Name: Oruy-Iye Eepho Matric no: 19/MHS01/357
Department: Medicine & Surgery. Course code: PHY104.

No 3

a. i. Volume charge density = $\frac{\text{Charge}}{\text{Volume}}$ ie $\rho = \frac{dQ}{dV} = dQ = \rho dV$

ii Surface charge density = $\frac{\text{Charge}}{\text{Area}}$ ie $\sigma = \frac{dQ}{dA} = dQ = \sigma dA$

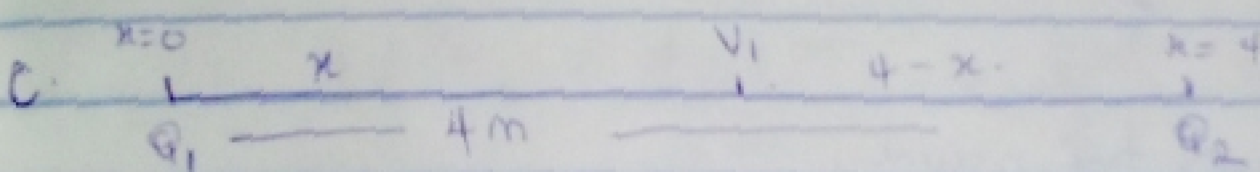
iii Linear charge density = $\frac{\text{Charge}}{\text{Length}}$ ie $\lambda = \frac{dQ}{dL} = dQ = \lambda dL$

b. Electric potential difference between two points in an electric field is the work done per unit charge against electrical forces when a charge is transported from one point to another.

Hence: $V_B - V_A = \frac{W(A \to B)}{q_0}$

where $V_B \to V_A$ = Potential difference
$W(A \to B)$ = Total work done in moving the test charge from A → B
q_0 = Test charge.

c.



$V_1 = \frac{Q_1}{4\pi\varepsilon_0 x}$, $V_2 = \frac{Q_2}{4\pi\varepsilon_0 (4-x)}$

$V_1 + V_2 = 0 = V$

$V = \frac{10 \times 10^{-6}}{4\pi\varepsilon_0 x} - \frac{2 \times 10^{-6}}{4\pi\varepsilon_0 (4-x)}$

$\frac{\cancel{10}^{5} \times \cancel{10^{-6}}}{\cancel{4\pi\varepsilon_0} x} = \frac{\cancel{2} \times \cancel{10^{-6}}}{\cancel{4\pi\varepsilon_0}(4-x)}$

$\frac{5}{x} \times \frac{1}{4-x} \Rightarrow 5(4-x) = x$

$20 - 5x = x$

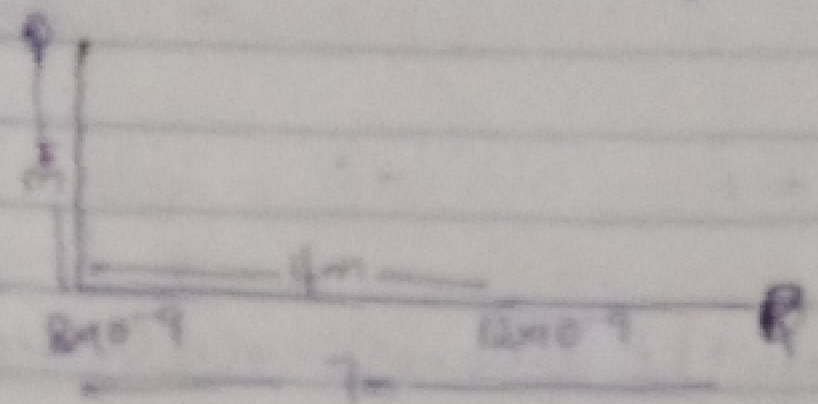
$20 = x + 5x$

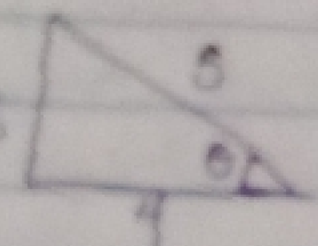
$20 = 6x$

$x = \frac{20}{6} = x = \frac{20}{6} = 3.33m$

2a. An electric field is a region of space in which an electric charge will experience an electric force while electric field intensity ~~____~~ is known as the force per unit charge.

b.





