Mass

Is the amount of matter in a particle/object

Is the amount of resistance a body has to being accelerated by force

Mass is a **constant**, until material is added / removed

It's measured with stuff like **grams**

$$\mathbf{m = F / a}$$

Where

- **m** is mass
- **F** is force
- **a** is acceleration

Weight

It's the measure of the gravitational force acting on you

It's **not a constant**, it changes from place to place depending on the **gravity**

It's take from the formula

It's measured with stuff like **newtons**

$$\mathbf{W = mg}$$

Where

- **W** is weight
- **m** is mass
- **g** is the gravitational acceleration

Points of comparison	Mass	Weight
- Definition :	It is the resistance of the body to change its velocity.	It is the force of Earth gravity acting on the body.
- Type of physical quantity :	Scalar.	Vector. to center of earth
- Measuring unit :	Kilogram (kg)	Newton (N)
- Constancy :	Constant any where.	Varies from place to another.
- law :	$m = \frac{F}{a}$	$W = mg$

2) The mass of a plane when taking off is 40 tons. knowing that the gravitational field strength at the surface of Earth is 9.8 N/kg, the weight of this plane at 9 km high would be

a) About 40 000 N
b) Exactly 392000 N
c) Slightly more than 392000 N
d) Slightly less than 392000 N

This is because the 9 kilometers mark, is not enough to make a change in gravity, speaking of distance

Newton's law of universal gravity

It says that every thing attracts each other with a force that is proportional to the **product of their masses**, and inversely proportional to the **square distance between them**

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

Where

- **F** is force, it's the force of attraction between any two masses in nature, which is directly proportional to their masses and inversely proportional with the distance squared
- **G** is the proportionality constant of $6.67 * 10^{-11}$ Nm^2/kg^2, it's the gravitational force between 2 masses, when the distance between the masses is 1 meter and the product of the masses is 1 kilogram squared
- M_1 is mass of object 1
- M_2 is mass of object 2
- d is distance

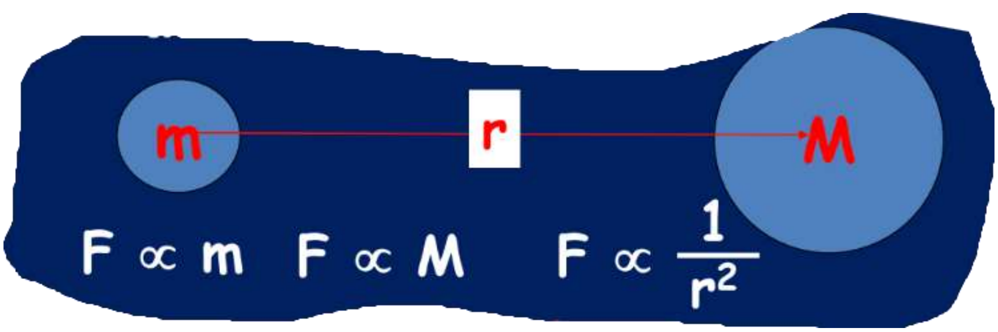
we can extract the dimensional formula of G which is

