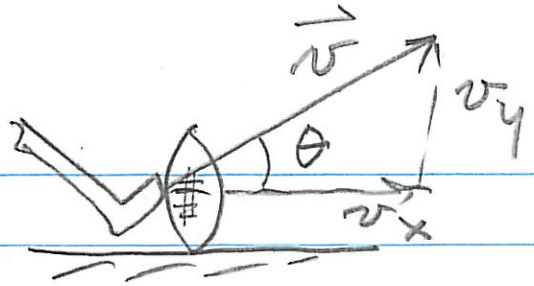
## 3-3




$$v_0 = at = 340\,m/s^2 \times 0.05\,s = 17\,m/s^2$$

$$v_x = v_0 \cos 51^\circ = 10.7\,m/s$$
$$v_y = v_0 \sin 51^\circ = 13.2\,m/s$$

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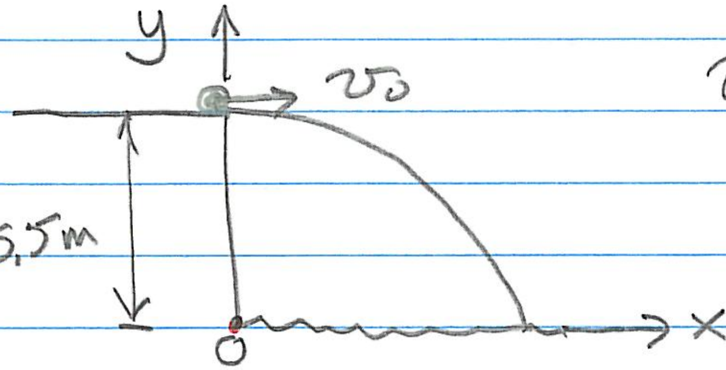
## 3-21




$v_0 = 11.4\,m/s$

Since the ball rolls off a horizontal cliff

$$v_{0x} = v_0, \quad v_{0y} = 0$$

Choosing (0,0) at the base of the cliff : $y_0 = 15.5\,m$

(a) $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

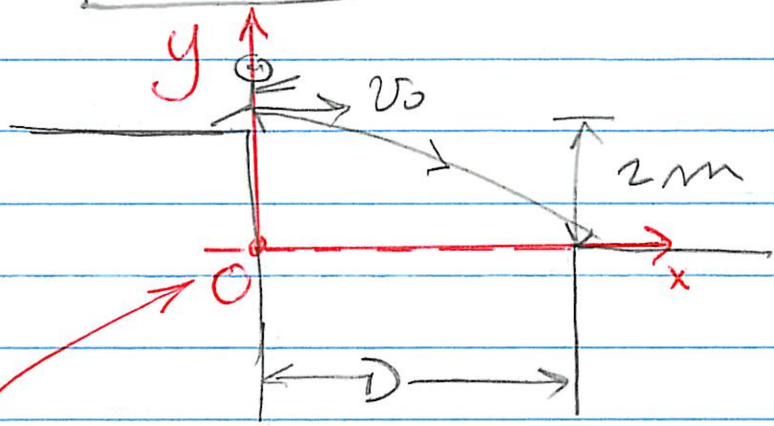
$$0 = 15.5 + 0 - \frac{1}{2}gt^2 \Rightarrow t = \sqrt{\frac{2 \times 15.5}{g}} = 1.8\,s$$

(b) $v_x = v = 11.4\,m/s$

$$v_y(t) = -9.8 \times 1.8\,s = -17.4\,m/s$$

$$\text{Speed} = \sqrt{(11.4)^2 + (-17.4)^2} = 20.8\,m/s$$

# 3-24




$v_0 = 5.3 \, m/s$

Choose (0,0) AS SHOWN, Then

$$\begin{cases} y_0 = 2\,m \\ v_{0x} = v_0 = 5.3\,m/s \\ v_{0y} = 0 \\ y_{final} = 0 \\ x_{final} = D \text{ (barely)} \end{cases}$$

