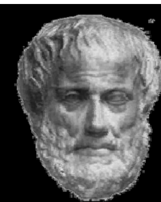


Aristotle

350 BC

In the absence of a FORCE

a body is at rest

A body only moves if it is driven.

Moving objects need to be pushed

No push ➔ no motion

Logical misconception from observation

Riding a bike stop pedalling>slow down

Driving a car, turn off engine> slow down

Newton clarified the mechanics of motion in the "real world".

He postulated that there existed an **absolute** (not accelerating) reference frame, and an absolute time.

His laws applied only when measurements were made in this reference frame….. …or

in any other reference frame that was <u>at rest</u> or <u>moving at a constant velocity</u> relative to this absolute frame.

The laws of physics are always the same in any inertial reference frame.

The laws of physics are always the same in any inertial reference frame.

?????

A given force always gives the same acceleration to a mass .

A body that is at rest in one inertial ref. frame will either be at rest, or have a constant velocity in the other .

A body that is has a constant velocity in one inertial ref. frame will either be at rest, or have a constant velocity in the other .

Newton's 1st Law

Every body perseveres in a state of rest, or uniform motion in a right line unless compelled to change that state by forces impressed thereon.

Why???

Mass

1660 BC

Newton's 1st Law

If a body is at rest, and no force acts on it, IT WILL REMAIN AT REST.

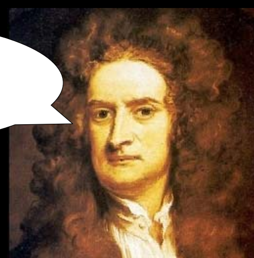
If it is moving with a constant velocity, IT WILL CONTINUE TO DO SO

If a body moving at constant velocity, we can always find a reference frame where it is AT REST.

At rest ≡ moving at constant velocity

Force: Newton 2

The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.



Force

If things do not need pushing to move at constant velocity, what is the role of FORCE???

An applied force changes the velocity of the body

acceleration → $a \propto F$ acceleration is proportional to the force!!!

$$a = \frac{1}{m}F$$

Inertial mass

$$a = F/m$$

The more massive a body is, the less it is accelerated by a given force.

Mass and Weight

MASS is the property that determines the INERTIA of the body

How difficult it is to get moving (accelerating)

WEIGHT is the FORCE with which Earth pulls the mass

6×10^{24} kg

6×10^{6} m

$$F = m(0.00000000007\ M/R^2)$$

$$F = mg = \text{weight}$$

Gravitational field $9.8\ N\ kg^{-1}$
or
acceleration due to gravity $9.8\ m\ s^{-2}$

Every mass on Earth accelerates at the same rate downward!

the acceleration of a mass towards the centre of Earth is $9.8\ m\ s^{-1}$ each sec.

A common misconception

Heavy things fall faster than light things

$$a = \Sigma F/m$$

mg

$$a = \frac{\text{SUM of ALL EXTERNAL forces acting on the body}}{m}$$

$$a = \frac{mg}{m}$$

The acceleration of a falling object does NOT depend on its mass!!!!!

Newton's 3rd Law

Forces come in pairs

To every action there is an equal and opposite reaction.

The action-reaction pairs

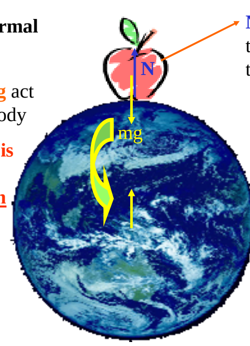
ALWAYS act on DIFFERENT bodies

What is reaction pair to the weight force mg?

Is it N (normal reaction)?

