

Electric Charge and Coulomb's Law

Fundamental Charge: The charge on one electron.

$$e = 1.6 \times 10^{-19} \text{ C}$$

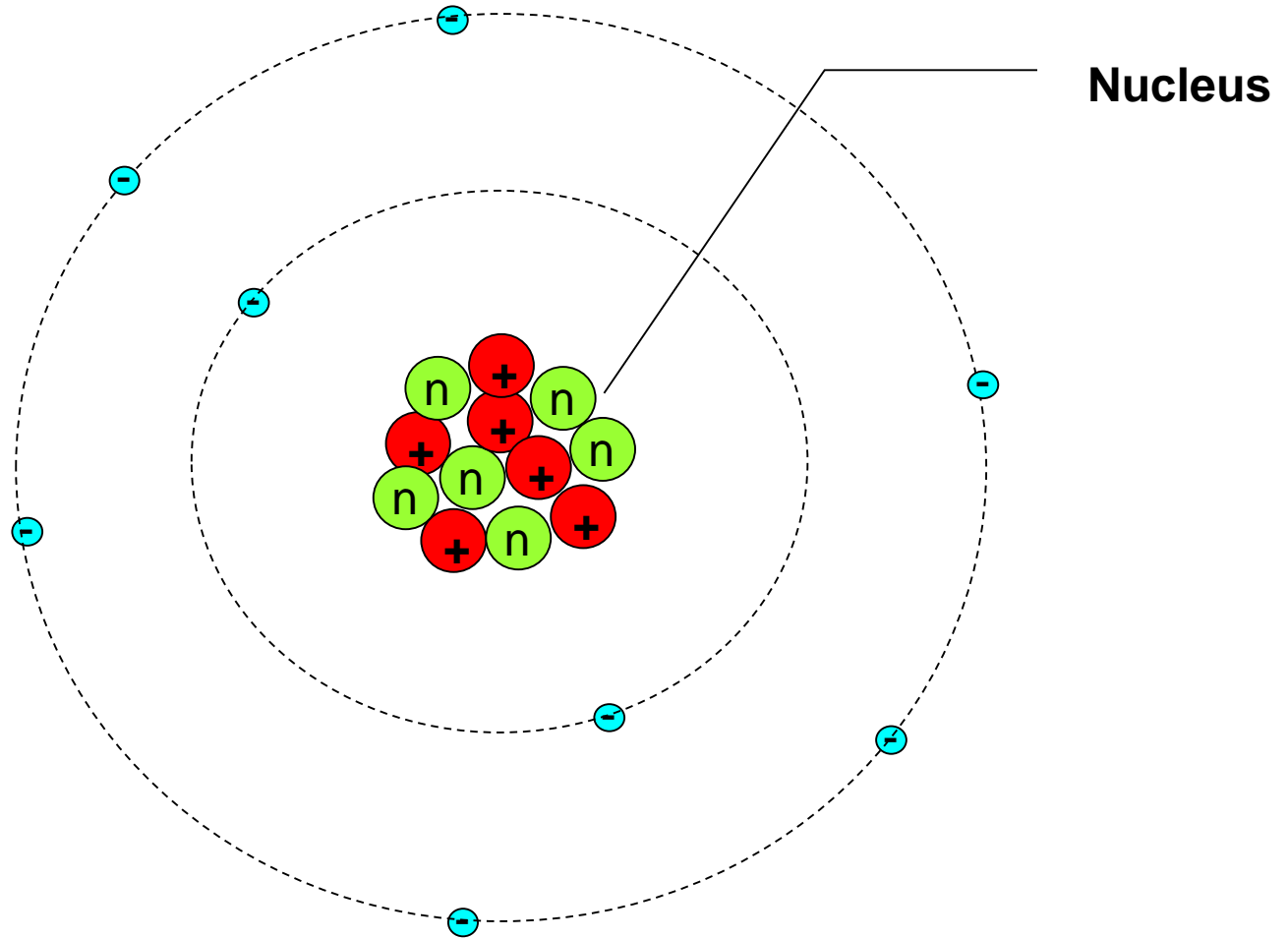
Unit of charge is a Coulomb (C)

Two types of charge:

Positive Charge: A shortage of electrons.

