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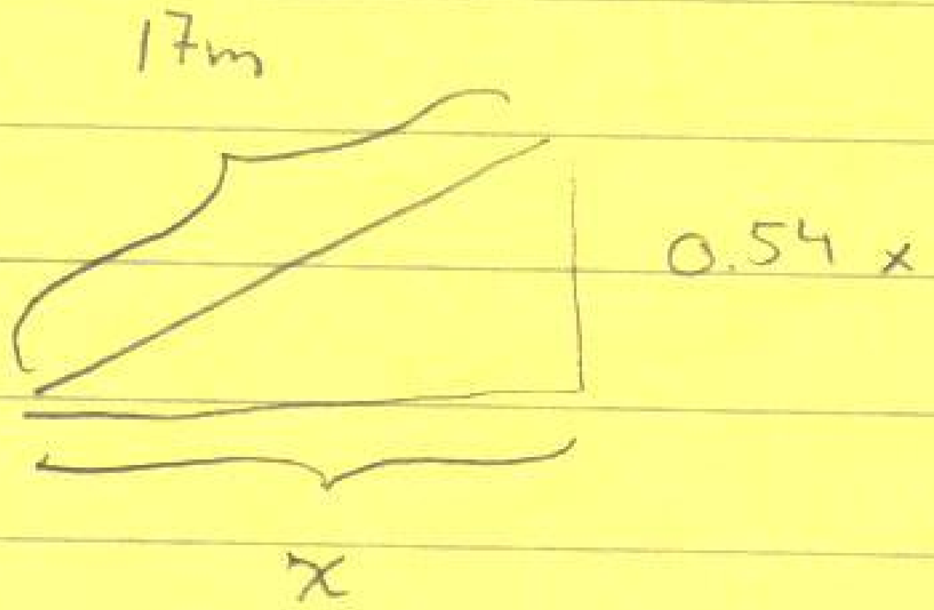
Projectile Motion Practice

Review Problem #13 of Homework - Projectile Motion

First find Billy's (x,y) coords



$$17 = \sqrt{x^2 + (0.54x)^2} = x\sqrt{1+(0.54)^2} = x\,(1.1365$$

$$x = 14.95 \qquad y = 0.54x = 8.077$$

$$\vec{r}(t) = \cancel{\vec{r}_0}^{\,0} + \vec{v}_0 t + \frac{1}{2}\vec{a}\,t^2$$

$$\vec{v}_0 = \begin{pmatrix} v_0 \cos 53^\circ \\ v_0 \sin 53^\circ \end{pmatrix}$$

$$\begin{pmatrix} x(t) \\ y(t) \end{pmatrix} = \begin{pmatrix} v_0 \cos 53^\circ \\ v_0 \sin 53^\circ \end{pmatrix} t + \frac{1}{2}\begin{pmatrix} 0 \\ -9.8 \end{pmatrix} t^2$$

This gives the (x,y) coordinates as a function of time for a given velocity v_0

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There is a special velocity and time such that $(x, y) = (14.95, 8.077)$ which we find

$$\begin{matrix}(1)\\(2)\end{matrix} \quad \begin{pmatrix} 14.95\text{ m} \\ 8.077\text{ m} \end{pmatrix} = \begin{pmatrix} v_0 \cos 53^\circ \\ v_0 \sin 53^\circ \end{pmatrix} t + \frac{1}{2}\begin{pmatrix} 0 \\ -9.8 \end{pmatrix} t^2$$

There are two equations and two unknowns v_0 + t

From (1) $$\frac{14.95\text{m}}{v_0 \cos 53^\circ} = t$$

From (2) $$8.077\text{ m} = \cancel{v_0} \sin 53^\circ \left(\frac{14.95\text{m}}{\cancel{v_0} \cos 53^\circ}\right) - 4.9 \frac{\text{m}}{\text{s}^2}\left(\frac{14.95}{v_0 \cos}\right.$$

