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MATRIC NO:- 19/MHS11/111

COURSE :- PHY 102 ASSIGNMENT

PHARMACY SECTION A

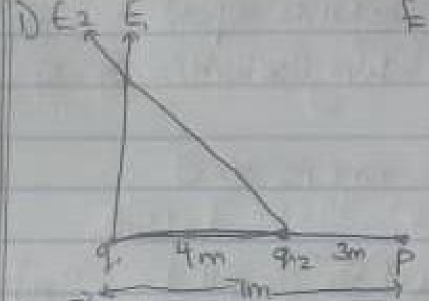
Electric field & electric field intensity

electric field	electric field intensity
It is a region of space in which an electric charge will experience and electric force	It is the force per unit charge.

$q_1 = 8nC$ at origin, $q_2 = 12nC$ on x-axis at $x = 4m$

(i) net electric field at point P on the x axis at $x = 7m$

(ii) electric field at a point Q on the y axis at $y = 3m$ due to the charges

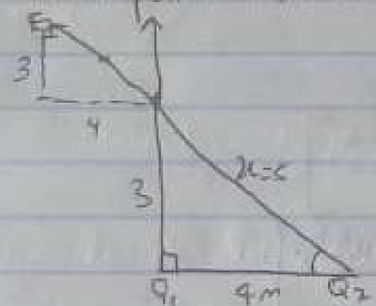
i) 

$E_1 = \frac{kQ_1}{r_2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469N/C \approx 1.5N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{7^2} = 12N/C$

$\Rightarrow E_{net} = \vec{E_1} + \vec{E_2} = 1.5 + 12 = 13.5N/C$

ii) $\vec{E}$ at point Q on the y axis at $y = 3m$ due to charge



$c^2 = a^2 + b^2$

$c^2 = 4^2 + 3^2$

$c = 5$

$E_1 = \frac{kQ_1}{r_2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2}$ $E_1 = 8N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32N/C$

Vector	Angle	x-comp	y-comp
$E_1 = 8N/C$	90	0 N/C	8N/C
$E_2 = 4.30$	36.87°	$-3.45N/C$	$2.59N/C$
		$\Sigma_{Fx} = -3.45N/C$	$\Sigma_{Fy} = 10.59N/C$

$E_{net} = \sqrt{\Sigma_{Fx}^2 + \Sigma_{Fy}^2}$

$E_{net} = 11.12N/C$

3 - Formulation of identities of charge

a) Volume charge density $\rho = \frac{dQ}{dV} = dQ = \rho dV$

b) Surface charge density $\sigma = \frac{dQ}{dA} = dQ = \sigma dA$

c) linear charge density $\lambda = \frac{dQ}{dL} = dQ = \lambda dL$

b) electric potential difference equation

- due to a single point charge

$$V_B - V_A = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

where Q = point charge V = electric potential

r_B = distance of Q to point B

r_A = distance of Q to point A

- due to several point charges

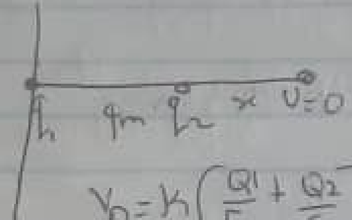
$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$ where V = electric potential

Q = point charge

r = distance of Q

3a) point charge $Q_1 = 10\mu C$ $Q_2 = -2\mu C$ along x-axis x=0 x=4m respectively.

find the position along the x-axis where V=0



$$V_p = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$ recall $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$

$$V_p = k\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

$$V_p = 9\times10^9\left[\frac{10\times10^{-6}}{4+x} + \frac{-2\times10^{-6}}{x}\right]$$

$$0 = 9\times10^9\left[\frac{10\times10^{-6}}{4+x} + \frac{-2\times10^{-6}}{x}\right]$$

$$0 = \frac{10\times10^{-6}}{4+x} + \frac{-2\times10^{-6}}{x} = \frac{10\times10^{-6}}{4+x} \cancel{+} = \frac{-2\times10^{-6}}{x}$$

$$10\times10^{-6}x = (4+x)(-2\times10^{-6})$$

$$10\times10^{-6}x = 8\times10^{-6} + (-2\times10^{-6}x)$$

$$8\times10^{-6} = 10\times10^{-6}x - 2\times10^{-6}x$$

$$\cancel{10x}\ 8\times10^{-6} = 8\times10^{-6}x$$

$$x = \frac{8\times10^{-6}}{8\times10^{-6}}$$

$$x = 1$$

∴ position along the x-axis is 1m.

