CHAPTER I: STATIC ELECTICITY

Introduction

Electricity is divided into two types: static electricity and mobile electricity.

Static electricity is a study of the phenomena caused by electrical charges in a state of silence.

1. Electrical charge

Experience 1: When combing the hair and rounding it up to the scraps of paper, we notice that it was quickly attracted to the comb.

Experience 2: When that balloon is puffed with wool and it's close to the wall, it's gonna stick to it for hours.

Many experiments have shown that bodies acquire a property called "electricity," which would generate a reaction called "electricity."

In fact, all objects are electrifiable whether by massage or contact with an electrical object or connect to one of the two ends of the generator.

Electrical force forces are produced when there is a distinctive physical amount of particles called "q" charge and they play a similar role to that of mass in heavy reactions. Mass characteristics enable an object if a mass attracts other blocks and a body charge enables it to push or attract other charged objects. Charges affect each other with electrical power and mass influence some with gravity.

Mass gravitational force is responsible for the preservation of massive celestial bodies in their orbits around their motion centres, and electric power is much greater than mass gravitational force, so the stability of the atom is due to electrical power where the force of gravity is neglected for the electric power.

2. Basic charge and quantization electrical charge.

The atom is made up of a nucleus, floating around the nucleus, a cloud formed by electrons, and it's appropriate to give a negative charge to an electron, so these electrons are disconcerting among themselves as long as they remain coarse around a nucleus.

The nucleus is made up of protons with positive charges and uncharged neutrons. The electrons and protons carry the same electrical charge (the smallest known shipment to man) and we code it as "e" and it's called the basic charge, estimated at $1.6\ 10^{-19}$.

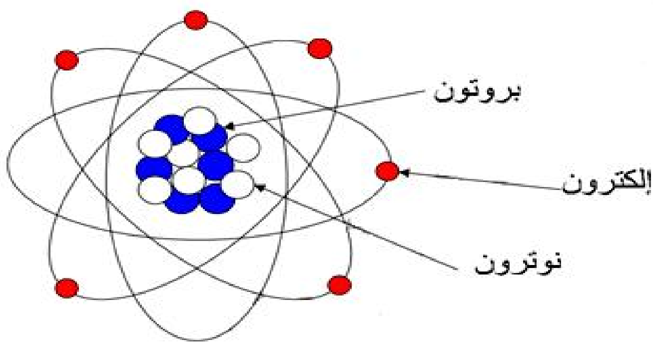


Figure 1: **An atom ' s shape**

Example 1: How many electrons is in one colom?

The solution: to calculate the number of electrons in one colum, we write one electron charge.

$$1e = 1.6\,.\,10^{-19}\,C \Rightarrow \;\; 1C = \frac{1e}{1.6\,.\,10^{-19}} = 6.25\,.\,10^{18}e$$

That is, shipping a single colom body requires that it be stripped of more than six million electrons!

An electrical charge can't take any numerical value, and indeed every electrical charge is a natural multiplier of the basic charge.

$$q = \pm\, n.e \qquad (n \in N)$$

And that translates into the basic principle of gagging the electrical charge.

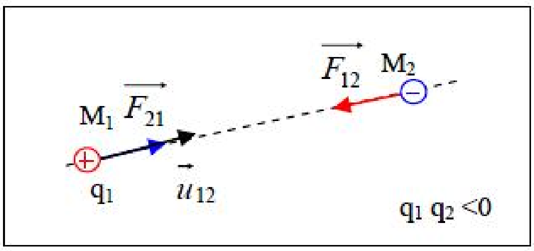
Observations

- A body charged with electrical power does not affect an uncharged body like neutron while it affects it with gravity because they each have a mass, but it does not affect a body without mass and the charge as light as strong as it affects electrons with electric pull.
- When you remove a number of electrons from a body, the charge becomes positive, but when you add a number of electrons to it, it becomes negative.
- The dot charge is a scientific abstraction, a body charged with neglected dimensions compared to the distances that separate it from the other effects, and it plays the same role as the physical point in the mechanics.
- The bodies carrying the same type of charge are dissonanced, the bodies carrying two different types are attractive, and the bodies that do not exchange the electrical effect are electrically equivalent.

