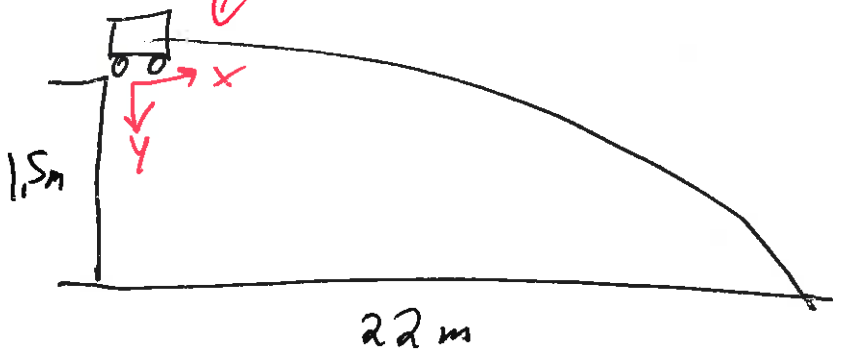
Disc 2
p 50

AES

note the axis choice!

2)



x	y
$x_0 = 0m$	$y_0 = 0m$
$x_f = 22m$	$y_f = +1.5\,m$
$v_{ox} = ?$	$v_{oy} = 0 m/s$
~~$v_{fx} = v_{ox}$~~	~~$v_{fy} = ?$~~
$a_x = 0 m/s$	$a_y = +9.8 m/s^2$
~~$\theta = 0°$~~	
	$t = ?$

y direction, general formula "$x = \frac{1}{2}at^2 + v_0 t + x_0$"

This choice of axes makes the math easy here →

$$y_f = \tfrac{1}{2}a_y t^2 + \cancel{v_{oy}}^{\,0} t + \cancel{y_0}^{\,0}$$

$$t^2 = \frac{2y_f}{a_y} \rightarrow t = \sqrt{\frac{2y_f}{a_y}} = \sqrt{\frac{2 \cdot 1.5}{9.8}}$$

$$t = 0.55328 s$$

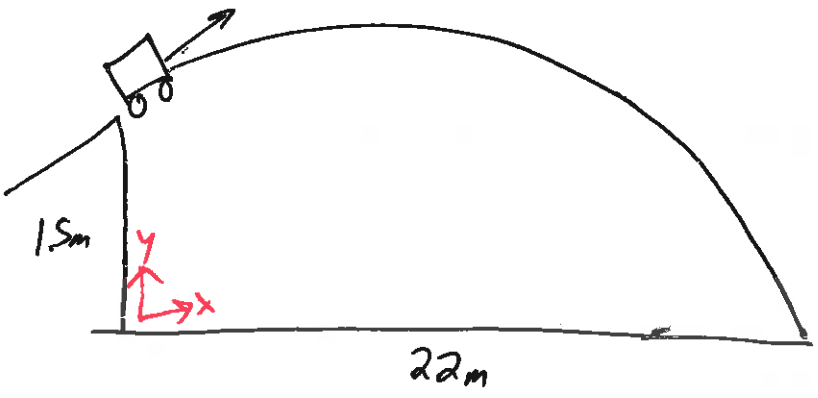
x-direction, general formula "$\langle v \rangle = \Delta x / \Delta t$"

v_x const, so $\langle v \rangle = v_{ox}$ dug

$$\rightarrow v_{ox} = \frac{x_f}{t} = \frac{22}{0.55328} = 39.7626$$

$$= \boxed{40. m/s}$$

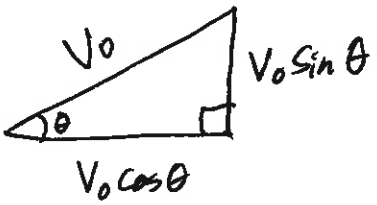
b)



x	y
$x_0 = 0m$	$y_0 = +1.5m$
$x_f = 22m$	$y_f = 0m$
$v_{ox} = +v_0 \cos\theta$	$v_{oy} = +v_0 \sin\theta$
~~$v_{fx} = v_0 \cos\theta$~~	~~$v_{fy} = ?$~~
$a_x = 0 m/s^2$	$a_y = -9.8\ m/s^2$

$\theta = ?°$

$t = ?$



SOHCAHTOA
or
"Cosine thru the angle"

