No.
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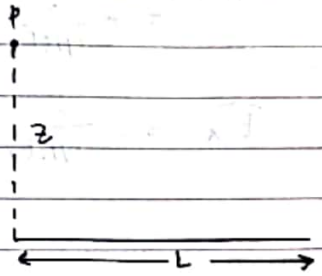
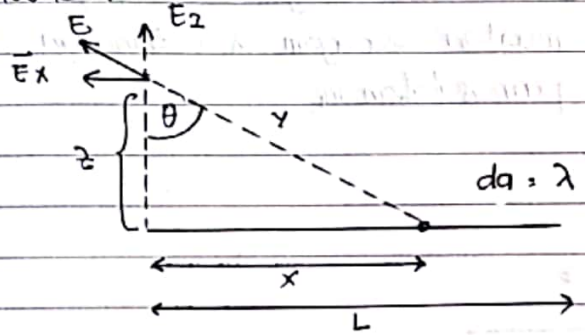
NPM = 2013022040

1) Hitung medan listrik pada salah satu ujung kawat yang panjangnya L yang membawa muatan seragam λ. Bagaimana besar E, jika $z \gg L$



Jawaban:



$$\vec{E} = \vec{E}_z + \vec{E}_x$$

$$\vec{E}_z = \frac{1}{4\pi\varepsilon_0} \int_0^L dE \cos\theta$$

$$\vec{E}_x = \frac{1}{4\pi\varepsilon_0} \int_0^L \frac{dq}{r^2} = \frac{1}{\square} \int_0^L \frac{\lambda\, dx}{r^2} \cos\theta$$

$$\Rightarrow \cos\theta = \frac{z}{r}$$

$$\vec{E}_z = \frac{1}{\square} \int_0^L \frac{z\lambda dx}{r^3} = \frac{1}{\square} \int_0^L \frac{z\lambda dx}{(z^2+x^2)^{3/2}}$$

$$= \frac{z\lambda}{4\pi\varepsilon_0} \int_0^L \frac{dx}{(z^2+x^2)^{3/2}}$$

lihat di daftar integral $\int_0^L \frac{dx}{(z^2+x^2)^{3/4}} = \frac{1}{z^2} \frac{x}{\sqrt{z^2+x^2}} \Big|_0^L$

$$= \frac{1}{4\pi\varepsilon_0} \lambda z \left[\frac{1}{z^2} \frac{x}{\sqrt{z^2+x^2}} \right|_0^L$$

$$\vec{E}_z = \frac{\lambda z}{4\pi\varepsilon_0} \frac{L}{z^2\sqrt{z^2+x^2}} = \frac{\lambda}{4\pi\varepsilon_0} \frac{L}{z\sqrt{z^2+x^2}}$$

$$\vec{E}_x = -\frac{1}{4\pi\varepsilon_0}\int_0^L \frac{\lambda\,dx}{r^2}\sin\theta = -\frac{\lambda}{4\pi\varepsilon_0}\int_0^L \frac{z\,dx}{(z^2+x^2)^{3/2}}$$

$$= -\frac{\lambda}{4\pi\varepsilon_0}\cdot\frac{1}{2}\int_0^L \frac{dx^2}{(z^2+x^2)^{3/2}}$$

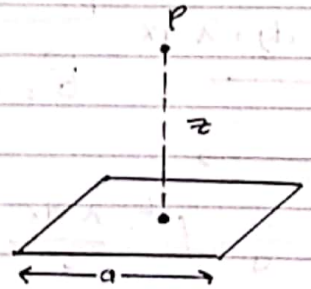
$$= -\frac{\lambda}{4\pi\varepsilon_0}\cdot\frac{1}{z}\left[-2\frac{1}{(z^2+x^2)^{1/2}}\right]_0^L$$

$$= -\frac{\lambda}{4\pi\varepsilon_0}\left[-\left(\frac{1}{\sqrt{z^2+x^2}} - \frac{1}{z}\right)\right]$$

$$\vec{E}_x = -\frac{\lambda}{4\pi\varepsilon_0}\left[\frac{1}{z} - \frac{1}{\sqrt{z^2+x^2}}\right]$$

