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MATRIC No -> 19/MHS11/003

PHARMACY

PHY102 Assignment

Section A

2) Electric field and electric field intensity

Electric field	Electric field intensity
* Its a region of space which an electric charge will experience an electric force	* Is force per unit charge.

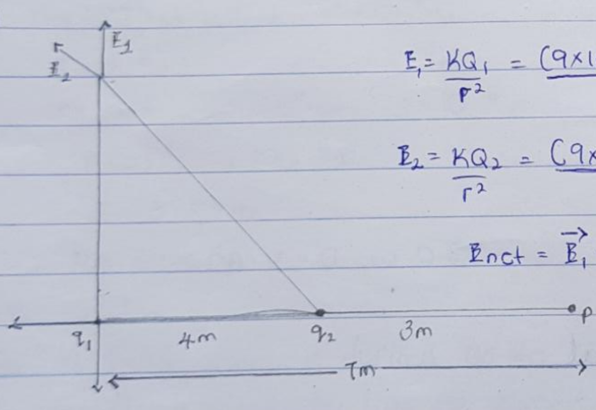
2b)

=> $q_1 = 8nC$, $q_2 = 12nC$ On x axis at $r = 4m$

i find 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

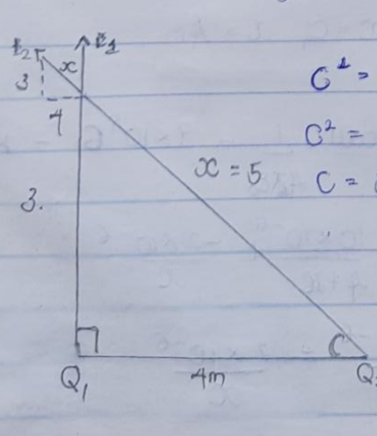


$$E_1 = \frac{KQ_1}{r^2} = \frac{(9\times10^9)(8\times10^{-9})}{7^2} = 1.469\ N/C \approx 1.5\ N/C$$

$$E_2 = \frac{KQ_2}{r^2} = \frac{(9\times10^9)(12\times10^{-9})}{7^2} = 12\ N/C$$

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

ii $\vec{E}$ at Point Q on the y axis at $y = 3m$ due to Charge



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

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

$c = 5$

$$E_1 = \frac{KQ_1}{r^2} = \frac{(9\times10^9)(8\times10^{-9})}{3^2}$$

$$= 8\ N/C$$

$$E_2 = \frac{KQ_2}{r^2} = \frac{(9\times10^9)(8\times10^{-9})}{5^2} = 4.32\ N/C$$

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vector	angle	x-component (N/C)	y-component (N/C)
E_1 8N/C	90°	0	8.00
4.32N/C	36.87	−3.45	2.59
		E_{px} = −3.45 N/C	E_{py} = 10.59 N/C

$E_{net} = \sqrt{E_{px}^2 + E_{py}^2}$

$E_{net} = \sqrt{(-3.45)^2 + (10.59)^2}$

$= \sqrt{11.9025 + 112.1481}$

$= \sqrt{124.0506}$

$= \underline{11.138\,N/C}$

3a i Volume charge density $\cdot \rho = dQ/dV = dV = \rho dV$

ii Surface charge density $\sigma = dQ/dA = dQ = \sigma dA$

iii Linear charge density $\cdot \lambda = dQ/dL = dQ = \lambda dL$

3b Electric potential difference equation

· due to a single point charge

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

where Q = Point charge

r_B = distance of Q to point B

r_A = distance of Q to point A

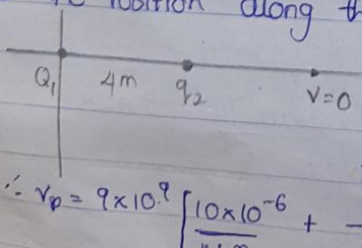
due to several point charges

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

Q = Point charge

r = distance of Q

3c Point charge $Q_1 = 10\mu C$ $Q_2 = 2\mu C$ along the x axis $x = 0,\ x = 4m$
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 $\frac{1}{4\pi\varepsilon_0} = 9\times10^9 G = K$

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

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

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

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

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

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

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

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

$8 \times 10^{-6} = 8 \times 10^{-6}x$

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

$1 = x \quad \therefore \quad x = 1$

$\therefore$ The Position along the x axis is 1m

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

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

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

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

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

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

$8 \times 10^{-6} = 12 \times 10^{-6}x$

$x = 0.67m$

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

Section B

4a) Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is denoted as ϕ. $\phi = B \cdot dA$

4b) $m_e = 9.11 \times 10^{-31}Kg$; $r = 1.4 \times 10^{-7}m$; $B = 3.5 \times 10^{-1} w/m^2$

Cyclotron frequency = angular speed. $q = 1.6 \times 10^{-19}$

$F_B = qvB = \frac{m_e v^2}{r}$

$m_e v = qBr$

$v = \frac{qBr}{m_e} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1} \times 1.4 \times 10^{-7}}{9.11 \times 10^{-31}}$

$v = 8.6 \times 10^{3} m/s$

$\omega = \frac{v}{r} = \frac{qB}{m_e} = \frac{1.6 \times 10^{-19} \times 3.6 \times 10^{-1}}{9.11 \times 10^{-31}} = 6.14 \times 10^{10} s^{-1}$

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4c In 4b, we were given parameters; mass of electron = $9.11 \times 10^{-31} kg$
radius = $1.4 \times 10^{-7} m$, $B = 3.5 \times 10^{-1} w/m^2$
And we were asked to find cyclotion frequency which is the same thing as ~~which is the same thing as angular speed~~ angular speed. It is called cyclotion frequency because it is a frequency of an accelerator called cyclotion

Recall ω = angular speed

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

The cyclotion frequency = $6.14 \times 10^{-10} s^{-1}$ having a unit of $1/t$ which is the unit of frequency dimensionally.

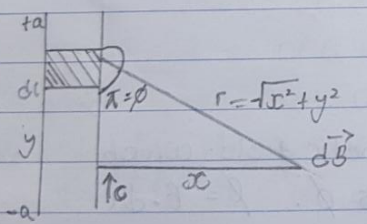
5a) Bio savart law states that the magnetic field is directly proportional to the product permeability of free space (μ) the current (I), the change in length, the radius and inversely proportional to square of radius (r^{-2}). Mathematically;

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

Where μ_0 = permeability of free space = $4\pi \times 10^{-7} T \cdot m/A$; radius $d\vec{B}$ = 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-sarvat law, we find the magnitude of the field ($d\vec{B}$) 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 $r^2 = x^2 + y^2$

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

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

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

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

~~$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a}$~~

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

Substitute (II) into (I)

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

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

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

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

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

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

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