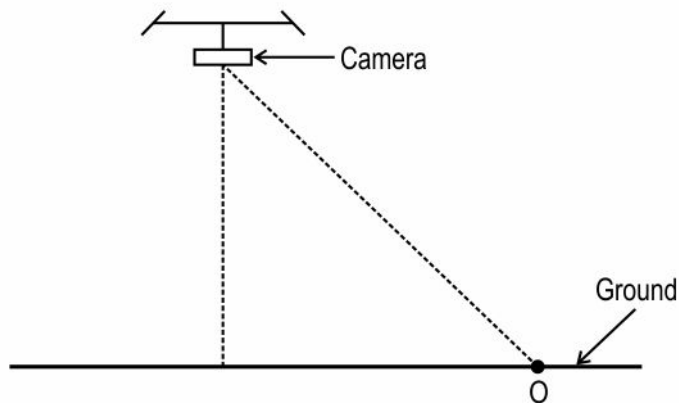**1** only Ananya **2** only Suman
3 only Suman and Dipti **4** only Ananya and Suman

Free Response Questions

Q: 4 **A drone camera is used by a photographer for shooting videos. On some day, it is focussing at point O on the ground as shown in the figure.** **[1]**
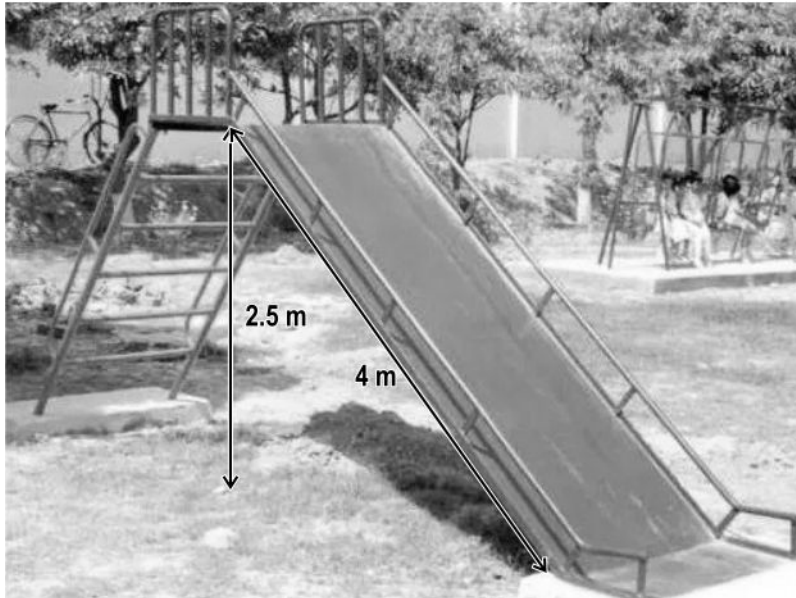

The camera is at a perpendicular height of 6 m from the ground and at a distance of 4√3 m from point O.

Find the angle of depression of point O from the camera. Show your steps.

Q: 5 Ajay wants to play on a newly installed slide in the playground, as shown in the figure **[1]** below.
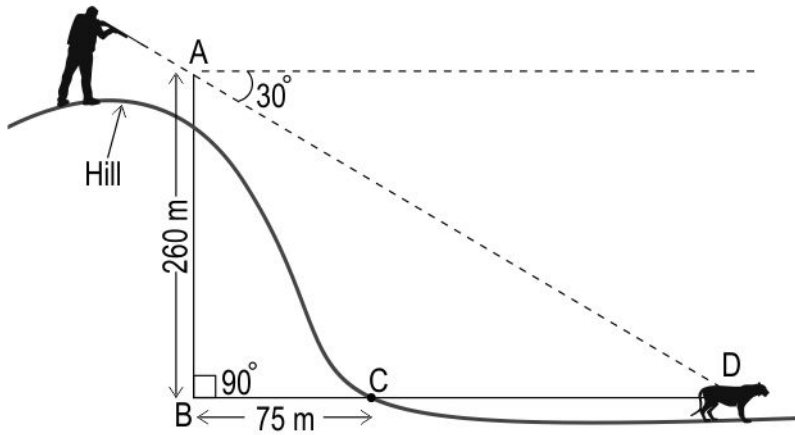

(Note: The figure is not to scale.)

