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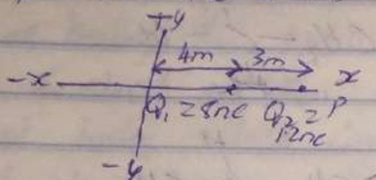
Course Phy 102

Assignment

2a An electric field is a region of space in which an electric charge will experince an electric force while electric field intensity E, can be defined as the force per unit charge

b $Q_1 = 8nC$, $Q_2 = 12nC$ are on the x-axis of $x = 4m$. Find the net electric field at a point P on the x-axis at $x = 7m$.



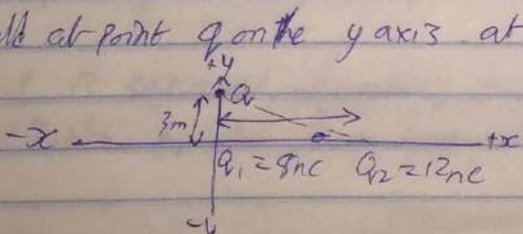
$$\varepsilon_1 = \frac{kq_1}{r_1} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.4694 N/C$$

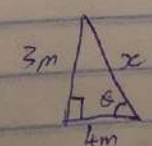
$$\varepsilon_2 = \frac{kq}{r_2} = \frac{9\times10^9 \times 12\times10^{-9}}{9} = 12N/C$$

vector	Angle	x—Component	y—Component
$\varepsilon_1 = 1.4694 N/C$	0	$1.4694\cos\theta = 1.4694$	0
	0	$12\cos\theta = 12$	0
		13.4694	

$$\varepsilon = \sqrt{\sum\varepsilon_x^2 + \sum\varepsilon_y^2}$$
$$E = \sqrt{\sum\varepsilon_x^2}$$
$$E = \sqrt{13.4694^2}$$
$$\varepsilon = 13.4694 N/C$$

ii) The electric field at point q on the y axis at $y = 3m$ due to the charge





$$x^2 = 3^2 + 4^2$$
$$x^2 = 9+16$$
$$\sqrt{x^2} = \sqrt{25}$$
$$x = 5m$$

$\varepsilon_1 =$
$\varepsilon_2 =$
ve
$\varepsilon_1 = 8$
$\varepsilon_2 = 4$
3a) Form
i volume
ii Surface
iii linear
b) Elect
Can be
Charge
We
a) When the
b Electr
Charge
c We
d We als
C $Q_1 =$
and
When

$\sin\theta = \frac{3}{5}$

$\theta = \sin^{-1}\frac{3}{5}$

$\theta = 36.87°$

$\mathcal{E}_1 = \frac{kq_1}{r^2} = \frac{9\times10^{9}\times8\times10^{-9}}{9} = 8N/c$

$\mathcal{E}_2 = \frac{kq_2}{r_2^2} = \frac{9\times10^{9}\times12\times10^{-9}}{5^2} = 4.32N/c$

Vector	Angle	X-component	Y-component
$\mathcal{E}_1 = 8N/c$	$90°$	$8\cos 90 = 0$	$8\sin 90 = 8$
$\mathcal{E}_2 = 4.32N/c$	$36.87°$	$4.32\cos 36.87 = 3.455995$	$4.32\sin 36.87°$
		3.455995	2.592
			10.592

$\mathcal{E} = \sqrt{\Sigma\mathcal{E}_x^2 + \Sigma\mathcal{E}_y^2} = \sqrt{3.455995^2 + 10.592^2}$

$E = 11.2N/c$

3a) Formulation of the following densities of charges

i volume charge density, $\rho = \frac{dQ}{dV} \rightarrow dQ = \rho dv$

ii Surface charge density, $\sigma = \frac{dQ}{dA} \rightarrow dP = \sigma dA$

iii linear charge density, $\lambda = \frac{dQ}{dL} \rightarrow dQ = \lambda dL$

b Electric potential difference between two points in an electric field can be defined as the workdone per unit charge against forces when a charge is transported from one point to the other.

