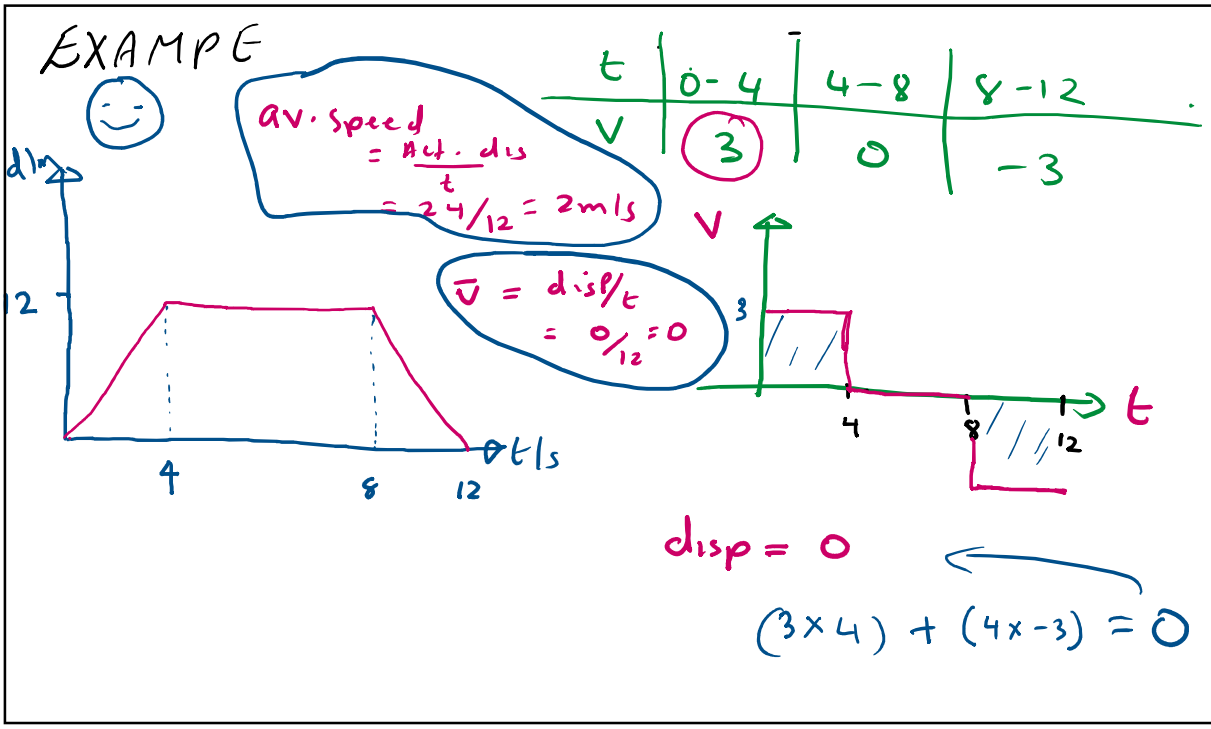
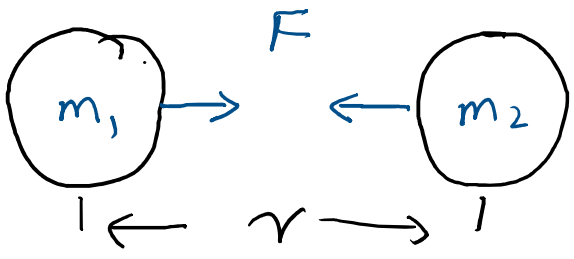
EXAMPLE



Free fall – falling under gravity.

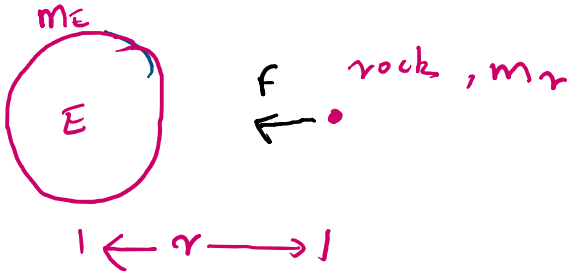
Universal Law of gravitation



$F = G\frac{m_1 m_2}{r^2}$

G = gravitational constant.

