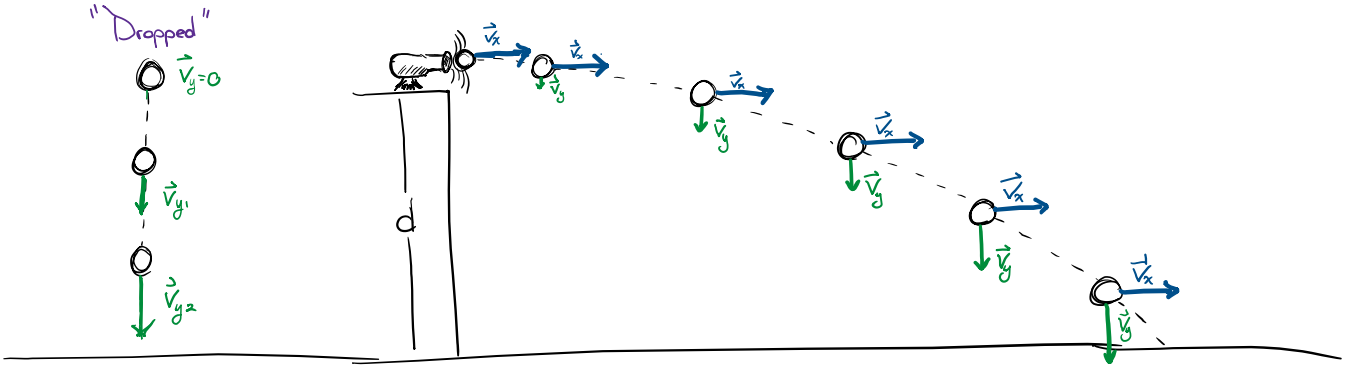
Lesson 1.6: Projectile Motion I

Unit 1: Kinematics, Vectors, and Mathematics

2-Dimensional motion of an object (ignoring air resistance).

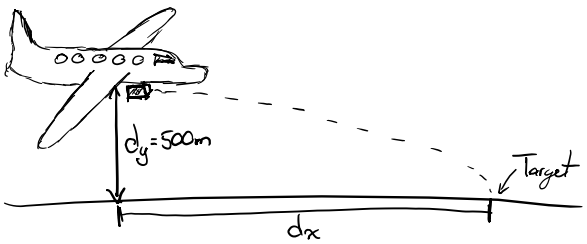
* Split into horizontal + vertical components and solve them independently

Consider a ball dropped straight down compared to a ball being projected horizontally off a cliff.



Variable Components	Straight down	Horizontal Projectile
$\overrightarrow{v_x}$	0	constant
$\overrightarrow{v_y}$	increasing	increasing
$\overrightarrow{a_x}$	0	0
$\overrightarrow{a_y}$	constant (g)	constant
t	same in both	

Example 1: A cargo plane dropping supplies is travelling 320 km/h at an altitude of 500 m. How far before the target (horizontally) must the supplies be released?



Vertical (y)

~~V_{0x}~~ =
$V_{0y} = 0 m/s$
$a_y = -9.8 m/s^2$
$d_y = -500 m$
$t = ?$

Use $d_y = \cancel{V_{0y}t} + \frac{1}{2}a_y t^2$

$-500m = \frac{1}{2}(-9.8m/s^2)t^2$

$t = \sqrt{102.04}$

$= 10.1s$

Horizontal (x)

$\frac{320km}{h} \times \frac{1h}{3600s} \times \frac{1000m}{1km} = 88.9 m/s$

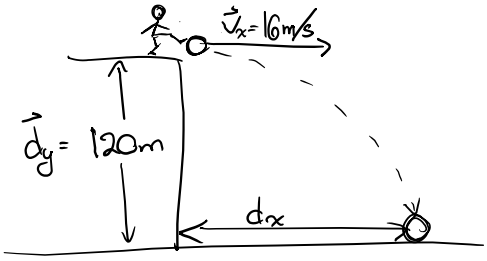
$\vec{v}_x = 88.9 m/s$
$\vec{a}_x = 0$
$\vec{d}_x = ?$
$t = 10.1s$

$\vec{d}_x = \vec{v}_x t$

$= 88.9 m/s (10.1s)$

$= \boxed{898 m}$

Example 2: A rock is kicked horizontally off a 120 m cliff with a velocity of 16 m/s.



Horizontal

$\vec{V}_x = 16 m/s$

$d_x =$

$t =$ time

Vertical

$\vec{V}_{oy} = 0 m/s$

$\vec{V}_{fy} =$

$\vec{d}_y = -120m$

$\vec{a}_y = -9.8 m/s$

$t = ?$ (4.9s)

a) How long until it hits the bottom?

$d_y = \cancel{V_{oy}}t + \frac{1}{2}\vec{a}_y t^2 \rightarrow -120m = \frac{1}{2}(-9.8 m/s^2)t^2$

$t = \sqrt{\frac{2\vec{d}_y}{\vec{a}_y}}$

$t = \sqrt{24.49}$

$t = 4.9s$

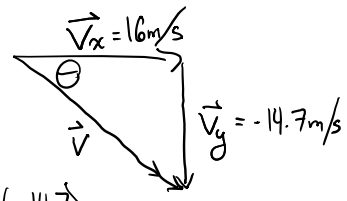
b) How far horizontally from the base of the cliff does it land?

$\vec{d}_x = \vec{V}_x t$

$= 16 m/s (4.9s)$

$= 78.4m = \boxed{78m}$

c) What is the velocity at 1.5s?



x

$\vec{V}_x = 16 m/s$

$t = 1.5s$

y

$\vec{V}_y = ?$

$\vec{V}_{oy} = 0 m/s$

$\vec{V}_{fy} = \cancel{\vec{V}_{oy}} + \vec{a}_y t$

$\vec{V}_y = (-9.8 m/s^2)(1.5s)$

$= -14.7 m/s$

$\theta = \arctan\left(\frac{-14.7}{16}\right)$

$= -43°$

$\vec{V} = \sqrt{16^2 + (-14.7)^2}$

$= 21.73$

$= 22 m/s$ at $43°$ below the horizontal