y component

$E_{1y} = 1.47 \sin\theta$

$E_{1z} = 0$

$E_{2y} = 1.2 \sin\theta$

$E_{xy} = 0$

$E_{2z} = 0$

charge density

charge

surface charge

charge

charge

charge.

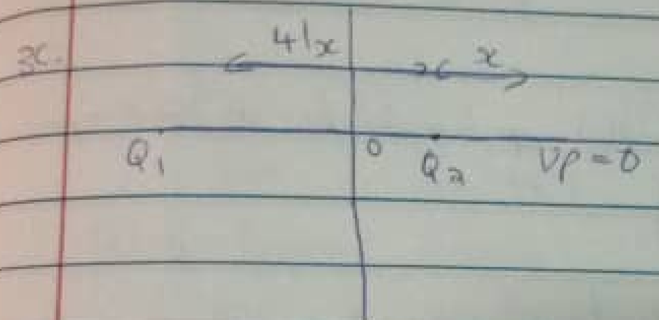
Electric Potential Difference

This can be defined as the difference in electric potential (v) between the final and the initial position when work is done upon a charge to change its potential energy. In equation:

$$\Delta V = V_2 - V_1 = \frac{Work}{Charge} = \frac{\Delta P_E}{Charge}$$

where $1V = 1J/C$

Unit of potential difference are Joule per Coulomb given the name volt (v) after Alessandro Volta.



$r_1 = 4 + x, \quad Q_1 = 10 \times 10^{-6} C$

$r_2 = x \quad Q_2 = -2 \times 10^{-6}$

$$V_P = K\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

$$0 = 9 \times 10^9 \left[\frac{10 \times 10^{-6} x + (4+x)(-2 \times 10^{-6} x)}{x(4+x}\right]$$

$$0 = 9 \times 10^9 \left[\frac{10 \times 10^{-6} x - 8 \times 10^{-6} - 2 \times 10^{-6} x}{x(4+x)}\right]$$

$$0 = 9 \times 10^9 \left[\frac{8 \times 10^{-6} x - 8 \times 10^{-6}}{x(4+x)}\right]$$

$$0 = 7.2 \times 10^4 x - 7.2 \times 10^4$$

$$-7.2 \times 10^4 x = -7.2 \times 10^4$$

$$\frac{\cancel{-7.2 \times 10^4} x}{\cancel{-7.2 \times 10^4}} = \frac{\cancel{-7.2 \times 10^4}}{\cancel{7.2 \times 10^4}}$$

$r_2 = x_1 = 1m$

$r_1 = 4 + x = 4 + 1$

$r_1 = 5$

Positions are : 1m and 5m

5a Biot-Savart law states that the magnetic field is directly proportional to the product permeability of free space (μ_0), the current (i), the change in length, the radius and inversely proportional to square of radius (r^2). It can be represented mathematically by

$$\vec{dB} = \frac{\mu_0 I d\vec{l} \times \vec{r}}{4\pi r^2}$$

where μ_0 is a constant called permeability of free space

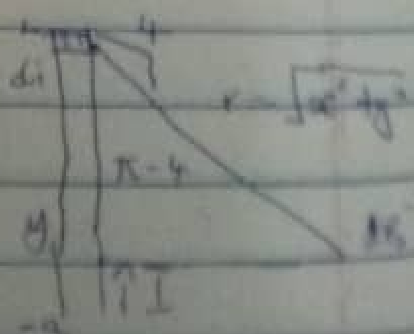
$$\mu_0 = 4\pi \times 10^{-7} \frac{T \cdot M}{A}$$

The Unit of B is weber/meter square.