– This force is only appreciable when one of the masses or both is/are astronomical.



$$F = \frac{G M_E m_r}{r^2}$$
$$= \text{weight}$$
$$= m_r g$$

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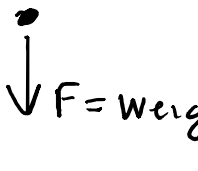
rock



Earth

$$F = ma$$
$$\therefore m_r a = m_r g$$
$$a = g.$$

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rock

F = weight = $m_r g$

Earth

$F = ma$

$\therefore m_r a = m_r g$

$a = g$.

Any falling object falls with acceleration $a = g$.

$g = 9.8\ m/s^2$

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At any location on Earth, and in the absence of air resistance all objects fall with same constant acceleration.

This acc. is called acceleration due to gravity, g.

approx. $g \simeq 9.8\ m/s^2$

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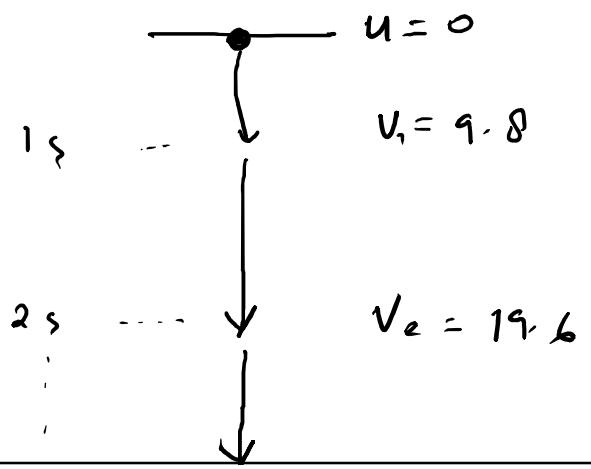
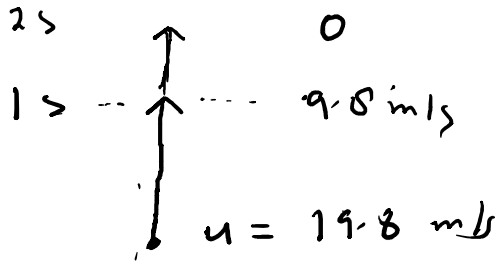
$a = g = 9.8\ m/s^2$.

An object falling has its speed increasing at a rate of 9.8 m/s per second.



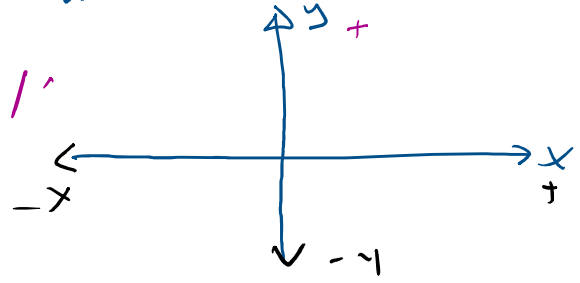
$a = g = 9.8\ m/s^2$.

An object going up has its speed decrease at a rate of 9.8 m/s per second.



- Since acceleration is known, $a = g$ we need to choose a convention.

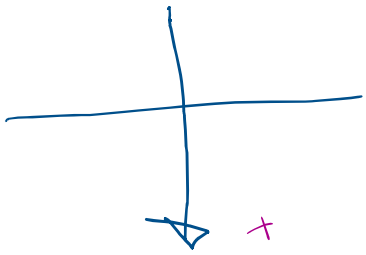
1.



↑ + ↓ − up positive

or

2.



↓ − down positive

Once you choose your convention stick to it.

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Lets choose ↑ + ↓ −

↓ $a = -g$

acc. due to gravity always points down!

Earth

So: $a = -9.8\ m/s^2$

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↑ + ↓ −

$a = -g$ → acc. due gravity is always pointing down.

