field is vector
potential is scalar

Date

Electric Potential:

Electric Potential $V = \frac{W}{q}$

Electric potential energy = $U = qV$

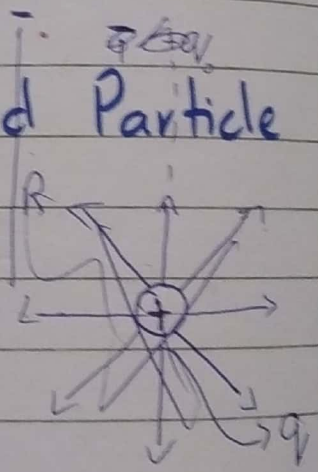
Equipotential surfaces $V_i = V_f$

Potential form field.

$$V_f - V_i = -\int_i^f \bar{E} \cdot \bar{ds}$$

Potential due to a charged Particle

Potential from P to infinity



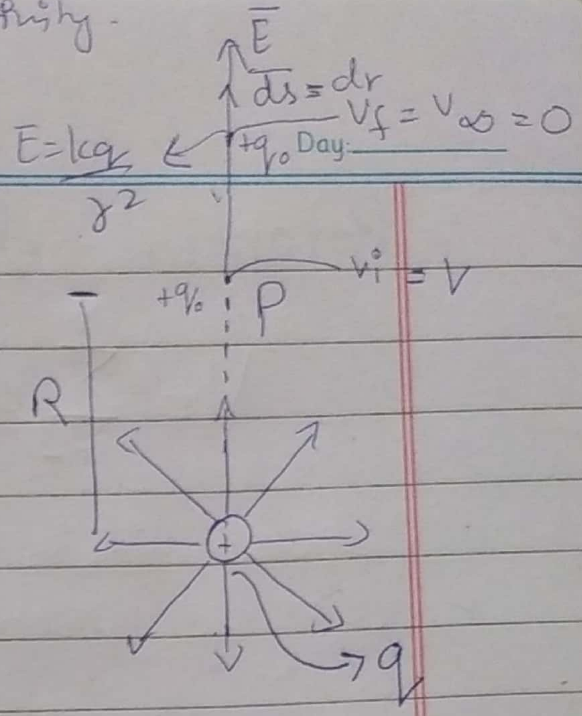
$$V_f - V_i = -\int_R^\infty E\,dr$$

$V_f = 0$

$$\therefore V = \int_R^\infty E\,dr$$

$\because$ At any point electric field due to point charge is

Potential is said to be zero at infinity.
potential has no direction.



$$E = \frac{kq}{r^2}$$

$$V = \int_R^\infty \frac{kq}{r^2}\, dr$$

$$V = kq \int \frac{1}{r^2}\, dr$$

$$V = kq \int r^{-2}\, dr$$

$$V = kq \left[\frac{r^{-2+1}}{-2+1} \right]_R^\infty$$

$$V = \frac{kq}{R}$$

At $r = R$

$$V = \frac{kq}{r}$$

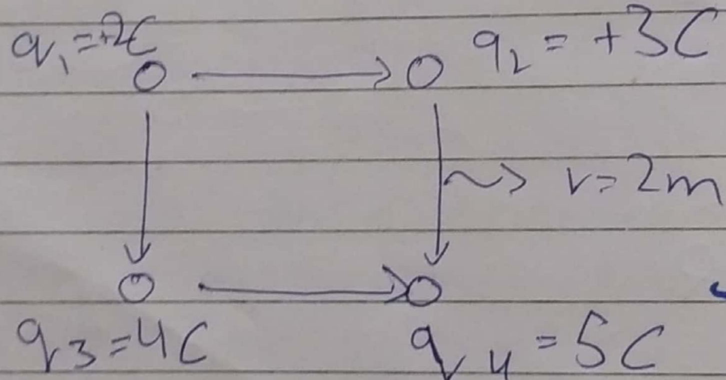
Potential due to N-charged Particle:

$$V = \sum_{i=1}^{N} V_i = V_1 + V_2 + \dots + V_n$$

where $V_1, V_2, \dots$ potential, due to charge particles 1, 2 ---

$V = k\frac{|q|}{r}$ holds for both -ive and +ive point charges.

