Solutions

Section A — Multiple Choice Questions

Q1. Correct Option: (B) Above the horizontal, from the observer's eye to a higher object.

Reason: The angle of elevation is the angle formed between the horizontal line of sight and the line of sight directed **upward** to the object. It is always measured above the horizontal.

Q2. Correct Option: (C) 45°

Reason: The angle of depression from the top of the tower to point P and the angle of elevation from P to the top of the tower are **alternate interior angles** formed by a transversal cutting two parallel horizontal lines. Hence they are equal.

$$\text{Angle of elevation from } P = 45^\circ$$

Q3. Correct Option: (D) $h = d\tan\theta$

Reason: In the right triangle formed by the tower (height h), horizontal distance d, and the line of sight:

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}} = \frac{h}{d} \implies h = d\tan\theta$$

Q4. Correct Option: (C) 60 **m**

Reason: Let the height of the pole be h. With distance = 60 m and angle of elevation = 45°:

$$\tan 45^\circ = \frac{h}{60}$$
$$1 = \frac{h}{60}$$
$$h = 60 \text{ m}$$

Q5. Correct Option: (B) $50\sqrt{3}$ **m**

Reason: The angle of depression from the top of the cliff is 30°, so the angle of elevation from the boat to the top of the cliff is also 30°. Let d be the horizontal distance.

$$\tan 30^\circ = \frac{50}{d}$$
$$\frac{1}{\sqrt{3}} = \frac{50}{d}$$
$$d = 50\sqrt{3} \text{ m}$$

Q6. Correct Option: (A) $15\sqrt{3}$ **m**

Reason: Let height of tower $= h$ and final distance from base $= x$.

$$\tan 60^\circ = \frac{h}{x} \implies x = \frac{h}{\sqrt{3}} \quad \cdots (1)$$

$$\tan 30^\circ = \frac{h}{x+30} \implies x + 30 = h\sqrt{3} \quad \cdots (2)$$

Substituting (1) into (2):

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

$$30 = h\sqrt{3} - \frac{h}{\sqrt{3}} = h \cdot \frac{3-1}{\sqrt{3}} = \frac{2h}{\sqrt{3}}$$

$$h = \frac{30\sqrt{3}}{2} = 15\sqrt{3} \text{ m}$$

Q7. Correct Option: (A) Both A and R are true, and R is the correct explanation of A.

Reason:

Checking Assertion A:

$$\text{Shadow length} = \frac{\text{height}}{\tan 60^\circ} = \frac{12\sqrt{3}}{\sqrt{3}} = 12 \text{ m} \quad \checkmark$$

Assertion A is TRUE.

Reason R correctly states the formula shadow $= \dfrac{h}{\tan\theta}$ and the value $\tan 60^\circ = \sqrt{3}$, which is exactly the computation used to verify A. **R is TRUE and is the correct explanation of A.**

Q8. Correct Option: (C) 30°

Reason: Let the angle of elevation of the sun be θ. Shadow length $= h\sqrt{3}$.

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

$$\theta = 30^\circ$$

Q9. Correct Option: (B) $80\sqrt{3}$ **m**

Reason: Tower height $= 60$ m.

Distance of first man (angle 30°):

$$d_1 = \frac{60}{\tan 30^\circ} = 60\sqrt{3} \text{ m}$$

Distance of second man (angle 60°):

$$d_2 = \frac{60}{\tan 60^\circ} = \frac{60}{\sqrt{3}} = 20\sqrt{3} \text{ m}$$

Total distance between the two men:

$$d_1 + d_2 = 60\sqrt{3} + 20\sqrt{3} = 80\sqrt{3} \text{ m}$$

Q10. Correct Option: (D) $1000\sqrt{3}$ m

Reason: Speed $= 60$ km/h $= \dfrac{60 \times 1000}{60} = 1000$ m/min.

Distance covered in 2 minutes $= 2000$ m.

