Electric field Intensity

"The intensity of electric field at a Point in an electric field is The ratio of The force acting on The test charge Placed at That Point to The magnitude of The test charge".

If The force acting on a test charge q_0 be $\vec{F}$ which is Placed at a Point in an electric field, Then its intensity at That Point is given by ;

$$\vec{E} = \frac{\vec{F}}{q_0} \quad \text{--- (1)}$$

Electric field intensity $\vec{E}$ is defined as The force Per unit charge when it is Placed in The field i.e';

Simply $$\vec{E} = \frac{\vec{F}}{q} \quad \text{--- (2)}$$

where test charge q is a Scalar Quantity and force $\vec{F}$ is a vector quantity. Therefore, The intensity of electric field $\vec{E}$ will also be a vector Quantity. The direction of electric field $\vec{E}$ will be The Same as The direction of The force $\vec{F}$, which means, The direction in which The +ve charge Placed in The electric field tends to move.

If we have negetive test charge Then The direction of electric field $\vec{E}$ will be opposite to The direction of The face acting on The -ve charge.

Note:

It is observed that the field intensity is in the same direction as the force and is expressed in Newton per Coulomb (N/c) and Volt per metre (V/m).

If the intensity of electric field $\vec{E}$ at a point in an electric field be known, then we can determine the force $\vec{F}$ acting on a charge q placed at the point by the following equations.

$$\vec{F} = q\vec{E} \quad \text{—} \quad (3)$$

It is also as a -ve gradient of a potential due to a charge i.e.

$$\vec{E} = -\nabla V, \text{ Volts/metre.}$$

Electric Potential

Introduction:

Electric potential is the work done in bringing one Coulomb of charge from infinity to the point against the force created by the fixed charge. The potential, V at a point due to a fixed charge, q_r is specified as,

work done to bring a charge

$$V = \frac{q \text{ from } \infty \text{ to the Point towards } q_r}{q}$$

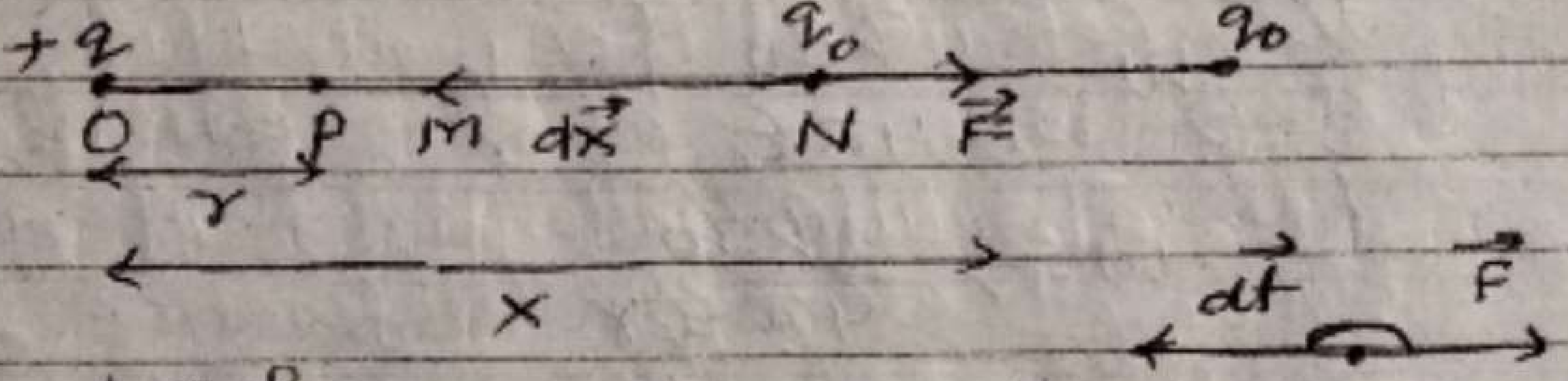
Simply, $V = \frac{\text{Work done}}{q}$, J/C or volt

Electrostatic Potential due to a Point charge:

1.) Suppose q is a charge at O and assume That test charge q_0 is lying a infinity.

2.) Suppose There is Point P where net electric Potential is to be Calculated,

Suppose $OP = r$



$\theta = 180^0$

The work done is given by

$$dw = \vec{F} \cdot \vec{dx}$$
$$= F\,dx \cos\theta$$
$$= F\,dx \cos 180$$
$$dw = -F\,dx \quad \text{--- (1)}$$

Thus, The force between q and q_0 is given by

$$F = \frac{q q_0}{4\pi\varepsilon_0 x^2} \quad \text{--- (2)}$$

Substitute The value of equ^n (2) in equ^n (1), we get

$$dw = \frac{-q q_0}{4\pi\varepsilon_0 x^2} dx \quad \text{--- (3)}$$

on integrating both sides of eqn (3), we get

$$\int_0^W dW = \frac{-q q_0}{4\pi \varepsilon_0} \int_\infty^r \frac{1}{x^2} dx$$

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$$[W]_0^W = \frac{-q q_0}{4\pi \varepsilon_0} \left[\frac{-1}{x}\right]_\infty^r$$

$$[W-0] = \frac{q q_0}{4\pi \varepsilon_0} \left[\frac{1}{x}\right]_\infty^r$$

$$W = \frac{q q_0}{4\pi \varepsilon_0} \left[\frac{1}{r} - \frac{1}{\infty}\right]$$

$$W = \frac{q q_0}{4\pi \varepsilon_0 r}$$

we know $V = \frac{W}{q_0}$

$$V = \frac{q q_0}{4\pi \varepsilon_0 r \times q_0}$$

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

Then unit of Potential is joule per Coulomb (J/C) or Volt. The dimensions of electric Potential in terms of M, L, T and I are $[ML^2T^{-3}I^{-1}]$.