3. Colum's law.

As a result of the experiments carried out by the world, Charles Coulomb 1736-1806 on static dots to characterize the static electric power that the charge of $q_1$affects a second charge, q_2 or vice versa, it was found that:

- The electrostatic charge is carried on the line connecting the two charges
- The force shall be appropriate to the seriousness of the two shipments, where:
  - ✓ If $q_1$and q_2 of a single signal, grandpa gives a positive signal.
  - ✓ If q_1 and q_2 are opposites in the signal, the frogs give a negative signal.
- The force is inversely proportional to the square of the distance between the charges r^2



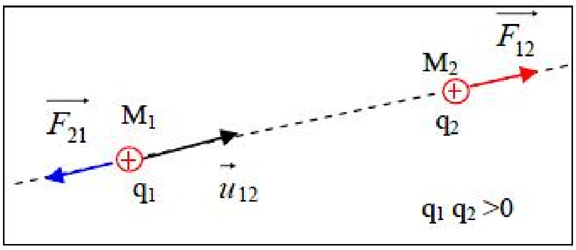


Figure 2: Strength between two identical shipments Figure 3: Strength between two opposite shipments

The mathematical expression of Colum's law is:

$$\vec{F}_{12} = K.\,\frac{q_1 q_2}{r^2}\vec{u}$$

Where

$$\vec{F}_{12} =- \vec{F}_{21}$$

$$\vec{u} = \frac{\vec{r}}{r}$$

The constant K is called "electric constant" or "colum constant."

$$k = \frac{1}{4\pi\varepsilon_0} = 9.10^9 \; N.m^2.C^{-2}$$

The space graces of ε_0

$$\varepsilon_0 = 8{,}8542 \times 10^{-12}$$

Example 2: What is the force of colominal disharmony between two shipments of $1C$ distanced by $1Km$?

The solution:

$$F = K\frac{q^2}{r^2} = 9.10^9 \frac{1}{(10^3)^2} = 9.10^3 N$$

Observations

The electric power is subject to the principle of fracking, the electric power $\vec{F}$, which affects the charge q_0 by $q_1, q_2, q_3 ......q_N$ is equal to the ray total of all forces (this principle only works in cases of static shipments)

$$\vec{F} = \sum_{i=1}^{N} \vec{F}_{i0} = \vec{F}_{10} + \vec{F}_{20} + ... + \vec{F}_{N0}$$

Colum's law is similar to that of general attraction (or cosmic) between the bodies of their mass m_1 and m_2, which is what we call the symmetry of the laws of nature.

$$\vec{F} =- G\frac{m_1 m_2}{r^2}\vec{u}$$

4. Transport and seclusion

Any substance consists of a large number of electrical charges, but these charges are equivalent and non-existent (number of electrons equal to number of protons) at normal temperature. The electrical charge of the substance is non-existent, which explains why we do not electrocute when touching a metal object that is not connected to an electrical generator.

When there's an electrocution, that means there's been a transfer of charges from one body to another. In corn, electrons float around the nucleus in varying orbits, if the last layer of the atom of a chemical element is close to saturation, it will lose no electron, but it will try to acquire one or more electrons until it is saturated, such an element is isolated and vice versa if the outer layer is far from saturated, the element will easily lose one or more electrons, such an element being a good vector.

Thus, a good carrier is an element with a large number of free electrons (with freedom of movement) and a buffer is an element with a small number of free electrons, the ideal buffer being the one with no free electron.

5. Electric field

Just as the Earth affects the surrounding area in the field of gravity where any object near Earth is subject to gravity force, any charge generated in space from around it is an electrical field that produces electrical power to which any charged object is subject.

We call the static E-field the ratio between the electrical power and the electrical charge q0 affected by the F-force (q0 is too small to affect others)

$$\vec{E} = \frac{\vec{F}}{q_0} \left({}^{N}\!/_{C} \right)$$

$\vec{F} and\ \vec{E}$are the same carrier, and the direction in this case is related to a q_0 signal.