Negative Charge: An excess of electrons.

Conservation of charge – The net charge of a closed system remains constant.



Negative Atom
Positive Atom

Number of electrons > Number of protons
Number of electrons < Number of protons

$$-2e = -3.2 \times 10^{-19} \text{C}$$

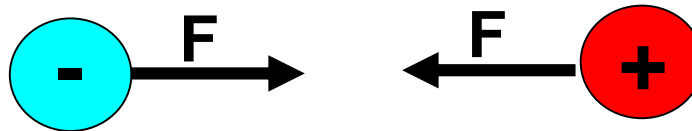
$$+2e = +3.2 \times 10^{-19} \text{C}$$

Electric Forces

Like Charges - Repel



Unlike Charges - Attract



Coulomb's Law – Gives the electric force between two point charges.

$$F = k \frac{q_1 q_2}{r^2} \quad \text{Inverse Square Law}$$

k = Coulomb's Constant = $9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$

q_1 = charge on mass 1

q_2 = charge on mass 2

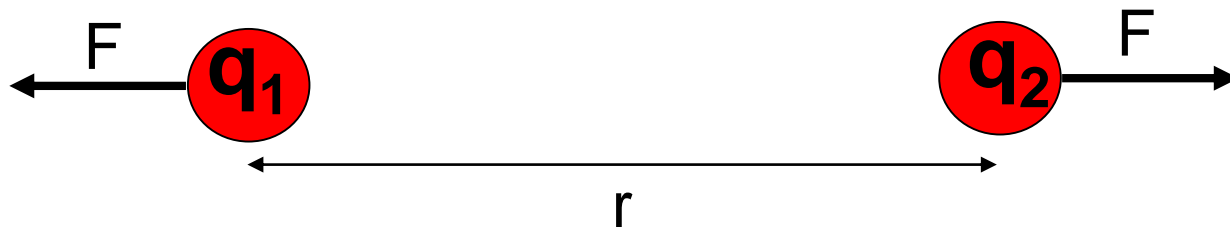
r = the distance between the two charges

The electric force is much stronger than the gravitational force.

Example 1

Two charges are separated by a distance r and have a force F on each other.

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



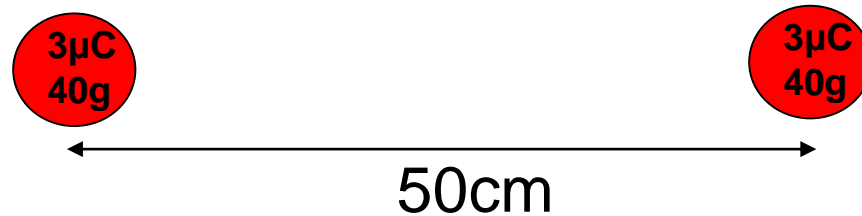
If r is doubled then F is : $\frac{1}{4}$ of F

If q_1 is doubled then F is : $2F$

If q_1 and q_2 are doubled and r is halved then F is : $16F$

Example 2

Two 40 gram masses each with a charge of $3\mu\text{C}$ are placed 50cm apart. Compare the gravitational force between the two masses to the electric force between the two masses. (Ignore the force of the earth on the two masses)



$$F_g = G \frac{m_1 m_2}{r^2}$$
$$= 6.67 \times 10^{-11} \frac{(.04)(.04)}{(0.5)^2} \approx 4.27 \times 10^{-13} N$$

$$F_E = k \frac{q_1 q_2}{r^2}$$
$$= 9.0 \times 10^9 \frac{(3 \times 10^{-6})(3 \times 10^{-6})}{(0.5)^2} \approx 0.324 N$$

The electric force is much greater than the gravitational force