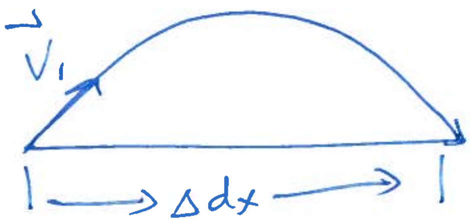
Projectile Motion Day 2 P1-3 pg 42, 59 pg 43

Range equations for projectile that lands at same height from which it was launched:



$$\boxed{\Delta t = \frac{2 v_1 \sin\theta}{g}}$$

$$\boxed{\Delta d_x = \frac{V_1^2 \sin 2\theta}{g}}$$

1. $V_1 = 2.2 \times 10^2$ m/s
   $\theta = 45°$
   $\Delta d_y = 0$

a) $\Delta t = ?$ $\quad \Delta t = \frac{2(V_1 \sin\theta)}{g} = \frac{2(2.2\times10^2 \text{ m/s}) \sin 45°}{(9.80)}$

$= 31.7 s \simeq 32 s$

b) $\Delta d_x = \frac{V_1^2 \sin 2\theta}{g} = \frac{(2.2\times10^2 \text{ m/s})^2 \sin((2)45°)}{9.80} = 4938.78 \text{ m}$

$\simeq 4.9 \times 10^3$ m

c) Max height, $\Delta d_{y\,max} = ?$ $\quad \Delta d_{y\,max} = \frac{V_{2y}^2 - V_{1y}^2}{2a_y}$

$V_{2y} = 0.0$

$= \frac{0 - ((2.2\times10^2)(\sin 45°))^2}{2(-9.80)}$

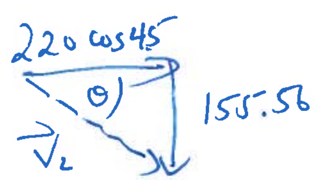
$= 1234.69 \text{ m} \simeq 1.2 \times 10^3$ m

* $\boxed{\text{You can also solve for } \vec{V}_2 \text{ using symmetry!}}$

d) $V_{2y} = ?$ $\quad V_{2y} = V_{1y} + a_y \Delta t$

$= (220 \sin 45) + (-9.80)(31.7 s)$

$= -155.56$ m/s



$\vec{V}_2 = 220$ m/s

$\theta = 45°$

$\therefore \vec{V}_2 = 220$ m/s [45° below horizontal]

2)

a) $\Delta d_{y_{max}} = ?$ $\Delta d_{y_{max}} = \dfrac{V_{2y}^2 - V_{1y}^2}{2a_y}$

$= \dfrac{0 - (14.5 \sin 35)^2}{2(-9.80)}$

$= \boxed{3.53\,m.}$

b) $\Delta d_x = \dfrac{V_1^2 \sin 2\theta}{g} = \dfrac{(14.5^2)(\sin 70.0°)}{(9.80)}$ $= 20.16m \approx \boxed{20.2m}$

c) $\Delta t_{max} = ?$ $\Delta t_{max} = \dfrac{2V_1 \sin\theta}{g} \div 2 = \dfrac{V_1 \sin\theta}{g} = \dfrac{(14.5)(\sin 35.0°)}{(9.80)}$

$= 0.849s$

3)

a) double $V_1 \rightarrow V_1' = 2V_1$, $\Delta t' = ?$

$\Delta t = \dfrac{2V_1 \sin\theta}{g}$ $\Delta t' = \dfrac{2(2V_1)\sin\theta}{g} = \dfrac{4V_1 \sin\theta}{g}$

$\therefore$ the time is doubled.

b) $\Delta d_x' = ?$ $\Delta d_x' = \dfrac{V_1'^2 \sin 2\theta}{g} = \dfrac{(2V_1)^2 \sin 2\theta}{g} = \dfrac{4V_1^2 \sin 2\theta}{g}$

$\therefore$ the range is doubled.

c) max height? $\Delta d_{y_{max}}' = ?$

$\Delta d_{y_{max}} = \dfrac{V_{2y}^2 - V_{1y}^2}{2a_y}$

$= \dfrac{0 - (V_1 \sin\theta)^2}{-2(9.80)}$

$= \dfrac{V_1^2 \sin^2\theta}{}$

$\Delta d_{y_{max}}' = \dfrac{V_{2y}^2 - V_{1y}^2}{2a_y}$

$= \dfrac{0 - (2V_1 \sin\theta)^2}{-2(9.80)}$

$= \dfrac{4V_1^2 \sin^2\theta}{(2)(9.80)} = \dfrac{2V_1^2 \sin^2\theta}{9.80}$.

$\therefore$ the max. height is quadruple.

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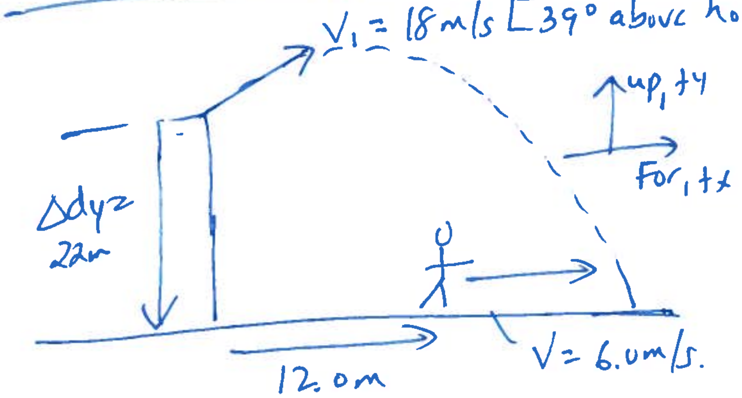

X	Y
$V_{1x} = 18\cos 39$ m/s	$V_{1y} = 18\sin 39$ m/s
$\Delta t = ?$	$a_y = g = -9.80$ m/s²
$\Delta d_x = ?$	$\Delta d_y = -22.$ m
	$\Delta t = ?$

Solve for time to land:

$$\Delta d_y = V_{1y}\Delta t + \frac{1}{2}a_y\Delta t^2$$

$$-22 = 18\sin 39\,\Delta t + \left(\frac{1}{2}\right)(-9.80)\Delta t^2$$

$$\therefore 4.90\Delta t^2 - 11.33 \quad - 22 = 0$$

$$\therefore \Delta t = \frac{11.33 \pm \sqrt{(-11.33)^2 - 4(4.90)(-22)}}{2(4.90)} = \frac{11.33 \pm 23.65}{9.80}$$

$$= 3.57\text{ s or } \cancel{-1.26\text{ s}}$$

$\therefore$ horizontal range $\Delta d_x = V_{1x}\Delta t$

$$= (18\cos 39)(3.57\text{ s}) = 49.93\text{ m.}$$

Solve for player's horizontal distance. If $\Delta d_{player} \geq \Delta d_x$ then it is possible for the player to catch the ball.

$$\Delta d_x = 12.0\text{ m} + (6.0)(3.57\text{ s}) = \underline{33.4\text{ m}}$$

Since the player is only at 33.4 m when the ball lands at 49.93 m it is <u>NOT</u> possible for the player to catch the ball.