Let h be the height of the tower and d_2 the closer distance.

$$\tan 60^\circ = \frac{h}{d_2} \implies d_2 = \frac{h}{\sqrt{3}} \quad \cdots (1)$$

$$\tan 30^\circ = \frac{h}{d_2 + 2000} \implies d_2 + 2000 = h\sqrt{3} \quad \cdots (2)$$

Substituting (1) into (2):

$$\frac{h}{\sqrt{3}} + 2000 = h\sqrt{3}$$

$$2000 = h\sqrt{3} - \frac{h}{\sqrt{3}} = \frac{2h}{\sqrt{3}}$$

$$h = \frac{2000\sqrt{3}}{2} = 1000\sqrt{3} \text{ m}$$

Q11. Correct Option: (C) $60\sqrt{3}$ m/s

Reason: Height of aeroplane $= 1800$ m.

When the aeroplane is directly overhead, angle of elevation $= 90^\circ$, so the observer is directly below it. After 10 seconds, the angle of elevation is 60°.

Let x be the horizontal distance covered in 10 s.

$$\tan 60^\circ = \frac{1800}{x}$$

$$\sqrt{3} = \frac{1800}{x}$$

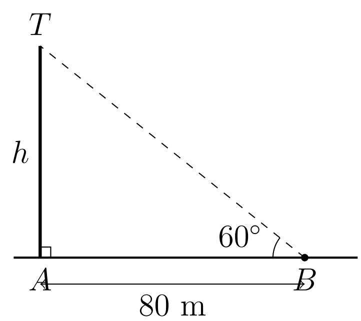
$$x = \frac{1800}{\sqrt{3}} = 600\sqrt{3} \text{ m}$$

Speed of the aeroplane:

$$v = \frac{x}{t} = \frac{600\sqrt{3}}{10} = 60\sqrt{3} \text{ m/s}$$

Section B — Short Answer Questions

Q12. Diagram:



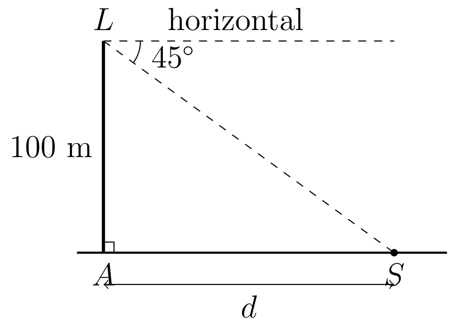
Solution:

Let the height of the tower be h metres. In right triangle TAB, with $AB = 80$ m and $\angle TBA = 60^\circ$:

$$\tan 60^\circ = \frac{h}{80}$$
$$\sqrt{3} = \frac{h}{80}$$
$$h = 80\sqrt{3} \text{ m}$$

$$\boxed{\text{Height of tower} = 80\sqrt{3} \approx 138.56 \text{ m}}$$

Q13. Diagram:



Solution:

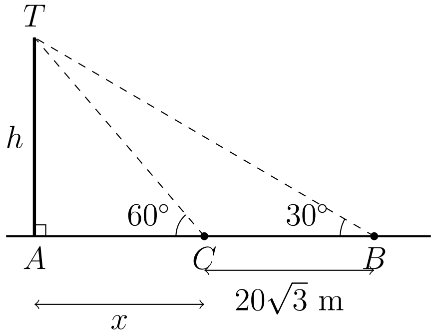
Let d be the horizontal distance of the ship from the foot of the lighthouse. The angle of depression from L to ship S is 45°, which equals the angle of elevation from S to L.

$$\tan 45^\circ = \frac{100}{d}$$
$$1 = \frac{100}{d}$$
$$d = 100 \text{ m}$$

Time to reach directly below the lighthouse at speed 10 m/s:

$$t = \frac{d}{\text{speed}} = \frac{100}{10} = \mathbf{10} \text{ seconds}$$

Q14. Diagram:



Solution:

Let height of pole $= h$ and final distance $AC = x$.