For a slide to be safe for use, it is to be installed with the specification that the angle made by the slide with the ground should be less than 45°.

Is the slide in the playground safe for Ajay to use? Explain your reasoning.

(Note: Use √2 as 1.4.)

Q: 6 A hunter is asked to stun a man-eater lioness with a stun gun from the top of a cliff. **[1]** The angle of depression of the gun from the lioness is 30°. The vertical distance between point A and the lioness is 260 m and BC = 75 m (horizontal distance between point A to base point of the cliff).
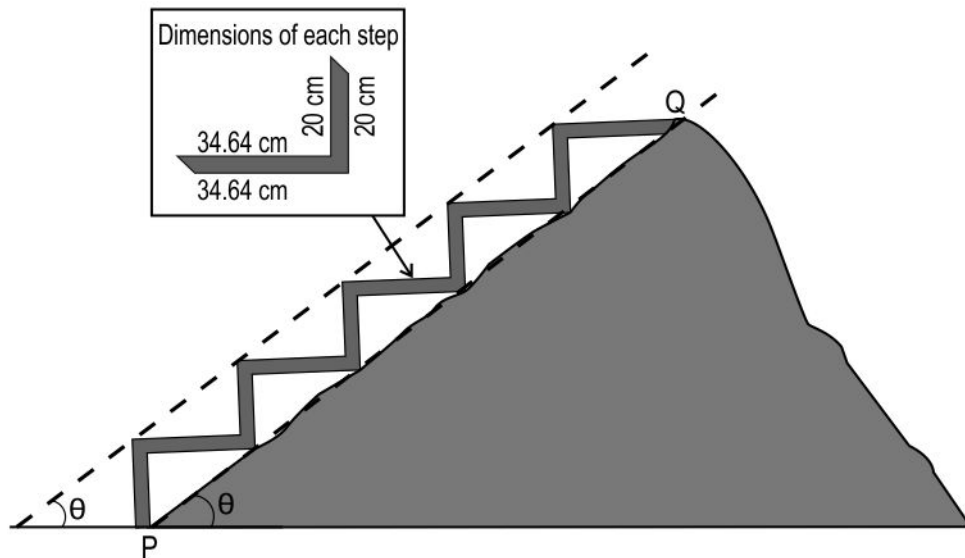

(*Note: The figure is not to scale*)

How far from point C at the base is the lioness standing? Round to the nearest whole number and show your work.

(*Note: Take √2 as 1.41 and √3 as 1.73.*)

Q: 7 A hiking trail is built using stones' steps to reach the top of a small hill as shown below. There are a certain number of similar steps built each 34.64 cm wide and 20 cm high. **[1]**
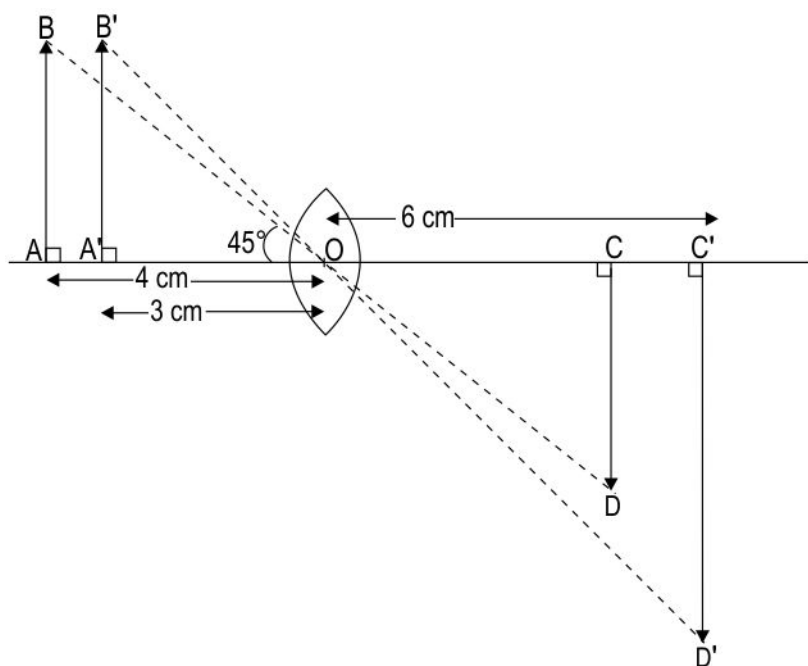

