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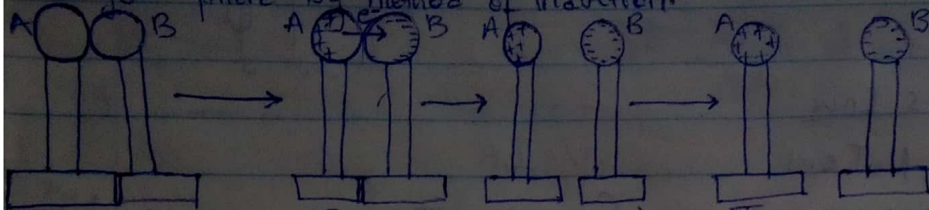
Dept: Petroleum Engineering 19/ENG07/022

1a) Explain with the aid of a diagram how you can produce a negatively charged sphere by method of induction.



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 separated from sphere A using the insulating stand. The two sphere have opposite charge.

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

1b) Each of two small spheres is charged positively, the combined charged being $5.0 \times 10^{-5} C$. If each sphere is repelled from the other by a force of 1.0N when the sphere are 2.0m apart, Calculate the charge on each sphere.

Solution

$|q_1| = q_1$ and $|q_2| = q_2$ $F = \frac{Kq_1q_2}{r^2} = 1.0N$ $q_1q_2 = (1.0N)\frac{r^2}{K}$

$(1.0N)(2.0m)^2 8.99 \times 10^9 N \cdot m^2 C^2 = 4.449 \times 10^{-10} C^2$ $q_2 = 5.0 \times 10^{-5} - q_1$

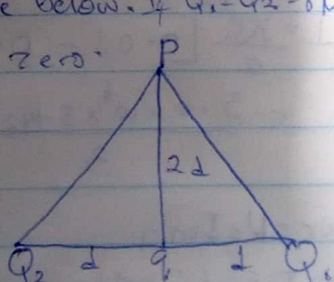
$q_1q_2 = 4.449 \times 10^{-10}$ $q_1(5.0 \times 10^{-5} - q_1) = 4.449 \times 10^{-10}$ $(5.0 \times 10^{-5} q_1 - q_1^2) = 4.449 \times 10^{-10}$

$q_1^2 - (5.0 \times 10^{-5} C)q_1 + 4.449 \times 10^{-10} = 0$ using quadratic equation

$= (5 \times 10^{-5}) \pm \sqrt{(5 \times 10^{-5})^2 - 4(4.449 \times 10^{-10})}$

$q_1 = 3.84 \times 10^{-5} C$, $q_2 = 1.16 \times 10^{-5} C$

1c) Three charges were positioned as shown in the figure below. If $Q_1 = Q_2 = 8\mu C$ and $d = 0.5m$ determine q if the electric field at P is zero.



Solution

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

$0 = \frac{1}{4 \times 3.142 \times 8.85 \times 10^{-12}} \frac{Q}{(0.5)^2}$

$= \frac{1}{1.112268 \times 10^{-10}} \frac{Q}{0.25}$

$= 0.25 \times 1.112268 \times 10^{-10} q$

$Q = \frac{1.112268 \times 10^{-10}}{0.25} = 4.45 \times 10^{-10}$ //

2a) Distinguish between the terms: Electric field and electric field intensity.
The electric field is a region around a charge in which it exerts electrostatic force on another charges. While the strength of electric field at any point in space is called electric field intensity. It's unit is NC^{-1}.

2b) A positive charge $Q = 8nC$ is at the origin, and a second positive charge $Q_2 = 12nC$ is on the x-axis at $x = 4m$. find
i) The net electric field at a point P on the x axis at $x = 7m$.
ii) The electric field at a point Q on the y axis at $y = 3m$ due to the charges.

Solution

1) $E = K\frac{Q}{r^2}$ due to 8nC $E = 9\times10^9 \frac{8\times10^{-9}}{7^2}$ v/m
So it will be 1.47 v/m away from 8nC
due to 12nC it will be 12 v/m
This is because the distance of the point right from 12nC is (7.4)
i.e 3m hence total electric field is 13.47 v/m.

ii) $E = K\frac{Q}{r^2}$ due to 8nC $E = 9\times10^2 \frac{(8\times10^{-9}}{3^2}$ v/m
So it will be 8 v/m away from 8nC
due to 12nC it will be 12v/m
This is because the distance of the point right from 12nC is (
i.e

4a) What is Magnetic flux? Magnetic flux is defined as the strength of magnetic field represented by lines of force.

4b) An electron with a rest mass of 9.11×10^{-31} kg moves in a circular orbit of radius 1.4×10^{-7} m in a uniform magnetic field of 3.5×10^{-1} weber/meter square, perpendicular to the speed with which electron moves. find the cyclotron frequency of the moving electron.

Solution

$$f = \frac{q \times B}{2\pi \times m}$$

$$f = \frac{1.4\times10^{-7} \times 3.5\times10^{-1}}{2\times3.142\times9.11\times10^{-31}}$$

$$f = \frac{4.9\times10^{-8}}{5.72\times10^{-30}} = 8.56\times10^{21}$$

5a) What is Biot - Savart law.

The Biot — Savart law states that it is a mathematical expression which illustrates the magnetic field produced by a stable electric current in the particular electromagnetism of physics

5b) Using the Biot- Savart law, show that the magnitude of the magnetic field of a straight current - carrying conductor is given as

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \frac{\mu_0 I}{4\pi} \int \frac{dl \times \hat{r}}{r^2}$$

$$\oint B \cdot dl = \mu_0 \iint_S J \cdot ds = \mu_0 I_{enc}$$

$$f = qvB\sin\theta$$

So, for N charges where

$$N = nlA$$

The force exerted on the conductor is $F = fN = qvSBnlA\sin\theta = BIl\sin\theta$