Case Study 1: Observing a Flagpole from Different Points

Ritika visits her school ground where a tall flagpole is erected. She wants to calculate the height of the flagpole without actually measuring it directly. She stands at a certain distance from the base of the flagpole and measures the angle of elevation of the top of the pole using a clinometer she made in her science class. She then walks closer to the pole and measures the angle again. Using the two angles of elevation and the distance between the two observation points, she is able to calculate the height of the flagpole. This practical approach shows how trigonometry can be used to find heights of tall objects without physically climbing them. It involves right-angled triangles formed by the line of sight, the height of the flagpole, and the ground.

Formulas used:

$$\tan\theta = \frac{\text{opposite side}}{\text{adjacent side}},$$

$$\sin\theta = \frac{\text{opposite side}}{\text{hypotenuse}}, \quad \cos\theta = \frac{\text{adjacent side}}{\text{hypotenuse}}$$

MCQ Questions

1. Ritika first stands 20 m away from the flagpole and measures the angle of elevation to be 30°. The height of the flagpole is:
   (a) $10\sqrt{3}$ m (b) $20\sqrt{3}$ m (c) 30 m (d) 40 m

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

   Solution: $\tan 30^\circ = \frac{h}{20} \implies \frac{1}{\sqrt{3}} = \frac{h}{20} \implies h = \frac{20}{\sqrt{3}} = 10\sqrt{3}$.

2. If instead she stands 20 m away and measures angle of elevation as 45°, the height of the flagpole would be:
   (a) 10 m (b) 15 m (c) 20 m (d) 25 m

   Answer: (c) 20 m

   Solution: $\tan 45^\circ = \frac{h}{20} \implies 1 = \frac{h}{20} \implies h = 20$.

3. Ritika then walks 10 m closer to the flagpole. If the angle of elevation now is 60°, what is the height of the pole?
   (a) $10\sqrt{3}$ m (b) $15\sqrt{3}$ m (c) $20\sqrt{3}$ m (d) $25\sqrt{3}$ m

   Answer: (b) $15\sqrt{3}$ m

   Solution: New distance $= 20 - 10 = 10$ m. $\tan 60^\circ = \frac{h}{10} \implies \sqrt{3} = \frac{h}{10} \implies h = 10\sqrt{3}$.
   Correction: Actual answer is (a) $10\sqrt{3}$ m.

4. Which trigonometric ratio is most useful for solving these height and distance problems?
   (a) $\sin\theta$ (b) $\cos\theta$ (c) $\tan\theta$ (d) $\sec\theta$

   Answer: (c) $\tan\theta$

   Solution: Because $\tan\theta$ relates vertical height to horizontal distance.

5. If Ritika stands at 15 m from the base and finds the angle of elevation to be $arctan(\frac{4}{3})$, then the height of the pole is:
   (a) 15 m (b) 20 m (c) 25 m (d) 30 m

   Answer: (c) 20 m

   Solution: $\tan\theta = \frac{h}{15} = \frac{4}{3} \implies h = \frac{4}{3} \times 15 = 20$. Correction: Correct answer is (b) 20 m.