(Note: The figure is not to scale.)

What is the approximate angle of elevation from the point P at the base of the hill to peak Q? Show your work.

(*Note: Take √2 as 1.414 and √3 as 1.732.)*

Q: 8 **An inverted image CD is formed on the other side when an object AB is positioned in front of a convex lens at a distance of 4 cm from point O. Similarly, when the same object is placed at a distance of 3 cm, it forms an image C'D' as depicted in the diagram.** **[2]**
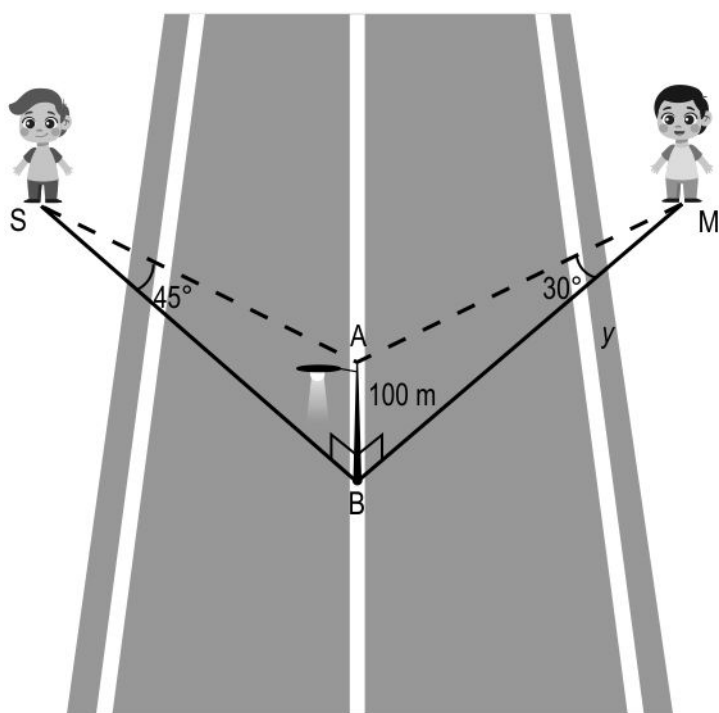

(Note: The figure is not to scale.)

i) Find the height of the object AB.

**ii) Find the height of the image C'D'.**

Show your work.

Shoaib and Mihir are playing in their school playground which has a 100 m light pole. [3]
**Shoib is standing towards the north of the light pole and Mihir is standing towards the
east of the light pole. From the point where Shoaib and Mihir stand, the angle of
elevation of the top of the pole is 45° and 30° respectively, as shown in the image
below.**

(Note: The figure is not to scale.)

Find the shortest distance between Shoib and Mihir. Show your work.

