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KELAS: B.

"UTS Listrik dan magnet"

(9.) Apa yang anda ketahui tentang hukum gauss, <jelaskan secara verbal, lalu gambar permukaan gauss, dan jelaskan secara simbolik <Rumus> sesuai definisi dan gambar yang anda kemukakan dimana hukum gauss diterapkan, dan berikan contoh?

Jawab:

- Hukum gauss dapat digunakan untuk menurunkan hukum Coulomb. hukum gauss berbunyi: Fluks Listrik bersih yang melewati permukaan tertutup sama dengan $\frac{1}{\varepsilon}$ x muatan Listrik bersih yang berada didalam permukaan tertutup itu. Hukum gauss dapat dinyatakan dalam medan listrik E atau electric displacement field D.

$$\oint \vec{E} \cdot d\vec{s} = \int \nabla \cdot \vec{E} \, d\tau$$

$$\nabla \cdot \vec{E} = \frac{1}{4\pi\varepsilon_0} \int \left\langle \frac{\vec{r}_0}{r^2} \right\rangle \cdot \nabla \rho \, d\tau$$

$$= \frac{1}{4\pi\varepsilon_0} \int \nabla \cdot \left\langle \frac{\vec{r}_0}{r^2} \right\rangle \rho \, d\tau$$

$$= \frac{1}{4\pi\varepsilon_0} \int_0^{\infty} 4\pi \delta\langle r \rangle \rho \, d\tau$$

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$$

$$\oint \vec{E} \cdot d\vec{s} = \frac{1}{4\pi\varepsilon_0} \int_t \frac{Q}{r^2} \cdot r^2 \sin\theta \, d\theta \, d\phi$$

$$= \frac{Q}{4\pi\varepsilon_0} \int_0^{\pi} \int_0^{2\pi} \sin\theta \, d\theta \, d\phi$$

$$\oint \vec{E} \cdot d\vec{s} = \frac{Q}{\varepsilon_0}$$

- untuk distribusi muatan yang kontinu, maka:

$$Q = \int \rho \, d\tau$$

$$\oint \vec{E} \cdot d\vec{s} = \frac{1}{\varepsilon_0} \int \rho \, d\tau$$

- menurut teorema diversens: dari gauss berlaku.

1. $\oint \vec{E} \cdot d\vec{s} = \int \nabla \cdot \vec{E} \, d\tau = \frac{1}{\varepsilon_0} \int \rho \, d\tau$,

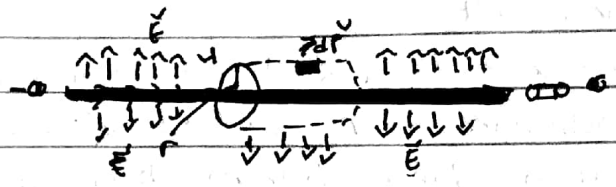
2. $\oint \vec{E} \cdot d\vec{s} = \frac{1}{\varepsilon_0} \int \sigma \, ds$ → muatan keping

3. $\oint \vec{E} \cdot d\vec{s} = \frac{1}{\varepsilon_0} \int \nabla \, d\vec{l}$ → muatan batang.

KIKY

- aplikasi hukum gauss.

a. pada kawat lurus panjang, dy jari R.



a). E <r> pada r>R

b). E <r> pada r>R.

Solusi : pada r>R

$$\oint \vec{E}.d\vec{s} = \frac{1}{\varepsilon_0}\int \lambda . d\vec{l}$$

$$\vec{E}\langle 2\pi r.\ell\rangle = \frac{1}{\varepsilon_0}\lambda.\ell$$

$$\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}.\vec{r}_0,\ r>R.$$

Pada. r<R

$$\oint E.d\vec{s} = \frac{1}{\varepsilon_0}\int \lambda . d\vec{l}$$

$$\vec{E}\langle 2\pi r.\ell\rangle = \frac{1}{\varepsilon_0}\lambda.\ell$$

$$\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\vec{r}_0 .\ r<R.$$

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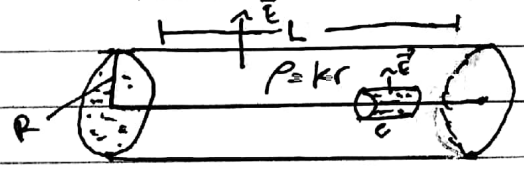
b. Pada silinder dengan jari-jari R.