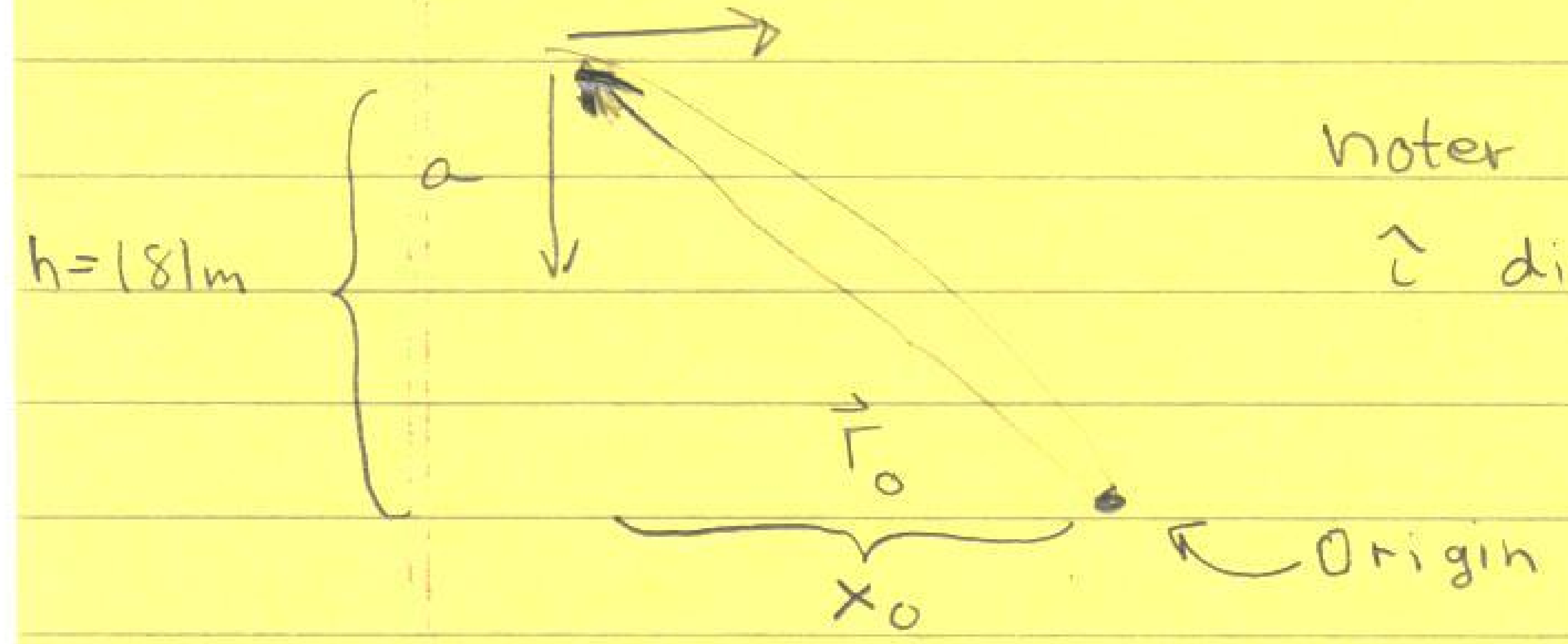
$$8.077\text{m} = 19.89\text{m} - 4.9 \frac{\text{m}}{\text{s}^2}\left(\frac{14.95\text{ m}}{v_0 \cos 53^\circ}\right)^2$$

$$v_0 = 16\text{ m/s}$$

③

Lab #2 Problem 3 - Solution (See Lab #2 for explanation)

$V_{ox} = 40\,m/s$



note: $\vec{r}_0$ points in negative $\hat{i}$ direction and up

$$\vec{r}(t) = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}\,t^2$$

$$\begin{pmatrix} x(t) \\ y(t) \end{pmatrix} = \begin{pmatrix} -x_0 \\ h \end{pmatrix} + \begin{pmatrix} V_{ox} \\ 0 \end{pmatrix} t + \frac{1}{2}\begin{pmatrix} 0 \\ -g \end{pmatrix} t^2$$

$x(t) = -x_0 + V_{ox}\,t$ ⇐ x coordinate as a function of time

$y(t) = h - \frac{1}{2} g t^2$ ⇐ y coordinate as a function of time

There is a special time t_* and x_0 when $x(t_*) = y(t_*) = 0$, when backpack reaches the bottom

$$0 = -x_0 + v_{ox} t_*$$

$$0 = h - \frac{1}{2} g t_*^2$$

$$\sqrt{\frac{2h}{g}} = t_* \Rightarrow x_0 = +V_{ox}\sqrt{\frac{2h}{g}}$$

(1) Projectile Motion Practice

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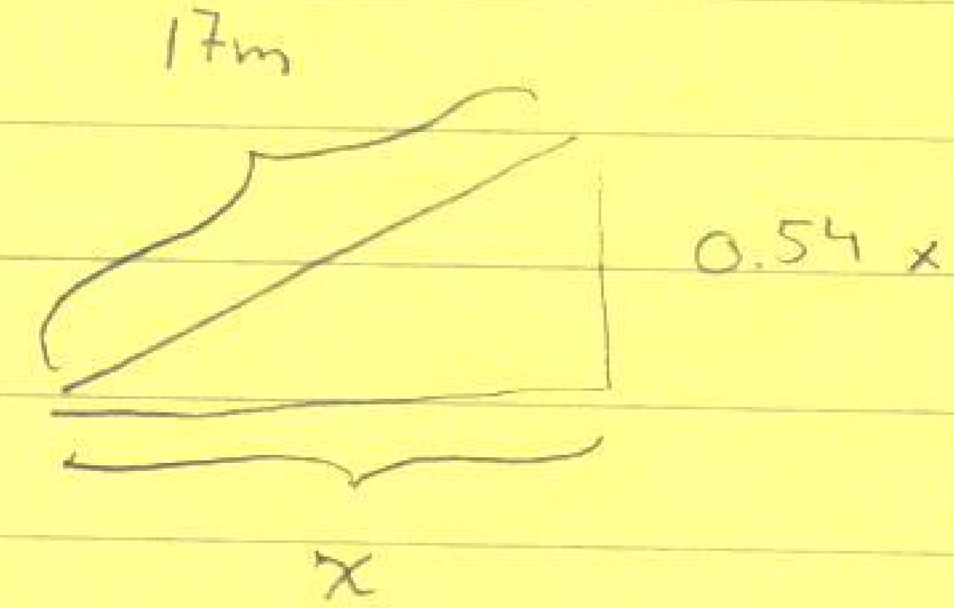

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