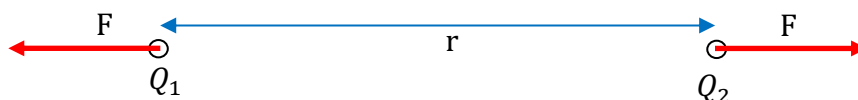


7.5 Coulomb's Law

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:

$$F = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{r^2}$$

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 = $8.85 \times 10^{-12} \text{ Fm}^{-1}$.

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 $+4.0 \times 10^{-6} \text{ C}$ and -3.0×10^{-6} , separated by a distance of 0.30 m ?*

(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 $1 \times 10^{-10} \text{ m}$. 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 $+3.0 \times 10^{-6} \text{C}$ is located on the surface of a charged sphere with a radius of 0.20m . The sphere has a charge density of $+0.20 \times 10^{-6} \text{C per metre squared}$. What force is felt by the $+3.0 \times 10^{-6} \text{C}$ charge?