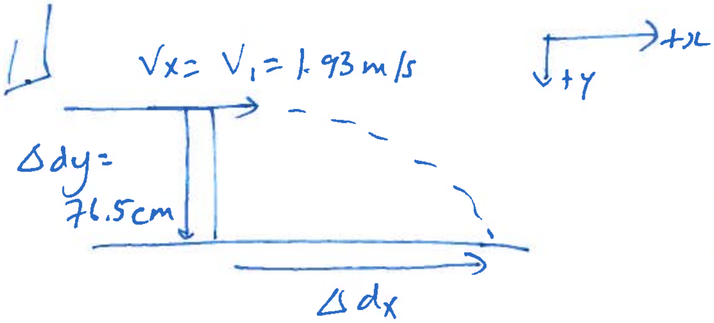
1]



x	y
$V_1 = V_x = 1.93\,m/s$	$V_{1y} = 0$
$\Delta d_x = ?$	$V_{2y} = ?$
$\Delta t = ?$	$a_y = g = 9.80\,m/s^2$ [down]
	$\Delta d_y = 0.765\,m$ [down]
	$\Delta t = ?$

a) Solve for time using vertical information

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

$$0.765 = 0 + \frac{1}{2}(9.80)\Delta t^2$$

$$0.765 = 4.90\,\Delta t^2$$

$$\Delta t = \pm\sqrt{\frac{0.765}{4.90}} = 0.395\,s$$

b) Solve for range:

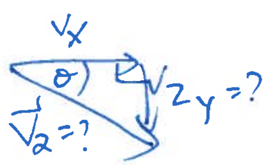
$$\Delta d_x = V_x\,\Delta t$$

$$= (1.93\,m/s)(0.395\,s)$$

$$= 0.7621\,m$$

$$= 0.763\,m$$

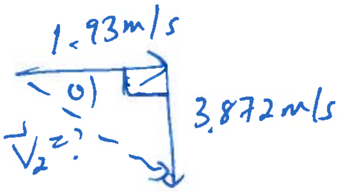
c)



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

$$= 0 + (9.80\,m/s^2)(0.395\,s)$$

$$= 3.872\,m/s$$

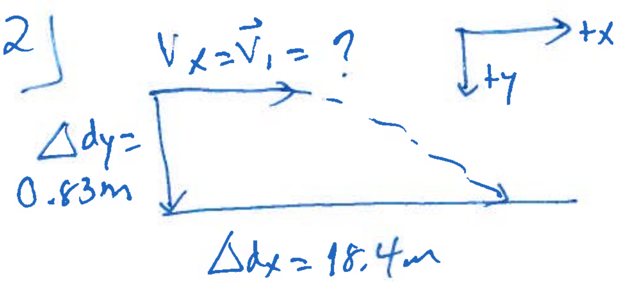


$$V_2 = \sqrt{1.93^2 + 3.872^2} = 4.327\,m/s$$

$$\theta = \tan^{-1}\left(\frac{3.872}{1.93}\right) = 63.51°$$

$\therefore \vec{V}_2 =$ 4.33 m/s [63.5° below the horizontal].

2]



x	y
$V_{1x} = V_1 = ?$	$V_{1y} = 0$
$\Delta d_x = 18.4\,m$	$\Delta d_y = 0.83\,m$
$\Delta t = ?$	$a_y = g = 9.80\,m/s^2$
	$\Delta t = ?$

Solve for time:

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

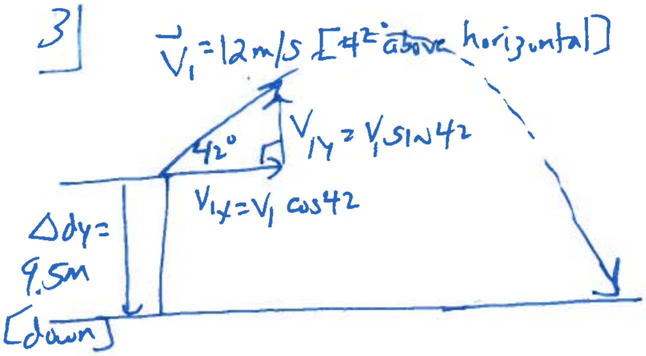
$$\Delta t = \sqrt{\frac{2(\Delta d_y)}{g}}$$