From second position C (angle $60°$):

$$\tan 60° = \frac{h}{x} \implies x = \frac{h}{\sqrt{3}} \quad \cdots (1)$$

From first position B (angle $30°$), $AB = x + 20\sqrt{3}$:

$$\tan 30° = \frac{h}{x + 20\sqrt{3}} \implies x + 20\sqrt{3} = h\sqrt{3} \quad \cdots (2)$$

Substituting (1) into (2):

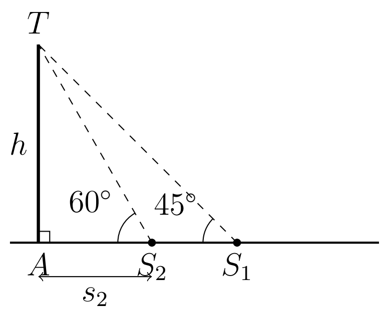
$$\frac{h}{\sqrt{3}} + 20\sqrt{3} = h\sqrt{3}$$

$$20\sqrt{3} = h\sqrt{3} - \frac{h}{\sqrt{3}} = h \cdot \frac{3-1}{\sqrt{3}} = \frac{2h}{\sqrt{3}}$$

$$h = \frac{20\sqrt{3} \cdot \sqrt{3}}{2} = \frac{60}{2} = 30 \text{ m}$$

$$\boxed{\text{Height of pole} = 30 \text{ m}}$$

Q15. Diagram:



Solution:

(i) **Height of the pole ($\theta = 45°$, shadow $= 25$ m):**

$$\tan 45° = \frac{h}{25} \implies 1 = \frac{h}{25} \implies h = 25 \text{ m}$$

(ii) **Shadow length when $\theta = 60°$:**

$$\tan 60° = \frac{25}{s_2}$$

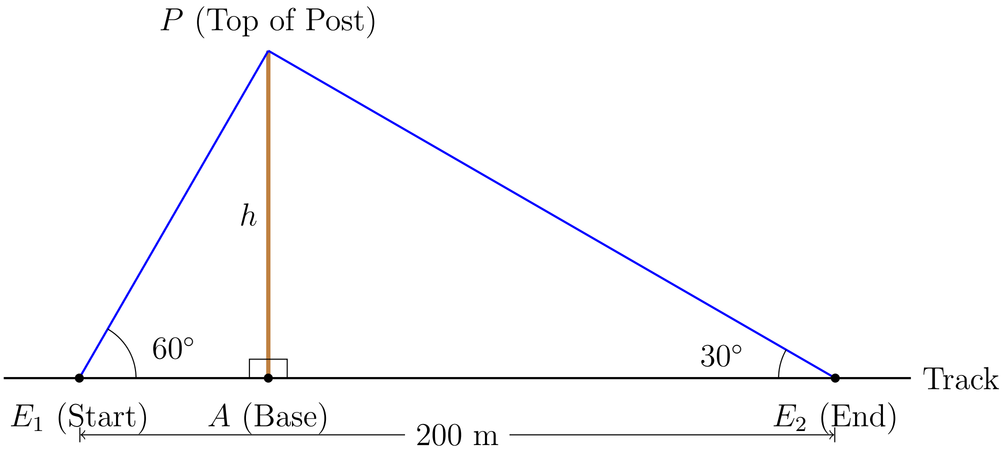
$$s_2 = \frac{25}{\sqrt{3}} = \frac{25\sqrt{3}}{3} \text{ m}$$

(iii) **Reduction in shadow length:**

$$\Delta s = 25 - \frac{25\sqrt{3}}{3} = 25\left(1 - \frac{\sqrt{3}}{3}\right) = \frac{25(3-\sqrt{3})}{3} \text{ m}$$

$$\boxed{\Delta s = \frac{25(3-\sqrt{3})}{3} \approx 10.57 \text{ m}}$$

Q16. Diagram:



Solution:

Q16. Let height of post $= h$, and distance from E_1 to base $A = x$.

