Elektrodinamika

* Kelistrikan

statis : gaya, medan, potensial, energi usaha polarisasi

dinamis : listrik yang bergerak dalam suatu rangkaian

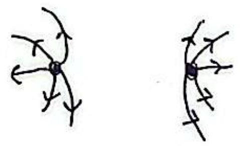
* Kemagnetan : ~~b~~ sifat benda yang saling menarik benda lain lain yang bersifat atau mengandung besi, kosam, baja dll.

medan magnet, kutub magnet, bahan magnetik, elektromagnetik

* muatan listrik adalah partikel yang menyebabkan mereka mengalami interaksi elektromagnetik.

(+) proton : $+1{,}602 \times 10^{-19}$ columb

(-) elektron : $-1{,}602 \times 10^{-19}$ columb

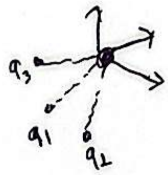


$\hat{r} = \dfrac{\vec{r}}{|r|}$

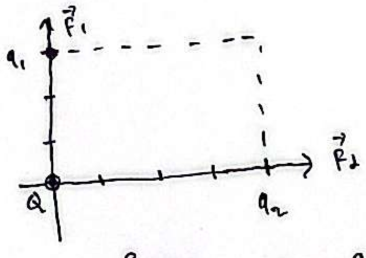
$\vec{F} \cdot \vec{k}$

$k = \dfrac{1}{4\pi\varepsilon_0} \quad \dfrac{qq}{r^2}$

* contoh penerapan

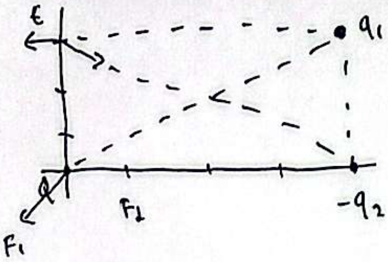


$\vec{F}_a = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$



$$F_Q = kQ\left[\frac{q_1}{3^2}\hat{j} + \frac{q_2}{4^2} - \hat{i}\right]$$

$$= -kQ\left[\frac{q_1}{9}\hat{j} + \frac{q_2}{16}\hat{i}\right]$$



$\hat{P} = \dfrac{\vec{P}}{r}$

$$\vec{F} = kQ\left[\frac{q_1}{5^2}\ \frac{(-4\hat{i} - 3\hat{j})}{5} + \frac{q_2}{4^2}\ (\hat{i})\right]$$

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elektrodinamika

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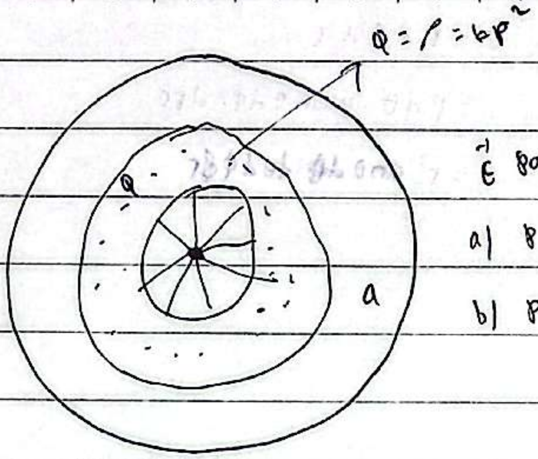

$\vec{E}$ pada

a) $\rho < R$

b) $\rho > R$

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

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

$$\vec{E} = \frac{Q}{4\pi\varepsilon_0 R^2}$$

$$\vec{E} = \frac{Q}{4\pi\varepsilon}$$

a. $\vec{E} \cdot A = \frac{1}{\varepsilon_0} \iiint \rho \, db$

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

$$= \frac{1}{\varepsilon_0} (4\pi) k \int_0^{r} r^4 \, d\rho$$

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

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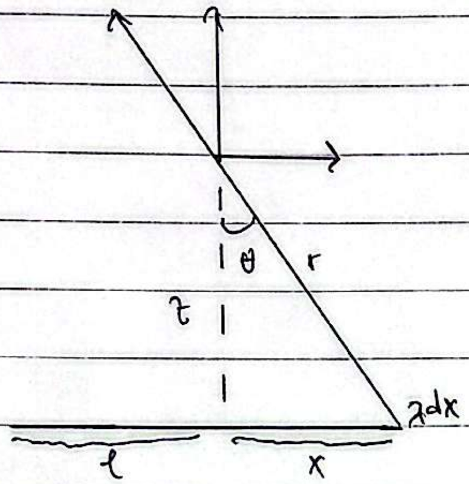

$d\vec{E} = d\vec{E} + d\vec{E}_x$

$= d\vec{E} \cos\theta$

$= \frac{1}{4\pi\varepsilon_0} \int_{-L}^{L} \frac{\lambda\, dx}{r^2} \cos\theta$

$= \frac{1}{4\pi\varepsilon_0} \int_{0}^{L} \frac{2\lambda\, dx}{r^2} \cos\theta$

$= \frac{1}{4\pi\varepsilon_0} \int_{0}^{L} \frac{z\, 2\lambda\, dx}{(x^2+z^2)^{3/2}}$

$= \frac{2z\lambda}{4\pi\varepsilon_0} \int_{0}^{L} \frac{dx}{(x^2+z^2)^{3/2}}$

$= \frac{2z\lambda}{4\pi\varepsilon_0} \left[\frac{x}{z^2\sqrt{x^2+z^2}} \Bigg|_0^L \right]$