A smash shot in badminton is when the shuttlecock travels in a straight line just above [3] the nets. The line of impact and the net are perpendicular to the horizontal ground.
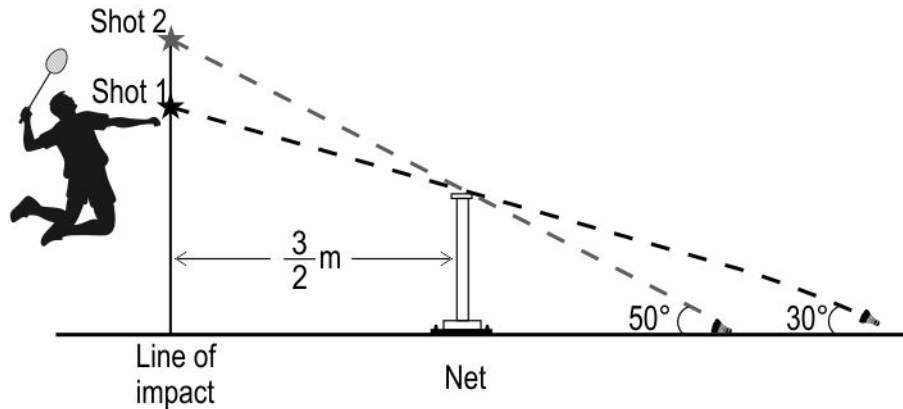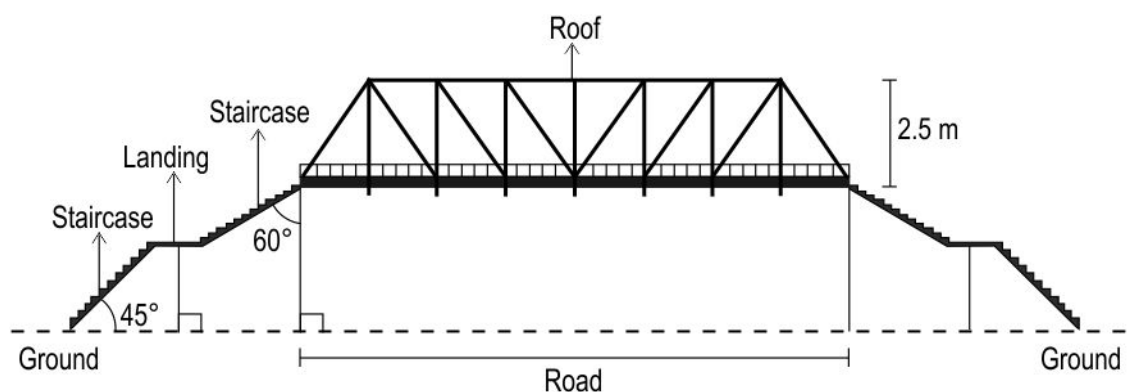

(Note: The figure is not to scale.)

How much higher is shot 2 than shot 1? Draw a rough diagram and show your work.

(Note: Take sin 30° as 0.5, cos 30° as 0.9, sin 50° as 0.8 and cos 50° as 0.6.)

A pedestrian bridge is built across a main road to help pedestrians cross the road [5] safely without slowing the traffic as shown below.
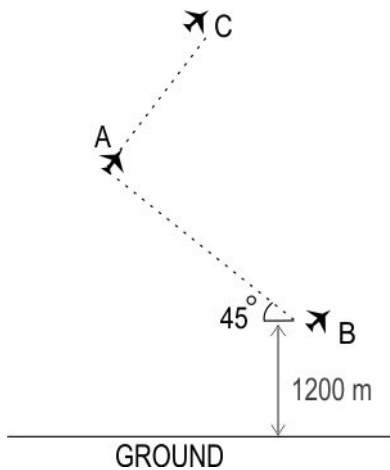

(Note: Figure is not to scale.)

The length of each staircase is approximately 3 metres and the length of each landing is 2 metres.

Find the approximate height of the roof from the ground. Show your work.

Q: 12 Three fighter pilots are participating in a training activity. For one particular maneuver, planes A and C are at an altitude above plane B as shown below.

[5]

♦ **The horizontal distance between planes A and B is equal to plane B's altitude.**
♦ **Planes A, B and C are placed such that ∠BAC = 90°, and the angle of elevation of plane C from plane B is 75°.**

Find the:
i) altitude of plane A.
ii) shortest distance between planes A and C.
**iv) shortest distance between planes B and C.**

(Note: Consider the planes as point sized objects; the figure is not to scale.)

