Note: 03

The coulomb's law applies to particles - electron and protons - and also to any small charged bodies, ~~Proni~~ provided that the size of these bodies are much smaller than the distance between them. Such bodies are called "point charges".

Problem 2: Compare the magnitude of gravitational force of attraction and of the electric force of attraction between the electron and proton in an hydrogen atom.

Solution: Gravitational force $F_g = G\frac{Mm}{r^2}$

$$F_g = (6.67\times10^{-11}\ \frac{N\text{-}m^2}{kg^2}) \times \frac{9.11\times10^{-31}kg \times 1.67\times10^{-27}kg}{(5.3\times10^{-11}m)^2}$$

value of $G = 6.67\times10^{-11}\ N\text{-}m^2/kg^2$

mass of electron $= 9.11\times10^{-31}kg$

mass of proton $= 1.67\times10^{-27}kg$

$$\Rightarrow F_g = 3.6\times10^{-47}\ N$$

Magnitude of electric force is $F_e = k\frac{e\times e}{r^2}$

charge of electron : $-e$

charge of proton : e

$$\Rightarrow F_e = \frac{-1}{4\pi\epsilon_0}\frac{e^2}{r^2}$$

$$= -\left(9\times10^9 \ \frac{N\cdot m^2}{c^2}\right) \times \frac{(1.6\times10^{-19}\,c)^2}{(5.3\times10^{-11}\,m)^2}$$

$$= -8.2\times10^{-8}\,N$$

Here '-ve' sign signifies the attractive nature of force.

$$\text{Ratio } \frac{F_e}{F_g} = \frac{(8.2\times10^{-8})\,N}{(3.6\times10^{-47})\,N} = 2.3\times10^{39}$$

The electric force is much stronger than gravitational force.

~~Problems~~

Question for practice

Q1. Suppose that the electric force between two charges is attractive. What can you conclude about the sign of these charges?

Q2. Suppose that the electric force between two charges separated by a distance 1m is 1×10^{-4} N. What will be the electric force if we increase the distance to 10m.

Q3. Two balls, separated by some distance, carry equal charges and exerts a repulsive electric force on each other. If we transfer a fraction of the electric charges of one ball to the other, will the electric force (coulomb force) increase or decrease?

Q.4. Two particles are separated by a distance 3.0 m; each exerts an electric force of 1.0 N on each other. If one particle carries 10 times as much electric charge as the other, what is the magnitude of the smaller charge?