where V=0

$$V = k\left[\frac{q_1}{r_1} + \frac{q_2}{r_2}\right]$$

$$0 = \left[\frac{10\times10^{-6}}{4-x} + \frac{-2\times10^{-6}}{x}\right]$$

$$\frac{2\times10^{-6}}{x} = \frac{10\times10^{-6}}{4-x}$$

$$[4-x][2\times10^{-6}] = 10\times10^{-6}x$$

$$8\times10^{-6} - 2\times10^{-6}x = 10\times10^{-6}x$$

$$8\times10^{-6} = 10\times10^{-6}x + 2\times10^{-6}x$$

$$8\times10^{-6} = 12\times10^{-6}x$$

$$x = \frac{8\times10^{-6}}{12\times10^{-6}}$$

$$x = 0.67m$$

$\therefore$ position of $V=0$ is $0.67m$

SECTION B

(44) Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is denoted as ϕ

$$\phi = B.dA$$

(45) $m_e = 9.11\times10^{-31}kg$, $r = 1.4\times10^{-7}m$; $B = 3.5\times10^{-1}\,w/m^2$

Cyclotron frequency = angular speed $q = 1.6\times10^{-19}$

$$f_B = qV_B = \frac{m_eV^2}{r}$$

$$M_eV = qBr$$

$$V = \frac{qBr}{m_e} = \frac{1.6\times10^{-19}\times3.5\times10^{-1}\times1.4\times10^{-7}}{9\times11\times10^{-31}}$$

$$V = 8.61\times10^{-3}m/s$$

$$\omega = \frac{V}{r} = \frac{qB}{m_e} = \frac{1.6\times10^{-19}\times3.5\times10^{-1}}{9.11\times10^{-31}}$$

$$\omega = 6.14\times10^{10}s^{-1}$$

(46) In 4b we were given parameters, mass of electron $= 9.11\times10^{-31}kg$ radius $= 1.4\times10^{-7}m$ $B = 3.5\times10^{-1}w/m^2$

And we were asked to find the cyclotron frequency which is the same thing as angular speed. It is called cyclotron frequency because it is a frequency of an accelerator called cyclotron.

$\omega =$ angular speed

$\omega = \frac{qB}{m_e}$ since cyclotron frequency = angular speed

The cyclotron frequency $= 6.19 \times 10^{-19} s^{-1}$

having a unit of $\frac{1}{T}$ which is the unit of frequency dimensionally.

5) Bio-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 the square of radius (r^2). mathematically:-

$$\vec{dB} = \frac{\mu_0 I \, dl \times \hat{r}}{4\pi r^2}$$

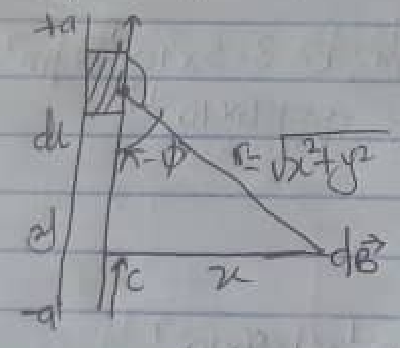
where μ_0 = permeability of free space $= 4\pi \times 10^{-7}$ T.m/A

r = radius

$\vec{dB}$ = magnetic field, I = steady current, dl = length of wire

unit is W/m^2

5b) magnetic field of a straight current carrying conductor



A section of a straight current carrying conductor.

Applying Bio-savart law, we find the magnitude of the field ($\vec{dB}$) from the diagram,

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

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

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

from the diagram $r^2 = x^2 + y^2$

$$B = \frac{\mu_0 I}{4\pi}\int_{a}^{a} \frac{dl \sin(\pi - \phi)}{x^2 + y^2} = \text{---} \quad (1)$$

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

substitute (ii) into (i)

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} dl \frac{x}{(x^2+y^2)(x^2+y^2)^{1/2}}$$

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

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

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

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

$$B = \frac{\mu_0 I}{2\pi x} = \frac{\mu_0 I}{2\pi r}$$