We have different formulas depending on how the case maybe.

a) When the electric potential is in a uniform electric field

$V_B - V_A = \frac{W_{BA}}{q_0} \rightarrow B/m$

b Electric potential difference is also the potential energy per unit charge $\quad V_B - V_A = \frac{\Delta U}{q_0}$

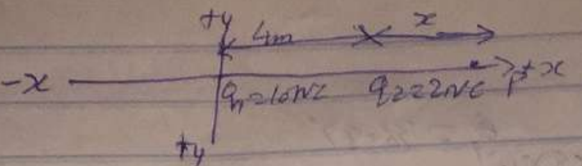
c we also have electric potential due to a single point charge

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

d We also have electric potential due to several point charge.

$V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2} + \frac{Q_3}{r_3} + \frac{Q_4}{r_4} + \cdots + \frac{Q_n}{r_n}\right]$

C $Q_1 = 10nC$ and $Q_2 = -2nC$ are along the x-axis at $x=0$ and $x=4m$ respectively. find the position along the x-axis where $V=0$



$$V_P = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{r_1} + \frac{q_2}{r_2}\right)$$

Let $V_P = 0$

$$0 = 9\times10^9\left[\frac{10\times10^{-16}}{4+x} + \frac{(-2\times10^{-6})}{x}\right]$$

$$0 = \frac{9000}{4+x} - \frac{18000}{x}$$

multiply through by $(4+x)(x)$

$$(4+x)(x)0 = \frac{90000}{\cancel{4+x}}\cancel{(4+x)}(x) - \frac{18000}{\cancel{x}}(4+x)\cancel{(x)}$$

$$0 = 90000x - 18000(4+x)$$

$$0 = 90000x - 72000 - 18000x$$

$$72000 = 90000x - 18000x$$

$$72000 = 72000x$$

$$x = 1$$

$$\therefore 4+x = 4+1 = 5$$

So, the position along the x-axis where $V=0$ is 5m

4a Magnetic flux is define as the strength of a magnetic field represented by the lines of force: It is represented by the symbol Φ

b $m_e = 9.11\times10^{-31}kg$, $r = 1.4\times10^{-7}m$, $B = 3.5\times10^{-1}\ W/m^2$ $\theta = 90^0$

$F_B = qvB\sin\theta$, where $\theta = 90^0$

$$F_B = qvB$$

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

$$V = \frac{qBr}{m_e} \qquad V = \frac{1.6\times10^{-19}\times3.5\times10^{-1}\times1.4\times10^{-7}}{9.11\times10^{-31}}$$

$$V = 8.605.93m/s$$

Hence, the angular speed

$$w = \frac{qB}{mp} = \frac{1.6\times10^{-19}\times3.5\times10^{-1}}{9.11\times10^{-31}} = 6.147\times10^{10}$$

C) We were told to find the cyclotron frequency which is the angular speed. the formula was provided above and the value were slotted into the formula.

5 State the Biot-Savart law.

i) The vector $d\vec{B}$ is perpendicular both to $d\vec{l}$ (which points in the direction of the current) and to the unit vector $\hat{r}$ directed from $d\vec{B}$ toward P

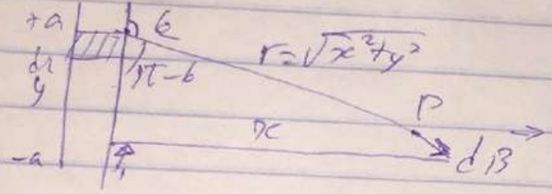
ii) The magnitude of $d\vec{B}$ is inversely proportional to r^2

iii) The magnitude of $d\vec{B}$ is proportional to the current I and to the magnitude of the length element $d\vec{l}$

iv) The magnitude of dB is proportioned to $\sin\theta$, where θ is the angle between $\hat{r}$ and $d\vec{l}$

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

b



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

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

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

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

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

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

Substituting (2) into (1) we have

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

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

Recall $dl = dy$

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

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

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

Equation (3) $\therefore$ becomes

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

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

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

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

In a physical situation, we have axial symmetry about the y-axis. Thus, at all point in a circle of radius r, around the conductor, the magnitude of B is

$$B = \frac{\mu_0 I}{2\pi r} \quad --- (4)$$