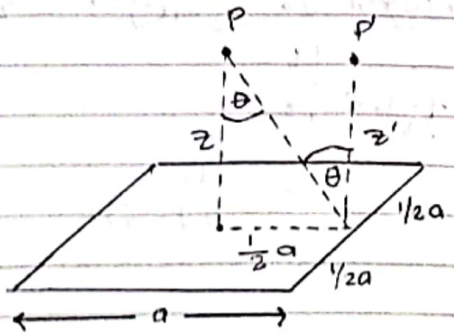
Jadi $\vec{E} = \vec{E}_z + \vec{E}_x$

2) Hitung medan listrik sejauh z dari titik tengah loop segi empat panjang yang membawa muatan seragam λ. Gunakan contoh no.3 untuk menyelesaikan permasalahan ini.



Penyelesaian:
Untuk menyelesaikan soal diatas gunakan contoh nomor 3, yaitu kawat yang panjangnya 2L, dengan $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda L}{z^2}$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda L}{z'^2}$$



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$p = p' \cos\theta$, karena ada 4 sisi , maka

$p = 4p' \cos\theta$

Sehingga :

$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{2\lambda L}{z'^2} = 4 \frac{1}{4\pi\varepsilon_0} \frac{2\lambda L}{z'^2} \cos\theta$

Karena $L = \frac{1}{2}a$ dan $z' = r = \sqrt{z^2 + (\frac{1}{2}a)^2}$

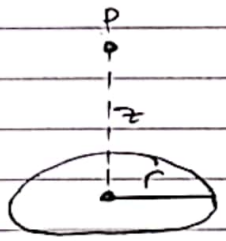
dan $\cos\theta = \frac{z}{\sqrt{z^2 + (\frac{1}{2})^2}}$

maka :

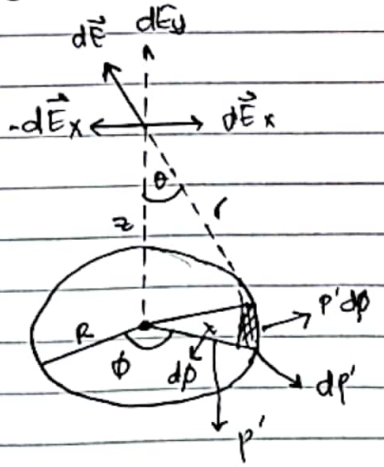
$\vec{E} = 4 \frac{1}{4\pi\varepsilon_0} \frac{2\lambda(\frac{1}{2}a) \cdot z}{(z^2 + (\frac{1}{2}a)^2)\sqrt{z^2 + (\frac{1}{2}a)^2}}$

$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{4\lambda a z}{(z^2 + \frac{a^2}{a})\sqrt{z^2 + \frac{a^2}{4}}}$

3) Hitung medan listrik diatas pusat kawat melingkar tejauh z yang membawa muatan seragam λ



penyelesaian :



$ds = da = p \times l$

$= dp' \cdot p' d\phi$

$da = p' dr' d\phi$

$\vec{E} = \frac{1}{4\pi\varepsilon_0} \int_S \frac{\sigma da}{p^2} \cos\theta$

$d\vec{E} = d\vec{E}_y + d\vec{E}_x = 0$

$= dE \cos\theta$

$\vec{E} = \frac{1}{4\pi\varepsilon_0} \int_0^R \int_0^{2\pi} \frac{r}{p^2} \cos\theta \cdot$

$r' dp' \, dp$

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buka $\cos\theta$ dengan ρ^2. sehingga menjadi

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\sigma z \int_0^R \int_0^{2\pi} \frac{\rho' d\rho' d\phi}{(\rho'^2+z^2)^{3/2}}$$

$$= \frac{2\pi\sigma z}{4\pi\varepsilon_0} \int_0^R \frac{\rho' d\rho'}{(\rho' z+z^2)^{3/2}}$$

$$= \frac{\sigma z}{2\varepsilon_0} \int_0^R \frac{1}{2} \frac{d(\rho'^2+z^2)}{(\rho'^2+z^2)^{3/2}}$$

- ρ' dibuat dalam bentuk diferensial, tetapi tidak mengubah makna.