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16/MHSN/118 (Carryover)
Human Nutrition and Dietetics
Physics 102

Holiday assignment:

3 A) i) Volume charge density: Charge density per unit volume of a solid material. The formula is $\rho = \frac{q}{V}$, where q is the charge and V is the volume of distribution. The SI unit is Cm^{-3}.

ii) Surface charge density: Charge density per unit area of the surface. The formula is $\sigma = \frac{q}{A}$, where q is the charge and A is the area of the surface. The SI unit is Cm^{-2}.

iii) Linear charge density: Charge density per unit length of thin rod or thin wire. The formula is $\lambda = \frac{q}{L}$, where q is the charge and L is the length over which is distributed. SI unit is Cm^{-1}.

B Electric potential difference

$dW = f \cdot dl$ ...... (1) But

$f = q_0 E$ .... (2)

Substituting equation (2) in (1) yields

$dW = q_0 E dL$ ..... (3)

Then total work done in moving the test charge from A to B is:

$W(A \to B)_{Ag} = -q_0 \int_A^B E dL$ .... (4)

It follows that:

$V_B - V_A = \frac{W(A \to B)_{Ag}}{q_0}$ ...... (5)

~~Putting~~

Putting equations (4) in (5) yields

$V_B - V_A = -\int_A^B E dL$ .... (6)

The electric potential difference is the work done per unit charge against electrical forces when a charge is transferred from one point to the other.

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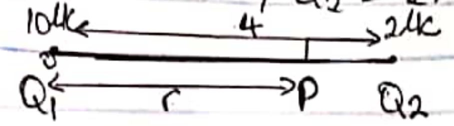
C $Q_1 = 10\,\mu C$, $Q_2 = 2\,\mu C$



$V = \frac{Kq_1}{r} + \frac{Kq_2}{4-r}$

If $V = 0$

$\frac{Kq_1}{r} = -\frac{Kq_2}{4-r}$

$\frac{10\times10^{-6}C}{r} = \frac{(-2\times10^{-6}C)}{4-r}$

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

$\frac{4}{r} - 1 = \frac{2}{10}$

$\frac{4}{r} = \frac{2}{10} + 1$

$\frac{4}{r} = \frac{2+10}{100} = \frac{12}{10}$

$\frac{4}{r} = \frac{12}{10}$

$\frac{4\times10}{12} = \frac{40}{12} = 3.3m$ $\therefore r = 3.3m$

④

A The magnetic flux is defined as the strength of magnetic field represented by lines of force. The symbol is Φ.

B The cyclotron frequency of the moving electron.

Soln.

$M = 9.11\times10^{31}$ kg, $r = 1.4\times10^{-4}$ m, $B = 3.5\times10^{-1}$ weber/m^2, $\theta = 90^0$

$w = ?$, $q = -1.60\times10^{-19}$C

$w = \frac{-1.60\times10^{-19}\times3.5\times10^{-1}}{9.11\times10^{31}}$

$= -6.15\times10^{10}$ rad/sec)

C Since our cyclotron frequency is negative $\therefore -6.15\times10^{10}$ rad/sec

It means that the charge particle electron circulates in a negative or opposite direction of the angular frequency.

(5)

A The Biot-Savart law is an equation that describes the magnetic field created by a current-carrying wire and allows you to calculate it's strength at various points.

B $$d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\,d\vec{s}\times\vec{r}}{r^3}$$

$$dB = \frac{\mu_0}{4\pi}\frac{i\,ds(r\sin\theta)}{r^3}$$

$$B = \frac{\mu_0 i}{4\pi}\int_{-\infty}^{\infty}\frac{ds\,(r\sin\theta)}{r^3}$$

$$= \mu_0 i\int_{-\infty}^{\infty}\frac{R\,ds}{(s^2+R^2)^{3/2}}$$

$$= \mu_0 i\int_{0}^{\infty}\frac{R\,ds}{(s^2+R^2)^{3/2}}$$

$$= \frac{\mu_0 i R}{2\pi}\left[\frac{s}{R^2(s^2+R^2)^{1/2}}\right]_0^{\infty}$$

$$B = \frac{\mu_0 i}{2\pi R}$$

(1)

B $$F = \frac{kq_1q_2}{r^2} = 1.0N$$

Solve for the value of the product of the charges!

