NAME: answers.

U3:L1 Gravitational Fields

Use a highlighter and colored pencils/markers to highlight important information while you read. Doodle and color-coordinate information to organize your thinking.

Not JUST Earth!

Gravity is a force that surrounds ALL massive objects.

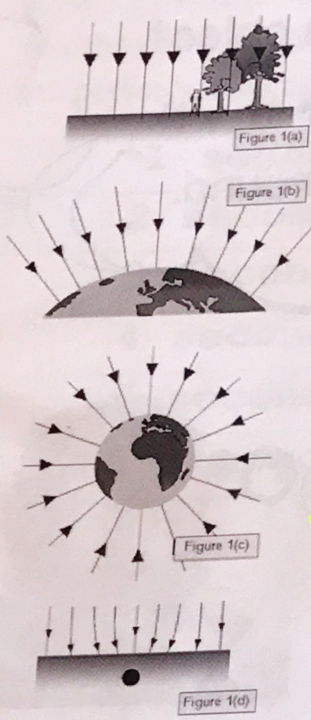
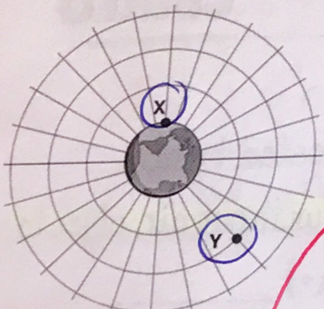


Figure 1(a) Figure 1(b) Figure 1(c) Figure 1(d)

The Earth, for example, has a gravitational field that pulls everything to its centre.

A **FIELD** is a region of space around a mass where another mass experiences a force.

These images are an example of how to diagram Earth's gravitational field.



Earth's gravitational field is stronger the closer you are to the surface of the Earth.

On the surface of the Earth, we feel an acceleration due to gravity of $9.8\ m/s^2$

This lessens the further you are from the surface of the Earth.

Represented as "g" aka "little g"

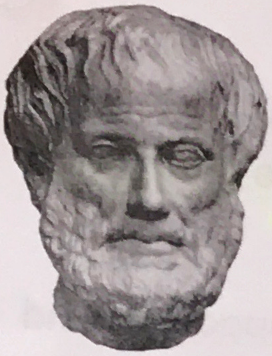
So, on the image to the left, X's "g" is stronger than Y's

FREEFALL

Freefall is when an object is experiencing downward motion, solely under the influence of gravity.

→ No other push/pull OR Resistance.

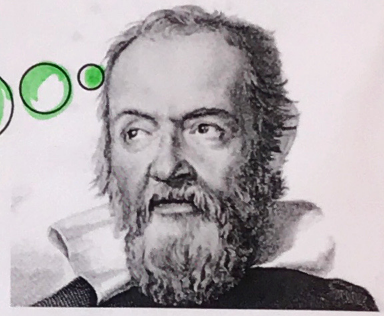
There are two early thinkers, who began discussions about gravity:



The **heavier** an object is, the **faster** it will fall to the ground.

ARISTOTLE

Objects dropped from the same height (**regardless of their mass**) will hit the ground at the **same time**.



GALILEO

Who was right?

Technically speaking, neither are correct! Objects are affected by air resistance depending on their surface area. In a vacuum without air, objects will fall to the ground at the same rate (YAY Gallileo! A+)

YOUTUBE "*Brian Cox BBC Human Universe Biggest Vacuum*" to see it in action!

Watch This!

There are 2 very important characteristics of objects in freefall:

1. **The object in freefall does NOT experience AIR RESISTANCE**
2. **Any object in freefall on Earth accelerates towards the Earth at $9.8\ m/s^2$**

It's getting FASTER!

Consider the diagram to the right

→→→→→→→→→→→→→→→→→→→→→→→→

Neglect air resistance to consider the ball in freefall. If each ball drawn represents where the ball is in one second intervals, find how fast the ball is moving at every second (the ball starts from rest in the person's hand and the first ball drawn is at 1 second).

