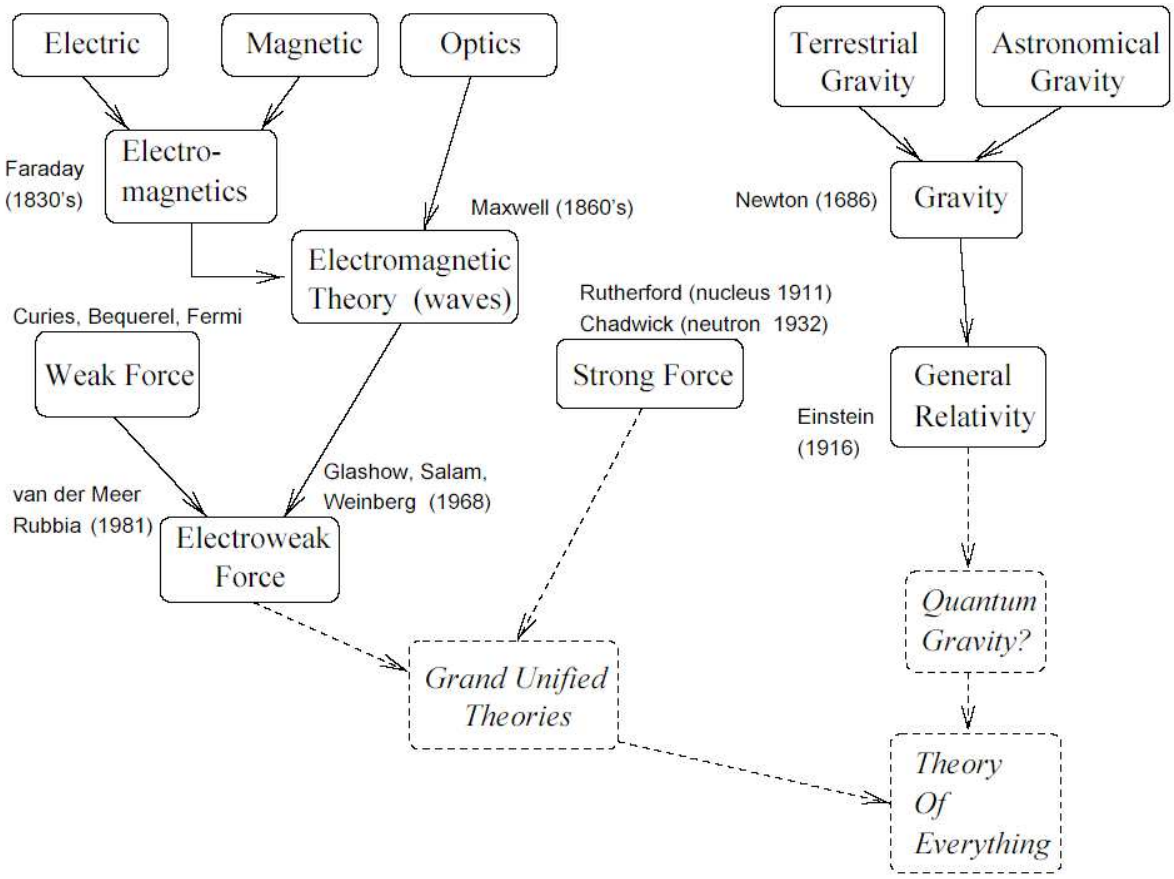
Unification of Forces



Newton's Laws of Motion

(or, you can't push on a rope)

Force: any agent of change

A force is an interaction among two objects.

A force can be a push or a pull. ☞

Some scientists before Newton believed that some force was required to keep an object moving.

No force is required to keep a body moving.

However, a force *is* needed to:

*start it moving, or
*slow it down or speed it up

Two types of forces:

1. contact
2. action-at-a-distance

Newton's 1st Law of Motion

A body at rest will remain at rest,

and a body moving in a straight line at constant speed will continue to do so,…

unless acted upon by some *net external* force.

If you *do* try to change an object's velocity, it offers some resistance to a change in its motion.

This resistance is called _____.

Newton's 1st Law is often referred to as the "Law of Inertia":

- all bodies offer some resistance to a change in their motion, this resistance is called *Inertia*.

An object's inertia is measured by its _____.

Mass: a measure of a body's quantity of matter (or 'stuff).

Let's go back to the car example:

How did it get moving in the first place?

What caused it to accelerate?

Someone must have exerted a force on it ☞ , causing its velocity to change from zero to 5 mph.

Thus, a force can cause an acceleration.

Newton's 2nd Law of Motion

When a net external force ΣF_{ext} acts on a body of mass *m*, the resulting acceleration *a* is:

- directly proportional to ΣF,

$$a \propto \Sigma F_{ext}$$ and

- inversely proportional to *m*

$$a \propto 1/m$$

or,… $$a = \frac{\Sigma F_{ext}}{m}$$

This is Newton's 2nd Law of Motion.

It is usually written as:

$$\sum \vec{F}_{ext} = m\vec{a}$$

What are the units of Force?

Weight and *Mass*

A body's *weight* is the downward force with which the Earth's gravity exerts on it.

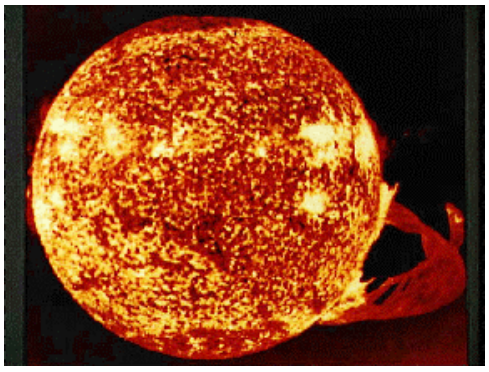
Recall: *force = mass * acceleration*

So *weight = mass * g*

$$W = mg$$

Newton's 3rd Law of Motion

Two bodies *interact* such that whenever one body exerts a force on a second body, the second body exerts an equal force on the first body, but in the opposite direction.



or,…

"Forces always occur in pairs"

Let’s look at some action-reaction pairs of forces:

5-Step Method for Applying Newton's' 2nd Law

1. Draw and label a large diagram (Neatly, with a ruler or straight-edge)

2. Draw all forces acting on the body(s) being analyzed. (Most of the time it will only be one body).

3. Choose an appropriate coordinate system

Helpful rule of 

* Make one of the axes parallel to the acceleration.

4. Resolve all forces along your coordinate system.

5. Apply $\sum \vec{F}_{ext} = m\vec{a}$ in component form along each axis.