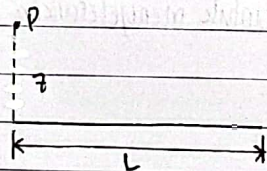
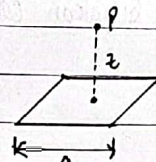


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1. Hitung medan listrik pada salah satu ujung kawat yang panjangnya L (Gambar 2.10) yang membawa muatan seragam λ . Bagaimana besar E , jika $z \gg L$.

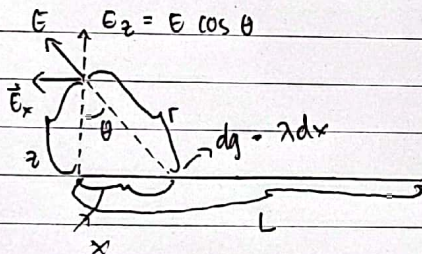


Gambar 2.10



Gambar 2.11

Penyelesaian :



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

$$\text{Ambil } \vec{E}_z = \frac{1}{4\pi\epsilon_0} \int_0^L \frac{dq}{r^2} = \frac{1}{4\pi\epsilon_0} \int_0^L \frac{\lambda dx}{r^2} \cos \theta \Rightarrow \cos \theta = \frac{z}{r}$$

$$\begin{aligned} \vec{E}_z &= \frac{1}{4\pi\epsilon_0} \int_0^L \frac{z \lambda dx}{r^3} = \frac{1}{4\pi\epsilon_0} \int_0^L \frac{z \lambda dx}{(z^2 + x^2)^{3/2}} \\ &= \frac{z \lambda}{4\pi\epsilon_0} \int_0^L \frac{dx}{(z^2 + x^2)^{3/2}} \end{aligned}$$

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

$$= \frac{1}{4\pi\epsilon_0} \lambda z \left[\frac{1}{z^2} \frac{x}{\sqrt{z^2 + x^2}} \Big|_0^L \right]$$

$$\vec{E}_z = \frac{\lambda z}{4\pi\epsilon_0} \frac{L}{z^2 \sqrt{z^2 + x^2}} = \frac{\lambda}{4\pi\epsilon_0} \frac{L}{z \sqrt{z^2 + x^2}}$$

$$\vec{E}_x = -\frac{1}{4\pi\epsilon_0} \int_0^L \frac{\lambda dx}{r^2} \sin \theta = -\frac{\lambda}{4\pi\epsilon_0} \int_0^L \frac{dx}{r^2}$$

$$= -\frac{\lambda}{4\pi\epsilon_0} \cdot \frac{1}{2} \int_0^L \frac{dx^2}{(z^2 + x^2)^{3/2}}$$

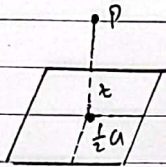
$$= -\frac{\lambda}{4\pi\epsilon_0} \cdot \frac{1}{2} \left[-2 \frac{1}{(z^2 + x^2)^{1/2}} \right]_0^L$$

$$= -\frac{\lambda}{4\pi\epsilon_0} \left[-\left(\frac{1}{\sqrt{z^2+x^2}} - \frac{1}{z} \right) \right]$$

$$\vec{E}_x = -\frac{\lambda}{4\pi\epsilon_0} \left[\frac{1}{z} - \frac{1}{\sqrt{z^2+x^2}} \right]$$

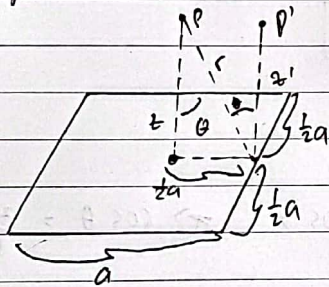
$$\therefore \vec{E} = \vec{E}_z + \vec{E}_x$$

2. Hitung medan listrik sejalan z dari titik tengah loop segi empat panjang (Gambar 2.11) yang membawa muatan seragam λ . Gunakan contoh no. 3 untuk menyelesaikan permasalahan.



$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{2\lambda L}{z'^2}$$

konsepnya



$P = P' \cos \theta$; karena ada 4 sisi maka

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

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{2\lambda L}{z'^2} = 4 \cdot \frac{1}{4\pi\epsilon_0} \frac{2\lambda L}{z'^2} \cos \theta$$

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

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

$$\vec{E} = 4 \cdot \frac{1}{4\pi\epsilon_0} \frac{2\lambda (\frac{1}{2} a) \cdot z}{(z^2 + (\frac{1}{2} a)^2) \sqrt{z^2 + (\frac{1}{2} a)^2}}$$

$$\therefore \vec{E} = \frac{1}{4\pi\epsilon_0} \frac{4\lambda a z}{(z^2 + \frac{a^2}{4}) \sqrt{z^2 + \frac{a^2}{4}}}$$