E1 E2 E3

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Assignment

Section A

1. Charging by induction

Electric charges can be Obtained on object without touching it, by a process called electrostatic induction. Consider a negatively charged rubber rod brought near a neutral (uncharged) conducting sphere that is insulated so that there is no conducting path to ground as shown below. The repulsion force between the electrons in the rod, and those in the sphere so that some electron move to the side of the farthest away from the rod has an excess of positive charge because of the migration of electron away from this location. If a grounded conducting wire is the electrons leave the sphere and travel to the earth. If the wire to the ground is then removed, the conducting sphere is left with an excess of induced positive charge. Finally, when the rubber rod is removed from the vicinity of the sphere the induced positive charge remains on an sphere and becomes uniformly distributed over the surface of the sphere

a) $.k=9x10^9$

$.q1+q2=5\times10^{-5}c$

$.f=1N$

$d= 2m$

Charge on each sphere=?

$.f=kq1q2/r^2$

$1=9x10^{-9}(q1q2\ 5x10^{-5})/2^2$

$4=9x10^9x5x10^{-5}\ q1+q2x10^9$

$4=4.5x10^5q1+4=0$

Quadratic equation

$9x10^9q2-4.5x10^3q1+4=0$

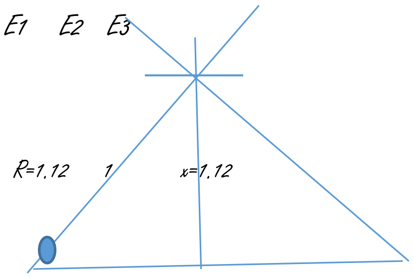
$.q1=0.0000111c=1.11x10^{-5}c$

$.q2=0.000038c=3.8x10^{-5}c$

- Q1=Q2=8Uc

D=0.5m

If electric field point p is zero



2d=0.5 qd=0.5

$E1=kq1/r^2$

$=9x10^9x8x10^{-6}/(1.12)$

=57397.9598

$x^2=1^2+0.5$

$=\sqrt{1.25}$

.x=1.12

Tan =opp/adj

Tan=1/0.5

$Ð=Tan^{-1}$

=63.4

$E2=kq2/r^2$

$= 9x10^9x8x10^{-6}=57387.95918$

$Eq=kq/r^2=9x10^9xq/1=9x10^9q$

Vector	Angle	X-component	Y-component
E1=57397.95918	63.4^o	E1cosÐ=2570.04785	E1sinÐ=5132.26283
E2=57397.95918	63.4^o	2570.046785	5132.26283
$Eq=9x10^9q$	90^o	EqcosÐ=0 Ex=0	$9x10^9q$ Ey=10264.52568

- $Magnitude=\sqrt{(Ex)^2+(Ey)^2}$

$Eq=\sqrt{(0)^2+(10264.52568)^2}$

Since Eq=0

$0=9x10^9+10264.52568$

Making q subject of the fprumlar

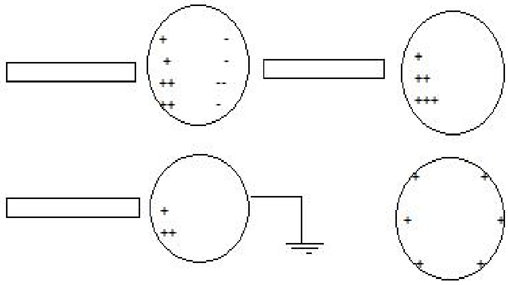
$.q=10264.52568/9x10^9$

$q=1.14050285x10^{-16}$

.q=11.4Uc

- The induced positive charge remains on the underground sphere and becomes uniformly distributed over the surface of the sphere

E1 E2 E3



Volume charge density ∫=dQ/dv n dQ= ∫dv
Surface charge density= dQ/dA n dQ=ÕdA
Linear charge density=dQ/dl in dQ=dl

❖ <u>Electric potential difference</u>

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 charge is transparent from one point to another. It is measured in volt (v) or jolts per unit columb(J/c)it is a scaler quantity

Elemental work done dw is given as

.dw=F.dl- -(1)

$F= q_o b$- -(2)

Subtituting equation (2)in(1)= dw= $-q_o Edl$- -(3)

$W(A' n B)_{Ag}$= -qo $\int^B{}_A$ Edl- -(4)

From the definition of electric potential difference follows that:

VB-VA=$W(A'n B)_{Ag}$/qo

Putting equation (4)in (3)yields VB-VA=- $\int^B{}_A$Edl- -(b)

❖ <u>Section B</u>

Magnetic field is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol ØB-dA

E1 E2 E3

- $m=9x10^{-31}kg$

.$r=1.4x10^{-7}m$

$B = 3.5x10^{-1}$ weber/meter

Cyclone frequency= angular speed

$W=v/r=qB/m$

$W=qB/m=1.6x10^{-19}x3.5x10^{-1}/9.9x10^{-31}$

$W=6.22x10^{10}T^{-1}$

- . Mass of electron=$9.11x10^{-31}kg$

Radius=$1.4x10^{-7}$

Magnetic field=$3.5x10^{-1}$ weber/meter^2

Cyclone frequency can be called angular speed

Recall angular speed $W=v/r=qb/m$

Substituting we have $W=v/r=qb/m=1.6x10^{-19}x3.5x10^{-1}/9.11x10^{-31}$

$=6.22x10^{10}T^{-1}$.

So cyclotron frequency=$6.22x10^{10}T^{-1}$, the unit is equal to the frequency dimentionaly.

- But-savatrt law states that the magnetic field is directly proportional to the product permeability of free space (U) the current (I), the change in length, the radius of (r^2)
- It can be represented mathematically by

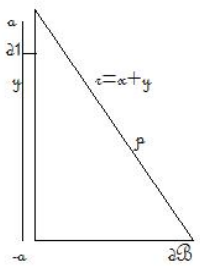
$dB=MoIDlxr/4\pi r^2$ where U is constant called

Permeability of free space

$U=4\pi x10^{-7}Tm/a$

Unit of B is weber/meter square

- Magnetic field of a straight current carrying conductor



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Applying the Bio-Savart law, we find the magnitude of the field $d\vec{B}$

$$B = \frac{\mu_o I}{4\pi}\int_{-a}^{a} \frac{dl \sin\varphi}{r^2}$$

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

$$\therefore B = \frac{\mu_o I}{4\pi}\int_{-a}^{a} \frac{dl sin(\pi - \varphi)}{r^2}$$

From diagram, $r^2 = x^2 + y^2$ $(Pythagoras\ theorem)$

$$B = \frac{\mu_o I}{4\pi}\int_{-a}^{a} \frac{dl sin(\pi - \varphi)}{x^2 + y^2} \quad \ldots \quad (*)$$

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

Substituting $(**)$ into $(*)$, we have

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

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

Recall $dl = dy$

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

$$B = \frac{\mu_o I x}{4\pi}\int_{-a}^{a} \frac{1}{(x^2 + y^2)^{3/2}} dy \quad \ldots \quad (***)$$

Using special integrals:

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

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$$\left(\frac{2a}{\left(x^2 + a^2\right)^{1/2}}\right)$$

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,

$$(x^2 + a^2)^{1/2} \cong a, as\ a \to \infty$$

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

In a physical situation, we have axial symmetry about the y- axis. Thus, at all points in a circle of radius r, around the conductor, the magnitude of B is

$$B = \frac{\mu_o I}{2\pi r} \qquad \ldots \qquad (\#)$$

Equation $(\#)$ defines the magnitude of the magnetic field of flux density B near a long, straight current carrying conductor.