Case-Based Questions

Answer the questions based on the given information.
A drone, is an aircraft without any human pilot and is controlled by a remote control device. Its various applications include policing, surveillance, photography, precision agriculture, forest fire monitoring, river monitoring and so on.
David used an advanced drone with high resolution camera during an expedition in a forest region which could fly upto 100 m height above the ground level. David rode on an open jeep to go deeper into the forest. The initial position of drone with respect to the open jeep on which David was riding is shown below.
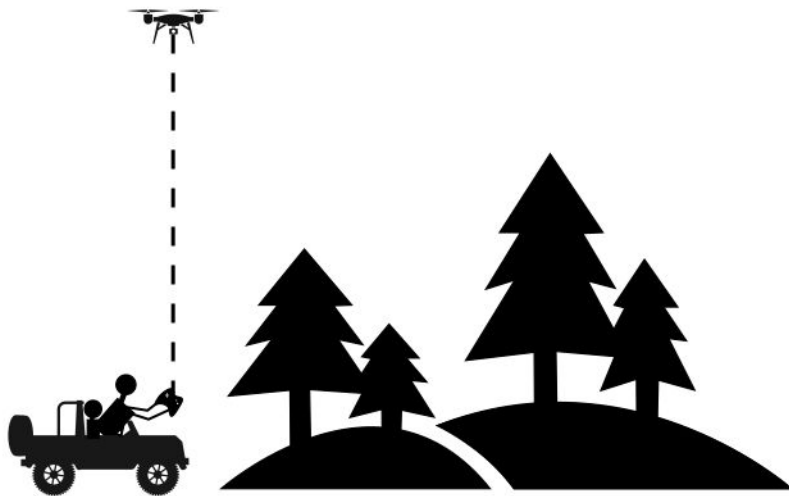
David started flying the drone as soon as the jeep started moving to enter the forest at an average speed of 10 m/s in the same direction as that of the jeep.

Q: 13 **At some point during the expedition, David kept the drone stationary for some time to capture the images of a tiger. The angle of depression from the drone to the tiger changed from 30° to 45° in 3 seconds as shown below.** **[2]**
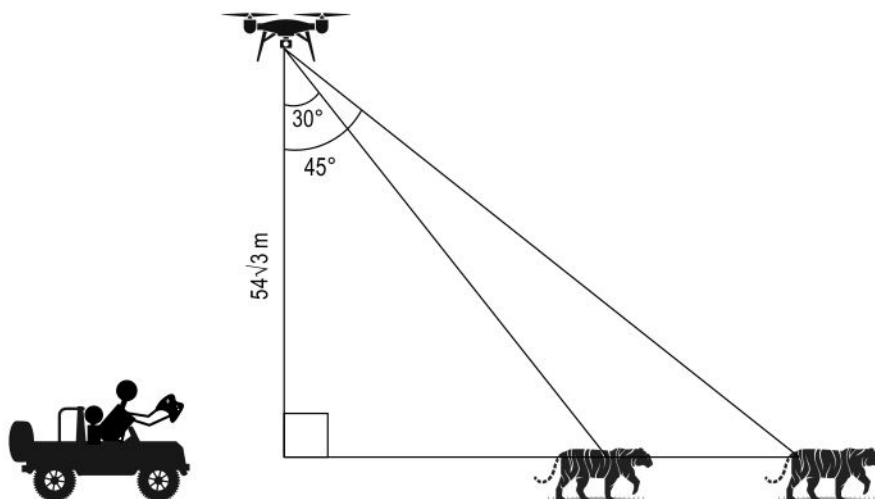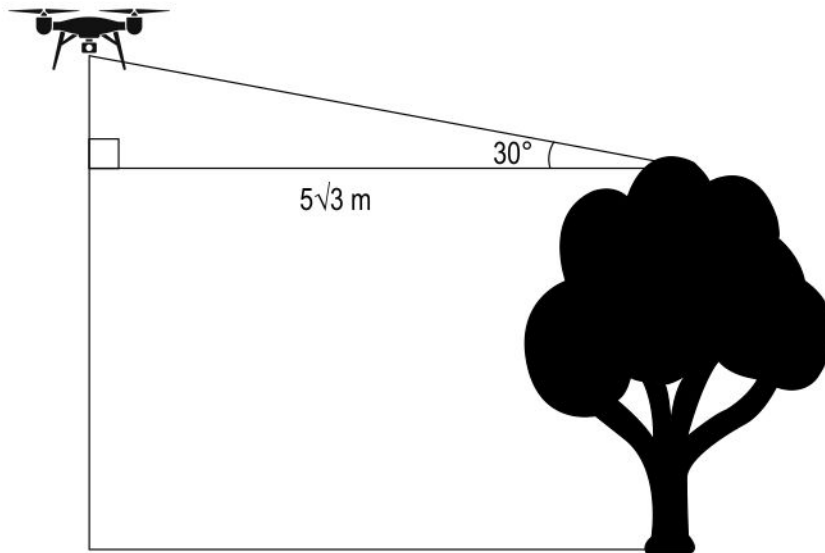

