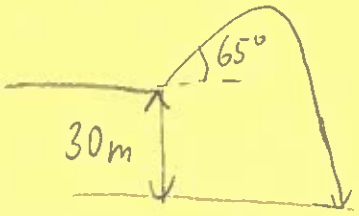
PHYSICS 12

KEY

PROJECTILE MOTION

1. A rock is fired from a slingshot at an angle of 65° above horizontal. The tone strikes the ground 8.0 s later an altitude 30.0 m below the height at which it was released.
   (a) At what initial velocity as the stone released?
   (b) How far horizontally does the stone go before striking the ground?
   (c) What is the final velocity of the rock just before it hits the ground?



- $v_i = ?$ m/s
- let $y = v_i \cdot \sin 65°$
- Find y first

$$t_{air} = t_{h_{max}} + t_{ff}$$

$$8.0 = \frac{0 - y}{a_y} + \sqrt{\frac{2 d_y}{a_y}}$$

$$8 = \frac{y}{a} + \sqrt{\frac{2\left(\frac{y^2 + 60a}{2a}\right)}{a}}$$

$$8 = \frac{y}{a} + \sqrt{\frac{y^2 + 60a}{a} \cdot \frac{1}{a}}$$

$$8 - \frac{y}{a} = \sqrt{\frac{y^2 + 60a}{a^2}}$$

$$8 - \frac{y}{a} = \frac{1}{a}\sqrt{y^2 + 60a}$$

$$(8a - y)^2 = \left(\sqrt{y^2 + 60a}\right)^2$$

$$64a^2 - 16ay + y^2 = y^2 + 60a$$

$$-16ay = 60a - 64a^2$$

$$y = \frac{60a - 64a^2}{-16a}$$

$a = 9.8$

$y = 35.45$ m/s

- $h_{max} = \frac{v_{fy}^2 - v_{iy}^2}{2a_y}$

$$= \frac{0^2 - y^2}{-2a}$$

- $\vec{d_y}$ = displacement of the freefall

$$d_y = -(h_{max} + 30)$$

$$= -\left(\frac{y^2}{2a} + 30\right)$$

$$= \frac{y^2 + 60a}{2a}$$

$$35.45 = v_i \sin 65°$$

$$v_i = \frac{35.45}{\sin 65°}$$

$$v_i = 39.1147 \text{ m/s}$$

∴ The initial velocity is 3.9×10^1 m/s 65° above horizontal.

(b) $d_x = (v_{ix})(t_{air})$

$v_{ix} = v_i \cos 65°$

$= (39.1147) \cos 65°$

$= 16.5306$ m/s

$d_x = (16.5306)(8.0)$

$d_x = 132.2449$ m

∴ The horizontal distance covered is 1.3×10^2 m.

(c)

$v_{fx} = v_{ix} = 16.5306$ m/s

$d_y = \frac{y^2 + 60a}{2a}$

$d_y = \frac{35.45^2 + 60(9.8)}{2(9.8)}$

$d_y = 94.1175$ m

$v_{fy}^2 = v_{iy}^2 + 2a_y d_y$

$= 0^2 + 2(-9.8)(-94.1175$

$= \sqrt{1844.7025}$

$= 42.95$ m/s

$\therefore \vec{v}_f = [17, -43]$ m/s

$\therefore \|\vec{v}_f\| = 46$ m/s [R 69° D].