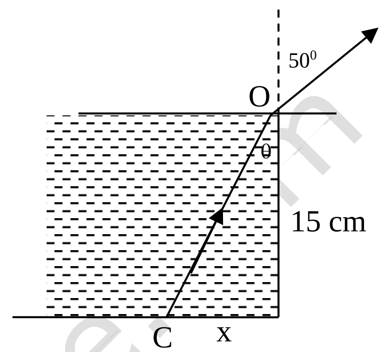
Q- An opaque container is 15 cm deep. It contains only a single coin. When looking into the container at a viewing angle of 50° relative to the vertical side of the container, you see nothing on the bottom. When the container is filled with water, you see the coin (from the same viewing angle) on the bottom of, and just beyond, the side of the container. How far is the coin from the side of the container?



To see the coil the ray of light should reach your eye. Let the distance of coin from the side of the container is x. then for the ray of light from the container just near the side CO the angle of incidence θ is given by

$$\tan\theta = \frac{x}{15}$$

Or $$\sin\theta = \frac{x}{\sqrt{x^2+225}}$$

As the angle of refraction in air is 50^0

As the refractive index of water is μ = 1.33, refractive index of air relative to water will be $1/\mu$ and thus applying Snell's law we get

$$\frac{1}{\mu_w} = \frac{\sin\theta}{\sin 50}$$

Or $$\frac{1}{1.33} = \frac{\sin\theta}{0.766}$$

Gives $\sin\theta = 0.576$

Substituting in equation (1) we get

$$\frac{x}{\sqrt{x^2+225}} = 0.576$$

Squaring

$0.33\ (x^2 + 225) = x^2$

Or $x^2 = 0.33*225/0.67 = 111.1$

Or $x = 10.54$ cm.

Hence the distance of the coin from the side of the container is **10.54 cm**.