(Note: The figure is not to scale.)

What was the average speed of the tiger during that time? Show your work.

(Note: Take √3 as 1.73.)

Q: 14 David reached near one of the tallest trees in the forest. He stopped the drone at a **[1]** horizontal distance of 5√3 m from the top of the tree and at a vertical distance of 65 m below its maximum vertical range.

(Note: The figure is not to scale.)

If the angle of elevation of the drone from the top of the tree was 30°, find the height of the tree. Show your work.

Q: 15 The drone was flying at a height of 30√3 metres at a constant speed in the horizontal **[1]** direction when it spotted a zebra near a pond, right below the drone.
The drone travelled for 30 metres from there and it could see the zebra, at the same place, at an angle of depression of *θ* from it.

Draw a diagram to represent this situation and find *θ*. Show you work.
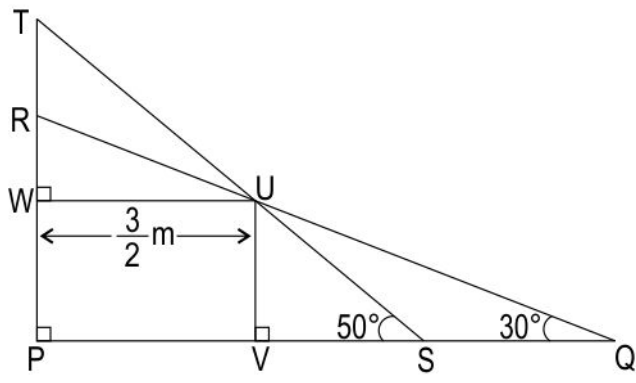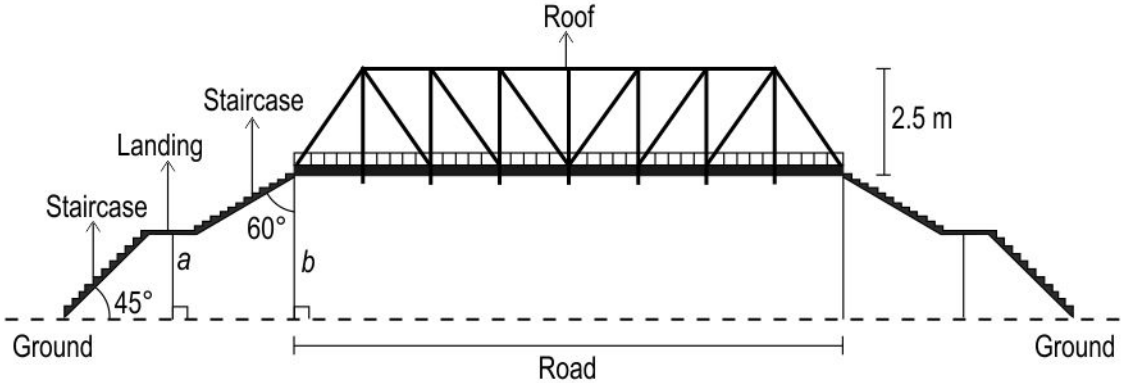
Q.No	Correct Answers
1	2
2	3
3	2