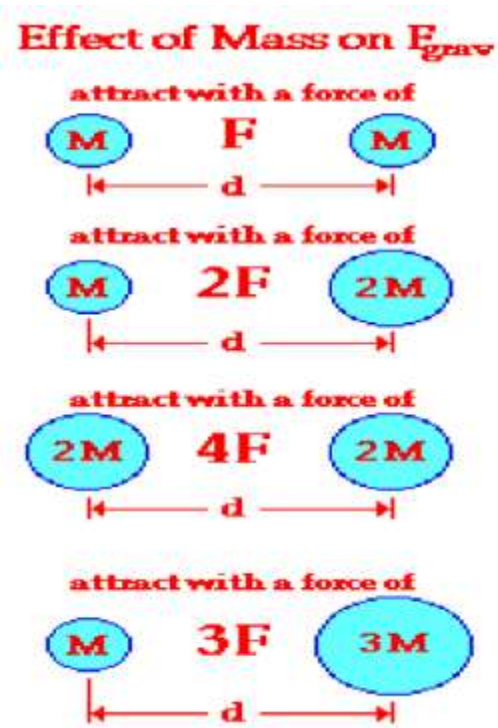
$G = F * d^2 / m_1 * m_2$

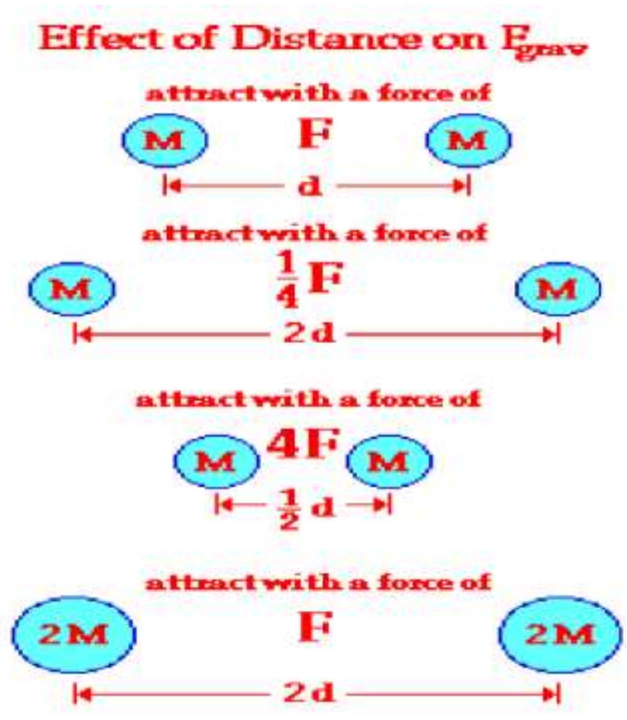
$G = M.L.T^{-2} * L^2 / M^2$

$G = M^{-1}.L^3. T^{-2}$

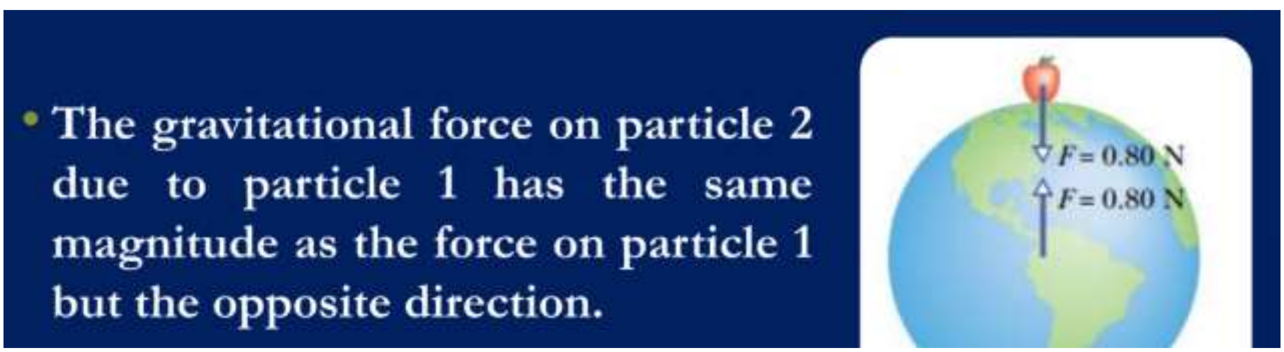
$g = L.T^{-2}$







That is how the action-reaction force pairs work with the gravitational force



How to get the gravitational acceleration from this equation

We all know that F

- F_g = target mass (m1) *G * source mass (m2) / d^2
- F = m*a

So target mass (m1) *a = target mass (m1) *G * source mass (m2) / d^2

Then
a (g) = G * m2 / d^2

Gravitational field

What is a force field in the first place?

so we have two types of force, contact and non-contact, we can observe contact forces and their effects like pushing someone, on the other hand, we cannot observe the non-contact force, but we can't see its effect

The range affected by a non-contact force is called a **force field**

Gravitational field

An area with gravity, surrounding a massive object, which leads to the use of its mass while neglecting the small object's mass

So if like you are standing on the earth, we neglect your mass because you're no match

