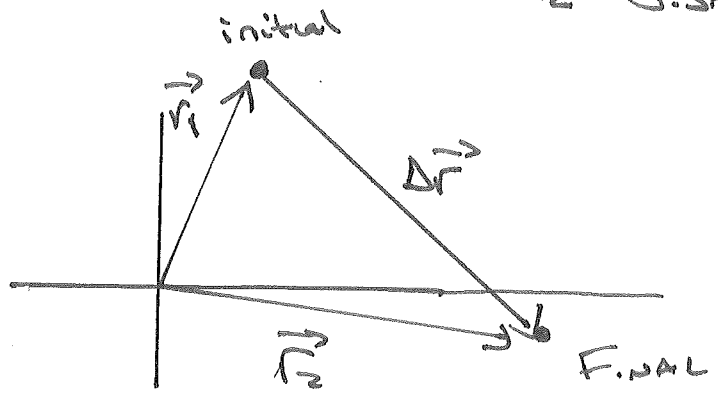
Physics 160

Extra Credit #8

3.1 A squirrel has $x_1 = 1.3\text{m}$, $y_1 = 3.3\text{m}$ at $t_1 = 0$

$x_2 = 5.3\text{m}$, $y_2 = -0.3\text{m}$ at $t_2 = 2.7\text{s}$



$$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1$$

$$\Rightarrow \Delta x = x_2 - x_1, \quad \Delta y = y_2 - y_1$$

Δx: $\Delta\vec{r}$'s x-component; Δy: $\Delta\vec{r}$'s y-component

$$\Delta x = x_2 - x_1 = 5.3\text{m} - 1.3\text{m} = 4\text{m}, \quad \Delta y = -0.3\text{m} - 3.3\text{m} = -3.6\text{m}$$

$$\vec{v}_{Av} = \frac{\Delta\vec{r}}{\Delta t} \Rightarrow v_{Av,x} = \frac{\Delta x}{\Delta t} = \frac{4\text{m}}{2.7\text{s}} = 1.48\text{m/s} = 1.5\text{m/s}$$

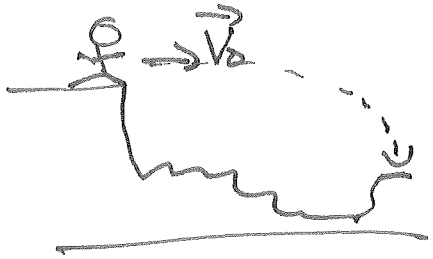
$$v_{Av,y} = \frac{\Delta y}{\Delta t} = \frac{-3.6\text{m}}{2.7\text{s}} = -1.33\text{m/s} = -1.3\text{m/s}$$

$$v_{Av} = \sqrt{v_{Av,x}^2 + v_{Av,y}^2} = \sqrt{(1.5\text{m/s})^2 + (1.3\text{m/s})^2} = 1.984\text{m/s} \approx 2\text{m/s}$$

$\theta = \tan^{-1}\left(\frac{v_{Av,y}}{v_{Av,x}}\right)$ $v_{Av,y} < 0$, $v_{Av,x} > 0 \Rightarrow$ 4th Quadrant, so Calc. OK

Since Mastering wants "Angle Below X-Axis": Enter $|\theta| = |\tan^{-1}\left(\frac{-1.3}{1.5}\right)| = 41°$

Direction of Velocity

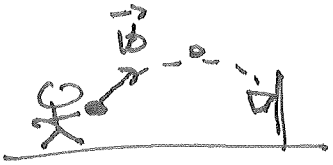


Jumps horizontally ⇐ no x-component

$\Rightarrow V_{ox} = +,\ V_{oy} = 0$

When he lands, he is going Down and to the Right $\Rightarrow$

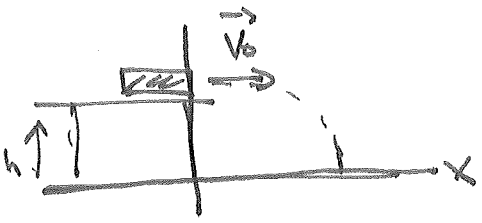
$V_x = +,\ V_y = -$



Shoots up and to the right $\Rightarrow$ $V_{ox} = +,\ V_{oy} = +$

At max height, motion changes from up to down, but always going to the Right $\Rightarrow$ $V_x = +,\ V_y = 0$

3.9



$V_0 = 1.35 m/s$

$t = 0.38s$ to hit Floor

Setup Coordinates as shown: $x_0 = 0$, $y_0 = h = ?$

KNOWN: $x_0 = 0$, $V_{ox} = 1.35 m/s$, $V_{oy} = 0$ ← Horizontal Vector has no y-component And All x-component

$t = 0.38s$, $y = 0$ ← floor!

