CLIL Project – Physics in English

Anno scolastico 2013-2014

Newton's Laws
Force and Motion
Lecture 3

Classe 3ª A Linguistico

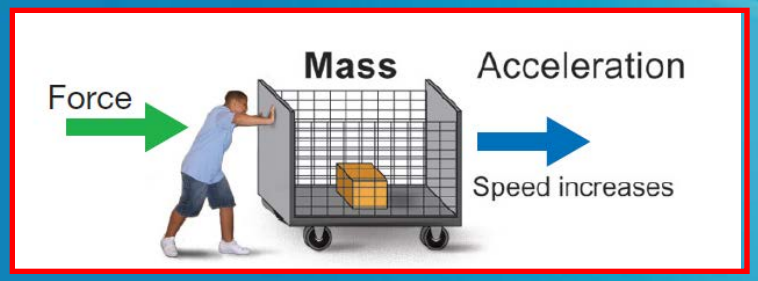
Istituto Superiore "Marini-Gioia" - AMALFI

The Second Law: Force, Mass, and Acceleration

Investigation Key Question:

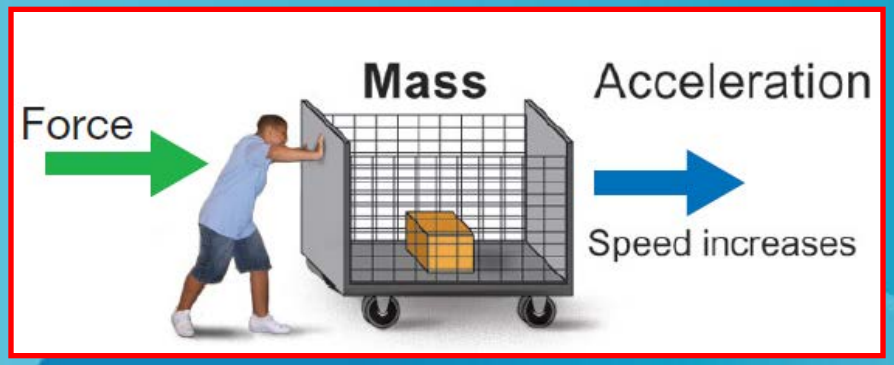
What is the relationship between force, mass, and acceleration?

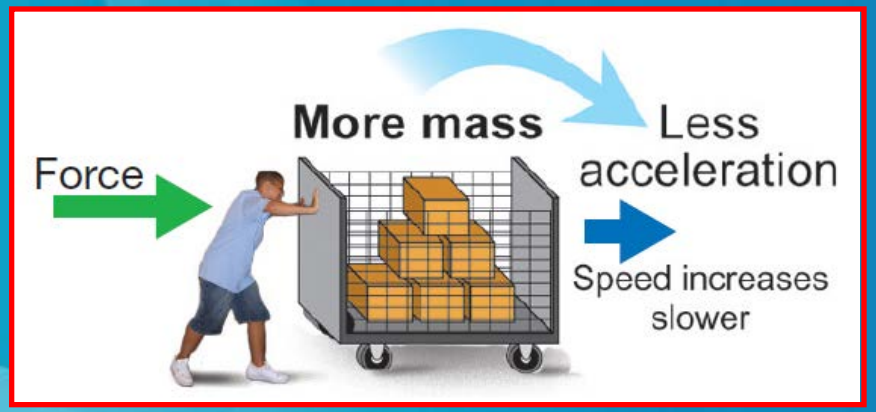
- If you apply more force to an object, it accelerates at a higher rate.



The Second Law: Force, Mass, and Acceleration

- If the same force is applied to an object with greater mass, the object accelerates at a slower rate because mass adds inertia.



