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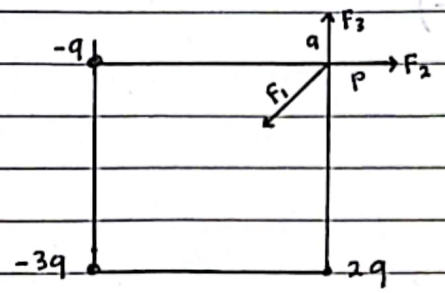
Kelas : 23 A

UTS Kelistrikan dan Kemagnetan

1. a)



b) • $F_1 = k \cdot \frac{q^2}{a^2}$

• $F_2 = k \cdot \frac{3q^2}{2a^2}$ (sudut 45° terhadap sumbu x dan y)

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

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

• $F_3 = k \cdot \frac{2q^2}{a^2}$

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 $\sqrt{2} \approx 1,414$

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

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

$\therefore$ * $f_x < 0$ (ke kiri)

$F_y > 0$ (ke atas)

Maka gaya berada di kuadran II, sudutnya:

θ dari sumbu x positif = 180° − 24,5°

= 155,5°

(ke atas)

d) Dari 1 6, besar gaya listrik total :

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

Maka, medan listrik di titik P :

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

arah medan listrik :

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

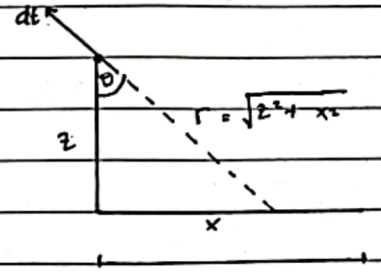
$$\theta = \tan^{-1}\left(\frac{2-\frac{3\sqrt{2}}{4}}{1+\frac{3\sqrt{2}}{4}}\right)$$

Arah medan listrik = $180° - \theta$, kuadran II (karena $f_x < 0$, $f_y > 0$).

e) Tidak terjadi keseimbangan gaya, karena F total $\neq 0$.

2. P diujung kawat

a)



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

$$q = \lambda x$$

$$dq = \lambda\,dx$$

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

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

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

misal $x = z\tan\theta$

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

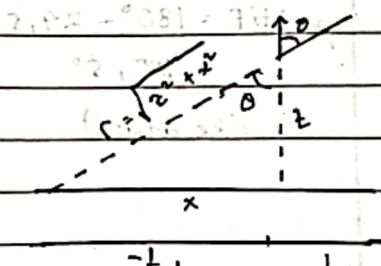
$$E = \frac{\lambda}{4\pi\varepsilon_0}\int_0^L \frac{z\sec^2\theta\,d\theta}{\sqrt{z^2+z^2\tan^2\theta}}$$

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

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

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

b. P ditengah kawat



$$dE = dE_y$$

$$dE_y = dE\cos\theta$$

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

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

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

3. Terdapat 3 kondisi :

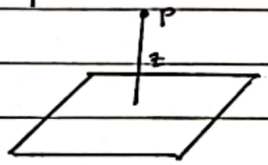
1) E didalam bola ($r < R$), berdasarkan hukum gauss nilai E adalah 0

2) E diluar 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 di atas pusat kawat yang membentuk segi empat berikut :



Medan listrik vertikal E_z yaitu

$$E_z = \frac{2\,k_e\,\lambda}{z}\sin\theta \qquad \text{dimana : } k_e = \frac{1}{4\pi\varepsilon_0}$$

total medan 4 sisi $\qquad \lambda$: muatan

$$E_{total,z} = 4\,E_{sisi,z} = \frac{4\cdot 2\,k_e\,\lambda}{z}\sin\theta \qquad \theta = \tan^{-1}\left(\frac{3/2}{z}\right)$$

$$= \frac{8\,k_e\,\lambda}{z}\sin\theta$$

dengan $\sin\theta = \frac{3/2}{\sqrt{z^2+\left(\frac{3}{2}\right)^2}} = \frac{5}{2\sqrt{z^2+\frac{5^2}{4}}}$

sehingga

$$E_z = \frac{8\,k_e\,\lambda}{z}\,\frac{5}{2\sqrt{z^2+\frac{5^2}{4}}} = \frac{4\,k_e\,\lambda\,5}{z\sqrt{z+\frac{5^2}{4}}}$$

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

$$E_z = \frac{\lambda 5}{\pi\varepsilon_0 z\sqrt{z^2+\frac{5^2}{4}}}$$ //