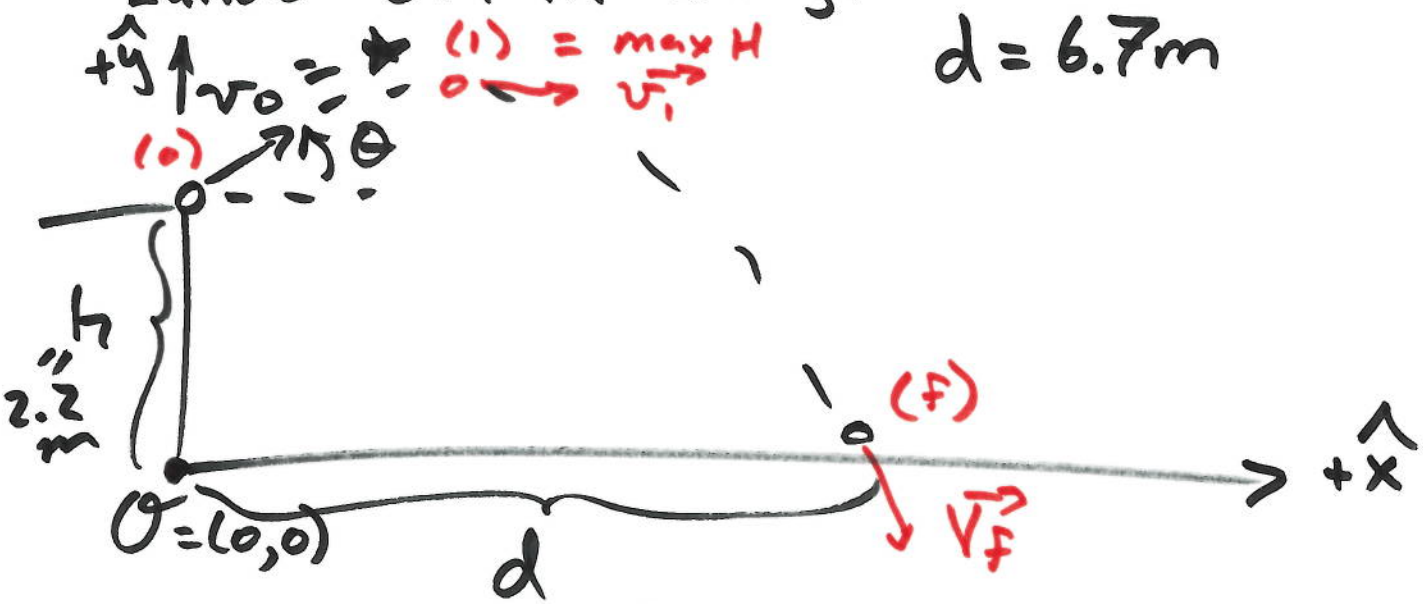
Physics 200 — Exam 1 Review

Tuesday 9/26

Topics

- vectors { adding, Converting }
- 1-D Motion
- 2-D: Projectile Motion

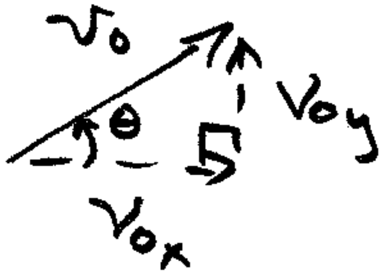
launch ball at 33° above the horizontal from 2.2 m above flat ground. Lands 6.7 m away.



$d = 6.7\,m$

Find: v_0, t, $\vec{V}_f$ just before it strikes ground

also (long) could find: max H above ground, the $\vec{v}$ at max H, t to reach max H.