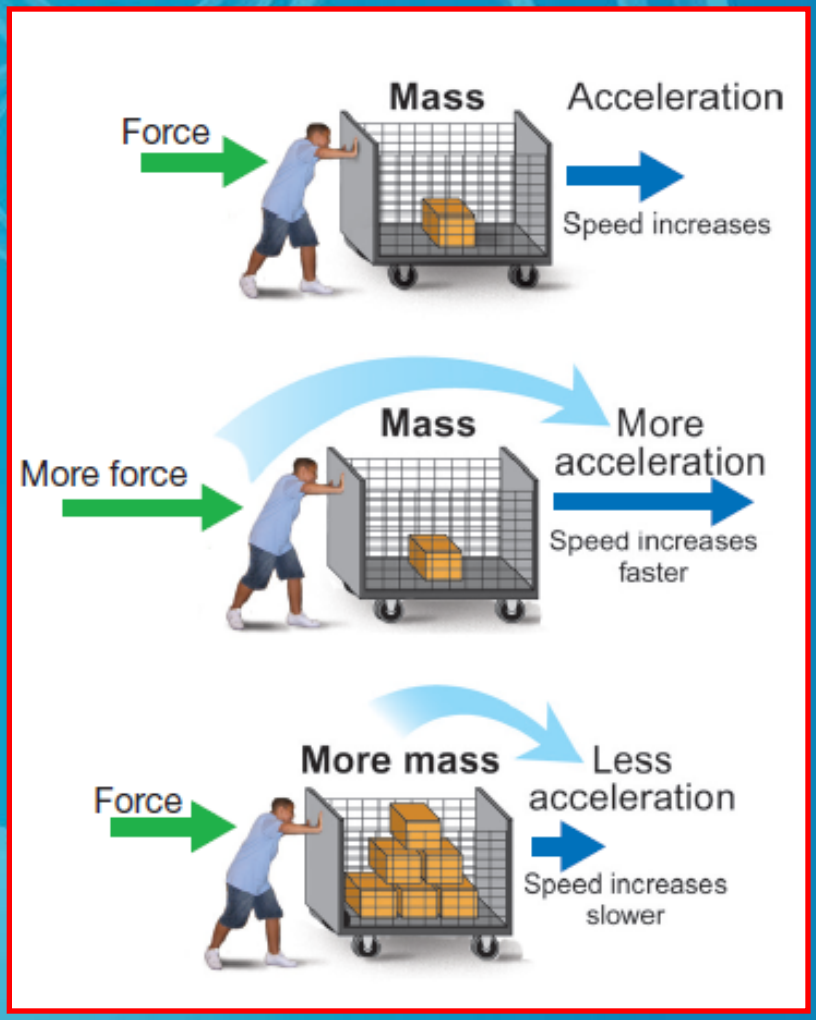


The Second Law: Force, Mass, and Acceleration

Math formulation:

Acceleration (m/s²) $a = \frac{F}{m}$ **Force** (N)

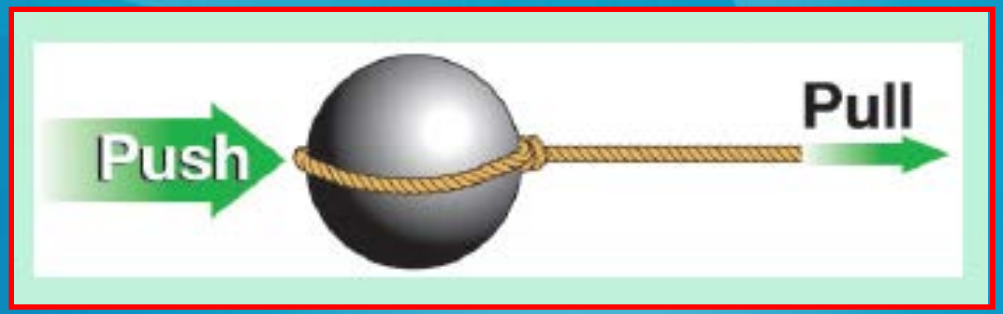
Mass (kg)



The Second Law: Force, Mass, and Acceleration

The definition of force

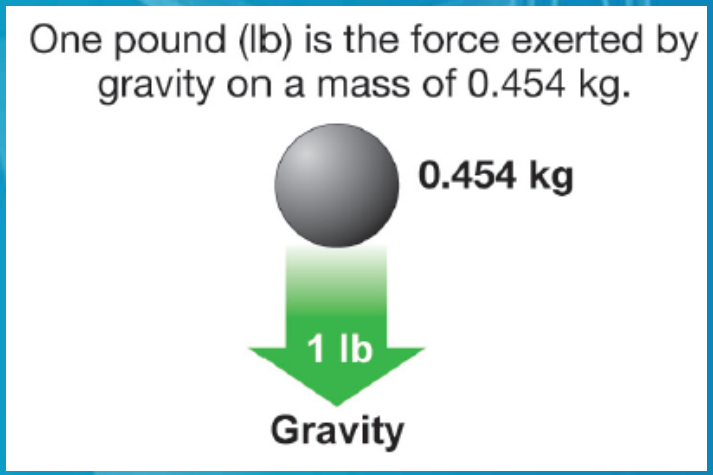
- The simplest concept of force is a push or a pull.
- On a deeper level, force is the action that has the ability to create or change motion.



