Parabolic/Projectile Motion:

Two dimension motion of objects in free fall.

Downward acceleration is 9.8 m/s^2.

Horizontal acceleration is 0!

All vectors (displacement, velocity, acceleration) can be broken into x- and y-components (true for ANY two-dimensional motion).

Variables in the x- and y-dimensions can be considered completely independently (i.e., the Big 4 can be used for each)


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Steps for solving 2-D Kinematics Problems:

Same as for 1-D problems except:

Before variable inventory, break all vectors into x- and y-components

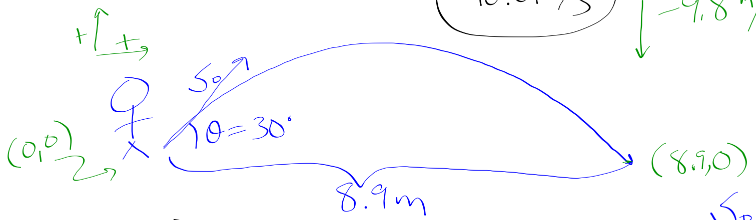
Make TWO variable inventories - one for each dimension

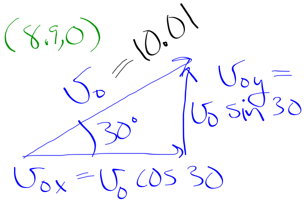
If necessary, after using the Big 4, resolve component vectors into resultants

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

10.01 m/s

$a = -9.8\ m/s^2$





$x_0 = 0$
$x = 8.9$
$v_{ox} = v_0 \cos 30$
$v_x =$
$a_x = 0$
$\boxed{t} = \frac{8.9}{v_0 \cos 30}$

$y_0 = 0$
$y = 0$
$v_{oy} = v_0 \sin 30$
$v_y =$
$a_y = -9.8\ m/s^2$
$\boxed{t} = \frac{v_0 \sin 30}{4.9}$

