

UNIQUE STUDY POINT

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Class: X	Subject: Mathematics	Session: 2024-25
Chapter: 09 - Some Applications of Trigonometry	Time: 1½ Hours	Max. Marks: 40

General Instructions:

1. All questions are compulsory.
2. This question paper contains 20 questions divided into five sections A, B, C, D and E.
3. Section A comprises of 10 MCQs of 1 mark each.
4. Section B comprises of 4 questions of 2 marks each.
5. Section C comprises of 3 questions of 3 marks each.
6. Section D comprises of 1 question of 5 marks.
7. Section E comprises of 2 Case Study Based questions of 4 marks each.
8. Use of Calculators is not permitted.

SECTION A - Multiple Choice Questions (1 mark each)

1. A kite is flying at a height of 60 m above the ground. The string attached to the kite is temporarily tied to a point on the ground. If the length of the string is 120 m, then the angle made by the string with the ground is:
 - (a) 45°
 - (b) 60°
 - (c) 30°
 - (d) 90°
2. From the top of a 7 m high building, the angle of elevation of the top of a cable tower is 60° and the angle of depression of its foot is 45° . The height of the tower is:
 - (a) $7(1 + \sqrt{3})$ m
 - (b) $7\sqrt{3}$ m
 - (c) 14 m
 - (d) $7 + \sqrt{3}$ m
3. The angle of elevation of the top of a tower from a point on the ground which is 30 m away from the foot of the tower is 30° . The height of the tower is:
 - (a) 10 m
 - (b) $10\sqrt{3}$ m
 - (c) $20\sqrt{3}$ m
 - (d) 30 m
4. A ladder leaning against a wall makes an angle of 60° with the ground. If the length of the ladder is 19 m, find the distance of the foot of the ladder from the wall:

- (a) 9.5 m
- (b) 19 m
- (c) $19\sqrt{3}$ m
- (d) 38 m

5. The shadow of a tower standing on level ground is found to be 40 m longer when the sun's altitude is 30° than when it is 60° . The height of the tower is:

- (a) 20 m
- (b) $20\sqrt{3}$ m
- (c) 40 m
- (d) $40\sqrt{3}$ m

6. An observer 1.5 m tall is 28.5 m away from a tower. The angle of elevation of the top of the tower from his eyes is 45° . The height of the tower is:

- (a) 27 m
- (b) 30 m
- (c) 28.5 m
- (d) 32 m

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

- (a) $20(\sqrt{3} - 1)$ m
- (b) $20(\sqrt{3} + 1)$ m
- (c) $20\sqrt{3}$ m
- (d) 40 m

8. The angle of depression from the top of a tower of a point A on the ground is 30° . On moving a distance of 20 m from the point A towards the foot of the tower to a point B, the angle of elevation of the top of the tower from B is 60° . The height of the tower is:

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

In the following questions 9 and 10, 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.

9. **Assertion (A):** The height of a tower is 100 m. When the angle of elevation of the sun changes from 30° to 45° , the shadow of the tower becomes $100(\sqrt{3} - 1)$ m shorter.

Reason (R): The length of shadow decreases as the angle of elevation increases.

10. **Assertion (A):** A tree is broken by wind. Its top strikes the ground at an angle of 30° and at a distance of 12 m from the foot. The total height of the tree is $8\sqrt{3}$ m.

Reason (R): In a right triangle with angle 30° , the side opposite to 30° is half of the hypotenuse.

SECTION B - Short Answer Questions (2 marks each)

- 11.** 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. If the angle made by the rope with the ground level is 30° , find the height of the pole.
- 12.** From a point on the ground, the angle of elevation of the top of a tower is observed to be 60° . From a point 40 m vertically above the first point, the angle of elevation is 45° . Find the height of the tower.
- 13.** A vertical tower stands on a horizontal plane and is surmounted by a vertical flagstaff of height h . At a point on the plane, the angles of elevation of the bottom and top of the flagstaff are α and β respectively. Prove that the height of the tower is $h \tan \alpha / (\tan \beta - \tan \alpha)$.
- 14.** The angle of elevation of a jet plane from a point A on the ground is 60° . After a flight of 15 seconds, the angle of elevation changes to 30° . If the jet plane is flying at a constant height of $1500\sqrt{3}$ m, find the speed of the jet plane.