$X = D = v_0 t$

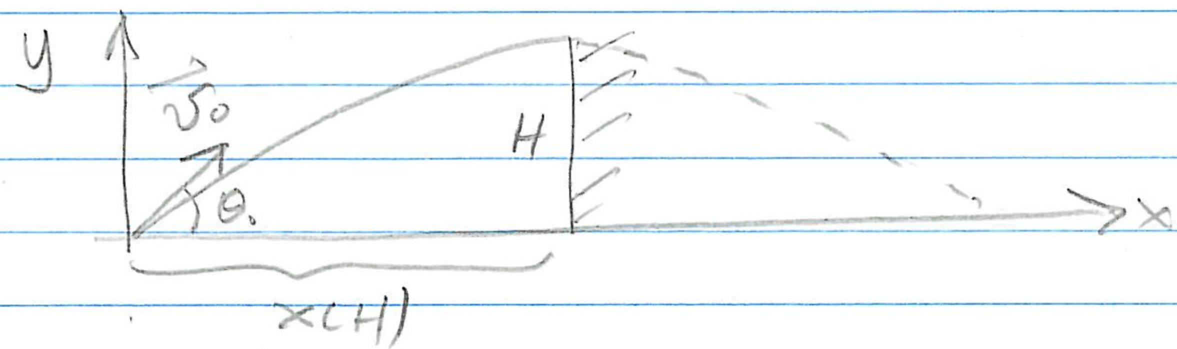
$Y = y_0 + v_{0y} t - \frac{1}{2} g t^2$

$0 = 2 + 0 - \frac{1}{2} g t^2$

$g t^2 = 4 \Rightarrow t = 0.63\,s$

$D = 5.3(0.63) = \underline{\underline{3.4\,m}}$ ← No larger than this

# 3-27




The firehose should be placed so that the highest part of the building is at the maximum vertical point of the trajectory, $y_{max} = H$