The train passes the post: E_1 is before A, E_2 is past A.

$$E_1A = x, \qquad E_2A = 200 - x$$

At position E_1 (angle $60°$):

$$\tan 60° = \frac{h}{x} \implies x = \frac{h}{\sqrt{3}} \quad \cdots (1)$$

At position E_2, looking back (angle $30°$):

$$\tan 30° = \frac{h}{200 - x} \implies 200 - x = h\sqrt{3} \quad \cdots (2)$$

Adding equations (1) and (2):

$$x + (200 - x) = \frac{h}{\sqrt{3}} + h\sqrt{3}$$

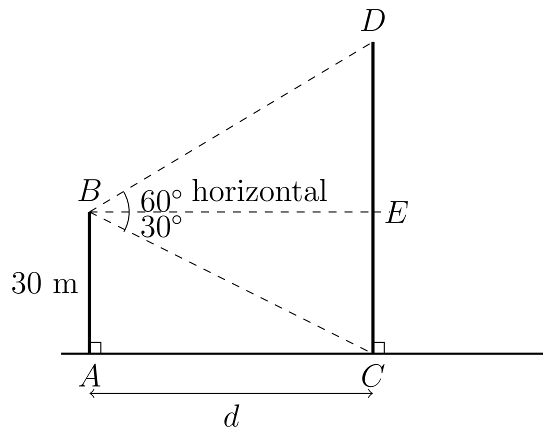
$$200 = h\left(\frac{1}{\sqrt{3}} + \sqrt{3}\right) = h \cdot \frac{1+3}{\sqrt{3}} = \frac{4h}{\sqrt{3}}$$

$$h = \frac{200\sqrt{3}}{4} = 50\sqrt{3} \text{ m}$$

$$\boxed{\text{Height of signal post} = 50\sqrt{3} \approx 86.6 \text{ m}}$$

Section C — Long Answer Questions

Q17. (i) **Diagram:**



(ii) **Horizontal distance between the buildings:**
From the top B of the shorter building, the angle of depression to base C of the taller building is 30°. BC is horizontal at height 30 m, so in triangle ABC:

$$\tan 30^\circ = \frac{30}{d}$$
$$\frac{1}{\sqrt{3}} = \frac{30}{d}$$
$$d = 30\sqrt{3} \text{ m}$$

$$\boxed{\text{Horizontal distance} = 30\sqrt{3} \text{ m}}$$

(iii) **Height of the taller building:**
Let E be the point on CD at the same height as B (i.e., 30 m). Then $BE = d = 30\sqrt{3}$ m.
From B, angle of elevation to D is 60°:

$$\tan 60^\circ = \frac{DE}{BE}$$
$$\sqrt{3} = \frac{DE}{30\sqrt{3}}$$
$$DE = 30\sqrt{3} \times \sqrt{3} = 90 \text{ m}$$

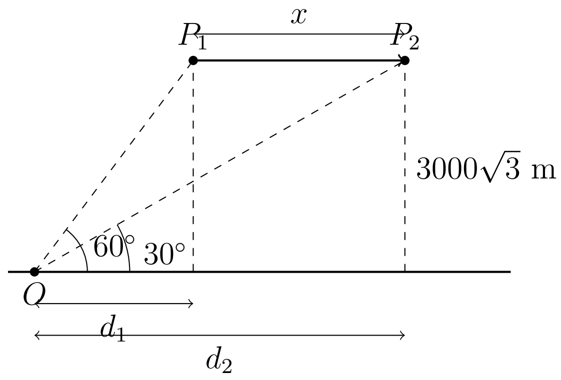
$$\text{Total height of taller building} = DE + EC = 90 + 30 = 120 \text{ m}$$
$$\boxed{H = 120 \text{ m}}$$

(iv) **Vertical distance between the tops:**

$$BD = DE = 90 \text{ m}$$

$$\boxed{\text{Vertical distance between tops} = 90 \text{ m}}$$

Q18. **Diagram:**



Solution:
Height $h = 3000\sqrt{3}$ m.