The Second Law: Force, Mass, and Acceleration

The definition of force

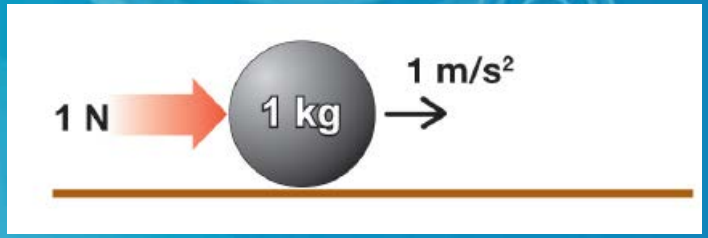
- *In the English system, the unit of force, the pound, was originally defined by gravity.*
- *The metric definition of force depends on the acceleration per unit of mass.*



The Second Law: Force, Mass, and Acceleration

Newton's Second Law

- *A force of one Newton is exactly the amount of force needed to cause a mass of one kilogram to accelerate at one m/s².*



- *We call the unit of force the Newton (N).*

Force (Newtons, N)

Acceleration (m/sec²) → $a = \frac{F}{m}$

Mass (kg)

The Second Law: Force, Mass, and Acceleration

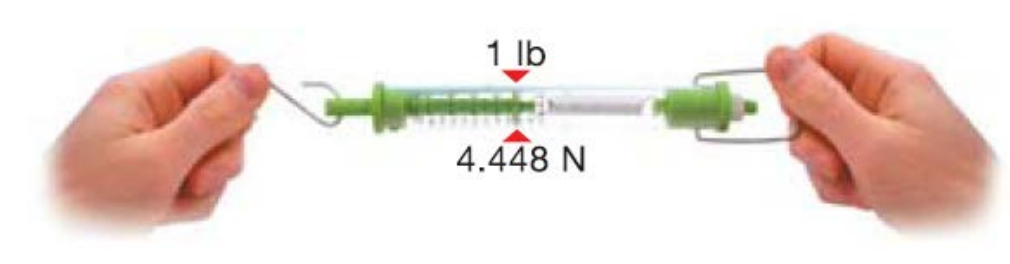
Using the second law of motion

- *The force F that appears in the second law is the net force.*
- *There are often many forces acting on the same object.*
- *Acceleration results from the combined action of all the forces that act on an object.*
- *When used this way, the word net means "total."*

The Second Law: Force, Mass, and Acceleration

Converting Newtons and Pounds

- *A force of one Pound is equal to about 4.448 Newtons.*

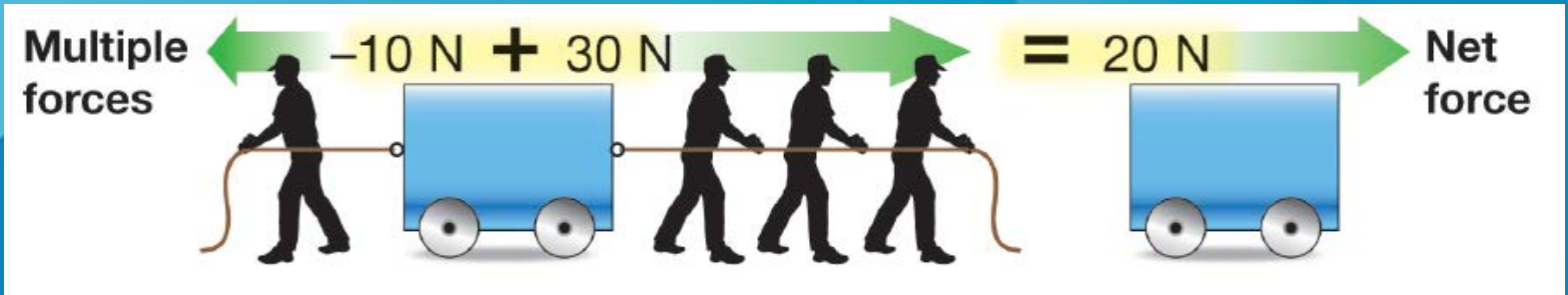


A force of one Pound corresponds to the weight of a body having mass equal to 0.453 Kgm

The Second Law: Force, Mass, and Acceleration

Using the second law of motion

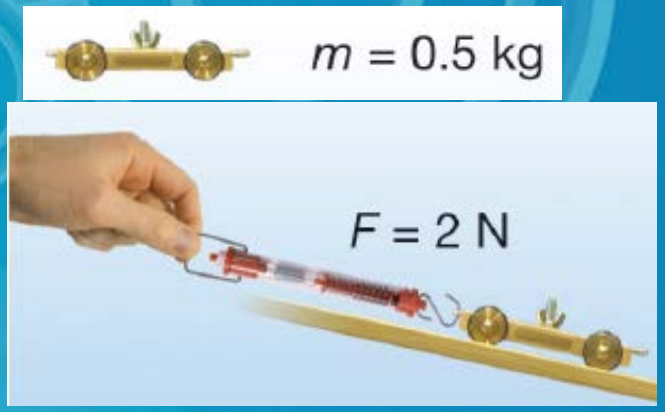
To solve problems with multiple forces, you have to add up all the forces to get a single net force before you can calculate any resulting acceleration.