$v_0 = 25 m/s$ , $\theta_0 = 35^\circ$

$v_{0x} = v_0 \cos\theta_0 = 20.5 m/s$

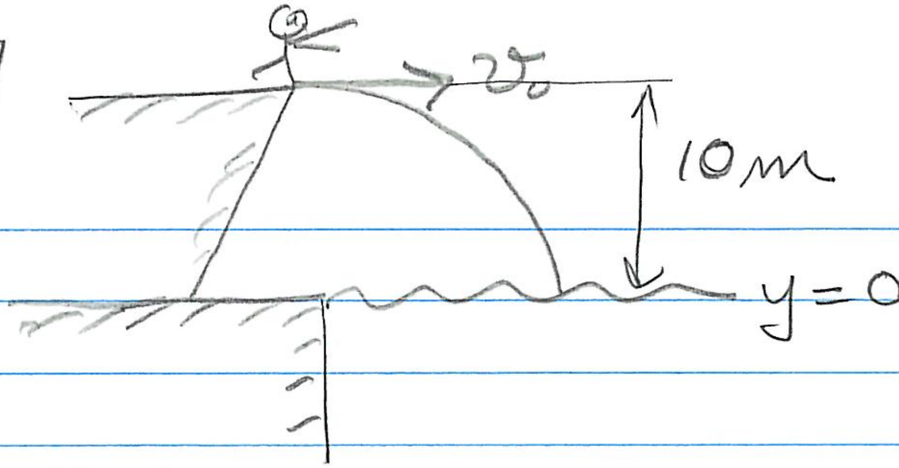
$v_{0y} = v_0 \sin\theta_0 = 14.3 m/s$

AT $y_{max} = H$ , $v_y = 0 \rightarrow v_y = v_{0y} - g t_H$

$\Rightarrow t_H = v_{0y}/g = 14.3/9.8 = 1.46 s$

$x(H) = v_{0x} t_H = 20.5 \times 1.46 s \cong \underline{30 m}$

$\boxed{3-31}$




$v_0 = 1.2 m/s$

$v_x = v_{0x} = 1.2 m/s$

$v_{0y} = 0$

Choose $y=0$ at pool level, so $y_0 = 10 m$

$v_y = v_{0y} - gt = -gt$

$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

$0 = 10 + 0 - \frac{1}{2}gt^2$

so diver hits water at $t = \sqrt{\frac{2\times 10}{9.8}} = \underline{1.43 s}$

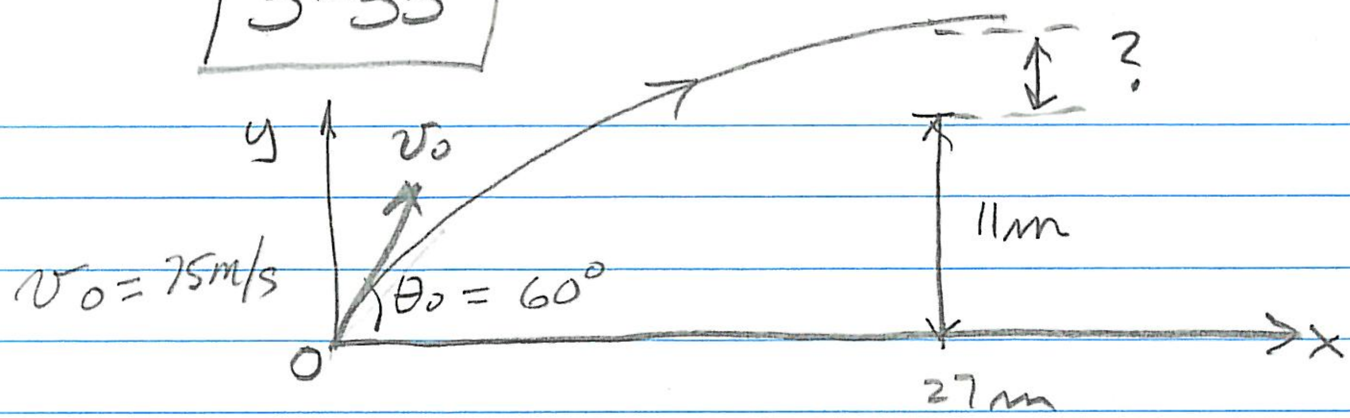
$\therefore v_y = -9.8(1.43 s) = 14 m/s$

