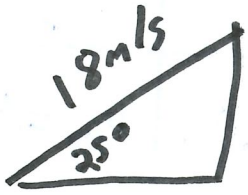
Type 2 Projectile Motion Problems: Angled launch

A baseball player throws a ball to a teammate at 18m/s at an angle of 25° above the horizontal.

What are the initial horizontal and vertical velocities? What is the maximum height the ball reaches? How far away horizontally is the ball caught?



$\sin 25 = \frac{V_{oy}}{18}$

$\sin 25 \times 18 = V_{oy}$

$7.6071\ m/s$

$\cos 25 \times 18$

$V_x = 16.3135\ m/s$

X	Y
$V_x = 16.3135\ m/s$	$V_{oy} = 7.6071\ m/s$
	$a_y = -9.8\ m/s^2$
	~~$V_{fy} = 0$~~

Use $V_f^2 = V_0^2 + 2ad$ to find max height

V_f: ↑ 0 V_0: ↑ 7.6071 a: ↑ −9.8

$d = 2.9524\ m$

$\approx 3.0\ m$

Since ball is caught at some height its final vertical velocity is $-7.6071\ m/s$

$V_f = V_0 + at$ to find t

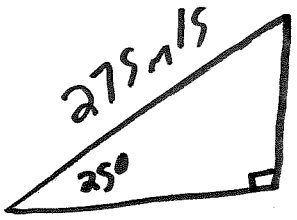
$t = 1.5525\ sec$

Use $d = \bar{v}t$ to find d_x

$d = 25m$

Problem: A cannonball is launched at 275 m/s at an angle of 25° above the horizontal.

What are the initial horizontal and vertical velocities? How long is the cannonball airborne? How far horizontally does the cannonball travel? What is the final velocity of the cannonball?



$V_{oy} = \sin 25 \times 275$
$= 116.22 \text{ m/s}$

$V_x = \cos 25 \times 275$
$= 249.23 \text{ m/s}$

x	y
$V_x = 249.23 \frac{m}{s}$	$V_{oy} = 116.22 \text{ m/s}$
	$a_y = -9.8 \frac{m}{s^2}$
	$V_{fy} = -116.22 \text{ m/s}$

Use $V_f = V_i + at$ to find t

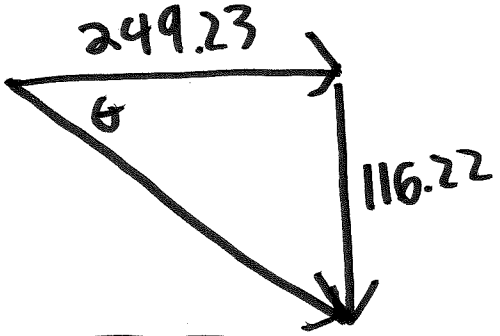
$t = 23.7184 \text{ sec}$

$\approx 24 \text{ sec}$

Use $d = \bar{v}t$ to find d_x

$d = 5911.33 \text{ m}$

$\approx 5900 \text{ m}$



$\text{mag} = \sqrt{249.23^2 + 116.22^2}$

$= 274.996 \text{ m/s}$

$\theta = \tan^{-1}\left(\frac{116.22}{249.23}\right)$

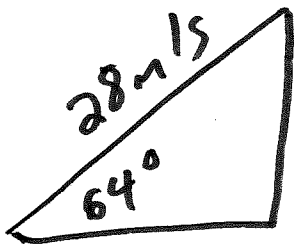
$= 25°$

270 m/s, 25° below horizontal

Type 3 Projectile Motion Problems: Angled launch from a height

A cannonball is launched from a cliff 45m tall at 28 m/s an angle of 64° above the horizontal.

What are the initial horizontal and vertical velocities? What is the final velocity? How long it the cannonball airborne? What is the maximum height relative to the ground below?



$V_{0y} = 25.1662 m/s$

$V_x = 12.2744 m/s$

x	y
$V_x = 12.2744$	$V_{0y} = 25.1662$ m/s
	$a = -9.8$ m/s
	$d_y = -45$ m

① V_{fy} → use $V_f^2 = V_0^2 + 2ad$

$V_f = \pm 38.9273 m/s$

$V_f = -38.9273 m/s$

② t → $V_f = V_0 + at$

$t = 6.5 sec$

③ Use $V_{fy} = 0$ to find height

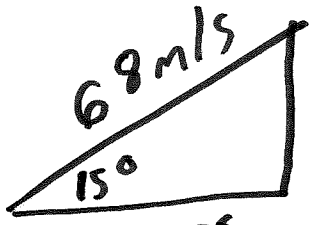
use $V_f^2 = V_0^2 + 2ad$

$d = 32m$

$32 + 45 = 77m$

An archer standing on a castle 12 m tall shoots an arrow at a velocity of 68 m/s 15° above the horizontal. It hits a wall 200.0 m horizontally away.

At what height on the wall does the arrow hit?



$\sin 15 \times 68 = 17.5997$

$\cos 15 \times 68 = 65.6830$

x	y
$v_x = 65.6830$ m/s	$v_{oy} = 17.5997$ m/s
$d_x = 200.0$ m	$a = -9.8$ m/s
	$d_y = ?$

Use $d = \bar{v}t$ to find t

200 ↑ ↑ 65.6830

$t = 3.044$

Use $d = v_0 t + \frac{1}{2}at^2$ to find d_y

$d = 8.17$ m above initial

Hits wall at $12 + 8.17$ m

≈ 20 m $\approx (2.0 \times 10^1$ m)