1.5. Electrical field resulting from a point charge

If you find a mass of its charge q at point O, it generates at every point M of space surrounding it a radiation field called the electrostatic field.

$$\vec{E}(M) = \frac{\vec{F}}{q_M} = K \frac{q q_M}{q_M r^2} \vec{u} = K \frac{q}{r^2} \vec{u}$$

q_M default charge placed at point M (not having any effect on the electrical field account) and affected by force $\vec{F}$

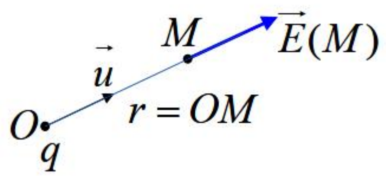


Figure 4: Electrical field resulting from a point charge

The electrical field generated by a dot charge is:

- Qatari: Carrier passing through the shipment.

- Headed out if it's $q > 0$.

- Headed in if it's $q < 0$.

- :$E(M) = K \frac{|q|}{r^2}$

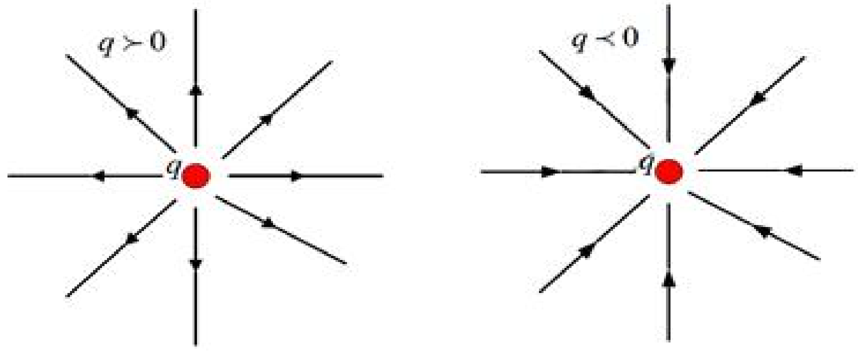


Figure 5: The direction of the electrical field in case of positive and negative shipment

Example 3: What is the value and direction of the electrical field resulting from a negative dot charge of $Q = 1 \times 10^{-4} C$at a point 50cm away?

What power does it have on a small charge of $=+\ 4\mu C$?

The solution: the electric field is given the following relationship:

$$E = K\frac{Q}{r^2} = 9.10^9 \frac{1 \times 10^{-4}}{(0.5)^2} = 3.6 \times 10^6\, {}^{N}\!/_{C}$$

Since Q is negative, the electric field is headed towards it.

The power that affects the charge of q is equal to $q =+\ 4\mu C$ at that location we find it in writing:

$$E = \frac{F}{q} \Rightarrow \quad F = q.E = 4.10^{-6}(3.6.10^6) = 14.4N$$

And this force is going in the same direction as the electric field, i.e., about Q because q is positive, and that's normal, because any two opposite shipments are going to be attracted.

2.5. Electrical field resulting from several point shipments

As in the case of the powers, the principle of collage is also valid for the electrical field, so if we have n is massive, its electrical charge q_i at points p_i is the electrostatic field generated by this set of charge at point M is:

$$\vec{E}(M) = \sum_{i=1}^{n} K\frac{q_i}{r_i^2}\vec{u}_i$$

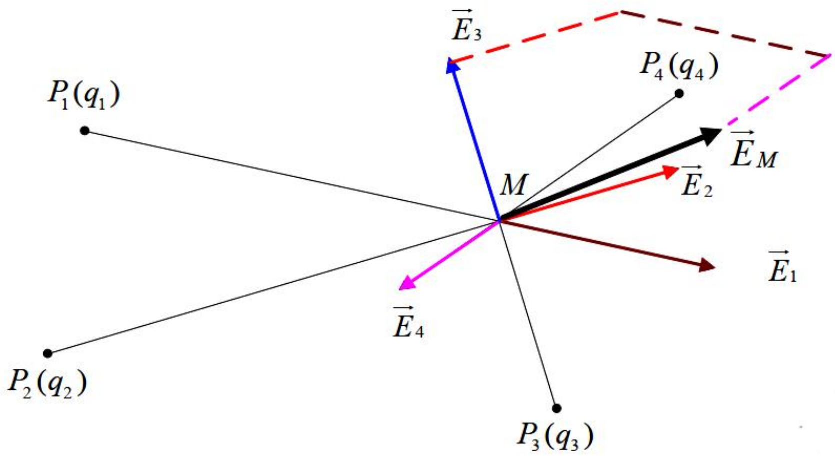
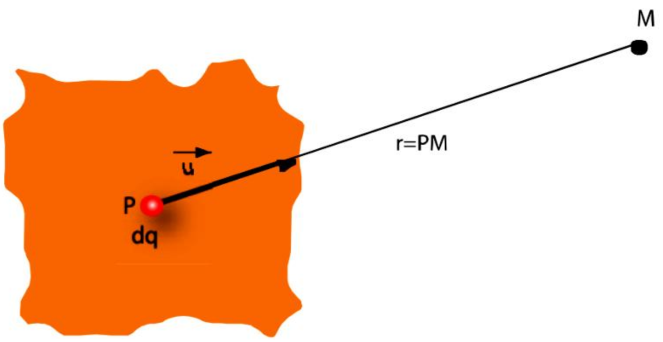


