7.5 Coulomb's Law

When we bring charged objects together, they feel an electrostatic force of attraction or repulsion.

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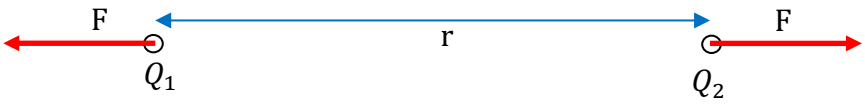

Opposite charges will feel an attractive force and like charges will feel a repulsive force. The magnitude of this force is given by the relationship:

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$$

This is known as Coulomb's Law.

where Q_1= charge (in coulombs) of the first charge, Q_2= charge of second charge, r = distance between charges, and ε_0 is the permittivity of free space = $8.85 \times 10^{-12} Fm^{-1}$.

A positive force signifies that the force is repulsive, and a negative force signifies that a force is attractive.

(1) What is the force felt by charges of $+4.0 \times 10^{-6} C$ *and* -3.0×10^{-6}*, separated by a distance of 0.30m?*

(2) How is the equation (above) similar to the equation for the gravitational attraction between 2 masses?

(3) How is the equation different to the equation for the gravitational attraction between 2 masses?

The permittivity constant ε_0 is for 'free space'. This means that it is the value for a vacuum. The permittivity of air is almost indistinguishable to that of a vacuum.

(4) The separation between an electron and a proton in an atom is of the order $1 \times 10^{-10} m$*. Work out the electrostatic force of attraction between them.*

(5) Work out the gravitational force of attraction between the electron and proton. (You will need to use the rest mass of a proton and an electron.)

(6) How does the electrostatic force compare to the gravitational force?

We have seen for gravity that a spherical mass can be replaced in calculations by a 'point mass' located at the centre of the sphere.

The same method can be used for a charge distributed uniformly on a sphere. We just use the total charge located at the centre of the sphere in our calculations.

(7) A charge of $+3.0 \times 10^{-6} C$ *is located on the surface of a charged sphere with a radius of 0.20m. The sphere has a charge density of* $+0.20 \times 10^{-6} C$ *per metre squared. What force is felt by the* $+3.0 \times 10^{-6} C$ *charge?*