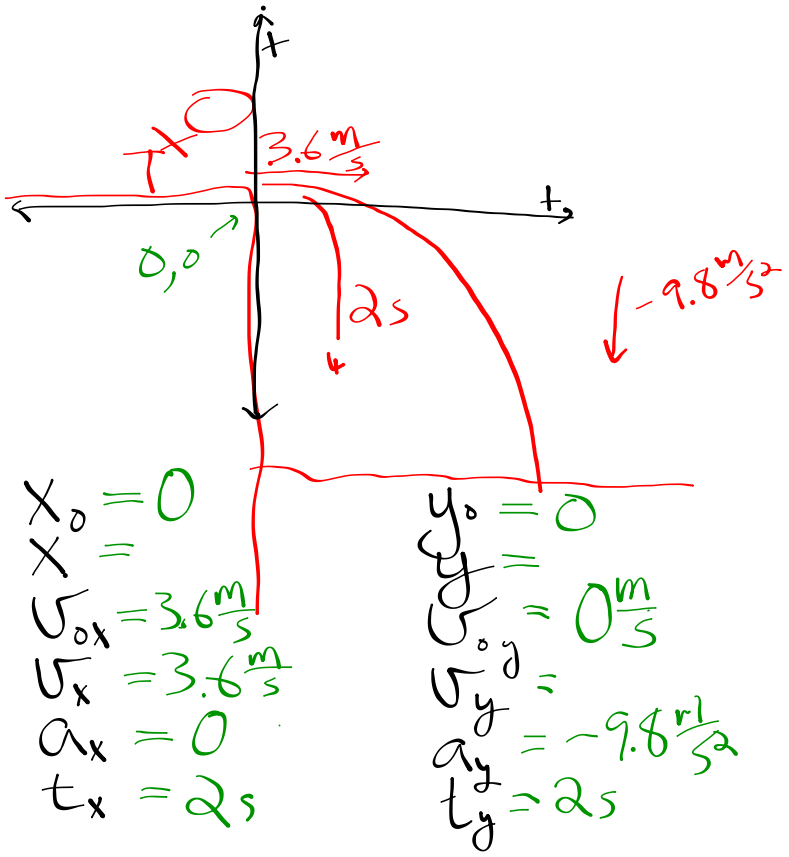
A diver running 3.6 m/s dives out horizontally from the edge of a vertical cliff and reaches the water below 2.0 s later. How high was the cliff and how far from its base did the diver hit the water?

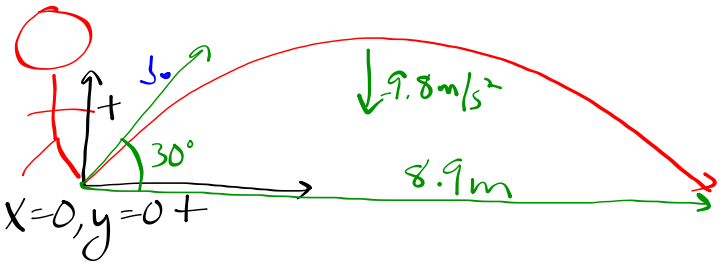


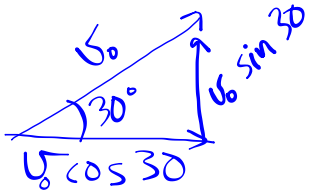
$X_0 = 0$
$X =$
$v_{0x} = 3.6\frac{m}{s}$
$v_x = 3.6\frac{m}{s}$
$a_x = 0$
$t_x = 2s$

$y_0 = 0$
$y =$
$v_{0y} = 0\frac{m}{s}$
$v_y =$
$a_y = -9.8\frac{m}{s^2}$
$t_y = 2s$

- You can break any vector (d, v, a) into x/y components
- You can consider motion in the x-axis separately from motion in the y-axis
- Motion in one direction is independent from motion 90° away

An athlete executing a long jump leaves the ground at a 30* angle and travels 8.90 m. What was the takeoff speed?





$x_0 = 0$ $\quad y_0 = 0$

$x = 8.9m$ $\quad y = 0$

$v_{0x} = v_0 \cos 30$ $\quad v_{0y} = v_0 \sin 30$

$v_x = v_0 \cos 30$ $\quad v_y = v_0 \sin 30 + -9.8t$

$a_x = 0$ $\quad a_y = -9.8 \frac{m}{s^2}$

$t_x = \frac{8.9}{v_0 \cos 30}$ $\quad t_y = \frac{v_0 \sin 30}{4.9}$

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

$8.9 = (v_0 \cos 30) t$

$t = \frac{8.9}{v_0 \cos 30}$

$0 = 0 + (v_0 \sin 30) t + -4.9 t^2$

$v = v_0 + at$

$v = v_0 \sin 30 + -9.8t$

$t = \frac{v_y + v_0 \sin 30}{+9.8}$

$0 = (v_0 \sin 30) t + -4.9 t^2$

$-4.9t^2 + (v_0 \sin 30) t = 0$

$t(-4.9t + v_0 \sin 30) = 0$

$t = 0 \qquad -4.9t + v_0 \sin 30 = 0$

$t = \frac{v_0 \sin 30}{4.9}$

The two times are the same!

So: $\frac{8.9}{v_0 \cos 30} = \frac{v_0 \sin 30}{4.9}$

$(8.9)(4.9) = (v_0 \sin 30)(v_0 \cos 30)$

$v_0^2 = \frac{(8.9)(4.9)}{(\sin 30)(\cos 30)}$