Projectile Motion

An object launched and falls to the ground, and we ignore air resistance. This is projectile motion.

The key to solving projectile motion problems is the fact that horizontal and vertical components are independant.

Horizontal (x) components	**Vertical (y) components**
Acceleration is always 0	Always a constant acceleration $-9.8 m/s^2$
The only equation you ever need is $d = \bar{v} t$	Need to use constant acceleration formulas $d = v_0 t + \frac{1}{2} a t^2$, $v_f^2 = v_0^2 + 2ad$, $v_f = v_0 + at$

The only value connecting both components is time

Horizontal Launch Problems

An object is launched at 25 m/s horizontally from a height of 12 m.

How long will it be airborne? How far will it travel?

How long it is airborne depends only on the vertical components

How far it travels in the x-direction depends only on: v_x and time

① Use $d = v_0 t + \frac{1}{2} a t^2$

$-12m$ ↑ 0 ↑ $-9.8 m/s^2$

$t = 1.5649 sec$

② Use $d = \bar{v} t$ ← $25 m/s$

$d = 39m$

X	Y
$v_x = 25 m/s$	$v_{oy} = 0 m/s$
	$a_y = -9.8 m/s^2$
	$d_y = -12m$
	$t = ?$

An object is launched at 35 m/s horizontally from a height of 42 m.

How long will it be airborne? How far will it travel? What is the final velocity of the object?

x	y
$V_x = 35 m/s$	$V_{oy} = 0 m/s$
	$a = -9.8 m/s^2$
	$d = -42 m$
	$t = 2.9277 sec$

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

$t = 2.9277 sec$

$\approx 2.9 sec$

② Use $d = \bar{v} t$ to find d_x

$d_x = 102.47 m$

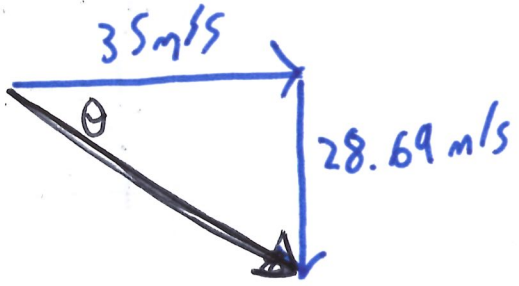
$\approx 1.0 \times 10^2 m$

③ Determine V_{fy} using $V_f^2 = V_0^2 + 2ad$

$V_f = \pm 28.69 m/s$

$V_f = -28.69 m/s$

④ Determine final velocity



$magnitude = \sqrt{35^2 + 28.69^2}$

$= 45 m/s$

$angle = \tan^{-1}\left(\frac{28.69}{35}\right)$

$= 39°$

45 m/s, 39° below the horizontal

A gun is pointed directly at the centre of a target 50.0 m away. The bullet's velocity is 450 m/s.

How long will it take for the bullet to hit the target? How far below the bullseye will the bullet be?

x	y
$v_x = 450 m/s$	$v_{oy} = 0 m/s$
$d_x = 50.0 m$	$a_y = -9.8 m/s^2$

50 450

① Use $d = \bar{v}t$ to solve for t

$t = 0.11111 sec$

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

$d_y = -0.06049 m$

0.060m below

= 6.0cm below

A helicopter is flying horizontally at 45 m/s at an altitude of 250m. They drop an aid package to a town.

How long will it take for the package to fall to the ground? How far horizontally should the helicopter be from the town when it drops the package?

X	Y
$V_x = 45 m/s$	$d_y = -250 m$
	$V_{oy} = 0$
	$a = -9.8 m/s^2$

① Use $d = v_0 t + \frac{1}{2} a t^2$ to solve for t

$t = 7.14 sec$

$\approx 7.1 sec$

② Use $d = \bar{v} t$ to find d_x

$321.3 m$

$\approx 320 m$

A gun pointing directly at a target 40.0 m away fires and the hits 4.0 cm below the bullseye.

What was the initial velocity of the bullet?

x	y
$d_x = 40.0\,m$	$v_{oy} = 0\ m/s$
	$a_y = -9.8\ m/s^2$
	$d_y = -0.04\,m$

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

$t = 0.09035\,sec$

② Use $d = \bar{v} t$ to find $\bar{v}$

$v_t = 442.72\ m/s$

$\approx 440\ m/s$

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?