Case Study 3: Street Light Pole and Shadow

A tall street light pole stands vertically on the side of a straight road. On a sunny day, the pole casts a shadow on the road. Students of Class 10 decided to calculate the angle of elevation of the Sun by measuring the length of the pole and its shadow. They also verified trigonometric identities using the calculated values of sine, cosine, and tangent. This real-life context connects basic trigonometric ratios to a practical observation. It helps to demonstrate how identities like $\sin^2\theta + \cos^2\theta = 1$ and $1 + \tan^2\theta = \sec^2\theta$ can be applied to everyday situations involving right-angled triangles.

Formulas used:

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

$$\sin^2\theta + \cos^2\theta = 1, \quad 1 + \tan^2\theta = \sec^2\theta$$

MCQ Questions

1. A pole 12 m high casts a shadow of length 5 m. The hypotenuse of the right triangle formed is:
   (a) 12 m (b) 13 m (c) 14 m (d) 15 m

   Answer: (b) 13 m

   Solution: Hypotenuse $= \sqrt{12^2 + 5^2} = \sqrt{144 + 25} = \sqrt{169} = 13$.

2. The sine of the angle of elevation of the Sun is:
   (a) $\frac{5}{12}$ (b) $\frac{12}{13}$ (c) $\frac{12}{5}$ (d) $\frac{13}{12}$

   Answer: (b) $\frac{12}{13}$

   Solution: $\sin\theta = \dfrac{12}{13}$.

3. The cosine of the angle of elevation of the Sun is:
   (a) $\frac{5}{12}$ (b) $\frac{12}{13}$ (c) $\frac{5}{13}$ (d) $\frac{13}{5}$

   Answer: (c) $\frac{5}{13}$

   Solution: $\cos\theta = \dfrac{5}{13}$.

4. Verify which identity holds for these values of sine and cosine:
   (a) $\sin^2\theta + \cos^2\theta = 1$ (b) $\sin\theta\cos\theta = 1$ (c) $\tan^2\theta + 1 = \csc^2\theta$ (d) $\cos^2\theta - \sin^2\theta = 1$

   Answer: (a) $\sin^2\theta + \cos^2\theta = 1$

   Solution: $\left(\frac{12}{13}\right)^2 + \left(\frac{5}{13}\right)^2 = \frac{144}{169} + \frac{25}{169} = \frac{169}{169} = 1$.

5. If $\tan\theta = \frac{12}{5}$, then $\sec^2\theta$ equals:
   (a) $\frac{144}{25}$ (b) $\frac{169}{25}$ (c) $\frac{25}{169}$ (d) $\frac{13}{12}$

   Answer: (b) $\frac{169}{25}$

   Solution: $1 + \tan^2\theta = \sec^2\theta = 1 + \left(\frac{12}{5}\right)^2 = 1 + \frac{144}{25} = \frac{169}{25}$.