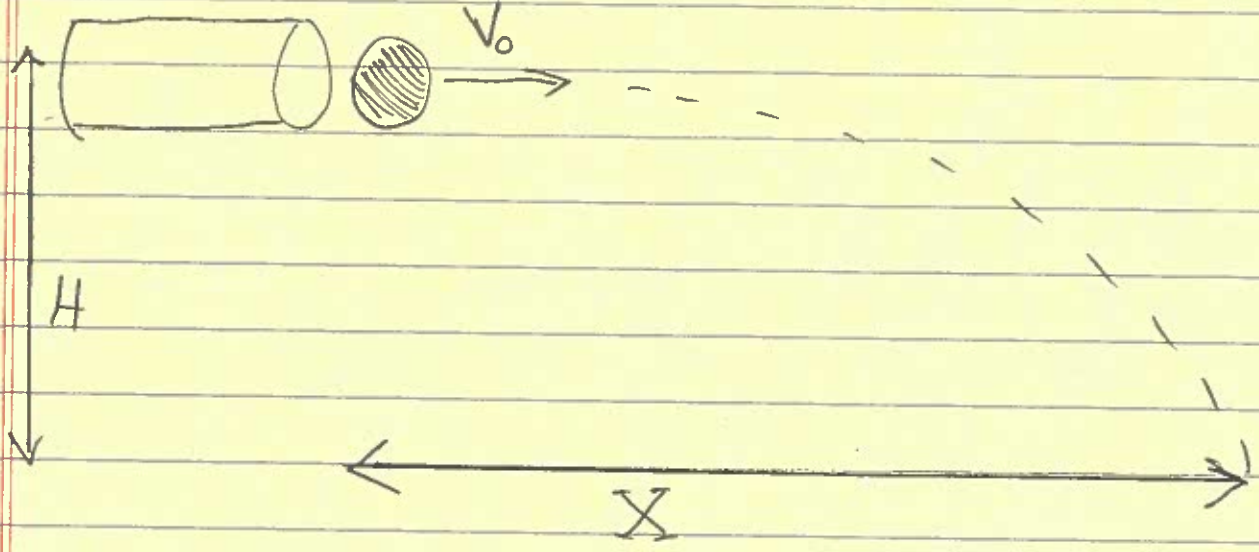

A gun sitting a height $H = 1$ m above the floor fires a ball at initial speed v horizontally. The ball lands on the floor, a distance X away from the gun.

What is initial velocity v?

time to fall to floor t_1 is given by

$$y(t) = H + v_y t + \frac{1}{2} a_y t^2$$

$$= H + 0 + \frac{1}{2}\left(-9.8 \frac{m}{s^2}\right) t^2$$

So time t_1 when ball hits floor is given by

$$0 = H - \left(4.9 \frac{m}{s^2}\right) t_1^2$$

Solving for time t_1,

$$\boxed{t_1 = \sqrt{\frac{H}{4.9\ m/s^2}}}$$

Since the horizontal speed of the ball is constant (we ignore air resistance), we can easily compute the initial speed.

$$x(t) = 0 + v_x t + \tfrac{1}{2} a_x t^2$$

$$\simeq 0 + Vt + 0$$

At time t_1,

$$X = V t_1$$

$$\rightarrow \boxed{V = \frac{X}{t_1}}$$

Suppose we place the gun at a much larger height, H_2. How far would the ball travel?

time to hit ground $t_2 = \sqrt{\frac{H_2}{4.9\ m/s^2}}$

distance travelled horiz $X_2 = V t_2$

same initial speed

So, if we are given a new distance X_2, we can figure out the new height like so:

$$t_2 = \frac{X_2}{V}$$

and then

$$H_2 = \left(4.9 \frac{m}{s^2}\right) t_2$$