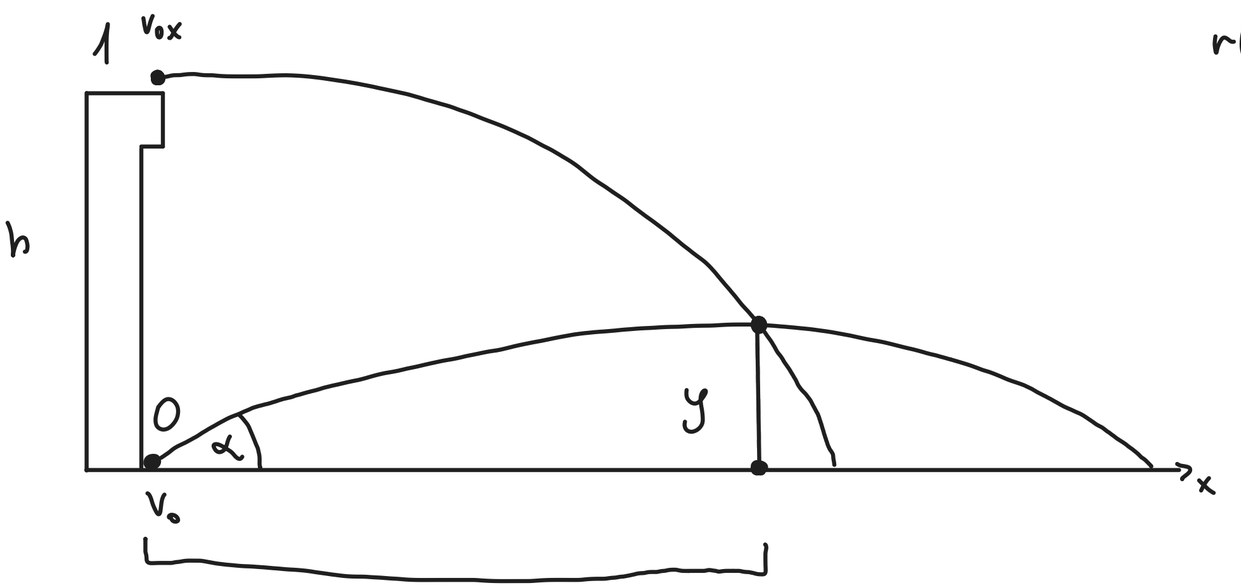
Problem 3.11. Two bodies are thrown simultaneously from 2 different points. One body is thrown with a velocity v_{0x} horizontally from a tower of height h, the other with a velocity v_0 at an angle α to the horizontal at the base of the tower. What should be the value of v_0 and α for the bodies to meet above the ground?



$$r(t) = \left[v_0 \cos\alpha t ; v_0 \sin\alpha t - \frac{gt^2}{2} \right]$$

0) $$r(t) = \left[v_0 \cos\alpha t ; v_0 \sin\alpha - \frac{gt^2}{2} \right]$$

1) $$r(t) = \left[v_{0x} t ; \frac{gt^2}{2} \right]$$

$$v_0 \cos\alpha t = v_{0x} t$$

$$\wedge$$

$$v_0 \sin\alpha - \frac{gt^2}{2} = \frac{gt^2}{2}$$

$$v_0 \sin\alpha = gt^2 \quad \wedge \quad v_0 \cos\alpha = v_{0x}$$

$$\begin{cases} v_0 \sin\alpha = gt^2 \\ v_0 \cos\alpha = v_{0x} \end{cases}$$

$$\begin{cases} v_0 = \dfrac{gt^2}{\sin\alpha} \\ v_0 = \dfrac{v_{0x}}{\cos\alpha} \end{cases} \qquad \frac{gt^2}{\sin\alpha} = \frac{v_{0x}}{\cos\alpha}$$

$$gt^2 = v_{0x} \tan\alpha$$

$$\frac{gt^2}{v_{0x}} = \tan\alpha \rightarrow \operatorname{arctan}\left(\frac{gt^2}{v_{0x}}\right) = \alpha$$

$$v_0 \sin\left(\operatorname{arctan}\left(\frac{gt^2}{v_{0x}}\right)\right) = gt^2$$

$$v_0 = \frac{gt^2}{\sin\left(\operatorname{arctan}\left(\frac{gt^2}{2}\right)\right)}$$