UNKNOWN: V_x, y_0, x

$y = y_0 + V_{oy}t - \frac{1}{2}gt^2 \Rightarrow 0 = h + 0 - \frac{1}{2}(9.8 m/s^2)(.38s)^2 \Rightarrow 0 = h - 0.70756m$

$\Rightarrow h = 0.70756m = 0.708m$

b) Find x

$X = X_0 + V_{ox}t \rightarrow X = (1.35 m/s)(0.38s) = 0.513m$

c) Find V_x just Before it hits Floor.

$V_x = V_{ox} = 1.35 m/s$

d) Find V_y

$V_y = V_{oy} - gt = 0 - 9.8 m/s^2 (+0.38s) = -3.724 m/s$

e) Find speed : $V = \sqrt{V_x^2 + V_y^2}$

$V = \sqrt{(1.35\,m/s)^2 + (3.724\,m/s)^2} = 3.96\,m/s$

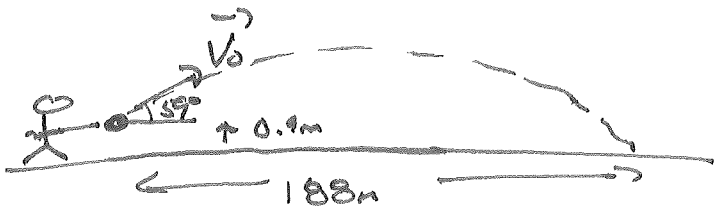
F) Find direction

$\theta = \tan^{-1}\left(\frac{V_y}{V_x}\right)$ $V_y < 0$, $V_x > 0 \Rightarrow$ 4th QUADRANT so CALCULATOR OK

but masking wants "Below the Horizontal" $\Rightarrow$ input 101

$\theta = \tan^{-1}\left(\frac{-3.724}{1.35}\right) = -70.1°$

3.59



KNOWN: $x_0 = 0$, $x = 188m$

$y_0 = 0.9m$, $y = 0$

$\alpha = 59° \Rightarrow V_{0x} = V_0 \cos 59°$, $V_{0y} = V_0 \sin 59°$

UNKNOWN: V_0, t, V_x, V_y

Have to be tricky: $y = y_0 + V_{0y}t - \frac{1}{2}gt^2 \Rightarrow 0 = 0.9m + V_0 \sin 59° t - \frac{1}{2}(9.8m/s^2)t^2$

$\Rightarrow V_0 \sin 59° t - 4.9m/s^2 t^2 = -0.9m$

$x = x_0 + V_{0x}t \Rightarrow 188m = 0 + V_0 \cos 59° t \Rightarrow t = \frac{188m}{V_0 \cos 59°}$

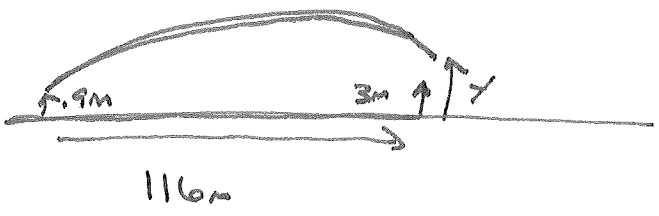
$\Rightarrow V_0 \sin 59° \left(\frac{188m}{V_0 \cos 59°}\right) - 4.9m/s^2 \left(\frac{188m}{V_0 \cos 59°}\right)^2 = -0.9m$

$\Rightarrow \tan 59° \, 188m - \frac{4.9m/s^2 (188m)^2}{V_0^2 \cos^2 59°} = -0.9m$

$\Rightarrow -\frac{4.9m/s^2 (188m)^2}{V_0^2 \cos^2 59°} = -0.9m - \tan 59° \, 188m = -313.78m$

$\Rightarrow V_0^2 = -\frac{4.9m/s^2 (188m)^2}{\cos^2 59° (-313.78m)} = 2080.66m^2/s^2 \Rightarrow V_0 = 45.6m/s$

b) at $x = 116\,m$, how far above 3m fence?



So answer is $y - 3m$

KNOWN: $y_0 = 0.9m$, $V_0 = 45.6 m/s$, $\alpha = 59°$ $\Rightarrow$ $V_{ox} = 23.5 m/s = 45.6 m/s \cos 59°$

$V_{oy} = 45.6 m/s \sin 59° = 39.1 m/s$

$X = 116m$

UNKNOWN: y, t, V_y

$y = y_0 + V_{oy}t - \frac{1}{2}gt^2$ ← need t

$X = X_0 + V_{ox}t$ can find it $\Rightarrow 116m = 23.5 m/s\, t \Rightarrow t = \frac{116m}{23.5 m/s} = 4.936s$

$y = y_0 + V_{oy}t - \frac{1}{2}gt^2 \Rightarrow y = 0.9m + 39.1 m/s(4.936s) - \frac{1}{2}(9.8 m/s^2)(4.936s)^2$

$\Rightarrow y = 74.5m$

so $h = 74.5m - 3m = 71.5m$