SECTION C - Short Answer Questions (3 marks each)

- 15.** The angles of depression of the top and bottom of a 50 m high building from the top of a tower are 45° and 60° respectively. Find the height of the tower and the horizontal distance between the tower and the building. (Use $\sqrt{3} = 1.73$)
- 16.** A straight highway leads to the foot of a tower. A man standing at the top of the tower observes a car at an angle of depression of 30° . The car is approaching the foot of the tower with a uniform speed. Six seconds later, the angle of depression of the car is found to be 60° . Find the time taken by the car to reach the foot of the tower from this point.
- 17.** Two poles of equal heights are standing opposite to each other on either side of the road which is 80 m wide. From a point between them on the road, the angles of elevation of the top of the poles are 60° and 30° respectively. Find the height of the poles and the distances of the point from the poles.

SECTION D - Long Answer Question (5 marks)

- 18.** The angle of elevation of an aeroplane from a point on the ground is 45° . After flying for 15 seconds, the angle of elevation becomes 30° . If the aeroplane is flying at a height of 2500 m, calculate the speed of the aeroplane. (Take $\sqrt{3} = 1.732$)

SECTION E - Case Study Based Questions (4 marks each)

- 19.** A contractor plans to install two slides for children to play in a park. For the children below the age of 5 years, she prefers to have a slide whose top is at a height of 1.5 m and is inclined at an angle of 30° to the ground, whereas for elder children, she wants to have a steep slide at a height of 3 m and inclined at an angle of 60° to the ground.

Based on the above information, answer the following questions. (Take $\sqrt{3} = 1.732$)

- (i) What should be the length of the slide for younger children? (2 marks)
- (ii) What should be the length of the slide for elder children? (2 marks)

OR

(ii) What is the horizontal distance covered by the slide for younger children on the ground? (2 marks)

20. A bird is sitting on the top of a 80 m high tree. From a point on the ground, the angle of elevation of the bird is 45° . The bird flies away horizontally in such a way that it remained at a constant height from the ground. After 2 seconds, the angle of elevation of the bird from the same point is 30° .

Based on the above information, answer the following questions: (Take $\sqrt{3} = 1.732$)

(i) What is the distance of the bird from the point on the ground initially? (1 mark)

(ii) What is the distance travelled by the bird in 2 seconds? (2 marks)

OR

(ii) At what speed is the bird flying? (2 marks)

(iii) After 2 seconds, how far is the bird from the point on ground? (1 mark)

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SECTION A - Answers to MCQs

1. Answer: (c) 30°

Explanation: Height = 60 m, Length of string = 120 m

$$\sin \theta = 60/120 = 1/2$$

Therefore, $\theta = 30^\circ$

2. Answer: (a) $7(1 + \sqrt{3})$ m

Explanation: Let distance from building to tower = x

From angle of depression 45° : $x = 7$ m

Let height of tower above building = h

From angle of elevation 60° : $\tan 60^\circ = h/7 \rightarrow h = 7\sqrt{3}$

Total height of tower = $7 + 7\sqrt{3} = 7(1 + \sqrt{3})$ m

3. Answer: (b) $10\sqrt{3}$ m

Explanation: Distance = 30 m, Angle = 30°

$$\tan 30^\circ = h/30$$

$$1/\sqrt{3} = h/30$$

$$h = 30/\sqrt{3} = 10\sqrt{3} \text{ m}$$

4. Answer: (a) 9.5 m

Explanation: Length of ladder = 19 m, Angle with ground = 60°

$$\cos 60^\circ = \text{distance}/19$$

$$1/2 = \text{distance}/19$$

$$\text{distance} = 19/2 = 9.5 \text{ m}$$

5. Answer: (b) $20\sqrt{3}$ m

Explanation: Let height = h

At 60° : shadow = $h/\sqrt{3}$

At 30° : shadow = $h\sqrt{3}$

$$\text{Difference} = h\sqrt{3} - h/\sqrt{3} = h(3-1)/\sqrt{3} = 2h/\sqrt{3} = 40$$

