No.

Date :

Nama : Dian Permata Hati

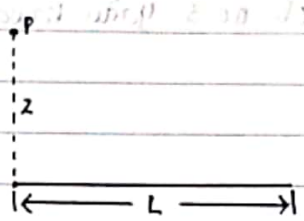
NPM : 2013022036

Mata Kuliah : Kelistrikan & Kemagnetan.

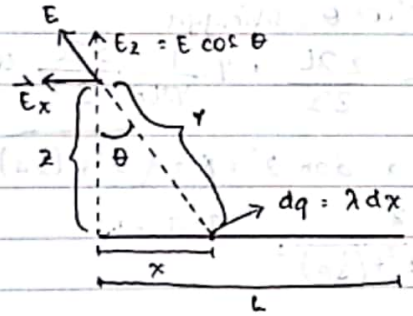
Prodi : Pendidikan Fisika (B).

Tugas.

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



Jawaban :



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

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

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

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

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

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

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

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

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

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

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

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

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

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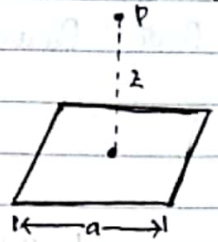
2. Hitung medan listrik sejauh z dari titik tengah loop segi empat panjang yang membawa muatan serogam λ.



Jawaban :

Untuk menyelesaikan soal diatas, gunakan contoh no.3 yaitu kawat yang panjangnya 2 L dengan $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{2\lambda L}{z^2}$

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

$P = P' \cos\theta$, karena ada 4 titi, maka :

$P = 4P' \cos\theta$, sehingga

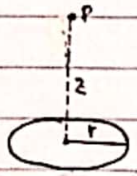
$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{2\lambda L}{z'^2} \cdot 4 \cdot \frac{1}{4\pi\varepsilon_0} \frac{2\lambda L}{z'^2} \cos\theta$$

Karena $L = \frac{1}{2}a$, dan $z' = \gamma = \sqrt{z^2 + (\frac{1}{2}a)^2}$ dan $\cos\theta = \frac{z}{\sqrt{z^2 + (\frac{1}{2}a)^2}}$ maka,

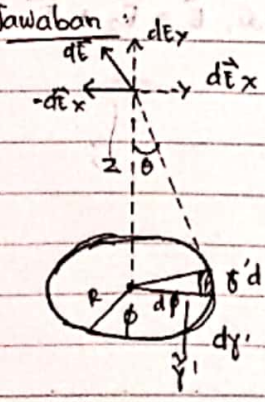
$$\vec{E} = 4 \cdot \frac{1}{4\pi\varepsilon_0} \frac{2\lambda(\frac{1}{2}a) \cdot z}{(z^2 + (\frac{1}{2}a)^2)\sqrt{z^2 + (\frac{1}{2}a)^2}}$$

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

3. Hitung medan listrik pusat kawat melingkar sejauh z yang membawa muatan seragam λ



Jawaban :



$ds = da = p \times \ell$

$= ds' \cdot r' d\phi$

$da = r' dr' d\phi$

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

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

$= dE \cos\theta$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \int_0^R \int_0^{2\pi} \frac{r}{r'} \cos\theta \underbrace{r' ds' d\phi}_{da}$$

buka $\cos\theta$ dengan r^2, menjadi

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

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

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

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