$$g = G\frac{M}{d^2}$$

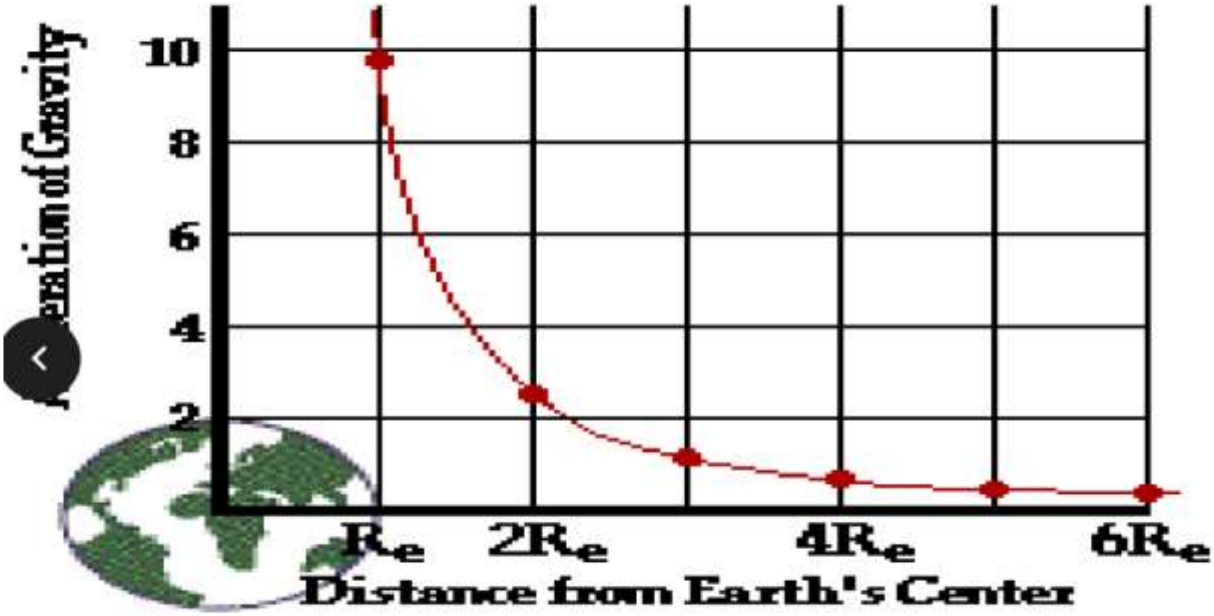
Where

- **g** is the gravitational acceleration
- **G** is the proportionality constant of 6.67 * 10^{-11} Nm^2/kg^2
- M_1 is mass of the big object
- d is distance

