19/ENG04/1024 PHY 102

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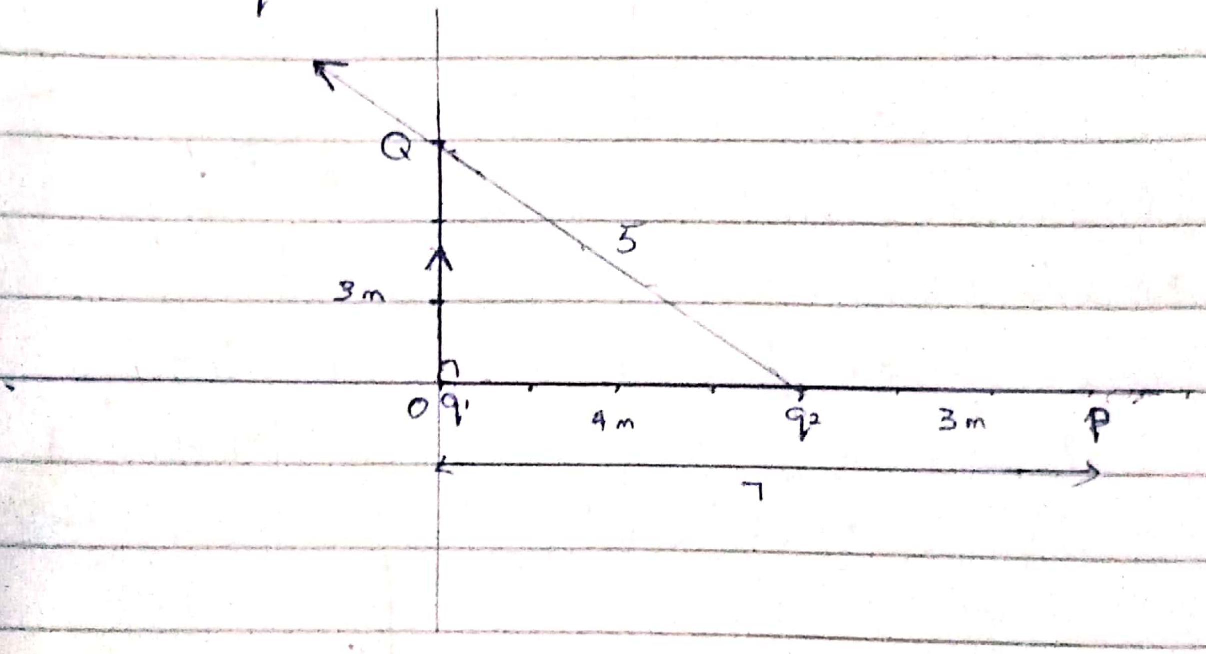
2)a) An electric field is a vector quantity, that has magnitude and direction while electric field intensity is just the magnitude.

2)b) $q_1 = 8nC$ $q_2 = 12nC$ $k = 9.9 \times 10^9 Nm^2/C^2$ ~~is on the xcoo~~



i) Net field at point P, E_{net}

$E_1 = \frac{kq_1}{r_1^2}$ $r_1 = 7m$

$= 9 \times 10^9 \times \frac{8 \times 10^{-9}}{7^2}$

$= 1.5 N/C$

$E_2 = \frac{kq_2}{r_2^2}$ $r_2 = 3m$

$= 9 \times 10^9 \times \frac{12 \times 10^{-9}}{3^2}$

$= 12 \, N/C$

$\therefore \quad E_{net} = E_1 + E_2 = \cancel{12}\, 1.5 + 12 = 13.5 \, N/C$

ii) Net field at point Q, E_{net}

$E_1 = \frac{kq_1}{r_1^2} \qquad r_1 = 3$

$= 9 \times 10^9 \times \frac{8 \times 10^{-9}}{3^2}$

$= 8 \, N/C$

$E_2 = \frac{kq_2}{r_2^2} \qquad r_2 = 5$

$= 9 \times 10^9 \times \frac{12 \times 10^{-9}}{5^2}$

$= 4.32 \, N/C$

$\therefore \quad E_{net} = E_1 + E_2 = 8 + 4.32 = 12.32 \, N/C$

1) a) Consider two metal spheres supported by insulating stands so that any charge acquired by the spheres cannot travel to the ground, as shown below