2 unknowns (t, v_0) so find 2 equations

y-direction "$x = \frac{1}{2}at^2 + v_0t + x_0$" becomes

$$y_f = \frac{1}{2}a_y t^2 + v_0(\sin\theta)t + y_0 \quad (1)$$

x-direction, "$\langle v \rangle = \Delta x / \Delta t$" becomes

$$(2)\quad v_0 \cos\theta = \frac{x_f}{t} \rightarrow t = \frac{x_f}{v_0 \cos\theta}$$

plug into (1)

$$0 = \frac{1}{2}a_y\left(\frac{x_f}{v_0\cos\theta}\right)^2 + v_0 \sin\theta\left(\frac{x_f}{v_0\cos\theta}\right) + y_0$$

$$0 = \frac{\frac{1}{2}a_y x_f^2}{v_0^2 \cos^2\theta} + x_f \tan\theta + y_0$$

$$\frac{-a_y x_f^2}{2v_0^2 \cos^2\theta} = x_f \tan\theta + y_0$$

$$\frac{-a_y x_f^2}{x_f \tan\theta + y_0} = 2v_0^2 \cos^2\theta$$

$$2v_0^2 \cos^2\theta = \frac{-a_y x_f^2}{x_f \tan\theta + y_0}$$

$$v_0^2 = \frac{-a_y x_f^2}{2\cos^2\theta (x_f \tan\theta + y_0)}$$

$$v_0 = \frac{x_f}{\cos\theta} \sqrt{\frac{-a_y}{2(x_f \tan\theta + y_0)}}$$

$$= \frac{22}{\cos 7^\circ} \sqrt{\frac{-(-9.8)}{2(22 \tan 7 + 1.5)}}$$

$$= 23.937578$$

$$\boxed{v_0 = 24 \text{ m/s}}$$

I didn't need to find time, but if you did I think it was around $t \approx 0.35$s?

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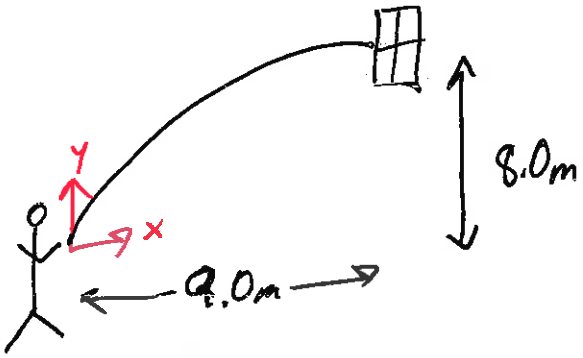

The key to this problem is that when the pebbles hit the window, they only have a horizontal component to their velocity, that is, $V_{fy} = 0$.

We want to find $V_{fx} = V_{ox} = ?$

x	y
$X_0 = 0$	$Y_0 = 0$
$X_f = 9.0m$	$Y_f = 8.0m$
$V_{ox} = ?$	$V_{oy} = ?$
$V_{fx} = V_{ox}$	$V_{fy} = 0$
$a_x = 0 m/s^2$	$a_y = -9.8 m/s$
~~$\theta = ?$~~	
$t = ?$	

- It looks like we have 3 unknowns (V_{ox}, V_{oy}, t), so we'll need 3 equations.
- Plan:
  1) Timeless equation to find V_{oy}.
  2) $v(t)$ equation in y-dir^n to find t
  3) Definition of $\langle v \rangle$ to find V_{ox}

1) *Timeless equation: "$V_f^2 = V_0^2 + 2ad$"

$$V_{fy}^2 = V_{oy}^2 + 2a_y(y_f - y_0)$$

$$V_{oy}^2 = -2a_y y_f$$

$$V_{oy} = \sqrt{-2a_y y_f}$$

$$" = \sqrt{+2\cdot(+9.8)\cdot 8}$$

$$V_{oy} = 13.28156617 \text{ m/s}$$

2) v equation: "$V_f = at + V_0$" (same as definition of acceleration, $a = \frac{\Delta V}{\Delta t}$)

$$V_{fy} = a_y t + V_{oy}$$

$$a_y t = V_{fy} - V_{oy}$$

$$t = \frac{-V_{oy}}{a_y} = \frac{-13.28156617}{-9.8}$$

keep extra digits in middle to avoid rounding errors

$$t = 1.355261854 \text{ s}$$

6) definition of v : "$\langle v \rangle = \frac{\Delta x}{\Delta t}$"

$$V_{ox} = \frac{x_f - x_o}{t}$$

$$V_{ox} = \frac{9}{1.355261854}$$

$$V_{ox} = 6.640783086$$

$$\boxed{V_{ox} = 6.6 \text{ m/s}}$$

Tip! Do a "Sanity Check" - does your answer make sense?