NAME:_____

U2L1 Intro to Forces

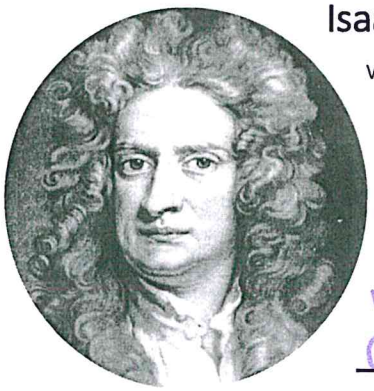
DYNAMICS	The study of forces and their effects on motion.
FORCE	Simply put, forces are a push or pull.

What are the four fundamental forces in nature?

1. Gravitational
2. Strong nuclear
3. weak nuclear
4. Electromagnetic

Forces can be categorized under two sections: either contact or non-contact forces.

CONTACT FORCES	NON-CONTACT FORCES
...are types of forces that result when the two interacting objects are physically touching	...are types of forces that result even when the two interacting objects are not in physical contact with each other, yet are able to exert a push/pull despite their separation
EXAMPLES: APPLIED AIR Resistance Tension Friction Normal	EXAMPLES: Gravity Electric magnetic



Isaac Newton (17th century physicist) formulated **3 laws of motion** which are fundamental to understanding dynamics.

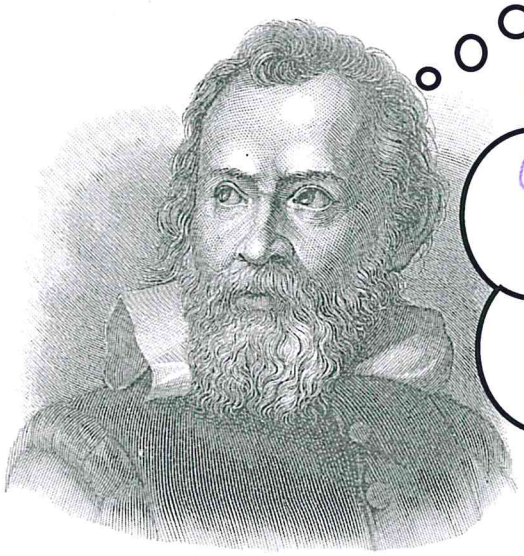
Newton's First Law is:

an object @ rest, and object in motion stay @rest or moving in same speed + direction unless acted upon by an unbalanced force

In other words: Objects "*tend to keep on doing what they're doing.*"

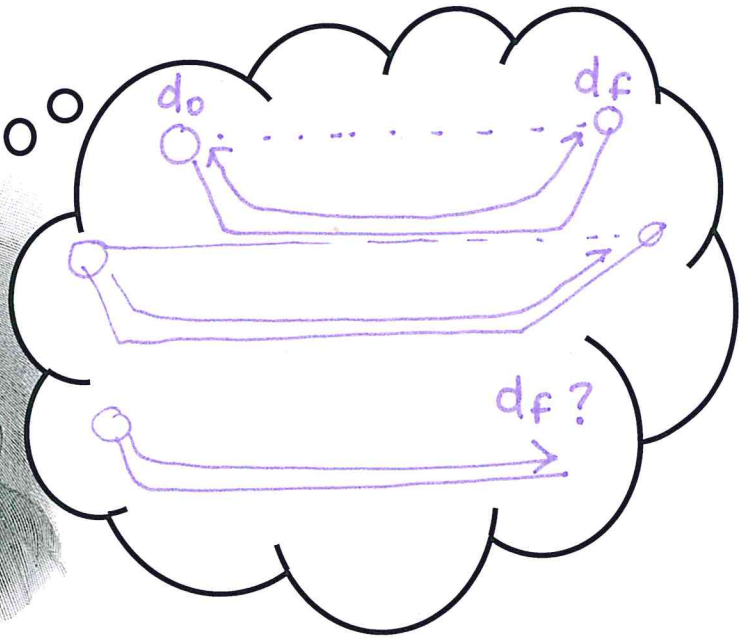
In order to understand Newton's 1st Law, we should time-travel to look at another thinker...

Galileo Galilei (16th century astronomer) conceptualized the idea of a constant state of motion in absence of any forces. He did this through a thought experiment.



Galileo Galilei.

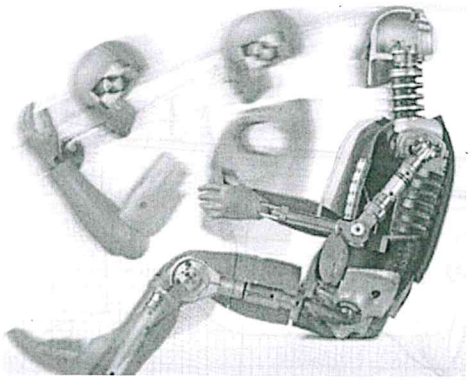
A



A **thought experiment** is essentially a made-up, imaginary experiment done in your mind. Thought experiments exist to explore ideas in absence of the technology to tangibly do so.

