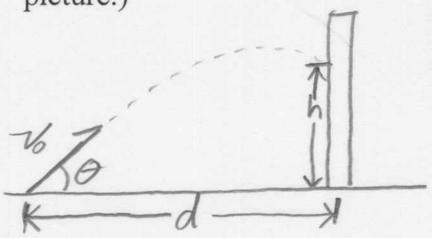
# 1D Kinematics, Part 2

2. You throw a ball toward a wall with a speed of 25.0 m/s and at an angle of 40.0° above the horizontal. The wall is 22.0 m from the release point of the ball.

   (a) How far above the release point does the ball hit the wall? (Be sure to draw a picture.)




Given
$V_0 = 25\ m/s$
$\theta = 40°$
$d = 22\ m$

Want
h

Part a

x

$x_F = x_0 + V_{0x}t + \frac{1}{2}a_x t^2$

Solve for t → $d = 0 + V_0 \cos\theta\, t + 0$

$t = \frac{d}{V_0 \cos\theta}$ Plug into y eq →

y

$y_F = y_0 + V_{0y}t + \frac{1}{2}a_y t^2$

$h = 0 + V_0 \sin\theta\, t - \frac{1}{2}gt^2$

$h = V_0 \sin\theta \frac{d}{V_0 \cos\theta} - \frac{1}{2}g \frac{d^2}{V_0^2 \cos^2\theta}$

   (b) What are the horizontal and vertical components of its velocity as it hits the wall?

$$h = d\tan\theta - \frac{1}{2}\frac{gd^2}{V_0^2\cos^2\theta}$$ *

$h = 22 \cdot \tan(40) - \frac{1}{2}\frac{(9.8)(22)^2}{(25)^2\cos^2(40)}$

$h = 12.0\ m$

Part B - Find $\vec{V}_F$, Final velocity

x

$V_{Fx} = V_{0x} + a_x t$

y

$V_{Fy} = V_{0y} + a_y t$

   (c) When it hits, has it passed the highest point on its trajectory? How do you know?

$V_{Fx} = V_0 \cos\theta$

$V_{Fx} = (25)\cos(40)$

$= 19.2\ m/s$

get from part a ↓

$V_{Fy} = V_0 \sin\theta - gt$

$V_{Fy} = V_0 \sin\theta - \frac{gd}{V_0 \cos\theta}$

$V_{Fy} = 25 \sin 40 - \frac{(9.8)(22)}{(25)\cos(40)}$

$V_{Fy} = 4.8\ m/s$



Part C Not past apex because $V_{yF}$ is positive

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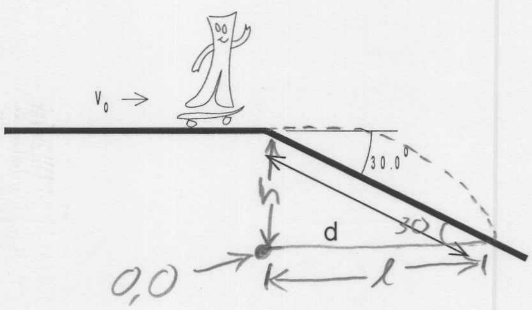
3. Gumby has just purchased a new skateboard; but, unfortunately, he does not know how to stop. Traveling at 8.0 m/s, he reaches the top of a hill sloping down at 30.0°.

   How far down the hill does Gumby crash (i.e., find the distance *d*)?




Given

$v_{0x} = 8.0\ m/s$

$v_{0y} = 0$

$\theta = 30^\circ$

want

$d$

x

$x_f = x_0 + v_{0x}t + \frac{1}{2}at^2$

$\ell = 0 + v_{0x}t + 0$

y

$y_f = y_0 + v_{0y}t + \frac{1}{2}at^2$

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

Look at picture: write $\ell$ and $h$ in terms of $d$ and $\theta$

$\ell = d\cos\theta$, $h = d\sin\theta$

$d\cos\theta = v_{0x}t$

$t = \frac{d\cos\theta}{v_{0x}}$

$d\sin\theta = \frac{1}{2}gt^2$

$d\sin\theta = \frac{1}{2}g\frac{d^2\cos^2\theta}{v_{0x}^2}$

Solve for d

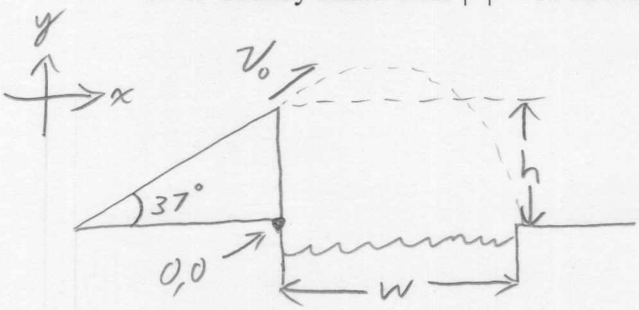
$$d = \frac{2v_{0x}^2\sin\theta}{g\cos^2\theta} \Rightarrow d = \frac{2(8)^2\sin(30)}{(9.8)\cos^2(30)} =$$

$d = 8.7\ m$

4. Having recovered from an earlier crash, Gumby is ready to try new and more exciting stunts on his skateboard. After some prodding from the Blockheads, he decides to jump across a river. Gumby knows that the far bank is 3.0 m below the top of the ramp. The ramp is inclined at 37.0° above the x-axis, and he is moving at 15 m/s when he leaves it.

a. How wide of a river can Gumby jump if he puts the ramp on the edge of the riverbank?

b. If Gumby lands with $|\vec{v}| > 16$ m/s his leg will break. Does Gumby need crutches?




$h = 3.0\,m$

$V_0 = 15\,m/s$

$\theta = 37.0°$

Want: $w$, $|\vec{V}_f|$

$x$

$$x = x_0 + V_{0x}t + \tfrac{1}{2}at^2$$

$$w = V_0 \cos\theta\, t$$

$y$

$$y = y_0 + V_{0y}t + \tfrac{1}{2}at^2$$

$$0 = h + V_0 \sin\theta\, t - \tfrac{1}{2}gt^2$$

$$t = \frac{1}{g}\left[V_0 \sin\theta \oplus \left(V_0^2 \sin^2\theta + 2gh\right)^{1/2}\right]$$

$$* \boxed{w = \frac{V_0 \cos\theta}{g}\left[V_0 \sin\theta + \left(V_0^2 \sin^2\theta + 2gh\right)^{1/2}\right]} *$$

$$= \frac{15\cos(37)}{9.8}\left[15 \sin 37 + \left(15^2 \sin^2 37 + (2)(9.8)(3)\right)^{1/2}\right]$$

$$= \underline{25\,m}$$

(b) Given: $W = 25m$

What is $|\vec{V_F}|$

**x**

$W = V_0 \cos\theta \, t \Rightarrow t = \frac{W}{V_0 \cos\theta}$

$$\boxed{V_{xF} = V_0 \cos\theta}$$

$V_{xF} = 15 \cos(37)$

$V_{xF} = 12.0 \, m/s$

**y**

$0 = h + V_0 \sin\theta \, t - \frac{1}{2} g t^2$

$V_{yF} = V_0 \sin\theta - gt$

$$\boxed{V_{yF} = V_0 \sin\theta - g \frac{W}{V_0 \cos\theta}}$$

$V_{yF} = 15 \cdot \sin 37 - \frac{(9.8)(25)}{15 \cos 37}$

$V_{yF} = -11.4 \, m/s$

$V_F = (12^2 + 11.4^2)^{1/2} = 16.5 \, m/s$

Gumby needs cruthes