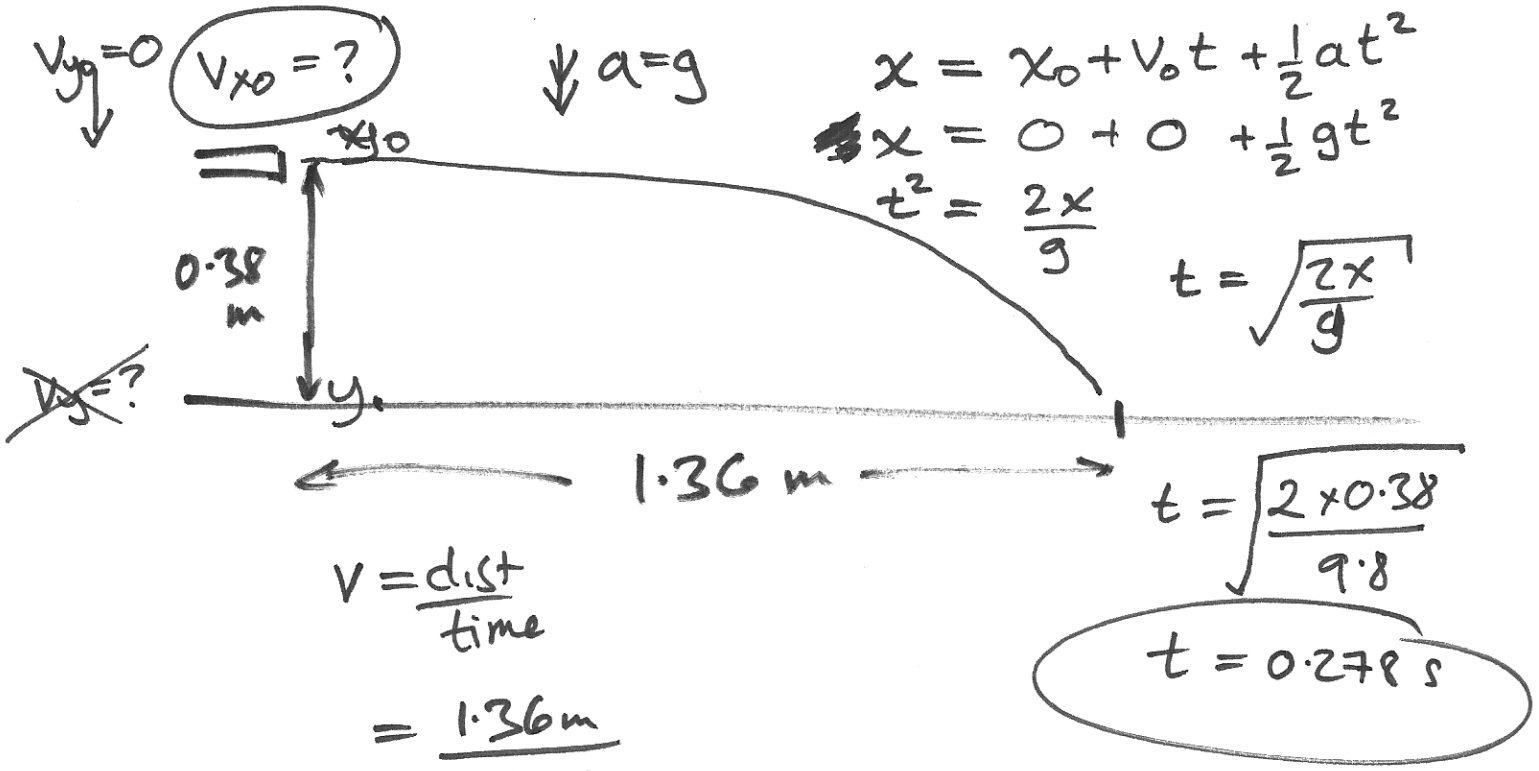
Projectile launcher lecture Demonstration



