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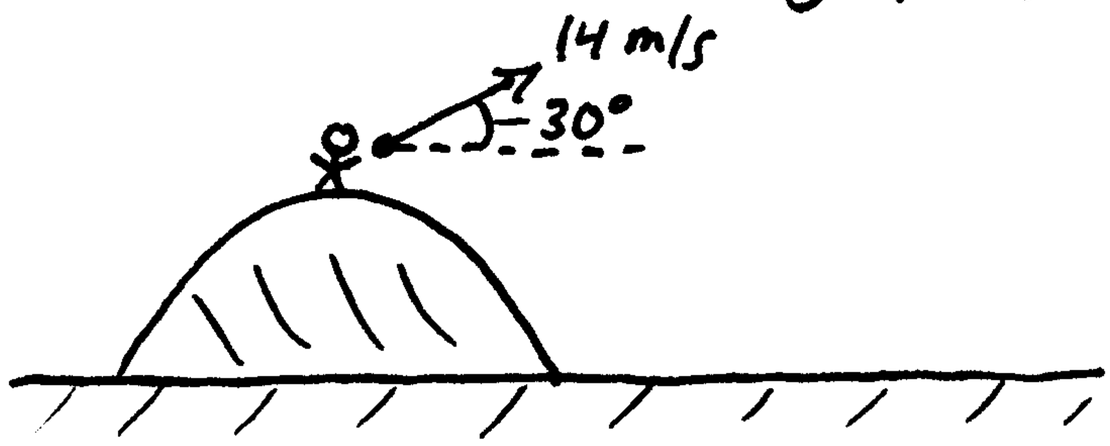
This is a problem involving projectile motion.



A person standing at the top of a hill throws a rock with an initial velocity of 14 m/s at an angle of 30° above the horizontal.

(a) Calculate the horizontal displacement of the rock 1.7 s later.

(b) Calculate the vertical displacement of the rock 1.7 s later.

(c) How long does it take the rock to fall 3.5 m below its initial launch height?

Solution: Assumption: - ignore air resistance → negligible

(a) The equation for horizontal motion is:

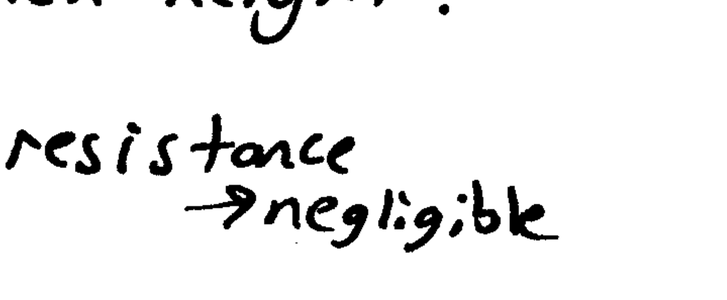
$$d_x = (v_0 \cos 30°)t$$

$d_x = ?$ (horizontal displacement of rock)

$v_0 = 14$ m/s (magnitude of initial rock velocity)

$t = 1.7$ s (desired time interval)

Set up xy coordinate frame with origin at the release point of the rock, as shown:



Substitute:

$$d_x = (14\cos 30°)(1.7) = 20.6 \text{ m (answer)}$$

(b) The equation for vertical motion is:

$$d_y = (v_0 \sin 30°)t - \frac{1}{2} g t^2$$

$d_y = ?$ (vertical displacement of rock)

$g = 9.8 \text{ m/s}^2$

Substitute: $d_y = (14\sin 30°)(1.7) - \frac{1}{2}(9.8)(1.7)^2$

$$d_y = -2.3 \text{ m (answer)}$$

(c) Once again, use the equation for vertical motion, where $d_y = -3.5$ m:

$$-3.5 = (14\sin 30°)t - \frac{1}{2}(9.8)t^2$$

$t = ?$ (The time it takes the rock to fall 3.5 m below its initial launch height)

Simplify above equation:

$$-4.9t^2 + 7t + 3.5 = 0$$

This is a quadratic equation. Solve for t:

$t = -0.39$ s or $t = 1.82$ s

(not valid)

Therefore, the time taken is 1.82 s (answer)