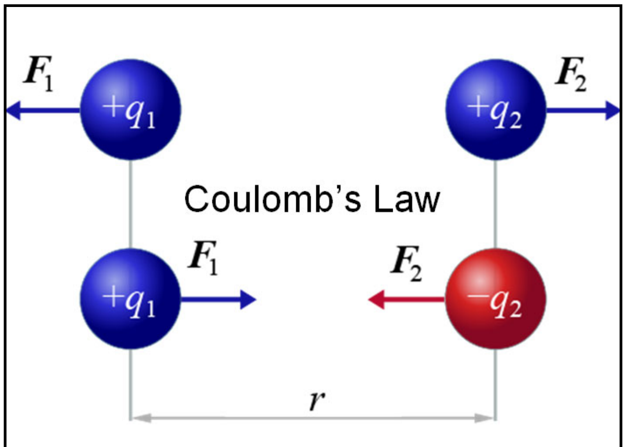
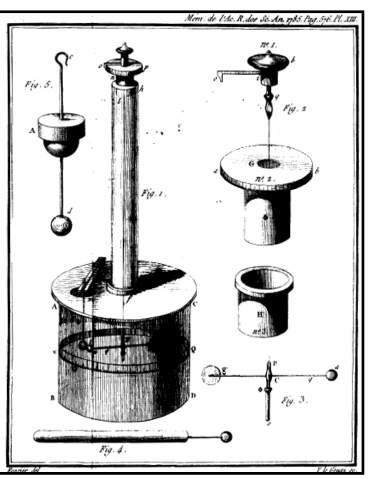


- In 1785, the French physicist Charles-Augustin de Coulomb published his first three reports of electricity and magnetism where he stated his law.

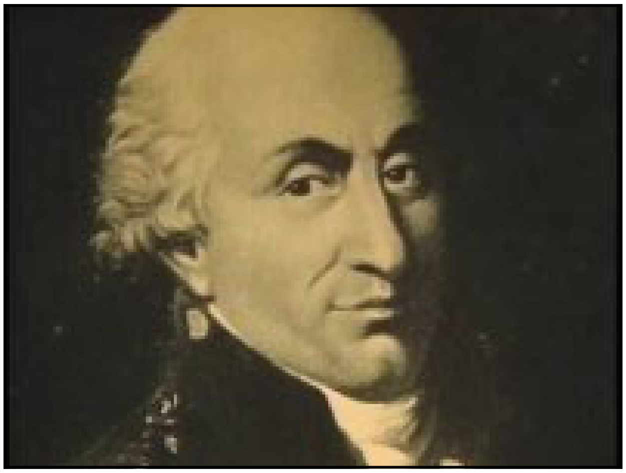
99-003694/MV5332
Charles-Augustin de Coulomb (1736-1806), lieutenant général du Génie
Hierle Louis (18e siècle)

Versailles, châteaux de Versailles et de Trianon

- He used a torsion balance to study the repulsion and attraction forces of charged particles.



Charles-Augustin de Coulomb
Recherches théoriques et expérimentales sur la force de torsion et sur l'élasticité des fils de metal
(Public Domain)



- The magnitude of the electric force between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.

$$F = k\frac{q_1 q_2}{r^2}$$

- q_1 and q_2 are the charges
- r is the distance between the charges
- $k = 9x10^9\ Nm^2/C^2$

- Coulomb’s law applies to objects whose size is much smaller than the distance between them.
  - In other words, they can be considered as point charges.

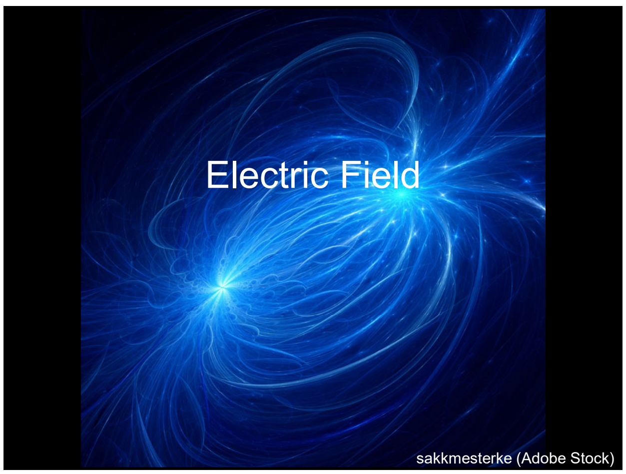
Example

- A hydrogen atom has a proton at its center and an electron "orbiting" at a distance of 0.53x10^{-10} m. Determine the magnitude of the force on the electron.

$$F = k\frac{q_1 q_2}{r^2}$$

$$F = (9\text{x}10^9\ \text{Nm/C}^2)\frac{(1.6\text{x}10^{-19}\ \text{C})(1.6\text{x}10^{-19}\ \text{C})}{(0.53\text{x}10^{-10}\ \text{m})^2}$$

$$F = 8.2\text{x}10^{-8}\ \text{N}$$



sakkmesterke (Adobe Stock)

- Michael Faraday (English)
  - Proposed the concept of an electric field.
  - If you know the electric field, then you can easily calculate the force (magnitude and direction) applied to any electric charge that you place in the field.


Henry Williams Picker (after)
Wellcome Collection
(public domain)

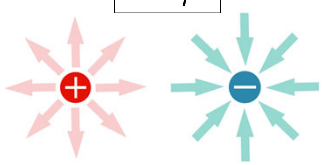
- We define the electric field as the force per unit charge experienced by a small positive test charge q:

$$E = \frac{F}{q} \qquad \boxed{F = qE}$$

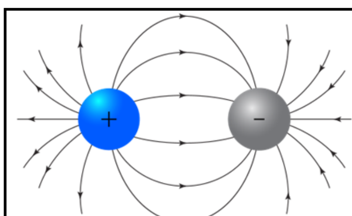
- The electric field points in the same direction as the force a positive charge would experience.
- Measured in N/C

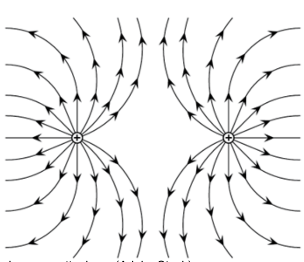
- If the electric field is constant (uniform field), then the force is constant.
- If the electric field is from a point charge, then the force is given by Coulomb's law.
  - The electric field from a point charge is therefore

$$\boxed{E = \frac{kq}{r^2}}$$

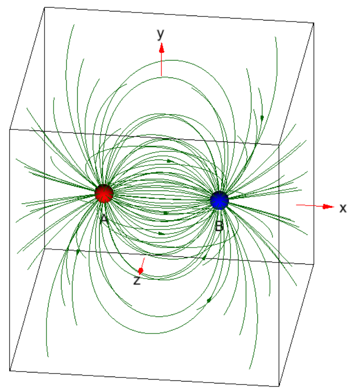


Oksana Zhigulenkova (Adobe Stock)





Credit: opposite charges – ser68orion (Adobe Stock); like charges – attaphong (Adobe Stock)



http://labman.phys.utk.edu/3D%20Physics/fieldlines/Fieldlines.html

Uniform Field

- A uniform field is one that has constant magnitude and direction.
  - Such a field is generated between two oppositely charged parallel plates.
- Near the edges of the plates the field lines are curved, indicating the field is no longer uniform there.
- This **edge effect** is minimized when the length of the plates is long compared with their separation.

Two long parallel charged plates