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**COLLEGE**: Medicine and Health Sciences

**DEPARTMENT**: Pre-medicine and Surgery

**LEVEL**: 100

**Assignment**

1. (a) Consider a positively 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 repulsive force between the protons in the rod and those in the sphere causes a redistribution of charges on the sphere so that some protons move to the side of the sphere farthest away from the rod (fig.a). The region of the sphere nearest the positively charged rod has an excess of negative charge because of the migration of protons away from this location. If a grounded conducting wire is then connected to the sphere, as in (fig.b), some of the protons leave the sphere and travel to the earth. If the wire to ground is then removed (fig.c), the conducting sphere is left with an excess of induced negative charge.

Finally, when the rubber rod is removed from the vicinity of the sphere (fig.d), the induced negative charge remains on the ungrounded sphere and becomes uniformly distributed over the surface of the sphere.

The diagram below illustrate how to produce a negatively charged sphere by the method of induction:

1. ++++ --- (ii) ---- +++

+ + + + + ++++ ----- + + + + + + ------ +++++

+++ --- ----- ++++

Fig.a Fig.b

(iii) - (iv) - - -

+ + + + + + + - - - - - - - - - - -

- - - - - - - - - -

- - - - - - -

Fig.c Fig.d

(b) q₁= ? q₂=? q₁+q₂=5.0×10e-5… (Equation 1) F=1.0N d=2.0m

Substitute equation 2 into equation 1

When

0r when

(c)

Electric field at P= 0

2d = 1m

P

2d

Q1 d q d Q2

1.0 x

0.5

Using Pythagoras triangle,

C

|  |  |  |  |
| --- | --- | --- | --- |
| Vector | Angle | X-components | Y-components |
| E₁=57600 | 63.43° | -25781.93 | 51507.78 |
| E₂=57600 | 63.43° | 25781.93 | 51507.78 |
| E**3**=9×10e9q | 90° | 0 | 9×10e9q |
|  | |  |  |

1. (a) Electric field is a region of space in which an electric charge will experience an electric force.

Electric field intensity can be defined as force per unit charge. It is measured by Newton per Coulomb (N\C).

(b) Y-axis

Point Q

3m 5m

Q1 Q2 point P

X-axis

0 4m 7m

q₁=8nC, q₂=12nC, r₁=7m, r₂=3m, k=9×10e9Nm²/C²

|  |  |  |  |
| --- | --- | --- | --- |
| Vector | Angle | X-component | Y-component |
| E₁=1.469 | 0° |  |  |
| E₂=12.00 | 0° |  |  |
|  |  |  |  |

(ii) q₁=8nC, q₂=12nC, r₁=3m, r₂=5m, k=9×10e9Nm²/C²

|  |  |  |  |
| --- | --- | --- | --- |
| Vector | Angle | X-components | Y-components |
| E₁=8N/C | 90° | 0 | 8 |
| E₂=4.32N/C | 53.13° | 2.59 | 3.46 |
|  |  |  |  |

SECTION B

1. (a) Magnetic flux is defined as the strength of magnetic field represented by lines of force. It is represented by the symbol Φ.

(b) M= 9.11×10e-31kg, r= 1.4×10e-7m, B= 3.5×10e-1 Webster/meter², q=1.6×10e-19C

(c) The cyclotron frequency is the inverse of the period which is the time taken for the accelerated electron to complete a cycle in the magnetic field.

The cyclotron frequency is also known as the angular speed of the particle.

1. (a) Biot-savart law states that the magnetic intensity at any point due to a steady current in an infinitely long straight wire is directly proportional to the current and inversely proportional to the distance from point to wire.

(b) +a

dl

y P

x dB

l

-a

A section of a straight current carrying conductor

Applying the Biot-Savart Law, we find the magnitude of the field d B

From the diagram, r²=x²+y² (Pythagoras theorem)

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

Recall dl=dy

Using special integrals:

Equation (\*\*\*) therefore becomes

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,

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

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