$v = \sqrt{v_x^2 + v_y^2}$

$= \sqrt{(1.2)^2 + (14)^2}$

$= \underline{\underline{14.1 m/s}}$

# 3-35




$v_{0x} = v_0 \cos\theta_0 = 37.5 m/s$

$v_{0y} = v_0 \sin\theta_0 = 65 m/s$

$x_0 = y_0 = 0$

find $y$ when $x = 27m$

$x = v_{0x} t$

$y = v_{0y} t - \frac{1}{2} g t^2$

$x = 27m = 37.5\, t \Rightarrow t = 0.72s$

$y(0.72s) = 65(0.72) - \frac{1}{2}(9.8)(0.72)^2$

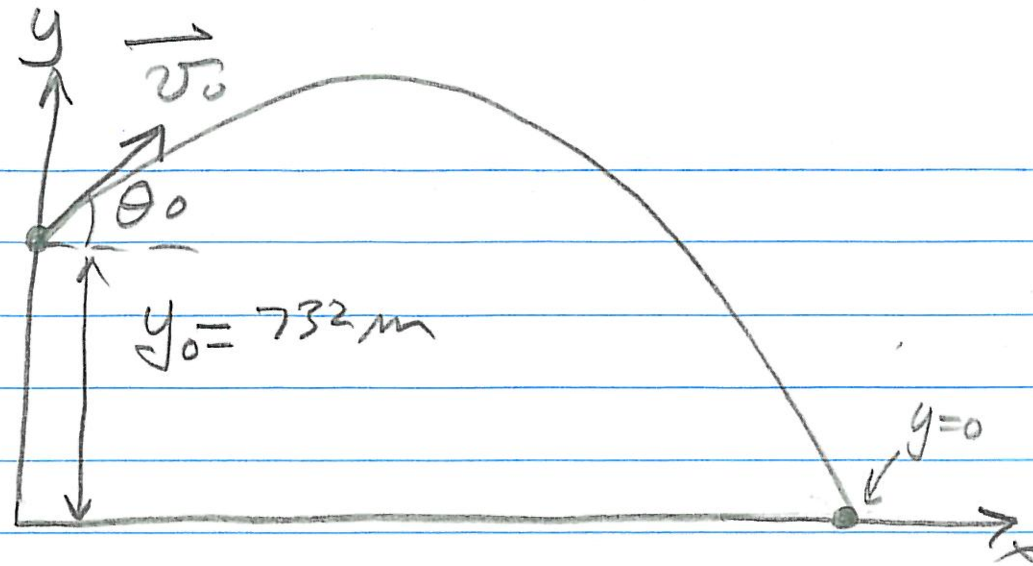
$y = 44.2 m$

So rocket clears wall by

$(44.2 - 11) = \underline{\underline{33.2 m}}$

$\boxed{3\text{-}37}$

$$\begin{cases} v_0 = 97.5\,\text{m/s} \\ \theta_0 = 50^\circ \end{cases}$$




Package leaves with same $\vec{v}_0$ AS plane

$v_{0x} = v_0 \cos\theta_0 = 62.7$ m/s

$v_{0y} = v_0 \sin\theta_0 = 74.7$ m/s

