Case Study 3: Trigonometry in Real Life – Flagpole and Building

Riya and Aman were walking in a park when they noticed a tall flagpole near the entrance and a tall building at the far end. Out of curiosity, they wanted to calculate the heights of both objects without actually measuring them. Riya stood at a certain distance from the flagpole and measured the angle of elevation of the top of the pole to be 30°. Walking 20 meters closer to the flagpole, she found the angle of elevation increased to 60°. Later, they looked at the tall building. Standing at a distance of 50 meters from the building, Aman measured the angle of elevation of the top to be 45°. They decided to use trigonometry to calculate the height of the flagpole and the building. This real-life scenario helps in understanding the applications of **heights and distances** using trigonometric ratios and identities.

Important Formulas:

$$\tan\theta = \frac{\text{Opposite side}}{\text{Adjacent side}}, \quad \sin^2\theta + \cos^2\theta = 1$$

MCQ Questions

1. If the distance of Riya from the flagpole initially was x meters, which equation correctly represents the situation when the angle of elevation was 30°?
   (a) $\tan 30^\circ = \frac{h}{x}$ (b) $\tan 30^\circ = \frac{x}{h}$ (c) $\tan 60^\circ = \frac{x}{h}$ (d) $\sin 30^\circ = \frac{h}{x}$

   Answer: (a) **Solution:** By definition, $\tan\theta = \frac{\text{Opposite}}{\text{Adjacent}}$, hence $\tan 30^\circ = \frac{h}{x}$.

2. After walking 20 meters closer, the new equation is:
   (a) $\tan 60^\circ = \frac{h}{x-20}$ (b) $\tan 45^\circ = \frac{h}{x+20}$ (c) $\tan 30^\circ = \frac{h}{x-20}$ (d) $\tan 60^\circ = \frac{x-20}{h}$

   Answer: (a) **Solution:** New distance $= x - 20$. Thus, $\tan 60^\circ = \frac{h}{x-20}$.

3. Solving the two equations gives the height of the flagpole as:
   (a) $10\sqrt{3}$ m (b) $20\sqrt{3}$ m (c) $30\sqrt{3}$ m (d) $40\sqrt{3}$ m

   Answer: (c) **Solution:** From $\tan 30^\circ = \frac{h}{x}$, we get $h = \frac{x}{\sqrt{3}}$. From $\tan 60^\circ = \frac{h}{x-20}$, we get $h = \sqrt{3}(x-20)$. Equating: $\frac{x}{\sqrt{3}} = \sqrt{3}(x-20) \implies x = 30, h = 10\sqrt{3}$. Correction: Correct option is (a).

4. The height of the building is:
   (a) 40 m (b) 45 m (c) 50 m (d) 55 m

   Answer: (c) **Solution:** $\tan 45^\circ = \frac{h}{50} \implies h = 50$ m.

5. Which trigonometric identity can be used to verify the values of $\sin\theta$ and $\cos\theta$ obtained in such problems?
   (a) $\tan^2\theta + 1 = \sec^2\theta$ (b) $\sin^2\theta + \cos^2\theta = 1$ (c) $1 + \cot^2\theta = \csc^2\theta$ (d) All of these

   Answer: (d) **Solution:** All identities are standard and can be used to check values of trigonometric ratios.