Fields: Note 1

Coulomb's Law

Force at a distance is best described through the use of fields. This means that objects may experience a force without actually contacting anything else.

Fields are a mathematical description that explains how the magnitude and direction of non-contact forces change in 3-D spaces:

Three types of examples:

Gravitational Field: Magnetic Field: Electric Field:

All of the forces associated with fields obey the **inverse square law** where:

We can use our knowledge about gravitational fields to understand electromagnetic fields:

Newton's Universal Law of Gravitation:

Coulomb's Law of Electrostatic Forces:

For Coulomb's law, the variables are:

F is force in Newtons (N)
q is the charge on an object/particle in Coulombs (C)
r is the separation distance in metres (m)
k is Coulomb's constant, equal to 9.0×10^9 Nm^2/C^2

Unit Analysis:

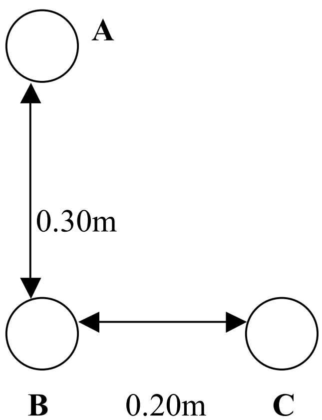
Notice the similarities between these two laws above. The major difference comes in the proportionality constants. Gravity's weakness is exhibited through 6.67×10^{-11} Nm^2/kg^2 compared to electromagnetism's 9.0×10^9 Nm^2/C^2.

From grade 11, a coulomb can be described as a "bucket of charge". The direction of the force depends on the sign of each q:

Opposite signs on q's = negative answer = ________________ force
Same signs on q's = positive answer = ________________ force

EG. Determine the separation of two charges if $q_1 = -8.0\mu C$ and $q_2 = 50\mu C$ if they experience a force of 0.50N. ($1\mu C = 1x10^{-6}C$).

This can also be applied to **two dimensions**:
EG. Find the net force on object C using the information on the following diagram:
*Note: $1\mu C = 1x10^{-6}$ C



A = 2.00μC
B = -4.00μC
C = -8.00μC

Electric Potential Energy
Again, electrostatics have a close connection to gravitation. We can compare the potential energy in a gravitational field with the potential energy in an electric field:

Gravitational
Potential Energy:

Electrostatic
Potential Energy:

*Note: All variables have the same units as Coulomb's Law.

Unit Analysis:

It is extremely important that students do not get mixed up with Coulomb's Law (which describes a **FORCE**) and electrostatic potential energy (which is a measure of **ENERGY**). Force and energy are two completely different concepts when examining a system.