SOH CAH TOA

$\sin\theta = \frac{opp}{hyp} = \frac{v_{oy}}{v_0} \rightarrow v_0 \sin\theta = v_{oy}$

$\cos\theta = \frac{adj}{hyp} = \frac{v_{ox}}{v_0} \rightarrow v_0 \cos\theta = v_{ox}$

(I) $v(t) = v_0 + at$

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

(III) $v^2(t) = v_0^2 + 2a(x(t) - x_0)$

$a_x = 0 \quad a_y = -g$

$y_0 = +2.2m$ (see where we put θ)

$x_0 = 0$

$y(t) = 0$

$x(t) = 6.7m$

$(III)_y \quad v_{fy}^2 = v_{oy}^2 + 2 a_y (y(t) - y_0)$

$v_{fy}^2 = v_0^2 \sin^2\theta + (2)(-g)(0 - 2.2m)$

? $\qquad$ ★

$(II)_y \quad y(t) = y_0 + v_{oy} t + \frac{1}{2} a_y t^2$

$0 = 2.2m + v_0 \sin\theta\, t - \frac{1}{2} g t^2$

$x(t) = x_0 + v_{ox} t + 0 \quad a_x = 0$

$(II)_x \quad 6.7m = 0 + v_0 \cos\theta\, t$

$$\frac{6.7m}{\cos\theta} = v_0 t$$

$$0 = 2.2m + \sin\theta \underbrace{\left(\frac{6.7m}{\cos\theta}\right)}^{v_0 t} - \frac{1}{2} g t^2 \quad \star$$

$$\frac{1}{2} g t^2 = 2.2m + 6.7m \tan(33^\circ)$$

$$4.9\tfrac{m}{s^2} t^2 = 6.55m$$

$$t^2 = 1.337\, s^2 \qquad \boxed{t = 1.16s}$$

choose ⊕.

$$6.7m = v_0 \cos 33^\circ (1.16s)$$

$$\frac{6.7m}{1.16s(\cos 33^\circ)} = \boxed{v_0 = 6.89\,m/s}$$

$$(\mathrm{I})_y : \quad v_y(t) = v_{0y} + a_y t$$

$\star$

$$v_y(t) = 6.89\tfrac{m}{s} \sin 33^\circ - 9.8\tfrac{m}{s^2}(1.16s)$$

$$\boxed{v_y(t) = -7.6\,m/s}$$

yes. − sign ⇒ down

since $a_x = 0$

$$(\mathrm{I})_x : \quad v_x(t) = v_{0x} + \cancel{a_x}^{\,0} t$$

$$= v_0 \cos 33^\circ$$

$$\boxed{v_x(t) = 5.78\,m/s}$$

$$\vec{v}_f = (\underset{v_{fx}}{5.78}, \underset{v_{fy}}{-7.6})\,m/s$$

at max H. $V_y = 0$. so $V_{y_1} = 0$.

Point 1 will be max H.

Know v_0 y_0 x_0 θ

find: $\vec{v_1} = (v_{1x}, \cancel{v_y})$ t_1 = time until max H

y_1 = max H above ground.

$v_{1x} = v_{0x} = v_{fx} = 5.78\,m/s$ const. since $a_x = 0$.

$\vec{v_1} = (5.78\frac{m}{s}, 0)$

$(I)_y$: $v_{1y} = v_{0y} + a_y t_1$

$0 = v_0 \sin\theta - g t_1$

$0 = 6.89\frac{m}{s} \sin 33^\circ - 9.8\,m/s^2\, t_1$

$t_1 = \frac{3.75\,m/s}{\cancel{4.9\,m/s^2}\ 9.8} = \cancel{0.766\,s}$ $\boxed{0.383\,s}$

