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HUKUM GAUSS

Hukum Gauss and Applied E = V

$$\oint_S E \cdot \vec{da} = \int_V (\nabla \cdot \vec{E})\, d\sigma$$

$$\oint \vec{E}\, da = \oint \frac{q}{4\pi\varepsilon_0 r^2} r^2 \sin\theta \, d\theta \, d\phi$$

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

$$= \frac{4\pi q}{4\pi\varepsilon_0}$$

$$\oint_S \vec{E}\, da = \frac{q}{\varepsilon_0}$$ → persamaan gauss dalam bentuk diferensial

$$\int_V (\nabla \cdot \vec{E})\, d\sigma$$

$$\oint_S \vec{E}\, da = \int_V (\nabla \cdot E)\, d\sigma = \rho\, d\sigma$$

$Q = \rho\, d\sigma$

$\int_V (\nabla \cdot \vec{E})\, d\sigma = \left(\frac{Q}{\varepsilon_0}\right)$ → Integral lipat 3

$\frac{1}{\varepsilon_0} \int_V \rho\, d\sigma$ → $\nabla \cdot \vec{E} = \frac{\rho}{\sigma}$ → Hukum gauss akan berbentuk diferensial

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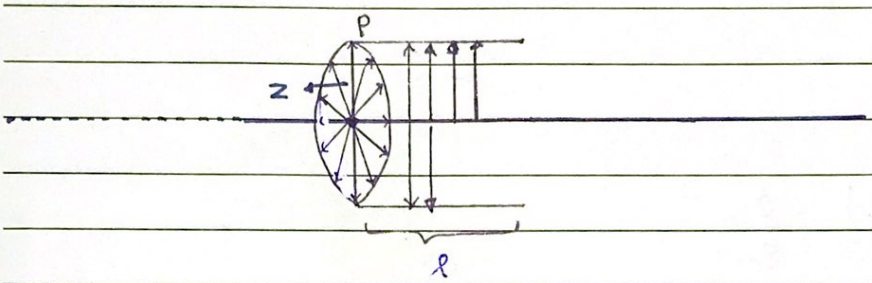
Contoh soal

1).



$$\oint E = da = \frac{q}{\varepsilon_0}$$

$$\vec{E}(2\pi z, \ell) = \frac{\lambda . \ell}{\varepsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi \varepsilon_0 z} \hat{z}_0$$

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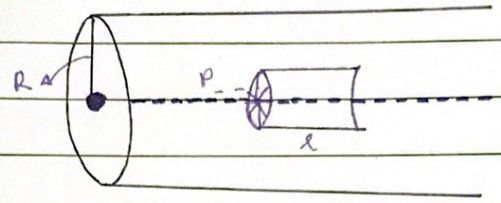
2].



$$\oint \vec{E}\, da = \frac{Q}{\varepsilon_0}$$

$$\vec{E}\,(2\pi r . l) = \frac{Q}{\varepsilon_0}$$

$$\vec{E} = \frac{Q}{2\pi \varepsilon_0 r l}\, \rho_0$$

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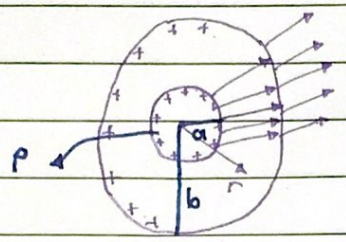
Contoh soal Latihan

1)



Calculate of $\vec{E}$

a. $r < a$

b. $a < r < b$

c. $r < b$

Jawab.

a. $r < a$

$= E = 0$

b. $a < r < b$

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

$$\oint \vec{E}\, da$$

$$\vec{E} \cdot (4\pi r^2) = \frac{1}{\varepsilon_0} \iiint \rho \, d\sigma$$

$$= \frac{1}{\varepsilon_0} \int_0^{a} \int_0^{2\pi} \int_0^{\pi} \rho \, r^2 \sin\theta \, d\theta \, d\phi \, dr$$

$$\vec{E}(4\pi r^2) = \frac{4\pi\rho}{\varepsilon_0} \int_0^{a} r^2 \, dr$$

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$$\vec{E}\,(4\pi r^2) = \frac{(4\pi\rho)}{\varepsilon_0}\int_0^a r^2\,dr$$

$$= \frac{4\pi\rho}{\varepsilon_0}\int_0^a \frac{r^{2+1}}{2+1}$$

$$= \frac{4\pi\rho}{\varepsilon_0}\int_0^a \frac{r^3}{3}$$

$$= \frac{4\pi\rho}{\varepsilon_0}\int_0^a \frac{1}{3}r^3$$

$$= \frac{4\pi\rho}{\varepsilon_0}\left(\frac{a^3}{3} - \frac{0^3}{3}\right)$$

$$= \frac{4\pi\rho}{\varepsilon_0}\left(\frac{a^3}{3}\right) = \frac{4\pi\rho a^3}{\varepsilon_0 \cdot 3}$$

