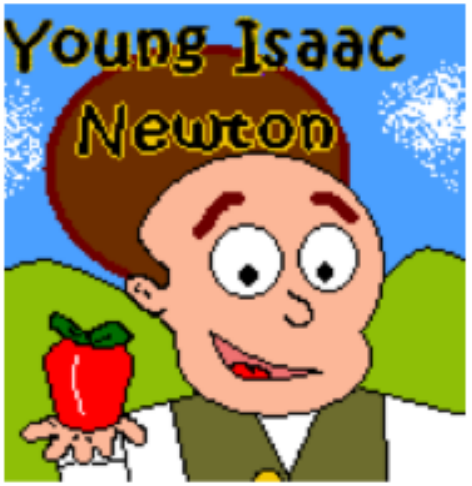
Newton's Second Law

Recall: Newton's First Law: Inertia

"An object at rest (or at a constant velocity) stays at rest (or at a constant velocity) unless acted on by an outside net force."

So, what happens when an object is acted on by a force?

Newton Knows!



Newton's Second Law

qualitative defn.

"Any net force produces an acceleration in the direction of the force. The magnitude of the acceleration is directly proportional to the force and inversely proportional to the mass of the object."

Simply put:

quantative defn.

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

where:

$\vec{F}$ = force (kgm/s^2 or N [a newton])

$\vec{a}$ = acceleration (m/s^2)

m = kg

Where do the units come from?

According to the equation and unit analysis, the units are:

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

$$= (kg)(m/s^2)$$

$$= kgm/s^2$$

However, because this is sort of cumbersome to write, we have replaced this term with N for newtons in Newton's honor.

What do you mean by directly proportional?

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

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

As the force increases, the acceleration increases.

$$\vec{F} \propto \vec{a}$$

$\propto$ = is proportional to

What do you mean by inversely proportional?

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

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

As the mass increases, the acceleration decreases.

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

Applying the Second Law:

ex) Curtis has a mass of 100 kg. What force is needed to accelerate Curtis to 1.5 m/s^2?

ex) A spring-scale can pull with a force of 2.0 N. What is the maximum acceleration such a scale could give to a 3.5 kg object?

ex) A person's mass is 88.18 kg. What is his weight?