$(III)_y$

$$v_{y_1}^2 = v_{0y}^2 + 2a_y(y_1 - y_0)$$

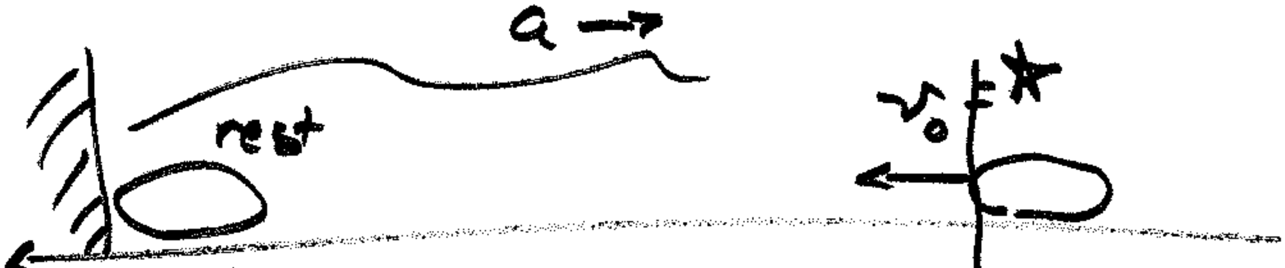
$$0 = v_0^2 \sin^2\theta - 2g\,(y_1 - 2.2m)$$

above ground. Note $y_0 \neq 0$

$$y_1 - 2.2m = \frac{v_0^2 \sin^2\theta}{2g} = \frac{14.08\,m}{2g}$$

$\boxed{y_1 = \cancel{16.08m}\ 2.92\,m}$ $\cancel{\text{m/s}}$

You toss your back pack from 5.3 m across the room. It reaches the wall with zero velocity. If this takes 1.0s (time), find v_0. You toss horizontally. And find a.



$v_f = 0$

$x_0 = 0$

$+\hat{x}$ $t = 1.0s$

$X(t) = 5.3m$

(I)$_x$ $\quad V(t) = V_0 + at \qquad v_0 = -at$

$$0 = v_0 + at$$

$$x(t) = x_0 + v_0 t + \frac{1}{2}at^2$$

$$= \cancel{x_0}^{\,0} + (-at)t + \frac{1}{2}at^2$$

$$= 0 - at^2 + \frac{1}{2}at^2$$

$$X(t) = -\frac{1}{2}at^2$$

$$5.3m = -\frac{1}{2}a(1.0s)^2$$

$$-\frac{2(5.3m)}{(1.0s)^2} = \boxed{a = -10.6\,\frac{m}{s^2}}$$

(III) $v^2(t) = v_0^2 + 2a\,(x(t) - x_0)$

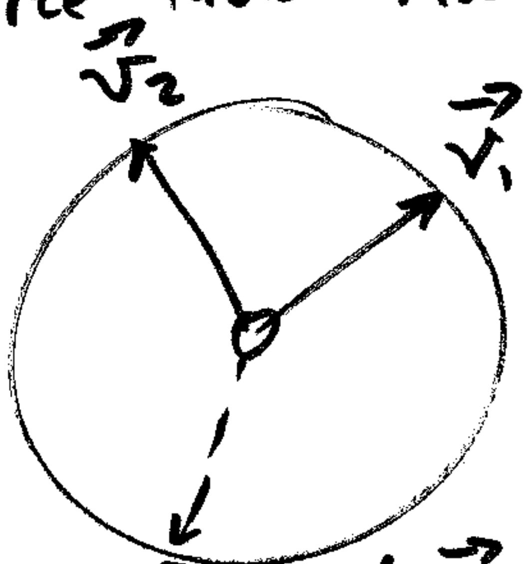
$0 = \overset{*}{v_0}{}^2 + 2\overset{*}{a}\,(5.3\,m)$