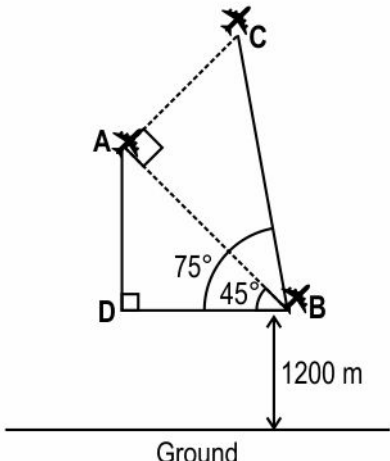| Q.No	What to look for	Marks
4	Uses sine ratio and writes: $\sin d = \frac{6}{4\sqrt{3}}$ $= \frac{\sqrt{3}}{2}$ where, d is the angle of depression.	0.5
	Finds $\angle d = 60°$.	0.5
5	Writes that the slide is safe for Ajay to use.	0.5
	Finds $\sin \theta = \frac{2.5}{4} = 0.625$, where θ is the angle at which the slide is inclined with the ground. Finds $\sin 45°$ as $\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2} = 0.7$. Gives the following reason: Since $\sin \theta$ increases as θ increases when $0° < \theta < 90°$, if $\sin \theta < \sin 45°$, then $\theta < 45°$.	0.5
6	Finds BD as $260 \times \tan 60° = 260 \times \sqrt{3} = 260 \times 1.73 = 449.8$ m or 450 m.	0.5
	Finds distance of the lioness from the point C at the base as: CD = BD - BC = 450 - 75 = 375 m	0.5
7	Finds angle of elevation θ by solving for $\cot \theta$ as follows: $\cot \theta = \frac{34.64}{20} = 1.732 = \sqrt{3}$ Hence, finds the value of θ as 30°.	1
8	i) From the figure, frames the equation as: $\frac{AB}{4} = \tan 45°$ Solves above to find the height of the object AB as 4 cm.	0.5
	ii) Assumes the $\angle B'OA'$ to be θ. Writes the equation as: $\tan \theta = \frac{4}{3}$	0.5

Q.No	What to look for	Marks
	Writes that alternate angles are equal and hence ∠C'OD' = θ. Writes the equation as: $$\tan \theta = \frac{4}{3} = \frac{C'D'}{6}$$ Finds the height of image C'D' as 8 cm. (Award full marks if any alternate method is correctly used.)	1
9	Finds the distance between the light pole and Shoib as: $$\tan 45° = \frac{AB}{SB}$$ $$\Rightarrow 1 = \frac{100}{SB}$$	0.5
	Solves the above equation and finds the distance between the light pole and Shoib as 100 m.	0.5
	Finds the distance between the light pole and Mihir as: $$\tan 30° = \frac{AB}{MB}$$ $$\Rightarrow \frac{1}{\sqrt{3}} = \frac{100}{MB}$$	0.5
	Solves the above equation and finds the distance between the light pole and Shoib as 100√3 m.	0.5
	Uses Pythagoras' theorem to find the shortest distance between Shoib and Mihir as $\sqrt{[(100)^2 + (100\sqrt{3})^2]}$ = 200 m.	1
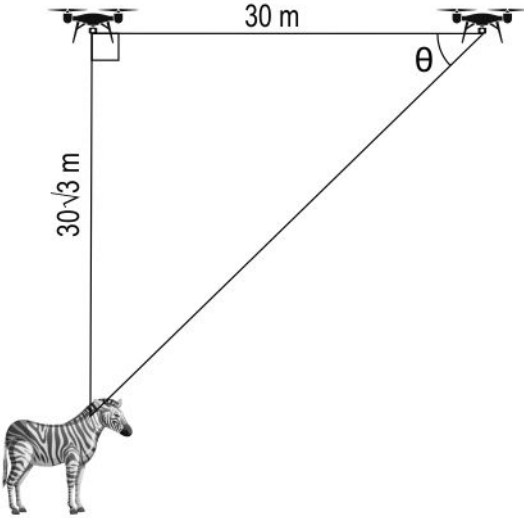
Q.No	What to look for	Marks
10	Draws a rough diagram with appropriate measurements. The diagram may look as follows: T R W $\frac{3}{2}$ m U 50° 30° P V S Q (Note: The figure is not to scale.)	0.5
	Finds ∠WUT as 50° and ∠WUR as 30°.	1
	Finds WT as $\frac{3}{2}$ tan 50° = $\frac{3}{2} \times \frac{0.8}{0.6}$ = 2 m.	0.5
	Finds WR as $\frac{3}{2}$ tan 30° = $\frac{3}{2} \times \frac{0.5}{0.9} = \frac{5}{6}$ m.	0.5
	Finds the height by which shot 2 is higher than shot 1 as: 2 - $\frac{5}{6} = \frac{7}{6}$ m	0.5