$$x = x_o + V_o t + \frac{1}{2}at^2$$

$$x = 0 + 0 + \frac{1}{2}gt^2$$

$$t^2 = \frac{2x}{g}$$

$$t = \sqrt{\frac{2x}{g}}$$

$$t = \sqrt{\frac{2 \times 0.38}{9.8}}$$

$$t = 0.278\ s$$

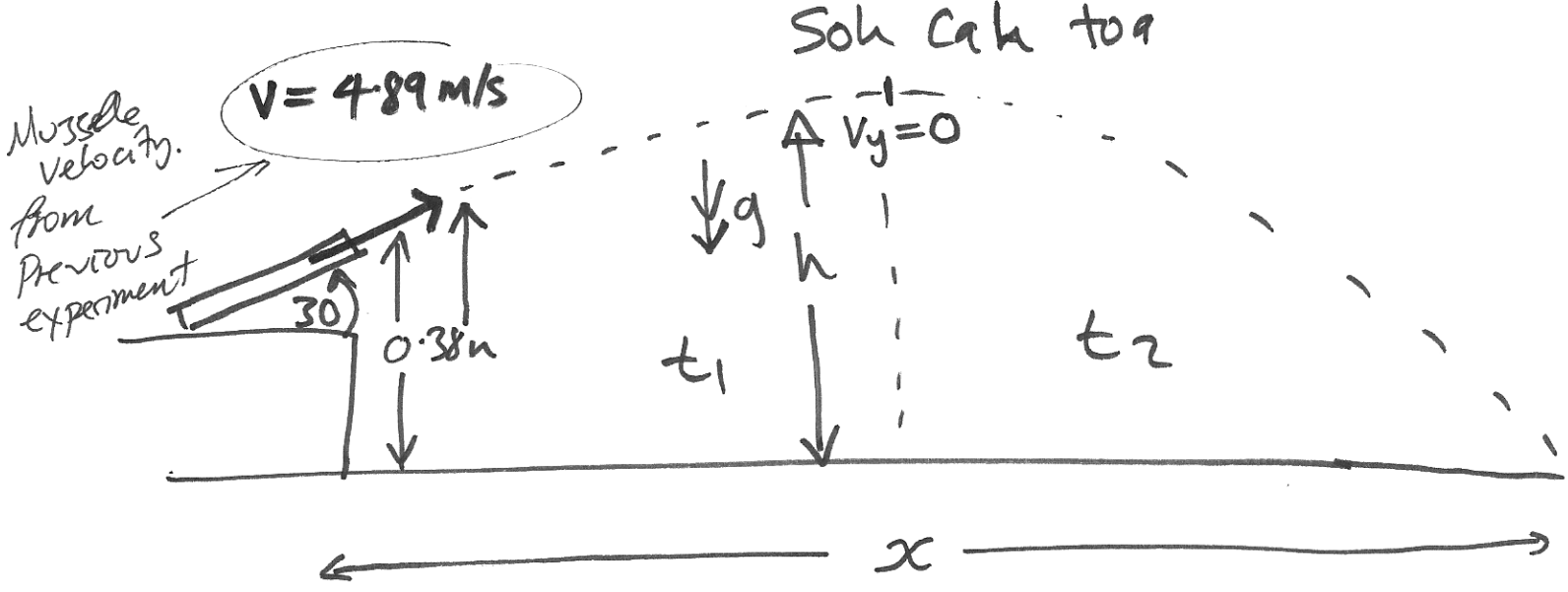
$$V = \frac{dist}{time}$$

$$= \frac{1.36\ m}{0.278\ s}$$

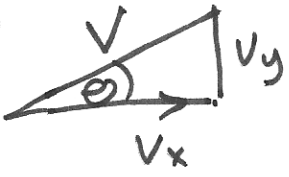
$$V_x = 4.89\ m/s$$

Here we fired horizontally, measured the range (x) = 1.36m and then calculated time for ball to fall from the height of launch. This is also the time-of-flight. Distance travelled in this time gives the horizontal velocity.

Now we have calibrated our launcher, and can predict <u>any</u> trajectory.