Using pythagoras:

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

$\theta = \sin \frac{opp}{hyp} = \frac{3}{5} = 0.6$, $\sin^{-1}(0.6) = 36.57°$.

i) $E_1 = \frac{Kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.5\ NC^{-1}$

$E_2 = \frac{Kq_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = 12\ NC^{-1}$

	Angle	x-Component	Y-Component
$E_1 = 1.5$	0	$1.5 \cos 0 = 1.5\ N/C$	$1.5 \sin 0 = 0$
$E_2 = 12$	0	$12 \cos 0 = 12\ N/C$	$12 \sin 0 = 0$
		$\Sigma = \cancel{27 N/C}\ 13.5\ NC^{-1}$	$\Sigma = 0\ N/C$

$\therefore |E| = \sqrt{\cancel{27^2} + 0^2}$ $\sqrt{13.5^2 + 0^2} = \sqrt{13.5^2}$

$\therefore |E| = 13.5\ NC^{-1}$

ii) $E_1 = \frac{Kq}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8\ NC^{-1}$

$E_2 = \frac{Kq_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32\ NC^{-1}$

	Angle	x-Component	Y-Component
$E_1 = 8$	90	$\cancel{Cos}\ 8 \cos 90 = 0$	$8 \sin 90 = 8$
$E_2 = 4.32$	36.87	$4.32 \cos 36.87 = 3.46$	$4.32 \sin 36.87 = 2.592$
		$\Sigma = 3.46\ NC^{-1}$	$\Sigma = 10.592\ NC^{-1}$

$|E| = \sqrt{3.46^2 + 10.59^2} = 11.14\ NC^{-1}$

a. Magnetic flux is the measure of the total size of a magnetic field. It is the scalar product of the flux density and area, measured in webers.

b. Using $\omega = \frac{qB}{m_e} = \frac{1.60\times10^{-19} \times 3.5\times10^{-1}}{9.11\times10^{-31}} = 6.15\times10^{10}$ rad/s

$\therefore \omega = 6.15\times10^{10}$ rad/s

c. The cyclotron frequency of a moving charged particle (eg electron) in a uniform magnetic field of flux density B is given by

$$\omega = \frac{qB}{m}, \quad \text{where}$$

q is the charge and m is the mass of the particle. From the above equation it shows that an increase in the flux density will bring about an increase in the cyclotron frequency and a decrease in the flux density will bring about a decrease in the cyclotron frequency.

NO6

a). In an electric guitar, the coil which is represented with the pickup coil is placed near the vibrating guitar string which is made of a metal and can be magnetized. A permanent magnet inside the coil magnetizes the portion of the string nearest the coil. When the string vibrates at some frequency, its magnetized segment produces a changing magnetic flux through the coil. The changing flux induces an emf in the coil that is fed to an amplifier. The output of the amplifier is sent to the loud speakers which produces the sound waves we hear.

b) i) The magnetic flux through the coil at $t = 0$ is because $B = 0$ at the time.

ii) $|\xi| = \frac{N dAB}{dt} = \frac{NA(B_{t_2} - B_{t_1})}{(t_2 - t_1)}$

$|\xi| = \frac{300 \times 10^{-2} \times (10-0)}{0.5}$

$|\xi| = 60 V$

iii) Current $(I) = \frac{|\xi|}{R} = \frac{60}{2} = 30A$.

c). Since the field changes with time, assume,

$B = B_0 \sin \omega t$

$\therefore \phi = AB = AB_0 \sin \omega t$

and $|\xi| = \frac{N d\phi}{dt} = \frac{d}{dt}(AB_0 \sin \omega t)$

$= \omega A B_0 \cos \omega t$.

Hence the magnitude of the induced e.m.f

$\xi_0 = N\omega AB_0$

Since $\frac{\xi_0}{R} = I$, $\xi_0 = IR = N\omega AB_0$

$\therefore \omega = \frac{IR}{NAB_0}$