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

6. Answer: (b) 30 m

Explanation: Observer height = 1.5 m, Distance = 28.5 m, Angle = 45°

$$\tan 45^\circ = h/28.5 \rightarrow h = 28.5 \text{ m (height from eye level)}$$

$$\text{Total height} = 28.5 + 1.5 = 30 \text{ m}$$

7. Answer: (a) $20(\sqrt{3} - 1)$ m

Explanation: Building height = 20 m

Let distance = x

$$\tan 45^\circ = 20/x \rightarrow x = 20 \text{ m}$$

Let total height = 20 + h

$$\tan 60^\circ = (20 + h)/20 \rightarrow \sqrt{3} = (20 + h)/20$$

$$20\sqrt{3} = 20 + h \rightarrow h = 20(\sqrt{3} - 1) \text{ m}$$

8. Answer: (b) $10\sqrt{3}$ m

Explanation: Let height = h, distance from B = x

$$\text{From B: } \tan 60^\circ = h/x \rightarrow \sqrt{3} = h/x \rightarrow x = h/\sqrt{3}$$

From A: distance = x + 20

$$\tan 30^\circ = h/(x + 20) \rightarrow 1/\sqrt{3} = h/(x + 20)$$

$$x + 20 = h\sqrt{3} \rightarrow h/\sqrt{3} + 20 = h\sqrt{3}$$

$$h(\sqrt{3} - 1/\sqrt{3}) = 20 \rightarrow h(2/\sqrt{3}) = 20$$

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

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

Explanation: At 30° : shadow = $100\sqrt{3}$ m

At 45° : shadow = 100 m

$$\text{Difference} = 100\sqrt{3} - 100 = 100(\sqrt{3} - 1) \text{ m} \checkmark$$

The reason correctly explains why shadow decreases.

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

Explanation: Broken part = hypotenuse, horizontal = 12 m

$$\cos 30^\circ = 12/\text{hypotenuse} \rightarrow \sqrt{3}/2 = 12/h \rightarrow h = 24/\sqrt{3} = 8\sqrt{3} \text{ m}$$

$$\text{Vertical part: } \sin 30^\circ = v/8\sqrt{3} \rightarrow v = 4\sqrt{3} \text{ m}$$

$$\text{Total height} = 4\sqrt{3} + 4\sqrt{3} = 8\sqrt{3} \text{ m} \checkmark$$

Reason R correctly explains the property used.

SECTION B - Answers to Short Answer Questions

11. Solution:

Length of rope = 20 m, Angle with ground = 30°

$$\sin 30^\circ = \text{height}/20$$

$$1/2 = \text{height}/20$$

Height of pole = 10 m

12. Solution:

Let height of tower = H, distance = x

$$\text{From first point: } \tan 60^\circ = H/x \rightarrow \sqrt{3} = H/x \rightarrow x = H/\sqrt{3}$$