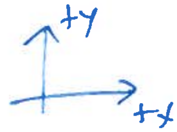
$$\Delta t = \sqrt{\frac{2(0.83)}{(9.80)}} = 0.412$$

Solve for V_x:

$$V_x = \frac{\Delta d_x}{\Delta t} = \frac{18.4\,m}{} = \boxed{44.7}$$

3]





x	y
$\Delta d_x = ?$	$V_{1y} = 12 \sin 42$ m/s
$\Delta t = ?$	$a_y = g = -9.80\ m/s^2$
$V_{1x} = 12 \cos 42$ m/s	$\Delta d_y = -9.5\,m$
	$\Delta t = ?$

a) Solve for time using y component:

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

$-9.5 = 12 \sin 42 \Delta t - 4.90 \Delta t^2$

$4.90 \Delta t^2 - 12 \sin 42 \Delta t - 9.5 = 0$

Solve for Δt using quadratic formula:

$$\Delta t = \frac{12 \sin 42 \pm \sqrt{(12 \sin 42)^2 - 4(4.90)(-9.5)}}{2(4.90)}$$

$$\Delta t = \frac{8.03 \pm 15.83}{9.80} = 2.43\,s \text{ or } \cancel{-0.7}$$

∴ the time of flight is 2.43 s.

b) $\Delta d_x = ?$ $\quad \Delta d_x = V_{1x} \Delta t$

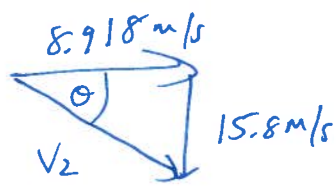
$= (12 \cos 42)(2.43) = 21.7\ m \simeq 22\,m.$

∴ The width of the moat is 22 m.

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

$= 12 \sin 42 - 9.80(2.43)$

$= -15.8\ m/s$



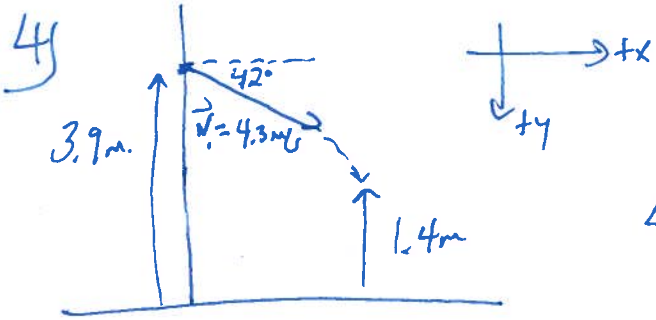
$V_2 = \sqrt{8.92^2 + 15.8^2}$

$= 18.2\ m/s$

$\theta = \tan^{-1}\left(\frac{15.8}{8.92}\right) = 60.61°$

∴ the final velocity is 18 m/s [61° below the horizontal].

4)



x	y
$V_{1x} = 4.3\cos 42$ m/s	$V_{1y} = 4.3\sin 42$
$\Delta d_x = ?$	$\Delta d_y = 3.9 - 1.4 = 2.5$ m
$\Delta t = ?$	$a_y = g = 9.80$ m/s^2
	$\Delta t = ?$

a) Solve for time:

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

$$2.5 = 4.3\sin 42\,\Delta t + 4.90\,\Delta t^2$$

$$\therefore\ 0 = 4.90\,\Delta t^2 + 2.877\,\Delta t - 2.5 = 0$$

$$\Delta t = \frac{-2.877 \pm \sqrt{2.877^2 - 4(4.90)(-2.5)}}{2(4.90)} = \frac{-2.877 \pm 7.568}{9.80}$$

$$\Delta t = 0.479 \text{ OR } -1.07$$

$\therefore$ the ball is in the air for 0.48 s.

