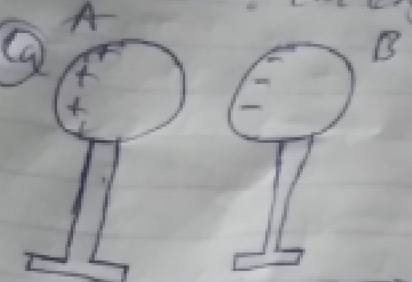
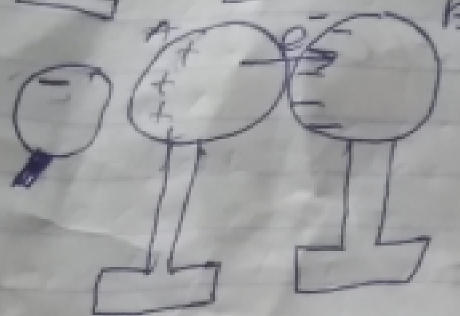
Name:- Oguchesom Department:- Aeronautical
Matric no.:- 1a(Eng 0a1012

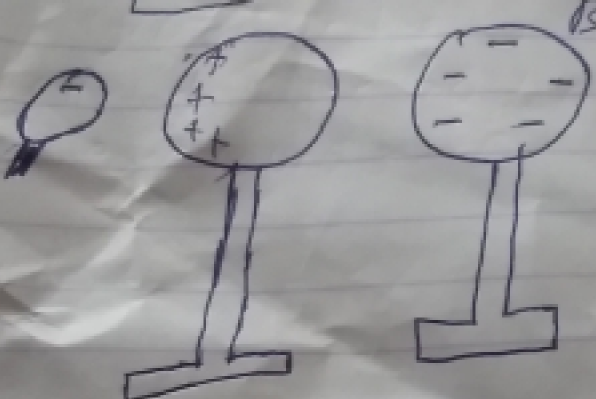
(a)



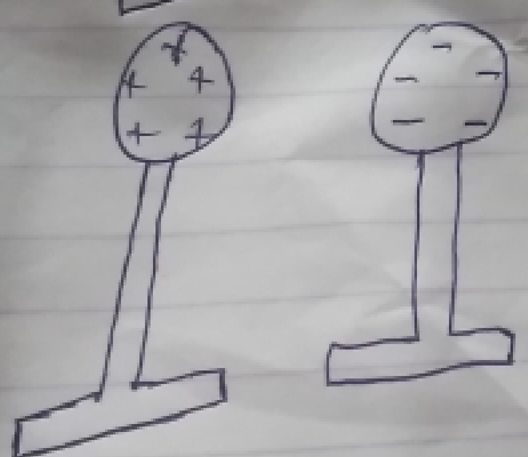
Two metal spheres are mounted on insulating stands.



The presence of a charge induces e^- to move from sphere A to B. The two sphere system is polarized.



Sphere B is seperated from sphere A using insulating stand. The two spheres have opposite charges.



The excess charge distributes itself uniformly over the surface of the spheres.

(b) $E = \frac{F}{Q}$

$$E = \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{r^2}$$

$$= 8.99\times10^{9} \times \frac{5\times10^{-5}}{(2)^2}$$

$= \frac{8.99 \times 5 \times 10^4}{4}$

$= \frac{44.95 \times 10^4}{4}$

$= 11.23 \times 10^4$

$= 1.12 \times 10^5 NC^{-1}$

$1.12 = \frac{1N}{q}$

$q = \frac{1N}{1.12 \times 10^5} = \cancel{0.836}\ 8.93 \times 10^{-6} C$

(2a) The electric field is a region around a charge in which it exerts electrostatic force on another charges, while the strength of the electric field at any point in space is called electric field intensity. It is a vector quantity. It is in NC^{-1}

$$E = \frac{F}{q_0}$$

(b) $$E = \frac{8.99\times10^{9}\times8\times10^{-9}\times12\times10^{-9}}{(3)^2}$$

$$= \frac{863\times10^{-9}}{9}$$

$$E = 9.59\times10^{-8}\,NC^{-1}$$

(3)(a) Volume charge density:-

$\rho = \frac{q}{V}$

where, q is the charge
V is the volume of distribution. The S.I unit is Cm^{-3}

(ii) Surface charge density

$\sigma = \frac{q}{A}$ where, q is the charge
A is the area of the surface
S.I unit is Cm^{-2}.