$$\text{From second point (40 m above): } \tan 45^\circ = (H - 40)/x$$

$$1 = (H - 40)/x \rightarrow x = H - 40$$

$$H/\sqrt{3} = H - 40 \rightarrow H = H\sqrt{3} - 40\sqrt{3}$$

$$H(\sqrt{3} - 1) = 40\sqrt{3} \rightarrow H = 40\sqrt{3}/(\sqrt{3} - 1)$$

$$H = 40\sqrt{3}(\sqrt{3} + 1)/2 = 20(3 + \sqrt{3})$$

Height of tower = $20(3 + \sqrt{3})$ m \approx 94.64 m

13. Solution:

Let height of tower = H, distance from point = x

$$\tan \alpha = H/x \rightarrow x = H/\tan \alpha$$

$$\tan \beta = (H + h)/x \rightarrow x = (H + h)/\tan \beta$$

$$H/\tan \alpha = (H + h)/\tan \beta$$

$$H \tan \beta = (H + h) \tan \alpha$$

$$H \tan \beta = H \tan \alpha + h \tan \alpha$$

$$H(\tan \beta - \tan \alpha) = h \tan \alpha$$

$H = h \tan \alpha / (\tan \beta - \tan \alpha)$ (Hence proved)

14. Solution:

$$\text{Height} = 1500\sqrt{3} \text{ m}$$

$$\text{At } 60^\circ: \tan 60^\circ = 1500\sqrt{3}/d_1 \rightarrow \sqrt{3} = 1500\sqrt{3}/d_1 \rightarrow d_1 = 1500 \text{ m}$$

$$\text{At } 30^\circ: \tan 30^\circ = 1500\sqrt{3}/d_2 \rightarrow 1/\sqrt{3} = 1500\sqrt{3}/d_2 \rightarrow d_2 = 4500 \text{ m}$$

$$\text{Distance covered} = 4500 - 1500 = 3000 \text{ m}$$

$$\text{Speed} = 3000/15 = 200 \text{ m/s}$$

Speed of jet plane = 200 m/s = 720 km/h

SECTION C - Answers to Short Answer Questions

15. Solution:

Let height of tower = H, building height = 50 m, distance = x

From top of tower to bottom of building (60°):

$$\tan 60^\circ = H/x \rightarrow \sqrt{3} = H/x \rightarrow x = H/\sqrt{3}$$

From top of tower to top of building (45°):

$$\tan 45^\circ = (H - 50)/x \rightarrow 1 = (H - 50)/x \rightarrow x = H - 50$$

$$H/\sqrt{3} = H - 50 \rightarrow H = H\sqrt{3} - 50\sqrt{3}$$

$$H(\sqrt{3} - 1) = 50\sqrt{3} \rightarrow H = 50\sqrt{3}/(\sqrt{3} - 1)$$

$$H = 50\sqrt{3}(\sqrt{3} + 1)/2 = 25(3 + \sqrt{3}) = 75 + 25\sqrt{3}$$

$$H = 75 + 25(1.73) = 75 + 43.25 = 118.25 \text{ m}$$

$$x = 118.25/1.73 = 68.35 \text{ m}$$

Height of tower = 118.25 m, Distance = 68.35 m

16. Solution:

Let height of tower = h , initial distance = x

$$\text{At } 30^\circ: \tan 30^\circ = h/x \rightarrow x = h\sqrt{3}$$

$$\text{After 6 seconds, at } 60^\circ: \tan 60^\circ = h/y \rightarrow y = h/\sqrt{3}$$

$$\text{Distance covered in 6 seconds} = x - y = h\sqrt{3} - h/\sqrt{3} = h(3-1)/\sqrt{3} = 2h/\sqrt{3}$$

$$\text{Speed} = (2h/\sqrt{3})/6 = h/(3\sqrt{3})$$

$$\text{Time to cover } y \text{ from } 60^\circ \text{ position} = y/\text{speed}$$

$$= (h/\sqrt{3}) \div (h/3\sqrt{3}) = (h/\sqrt{3}) \times (3\sqrt{3}/h) = 3 \text{ seconds}$$