(I) $0 = v_0 + at$

$v_0 = +10.6\,\frac{m}{s} = -at$

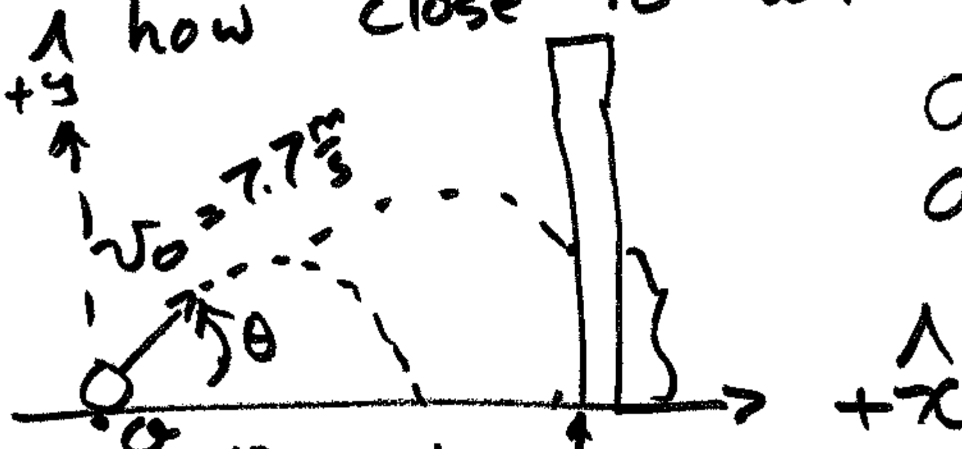
$v_0 = -(-10.6\,\frac{m}{s^2})(1.0\,s)$

Force Table: Adding Vectors:



$\vec{v}_3 = -(\vec{v}_1 + \vec{v}_2)$

you kick a ball at 7.7 m/s at 61° above horizontal toward a wall 2.9m distant. Does it hit wall? If so, find $\vec{v}$ with which it hits. If not, find how close to wall the ball lands.



$\theta = 61°$

$x_{wall} = 2.9m$

$a_x = 0$

$a_y = -g$

$x_0 = 0$

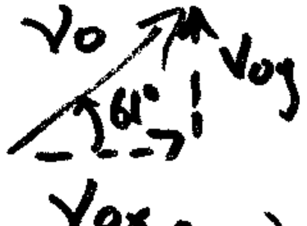
$y_0 = 0$

Let's set $x(t) = 2.9m$.

$(\mathrm{II})_x \quad x(t) = x_0 + v_{0x} t + \frac{1}{2} \cancel{a_x} t^2$

$2.9m = 0 + \underbrace{7.7\frac{m}{s} \cdot \cos 61°}_{3.73\frac{m}{s}} \cdot t$

$\boxed{0.777s = t}$



$(\mathrm{II})_y \quad y(t) = \cancel{y_0} + v_{0y} t - \frac{1}{2} g t^2$

$y(t) = 7.7\frac{m}{s} \cdot \sin 61° \cdot 0.777s - 4.9\frac{m}{s^2}(0.78s)^2$

$= 5.23m - 2.96m = \boxed{2.27m}$

find $\vec{V}$ with which ball hits wall.

$$(I)_y: \; V_y(t) = V_{oy} - gt$$

$$\star \quad = V_0 \sin\theta - gt$$

$$= 7.7\tfrac{m}{s} \cdot \sin 61^\circ - 9.8\tfrac{m}{s^2}(0.777s)$$

$$= 6.73\tfrac{m}{s} - 7.61\tfrac{m}{s}$$

$$\boxed{V_y(t) = -0.88\tfrac{m}{s}}$$

$$(I)_x \; V_x(t) = V_{ox} + \cancel{a_x}^{\,0} t$$

$$V_x(t) = V_0 \cos\theta$$

$$= 7.7\tfrac{m}{s} \cos 61^\circ = \boxed{3.73\tfrac{m}{s} = V_x(t)}$$

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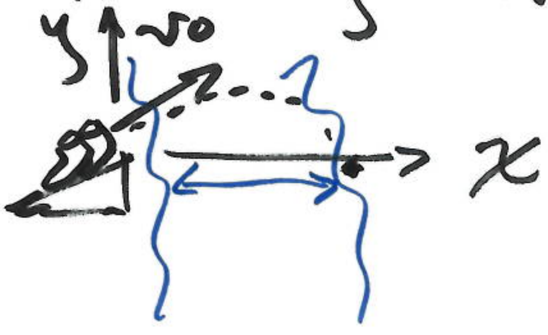
you have a ramp, 40° above horizontal. you move it next to a 7.1m wide river. What is the slowest speed you can launch your shoes so that they make it safely over.



$y_0 = 0 = y(t)$.