$$y = y_0 + v_{0y} t - \tfrac{1}{2} g t^2$$

$$0 = 732 + 74.3t - 4.9t^2$$ ← time package hits ground

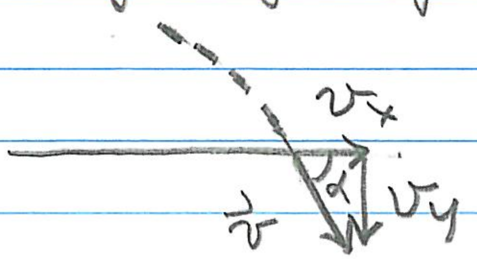
$$4.9t^2 - 74.3t - 732 = 0$$

$$t = \frac{-(-74.7) \pm \sqrt{(74.7)^2 + 4(4.9)(732)}}{2(4.9)}$$

$$= (74.7 \pm 141.2)/9.8 = 22\,\text{s}$$ $\Big\{$ choose +

(a) $x = v_{0x} t = 62.7\,(22\,\text{s}) = \underline{1381\,\text{m}}$

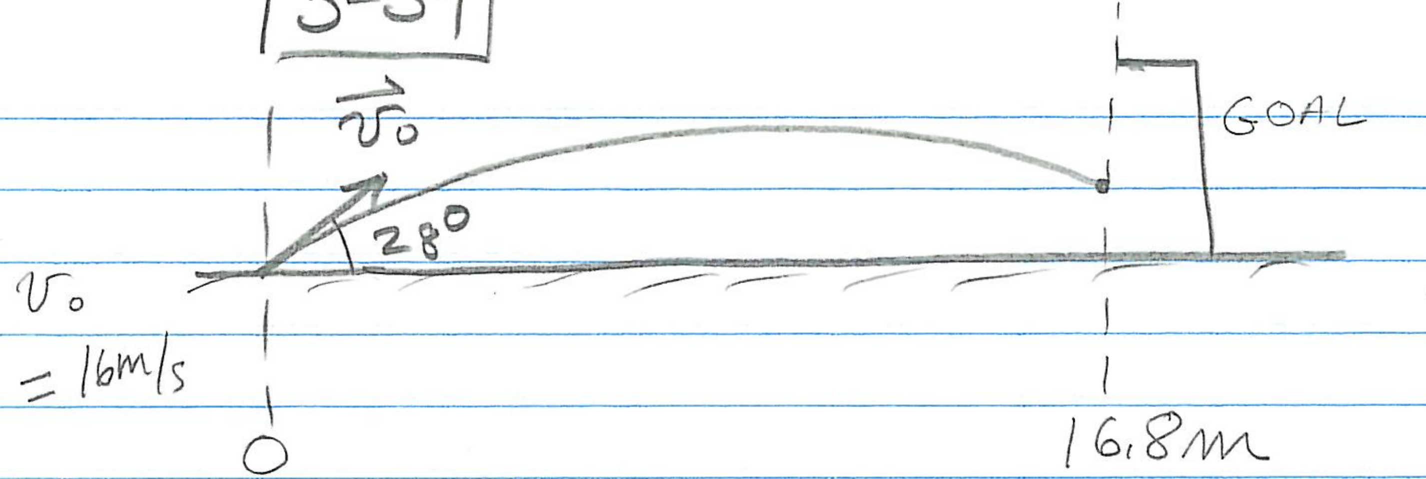
(b) $v_y = v_{y0} - gt = 74.3 - 9.8(22) = -141.3$ m/s




$$\tan\alpha = \frac{v_y}{v_x} = \frac{141.3}{62.7} = 2.25$$

$\alpha = 66^\circ$ below ground level.

**3-39**



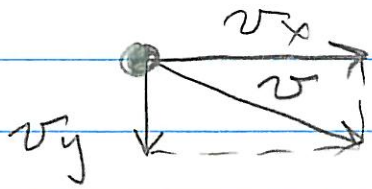

$$v_{0x} = v_0 \cos\theta_0 = 14.1 m/s$$
$$v_{0y} = v_0 \sin\theta_0 = 7.5 m/s$$

time for ball to get to goal:

