Remembering last year.

In our experiments with colliding carts we noticed that

if you add up the change of velocity of one cart times some number *m* (which is specific for that cart 1) and the change of velocity of the second one times another number *m'* (which is specific for that cart 2)

then the sum is zero:

$$m\Delta v + m'\Delta v' = 0$$

We named these *m*'s "masses"... So there was a property of that system which was not changing

$$\Delta(mv + m'v') = 0$$

We called that quantity "momentum", the general definition for the system made of n constituents is:

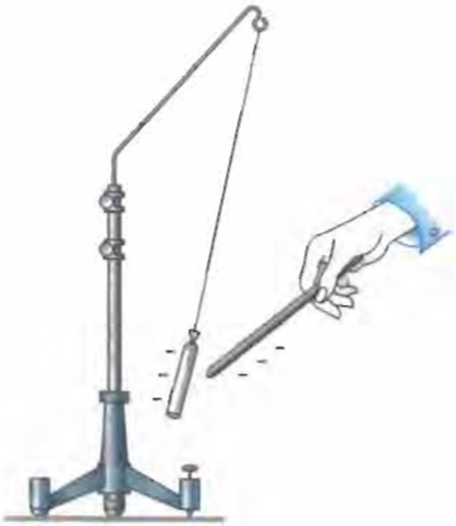
$$p = \sum_{i=1}^{n} m_i v_i$$

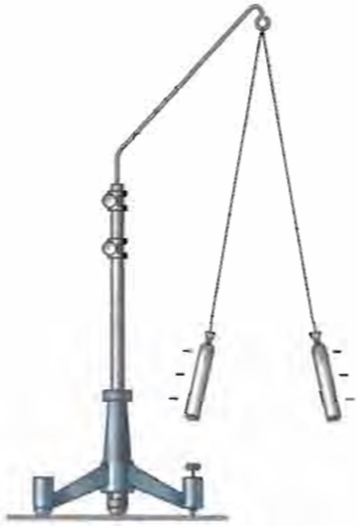
Where the index i runs over all the pieces which are included in the system. If nothing acts on the system from outside, this p does not change over time : $\Delta p = 0$. But if *there is* something that influences this system from outside, then the longer it acts, the larger is the disturbance. We named this reason for changing of the momentum ***"the force"*** and, to reflect that the longer it acts, the bigger is the change, we wrote the *definition* of the force as

$$\Delta\vec{p} = \vec{F}\,\Delta t$$

Forces in Nature

Interaction	*Relative strength*	*Radius of action, cm*	*Observed in*
Gravitational	10^{-39}	∞	Cosmos
Strong	100	10^{-13}	Nuclei, Elementary particles
Weak	10^{-14}	10^{-16}	Elementary particles transformations
Electromagnetic	1	∞	From Nucleus to Cosmos





A brief story of modern electromagnetic theory.

Year 1600

William Gilbert *(England)*

«De Magnete, Magneticisque Corporibus, et de Magno Magnete Tellure»
(On the Magnet and Magnetic Bodies, and on That Great Magnet the Earth)

ἠλεκτρον is (old) Greek for “amber”

Year 1785 *(France)*

Charles-Augustin de Coulomb . 22 years old:
«*Premier Mémoire sur l'Électricité et le Magnétisme*.» :

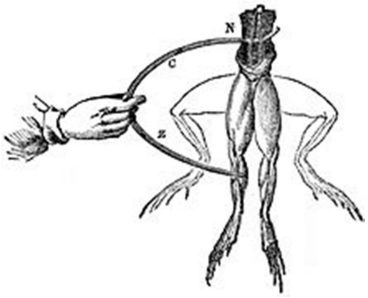
... Il résulte donc de ces trois essais, que l'action répulsive que les deux balles électrifées de la même nature d'électricité exercent l'une sur l'autre, suit la raison ***inverse du carré des distances.***

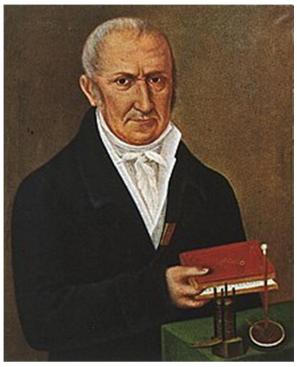
It follows therefore from these three tests, that the repulsive force that the two balls — [which were] electrified with the same kind of electricity — exert on each other, follows the inverse proportion of the square of the distance

Year 1780 *(Italy)*

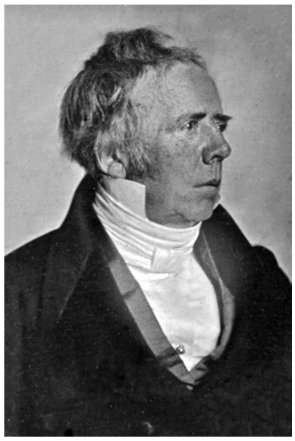
Luigi Aloisio Galvani

"Animal electricity"



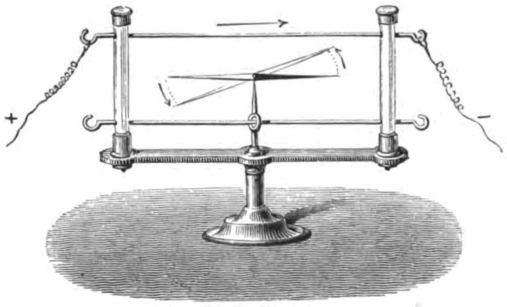


Alessandro Giuseppe Antonio Anastasio Volta *(Italy, 1800)*



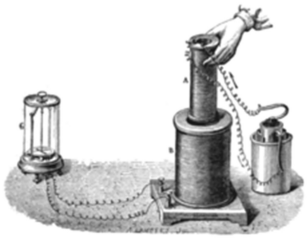
Year 1820 *(Denmark)*

Hans Christian Ørsted



Year 1831 *(England)*

Michael Faraday



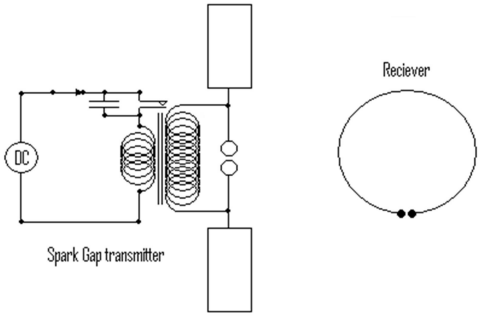
Year 1865 *(England, Scotland)*

James Clerk Maxwell

«A Dynamical Theory of the Electromagnetic Field»

Year 1887 *(Germany)*

Heinrich Rudolf Hertz



Homework problem #1. *How many electrons are there in a droplet of water with mass* $5 \times 10^{-5}\ kg$. *(Each molecule of water contains 10 electrons. Molar mass of water is* $1.8 \times 10^{-2}\ \frac{kg}{mol}$. *)*

Hint: 1 mole of water has,... remember how many molecules? ... yes, a mole of anything has $N_A \approx 6.02 \cdot 10^{23}$ *particles, this is what we termed "mole"....*