Figure 6: Electrical field riding at point M

3.5. Electrical field resulting from continuous distribution of cargo

In this case, we divide the q charge distributed across the body into differential elements of dq, and then we combine the effect of it, so we get:

$$\vec{E}(M) = \int d\vec{E}(M) = K\int \frac{dq}{r^2}\frac{\vec{r}}{r} = K\int \frac{dq}{r^2}\vec{u}$$



The charge in the body can be divided into three forms:

1 - The linear distribution: we know the linear density, which represents the amount of charge dq placed in the unit length dl:

$$dq = \lambda\, dl$$

In the case of this distribution, the field writes:

$$\vec{E}(M) = K\int_L \frac{\lambda\, dl}{r^2}\vec{u}$$

2 - Subsurface distribution: We know the surface density of the dq charge in the unit of the surface of $dq = \sigma\, dS$ He writes the field in case of this distribution ds.

$$\vec{E}(M) = K\int_S \frac{\sigma\, ds}{r^2}\vec{u}$$

3 - Subsurface distribution: We know the surface density of the x-ray, which represents the amount of charge dq placed in the unit sized dv, so.:

$$dq = \rho \, dv$$

He writes the field in case of this distribution.

$$\vec{E}(M) = K \int_V \frac{\rho \, dv}{r^2} \vec{u}$$

6. Electric potential.

The electric potential is defined as the potential energy given to the electron to be able to move, coded as V and measured by the unit of voltage. We remember from the study of gravity that a body with a mass of m is present in the gravitational field at the height of y from the surface of the Earth, giving the underlying energy (situation energy) in relation to:

Definition: the cumin difference is equal to the work to be done for one shipment to be moved from point A to point B.

6.1. The electrostatic potential caused by a dot charge.

We know the electron for the q-point charge in relation:

$$V = K\frac{q}{r}$$

6.2.Electrostatic potential resulting from several point chargess

Since V is a peaceful amount, the cufflink at point M, resulting from several chargess, is given the peaceful expression:

$$V(M) = K\sum_i \frac{q_i}{r_i}$$

Where r_i is the distance between q_i and point M, knowing that q_i can be positive or negative, so it has to be taken with its signal.

6.3 Electric potential resulting from an ongoing distribution of the charge

In such a case, it's enough to have an integral process.

$$V(M) = \int dV(M) = K\int \frac{dq}{r}$$

The charge in the body can be divided into three forms:

1 Written distribution:

$$V(M) = K\int_L \frac{\lambda dl}{r}$$

2 -Surface distribution:

$$V(M) = K\int_S \frac{\sigma dl}{r}$$

3 - Volume distribution:

$$V(M) = K\int_V \frac{\rho dl}{r}$$

6.4. Equivalent surfaces.

We call the surface equal to the cumin each surface, and at each point we find the same cumin, as a result of which the work required and done by the power F to move the electrical charge from point A to point B is non-existent.

$$W_{AB} = q\int_A^B dV = q(V_B - V_A) = 0$$

Because $V_A = V_B$

On the other hand, this work is expressed in terms of $\vec{F}$ power.

$$W_{AB} = \int_A^B \vec{F}.\overrightarrow{dr} = q\int_A^B \vec{E}.\overrightarrow{dr} = 0 \Rightarrow \vec{E} \perp \overrightarrow{dr} \Rightarrow \vec{F} \perp \overrightarrow{dr}$$

So $\vec{F}$ power is always vertical on the transport $\overrightarrow{dr}$ of this result that the field lines are vertical on the surfaces equal to the violin.