$x = \cancel{x_0} + v_{ox}t + \cancel{\frac{1}{2}a_x t^2}$

$8.9 = (v_0 \cos 30)t$

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

$y = \cancel{y_0} + v_{oy}t + \frac{1}{2}a_y t^2$

$0 = (v_0 \sin 30)t + \frac{1}{2}(-9.8)t^2$

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

$\cancel{t = 0}$

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

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

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

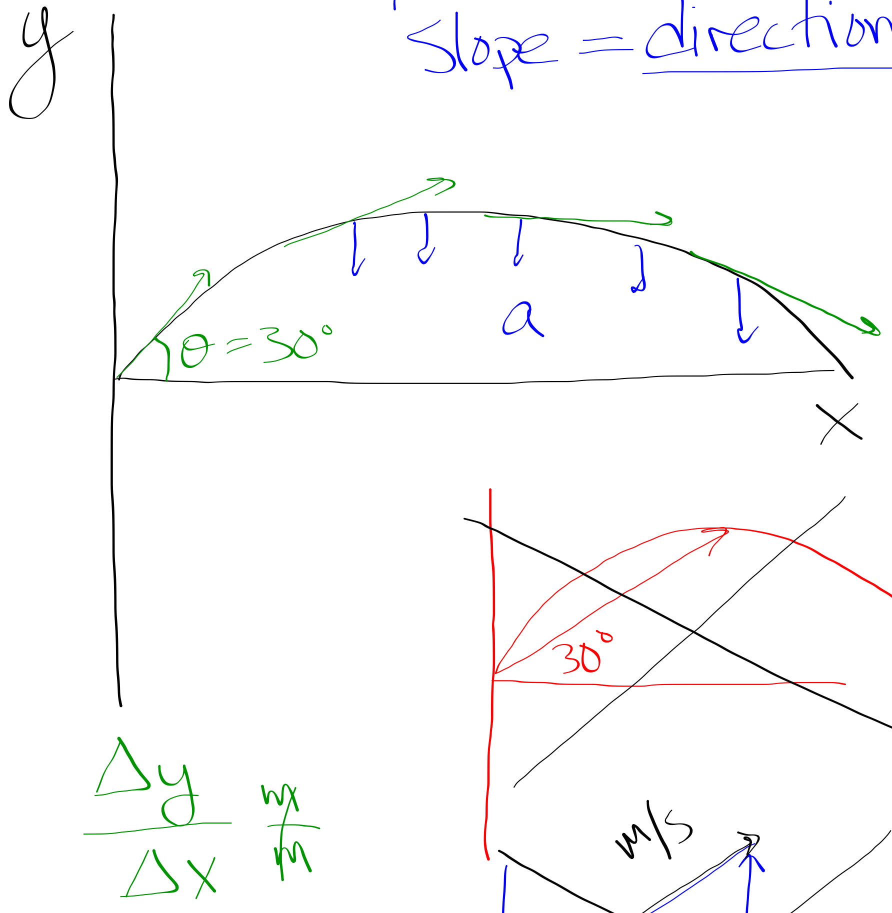
$$v_0^2(.5)(.87) = 8.9(4.9)$$

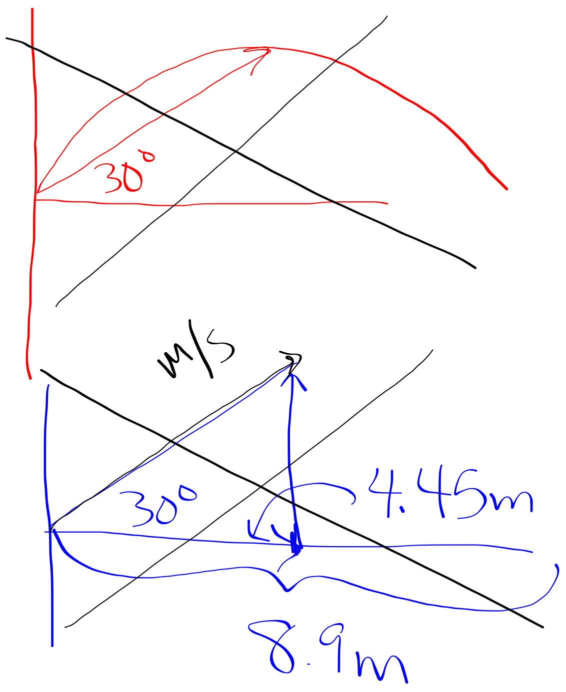
$$v_0 = \sqrt{\frac{(8.9)4.9}{(.5)(.87)}}$$

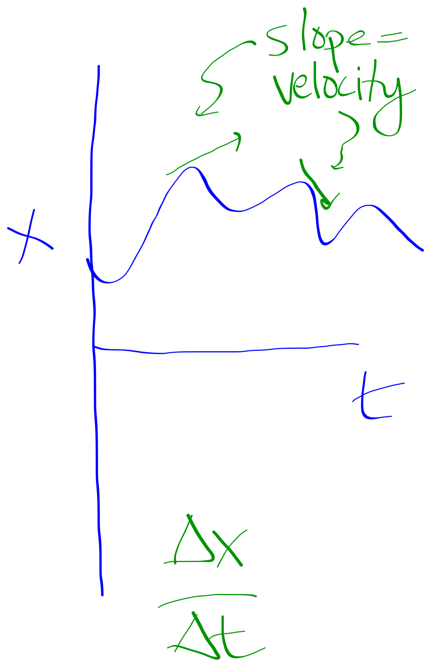
$$v_0 = 10.01\ m/s$$

X/Y POSITION GRAPH:

Slope = direction

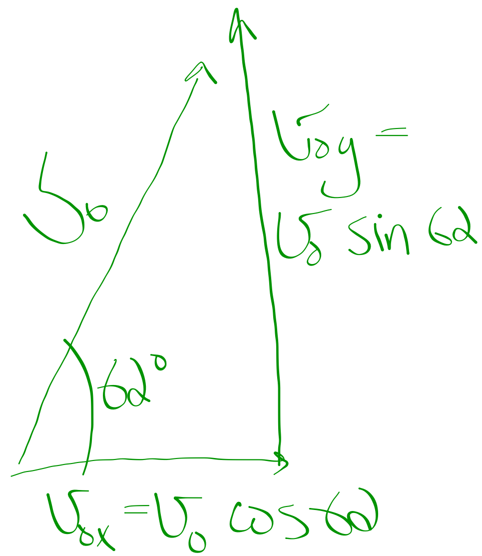






A ball is kicked from the ground at an angle of 62°. It lands, back on the ground, 5.1 seconds later. Find:

a) The ball's initial velocity
b) How far the ball traveled horizontally
c) The ball's final velocity
d) The ball's maximum height
e) The ball's x- and y- coordinates after 4 seconds
f) The time(s) at which the ball is 14 m above the ground



$x_0 = 0$ | $y_0 = 0$
$x =$ | $y = 0$
$v_{0x} = v_0 \cos 62$ | $v_{0y} = v_0 \sin 62$
$v_x =$ | $v_y =$
$a_x = 0$ | $a_y = -9.8\, m/s$
$t = 5.1\,s$ | $t = 5.1\,s$