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MEDICINE & SURGERY
19/MHS01/128
PHY 102

SECTION A

2 a Electric field is a region or space in which electric charge is feet

Electric field intesity is the force per unit Charge i.e $E = \frac{F(N)}{q(C)}$

b $Q_1 = 8 \times 10^{-6}$ $\quad E = \frac{kq}{r^2}$

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

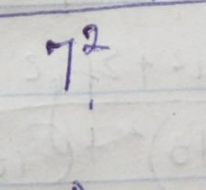
$r_1 = 4m$

i) Point P is a vector sum where $E_{net} = \sqrt{E_{x^2} + E_{y^2}}$

$Q_1 = \frac{kq}{r^2} = \frac{9.0 \times 10^4 \times 8 \times 10^{-6}}{7^2}$ $= 1.47 \times 10^3 N/C$

ii ~~$E_2 = r?$~~

~~$E_2 = \frac{kq}{r_2}$~~



~~$\sqrt{4^2 + 7^2}$~~

~~$r = \sqrt{64}$~~

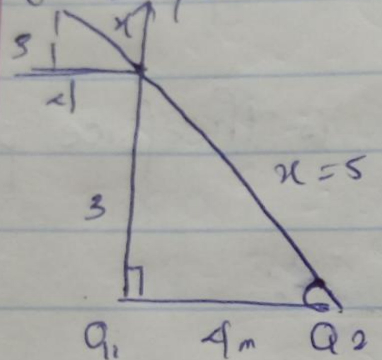
~~$r = 8$~~

$\cancel{\frac{9\times10^{9}\times12\times10^{-6}}{8^2}}$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^{9}\times12\times10^{-9}}{7^2} = 12 N/C$

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

ii) E at point Q on the y axis at y = 3m due to Q_1



$E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^{9}\times8\times10^{-9}}{3^2}$

$E_1 = 8 N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^{9}\times8\times10^{-9}}{5^2} = 4.32 N/C$

Vector	angle	X axis	Y axis
$E_1 = 8N/C$	90°	$0 N/C$	$8 N/C$
$E_2 = 4.32$	36.87°	$-3.45 N/C$	$2.59 N/C$
		$\Sigma f_x = -3.45 N/C$	$\Sigma f_y = 10.59 N/C$

$E_{net} = \sqrt{\Sigma f_x^2 + \Sigma f_y^2}$

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

$E_{net} = 11.12 N/C$

3a) Volume charge density $\rho = \frac{dq}{dv}$, $= dq = \rho dv$

Surface charge density $\sigma = \frac{dq}{dA}$ $= dq = \sigma dA$

Linear charge density $\lambda = \frac{dq}{dl}$ $= dq = \lambda dl$

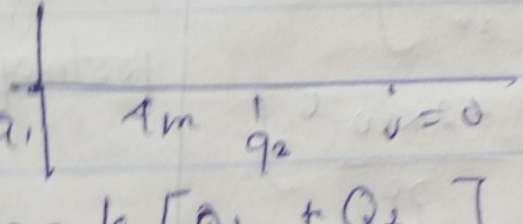
b) electric potential difference equation due to single point charge

$$V_B - V_A = \frac{Q}{4\pi\epsilon_0}\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

Q = point charge V = electric potential r_B = distance of Q to point B, R_A = distance of Q to point A

$V_P = \frac{1}{4\pi\epsilon_0}\left[\frac{q}{r}\right]$ where V = electric potential, r = distance of Q, Q = point charge

c) $V_p = \frac{1}{4\pi\epsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$ recall $\frac{1}{4\pi\epsilon_0} = 9\times10^9 = k$



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

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

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

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

Recall $dl = dy$

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

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

$$B = \frac{\mu_0 I x}{4\pi} \int_{-a}^{a} \frac{1}{(x^2+y^2)^{3/2}} dy \quad - (8)$$

Using Special Integrals:

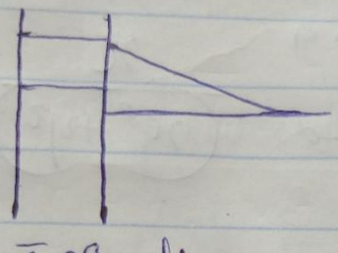
$$\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x} \frac{y}{(x^2+y^2)^{1/2}}$$

Eq(8) becomes

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

5 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 the diagram $r^2 = x^2 + y^2$ (phythagoran)

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

But $\sin(\pi - \varphi) = \dfrac{x}{\sqrt{x^2 + y^2}} = \dfrac{x}{(x^2 + y^2)^{1/2}}$. (2)

Sub (2) into (1)

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

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

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

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

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

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

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

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

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

$x = 1$: posn of x is 1m

Whe $V = 0$

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

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

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

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

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

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

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

$x = 0.67m$

postn of $y = 0.67m$

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

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

when a is greater than x we consider it infinitely long $(x^2 + a^2)^{1/2} \cong a$, as $a \longrightarrow \infty$

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

4. Magnetic flux is defined as the ~~strength~~ strength of magnetic field represented by lines ~~of force~~

5. $m = 9.11 \times 10^{-31}$

$r = 1.41 \times 10^{-7}$

$B = 3.5 \times 10^{-1}$

$$w = \frac{qB}{m}$$

$$w = \frac{1.60 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$w = 6.147 \times 10^{10}$ rad/s

$F_B = qvB = \frac{mv^2}{r}$

$m_p v = qBr$

$v = \frac{qBr}{m_p}$

$v = \frac{1.60\times10^{-19} \times 0.35 \times 1.4\times10^{-7}}{9.11\times10^{-31}}$

$v = 8.60\times10^{3}\, m/s$

4c In 4b we were give parameter and asked to find the cyclon freqveny which is the same thing as angular speed. It is called cyclotron freqeny because it is a freqneny of an accelerator calle cyclotram recall w = angular speed

$w = \frac{qB}{Me}$

Since Cyclon freqenay = angular speed the cyclon frequeny = $6.14\times10^{-10} e^{-1}$ having a unit of $\frac{1}{s}$ which is the unit of freqveny dimensionally