(i) **Horizontal distance at** $60°$**:**

$$\tan 60° = \frac{3000\sqrt{3}}{d_1}$$
$$d_1 = \frac{3000\sqrt{3}}{\sqrt{3}} = 3000 \text{ m}$$

(ii) **Horizontal distance at** $30°$**:**

$$\tan 30° = \frac{3000\sqrt{3}}{d_2}$$
$$d_2 = 3000\sqrt{3} \times \sqrt{3} = 9000 \text{ m}$$

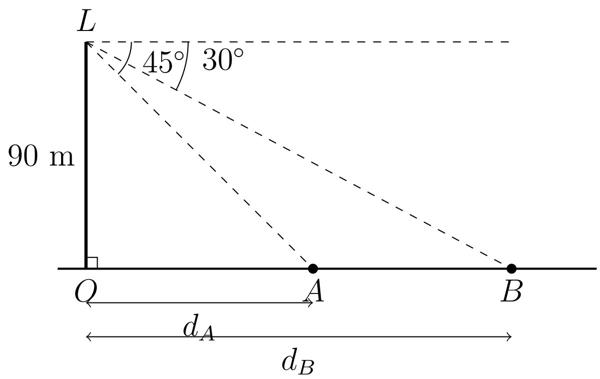
(iii) **Distance covered by the plane:**

$$x = d_2 - d_1 = 9000 - 3000 = 6000 \text{ m}$$

(iv) **Speed of the plane:**

$$\text{Speed} = \frac{6000}{20} = 300 \text{ m/s} = 300 \times \frac{3600}{1000} = \mathbf{1080} \text{ km/h}$$

Q19. Diagram:



Solution:

(i) **Distance of ship A (angle of depression $45°$):**

$$\tan 45° = \frac{90}{d_A}$$
$$d_A = 90 \text{ m}$$

(ii) **Distance of ship B (angle of depression $30°$):**

$$\tan 30° = \frac{90}{d_B}$$
$$\frac{1}{\sqrt{3}} = \frac{90}{d_B}$$
$$d_B = 90\sqrt{3} \text{ m}$$

(iii) **Distance between the two ships:**

$$AB = d_B - d_A = 90\sqrt{3} - 90 = 90(\sqrt{3} - 1) \text{ m}$$

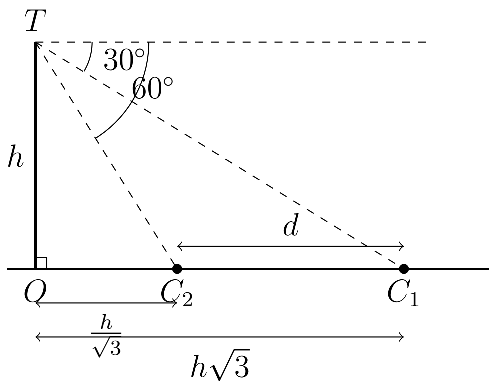
(iv) **Which ship reaches the base first?**

$$\text{Time for ship } A = \frac{d_A}{\text{speed}_A} = \frac{90}{10} = 9 \text{ s}$$

$$\text{Time for ship } B = \frac{d_B}{\text{speed}_B} = \frac{90\sqrt{3}}{5\sqrt{3}} = \frac{90}{5} = 18 \text{ s}$$

Ship A reaches the base first, **9 seconds** before ship B.