(iii) Linear charge density; $\lambda = \frac{q}{l}$

where q is the charge and l is the length over which it is distributed. The S.I unit is Cm^{-1}

(b) The electric potential at a particular point in space is the work done in moving a positive charge from infinity to that point. The electric potential at infinity is defined as zero. It is related to the electric potential energy in that electric potential is the electric potential energy between two points in space. It is also measured in Joules per coulomb.
In a uniform electric field, the equation to calculate the electric potential difference.

$V = Ed$

where, V is the potential difference in volts
E is the electric field strength in area
d is the distance between the two plates.

(c) (6) $F = \frac{kq_1q_2}{r^2} = \frac{8.99\times10^9\times10\times10^{-6}\times2\times10^{-6}}{(4)^2}$

$= 0.0112370$

$= 1.12\times10^{-2}N$

(4) Magnetic flux through a surface is the surface intergral of the normal component of the magnetic field flux density B passing through that surface
S.I unit is weber (wb) (volt-second)
It is usually measured with a flux-meter
It depends on:
- the ~~magn~~ strength of the magnetic field
- component of the vector of the magnetic field are perpendicular to the surface.
In the most general form, magnetic flux is defined as $\Phi_B = \iint B \cdot dA$. It is the intergral (sum) of all the magnetic field passing through infitesimal area elements dA.

(b) $m = 9.1 \times 10^{-31} kg$
$q = 1.6 \times 10^{-9} C$
$B = 7.5 \times 10^{-1}$
Cyclotron frequency $= f = \frac{qB}{2\pi m} = \frac{1.6 \times 10^{-9} \times 7.5 \times 10^{-1}}{2 \times \pi \times 9.11 \times 10^{-31}}$
$= \frac{5.6 \times 10^{-10}}{5.72 \times 10^{-3}}$
$= 9.78 \times 10^{19} Hz$

(5) Biot-savart law states that the magnetic flux density near a long, straight conductor is directly proportional to the distance from the conductor.
A small segment of a conductor Δl along which a current of strength I is flowing creates at a given point M in space, located at a distance from r from the segment

Δl ($\Delta l < r$) a magnetic field of strength

$$\Delta H = k \cdot \frac{I \Delta l \sin\theta}{r^2}$$

θ is the angle between the direction of the current in the segment.
r is the radius vector
m and k are the coefficient of proportionality

(6) Considering the magnetic field due to the current element $I\vec{dx}$ located at the position x
Using the right hand rule / from the
$\vec{dx} \times \vec{r}$
By using scalar addition

$$|\vec{dx} \times \hat{r}| = (dx)(1)\sin\theta$$

From biot savart law, $B = \frac{\mu_0}{4\pi} \int_0^\infty \frac{I \sin\theta \, dx}{r^2}$

Express r as in $r = \sqrt{x^2 + R^2}$
express $\sin\theta$ as in $\sin\theta = \frac{R}{\sqrt{x^2+R^2}}$

Substitution = $B = \frac{\mu_0 I}{2\pi} \int_0^\infty \frac{R\,dx}{(x^2+R^2)^{\frac{3}{2}}}$

~~Bo~~
evaluating the integral yields

$$B = \frac{\mu_0 I}{2\pi R} \left[\frac{x}{(x^2+R^2)^{\frac{1}{2}}} \right]_0^\infty$$

limiting the integral $B = \frac{\mu_0 I}{2\pi R}$

(6) The electric guitar is a type of string instruments that doesn't make sound directly from its strings but uses a kind of electromagnetic Induction. It send waves to a loud speaker and the loud speaker then recieves and plays sound speaker sound making is made up of paper or plastic moulded into a cone shape called diagraphic. When an audio signal from the guitar is applied to the sound speaker's voice coil which is suspended in a circular gap between the poles of a permanent magnet, the coil moves rapidly back and forth due to Faraday's law of induction. This causes the diagraphm in the loudspeaker attached to the coil to move back and forth, pushing air to create sound waves.