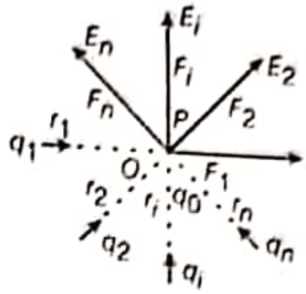
Electric Field due to System of Charges

If E is electric field at point P due to the systems of charges is given by

$$E = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{n} \frac{q_i}{r_i^2} \hat{\mathbf{r}}_i$$



Electric Potential (V)

Electric potential at any point is equal to the work done per unit positive charge in carrying it from infinity to that point in electric field.

Electric potential, $V = \frac{W}{q}$

Its SI unit is J/C or volt and its dimension is $[ML^2T^{-3}A^{-1}]$.

It is a scalar quantity.

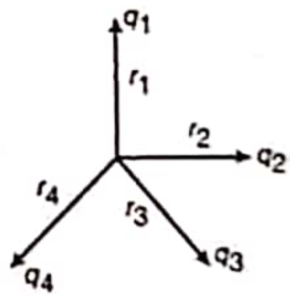
Electric potential due to a point charge at a distance r is given by

$$V = \frac{1}{4\pi\varepsilon_0} \frac{q}{r}$$

Potential due to System of Charges

Let there be a number of point charges $q_1, q_2, q_3, \ldots, q_n$ at distances $r_1, r_2, r_3, \ldots, r_n$ respectively from the point P, where electric potential is given by

$$V = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{n} \frac{q_i}{r_i}$$



Potential Gradient

The rate of change of potential with distance in electric field is called potential gradient.

Potential gradient $= \frac{dV}{dr}$

Its unit is V/m.

Relation between potential gradient and electric field intensity is given by

$$E = -\left(\frac{dV}{dr}\right)$$

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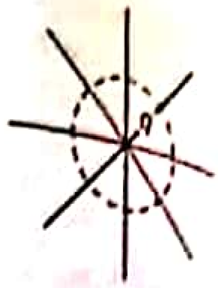
Equipotential Surface



Equipotential surface is an imaginary surface joining the points of same potential in an electric field. So, we can say that the potential difference between any two points on an equipotential surface is zero. The electric lines of force at each point of an equipotential surface are normal to the surface.

(i) Equipotential surface may be planer, solid etc. But equipotential surface can never be point size.

(ii) Electric field is always perpendicular to equipotential surface.

(iii) Equipotential surface due to an isolated point charge is spherical.

(iv) Equipotential surface are planer in an uniform electric field.

(v) Equipotential suface due to a line charge is cylindrical.

Electric Lines of Force

Electric lines of force are the imaginary lines drawn in electric field at which a positive test charge will move if it is free to do so.

Electric lines of force start from positive charge and terminate on negative charge.

A tangent drawn at any point on electric field represents the direction of electric field at that point.

Two electric lines of force never intersect each other.

Electric lines of force are always perpendicular to an equipotential surface.

Electric Flux (ϕ_E)

Electric flux over an area is equal to the total number of electric field lines crossing this area.

Electric flux through a small area element $d\mathbf{S}$ is given by

$$\phi_E = \mathbf{E} \cdot d\mathbf{S}$$

where $\mathbf{E}$ = electric field intensity

and $d\mathbf{S}$ = area vector.

Its SI unit is $N\text{-}m^2C^{-1}$.