Q20. (i) **Diagram and horizontal distances:**



Let height of tower $= h$. Using angles of depression:

$$\tan 30° = \frac{h}{OC_1} \implies OC_1 = h\sqrt{3} \quad \text{(first position, farther)}$$

$$\tan 60° = \frac{h}{OC_2} \implies OC_2 = \frac{h}{\sqrt{3}} \quad \text{(second position, closer)}$$

(ii) **Distance travelled in 6 seconds:**

$$d = OC_1 - OC_2 = h\sqrt{3} - \frac{h}{\sqrt{3}} = h\left(\sqrt{3} - \frac{1}{\sqrt{3}}\right) = \frac{2h}{\sqrt{3}} \text{ m}$$

(iii) **With $h = 60$ m:**

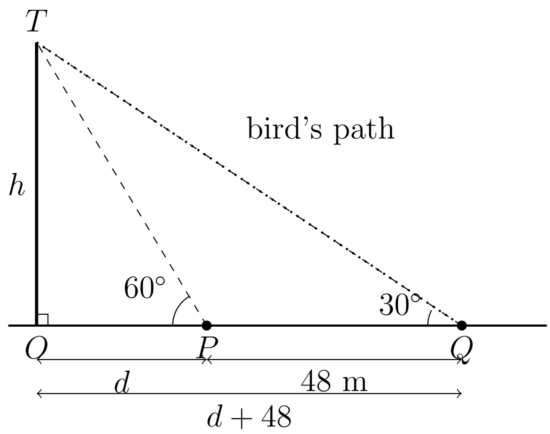
$$d = \frac{2 \times 60}{\sqrt{3}} = \frac{120}{\sqrt{3}} = \frac{120\sqrt{3}}{3} = 40\sqrt{3} \text{ m}$$

(iv) **Speed of the car:**

$$\text{Speed} = \frac{40\sqrt{3}}{6} = \frac{20\sqrt{3}}{3} \text{ m/s}$$

$$= \frac{20\sqrt{3}}{3} \times \frac{3600}{1000} = 24\sqrt{3} \approx \mathbf{41.57} \text{ km/h}$$

Q21. Diagram:



(i) **Two equations in h and d:**
From point P (nearer, angle 60°):

$$\tan 60^\circ = \frac{h}{d} \implies h = d\sqrt{3} \quad \cdots (1)$$

From point Q (farther, angle 30°), $OQ = d + 48$:

$$\tan 30^\circ = \frac{h}{d+48} \implies h = \frac{d+48}{\sqrt{3}} \quad \cdots (2)$$

(ii) **Solving for h and d:**
Equating (1) and (2):

$$d\sqrt{3} = \frac{d+48}{\sqrt{3}}$$
$$3d = d + 48$$
$$2d = 48$$
$$d = 24 \text{ m}$$

Substituting into (1):

$$h = 24\sqrt{3} \text{ m}$$

$$\boxed{h = 24\sqrt{3} \text{ m}, \qquad d = 24 \text{ m}}$$

(iii) **Distance flown by the bird from top of tower to Q:**
The bird flies from $T(0, h)$ to Q at distance $OQ = d + 48 = 72$ m from base, along the ground.
Using the Pythagorean theorem:

$$TQ = \sqrt{OQ^2 + h^2} = \sqrt{72^2 + (24\sqrt{3})^2}$$
$$= \sqrt{5184 + 1728} = \sqrt{6912} = \sqrt{576 \times 12} = 24\sqrt{12} = 48\sqrt{3} \text{ m}$$

$$\boxed{\text{Distance flown} = 48\sqrt{3} \text{ m}}$$

(iv) **Time taken at speed $5\sqrt{10}$ m/s:**

$$t = \frac{48\sqrt{3}}{5\sqrt{10}} = \frac{48\sqrt{3}}{5\sqrt{10}} \times \frac{\sqrt{10}}{\sqrt{10}} = \frac{48\sqrt{30}}{50} = \frac{24\sqrt{30}}{25} \text{ s}$$

$$\boxed{t = \frac{24\sqrt{30}}{25} \approx 5.26 \text{ seconds}}$$