$$q_1q_2 = (1.0N)\frac{r^2}{k}$$

$$(1.0N)(2.0m)^2\,8.99\times10^9\,N.m^2C^2 = 4.449\times10^{-10}\,C^2$$

Now we have two equations for the two unknowns q_1 q_2

$$q_2 = 5.0\times10^{-5} - q_1$$

$$q_1q_2 = 4.449\times10^{-10}$$

$$q_1(5.0\times10^{-5} - q_1) = 4.449\times10^{-10}$$

$(5.0\times10^{-5}\, q_1 - q_1^2) = 4.449\times10^{-10}$

$q_1^2 - (5.0\times10^{-5}\,C)\, q_1 + 4.449\times10^{-10} = 0$

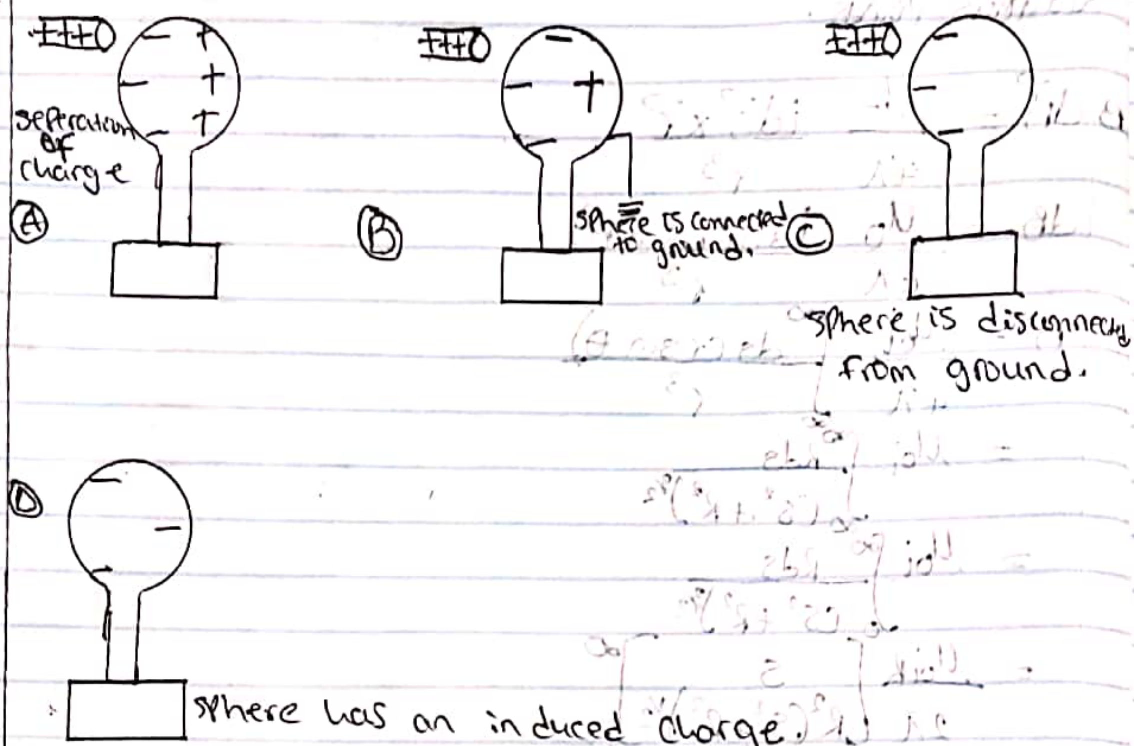
use a quadratic formula

$q_{1,2}$

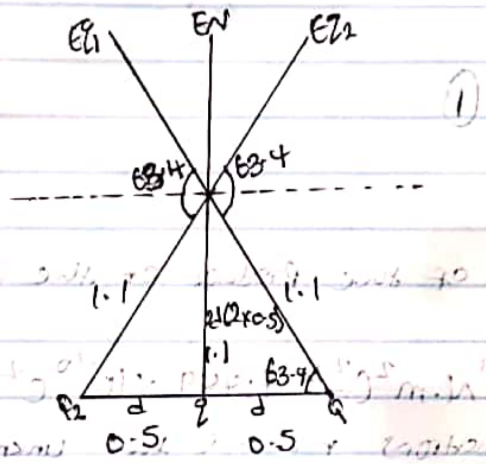
$$= \frac{(5\times10^{-5}) \pm \sqrt{(5\times10^{-5})^2 - 4(4.449\times10^{-10})}}{2}$$

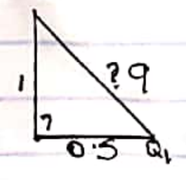
$q_1 = 3.84\times10^{-5}\,C$ and $q_2 = 1.11\times10^{-5}\,C$

A



C





using Pythagoras theorem

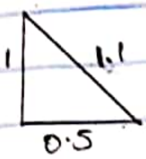
$r^2 q^2 = 1^2 + 0.5^2$

$q^2 = 1 + 0.25$

$q^2 = 1.25$

$q = \sqrt{1.25}$

$q = 1.1$



$\tan\theta = \frac{1}{0.5}$, $\theta = 63.4$

$E_P = E_{Q_1} + E_{Q_2} + E_Q$

$E_{Q_1} = \frac{KQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.1^2} = 59504\ N/C$

$E_{Q_2} = \frac{KQ_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.1^2} = 59504\ N/C$

$E_Q = \frac{KQ}{r} = \frac{9\times10^9 \times Q}{1^2} = 9\times10^9 Q\ N/C$

Vector	Angle	Xcomp	Ycomp
$E_{Q_1} = 59504$	63.4^0	$59504 \cos 63.4 = 26643$	$59504 \sin 63.4 = 53205$
$E_{Q_2} = 59504$	63.4^0	$59504 \cos 63.4 = 26643$	$59504 \sin 63.4 = 53205$
$E_Q = 9\times10^9 Q$	90	$9\times10^9 Q \cos 90 = 0$	$9\times10^9 Q \sin 90 = 9\times10^9 Q$
		$\Sigma F_x = 0$	$\Sigma F_y = 106410 + 9\times10^9 Q$

$E_P = \sqrt{0^2 + (106410 + 9\times10^9 Q)^2}$

$E_P = \sqrt{(106410 + 9\times10^9 Q)^2}$

$E_P = 106410 + 9\times10^9 Q$

at $E_P = 0$

$106410 + 9\times10^9 Q = 0$

$\frac{9\times10^9 Q}{9\times10^9} = \frac{106410}{9\times10^9}$

$Q = -1.18\times10^{-5}\ C$

$Q = \cancel{-}12\ \mu C$

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