and you can extract this equation from that equation

$$GmM/r^2 = mg = F_G = F_w$$

- So **gravity causes mass to have weight.**



We can now use newton's second law on **g**

Like how in **f = ma**

Acceleration has

- positive correlation with force
- negative correlation with mass

$$g = G\frac{M}{d^2}$$

Gravitational acceleration has

- positive correlation with mass
- negative correlation with distance

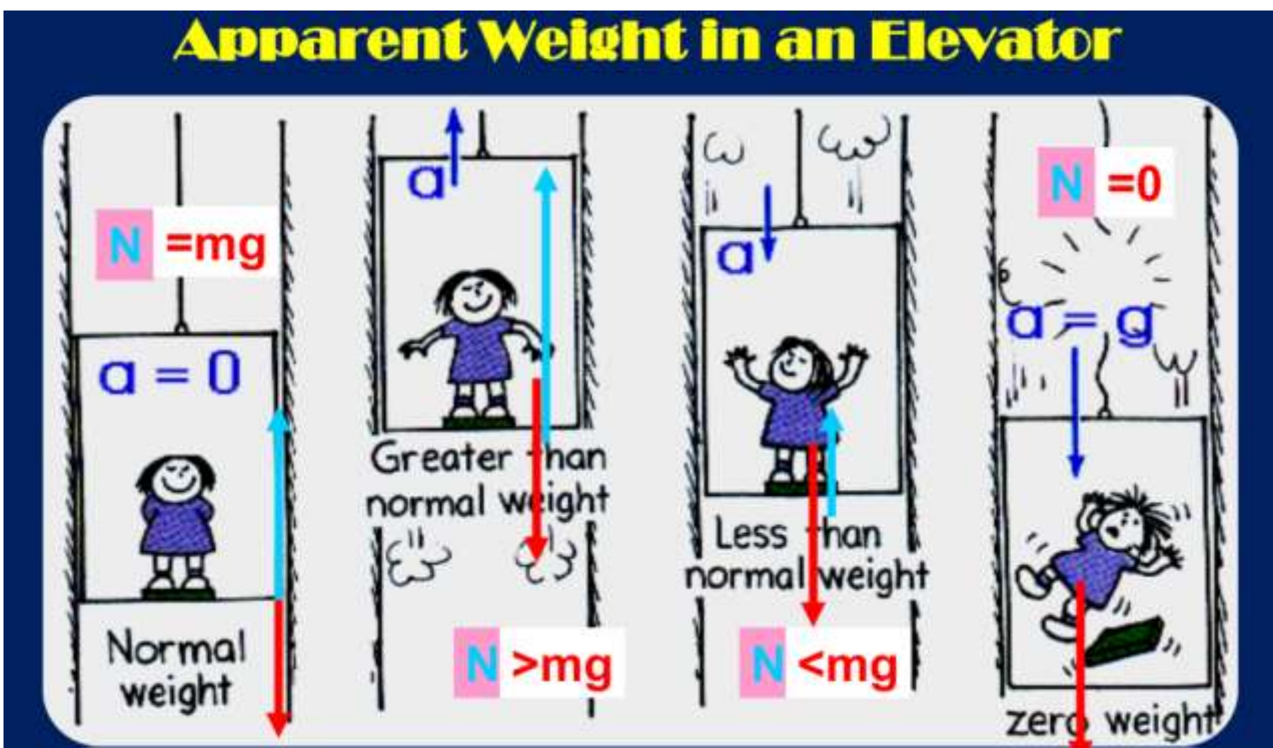
Notes when solving examples

- if you don't see another mass, use the law of gravitational field
- if it gives you variables, use one of the two laws to get the unknown

- if it gives you two bodies, use the first law

Apparent weight

When you're standing on the spring, the reading gives you the upward force that is going against the gravitational force



Your normal weight is the **gravitional weight**, aka **mg**

N = upward force | n = normal force

- **Normal weight**

  There are 2 forces acting on opposite directions

  Normal force, **gravitational force**

  So **$n = mg$**

  $N = n = mg$

  So the normal force equals your weight

- **Greater than Normal weight**

  There are 3 forces

  Normal force with **Applied force** against **gravitational force**

  $n = mg$

  a in the same direction as **n** and opposite to **mg**

  $N = n + a$

  $N > mg$

  So the normal force is greater than your weight

- **Less than Normal weight**

  There are 3 forces

  Normal force against **gravitational force** with **Applied force**

  $n = mg$

  a in the same direction as **mg** and opposite to **n**

  $N = n - a$

  $N < mg$

  So the normal force is less than your weight

- **Zero**

  There are 3 forces

  Normal force with **Applied force** against **gravitational force**

  $a = mg$

n = mg

a in the same direction as **mg** and opposite to **n**

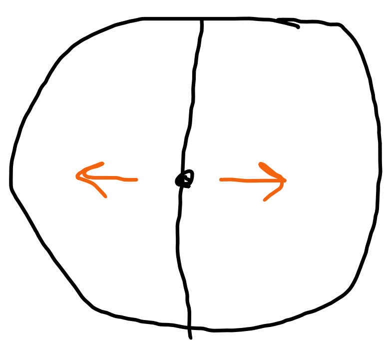
N = n – a = 0

N = 0

So the normal force is zero

SICK NOTES

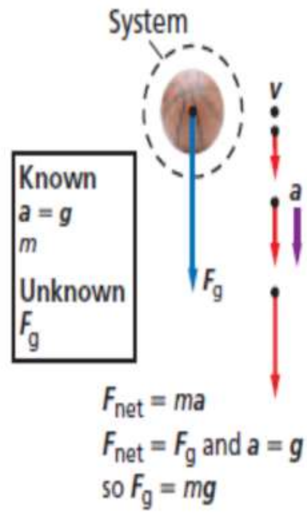
1. If you have three people with the same mass, one on top of a mountain, one on the surface, and one on the ocean floor, the one with the most net gravitational force is **the one on the surface**, that is because
    a. **The one on top of the mountain** has more distance so less gravitational force
    b. **the one on the ocean floor** has the buoyance of water + the mass of the ocean above him pulling him upwards
2. if you are In the center of the earth, the net gravitional force affecting you is **zero**, because when you are in the middle, the two equal sides of earth pull you in opposite directions, cancelling each other In the process



