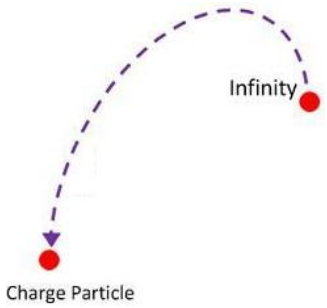
Electrostatic Potential and Capacitance

1.Electrostatic Potential: the electrostatic potential is defined as the amount of work done in bringing the unit positive test charge without acceleration from infinity to that point .

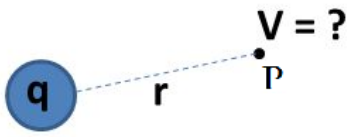


The SI unit is (V) volt. It is a scalar quantity.

2.Potential difference: the work done by a unit charge to displace it from a point to another point in electric field is known as potential difference.

$$V_B - V_A = \frac{W_{AB}}{q_0}$$

Electrostatic potential due to point charge

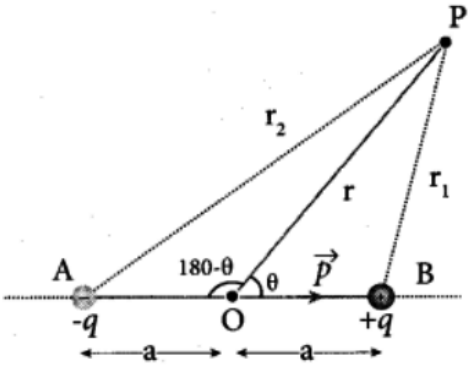


Electrostatic potential due to point charge q at any point P lying at a distance r from it is given by;

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

q: the point charge (C)
r: the distance between the charge and the point (m)

Electrostatic potential due to dipole

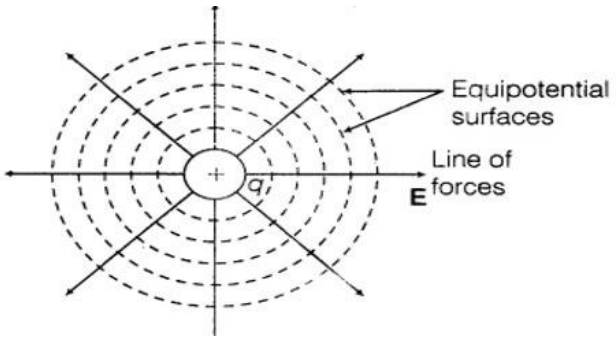


Electrostatic potential due to an electric dipole at any point P inclined at an angle θ whose position vector is r w.r.t mid point of the dipole is given by;

$$V = \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$

Where θ is the angle between r and p.

3.Equipotential surface: a surface which has same electric potential at every point on it , is known as equipotential surface.



Different properties of equipotential surface are:

1.equipotential surfaces do not intersect each other as it gives two directions of a electric field at intersecting point which is not possible .

2. equipotential surfaces are loosely spaced in a region of strong electric field

3. electric field is always normal to equipotential surface at every point of it and directed from one equipotential surface at higher equipotential surface to lower equipotential surface.

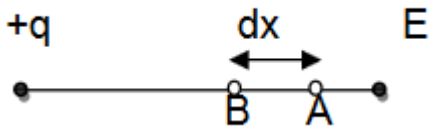
4.work done in moving test charge from one point of equipotential surface to other is zero.

4.Potential gradient: it is defined as the rate of change of potential with respect to displacement in the direction of electric field .

$$\frac{dV}{dx}$$

5. Relation between potential gradient and electric field:

A and B separated by a small distance dx in an electric field.



$$E = -\frac{dV}{dx}$$

6.Electrostatic shielding : The process of making a region free from any electric field is known as electrostatic shielding.

7.Capacitor: a capacitor is a device which is used to store electrostatic potential energy or the charge . it is having two conductors separated by an insulating medium.

