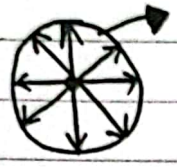
No Senin,
Date 25 - 03 - 2024

HUKUM GAUSS

$$\oint_S \vec{E} \cdot d\vec{a} = \int_V (\nabla \cdot \vec{E})\, d\tau \qquad \tau \Rightarrow V$$



Subtance of Gauss

$$\oint \vec{E} \cdot da = \oint \frac{q}{4\pi\epsilon_0 r^2} r^2 \sin\theta \, d\theta d\phi$$

$$= \frac{q}{4\pi\epsilon_0} \int_0^{\pi} \int_0^{2\pi} \sin\theta \, d\theta \, d\phi$$

$$= \frac{4\pi q}{4\pi\epsilon_0}$$

(E) Medan yg muncul dari sumber

$$\boxed{\oint_S \vec{E} \cdot da = \frac{q}{\epsilon_0}}$$

↓

Pers. Gauss dalam bentuk diferensial

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

$$Q = \rho \, d\tau \qquad \oint \vec{E} \cdot d\vec{a} = \int (\nabla . E)\, d\tau$$

$$\int (\nabla \cdot \vec{E})\, d\tau = \boxed{\frac{Q}{\epsilon_0}} \rightarrow \rho \, d\tau$$

$$\rightarrow = \frac{1}{\epsilon_0} \int_V \rho \, d\tau$$

$$\boxed{\nabla . \vec{E} = \frac{\rho}{\epsilon_0}} \rightarrow \text{Pers Gauss dalam bentuk diferensial}$$

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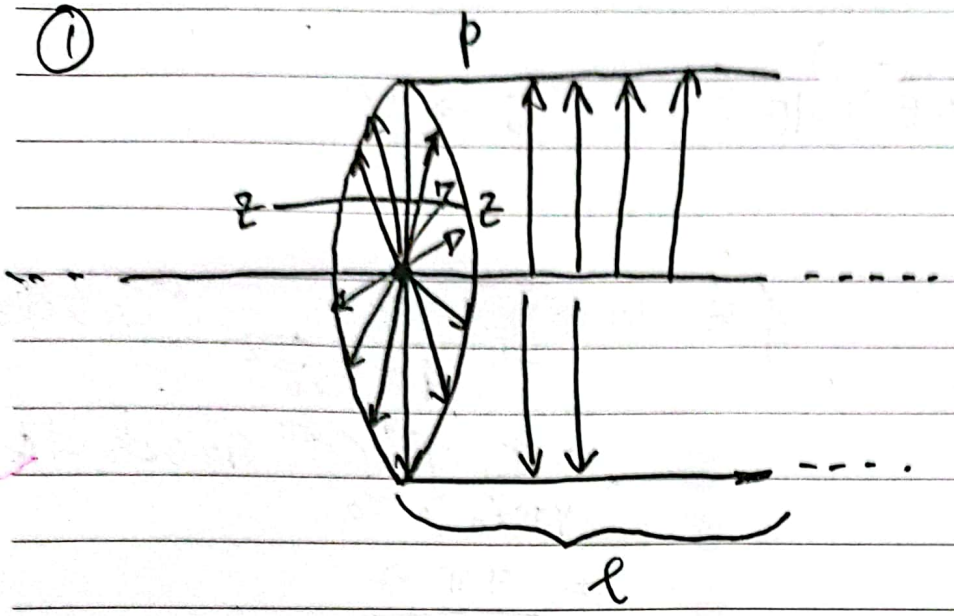
Contoh Soal

berlaku Simetri tinggi

①

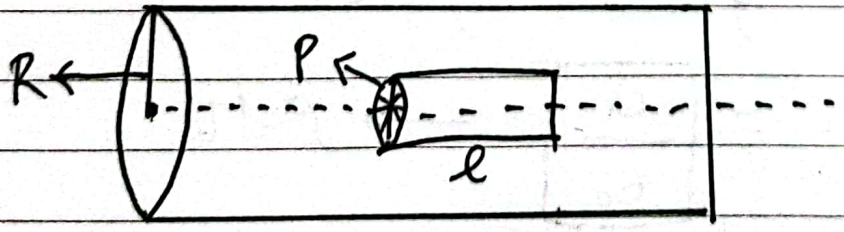


$$\oint \vec{E} \cdot da = \oint \frac{q}{\epsilon_0}$$

$$\vec{E} \cdot (2\pi z \cdot \ell) = \frac{\lambda \cdot \ell}{\epsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi \epsilon_0 z} \hat{z_0}$$

② · Sebuah silinder pejal panjang sekali. dg jari-jari silinder R, rapat muatannya q, hitung medan listrik di dalam silinder ?