1 second	9.8 m/s
2 seconds	19.6 m/s
3 seconds	29.4 m/s
4 seconds	39.2 m/s
5 seconds	49 m/s
6 seconds	58.8 m/s

$\vec{a} = \frac{\vec{v}}{\Delta t}$ so... $\vec{v} = \vec{a}(\Delta t)$

$9.8 m/s^2 \times \Delta t$ to find ANSWERS

@1s $\vec{v} = 9.8 m/s^2 (1s)$

$\vec{v} = 9.8 m/s$

@2s $\vec{v} = 9.8 m/s^2 (2s)$

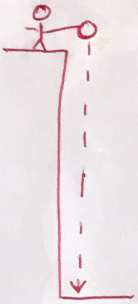
$\vec{v} = 19.6 m/s$

★ Fill the Rest yourself ☺

Try it:

❖ **REMEMBER: YOU MUST ASSIGN A DIRECTION TO BE POSITIVE**

EXAMPLE #1: Joe Bob drops a basketball off the roof of his apartment. The ball takes 3.2 seconds to reach the ground. Neglecting air resistance, find how fast the basketball was moving when it hit the ground, and at what height the basketball was dropped.



$\Delta t = 3.2 s$

$V_1 = 0 m/s$

$V_2 =$ ______

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

$\Delta d =$ ______

$\vec{a} = \frac{\vec{v}}{\Delta t}$ and $\Rightarrow \vec{v} = \vec{a}(\Delta t)$

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

NEW EQUATION ALERT!

$\vec{V_2} = \vec{a}(\Delta t)$

$\vec{V_2} = 9.8 m/s^2 (3.2 s)$

$\boxed{\vec{V_2} = 31.36 m/s}$

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

$\Delta d = \frac{1}{2}(9.8 m/s^2)(3.2 s)^2$

$\boxed{\Delta d = 50.18 m}$

Throwing Objects Upwards

*In all problems when an object is thrown upwards, its **initial velocity** will be **opposite** in direction to its **acceleration.** $\vec{v}_0$ ↑ $\vec{a}$ ↓

*The object is **slowing down** while it moves **upwards.** ... gravity pulls it downwards!

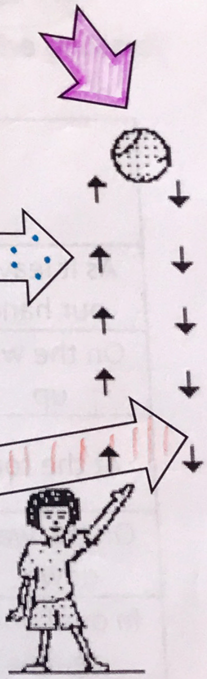
*When it begins to move **downwards** it is **speeding up**.

*When it reaches the **peak** of it's upwards motion, it is **momentarily motionless** $(\vec{v} = 0\frac{m}{s})$ ... it STOPS!

At the PEAK the object is **AT REST**

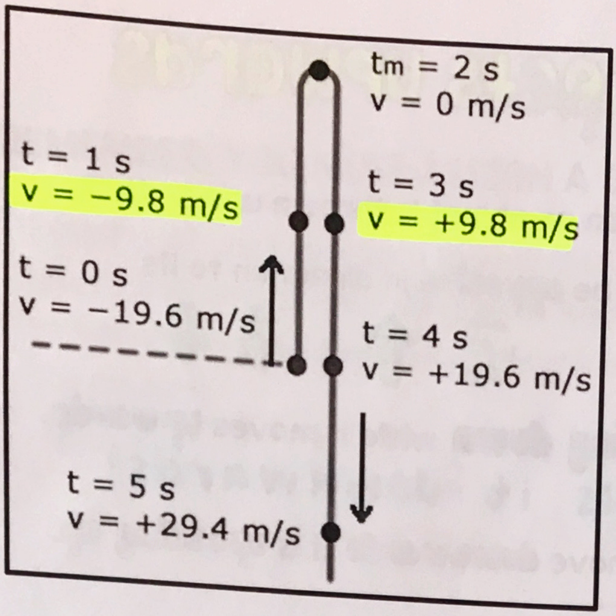
As the object travels upwards, it is **SLOWING DOWN** at a rate of

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



As the object travels downwards, it is **SPEEDING UP** at a rate of

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



- When an object is back at the **same level** it was during its upward motion, the velocity is **equal in magnitude but opposite in direction** during its downward motion.

- The time it takes for the object to rise to a position, is **equal** to the time it takes for it to descend to the same level.

For instance, if we throw a ball upwards with a velocity of 20 m/s...

Let's round acceleration to gravity to $10\ m/s^2$*...*

STOPS!

	Time (s)	Velocity (m/s)	Displacement from our hands (m)	Acceleration (m/s^2)
As it leaves our hand	0	20	0	-10
On the way up	1	10	15	-10
At the top	2	0	20	-10
On the way down	3	-10	15	-10
In our hand again	4	-20	0	-10