Electrostatic Force

Coulomb's Law

Charges

Two charges of the same type repel one another

Two charges of the opposite type attract one another

The two charges will experience a **FORCE** pushing them apart or pulling them together

How much force?

The amount of force that two charged objects experience depends on three factors

1. The charge on the 1st object (q_1)

2. The charge on the 2nd object (q_2)

3. The distance between them (r)

We use Coulomb's Law to calculate this force

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

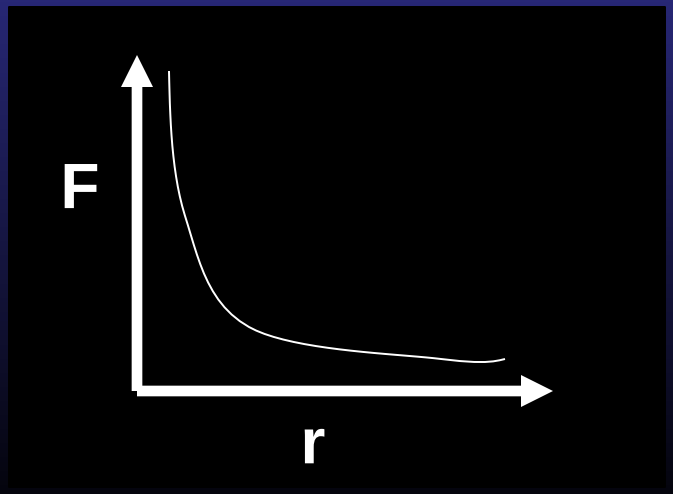
The constant for Coulomb's Law is "k"
"k" is the ELECTROSTATIC CONSTANT
8.99×10^9 N·m²/C²

Coulomb vs. Newton

This equation looks very much like Newton's Law of Universal Gravitation!

$$F_e = \frac{kq_1q_2}{r^2} \qquad F_g = \frac{Gm_1m_2}{r^2}$$

Both have an INVERSE SQUARE relationship between FORCE and DISTANCE



Gravitational force concerns MASS
Coulomb force is about CHARGE

Electrostatic force is MUCH stronger than gravitational force for small, charged objects like electrons and protons!!!

- Consider two electrons 1μm apart
  - What is the gravitational force between them?
    - Depends on mass

$$F_g = \frac{\square 1 \square 2}{r^2}$$

$$\frac{(6.67x10^{-11}\,N\cdot m^2/kg^2)(9.11x10^{-31}kg)(9.11x10^{-31}kg)}{(1x10^{-6}m)^2}$$

5.54 x 10^{-59} N

  - What is the electrostatic force between them?
    - Depends on charge

$$F_e = \frac{kq_1q_2}{r^2}$$

$$\frac{(8.99x10^{9}\,N\cdot m^2/C^2)(1.60x10^{-19}C)(1.60x10^{-19}C)}{(1x10^{-6}m)^2}$$

2.30 x 10^{-16} N

Example #1

What is the electrostatic force between these two objects?

A negative answer shows that the force is ATTRACTIVE

$q_1 = -2C$ $q_2 = +2C$

$$F_e = \frac{kq_1q_2}{r^2}$$

$$F_e = \frac{(8.99x10^9\ N \cdot m^2 / C^2)(-2C)(+2C)}{(2m)^2}$$

$$F_e = -8.99x10^9\ N$$

Example #2

What is the electrostatic force between these two objects?

A positive answer shows that the force is REPULSIVE

$q_1 = -5\mu C$ $q_2 = -2\mu C$

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

$$F_e = \frac{(8.99x10^9\, N \cdot m^2 / C^2)(-5x10^{-6}\, C)(-2x10^{-6}\, C)}{(5x10^{-9}\, m)^2}$$

$$F_e = 3.60x10^{15}\, N$$