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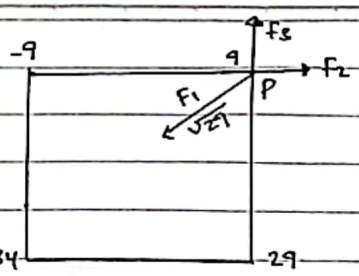
UTS Kelisma

1. a)



b) • $f_1 = k \cdot \frac{q_1}{a^2}$

* $f_2 = k \cdot \frac{3q^2}{2a^2}$ (Sudut 45° terhadap sumbu x dan y)

$F_{2x} = -\frac{3q^2}{2a^2} \cdot \cos 45^\circ = -\frac{3q^2}{2a^2} \cdot \frac{\sqrt{2}}{2} = -\frac{3q^2\sqrt{2}}{4a^2}$

$F_{2y} = -\frac{3q^2}{2a^2} \sin 45^\circ = -\frac{3q^2\sqrt{2}}{4a^2}$

* $f_3 = k \cdot \frac{2q^2}{a^2}$

Total komponen gaya

$F_x = -\frac{q^2}{a^2} - \frac{3q^2\sqrt{2}}{4a^2} = -\frac{q^2}{a^2}\left(1 + \frac{3\sqrt{2}}{4}\right)$

$f_y = \frac{2q^2}{a^2} - \frac{3q^2\sqrt{2}}{4a^2} = \frac{q^2}{a^2}\left(2 - \frac{3\sqrt{2}}{4}\right)$

$F_{total} = \frac{q^2}{a^2} \cdot k \cdot \sqrt{\left(1 + \frac{3\sqrt{2}}{4}\right)^2 + \left(2 - \frac{3\sqrt{2}}{4}\right)^2}$

c) $F_x = -\frac{q^2}{a^2}\left(1 + \frac{3\sqrt{2}}{4}\right)$

$F_y = \frac{q^2}{a^2}\left(2 - \frac{3\sqrt{2}}{4}\right)$

$\Rightarrow \tan\theta = \frac{F_y}{|F_x|} = \frac{2 - \frac{3\sqrt{2}}{4}}{1 + \frac{3\sqrt{2}}{4}}$

Gunakan $\sqrt{2} \times 1{,}414$

$\tan\theta = \frac{2 - 1{,}061}{1 + 1{,}061} = \frac{0{,}939}{2{,}061} \approx 0{,}456$

$\theta = \tan^{-1}(0{,}456) \approx 24{,}5$

* $F_x < 0$ (ke kiri)
$f_y > 0$ (ke kanan)

maka gaya berada di kuadran II,
Sudutnya :
θ dari sumbu x positif = $180^\circ - 24{,}5^\circ$
$= 155{,}5^\circ$
(kuadran)

d) dari I 6, besar gaya listrik total :

$$F_{total} = \frac{q^2}{a^2} \cdot k \cdot \sqrt{\left(1+\frac{3\sqrt{2}}{4}\right)^2 + \left(2-\frac{3\sqrt{2}}{4}\right)^2}$$

maka, medan listrik di titik P.

$$E_{total} = \frac{F_{tot}}{q} = \frac{q}{a^2} \cdot k \cdot \sqrt{\left(1+\frac{3\sqrt{2}}{4}\right)^2 + \left(2-\frac{3\sqrt{2}}{4}\right)^2}$$

arah medan listrik :

$$\tan\theta = \frac{F_y}{|F_x|} = \frac{2-\frac{3\sqrt{2}}{4}}{1+\frac{3\sqrt{2}}{4}}$$

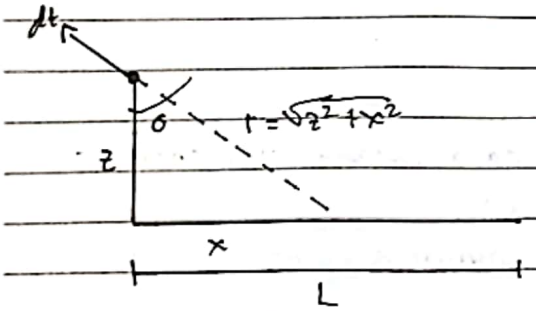
$$\theta = \tan^{-1}\left(\frac{2-\frac{3\sqrt{2}}{4}}{1+\frac{3\sqrt{2}}{4}}\right)$$

