Answer on Question #42940, Physics, Mechanics | Kinematics | Dynamics

A rifle is aimed directly at the centre of a target having a radius of 50 cm which is positioned at the same height as the rifle and is 200 m away. If the bullet leaves the muzzle at 500 m/s, will it miss the target? If so, by how much?
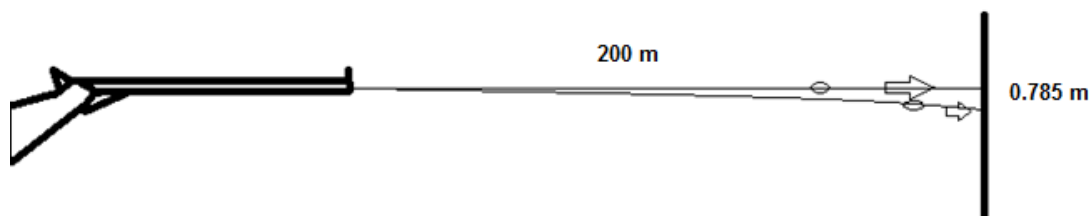
Solution:

Given:

$R = 50\ cm,$

$v_{0x} = 500\ \text{m/s},$

$v_{0y} = 0\ \text{m/s},$

$d = 200\ \text{m},$

$y =?$

Projectile motion is a form of motion in which an object or particle (called a projectile) is thrown near the earth's surface, and it moves along a curved path under the action of gravity only.

In projectile motion, the horizontal motion and the vertical motion are independent of each other; that is, neither motion affects the other.

The horizontal component of the velocity of the object remains unchanged throughout the motion. The vertical component of the velocity increases linearly, because the acceleration due to gravity is constant (g=9.81 m/s²).

Equations related to trajectory motion are given by

$$\text{Horizontal distance,}\quad d = v_{0x}t$$

$$\text{Vertical distance,}\quad y = y_0 + v_{0y}t - \frac{1}{2}gt^2$$

From first equation we have time of flight

$$t = \frac{d}{v_{0x}} = \frac{200}{500} = 0.4\ \text{s}$$

From second equation the displacement in vertical equation

$$y = -\frac{1}{2} \cdot 9.81 \cdot 0.4^2 = -0.785\ \text{m} = -78.5\ \text{cm}$$

Thus, bullet will miss the target by $|y - R| = 78.5 - 50 = 28.5$ cm.

Answer: The bullet will miss the target by 28.5 cm.