The Second Law: Force, Mass, and Acceleration

Calculating acceleration

A cart rolls down a ramp. Using a spring scale, you measure a net force of 2 Newtons pulling the car down. The cart has a mass of 500 grams (0.5 kg). Calculate the acceleration of the cart.



1. You are asked for the acceleration (*a*).
2. You are given mass (*m*) and force (*F*).
3. Newton's second law applies: $a = F \div m$
4. Plug in numbers. (Remember: 1 N = 1 kg·m/s^2)

The Second Law: Force, Mass, and Acceleration

Newton's Second Law

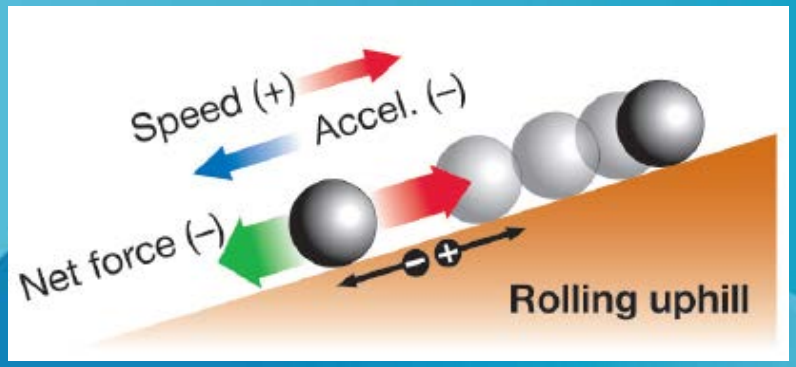
The three forms of the second law:

Use...	if you want to find...	and you know...
$a = \frac{F}{M}$	The acceleration (a)	The net force (F) and the mass (m)
$F = ma$	The net force (F)	The acceleration (a) and the mass (m)
$M = \frac{F}{a}$	The mass (m)	The acceleration (a) and the net force (F)

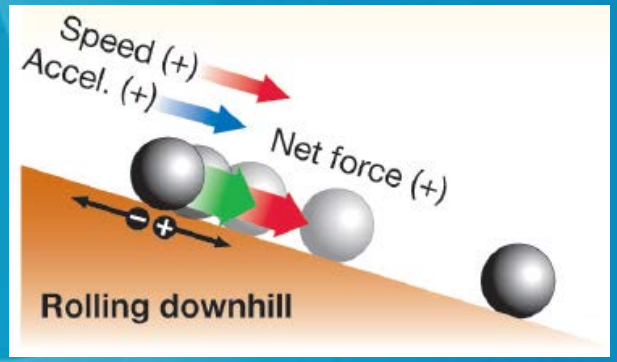
The Second Law: Force, Mass, and Acceleration

Finding the acceleration of moving objects

The word dynamics refers to problems involving motion.
In dynamics problems, the second law is often used to calculate the acceleration of an object when you know the force and mass.



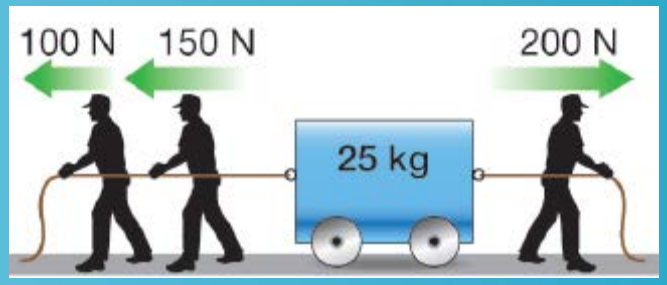
Speed *increases* when the net force is in the same direction as the motion.



Speed *decreases* when the net force is in the opposite direction as the motion.

The Second Law: Force, Mass, and Acceleration

Acceleration from multiple forces



Three people are pulling on a wagon applying forces of 100 N, 150 N, and 200 N. Determine the acceleration and the direction the wagon moves. The wagon has a mass of 25 kilograms.

1. You are asked for the acceleration (a) and direction
2. You are given the forces (F) and mass (m).
3. The second law relates acceleration to force and mass: $a = F \div m$
4. Assign positive and negative directions. Calculate the net force then use the second law to determine the acceleration from the net force and the mass.

The Second Law: Force, Mass, and Acceleration

Video on second law…