Freefall

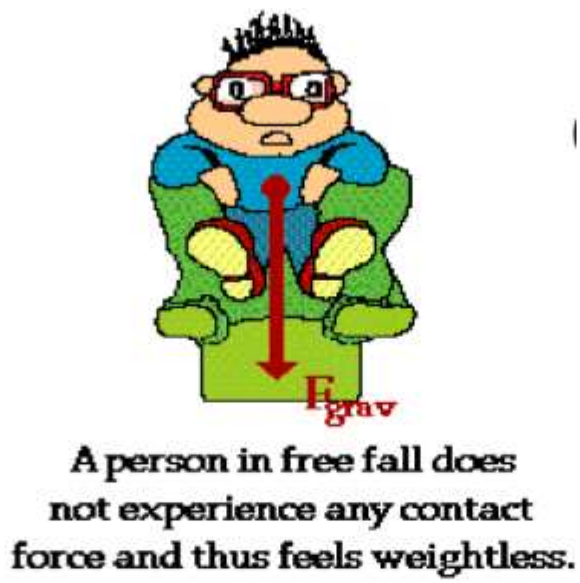
It's when an object is touching nothing and air resistance is neglected, the only force affecting it is the gravitational force

Then newton's 2nd law becomes **F = mg** instead of **F = ma**



weightlessness

it means that **N (upward force) = 0**



Examples

- **floating** in space means "free-falling" in space as there is no contact force
- **Orbit motion** is a free fall as there are no forces against your gravity

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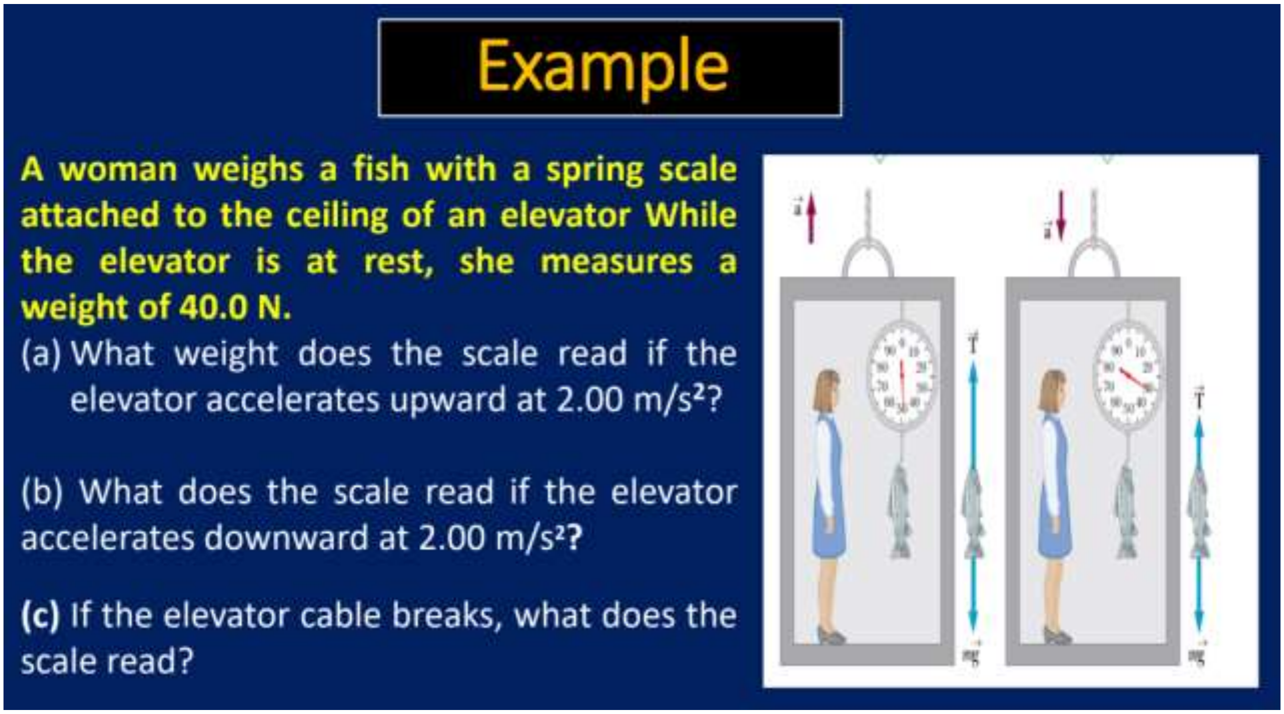

When no forces affecting

Netforce = T – mg = 0

T = mg

40 = m * 9.8

M = 4.08 kg

(a)

Net force = (T + ma) – mg

T = mg – ma

T = m(g-a)

T = 31.82n

(b)

Netforce = T – (mg + ma)

T = -(mg + ma)

$T = -48.14n$

(c)

$Netforce = T - (ma+mg)$

$T = -m(a+g)$
because the law of inertia (newton's first law)
$a = -g$

$T = -m * 0 = 0n$