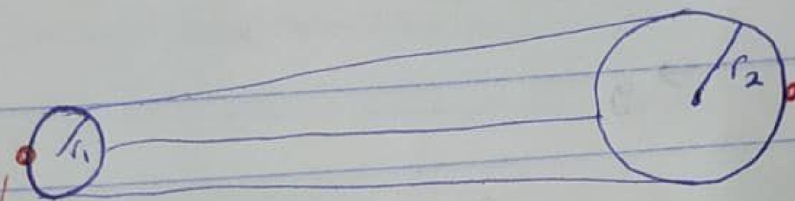
Hamza AlHasan

1181636

HW3

1



at this end:

$$E_2 = \frac{q}{4\pi\epsilon_0 r_2^2}$$

at this end:

$$E_1 = \frac{q}{4\pi\epsilon_0 r_1^2}$$

* q is same in the both spheres (conductor):

$$\Rightarrow \frac{E_1}{E_2} = \frac{\cancel{q}}{\cancel{4\pi\epsilon_0} r_1^2} \times \frac{\cancel{4\pi\epsilon_0} r_2^2}{\cancel{q}}$$

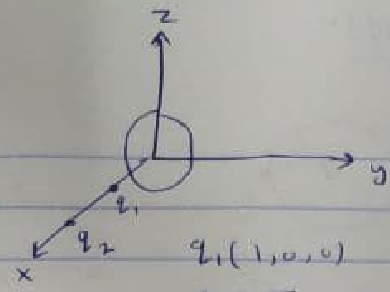
$$\Rightarrow \frac{E_1}{E_2} = \frac{r_2^2}{r_1^2}$$

$$E_1 = \frac{r_2^2}{r_1^2} E_2$$

greater than 1

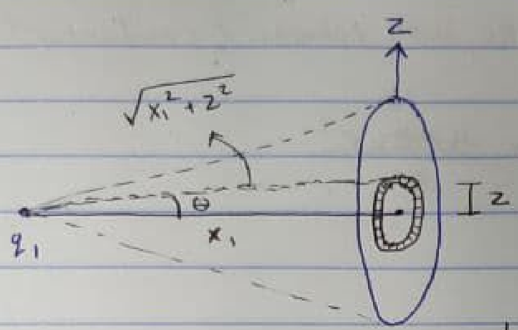
so $E_1 > E_2$

2



$q_1(1,0,0)$

$q_2(\sqrt{3},0,0)$



* Conic Symmetry :

all points surrounding the circle have same $\vec{E}$

flux

$$d\phi_1 = E_1\, da \cos\theta$$

$$= \left(\frac{1}{4\pi\epsilon_0}\frac{q_1}{z^2+x_1^2}\right)(2\pi z\, dz)\left(\frac{x_1}{\sqrt{x_1+z^2}}\right)$$

$$\phi_1 = \int d\phi_1 = \frac{q_1 x_1}{2\epsilon_0}\int_0^{R=1}\frac{z\,dz}{(x_1^2+z^2)^{3/2}}$$

$$\Rightarrow E_1 = \frac{1}{4\pi\epsilon_0}\frac{q_1}{z^2+x_1^2}$$

$da = 2\pi z\, dz$ (surface area)

(so we can integrate from $z=0$, to $z=1$)

Let $t = x_1^2+z^2$

$dt = 2z\,dz$

$$\left(\frac{-1}{\sqrt{x_1^2+z^2}}\right)$$

$$\Rightarrow \phi_1 = \frac{q_1 x_1}{2\epsilon_0}\left[\frac{-1}{\sqrt{x_1^2+z^2}}\Big|_0^1\right]$$

$$\phi_1 = \frac{q_1}{2\epsilon_0}\left[1 - \frac{x_1}{\sqrt{x_1^2+1}}\right] \quad ; \quad (x_1 = 1)$$

And with same procedure :

$$\phi_2 = \frac{q_2}{2\epsilon_0}\left[1 - \frac{x_2}{\sqrt{x_2^2+1}}\right] \quad ; \quad (x_2 = \sqrt{3})$$

Total flux through the circle = zero $\Rightarrow$

$$\phi_1 = -\phi_2$$

$$\frac{q_1}{\cancel{2\epsilon_0}}\left[1 - \frac{1}{\sqrt{2}}\right] = \frac{q_2}{\cancel{2\epsilon_0}}\left[\frac{\sqrt{3}}{2} - 1\right]$$

$$\Rightarrow q_2 = -2.18618\, q_1$$

or

$$\boxed{\frac{q_2}{q_1} = \frac{1-\frac{1}{\sqrt{2}}}{\frac{\sqrt{3}}{2}-1}}$$