7. The relationship between the field and the electric potential.

Let's figure out how the beam $\vec{E}$ travels through the length element $\overrightarrow{dr}$.

$$\vec{E}.\overrightarrow{dr} = K\frac{q}{r^2}\overrightarrow{dr}(*)$$

And by contrast, the cumin equation for the variable r .

$$\frac{dV}{dr} = -K\frac{q}{r^2} \Rightarrow dV = -K\frac{q}{r^2}dr \qquad (**)$$

By comparing the two relationships (*) and (**) we find the relationship:

$$dV = -\vec{E}.\overrightarrow{dr}$$

The electrostatic field travels on track A to point B.

* A to the B to the E to the D to the A to the A to the B to the V to the B.

$$\int_A^B \vec{E}.\overrightarrow{dr} =- \int_A^B dV = V(A) - V(B)$$

Observations

- This roaming is preserved. It's not about the path.
- Electrical field travels through a closed no-fly path.
- Using kartz in the equation, we find:

$$dV =- \vec{E}.\overrightarrow{dr} =- E_x.dx - E_y.dy - E_z.dz \quad \circ$$
$$dV = \frac{\partial V}{\partial x}dx + \frac{\partial V}{\partial Y}dy + \frac{\partial V}{\partial z}dz \quad \circ$$

By comparison:

$$\begin{cases} E_x =- \dfrac{\partial V}{\partial x} \\ E_y =- \dfrac{\partial V}{\partial y} \\ E_z =- \dfrac{\partial V}{\partial z} \end{cases} \Rightarrow \vec{E} =- \overrightarrow{grad}\, V$$

Example

The term electric field beam is derived from the following expression:

$$V(x, y, z) = 3x^2y + z^2$$

I'm calculating the $\vec{E}$ intensity at point $A(1,2,-1)$

The solution.

$$\vec{E} =- \left(6xy\vec{i} + 3x^2\vec{j} + 2z\vec{k}\right)$$

The severity of point A.

$$\vec{E} =- 12\vec{i} + 3\vec{j} - 2\vec{k} \Rightarrow E = \sqrt{12^2 + 3^2 + 2^2} = \sqrt{157}\, V/m$$

8. Electrical flow (diving theory)

We call the flow of the electric field across the surface of the amount:

$$\phi = \int \vec{E}.\overrightarrow{dS}$$

$\overrightarrow{dS}$ sync, corrected by elderman

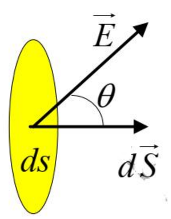


Figure 7: Inflow across a racist surface

If the angle between $\vec{E}$ and $\overrightarrow{dS}$ is θ so:

$$\phi = \int E.dS.\cos\theta$$

The power flow unit is Webber Web.

Diving theory:

The flow of an electrical field and the trans-closing of a closed surface is equal to the mandatory total of shipments within the limited size of the surface, dividing the vacuum permeability of the space.

$$\phi = \int \vec{E}.\overrightarrow{dS} = \sum_{i=1}^{n} q_i \frac{1}{\varepsilon_0} = \frac{Q_i}{\varepsilon_0} = \frac{q_{tot}}{\varepsilon_0}$$

The benefit of this law is that it allows for ease of calculation of the electrical field resulting from a simple distribution of cargo.

Application of diving theory

1. **Electrical field resulting from a point charge**

We consider positive charge q to be the center of a ball r with a diameter $\vec{E}$, $\cos 0 = 1$

$$\phi = \int \vec{E}.\overrightarrow{dS} \Rightarrow \phi = \int E.dS = \frac{q}{\varepsilon_0} = E.S$$

The surface of the ball is $S = 4\pi r^2$.

$$E = \frac{q}{\varepsilon_0.S} = \frac{q}{4\pi\varepsilon_0 r^2}$$

2. **Electrical fields resulting from a regularly charged and infinitely long wire**

The appropriate diving surface for this case is an axle cylinder that applies to the wire and its length I.