Q.No	What to look for	Marks
11	Given below is a rough figure of the figure in the question: **Identifies from the figure that the height of the roof from the ground is given by:** *b* + 2.5 m or *a* + (*b* - *a*) + 2.5 m **(Award full 1 mark even if the figure is not drawn.)**	1
	Identifies from the figure that: $\sin 45° = \frac{a}{3}$	0.5
	Finds *a* by evaluating the above expression as: $a = \frac{3}{\sqrt{2}}$ m	1
	Identifies from the figure that: $\sin 30° = \cos 60° = \frac{b\text{-}a}{3}$	1
	Finds the value of *b* a s: $\frac{3}{2} + \frac{3}{\sqrt{2}}$ m	1

Q.No	What to look for	Marks
	Finds the height of the roof from the ground as: **$(2.5 + \frac{3}{2} + \frac{3}{\sqrt{2}})$ m** (*Note: Students are not expected to simplify the expression further.*)	**0.5**
12	**Draws ∆ADB and ∆BAC. The figure may look as follows:** **(Note: The figure is not to scale.)**	**1**
	i) Uses tan 45° = $\frac{AD}{DB}$ = 1 in ∆ADB to find AD = DB. **Writes that AD = 1200 m.** **(Award full marks if the student finds AD by using the properties of isosceles triangles.)**	**0.5**
	Finds plane A's altitude as 1200 + 1200 = 2400 m.	**0.5**
	ii) In ∆ADB, uses sin 45° = $\frac{AD}{AB}$ = $\frac{1}{\sqrt{2}}$. **Substitutes value of AD as 1200 m to find AB as 1200√2 m.**	**0.5**
	Finds ∠ABC as 75° - 45° = 30°.	**0.5**

Q.No	What to look for	Marks
	In ▲ABC, uses tan 30° = $\frac{AC}{AB}$ = $\frac{1}{\sqrt{3}}$. Substitutes value of AB as 1200√2 m to find AC as 400√6 m.	1
	iii) In ▲ABC, uses cos 30° = $\frac{AB}{BC}$ = $\frac{\sqrt{3}}{2}$. Substitutes value of AB as 1200√2 to find BC as 800√6 m.	1
13	Assumes the horizontal distance between the drone and the tiger to be *x* when the angle of depression was 30° and finds the value of *x* as: *x* = 54√3 × tan 30° = 54√3 × $\frac{1}{\sqrt{3}}$ = 54 m	0.5
	Assumes the horizontal distance between the drone and the tiger after 3 seconds as *y* and finds the value of *y* as: *y* = 54√3 × tan 45° = 54√3 m	0.5
	Finds the distance covered by the tiger in 3 seconds as: 54√3 - 54 = 39.42 m	0.5
	Finds the average speed of the tiger during that time as: $\frac{39.42}{3}$ = 13.14 m/s.	0.5
14	Assumes the vertical distance between the top of the tree and the drone to be *h* and finds *h* as: *h* = 5√3 × tan 30° = 5√3 × $\frac{1}{\sqrt{3}}$ = 5 m.	0.5
	Finds the height of the tree as 100 - 65 - 5 = 30 m.	0.5

Q.No	What to look for	Marks
15	Draws a rough diagram to represent the situation. The figure may look as follows: 	0.5
	Finds the value of θ as: $\tan\theta = \frac{30\sqrt{3}}{30} = \sqrt{3}$. Thus finds the value of θ as 60°.	0.5