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Section 2.8: Acceleration Due to Gravity

There are many factors that affect how quickly a falling object picks up speed:

- objects mass
- objects area
- amount of area
- how close you are to equator
- elevation
- what the earth is made up beneath you
- what planet you are on

However, in many circumstances, these effects are small and can be ignored (thank goodness!). In that case, if an object...

1) doesn't experience much air resistance

2) is close to the earths surface

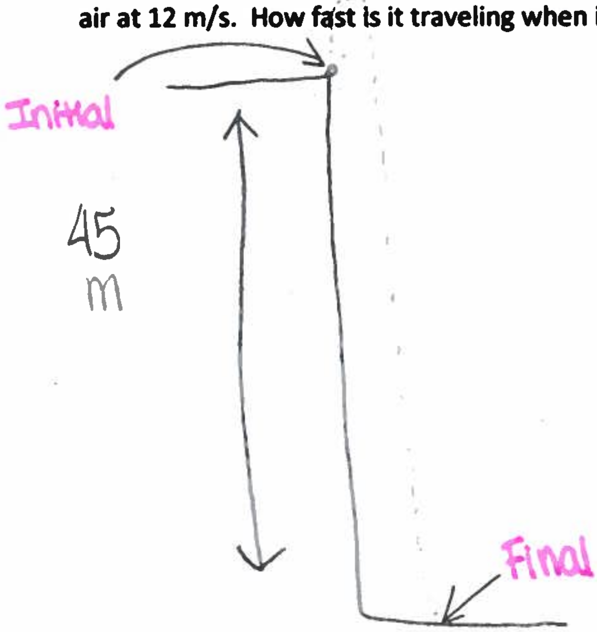
and 3) feels no force except gravity

then it will accelerate at

on equater 9.77m/s²
on poles 9.83m/s²

9.8m/s² down
(Acceleration due to gravity on Earth)

Example: A student stands on the edge of a 45 m high cliff and throws their homework straight up in the air at 12 m/s. How fast is it traveling when it hits the ground at the bottom of the cliff?



$\vec{v}_f =$
$\vec{v}_i = 12 m/s$
$\vec{a} = -9.8 m/s^2$
$\vec{d} = -45 m$
$t =$

$\vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2\vec{a}\vec{d}$

$\vec{v}_f^{\,2} = \pm\sqrt{\vec{v}_i^{\,2} + 2\vec{a}\vec{d}}$

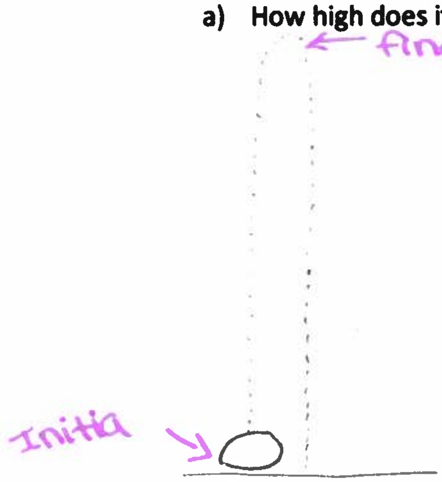
$= \pm\sqrt{(12)^2 + 2(-9.8)(-4}$

$= \pm\ 32.03$

$= 32.03 m/s$ dow

Example: A football is kicked straight up in the air at 15 m/s.

a) How high does it go?



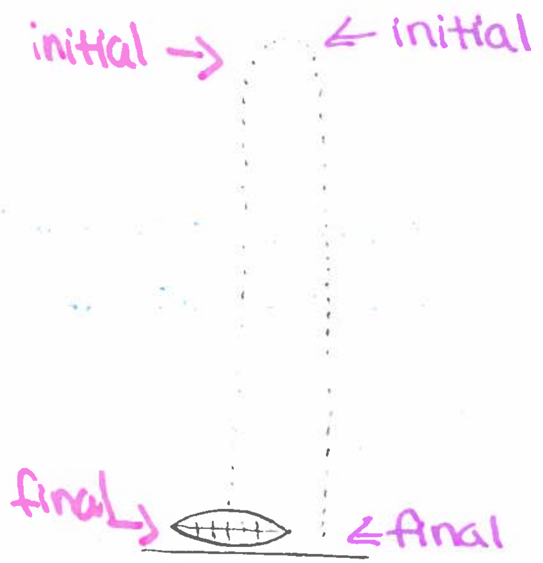
$\vec{v}_f = 0\,m/s$
$\vec{v}_i = 15\,m/s$
$\vec{a} = -9.8\,m/s^2$
$\vec{d} = ?$
$t =$

$\vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2\vec{a}\vec{d}$

$\dfrac{\vec{v}_f^{\,2} - \vec{v}_i^{\,2}}{2\vec{a}} = \vec{d}$

$\dfrac{0 - (15)^2}{2(-9.8)} = \dfrac{-225}{-19.6} = \boxed{11.5m}$

b) What is its total hangtime? and what is its velocity when it hits the ground.



way up

$\vec{v}_f = 0\,m/s$
$\vec{v}_i = 15\,m/s$
$\vec{a} = -9.8\,m/s^2$
$\vec{d} = 11.5\,m$
$t =$

$\vec{v}_f = \vec{v}_i + \vec{a}t$

$\dfrac{\vec{v}_f - \vec{v}_i}{a} = t$

$\dfrac{0 - 15}{-9.8} = 1.5s$

way down

$\vec{v}_f =$
$\vec{v}_i = 0\,m/s$
$\vec{a} = -9.8\,m/s^2$
$\vec{d} = -11.5\,m$
$t =$

$\vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2\vec{a}\vec{d}$

$\vec{v}_f^{\,2} = \pm\sqrt{\vec{v}_f^{\,2} + 2\vec{a}\vec{d}}$

$\vec{v}_f = \pm\sqrt{0 + 2(-9.8)(-11.5)}$

$\vec{v}_f = \pm\, 15\,m/s$

$= \boxed{15\,m/s \text{ down}}$

$\vec{v}_f = \vec{v}_i + \vec{a}t$

$\dfrac{\vec{v}_f - \vec{v}_i}{a} = t$

$\dfrac{(-15) - 0}{-9.8} = \boxed{1.5s}$

Final answers: hangtime $= 1.5s + 1.5s = \boxed{3s}$

velocity at ground $= \boxed{15\,m/s}$ down

The moral of the story is, on level ground...

- time up = time down
- velocity on way up = − velocity on the way down

↑ important