1 | Givens

- With v_o being the initial velocity of the projectile as a vector;
- With v_x and v_y being the x and y components of the initial velocity vector of the projectile;
- With v_1 being the initial downwards velocity of the target;
- With x_o and h_o being the initial horizontal distance between the projectile and target, and the initial height of the target, repectively;

2 | Proof

$$\begin{cases} h_{projectile}(t) & = v_y t - \frac{1}{2}gt^2 \\ h_{object}(t) & = h_o - v_1 t - \frac{1}{2}gt^2 \end{cases}$$

Because we want to know the time (t) when $h_{projectile}$ and h_{object} are equal, we will set them equal and get a good equation:

$$v_y t - \frac{1}{2}gt^2 = h_o + v_1 t - \frac{1}{2}gt^2$$
$$v_y t = h_o + v_1 t$$

Now that we have a nice equation, we can also solve for t. We will do this by using the $x(t)$ equation:

$$x_o = v_x t$$
$$t = \frac{x_o}{v_x}$$

We can plug t into our v_y equation now:

$$v_y \frac{x_o}{v_x} = h_o + v_1 \frac{x_o}{v_x}$$
$$x_o \frac{||v_o|| \sin\theta}{||v_o|| \cos\theta} = h_o + \frac{v_1 x_o}{||v_o|| \cos\theta}$$