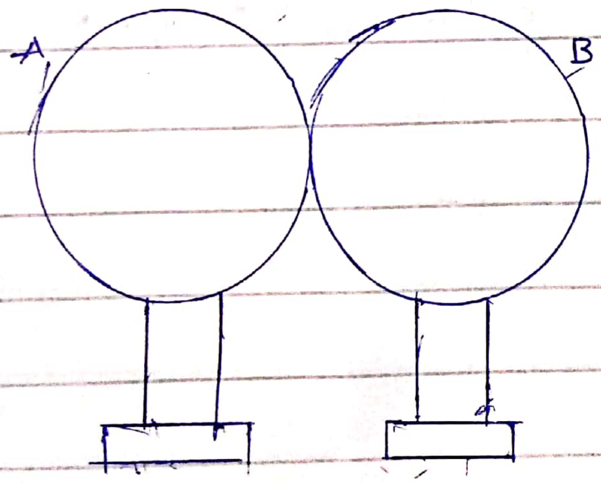


Fig 1

~~1/(a) Consider a positive~~

Being made of metal electrons are free to move between the spheres. If a rubber balloon is charged negatively and brought near the spheres electrons within the two spheres will be induced to move away from the balloon. Being negatively charged the electrons in the spheres are repelled away from the balloon. Subsequently there's a mass migration from sphere A to sphere B. This migration causes the two spheres to be polarized. Looking at the spheres individually, you can say sphere A has an overall positive charge and sphere B has an overall negative charge. Once they are polarized they are physically seperated.