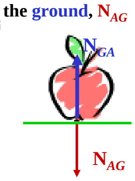
NO. N and mg act on the SAME body

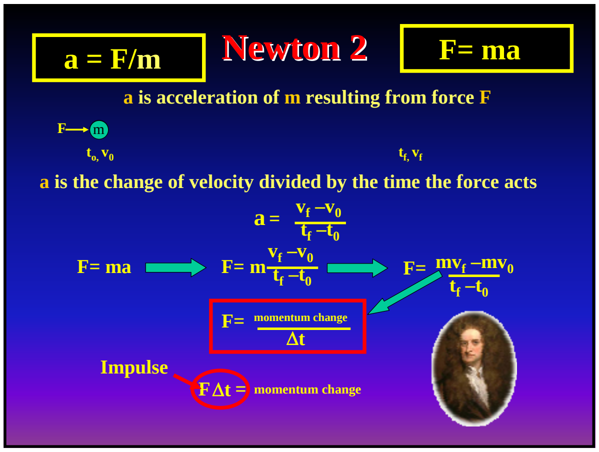
The reaction pair is the force of the apple on the Earth

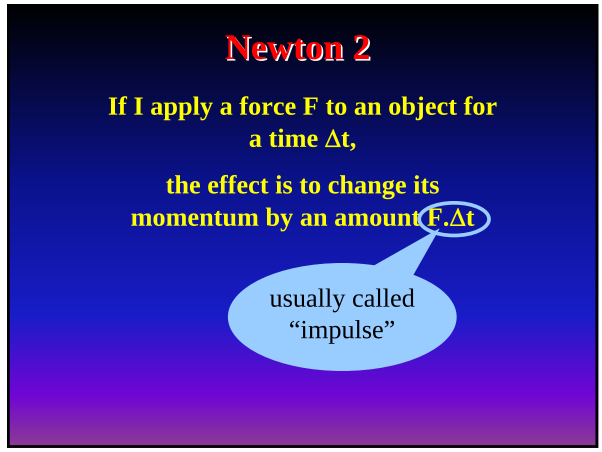


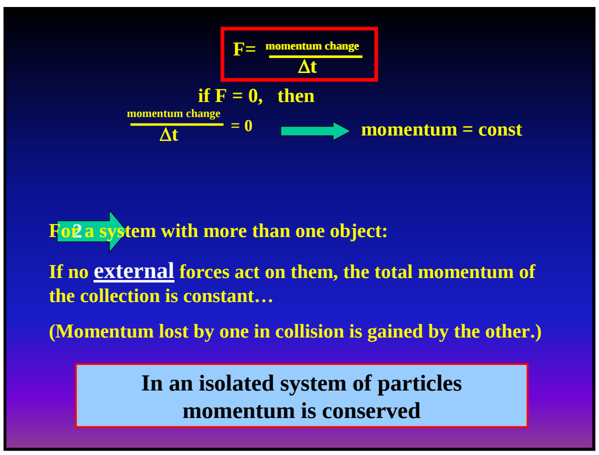
N is the force of the ground on the apple N_{GA}

The reaction pair to N_{GA} (or N) is the force of the apple on the ground, N_{AG}




a = F/m
Newton 2
F= ma
a is acceleration of m resulting from force F
F→ m
t_o, v_0
t_f, v_f
a is the change of velocity divided by the time the force acts
$a = \frac{v_f - v_0}{t_f - t_0}$
F= ma
$F = m\frac{v_f - v_0}{t_f - t_0}$
$F = \frac{mv_f - mv_0}{t_f - t_0}$
$F = \frac{\text{momentum change}}{\Delta t}$
Impulse
$F\Delta t$ = momentum change


Newton 2
If I apply a force F to an object for a time Δt,
the effect is to change its momentum by an amount F.Δt
usually called “impulse”


$F = \frac{\text{momentum change}}{\Delta t}$
if F = 0, then
$\frac{\text{momentum change}}{\Delta t} = 0$
momentum = const
For a system with more than one object:
If no external forces act on them, the total momentum of the collection is constant…
(Momentum lost by one in collision is gained by the other.)
In an isolated system of particles momentum is conserved