2.4 Projectile Motion & Gravity

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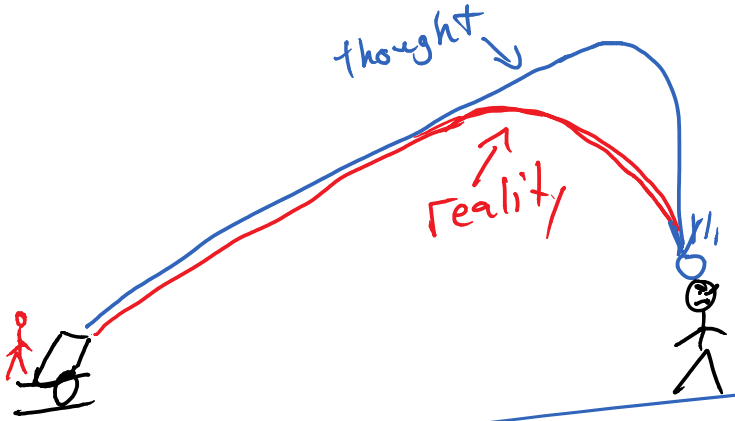
The accepted acceleration due to gravity at the surface of the Earth is $-9.8\ m/s^2$ towards the center of the Earth.

Assume: air resistance is NEGLIGIBLE

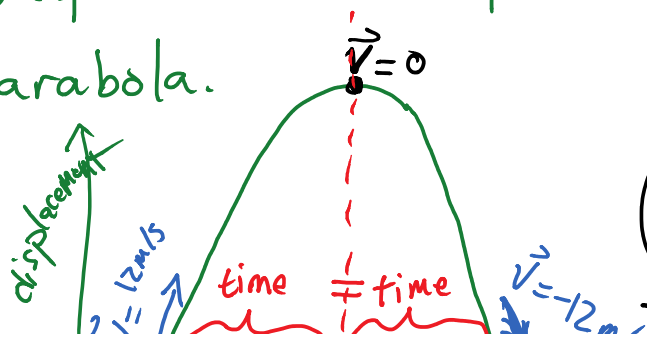
The Shape of a projectile's motion:

- Ye olde days
- Artillerists → shoot something

It will travel in a straight line until it runs out of "impetus". Then it drops.



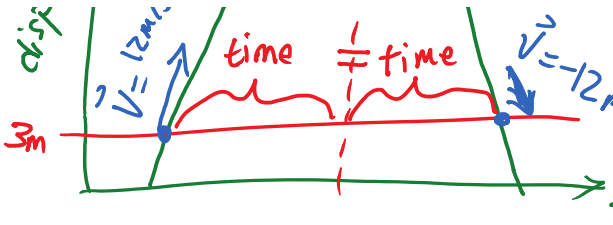
If air resistance is negligible then the shape of a projectile's path is a parabola.



Key Features

- At every point
- The vertex (turning point) vertical velocity = 0

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

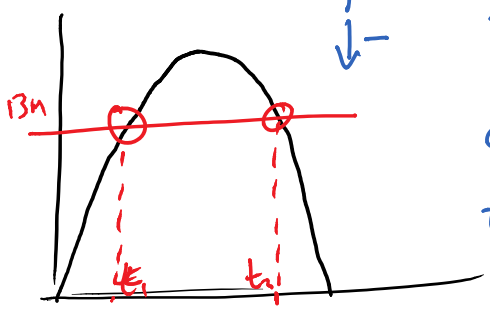


- The vertex (turning point) vertical velocity = 0
- Is perfectly symmetrical across the vertex.

Extra Points

- Drop or dropping → it means $v_i = 0$
- Be careful with what you define as + or −. Usually down is negative.

Examples: A cannonball is shot straight up from the ground at a velocity of 24m/s. At which time(s) does the ball reach 13m in height?



↑ +
↓ −

$v_i = 24m/s$

~~DC~~

$a = -9.8m/s^2$

$d = 13m$

$t = ?$

$-d = v_i t + \frac{1}{2}a t^2$ ← $-d$ & Find time

Use the quadratic equation

① Rearrange

$0 = \frac{1}{2}at^2 + v_i t - d$

② Put in the numbers

$0 = \frac{1}{2}(-9.8)t^2 + (24)t - (13)$

$t = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$0 = -4.9t^2 + 24t - 13$

a b c

③ Use the quadratic equation.

$\frac{-24 + \sqrt{(24)^2 - 4(-4.9)(-13)}}{}$ $\frac{-24 \pm \sqrt{576 - 254.8}}{}$

$$t = \frac{-24 \pm \sqrt{(24)^2 - 4(-4.9)(-13)}}{2(-4.9)} = \frac{-24 \pm \sqrt{576 - 254.8}}{-9.8}$$

$$t = \frac{-24 \pm \sqrt{321.2}}{-9.8} = \frac{-24 \pm 17.922}{-9.8}$$

$$+ \rightarrow \frac{-24 + 17.922}{-9.8} = 0.62\text{s} \checkmark$$

$$- \rightarrow \frac{-24 - 17.922}{-9.8} = 4.28\text{s} \checkmark$$

④ Check.

In most situations you can't have negative time.

The cannon ball was 13 m high after 0.62s and 4.28s.

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Worksheet #3