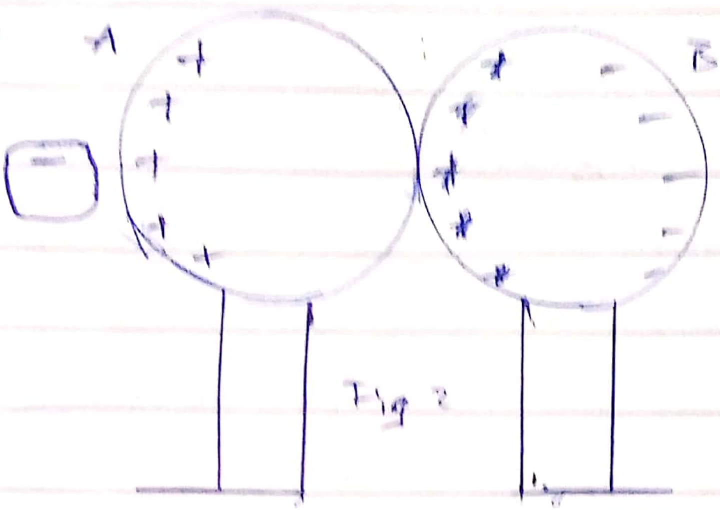


Fig 2

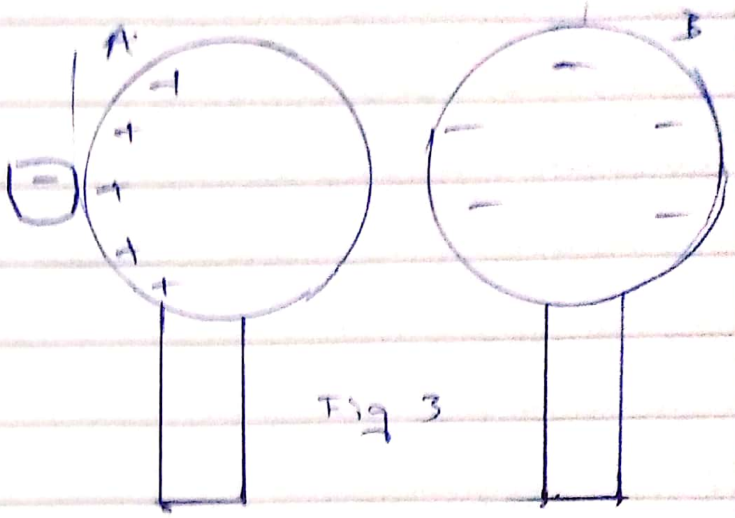


Fig 3

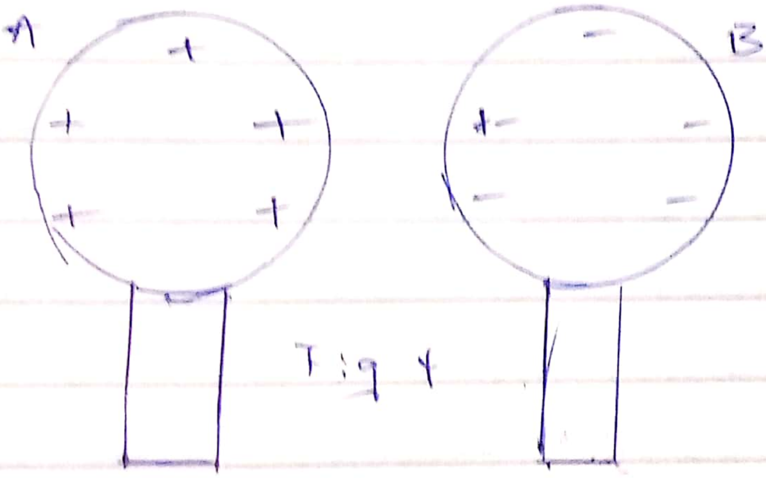


Fig 4

1b) $q_1 + q_2 = 5\times10^{-5}$ C $\therefore$ $q_1 = 5\times10^{-5} - q_2$ $r=2$

$F = \frac{kq_1q_2}{r^2}$ $F = 1$

$1 = \frac{9\times10^{9}(5\times10^{-5} - q_2)q_2}{2^2}$

$4 = 4.5\times10^{5} q_2 - 9\times10^{9} q_2^2$

$9\times10^{9} q_2^2 - 4.5\times10^{5} q_2 + 4 = 0$

Using quadratic equation

$a = 9\times10^{9}$, $b = -4.5\times10^{5}$, $c = 4$

$q_2 = \frac{4.5\times10^{5} \pm \sqrt{(4.5\times10^{5})^2 - 4(9\times10^{9}\times4)}}{2(9\times10^{9})}$

$= \frac{4.5\times10^{5} \pm \sqrt{5.85\times10^{10}}}{1.8\times10^{10}}$

$q_2 = 3.84\times10^{-5}$ C or $q_2 = 1.16\times10^{10}$ C

1c) $F = \frac{kq_1q_2}{r^2}$

$F\ \cancel{E_1} = \frac{9\times10^{9}(8\times10^{-6})^2}{1^2}$ $= 0.576$ N

$E_2 = \frac{9\times10^{9}(8\times10^{-6})}{\left(\frac{\sqrt{3}}{2}\right)^2}$ $= 57600$

$E_1 = E_2$

Vector	X · Component	Y Component
E_1	~~56760~~ 57600 $\cos 63.4$	$57600 \sin 26.6$
E_2	$57600 \cos 63.4$	$57600 \sin 26.6$
	$E_x = 0$	$E_y = 51581.85$ N/C

$$E = \sqrt{(51581.85)^2}$$

$$= 51581.85 \text{ N/C}$$

$$q = F/E = \frac{0.576}{51581.85}$$

$$= 1.1 \times 10^{-5} = 11 \times 10^{-6} \text{ C}$$

4) A magnetic flux is the measurement of the total magnetic field which passes through a given area. It is a useful tool for helping describe the effect of the magnetic force on something occupying a given area.

b) Cyclotron frequency $= qB/2\pi m$

$$= \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{2 \times 22/7 \times 9.11 \times 10^{-31}}$$

$$= 9.78 \times 10^{9} \text{ Hz}$$

c) We got the cyclotron frequency formula from the formula of a period

$T = 2\pi m / qB$ and we know $f = 1/T$ where q is the charge of the electron, B is the magnetic flux, m is the mass, 2π is the constant.

6 b) Using $\varepsilon_1 = \frac{N d\phi_B}{dt}$

$\phi_B = BA\cos\theta$

$\varepsilon_1 = \frac{-N(BA\cos\theta)}{dt}$

$\varepsilon = \frac{N(\phi_B(b_2) - \phi_B(b_1))}{t_2 - t_1}$

$= 300\left(\frac{0.0399 + 0.0}{0.5}\right)$

$= 188.4V$

(a) $I = V/R = \frac{188.4}{2}$

$= 94.2A$

c) Emf $\varepsilon = I \times A = 0.1 \times 8$

$= 0.8V$

Using $\varepsilon = \frac{N d\phi_B}{dt}$

$\phi_A = B_A$ $\therefore$ $\varepsilon = \frac{NA\,dB}{dt}$

$0.8 = 75(4 \times 10^{-3})\,dB/dt$

$0.8 = 0.3\frac{dB}{dt}$

$\frac{dB}{dt} = \frac{0.8}{0.3} = 2.67 T/S$

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