

20-P-KM-AF-008

Curvilinear Motion: Immediate

Q:

A dog owner throws the ball for their dog at angle θ° above it's horizontal. The owner is A meters tall and is standing on a hill with a downward slope of α° . What are the coordinates where the ball landed? What ^{constant} speed must the dog travel at to get to the ball at the same time?

if $v_i = B$ m/s

A:

Use $x = x_0 + v_{0x}t$, $y = y_0 + v_{0y}t + \frac{1}{2}at^2$, $\tan(\theta) = \text{slope}$

$\theta = \text{angle 1}$

$\alpha = \text{angle 2}$

$y_0 = A$

$v_i = B$

① $y = -\tan(\alpha)x$

② $y = A + B \sin(\theta)t + \frac{1}{2}(-9.8)t^2$

③ $x = 0 + B \cos(\theta)t$

3 eqns, 3 unknowns

combine ① and ②

$$-\tan(\alpha)x = A + B \sin(\theta)t + \frac{1}{2}(-9.8)t^2$$

add ③ $x = \frac{A + B \sin(\theta)t + \frac{1}{2}(-9.8)t^2}{-\tan(\alpha)} = B \cos(\theta)t$

$$A + B \sin(\theta)t + \tan(\alpha)B \cos(\theta)t - 4.9t^2 = 0$$

$$A + B [\sin(\theta) + \tan(\alpha)\cos(\theta)]t - 4.9t^2 = 0$$

$$t = \frac{-C \pm \sqrt{C^2 - 4(-4.9) \cdot A}}{2(-4.9)}, \quad x = B \cos(\theta)t, \quad y = -\tan(\alpha)x$$

$$C = \sqrt{x^2 + y^2} \quad \text{speed} = C/t$$