Time taken = 3 seconds

17. Solution:

Road width = 80 m, equal height poles = h

Let point be at distance x from first pole

$$\text{From first pole: } \tan 60^\circ = h/x \rightarrow h = x\sqrt{3}$$

$$\text{From second pole: } \tan 30^\circ = h/(80-x)$$

$$1/\sqrt{3} = h/(80-x) \rightarrow h = (80-x)/\sqrt{3}$$

$$x\sqrt{3} = (80-x)/\sqrt{3} \rightarrow 3x = 80 - x \rightarrow 4x = 80 \rightarrow x = 20 \text{ m}$$

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

$$\text{Distance from second pole} = 80 - 20 = 60 \text{ m}$$

Height of poles = $20\sqrt{3} \text{ m} \approx 34.64 \text{ m}$

Distances = 20 m and 60 m

SECTION D - Answer to Long Answer Question

18. Solution:

Height of aeroplane = 2500 m

Initial position at 45° : $\tan 45^\circ = 2500/d_1$

$$1 = 2500/d_1 \rightarrow d_1 = 2500 \text{ m}$$

After 15 seconds at 30° : $\tan 30^\circ = 2500/d_2$

$$1/\sqrt{3} = 2500/d_2 \rightarrow d_2 = 2500\sqrt{3} \text{ m}$$

$$d_2 = 2500 \times 1.732 = 4330 \text{ m}$$

$$\text{Distance travelled} = d_2 - d_1 = 4330 - 2500 = 1830 \text{ m}$$

Time = 15 seconds

$$\text{Speed} = 1830/15 = 122 \text{ m/s}$$

$$\text{Speed in km/h} = 122 \times 3.6 = 439.2 \text{ km/h}$$

Speed of aeroplane = 122 m/s or 439.2 km/h

SECTION E - Answers to Case Study Based Questions

19. Solution:

(i) Length of slide for younger children:

Height = 1.5 m, Angle = 30°

$$\sin 30^\circ = 1.5/\text{length}$$

$$1/2 = 1.5/\text{length}$$

$$\text{length} = 3 \text{ m}$$

Length of slide for younger children = 3 m

(ii) Length of slide for elder children:

Height = 3 m, Angle = 60°

$$\sin 60^\circ = 3/\text{length}$$

$$\sqrt{3}/2 = 3/\text{length}$$

$$\text{length} = 6/\sqrt{3} = 2\sqrt{3} = 2 \times 1.732 = 3.464 \text{ m}$$

Length of slide for elder children = 3.464 m or $2\sqrt{3}$ m

OR

(ii) Horizontal distance for younger children:

$$\cos 30^\circ = \text{horizontal distance}/3$$

$$\sqrt{3}/2 = \text{distance}/3$$

$$\text{distance} = 3\sqrt{3}/2 = 1.5 \times 1.732 = 2.598 \text{ m}$$

Horizontal distance = 2.598 m

20. Solution:

Height of tree = 80 m

(i) Initial distance:

$$\text{At } 45^\circ: \tan 45^\circ = 80/d_1 \rightarrow d_1 = 80 \text{ m}$$

$$\text{Distance} = \sqrt{(80^2 + 80^2)} = \sqrt{12800} = 80\sqrt{2} = 113.12 \text{ m}$$

Initial distance = 113.12 m or $80\sqrt{2}$ m

(ii) Distance travelled by bird:

$$\text{At } 30^\circ: \tan 30^\circ = 80/d_2 \rightarrow 1/\sqrt{3} = 80/d_2$$

$$d_2 = 80\sqrt{3} = 80 \times 1.732 = 138.56 \text{ m}$$

$$\text{Distance travelled} = 138.56 - 80 = 58.56 \text{ m}$$

Distance travelled = 58.56 m

OR

(ii) Speed of bird:

$$\text{Speed} = 58.56/2 = 29.28 \text{ m/s}$$

Speed = 29.28 m/s

(iii) Distance after 2 seconds:

$$\text{Distance} = \sqrt{(80^2 + 138.56^2)} = \sqrt{(6400 + 19198.88)} = \sqrt{25598.88} = 160 \text{ m}$$

Distance = 160 m

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