$$\oint \vec{E} \cdot da = \frac{Q}{\epsilon_0}$$

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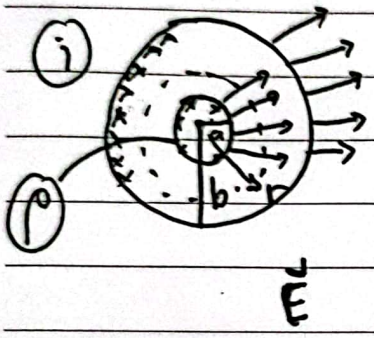
$$\vec{E}(2\pi r \cdot \ell) = \frac{Q}{\epsilon_0}$$

$$\vec{E} = \frac{Q}{2\pi \epsilon_0 r \ell} \hat{r}_0$$

Di daerah $a \leq r \leq b$. Cari medan listrik di tiga wilayah: (I) $r < a$, (II) $a < r < b$, (III) $r > b$. Plot $|E|$ sebagai fungsi dari r.



$\vec{E}$

① = $\vec{E} = 0$

② $\oint \vec{E} \cdot da = \frac{Q}{\epsilon_0}$

1). $r < a$
2). $a < r < b$
3). $r > b$

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

$\vec{E} \cdot (4\pi r^2) = \frac{1}{\epsilon_0} \iiint \rho \, d\tau$

$= \frac{1}{\epsilon_0} \int_0^{2\pi} \int_0^{\pi} \rho r^2 \sin\theta \, d\theta \, d\phi \, dr$

$= \frac{4\pi\rho}{\epsilon_0} \int_0^a r^2 dr$

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

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

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

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

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

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

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

(*) $r > b$

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

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

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

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

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

$$= \frac{4\pi\rho}{\varepsilon_0} \frac{b^3 - a^3}{3}$$

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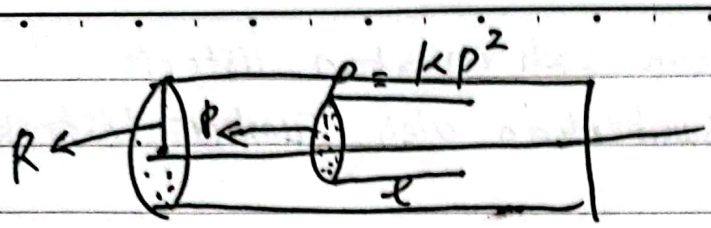

1). $r < R$

2). $r > R$

①

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

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

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

②. $$\oint \vec{E} \cdot da = \frac{Q}{\varepsilon_0}$$

$$\vec{E} \cdot (2\pi r \cdot \ell) = \frac{1}{\varepsilon_0} \int_0^{R} \int_0^{\pi}$$

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potensial : di sumberkan oleh muatan listrik
beda potensial : di sumberkan oleh arus listrik

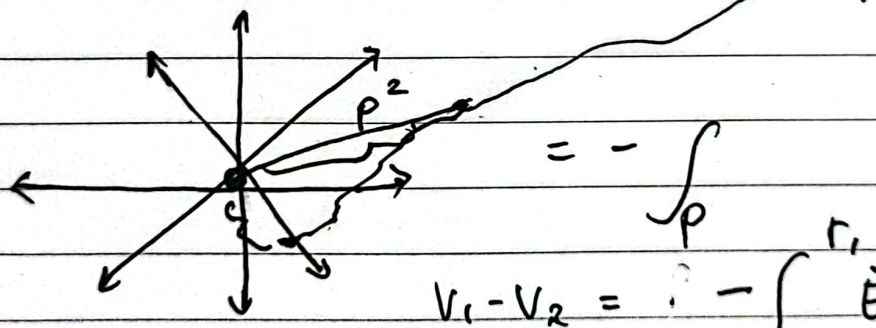
Usaha : Usaha memindahkan muatan

$$\boxed{W = F \cdot S}$$

$$V = \frac{W}{q_h} = \frac{F \cdot S}{q_h} = \frac{k \frac{q_h \cdot q_h}{r} \cdot s}{q_h}$$

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

$$V = -\int_{P_1}^{P_2} \vec{E}\, dr$$



$$= -\int_{P}$$

$$V_1 - V_2 = -\int_{r_1}^{r_1} \vec{E}\, d\vec{r}$$

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

$$= \frac{q}{4\pi\varepsilon_0} \int_{P_1}^{P_2} r^{-2} dr$$

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$$\Delta V = dV$$

$$= -\square \int_{p_1}^{p_2} r^{-2}\, dp$$

$$= -\square \left(\frac{1}{r} \Big|_{r_1}^{r_2} \right) = \square \left(\frac{1}{r_2} - \frac{1}{r_1} \right)$$

$$\boxed{V = \frac{1}{4\pi\varepsilon_0} \frac{q}{r} = k \frac{\theta}{r}}$$