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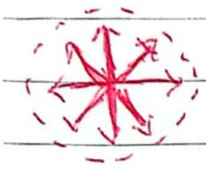
$\Delta v \neq dv$

$$\oint_s \vec{E}\, d\vec{a} = \int_v (\nabla \cdot \vec{E})\, d\tau$$



Menentukan lipat 2 atau l

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

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

$-\cos\pi - (\cos 0)$

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

$1 + 1 = 2$

$$\oint \vec{E}\, da = \frac{4\pi q}{4\pi\varepsilon_0}$$

$$\oint \vec{E}\, d\vec{a} = \frac{q}{\varepsilon_0}$$

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

$$Q_{inc} = \rho\, d\tau$$
$$= \sigma\, da$$
$$= \lambda\, dl$$

$$\iiint \nabla \cdot E\, d\tau = \iiint \frac{\rho\, d\tau}{\varepsilon_0}$$

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

$\downarrow$

Persamaan Gauss dalam bentuk differensial

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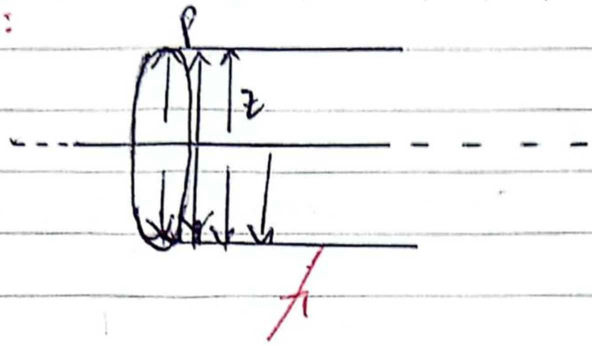
Contoh:



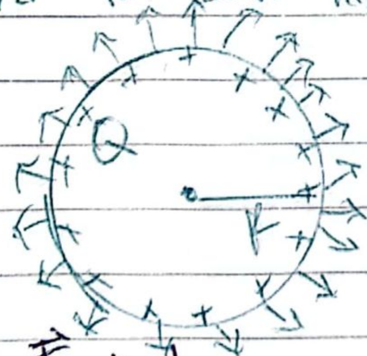
Permukaan Gauss

Sehingga,

$$\oint \vec{E} \cdot da = \frac{Q}{\varepsilon_0} \quad \lambda \cdot l \quad \vec{E} \cdot (2\pi P \cdot l) = \frac{\lambda l}{\varepsilon_0}$$

$$\oint \vec{E} \cdot d\vec{a} = \frac{\lambda l}{\varepsilon_0} \qquad \boxed{\vec{E} = \frac{\lambda}{2\pi \varepsilon_0 r} \hat{r}_0} \qquad \oint \vec{E} \cdot d\vec{a} = \frac{Q}{\varepsilon_0}$$

Fluks yang muncul pada lintasan tertutup karena ada sumber muatan disebut hukum gauss



Hitung $\vec{E}$ pada
a). $r < R$
b) $r > R$

$$\oint_S \vec{E} \cdot da = \frac{Q_r}{\varepsilon_0}$$

$$E (4\pi r^2) = \frac{Q}{\varepsilon_0}$$

$$E = \frac{Q}{4\pi \varepsilon_0 r^2} \hat{r}_0$$

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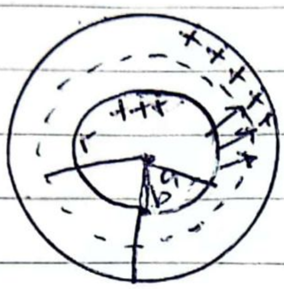

$$\int_0^{\pi}\int_0^{2\pi} \sin\theta \, d\theta \, d\rho = 4\pi$$

$r < a \rightarrow \vec{E} = 0$

$a < r < b$

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

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

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

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

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

$$= \frac{4\pi}{\varepsilon_0} \left(\frac{1}{3} r^3 \Big|_0^a \right.$$

$$\vec{E}(4\pi r^2) = \frac{4}{3}\pi \frac{r^3}{\varepsilon_0} = \vec{E} = \frac{r a^3}{3 \varepsilon_0 r^2} \hat{r}_0$$

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$\vec{E} \to \rho > b$

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

$$\vec{E} \cdot (4\pi r^2) = \frac{1}{\varepsilon_0} \int_a^b \int_0^{2\pi} \int_0^{\pi} \rho r^2 \sin\theta \, d\theta \, d\phi \, d\rho$$

$\rho > b$

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

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

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

$$\vec{E} = \frac{\rho}{3\varepsilon_0 r^2} (b^3 - a^3)$$