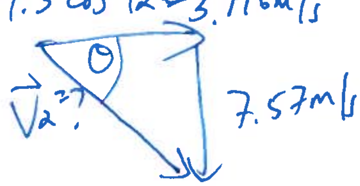
b) $\Delta d_x = V_{1x}\Delta t = (4.3\cos 42)(0.479\,s) = 1.53\,m \approx 1.5\,m$

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

$$= 4.3\sin 42 + (9.80)(0.479)$$

$$= 7.57$$

$4.3\cos 42 = 3.196$ m/s



$V_2 = 8.215$ m/s $\quad \theta = \tan^{-1}\left(\frac{7.57}{3.196}\right) = 67.1°$

$\therefore$ the speed of ball is 8.2 m/s as it is caught.

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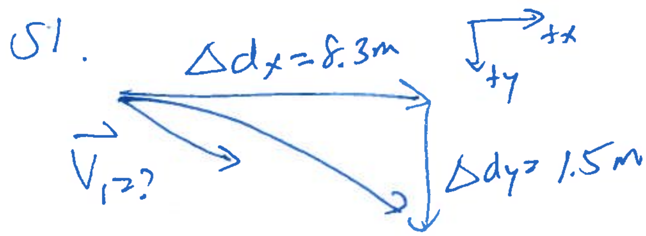
51.



X	Y
$\Delta d_x = 8.3m$	$V_{1y} = 0.0\ m/s$
$V_x = ?$	$a_y = g = 9.80\ m/s^2$
$\Delta t = ?$	$\Delta t = ?$
	$\Delta d_y = 1.5\ m$

Solve for time:

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

$$1.5 = \frac{1}{2}(9.80)\Delta t^2$$

$$\Delta t = \sqrt{\frac{1.5}{4.90}} = 0.553s$$

Solve for horizontal speed:

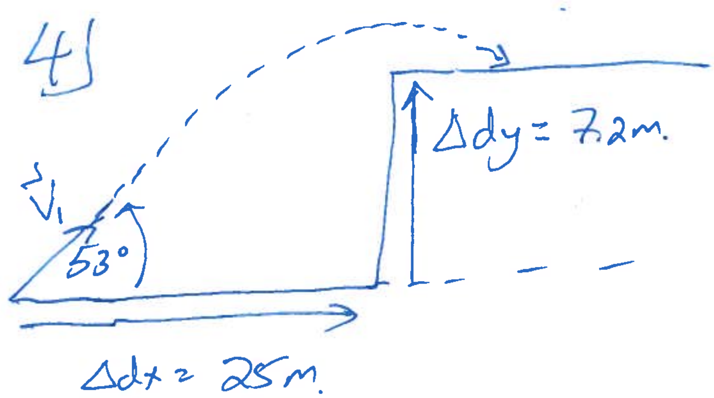
$$V_{1x} = \frac{\Delta d_x}{\Delta t} = \frac{8.3m}{0.553s}$$

$$= 15.0\ m/s.$$

∴ the rock's initial speed is 15.0 m/s.