Q1 Four charge particle



Solve for V_p?

$$V = \frac{kq_1}{r} + \frac{kq_2}{r} + \frac{kq_3}{r} + \frac{kq_4}{r}$$

$$V = \frac{k}{r}[2+3+4+5]$$

$$V = \frac{k}{2}\{14\}$$

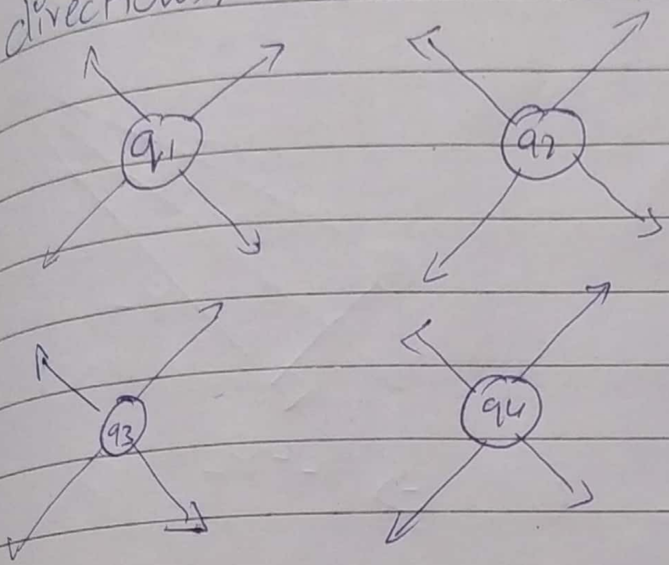
Day:

$V = 7k$

$V = 7 \times 9 \times 10^9\ Nm^2C^{-2}$

$V = 63 \times 10^9\ Nm^2C^{-2}$

directions:



Electric field cancels each other so the electric field will be zero

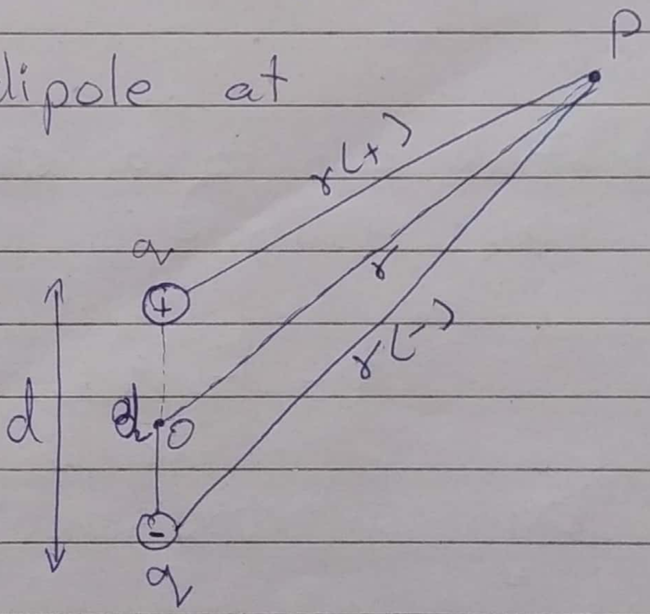
$E = 0$

Potential due to a dipole:

