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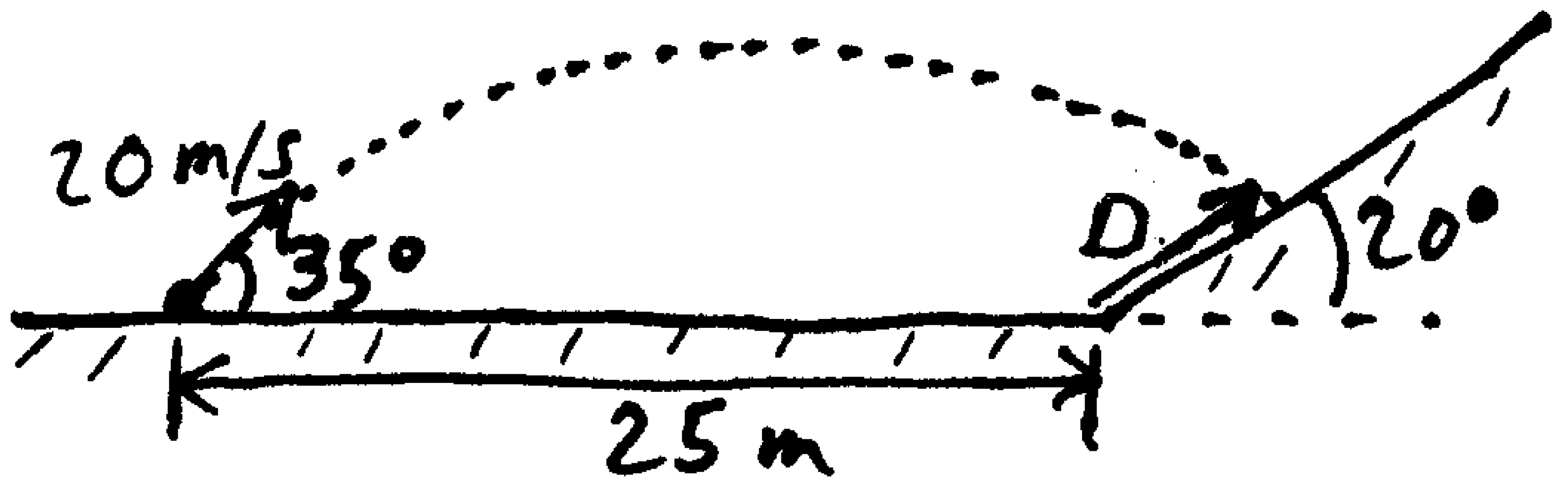
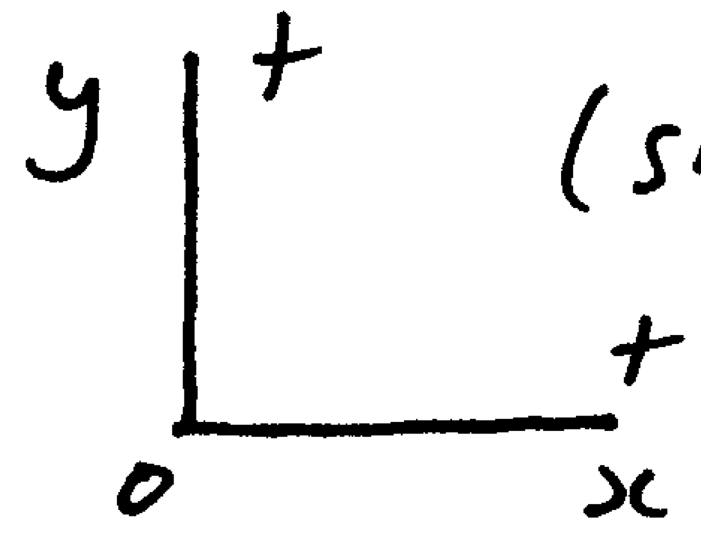


A ball is launched at ground level at a speed of 20 m/s, at an angle of 35° above the horizontal. A hill is located 25 m from the launch point, where it has an inclination of 20°. How far up the hill, D, does the ball land?

Solution: Assumption: - Air resistance is negligible

Set up an xy coordinate frame with origin at the launch point, as shown:



(sign convention)

The equation for horizontal motion is:

$$d_x = (V_0 \cos 35°)t \quad (1)$$

$d_x = 25 + D\cos 20°$ (horizontal displacement when ball lands on hill)

$V_0 = 20$ m/s (magnitude of initial ball velocity)

$t = ?$ (time that the ball is airborne)

The equation for vertical motion is:

$$d_y = (V_0 \sin 35°)t - \frac{1}{2}gt^2 \quad (2)$$

$d_y = D\sin 20°$ (vertical displacement when ball lands on hill)

$g = 9.8\ m/s^2$

From equation (1) $\Rightarrow 25 + D\cos 20° = (20\cos 35°)t$

From equation (2) $\Rightarrow D\sin 20° = (20\sin 35°)t - 4.9t^2$

From equation (1), solve for t:

$$t = \frac{25 + D\cos 20°}{20\cos 35°}$$

Substitute this into equation (2) and solve for D:

$$D\sin 20° = \tan 35°(25 + D\cos 20°) - 4.9\left(\frac{25 + D\cos 20°}{20\cos 35°}\right)^2$$

This equation simplifies to:

$$-0.01612D^2 - 0.5418D + 6.09515 = 0$$

This is a quadratic equation. Solve for D.

$D = \underbrace{-42.5\,m}_{\text{not valid}}$, or $D = 8.9\,m$ (answer)