$\downarrow \bar{a}$

Earth

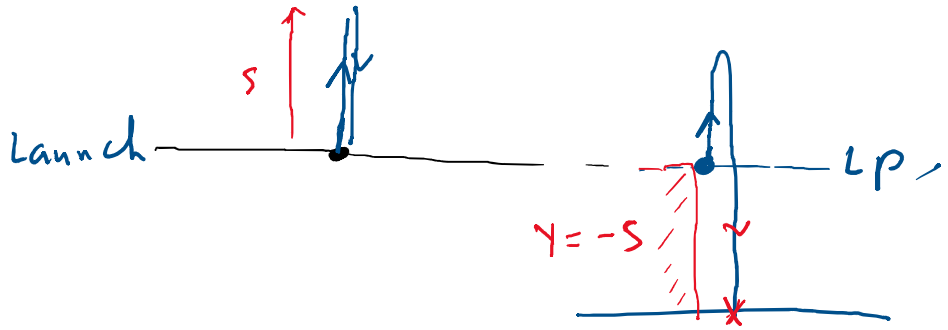
$10\,m/s^2$ or $9.8\,m/s^2$

$v = u + at$	$\rightarrow v = u - gt$
$v^2 = u^2 + 2as$	$\rightarrow v^2 = u^2 - 2gs$
$s = ut + \frac{1}{2}at^2$	$\rightarrow s = ut - \frac{1}{2}gt^2$
	$s = \bar{v}t$

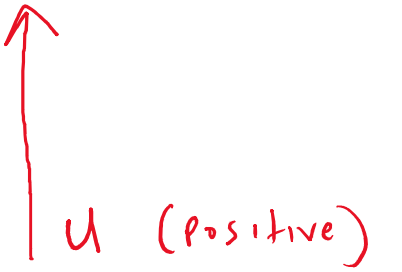
$g = 9.8\,m/s^2$

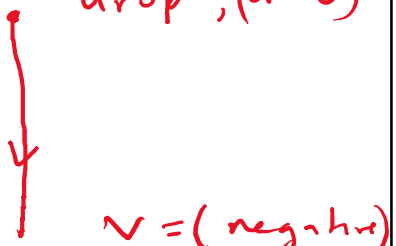
Launch point.

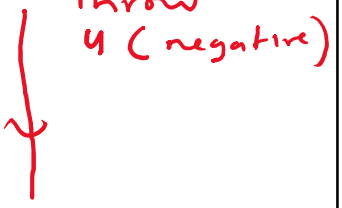
— This is where an object is launched.



↑ + ↓ −







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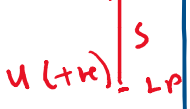
The sign of the velocity or displacement tells you a great deal of information about the motion

↑ + ↓ −



	Velocity	displacement (s)
+ve	object is going up	The object travels s distance above the launch point

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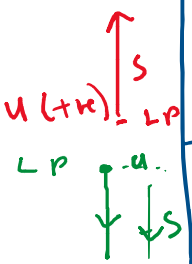
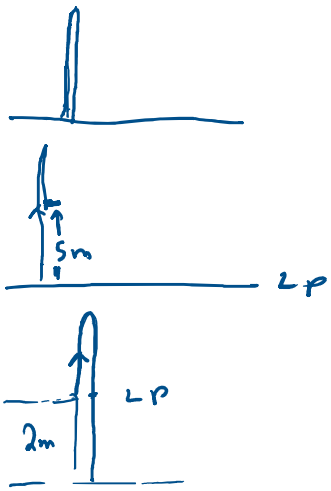
The sign of the velocity or displacement tells you a great deal of information about the motion

↑ + ↓ −



	Velocity	displacement (s)
+ve	object is going up	The object travels s distance above the launch point
−ve	object is going down	The object travels s distance below the launch point.

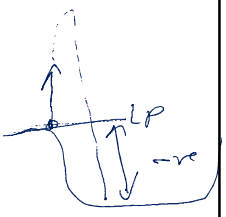
Consider an object below



$s = 0$ = displacement

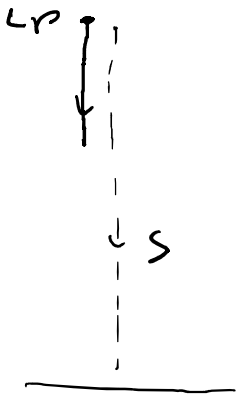
$s = 5m$ = displacement

$s = -2m$ = displacement



EXAMPLE 2–10 **Falling from a tower.** Suppose that a ball is dropped ($v_0 = 0$) from a tower. How far will it have fallen after a time $t_1 = 1.00\,s$, $t_2 = 2.00\,s$, and $t_3 = 3.00\,s$? Ignore air resistance.