Vertically



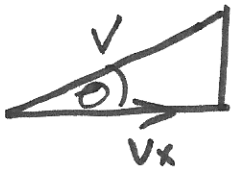
$$\sin\theta = \frac{V_y}{V}$$

$$V_y = V \sin\theta$$

$$= 4.89 \times \sin 30^\circ$$

$$V_{y_0} = 2.445 \text{ m/s}$$

Horizontally



$$\cos = \frac{V_x}{V}$$

$$V_x = V\cos(30)^\circ$$

$$= 4.89 \times \cos 30^\circ$$

$$V_x = 4.23 \text{ m/s}$$

$$a = \frac{\Delta V}{\Delta t}$$

$$t_1 = \frac{\Delta V}{a}$$

$$= \frac{2.445 \text{ m/s}}{9.8 \text{ ms}^{-2}}$$

$$t_1 = 0.249 \text{ s}$$

Height reached

$V_{y_0} = 2.445$ m/s

$V_{y_1} = 0$

$t = 0.249$ s

$h = ?$

$$\overline{V_y} = \frac{2.445 + 0}{2}$$

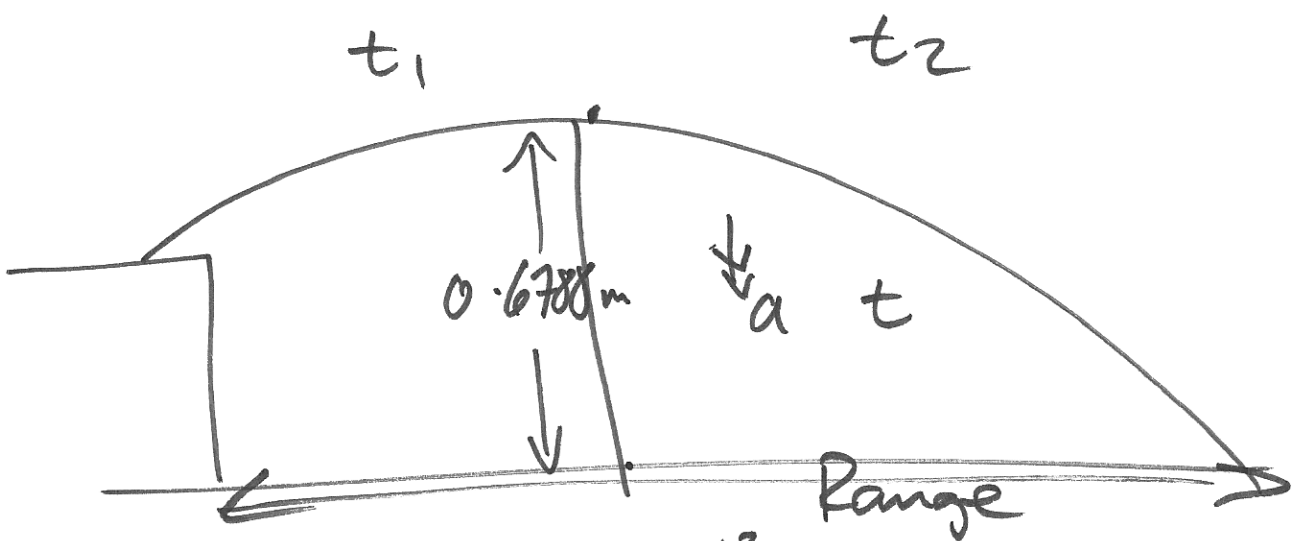
$$= 1.2225$$

$$\Delta y = 1.22 \times 0.249$$

$$= 0.2988 \text{ m}$$

$$h = 0.38 + 0.298$$

$$h = 0.6788 \text{ m}$$



$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$t^2 = \frac{2x}{g}$$

$$t_2 = \sqrt{\frac{2x}{g}}$$

$$t_2 = \sqrt{\frac{2 \times 0.6788}{9.8}}$$

$$= 0.369 s$$

t_2 = time for ball to get from highest point to the ground.

$$T = t_1 + t_2 \leftarrow \text{Total time of the flight}$$

$$= 0.249 s + 0.369 s$$

$$T = 0.62 \text{ s}$$

time of flight T

Range

$$\text{Range} = T \times V_x$$

$$= 0.62 \times 4.23$$

$$R = 2.63 \text{ m}$$

Actual distance was within 1-2 cm of this prediction!

2.67 m