Potential due to dipole at point P

we have

r = Distance from O to P



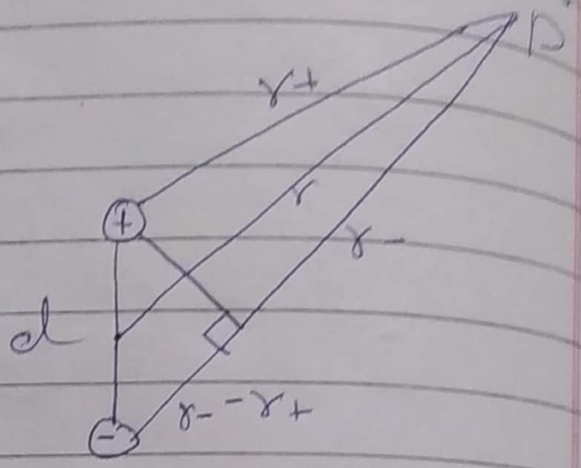
r_+ = Distance b/w positively charged particle to P

r_- = Distance b/w negatively charged particle to P

V_+ = Potential at P set up by positively charged particle

V_- = Potential at P set up by negatively charged particle

d = separation b/w two charged particles



$$\cos\theta = \frac{r_- - r_+}{d}$$

$$r_+ = r_- \approx r$$

$$r_+ r_- \approx r^2$$

$$r_- - r_+ \approx d\cos\theta$$

Potential due to a single positive/negative charge particle

$$V = \frac{k|q|}{r}$$

by superposition principle

$$V = kq\left[\frac{1}{r_+} - \frac{1}{r_-}\right]$$

$$= kq\left(\frac{r_- - r_+}{r_- r_+}\right)$$

Day:

$V = V_1 + V_2$

$$V = \frac{kqd\cos\theta}{r^2}$$

$$V = \frac{KP\cos\theta}{r^2}$$

$\because qd = P$ (magnitude)

Day 22 M

Potential due to continuous charge Distribution:

Continuous charge Distributions

i Linear

ii Spherical

For any general distribution we will

1 Divide the distribution into small patches / element of charges dq

$$dq = \lambda\, ds$$

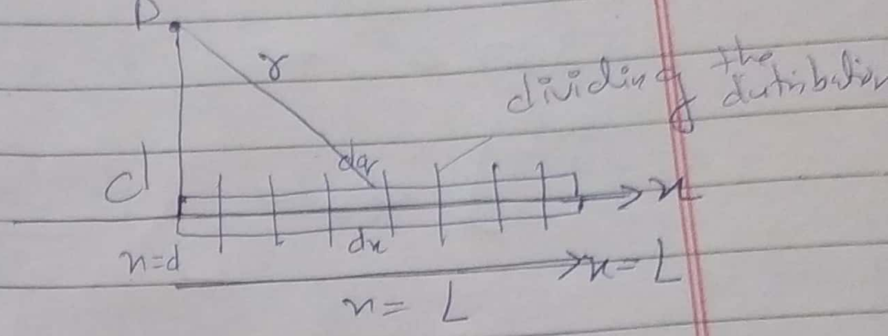
$$dv = k\frac{dq}{r} \quad \Big| \quad V\Big|_{V_\infty = 0} = k\frac{q}{r}$$

2 For complete distribution

$$\int dv = k\int \frac{dq}{r}$$

Case 1: (Linear Charge Distribution)

Consider a thin, non-conducting rod of finite length



d= Perpendicular distance from any element of length dx to point P

x= horizontal distance along the rod

d= Vertical distance perpendicular to rod

Using Pythagoras theorem

$$r^2 = d^2 + x^2$$

$$r = \sqrt{d^2+x^2}$$

Electric potential due to any small element considering as a whole distribution itself

$$dv = k\frac{dq}{r}$$

$$dq = \lambda dx$$

Date:

Day: Monday

$$dv = \frac{k\lambda\, dx}{\sqrt{x^2+d^2}}$$

Potential of any small element

for a rod, we have

$$\int dv = \int \frac{k\lambda\, dx}{\sqrt{x^2+d^2}}$$

$$\int dv = k\lambda \int_0^L \frac{dx}{\sqrt{x^2+d^2}}$$

$$\because \int \frac{dx}{\sqrt{x^2+d^2}} = \ln |x^2 + (x^2+d^2)^{1/2}|$$

$$= k\lambda \left\{ \ln (x + (x^2+d^2)^{1/2}) \right]_0^L$$

$$= k\lambda [\ln (L + (L^2+d^2)^{1/2}) - \ln (0+(0+d^2)^{1/2})]$$

$$= k\lambda \{\ln (l + (l^2+d^2)^{1/2}) - \ln (d^2)^{1/2}]$$

$$= k\lambda \{\ln (l + (l^2+d^2)^{1/2}) - \ln d$$

$$= k\lambda \left\{ \ln \left(\frac{l + (l^2+d^2)^{1/2}}{d} \right) \right]$$

Day:

$$= kx \cdot \ln\left[\frac{l + (l^2 + d^2)^{1/2}}{d}\right]$$

Date: Day:

Topics:

Electric Potential $V = \frac{W}{q_0}$ Unit: V

Electric Potential Energy $U = qV$

Equipotential Surfaces

Potential in a field

$$V_f - V_i = -\int_i^f \bar{E} \cdot \bar{ds}$$

Electric Potential due to a point charge $V = \frac{kq}{r}$

Electric Potential due to dipole

$$V = \frac{kP\cos\theta}{r^2}$$

Electric Potential due to N charge

$$V_i = \sum_{i=1}^{N} \frac{kq_i}{r_i}$$

Electric Potential due to continuous charge Distribution

Day:

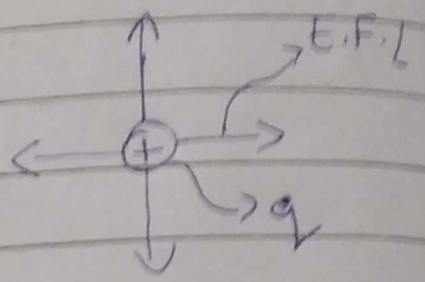
Electric Potential due to continous Charge

Line Charge Distribution a thin rod $\rightarrow V = k\lambda \ln\left[\frac{l + (l^2+d^2)^{1/2}}{d}\right]$

Circular Charge Distribution

Scanned with CamScanner

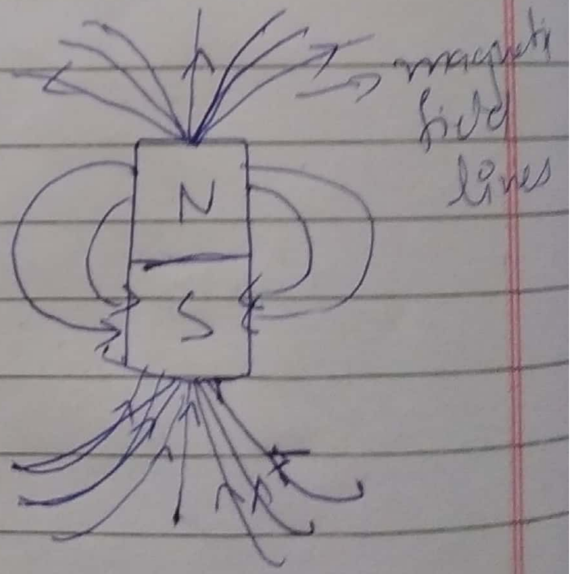
Magnetic Field:



Electric field is straight from one point to another while magnetic field moves in a circular path until we don't switch off the battery.

$$E = \frac{\vec{F_e}}{q}$$

In magnet curved move from North to south naturally unless we make it flow in opposite direction



Properties

Direction of magnetic field is known by the tangent of circular path

When lines are wider magnetic field is weaker

When lines are closer magnetic field is stronger

Day:

Magnetic Force: (F_B)

Magnetic field:

$$B = \frac{F_B}{qv}$$ Unit : Tesla

It is the magnitude of magnetic field.

$$F_B = qvB$$

$$\vec{F_B} = q\vec{v} \times \vec{B}$$

Here we use right hand Rule in which fingers shows direction of magnetic field

If q is positive then ~~magnitude~~ magnetic force(F_B) and $\vec{v} \times \vec{B}$ are in same direction

If q is negative then magnetic force direction is opposite of $\vec{v} \times \vec{B}$