drop : $u = 0$, $a = -g$.



$$s_1 = ut + \frac{1}{2}at^2$$
$$= ut - \frac{1}{2}gt^2$$
$$= ut - 4.9t^2$$
$$= 0 - 4.9(1)$$
$$= -4.9\,m$$

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EXAMPLE 2–10 **Falling from a tower.** Suppose that a ball is dropped ($v_0 = 0$) from a tower. How far will it have fallen after a time $t_1 = 1.00\,s$, $t_2 = 2.00\,s$, and $t_3 = 3.00\,s$? Ignore air resistance.

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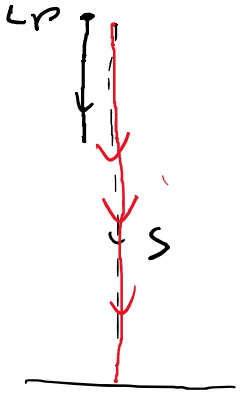

$$s_1 = ut + \frac{1}{2}at^2$$
$$= ut - \frac{1}{2}gt^2$$
$$= ut - 4.9t^2$$
$$= 0 - 4.9(1)$$
$$= -4.9\,m$$

dropped 4.9 m below the launch pt

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An object is thrown with a speed of 10 m/s. a) what is its speed after 0.5 s

Data: $u = +10\ m/s$, $a = -g$, $t = 0.5\ s$

↑ + ↓ −

$v = u + at$

$= 10 + (-9.8)(0.5) = +5.1\ m/s$

↑

Still going up.

An object is thrown with a speed of 10 m/s. a) what is its speed after 0.5 s
b) what is its speed after 2 sec

↑ +
↓ −

$a = -g = -9.8\ m/s^2$

$u = +10\ m/s$

b) $v = u + at$

$= 10 + (-9.8)\,2$

$= -9.6\ m/s$

↑

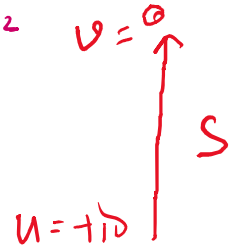
object going down

An object is thrown with a speed of 10 m/s. a) what is its speed after 0.5 s
b) what is its speed after 2 sec
c) How high does it go?

↑+ ↓−

$a = -g = -9.8\ m/s^2$

$u = +10\ m/s$



$v^2 = u^2 + 2as$

$0 = 10^2 + 2(-9.8)s$

$s = \frac{100}{2(9.8)} =$

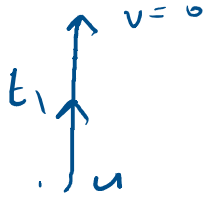
A ball is thrown upward with a velocity of 10 m/s. How long is it in the air.

time of flight

$u = +10\ m/s,\ a = -g$

$v = 0$

1. find t_1 to peak



$v = u + at$

$0 = 10 + (-9.8)t_1$

$t_1 = 10/9.8 =$

$t_1 = 1.02\ s$

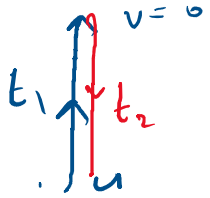
A ball is thrown upward with a velocity of 10 m/s. How long is it in the air.

time of flight

$u = +10\ m/s,\ a = -g$

$v = 0$

1. find t_1 to peak



$v = u + at$

$0 = 10 + (-9.8)t_1$

$t_1 = 10/9.8 =$

$t_1 = 1.02\ s$

Takes same time to return:

$\therefore t = 2 \times 1.02 = 2.04\ s$

A ball is thrown upward with a velocity of 10 m/s. How long is it in the air.

time of flight

$u = +10\ m/s,\ a = -g$

$v = 0$

2. Direct: $s = ut - 4.9t^2$

$s = 0$; $0 = 10t - 4.9t^2$

$t = \frac{10}{4.9} = 2.04\ s$