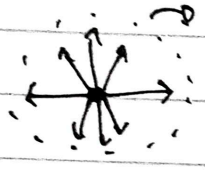
No.

Date 25-03-2024

Kalisma

Integral Lipat Tiga

Medan listrik - simetri tinggi (Panjang banget / Bulat)



→ Permukaan Gause

$\Delta V \neq dV$

$\oint \vec{E}\, d\vec{a} = \int (\nabla \cdot \vec{E})\, dE$

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

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

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

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

$\vec{E} = 4\pi r^2 = \frac{q}{\varepsilon_0}$

$\iiint \nabla E\, dv = \iiint \frac{\rho\, dv}{\varepsilon_0}$

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

$\boxed{\nabla \cdot \vec{E} = \frac{1}{\varepsilon_0} \rho}$

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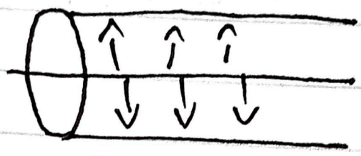
Contoh Soal



Permukaan Gauss

$$\oint \vec{E} \cdot d\vec{a} = \frac{q}{\varepsilon_0} \rightarrow \lambda l$$

$$\oint E \cdot da = \frac{\lambda l}{\varepsilon_0}$$

$$E\,(2\pi r l) = \frac{\lambda l}{\varepsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi \varepsilon_0 r} \; !^{a}_{o}$$

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2. Sebuah silinder pejal panjang sekali, dengan jari-jari silinder R, rapat muatannya ρ, hitung muatan listrik didalam silinder!

(Pada hal 61)

$\vec{E}(r)$ pada $r < R$

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

$\vec{E}(2\pi r \ell) = \frac{q}{\varepsilon_0}$

$E = \frac{q}{2\pi \varepsilon_0 r \ell} r_0$ dimana $r < R$

Pada $r = R$ maka $E(2\pi R \ell) = \frac{q}{\varepsilon_0} r_0$

$E = \frac{2}{2\pi \varepsilon_0 r \ell} \hat{r}_0$

3. Bola


Hitung E pada
a. $r < R$
b. $r > R$

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

$E(4\pi r^2) = \frac{Q_{net}}{\varepsilon_0}$ $\quad E = \frac{Q}{4\pi \varepsilon_0 r^2} \hat{r}_0$

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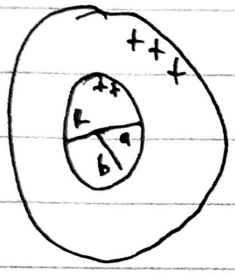
Contoh soal hal 62 dan 63




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

$a < r < b$

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

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

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

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

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

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

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

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

$$\vec{E} = \frac{\rho a^3}{3\varepsilon_0 r^2} \hat{r}_0$$

$\vec{E} \rightarrow r > b$

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

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

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

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

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

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