Galileo concluded that it is the natural tendency of objects to resist changes in their state of motion. This tendency to resist changes in their state of motion is called

INERTIA.



Newton's 1st Law

The Law of Inertia

net force: The sum of all of the forces acting on an object.

If the net external force on an object is zero, the object's velocity will remain unchanged.

Implications

- **A non-zero net force will change the velocity.**
- **A net force is not required to maintain the velocity.**
- **External forces change the motion, not internal forces.**

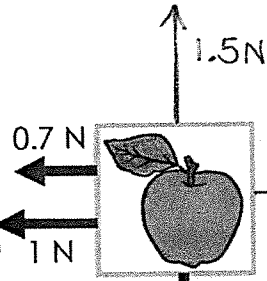
True or False?

If an object is stationary, it must have no external forces acting on it. There may be some external forces, but they would be balanced
TRUE
FALSE

If you throw a ball in space the ball will keep going in the same direction at the same speed.
TRUE There is no force to change the velocity.
FALSE

While sitting in a moving bus you throw an apple up into the air. The apple will land back in your hand. The apple, you & the bus all have the same horizontal velocity, with no forces changing it.
TRUE
FALSE

A bus accelerates forward. If an apple were on the floor of the bus it would move forward.
TRUE The apple would appear to move toward the back of the bus
FALSE



Draw additional forces so the apple has a net force of 0 N.

Buckle up!

If you are riding in a car and the speed suddenly decreases...

No seatbelt

You keep moving until something exerts a force to stop you (dashboard)

With seatbelt

Seatbelt exerts a force to stop you.

Name: Solutions

Newton's 2nd Law

The Law of Motion

If you're wearing a hat, you're going places. Vectors have direction.

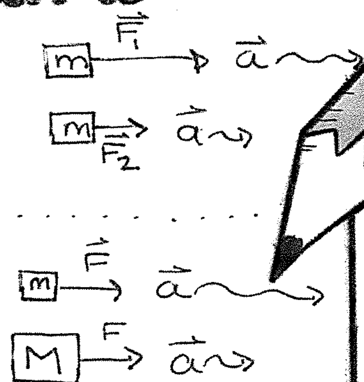
$$\vec{F}_{net} = m\vec{a}$$

(sum of ALL forces → $\vec{F}_{net}$; ↑ N; ↑ kg; ↑ m/s^2)

The net force acting on an object is equal to the product of its mass and its acceleration.

equation

draw it



write it

$a \propto F$

if the force increases so does the acceleration

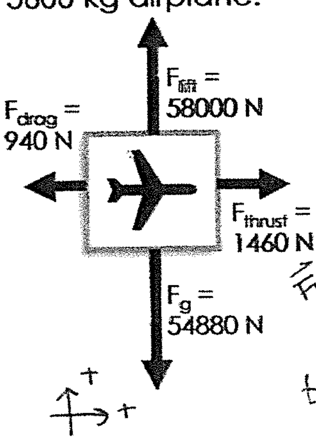
$a \propto \frac{1}{m}$

if the mass increases the acceleration decreases

An object will accelerate in the direction of the net force; the magnitude of the acceleration is proportional to the force and inversely proportional to the mass

use it

Use the FBD and Newton's 2nd Law to determine the acceleration of a 5600 kg airplane.



$\vec{F}_{net\,x} = \vec{F}_{thrust} + \vec{F}_{drag}$

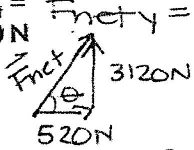
$\vec{F}_{net\,x} = 1460N - 940N$

$\vec{F}_{net\,x} = 520N$

$\vec{F}_{net\,y} = \vec{F}_{lift} + \vec{F}_g$

$\vec{F}_{net\,y} = 58000N - 54880N$

$\vec{F}_{net\,y} = 3120N$



$F_{net}^2 = 3120^2 + 520^2$

$F_{net} = 3163N$

$\tan\theta = \frac{3120N}{520N}$

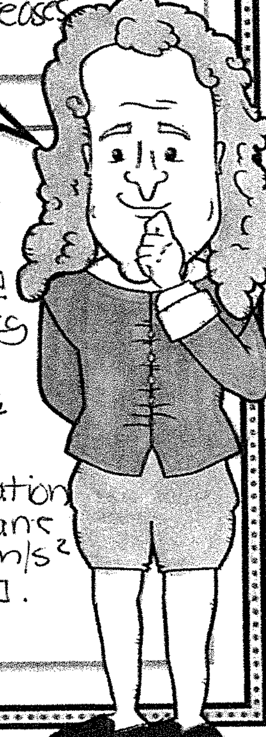
$\theta = 80.5°$

$\vec{a} = \frac{\vec{F}_{net}}{m}$

$\vec{a} = \frac{3163N}{5600kg}$

$\vec{a} = 0.56 \frac{m}{s^2}$

∴ The acceleration of the plane is $0.56\ m/s^2$ [81° ATH].



Name: Solutions