ELECTROSTATICS - I

PRESENTATION
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Topics

- Electric charge and its unit.
- Quantization of charge.
- Conservation of Electric charge.
- Coulomb's Law
- Limitations or Significance of Coulomb's Law.
- Principle of Superposition.
- Electric field
- Properties of Electric Lines of Forces

UNIT OF ELECTRIC CHARGE – COULOMB

$$q = i\,t$$

1c= Amp.-sec.

- An electron has charge = -1.6×10^{-19}c
- If a body have deficiency of one electron it will have charge

  $+1.6 \times 10^{-19}$c
- Thus amount of charge on a body can be expressed in terms of no of electrons.

QUANTIZATION OF CHARGE

- It can be e,2e,3e or -e, -2e, -3e and so on.
- But it can not be in fraction i.e. 2/3 e, 1/2 e, 4/7 e and so on.
- Electric charge can not be divided indefinitely.

CONSERVATION OF ELECTRIC CHARGE

EXAMPLES

$$_{92}U^{238} \rightarrow {}_{90}Th^{234} + {}_{2}He^{4}$$

+92e 90+2=92e

Before decay After decay

Similarly

$$\gamma \rightarrow e^+ + e^-$$

0 charge (+1 -1) = 0 charge

$$e^+ + e^- \rightarrow 2\gamma$$

net charge 0 net charge 0

COULOMB'S LAW

Coulomb's Law Formula

$$F = \frac{1}{4\pi\varepsilon_o\varepsilon_r} \cdot \frac{q_1 q_2}{d^2} = \frac{1}{4\pi\varepsilon_o K} \cdot \frac{q_1 q_2}{d^2}$$

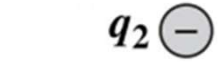
$$F = \frac{1}{4\pi\varepsilon} \cdot \frac{q_1 q_2}{d^2}$$

LIMITATIONS OR SIGNIFICANCE OF COULOMB'S LAW

1. This law holds only for stationary charges. The force between the moving charges is obtained by other laws.
2. Coulomb's law is true only for the point charges.
3.The force acting between the two point charges is unaffected by the presence of other charges in their vicinity.
4.Coulomb's law is true for the distances between the point charges ranging from the order of kilometer to 10^{-15} meter i.e. it is a long range force.
5. This law is based on experimental results.

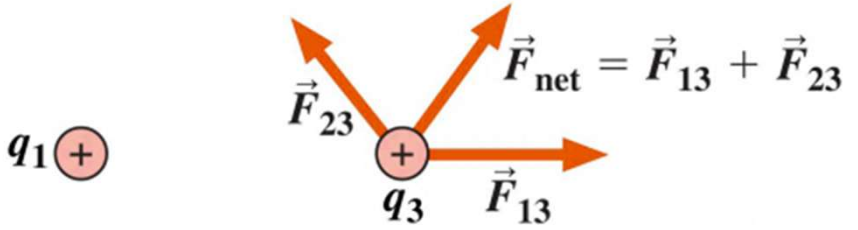
Principle of Superposition

When more than two charges are present, Coulomb's law holds for every pair of charges. Thus the net force on any one charge equals the vector sum of the forces exerted on it by all other charges. This is known as "Principle of Superposition".



If there are three charges q_1, q_2 and q_3 then the force on q_1 due to q_2 and q_3 and is

$$\vec{F}_1 = \vec{F}_{13} + \vec{F}_{12}$$



Source:fun-phys.blogspot.com

Where $\vec{F}_{12}$ is the force on $q_1$due to q_2 and $\vec{F}_{13}$ that due to q_3. Thus the force which two charges exert on each other is not changed by the presence of a third charge.

ELECTRIC FIELD

The space around the charge where other charge experience the force of attraction or repulsion is known as electric field of that charge.

ELECTRIC FIELD INTENSITY

$$\vec{E} = \frac{\vec{F}}{q_0}$$

From Coulomb's law $\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{qq_0}{r^2}\hat{r}$

$$\frac{\vec{F}}{q_0} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$

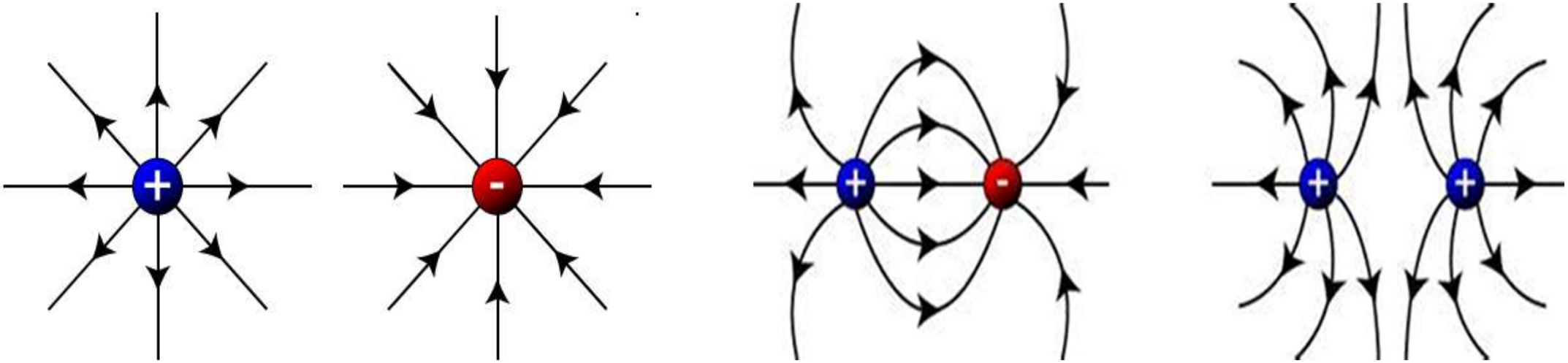
$$\vec{E} = \frac{\vec{F}}{q_0} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$

$$Unit\ \ of\ \vec{E} = \frac{Newton}{Coulomb}$$

ELECTRIC LINES OF FORCES

Properties of Electric Lines of Force

- The electric lines of force appear to start from positive charge and to end on a negative charge. If there is a single charge, they may start or end at infinity.



source:aplusphysics.com

Properties of Electric Lines of Force

- The tangent drawn at any point on the line of force gives the direction of the force acting on a positive charge at that point.
- No two electric lines of forces can intersect each other because if they do so, then two tangents can be drawn at the point of intersection which would mean two directions of electric field intensity at one point which is impossible.
- The electric lines of force do not pass through a conductor because electric field inside a conductor is zero.
- The equidistant electric lines of force represent uniform electric field while different separations represent non-uniform electric field.

Properties of Electric Lines of Force

- The relative closeness of lines of force expresses the relative strength of the electric field.
- The electric lines of force have a tendency to contract in length like a stretched elastic string and separate from each other laterally.
- The electric lines of force are open curves.
- The electric lines of force are imaginary but the electric field they represent is real.

REFERENCE

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