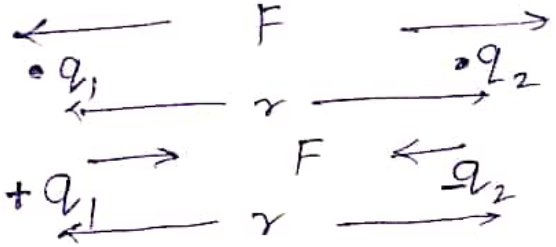
DDP, Topic Coulomb's Law Assignment, Topic .....

Statement : similar charges repel and dissimelar charges attract one another. The force of attraction or repulsion is given by



$$F \propto \frac{q_1 q_2}{r^2}$$

$$\boxed{F = K \frac{q_1 q_2}{r^2}} \qquad K = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \ Nm^2/C^2$$

K = Constant of proportionality depending on medium

ε_0 = Permitivity of vacuum or freespace or air

$= 8.85 \times 10^{-12} \ C^2/Nm^2$.

Coulomb's Law in vector form

$$\vec{F} = K \frac{q_1 q_2 \hat{r}}{r^2} \qquad \left(\hat{r} = \frac{\vec{r}}{r}\right)$$

$$= \frac{K q_1 q_2 \vec{r}}{r^3}$$

$\hat{r}$ = unit vector along $\vec{r}$

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Ex. of Coulomb's Law I. Calculate the force of electrostatic repulsion between two charges 10μC & 20μC separated by 20 cm in a medium of dielectric Constant 150.

$$F_{vacuum} = \frac{k q_1 q_2}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$= \frac{9\times10^9 \times 10\times10^{-6} \times 20\times10^{-6}}{(20\times10^{-2})^2}$$

$$= \frac{18\times10^{9+1-6+1-6}}{400\times10^{-4}}$$

$$= 4.5\times10^{-1+2} = 45\ N \text{ Ans.}$$

$$F_m = \frac{F_{vacuum}}{K} = \frac{45}{150} = 0.3\ N \text{ Ans}$$

Ex 2. Compare the electrostatic force & gravitational force between an electron & proton in an atom

$$F_e = \frac{k(-e)(+e)}{r^2} = \frac{9\times10^9 \times(1.6\times10^{-19})^2}{r^2}$$ (avoiding -ve sign)

$$F_g = \frac{G m_e m_p}{r^2} = \frac{6.67\times10^{-11}\times9.1\times10^{-31}\times1.67\times10^{-24}}{r^2}$$

$$\frac{F_e}{F_g} = 2.28\times10^{39} = \frac{ke^2}{G m_e m_p} = \text{A dimensionless quantity}$$

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Relative Permitivity (Dielectric Constant) :→

It is the ratio of permitivity of medium to the permitivity of vacuum. It is denoted by ϵ_r or K

$$\epsilon_r = K = \frac{\epsilon}{\epsilon_0} = \frac{F_0}{F_m} = \frac{\text{Force in vacuum}}{\text{Force in medium}}$$

Other definition → It is also the ratio of electrostatic force between two charges in vacuum to that in medium.

Dielectric Constant or relative permitivity is a number which represents how many times the force between two charges in vacuum is stronger than in medium

Dielectric Constant or relative Permitivity of

air = 1.0005 ≃ 1

Vacuum = 1

Metal = ∞.

Water = 81

22. Can a body have a charge of 0.8×10^{-19} C ? Justify your answer by comment ? [Himachal 99C]

23. How many electrons are present in 1 coulomb of charge ? [Himachal 92 ; Punjab 99]

24. In Coulomb's law, $F = k \frac{q_1 q_2}{r^2}$, what are the factors on which the proportionality constant k depends ? [Himachal 02 ; CPMT 93]

25. In the relation $F = k \frac{q_1 q_2}{r^2}$, what is the value of k in free space ? [Haryana 02]

26. Define SI unit of charge. [CBSE F 91, 95]

Or

Define Coulomb as a unit of charge. [Himachal 99 ; Punjab 06C, 11]

27. Give the SI unit of electrical permittivity of free space. [Haryana 02]

28. Write down the value of absolute permittivity of free space. [Punjab 96]

29. Deduce the dimensional formula for the proportionality constant k in Coulomb's law.

30. Write the dimensional formula for the permittivity constant ε_0 of free space.

31. Two electrically charged particles, having charges of different magnitude, when placed at a distance 'd' from each other, experience a force of attraction 'F'. These two particles are put in contact and again placed at the same distance from each other.