NAME: IVWURIE OGHENEMINE RUTH
COLLEGE: MEDICINE AND HEALTH SCIENCES
DEPARTMENT: MEDICINE AND SURGERY
MATRIC NUMBER: 19/MHS01/211

SECTION A

2(a)

Electric field	Electric field Intensity.
It is a region of space in which an electric charge will experience an electric force	It is the force per unit charge

2b

$q_1 = 8\mu C$
$q_2 \; 12\mu C$

$E_1 = \frac{KQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.5 N/C$

$E_2 = \frac{KQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{7^2} = 12 N/C$

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

$E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8 N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.3 N/C$

Vector	Angle	x-comp	y-comp
$E_1 = 8 N/C$	$90°$	0	8
$E_2 = 4.32 N/C$	$36.87°$	-3.45	2.59
		-3.45	10.59

$E_{net} = \sqrt{E_{fx}^2 + E_{fy}^2}$

$E_{net} = 11.12 N/C$

3(a) i) Volume charge density. $\rho = \frac{dQ}{dv} = dQ = \rho dv$

ii) Surface charge density $\sigma = \frac{dQ}{dA} = dQ = \sigma dA$

iii) Linear charge density $\lambda = dQ/dL = dQ = \lambda dL$

where Q = charge V = Volume L = Length A = Area

(b) Electric potential difference

(i) due to a single point charge

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

where Q = point charge
r_B = distance of Q to point B
r_A = distance of Q to point A

(ii) due to several point charges

$$V_P = \frac{1}{4\pi\varepsilon_0} = \left[\frac{Q_1}{r}\right] + \left[\frac{Q_2}{r}\right]$$

where V = Electric potential
Q = point charge
r = distance of Q

3c Point charge $Q = 10\mu C$ $Q_2 = 2\mu C$

$$V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

recall $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$

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

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

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

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

$8 \times 10^{-6} = 8 \times 10^{-6} x$

$x = 1$

$\therefore$ The position along the x axis is 1m

where $v = 0$

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

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

$8 \times 10^{-6} = 12 \times 10^{-6} x$

$$x = \frac{8 \times 10^{-6}}{12 \times 10^{-6}}$$

$x = 0.67m$

SECTION B

4a Magnetic flux is defined as the strenght of the magnetic field which can be represented by line of force. It is denoted by ϕ

b $$F_B = qVB = \frac{M_e V^2}{r}$$

$M_e V = qBr$

$$V = \frac{qBr}{M_e} = \frac{(1.6 \times 10^{-19})(3.5 \times 10^{-1})(1.4 \times 10^{-7})}{(9.11 \times 10^{-31})}$$

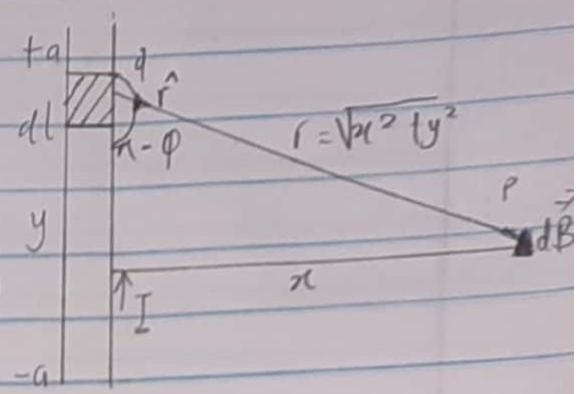
$V = 8.61 \times 10^{-3}$ m/s

$$w = \frac{v}{r} = \frac{qB}{m_e} = \frac{(1.6\times10^{-19})(3.5\times10^{-7})}{(9.11\times10^{-31})}$$

$$= 6.14\times10^{10} s^{-1}$$

5a Bio-Savart law states that the magnetic field is directly proportional to the product permeability of free space (μ), the current (I), the change in length, the radius and and inversely proportional to the square of radius.

b $$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} dl\,\frac{\sin\phi}{r^2}$$



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

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

$r^2 = x^2+y^2$ (from diagram)

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{dl\,\sin(\pi-\phi)}{x^2+y^2} \quad \ldots\ldots (i)$$

$$\sin(\pi-\phi) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}} \quad \ldots (2)$$

Substituting equ (ii) into equation (i)

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

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

Using special integral

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

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

$$(x^2+a^2)^{1/2} = a \quad \text{as } a \to \infty$$

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