LESSON:1- ELECTROSTATICS

I. Short Answers:

1. What is meant by quantization of charges?

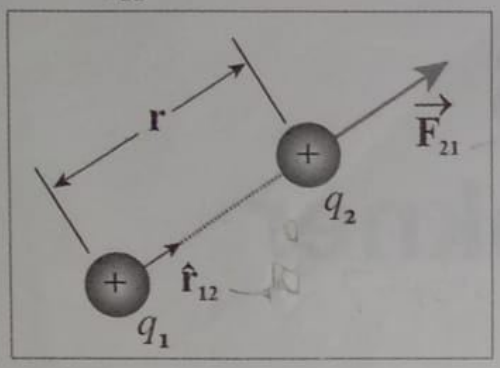
The charge q on any object is equal to an integral multiple of the fundamental unit of chage e. $q=ne$

Here n is any integer (0,±1, ±2, ….). This is called quantization of electric charge. [$e=1.6\times10^{-19}C$].

2. Write down coulomb's law in vector form and mention what each term represents.

Coulomb's law in vector form

$$\overrightarrow{F_{21}} = K\frac{q_1 q_2}{r^2}\hat{r}_{12}$$



q_1, q_2 → Two point charges at rest.

F_{21} → The force on charge q_2 exerted by another charge q_1.

r_{12} → The unit vector directed from q_1, to q_2.

K → Proportionality constant.

3. What are the differences between coulomb force and gravitational force.

S.No.	Coulomb force	Gravitational force
1	Coulomb force between two charges can be attractive or repulsive depending on the nature of charges.	Gravitational force between two masses is always attractive.
2	The value of constant K in coulomb's law is $K=9\times10^{9}Nm^2C^{-2}$ (K >> G)	The value of the gravitational constant is $G=6.67\times10^{-11}\ Nm^2Kg^{-2}$ (G << K)
3	The electrostatic force between two charges depends on nature of the medium.	The Gravitational force between two masses is independent of the medium.

4	The coulomb force between two point charges is same when they are at rest.	The Gravitational force between two point masses is same whether they are at rest or in motion.
5	Expression for coulomb force $\underset{F}{\rightarrow} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2} \cdot \widehat{r_{12}}$.	Expression for Gravitation. $\underset{F}{\rightarrow} = -\frac{G m_1 m_2}{r^2} \cdot \hat{r}$

4. Write a short note on superposition principle.

According to the superposition principle, the total force acting on a given charge is equal to the vector sum of forces exerted on it by all the other charges.

It explains the interaction between multiple charges.

Consider a system of n charges, namely q_1, q_2, q_3....q_n.

The total force acting on the charge q_1 due to all other charges is given by...

$$\vec{F}_{1TOT} = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14} + \ldots\ldots + \vec{F}_{1n}$$

$$\vec{F}_{1TOT} = K\left\{\frac{q_1 q_2}{r_{21}^2}\widehat{r_{21}} + \frac{q_1 q_2}{r_{31}^2}\widehat{r_{31}} + \ldots. + \frac{q_1 q_n}{r_{n1}^2}\widehat{r_{n1}}\right\}$$

5. Define electric field.

The electric field at the point P at a distance r from the point charge q is the force experienced by a unit charge.^

$$\vec{E} = \frac{\vec{f}}{q_0} = \frac{Kq}{r^2}\hat{r} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}$$

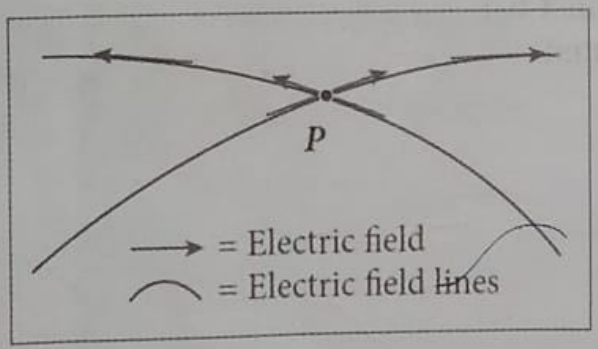
It is a vector quantity. SI unit : NC^{-1}.

6. What is meant by "Electric field lines"?

A set of continuous lines which are the visual representation of the electric field in some region of space.

7. The electric field lines never intersect. Justify.

No two electric field lines intersect each ot nher. If two lines cross at a point, then there will be two different electric field vectors at the same point.



8. Define electric dipole.

Two equal and opposite charges separated by a small distance constitute an electric dipole.

9. What is the general definition of electric dipole moment?

The magnitude of electric dipole moment is equal to the product of the magnitude of either charge and the distance between them.

$\vec{P} = q(2\vec{a})$ or $|\vec{P}| = q(2a)$ $\quad \vec{P} = q\,2a\,\hat{P}$

SI unit of dipole moment is C m.

10. Define "electrostatic potential".

The electric potential at a point P is equal to the work – done by an external force to bring a unit positive charge with constant velocity from infinity to the point P in the region of the external electric field $\vec{E}$.

$V_P = -\int_{\infty}^{P} \vec{E} \cdot \overrightarrow{dr}$

11. What is an equipotential surface?

An equipotential surface in a surface on which all the points are at the same potential.

12. What are the properties of an equipotential surface?

(i) The work done to move a charge q between any two points A and B, $w=q(V_B-V_A)$. If the points A and B,
$W=q(V_B-V_A)$. If the points A and B lie on the same equipotential surface, work done is zero, because
$V_A=V_B$.

(ii) The electric field is normal to an equipotential surface. If it is not normal, then there is a component of the field parallel to the surface. Then work must be done to move a charge between two points on the same surface.

13. Give the relation between electric field and electric potential.

- Consider a positive charge a kept fixed at the origin.
- It move small distance dx in the electric field E.

Workdonedw = -E.dx
(-ve sign implies the work done against E.)
Workdone is equal to Electric potential
`dw=dv
` dv=-E.dx

In general,

$$\vec{E} = -\left[\frac{\partial v}{\partial x}\hat{\imath} + \frac{\partial v}{\partial y}\hat{\jmath} + \frac{\partial v}{\partial z}\hat{k}\right].$$

14. Define electrostatic potential energy.

Electrostatic potential energy is defined as the system of charge is equal to the work done to arrange the charges in the given configuration.

15. Define electric flux.

The number of electric field lines crossing a given area kept normal to the electric filed lines in called electric flux.

Unit in N m^2C^{-1}. It is a scalar quantity.

16. What is meant by electrostatic energy density?

Electrostatic energy density is defind as energy stored per unit volume of space.

$$U = \frac{1}{2} \varepsilon_0 E_0^2.$$

17. Write a short note on electrostatic shielding.

- Consider a cavity inside the conductor.
- Whatever the charges at the surfaces and whatever the electrical disturbances outside, the electric field inside the cavity is zero.
- A sensitive electrical instrument which is to be protected from external electrical disturbance in kept inside this cavity. This is called electrostatic shielding.

18. What is polarization?

Polarisation is defined as the total dipole moment per unit volume of the dielectric.

$$\vec{P} = \chi_e \vec{E}_{ext}.$$

19. What is dielectric strength?

The maximum electric field the dielectric can with stand before it breakdowns is called dielectric strength.

20. Define capacitance. Give its unit.

The capactitance C of a capacitor in defined as the ratio of magnitude of charge on either of the conductor plate to the potential difference existing between the conductors.

$$C = \frac{Q}{V}$$

It is unit is C/V (or) CV^{-1} (or) farad.

21. What is corona discharge?

The reduces total charge of the conductor near the sharp edge. This is called action at points or corona discharge.