c. $r > b$

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

$$= \frac{1}{\varepsilon_0}\iiint \rho r^2 \sin\theta\, d\theta\, d\phi\, dr$$

$$= \frac{4\pi\rho}{\varepsilon_0}\int_a^b \rho^2\, d\rho$$

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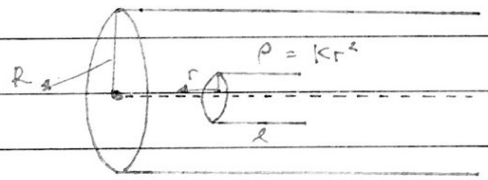
$$= \frac{4\pi\rho}{\varepsilon_0}\left(\frac{1}{3}r^2\Big|_a^b\right)$$

$$= \frac{4\pi\rho}{\varepsilon_0}\left(\frac{1}{3}b^3 - \frac{1}{3}a^3\right)$$

$$= \frac{4\pi\rho}{\varepsilon_0}\left(\frac{1}{3}b^3 - \frac{1}{3}a^3\right)$$

$$= \frac{4\pi\rho}{\varepsilon_0}\left(\frac{b^3 - a^3}{3}\right)$$



1. $r < R$

$$\oint \vec{E}\, da = \frac{1}{\varepsilon_0} \iiint \rho\, d\sigma$$

$$\vec{E}(2\pi r \cdot l) = \frac{1}{\varepsilon_0} \int_0^{2\pi} \int_0^{l} \int_0^{R} (k \cdot r^2)\, r \; d\phi\, dz\, dr$$

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$$= \frac{(2\pi K)}{\varepsilon_0} \int_0^{\ell} dz \int_0^{R} r^3 dr$$

$$= \frac{2\pi K}{\varepsilon_0} \int_0^{\ell} dz \int_0^{R} r^3 dr$$

$$= \frac{2\pi K}{\varepsilon_0} (z) \Big|_0^{\ell} \frac{r^4}{4} \Big|_0^{R}$$

$$= \frac{2\pi K}{\varepsilon_0} (\ell - 0) \cdot \left(\frac{R^4}{4} - \frac{0^4}{4} \right)$$

$$= \frac{2\pi K}{\varepsilon_0} (\ell \cdot \left(\frac{R^4}{4} \right)$$

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Potensial → disebabkan oleh muatan listrik

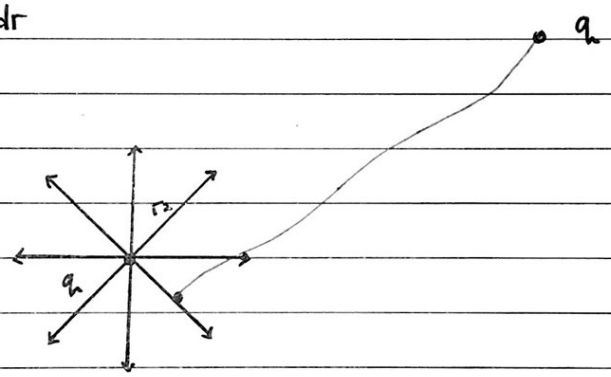
Beda potensial → ditimbulkan oleh arus listrik

$W = F.s$

$$V = \frac{W}{q} = \frac{F.s}{q} = \frac{k.\frac{q_1.q_2}{r}.s}{q}$$

$$V = k\frac{q}{r}$$

$$V = \int \vec{E}\, dr$$



$$dV = -\int_{r_1}^{r_2} \vec{E}\, dr$$

$$V_1 - V_2 = -\int \vec{E} \cdot dr$$

$$\Delta V = -\int_{r_1}^{r_2} \frac{q}{4\pi \varepsilon_0 r^{-2}}\, dr$$

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$$= -\frac{q}{4\pi\varepsilon_0}\int_{r_1}^{r_2} r^{-2}\,dr$$

$\Delta V \neq dV$

$$= -\frac{q}{4\pi\varepsilon_0}\left(\frac{r^{-2+1}}{-2+1}\right)\Bigg|_{r_1}^{r_2}$$

$$= -\frac{q}{4\pi\varepsilon_0}\,\frac{r^{-1}}{-1}\Bigg|_{r_1}^{r_2}$$

$$= -\frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

$$V = \frac{1}{4\pi\varepsilon_0}\,\frac{q}{r}$$

$$V = K\,\frac{q}{r}$$