$\vec{E}\langle r\rangle$ pada r<R.

$$\oint \vec{E}.d\vec{s} = \frac{1}{\varepsilon_0}\int_V \rho\, dV$$

$$\vec{E}\langle 2\pi r\ell\rangle = \frac{1}{\varepsilon_0}\int_0^{\ell}\int_0^{r}\int_0^{2\pi}\langle kr\rangle . r\,d\phi\,dr\,dz.$$

$$= \frac{2\pi k}{\varepsilon_0}\int_0^{\ell}\int_0^{r} r^2\,dr\,dz$$

$$= \frac{2\pi k}{3\varepsilon_0} r^3 \int_0^{\ell} dz.$$

$$E\langle 2\pi r\ell\rangle = \frac{2\pi k r^3 \ell}{3\varepsilon_0}$$

$$E = \frac{k r^2}{3\varepsilon_0}\hat{r}_0$$

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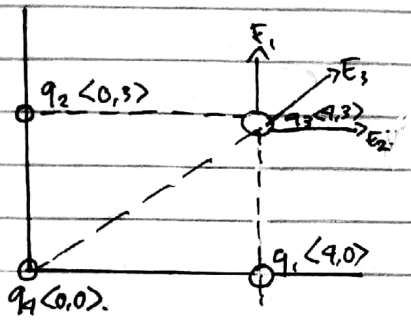
① Penyelesaian:

Dik: $q_1 = +2$ stat C $\rightarrow \langle 9,0 \rangle$ cm

$q_2 = +5$ stat C $\rightarrow \langle 0,3 \rangle$ cm

$q_3 = +10$ stat C $\rightarrow \langle q_3 \rangle$ cm

$q_4 = -1$ stat C $\rightarrow \langle 0,0 \rangle$ cm dan k dyne. cm^2 / stat. c^2.



Jawab.

(a). Gaya listrik pada q_4 <0,0>.

$$F = q_4 k \left[\frac{q_1}{r_{01}^2} \cdot \vec{r}_{01} + \frac{q_2}{r_{02}^2} r_{02}^2 + \frac{q_3}{r_{03}^2} \cdot r_{03}^2 \right]$$

$$= -1.1 \left[\frac{2}{16} \langle -1 \rangle + \frac{5}{9} \langle -j \rangle + \frac{10}{25} \left\langle \frac{-9i - 3j}{5} \right\rangle \right]$$

$$= 1 \left[\frac{2}{16} \langle i \rangle + \frac{5}{9} \langle j \rangle + \frac{90}{125} \langle i \rangle + \frac{30}{125} \langle j \rangle \right]$$

$$= \left[\left\langle \frac{2}{16} + \frac{90}{125} \right\rangle i + \left\langle \frac{5}{9} + \frac{30}{125} \right\rangle j \right]$$

$$= [\langle 0,9995 \rangle i + \langle 0,796 \rangle j]$$

$F = \tan \text{arc } \frac{0,796}{0,995}$.

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(b). medan listrik. q_1, q_2, q_3.

$$E_1 = \frac{k q_1}{r_1^2} = \frac{1.2}{9^2} \langle i \rangle = \frac{2}{16} \langle i \rangle.$$

$$E_2 = k \frac{q_2}{r_2^2} = \frac{1.5}{3^2} \langle j \rangle = \frac{5}{9} \langle j \rangle.$$

$$E_3 = k \frac{q_3}{r_3^2} = \frac{1.10}{5^2} = \frac{10}{25} \left\langle \frac{9i + 3j}{5} \right\rangle$$

$$E = \frac{2}{16} i + \frac{5}{9} j + \frac{90}{125} i + \frac{30}{125} j$$

$$E = \left\langle \frac{2}{16} + \frac{90}{125} \right\rangle i + \left\langle \frac{5}{9} + \frac{30}{125} \right\rangle j.$$

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(c) Potensial listrik pada titik $\langle 0,0 \rangle$.

$$V = k\left\langle \frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} \right\rangle$$

$$= 1\left\langle \frac{2}{4} + \frac{5}{3} + \frac{10}{5} \right\rangle$$

$$= 1\left\langle \frac{30 + 100 + 120}{60} \right\rangle$$

$$= 1\left\langle \frac{250}{60} \right\rangle$$

$$= 4,167 \text{ dyne.cm/mc}$$

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(d) • $W = W_1 + W_2 + W_3 + W_4$

