2.6 Projectile Motion (part 1)

If an object is launched at an angle, the flight path, or trajectory is affected by the launch angle . To determine how the projectile behaves, we must resolve the launch velocity into horizontal and vertical component velocities. As we saw last week, the horizontal motion component is considered uniform (constant velocity) while the vertical component is accelerated. Therefore, we must treat them separately.

$d = vt$

5 equ^{ns}

ex. A delivery drone flying horizontally at a velocity of 11 m/s drops a parcel destined for your doorstep. The drone flies at an elevation of 18 metres.

a) How long does it take for the package to land?

b) How far (horizontally) from your doorstep must the package be dropped in order to land at the desired location?

given: $\vec{v}_{1x} = 11\ m/s$ ← constant

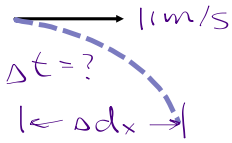
accel. $\vec{v}_{1y} = 0\ m/s$

$\Delta d_y = -18\ m$

$\vec{a} = -9.8\ m/s^2$

RTF: $\Delta t = ?$

$\Delta \vec{d}_x = ?$



* up and forward are +

① find Δt with vertical components ⇒ equ^n ③

$\Delta \vec{d}_y = \cancel{\vec{v}_{1y}}^{\,0} \Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$\frac{2\Delta \vec{d}_y}{\vec{a}} = \frac{\cancel{\frac{1}{2}}\cancel{\vec{a}}\Delta t^2}{\cancel{\vec{a}}}$

ignore ±

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

$\Delta t = \sqrt{\frac{2(-18)}{-9.8}}$

$\Delta t \doteq \boxed{1.9166\ s}$

$\boxed{\Delta t \doteq 1.9\ s}$

use this

b) now consider horizontal motion

→ $\vec{v}_{1x} = 11\ m/s$

→ $\Delta t = 1.9166\ s$

$\Delta \vec{d}_x = \vec{v}_{1x}\Delta t$

$= (11)(1.9166)$

$\Delta \vec{d}_x = 21.08\ m$

$\boxed{\Delta \vec{d}_x = 21\ m}$

∴ the parcel must be dropped a horizontal distance of 21 m from the doorstep and falls for 1.9 seconds

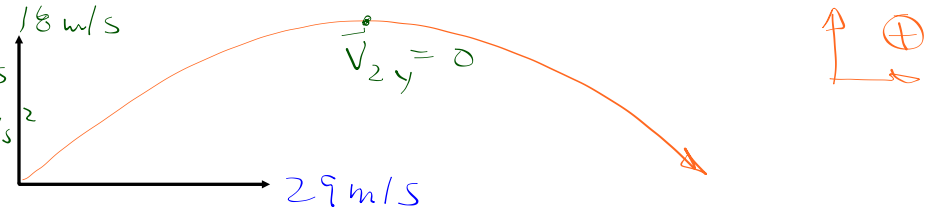
ex. A flaming arrow is fired across a horizontal battlefield. The archer wants to strick behind the enemy front line so aims upward at an angle . The arrow's initial vertical velocity component is 18 m/s and it's horizontal velocity component is 29 m/s. How far does the arrow travel? What is it's maximum height?

$\vec{v}_{1y} = 18\ m/s$

$\vec{a} = -9.8\ m/s^2$

$\vec{v}_{2y} = 0$

$\vec{v}_{1x} = 29\ m/s$



RTF: Δt → using equ^n ①

$$\frac{\cancel{\vec{v}_{2y}}^{\,0} - \vec{v}_{1y}}{\vec{a}} = \frac{\vec{a}\,\Delta t}{\vec{a}}$$

$$\frac{-\vec{v}_{1y}}{\vec{a}} = \Delta t$$

$$\frac{-(18)}{-9.8} = \Delta t$$

$\Delta t \doteq 1.8367$ s (for ½ of the flight)

$\times 2$

So... $\boxed{\Delta t \doteq 3.6735\ s}$

Now find its horizontal distance $\Delta \vec{d}_x$

$$\Delta \vec{d}_x = \vec{v}_{1x}\,\Delta t$$

$$= (29)(3.6735)$$

$$= 106.53\ m$$

$$\boxed{\Delta \vec{d}_x = 110\ m}$$

Now for $\Delta \vec{d}_y$ with equ^n ⑤

$$\frac{\cancel{\vec{v}_{2y}}^{\,0\,2} - \vec{v}_{1y}^{\,2}}{2\vec{a}} = \frac{2\vec{a}\,\Delta \vec{d}_y}{2\vec{a}}$$

$$\frac{-\vec{v}_{1y}^{\,2}}{2\vec{a}} = \Delta \vec{d}_y$$

$$\frac{-(18)^2}{2(-9.8)} = \Delta \vec{d}_y$$

$$\Delta \vec{d}_y = 16.53\ m$$

$$\boxed{\Delta \vec{d}_y \approx 17\ m}$$

∴ The arrow travels to a max height of 17 m and a horizontal distance of 1.1×10^2 m ... and it took about 3.75 s.

Practice: pg 113 #20 - 22, 24, 25, 27, 28

https://www.physicsclassroom.com/Physics-Interactives/Vectors-and-Projectiles/Projectile-Simulator/Projectile-Simulator-Interactive

not a vector so connects x and y components

Table 2.1
The Five Equations of Linear Kinematics

No.	Equation	$\Delta\vec{d}$	$\vec{a}$	$\vec{v}_2$	$\vec{v}_1$	Δt
1	$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$		✓	✓	✓	✓
2	$\Delta\vec{d} = \frac{1}{2}(\vec{v}_2 + \vec{v}_1)\Delta t$	✓		✓	✓	✓
3	$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$	✓	✓	✗	✓	✓
4	$\Delta\vec{d} = \vec{v}_2\Delta t - \frac{1}{2}\vec{a}\Delta t^2$	✓	✓	✓		✓
5	$\vec{v}_2^{\,2} = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$	✓	✓	✓	✓	