+y
+x

4)



X	Y
$V_{1x} = V_1 \cos 53$	$V_{1y} = V_1 \sin 53$
$\Delta t_1 = 2.1s$	$\Delta t_1 = 2.1s$
$\Delta d_{x_1} = 25m$	$\Delta d_{y_2} = 7.2m$
	$\Delta t_2 = ?$

a) $V_{1x} = \frac{\Delta d_{x_1}}{\Delta t_1} = \frac{25m}{2.1s} = 11.90\ m \rightarrow V_1 \cos 53 = 11.90m$

$$V_1 = \frac{11.90m}{\cos 53} = \boxed{19.8\ m/s}$$

Find time to land on building:

b) $\Delta t_2 = ?$

$$\Delta d_{y_2} = V_1 \sin 53\, \Delta t_2 - \frac{1}{2}(9.80)\Delta t_2^2$$

$$7.2 = 19.8 \sin 53\, \Delta t_2 - 4.90\, \Delta t_2^2$$

$$0 = -4.90\,\Delta t_2^2 + 19.8 \sin 53\, \Delta t_2 - 7.2$$

$$\Delta t = \frac{-19.8 \sin 53 \pm \sqrt{19.8 \sin 53^2 - 4(-4.90)(-7.2)}}{2(-4.90)} = \frac{-15.798 \pm 10.414}{-9.80} = 0.549s \text{ or } \underline{2.675s}$$

c) Find horizontal range.

$$\Delta d_x = V_1 \cos 53 \cdot \Delta t_2$$

$$= (19.8\,m/s)(\cos 53)(2.675s)$$

$$\boxed{= 31.8\,m}$$

c.) Find height of ball at time $\Delta t_1 = 2.1s$.

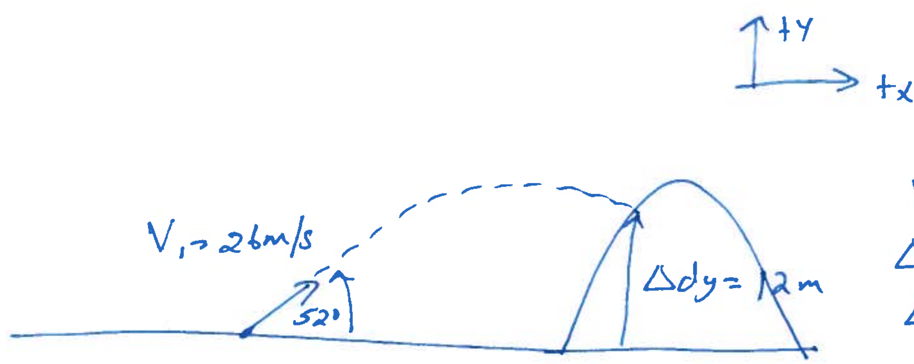
$$\Delta d_y = V_1 \sin 53\, \Delta t_1 - \frac{1}{2}(9.80)\Delta t_1^2$$

$$= (19.8\,m/s)(\sin 53)(2.1s) - 4.90(2.1s)^2$$

$$= 11.567\,m$$

$$\therefore \text{Clearance} = 11.567m - 7.2m = \boxed{4.4m}$$

5]



x	y
$V_{1x} = 26\cos 52$	$V_{1y} = 26\sin 52$
$\Delta d_x = ?$	$a_y = g_{mars} = -3.7\,m/s^2$
$\Delta t = ?$	$\Delta d_y = 12\,m$
	$\Delta t = ?$
	$\Delta d_{ymax} = ?$

a) Max height At $V_{2y} = 0$

$$\Delta d_{ymax} = \frac{V_{2y}^2 - V_{1y}^2}{2a_y} = \frac{0 - (26\sin 52\,m/s)^2}{2(-3.7\,m/s^2)} = 56.7m$$

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

$$12 = 26\sin 52\Delta t + \frac{1}{2}(-3.7)\Delta t^2$$

$$1.85\Delta t^2 - 20.49\Delta t + 12 = 0$$

$$\Delta t = \frac{20.49 \pm \sqrt{20.49^2 - 4(1.85)(12)}}{2(+1.85)}$$

$$\Delta t = \frac{20.49 \pm 18.19}{3.7}$$

$$= \boxed{10.45s} \text{ OR } 0.620s$$

∴ it passes through a height of 12.0m at two times. The ... it occurs after the

"6/7"

c) Solve for range:

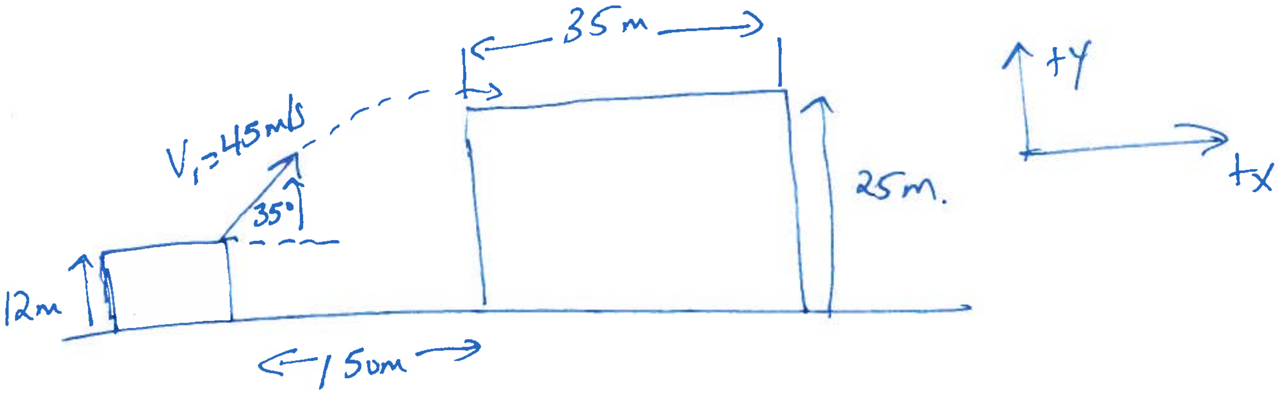
$\Delta d_x = V_x \Delta t$

$= (26 \cos 52)(10.45s)$

$= 167.3m$

$\therefore$ the max height of the rock is 57m. The time of flight is $1.0 \times 10^1 s$ and the range is $1.7 \times 10^2 m$.

7]



Solve for time of flight to reach building.

$V_{1x} = 45 \cos 35°$

$\Delta d_x = 150m$

$\Delta t = ?$

$\Delta t = \frac{\Delta d_x}{V_{1x}} = \frac{150m}{45 \cos 35} = 4.069s$

Solve for max height and time to reach max height.

$\Delta d_{y max} = ?$

$V_{2y} = 0.0$

$V_{1y} = 45 \sin 35$

$a_y = g = -9.80 m/s^2$

$\Delta t = ?$

$\Delta d_y = \frac{V_{2y}^2 - V_{1y}^2}{2a_y} = \frac{0 - (45 \sin 35)^2}{2(-9.80)}$

$= 33.99 m$

$\therefore$ max height from ground =

$33.99m + 12m = 45.99 \approx 46m$

from this we can see the snowball will rise and then land on the building on the way down

$\Delta t = \frac{V_{2y} - V_{1y}}{a_y} = \frac{0 - 45 \sin 35}{-9.80} = 2.634s.$

Solve for time to reach a height of 25m (13m above launch point)

$$13 = V_1 \sin 35 \Delta t + \frac{1}{2} a_y \Delta t^2$$

$$13 = 45 \sin 35 \Delta t - 4.90 \Delta t^2$$

$$4.90 \Delta t^2 - 25.81 \Delta t + 13 = 0$$

$$\Delta t = \frac{25.81 \pm \sqrt{25.81^2 - 4(4.9)(13)}}{2(4.90)} = \frac{25.81 \pm 20.28}{9.80} = 0.564s \text{ or } 4.70s$$

∴ at time 4.70s it is at roof height of the second building.

The final check is to make sure it has not overshot the building.

horizontal start of building 2

$$\Delta d_x = (45 \cos 35)\cdot(4.70s) = 173.4m - 150m = 23.4m$$

Since the second building is 35m wide the snowball will land on the roof!!