$$x = v_{0x} t$$
$$16.8 m = 14.1\, t \Rightarrow \underline{t = 1.2 s}$$

Need $v_y(t) = v_{0y} - gt = 7.5 - 9.8(1.2)$

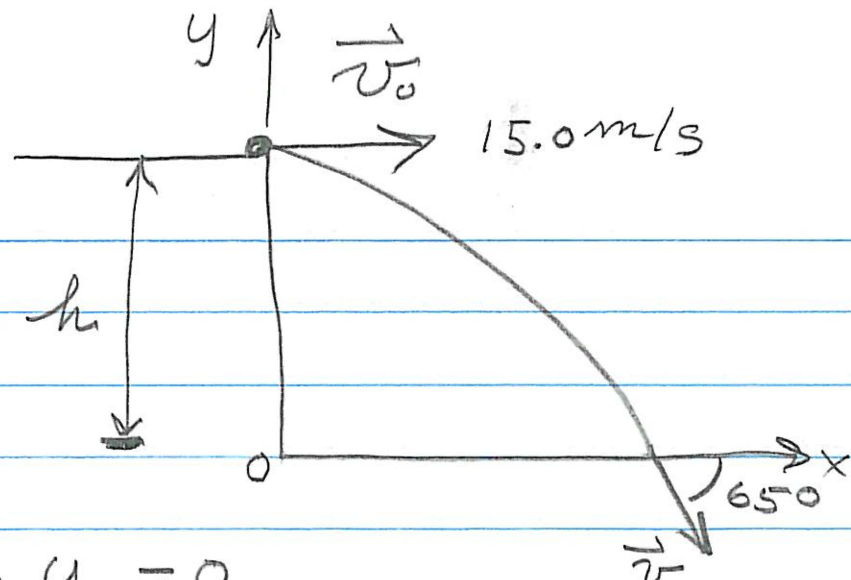
$$v_y = -4.3 m/s$$




$$v = \sqrt{v_x^2 + v_y^2}$$
$$= \sqrt{(14.1)^2 + (4.3)^2}$$

$$\underline{v = 14.7 m/s}$$

$\boxed{3-44}$




$y_0 = h\ ,\ y = 0$

$v_{0x} = v_0,\quad v_{0y} = 0$

$v_y = -v\sin 65^0\ ,\ v_x = v_0 = v\cos 65^0$

$\Rightarrow\ 15 = v\cos 65^0 \Rightarrow \underbrace{v = 35.5\,m/s}_{\text{magnitude of the final velocity}}$

$v_y = v_{0y} - gt$

$-35.5\sin 65 = 0 - gt$

$32.2 = gt \Rightarrow t = 3.3\,s \leftarrow$ time marble hits ground

$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

$0 = h - \frac{1}{2}gt^2 \Rightarrow h = \frac{1}{2}(9.8)(3.3)^2$

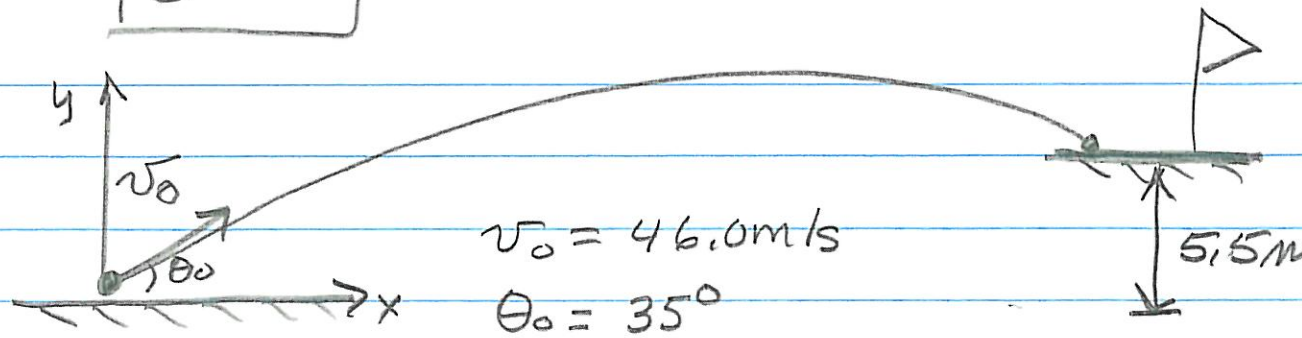
$\boxed{h = 52.8\,m}$

Could also use: $v_y^2 = v_{0y}^2 - 2g(y - y_0)$

$(-32.2)^2 = 0 - 2(9.8)(0 - h)$

$\Rightarrow h = 52.8\,m$

3-73




$v_{0x} = v_0 \cos\theta_0 = 37.7\,m/s$, $v_{0y} = v_0 \sin\theta_0 = 26.4\,m/s$

Choose (0,0) at point where ball takes off.

$\Rightarrow \quad y_0 = 0, \quad y = 5.5\,m$

$$y = y_0 + v_{0y} t - \tfrac{1}{2} g t^2$$
$$5.5 = 0 + 26.4\,t - 4.9 t^2$$

or $\quad 4.9t^2 - 26.4t + 5.5 = 0$

$$t = \frac{-(-26.4) \pm \sqrt{(-26.4)^2 - 4(4.9)(5.5)}}{2(4.9)}$$

$$= \frac{26.4 \pm 24.3}{9.8}$$

Solutions $\begin{cases} t_1 = 0.21\,s & \text{(choosing } -) \\ t_2 = 5.2\,s & \text{(choosing } +) \end{cases}$

The ball reaches the green at the later time $= \underline{5.2\,s}$ (there are 2 times when the ball is at $y = 5.5\,m$)