$x_0 = 0 \qquad x(t) = 7.1m$

$V_{ox} = V_0 \cos 40^\circ \qquad a_x = 0$

$V_{oy} = V_0 \sin 40^\circ \qquad a_y = -g$

$(\mathrm{II})_x \quad x(t) = x_0 + v_0 \cos 40° \, t$

$$\boxed{7.1\text{m} = 0 + v_0 \cos 40° \, t}$$

$\star$?

y: $(\mathrm{II})_y \quad y(t) = y_0 + v_{0y} t - \frac{1}{2} g t^2$

$$0 = 0 + v_0 \sin\theta \, t - \frac{1}{2} g t^2$$

$$\frac{7.1\text{m}}{t \cdot \cos 40°} = v_0$$

$$0 = \left(\frac{7.1\text{m}}{\cancel{t}\cos 40°}\right) \cdot \sin\theta \, \cancel{t} - \frac{1}{2} g t^2$$

$$\frac{1}{2} g t^2 = 7.1\text{m} \cdot \tan 40°$$

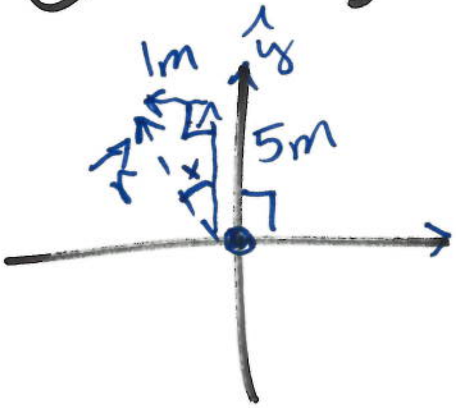
$$t^2 = \frac{2 \times 7.1\text{m} \cdot \tan 40°}{9.8 \text{ m/s}^2} = 1.22 \text{ s}^2$$

$$\boxed{t = 1.10 \text{ s}}$$

$$\frac{7.1\text{m}}{(\cos 40° \cdot t)} = v_0 = 8.39 \frac{\text{m}}{\text{s}}$$

$$8.4 \frac{\text{m}}{\text{s}}$$

Converting Vectors: not religion



Convert $(-1, +5)$m to polar form (length, θ).

$r = \sqrt{5^2 + 1^2}$

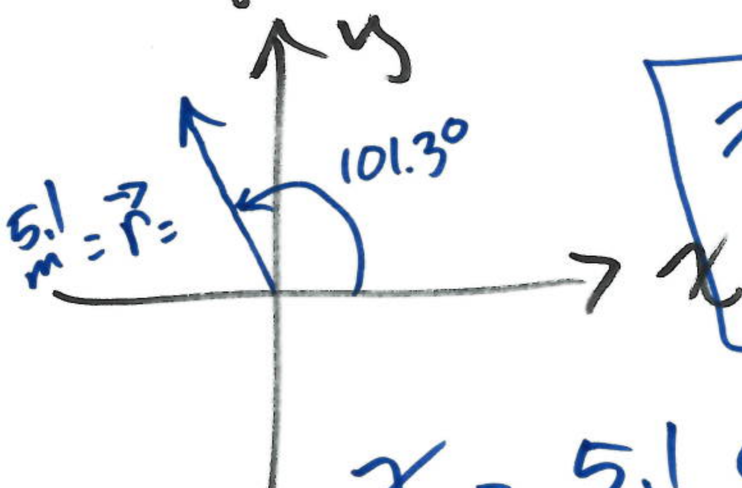
$= \sqrt{26}\,\text{m} = \boxed{5.10\text{m} = r}$

$\tan^{-1}\left(\frac{y}{x}\right) = \tan^{-1}\left(\frac{5}{-1}\right) = -78.7°$

$+180°$ since $x<0$

$\boxed{101.3°}$

If given: $r = 5.1$m, $\theta = 101.3°$,



$$\boxed{\begin{aligned} x &= r\cos\theta \\ y &= r\sin\theta \end{aligned}}$$

$x = 5.1\cos(101.3°) = -1.00$

$y = 5.1\sin(101.3°) = +5.00$