5B Magnetic Field of a straight current carrying conductor

A sector of a straight current carrying conductor applying the Biot-savart law, we find the magnitude of the field $\vec{dB}$

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin 4}{r^2}$$



$$\sin(\pi - 4) = \sin\theta$$

$$\therefore B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - 4)}{r^2}$$

From diagram $r^2 = x^2 + y^2$ (pythagoras theorem)

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$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{dl \sin(\pi - 4)}{x^2 + y^2} \quad \text{------} \quad (*)$$

But $\sin(\pi - 4) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}}$ ------ $(*)$

Substituting $(**)$ into $(*)$ we have

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} dl \, \frac{x}{(x^2+y^2)^{3/2}}$$

Recall $dl = dy$

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{x}{x^2+y^2}{}^{3/2} dy$$

$$B = \frac{\mu_0 I x}{4\pi}\int_{-a}^{a} \frac{1}{(x^2+y^2)^{3/2}} dy \quad \text{------} \quad (***)$$

Using special integrals

$$\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x^2} \frac{y}{(x^2+y^2)^{1/2}}$$

Equation $(***)$ therefore becomes

$$B = \frac{\mu_0 I x}{4\pi}\left[\frac{y}{x^2(x^2+y^2)^{1/2}}\right]^{a}$$

$$B = \frac{\mu_0 I x}{4\pi}\left[\frac{2a}{x^2(x^2+a^2)^{1/2}}\right]^{-a}$$

$$B = \frac{\mu_0 I}{4\pi x}\left[\frac{2a}{(x^2+a^2)^{1/2}}\right]$$

When the length $2a$ of the conductor is very great in comparison to its distance x from point P, we consider it infinitely long. That is when a is much larger than x.

$$(x^2+a^2)^{1/2} \simeq a, \text{ as } a \longrightarrow \infty$$

Vector	Angle	x Component	y Component
$E_1 = 1.47 N/C$	$0°$	$E_{1x} = 1.47 \cos 0°$ $E_{1x} = 1.47 N/C$	$E_{1y} = 1.47 \sin 0$ $E_{1y} = 0$
$E_2 = 12 N/C$	$0°$	$E_{2x} = 12 \cos 0°$ $= 12 N/C$	$E_{2y} = 12 \sin 0$ $E_{2y} = 0$
		$E_1 E_2 = 13.47 N/C$	$E_y = 0$

$$E_{net} = \sqrt{[E_x]^2 + [E_y]^2}$$

$$= \sqrt{[13.47]^2 + [0]^2}$$

$$= \sqrt{181.4409}$$

$$E_{net} = 13.47 N/C$$

II

3. Volume charge density: $\rho = q/v$

where $\rho = \frac{dQ}{dv}$ where ρ = volume charge density

q = electric charge

$dQ = \rho dv$ v = volume

II Surface charge density $= \sigma = q/A$ where σ = surface charge

where $\sigma = \frac{dQ}{dA}$ q = Electric charge

A = Area

$dQ = \sigma dA$

III Linear charge density $\lambda = q/L$

where $\lambda = \frac{dQ}{dL}$ where λ = Linear charge

q = Electric charge

$dQ = \lambda dL$ L = Length

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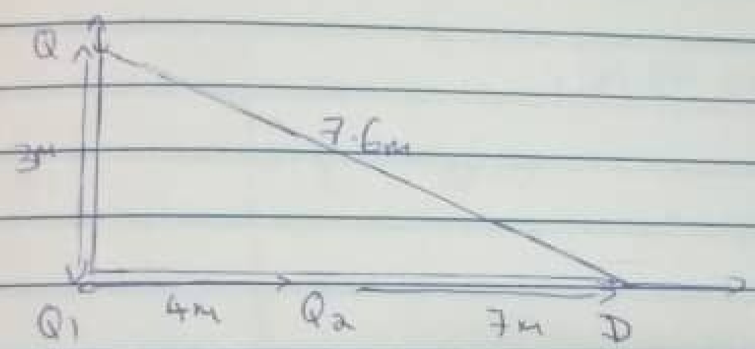
SECTION A {NUMBER 2 & 3}

2. Electric field is a region around a charge in which it exerts electrostatic force on another charge while Electric field intensity is the strength of electric field at any point in space.

b. 

where $Q_1 = 8nC$

$Q_2 = 12nC$

i. Recall $\mathcal{E} = kq/r^2$

$$\therefore \mathcal{E}_1 = \frac{\{9\times10^9 Nm^2/c\}\cdot\{8\times10^{-9}c\}}{\{7.0m\}^2}$$

$$\mathcal{E}_1 = 1.47N/c$$

$$\mathcal{E}_2 = \frac{\{9\times10^9 Nm^2/c\}\cdot\{12\times10^{-9}c\}}{\{3.0m\}^2}$$

$$E_2 = 12N/c$$