Capacitance

If charge q is given to an insulated conductor , it leads to increase its electric potential by V such that

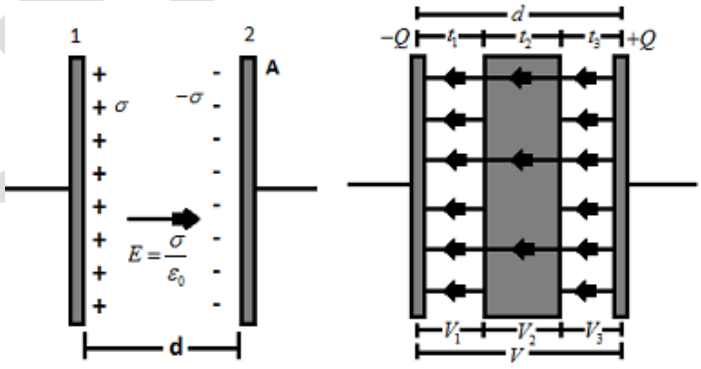
$$q \propto V \quad \Rightarrow \quad q=cv$$

Where **c** is known as the capacitance of the conductor

SI unit is farad(F)

Parallel plate capacitor

it comprises of two metal plate of area A and separated by distance d filled with air or some other dielectric medium.



$$C=\frac{\epsilon_0 A}{d}$$

Dielectric constant

If **C**(vacuum) be the apacity of a condenser with vaccum or air between its plates and **C**(dielectric) be the capacity with dielectric between the plates then the dielectric constant is defined as

$$K = \frac{C\,(\text{VACCUM})}{C\,(\text{DIELECTRIC})}$$

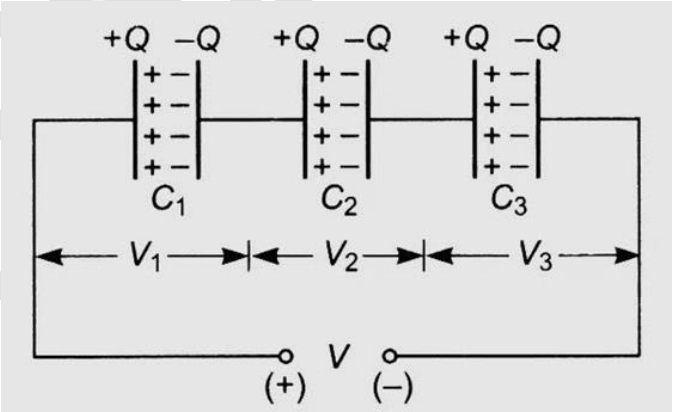
Dielectric constant is also known as **specific inductive capacity** of the dielectric.

Dielectric strength

It is equal to the value of the electric field that can exist in a dielectric.

Combination of capacitors

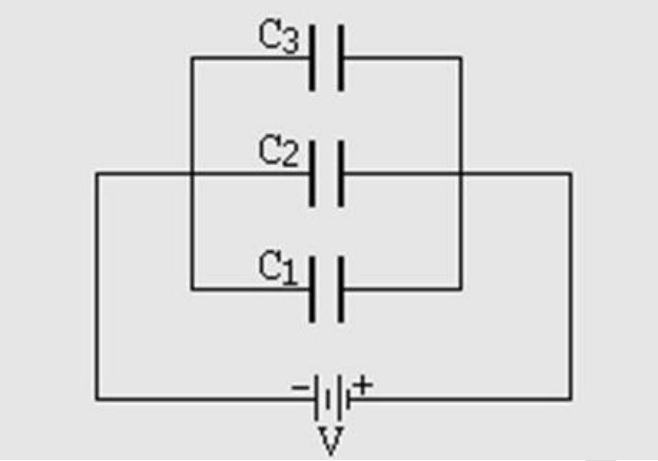
Series combination: in this capacitors are arranged in series**.**



The equivalent capacitance is given by

$$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

Parallel combination : In this capacitors are arranged parallel.



The equivalent capacitance is given by

$$C = C_1 + C_2 + C_3$$

Energy stored in a capacitor

Energy stored is given by;

$$U = \frac{1}{2}(C \times V^2)$$

Where,

C = capacitance
V = potential difference