$W_1 = 0$

$$W_2 = V_2 \cdot q_2 = k \cdot \frac{q_1 q_2}{r_1^2} = 1 \cdot \frac{2.5}{5} = 2 \text{ dyne.c}$$

$$W_3 = V_3 q_3 = \left[k\frac{q_1}{r_{13}} + k\frac{q_2}{r_{23}} \right] q_3$$

$$= \left[1 \cdot \frac{2}{3} + 1 \cdot \frac{5}{5} \right] \cdot 10$$

$$= 19,16 \text{ dyne.cm.}$$

$$W_4 = V_4 \cdot q_4 = \left[\frac{kq_1}{\sqrt{r_4}} + k\frac{q_2}{r_{24}} + \frac{kq_3}{\sqrt{r_{34}}} \right]$$

$$= \left[1 \cdot \frac{2}{4} + 1 \cdot \frac{5}{3} + 1 \cdot \frac{10}{5} \right]$$

$$= \left\langle \frac{50}{12} \right] \cdot 1$$

$$= 9,16 \text{ dyne.cm.}$$

$$W = W_1 + W_2 + W_3 + W_4$$

$$= 0 + 2 + 19,16 + 9,16$$

$$= 25,32 \text{ dyne.cm.}$$

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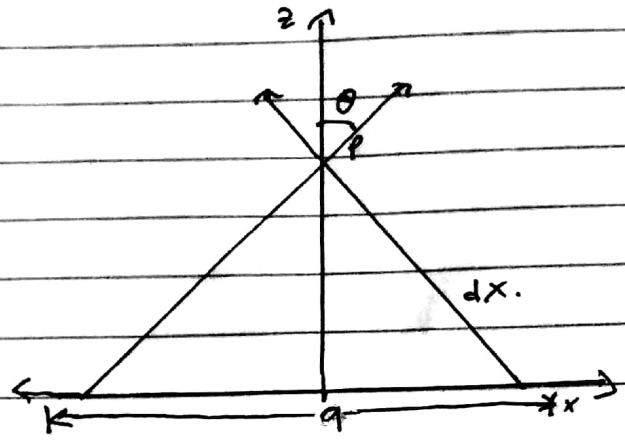
②



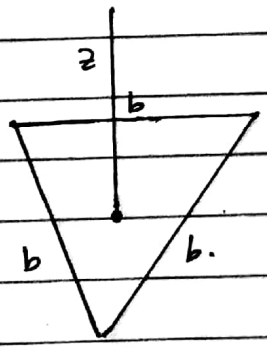
$dE = \frac{1}{4\pi\varepsilon_0} 2\left\langle \frac{\lambda dx}{r^2} \right\rangle \cos\theta \hat{k} \rightarrow \theta = \frac{z}{r} = \sqrt{z^2+x^2}$

$E = \frac{1}{4\pi\varepsilon_0} \int_0^2 \frac{2\pi z}{\langle z^2+x^2\rangle^{3/2}} dx = \frac{2\lambda z}{4\pi\varepsilon_0} \left[\frac{x}{z^2\sqrt{z^2+x^2}} \right] \Big|_0^L$

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

medan listrik pada kawat yg panjangnya a adalah: $E = \frac{1}{4\pi\varepsilon_0} \frac{2\pi L}{z^2}$ //

③.



Luas segitiga $= \frac{1}{2} a \times t$

$= \frac{1}{2} \cdot b \cdot b$

$= \frac{1}{2} b^2$.

$E = \frac{1}{4\pi\varepsilon_0} = \frac{2b\pi}{z^2}$

$E = A \cdot \frac{1}{4\pi\varepsilon_0} \cdot \frac{2\lambda\langle \frac{1}{2} b^2\rangle . z}{z^2 + \langle \frac{1}{2} b^2\rangle^2 \sqrt{z^2+\langle \frac{1}{2} b^2\rangle^2}}$

$E = \frac{1}{\pi\varepsilon_0} \cdot \frac{\pi \langle b^2\rangle z}{z^2 + \langle \frac{1}{4} b^4\rangle \sqrt{z^2+\frac{1}{4} b^4}}$