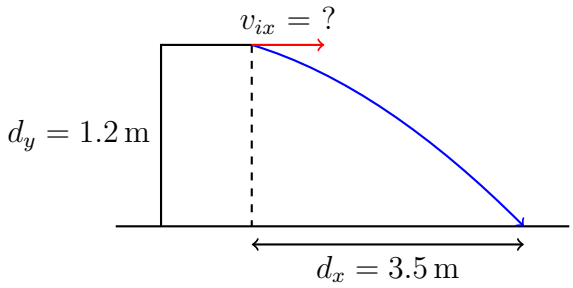
Projectile Motion Problem

Problem Statement

A ball is rolled off a desk that is 1.2 m tall, aiming to hit a target 3.5 m away from the base of the desk. The ball rolls horizontally off the edge. What must the initial horizontal velocity of the ball (v_{ix}) be to hit the target?

Step 1: Diagram



Step 2: Understand the Variables and Known Values

Horizontal		Vertical	
$d_x =$	$3.5\,\text{m}$	$d_y =$	$1.2\,\text{m}$
$v_{ix} =$	$?$	$v_{iy} =$	$0\,\text{m/s}$
$v_{fx} =$	$?$	$v_{fy} =$	$?$
$a_x =$	$0\,\text{m/s}^2$	$a_y =$	$9.81\,\text{m/s}^2$
$t =$		$?$	

Step 3: Use Vertical Motion to Find Time (t)

The vertical motion equation is:

$$d_y = v_{iy}t + \frac{1}{2}a_y t^2$$

Substitute $v_{iy} = 0$:

$$d_y = \frac{1}{2}a_y t^2$$

Rearrange to solve for t:

$$t = \sqrt{\frac{2d_y}{a_y}}$$

Substitute $d_y = 1.2\,\text{m}$ and $a_y = 9.81\,\text{m/s}^2$:

$$t = \sqrt{\frac{2(1.2)}{9.81}} = \sqrt{0.2445} \approx 0.494\,\text{seconds}$$

Step 4: Find Initial Horizontal Velocity

The horizontal motion equation is:

$$d_x = v_{ix}t + \frac{1}{2}a_x t^2$$

Since $a_x = 0\,\text{m/s}^2$, the equation becomes:

$$d_x = v_{ix}t$$

Rearrange to solve for v_{ix}:

$$v_{ix} = \frac{d_x}{t}$$

Substitute $d_x = 3.5\,\text{m}$ and $t = 0.494\,\text{s}$:

$$v_{ix} = \frac{3.5}{0.494} \approx 7.09\,\text{m/s}$$