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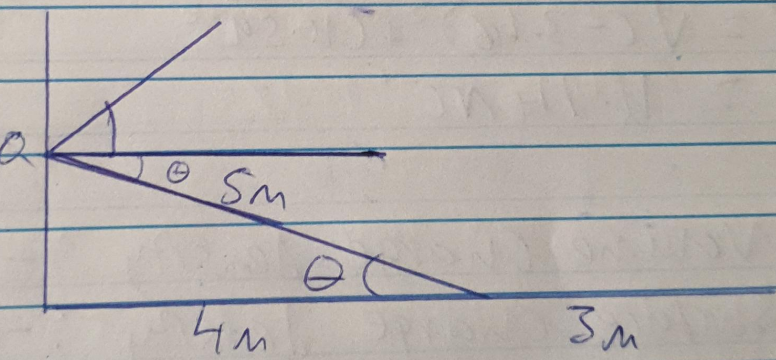
Section A

(2) (A) An electric field is a region in space in which an electric charge can be felt by an electric force within electric field intensity. It can also be defined as the force per unit charge.

(b) $Q_1 = 3\mu C$, $Q_2 = 12\mu C$, $x = 4m$

(i) $r = 7m$



$$E_1 = \frac{k_1 q_1}{r^2} = \frac{9\times10^4 \times 8\times10^{-4}}{7^2} = 1.5NC$$

$$E_2 = \frac{9\times10^4 \times 12\times10^{-4}}{3^2} = 12NC^{-1}$$

$$E_{net} = 12 + 1.5 = \underline{13.5NC^{-1}}$$

2 (ii) $QE_1 = \frac{9\times10^{9}\times8\times10^{-9}}{3^2} = 8NC^{-1}$

θ | $\times\cos\theta$ | $\times\sin\theta$
90° | 0 | +8

$E_2 = \frac{9\times10^{9}\times12\times10^{-9}}{5^2} = 4.32\,NC^{-1}$

$E_x = -3.46\,NC^{-1}$, $E_x = 10.59\,NC^{-1}$

$|\vec{E}| = \sqrt{(-3.46)^2 + (10.59)^2}$

$|E| = 11.14\,NC^{-1}$

5a (i) volume charge density :- $\rho = q/V$
(ii) surface charge density :- $\sigma = q/A$
(iii) linear charge density :- $\lambda = q/L$

(b) The electric potential difference between two points in an electric field can be defined as the work done per unit charge against electrical forces when a ~~Chage~~ charge transported from one point to another.

$dw = F.dl$

But $F = -q_0 E$

$\therefore dw = -q_0 E\,dl$

$W(A \to B)_{Ag} = -q_0 \int_A^B E\,dl$

$V_B - V_A = \frac{W(A \to B)_{Ag}}{q_0} = -\int_A^B E\,dl$

(c) Electrical field intensity $= \frac{q}{4\pi E_0 r^2}$

$\Rightarrow \frac{2 \times 10^{-9} C}{4\pi E_0 (d)^2} - \frac{10 \times 10^{-9} C}{4\pi E_0 (4+d)^2} = 0$

$2(16 + 8d + d^2) = 10d^2$, $32 + 16d + 2d^2 = 10d^2$

$32 + 16d^2 - 8d^2 = 0$

$8d^2 - 16d - 32 = 0$

$d^2 - 2d - 4 = 0$, using $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$d = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(-4)}}{2(1)}$

$d = 1 \pm 4.4721$

$d = 5.472$ or -3 ...

Based

h ...

Section B

4 (a) magnetic flux is defined as the str... represented by lines of ... of magnetic field ... forces.

(b) $B = 3.5 \times 10^{-1}$ weber/m^2

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

$r = 104 \times 10^{-7}$ m

$q = 1.6 \times 10^{-19}$

$w = ?$

$$w = \frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$w = 6.14 \times 10^{10}$ rad/s

5 (a) Biot-Savart law is an equation that describes the magnetic field created by current wire and allows you to calc... its strength at various points

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

(b) using Biot-Savart law, we gain the magnitude of the field $\vec{dB}$.

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

from Pythagoras theorem

$r^2 = x^2 + y^2$

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

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

substituting $(**)$ into $(*)$, 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 $dl = dy$

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

$$B = \frac{\mu_0 I}{4\pi} \int^{a} \ldots$$

Equation (***) therefore becomes

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

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

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

When the length 2a of the conductor is very great in comparison to its distance x from point, P, we consider it infinitely long. That is, when a is much larger than x, $(x^2+a^2)^{1/2} \approx a$, as $a \rightarrow \infty$

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

In a physical situation, we have axes symmetry about the y-axis. Thus, ~~at~~ all points in a circle of radius, r, around the conductor, the ~~m~~ magnitude of the magnetic field of a straight current carry of carrying conductor is ~~a~~ given as

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