②

2 Distinguish between the terms: electric field and electric field intensity

5) A positive charge $Q_1 = 8nC$ is at the origin, and a second positive charge $Q_2 = 12nC$ is on the x-axis at $x = 4m$. Find

1. the net electric field at a point P on the x axis at $x = 7m$

11. the electric field at a point O on the y axis at $y = 3m$ due to the charges

2a) Solution

Electric field is a region of space in which electric charge is felt while electric field intensity is the force per unit charge

mathematically:

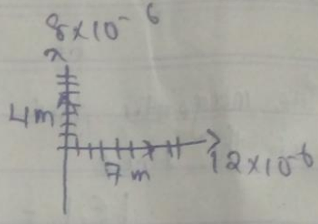
$$E = \frac{F(N)}{q(C)}$$

2b) $Q_1 = 8 \times 10^{-6}$

$Q_2 = 12 \times 10^{-6}$

$r_1 = 4m$

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



Note: Point P is a vector sum where $E_x(net) = \sum E_x = E_{x_1} + E_{x_2}$

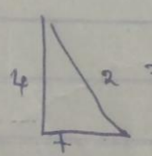
$\therefore E_{net} = \sqrt{E_{x2} + E_{y2}}$

Obtaining the electric fields:

$E_1 = \frac{kq}{r^2} = \frac{9.0 \times 10^9 \times 8 \times 10^{-6}}{7^2} = 1467.75 = 1.47 \times 10^3 N/C$

$E_2 = r?$ from the diagram

$E_2 = \frac{kq}{r^2}$



$= x = \sqrt{4^2 + 7^2}$

$r = 8$

$= \frac{9 \times 10^9 \times 12 \times 10^{-6}}{8^2} = 4.48 \times 10^1 N/C$

Calculating angle of $\tan\theta = (y/x)$

$\theta = \tan^{-1}(y/x)$

$= \tan^{-1} 4/7$

$= 29.7 \simeq 30°$

$\therefore (E_2)_x = 4.48 \times \cos 29.7 = 2.219$

$(E_2)_y = 4.48 \times \sin 29.7 = \underline{2.219}$

$\sum \underline{4.438}$

$\therefore E_x = 2.219 N/C$

$E_y = 147.000 + 21.438 = 147004.438$

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

$= \sqrt{(2.219)^2 + (147004.438)^2}$

$= 1.47 \times 10^5 N/C$

4

4a. Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol Φ. Mathematically as $\Phi = B \cdot dA$

4b. $m = 9 \times 10^{-31}$ kg $r = 1.4 \times 10^{-7}$ m

$B = 3.5 \times 10^{-1}$ weber/meter^2

f (Cyclotron frequency) = Angular speed

$\omega = v/r = qB/m$

$\omega = 1.6 \times 10^{-19} \times 3.5 \times 10^{-1} / 9 \times 10^{-31}$

$\omega = 62222222222.22222\ T^{-1}$

$= 6.2 \times 10^{10}\ T^{-1}$

4c. Parameters such as mass of electron $= 9.11 \times 10^{-31}$ kg

A radius of 1.4×10^{-7}

Magnetic fied of 3.5×10^{-1}

$f = ?$

Recall that $\omega = qB/m = v/r$

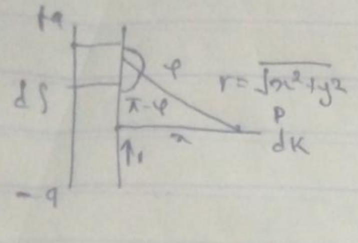
Substituting $= 1.6 \times 10^{-19} \times 3.5 \times 10^{-10} / 9.11 \times 10^{-31}$

$= 6.2 \times 10^{10}$ or $62222222222.22222\ T^{-1}$ having a unit of $1/T$ which is equal to the unit of frequeny dimensionally.

5

5a.) Bio savarts law is an equation that describes the magnetic field created by a current carrying wire and allows one to calculate its strength.

5b)



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

$\sin(\pi-\varphi)=\sin\varphi$

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

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

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

But $\sin(\pi-\varphi)=\dfrac{x}{\sqrt{x^2+y^2}}$

$$=\frac{x}{(x^2+y^2)^{1/2}} \quad \text{— (II)}$$

~~B= μ0I~~ Sub. eqn (II) in (I)

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

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

Recall $dl=dy$

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

$$B=\frac{\mu_0 Ix}{4\pi}\int_{-a}^{a}\frac{1}{(x^2+y^2)}\,dy \quad \text{— III}$$

Using integration

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

Equation (III) becomes

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

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

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

when the length 2a of the conductor is very great in comparison to its distance x from point p. we consider it infinetly long. That is when a is much larger than x

$(x^2+a^2)^{1/2}=a$, as a → ∞

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

6a

Applicatoon of Faradys law in the productoon of Sand on electric guitar

- The coil in this case called the pickup cool is placed near the vibrating guitar string which is made of a metal that can be magnetized. A permanent magnet inside the cool magnetizes the profurin of the string nearest the cool. When the string vibrates at some frequency, its magnetized segment produces a changing magnetic flux through the coil. The changing flux induces as emf in the coil that is fed to an amplifier. The output of the amplifior is sent to the loudspeakers, whic produces the sound waves we hear.

6b.

The magentic flux through the coil at $t=0$ is 0 because $B=0$ at the time

$$|\mathcal{E}| = N\, d\Phi_B/dt$$
$$|\mathcal{E}| = N\, \Delta\Phi_B/\Delta t$$
$$|\mathcal{E}| = N\, \Delta\Phi_B/\Delta t = N\,\frac{(\Phi_{B(t_2)} - \Phi_{B(t_1)})}{t_2 - t_1}$$

6c