Arah medan listrik : $180^\circ - \theta$, kuadran II (karena $F_x < 0, F_y \neq 0$)

e) Tidak terjadi keseimbangan gaya, karena $F_{total} \neq 0$

2. ●

a) P diujung kawat



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

$$q = \lambda x$$

$$dq = \lambda dx$$

$$dE = \frac{1}{4\pi\varepsilon_0}\frac{\lambda dx}{r^2}$$

$$dE = \frac{1}{4\pi\varepsilon_0}\frac{\lambda dx}{\sqrt{z^2+x^2}}$$

$$\int dE = \frac{\lambda}{4\pi\varepsilon_0}\int_0^L \frac{dx}{\sqrt{z^2+x^2}}$$

misal $x = z\tan\theta$

$$dx = z\sec^2\theta\, d\theta$$

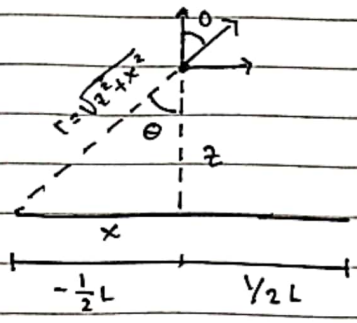
$$E = \frac{\lambda}{4\pi\varepsilon_0}\int_0^L \frac{z\sec^2\theta\, d\theta}{\sqrt{z^2+z^2\tan^2\theta}}$$

$$= \frac{\lambda}{4\pi\varepsilon_0}\int_0^L \sec\theta\, d\theta$$

$$= \frac{\lambda}{4\pi\varepsilon_0}\left(\ln|\sec\theta+\tan\theta|\Big|_0^L\right)$$

$$= \frac{\lambda}{4\pi\varepsilon_0}\ln(\sec(L)+\tan(L))$$

b) P ditengah kawat



$dt = dE_y$

$dE_y = dE\cos\theta$

$= \frac{1}{4\pi\varepsilon_0}\frac{\lambda dx}{(\sqrt{z^2+x^2})^2}\frac{z}{\sqrt{z^2+x^2}}$

$= \frac{\lambda z}{4\pi\varepsilon_0}\int_{-1/2L}^{1/2L}\frac{dx}{(z^2+x^2)^{3/2}}$

$= \frac{\lambda}{4\pi\varepsilon_0}\left(\frac{x}{\sqrt{z^2+x^2}}\right)\Big|_{-1/2L}^{1/2L}$

$= \frac{\lambda}{4\pi\varepsilon_0}\frac{L}{\sqrt{z^2+\frac{1}{4}L^2}}$

3. terdapat 3 kondisi :

1) E didalam bola ($r<R$)

Berdasarkan hukum gauss nilai E adalah 0

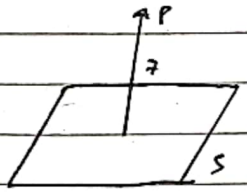
2) E di luar bola ($r>R$)

Berdasarkan hukum gauss memenuhi persamaan $E = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{r^2}\right)$

3) E dipermukaan bola ($r=R$)

Berdasarkan hukum gauss memenuhi persamaan $E = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R^2}\right)$

5. hitung medan listrik dititik P berjarak z diatas pusat kawat yang membentuk segi empat berikut



medan listrik vertikal E_z yaitu

$E_z = \frac{2xe\lambda}{z}\sin\theta$ dimana : $ke = \frac{1}{4\pi\varepsilon_0}$

λ = muatan / panjang

$\theta = \tan^{-1}\left(\frac{s/2}{z}\right)$

total medan 4 sisi

$E_{total}\, z^2 = 4\, E\sin,\lambda = 4\cdot\frac{2ke\lambda\sin\theta}{z} = \frac{8ke\lambda}{z}\sin\theta$

dengan $\sin\theta = \frac{s/2}{\sqrt{z^2+\left(\frac{s}{2}\right)^2}} = \frac{s}{2\sqrt{z^2+\frac{s^2}{4}}}$

Sehingga

$E_z = \frac{8ke\lambda}{z}\frac{s}{2\sqrt{z^2+\frac{s^2}{4}}} = \frac{4ke\lambda s}{z\sqrt{z^2+\frac{s^2}{4}}}$

$ke = \frac{1}{4\pi\varepsilon_0}$

$E_z = \frac{\lambda s}{\pi\varepsilon_0 z\sqrt{z^2+\frac{s^2}{4}}}$