There are three surfaces: a base surface S_1, a base surface S_2 and a side surface S_3. The flow across all the surfaces of a diving cylinder is the sum of flows across each surface:

$$\phi = \int_S \vec{E}.\overrightarrow{dS} = \int_{S_1} \vec{E}.\overrightarrow{dS} + \int_{S_2} \vec{E}.\overrightarrow{dS} + \int_{S_3} \vec{E}.\overrightarrow{dS}$$

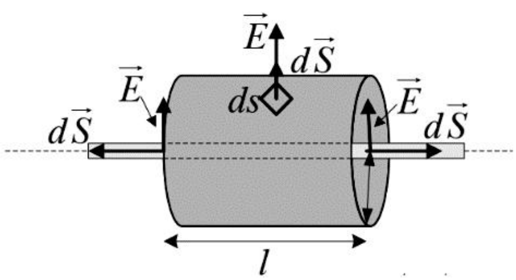


Figure 8: Charged wire

On the two base surfacesS_1 and S_2Field E, vertically on the beam (dS) . Therefore, there is no flow across these surfaces($\vec{E}$ $\cos 0 = 1$)

$$\phi = \int_S \vec{E}.\overrightarrow{dS} = \int_{S_3} \vec{E}.\overrightarrow{dS} = E.S_3 = \frac{Q_i}{\varepsilon_0} = \frac{q_{tot}}{\varepsilon_0}$$

In the light of the fact that:: $Q_i = \lambda.l$ and $S_3 = 4\pi l r^2$ of which:

$$E.2.\pi.R.l = \frac{\lambda.l}{\varepsilon_0} \Rightarrow \quad E = \frac{\lambda}{2.\pi.R.\varepsilon_0}$$

9. Electrical bipolarity

The electropolar is made up of two equal and opposite charges in the signal, and they're very small distances apart.

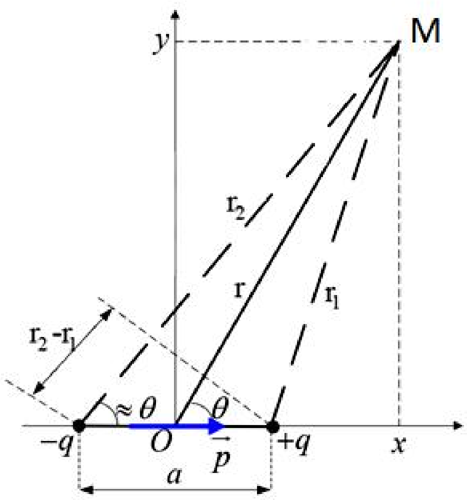


Figure 9: Electrical bipolarity

The electrode of the bipolar is a free beam,

$$\vec{P} = q.\vec{a}$$

1.9. Electric punch from the electropolar.

We want to calculate the electron charge from the two shipments $+q$ and $-q$ at the point of M, which is a little bit more than $r_1$than the charge$+q$ and b r_2 than the charge $-q$, which is a little bit too small for the two distancesr_1 and r_2.

$$V = \sum V_i \Rightarrow V = K\left(\frac{q}{r_1} - \frac{q}{r_2}\right) \Rightarrow V = K.q.\frac{(r_2 - r_1)}{r_2.r_1}$$

Since $r \gg a$ is $r_1.r_2 \approx r^2$ is equal to a $r_2 - r_1 = a\cos\theta$

$$V = K\,\frac{q.a.\cos\theta}{r^2} = K\frac{P.\,\cos\theta}{r^2}$$

2.9. Electrical field caused by bipolarity

E can be found from the equation: $\vec{E} =- \overrightarrow{grad}\,V$

10.Examples of static electricity use

Example 1: Paper Camera

The X-rays reflected on the paper to be photographed create a positive charge image inside the device that attracts the ink charged to a negative charge to print this image on the paper with a positive charge.

Example 2:

Spraying of pesticides and fertilizers by agricultural aircraft on farms to ensure that fertilizers or pesticides do not fly into the air, provides pesticides or fertilizers with a negative electrical charge where fertilizers or pesticides are attracted to plants or soils that are neutral or positive