$= \frac{\lambda}{2\pi\varepsilon_0}$

$= \left[\frac{L}{\sqrt{L^2+z^2}} \right]$

$E = \frac{\lambda L}{2\pi\varepsilon_0 z\sqrt{L^2+z^2}}$

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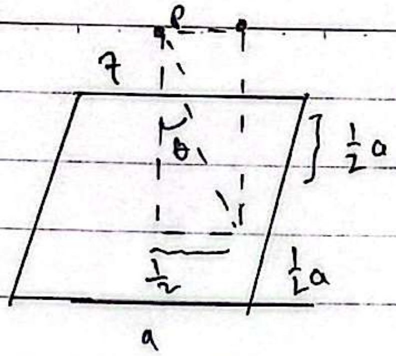


$$\vec{E_z} = E'_z \cos\theta$$

$$= q\vec{E_z} \cos\theta$$

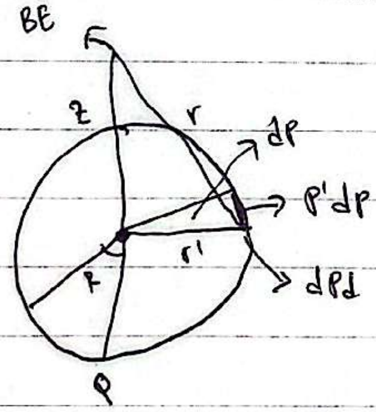
$$= q\left[\frac{\lambda L}{2\pi\varepsilon_0 z\sqrt{L^2+z^2}}\right]\cos\theta$$

$$\cos\theta = \frac{z}{z'}$$

$$z = z\cos\theta$$

$$z' = \sqrt{z^2 + \left(\frac{1}{2}a\right)^2}$$

$\vec{BE}$



$$E = \frac{1}{4\pi\varepsilon_0}\int_0^R\int_0^{2\pi}\frac{\sigma\, da}{r^2}\cos\theta\,\vec{j}$$

$$r = (z^2 + r'^2)^{1/2}$$

$$= \frac{6}{4\pi\varepsilon_0}2\pi z\int_0^R \frac{r'\,dr'}{(z^2 + r'^2)^{3/2}}$$

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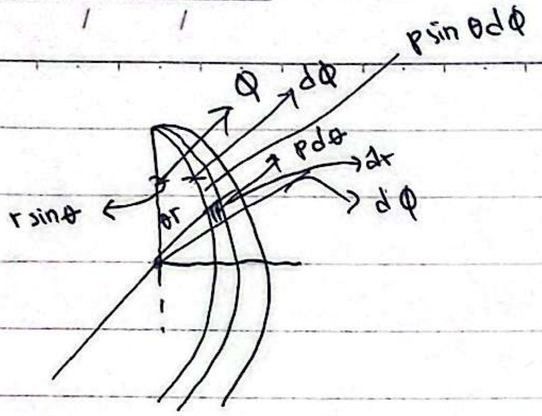
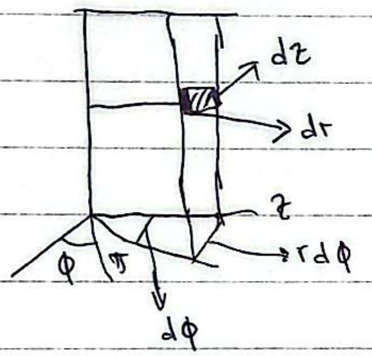


$V = p \times \ell \times t$

$= p\,d\theta \cdot p\sin\theta\,d\phi \cdot dpr$

$= r^2 \sin\theta\,d\theta\,d\phi\,dr$

Potensial listrik

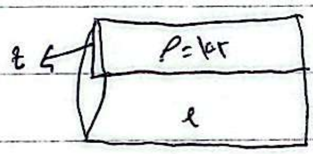


$V = p \times \ell \times t$

$= r\,d\phi \cdot dr \cdot dz$

a. $r < z$

b. $r > z$



$2\pi r$

a. $\oint\!\!\oint \vec{E}\,da = \dfrac{Q_{in}}{\varepsilon_0}$

$(2\pi r\ell) = \dfrac{1}{\varepsilon_0}\iiint \rho\,db$

$= \dfrac{1}{\varepsilon_0}\int_0^{r}\int_0^{2\pi}\int_0^{\ell} (kr)\,r\,dr\,d\phi\,dz$

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

b. $\oint\!\!\oint \vec{E}\,da = \dfrac{Q_{in}}{\varepsilon}$

$\vec{E}\,(4\pi r^2) = \dfrac{Q}{\varepsilon_0}$

$\vec{E} = \dfrac{Q}{4\pi\varepsilon_0 r^2}$ $r < R$

$\vec{E} = \dfrac{Q}{4\pi\varepsilon_0 r^2}$ $r > R$

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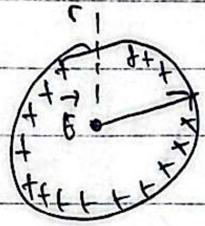
V

$\vec{E} = -\nabla V$

$\vec{E} \cdot d\rho = -\nabla V \cdot d\rho$

$\int \vec{E}\, d\rho = -\int \nabla V\, d\rho$



$= -dV$

$dV = -\int \vec{E}\, d\rho$

$\int_a^b dV = -\int \frac{Q}{4\pi\varepsilon_0 r} dr$

$\boxed{V_b - V_a = \frac{Q}{4\pi\varepsilon_0 r}}$ $\boxed{V_b = V_a = \frac{Q}{4\pi\varepsilon_0 R}}$

a) diluar

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

$= \frac{q}{4\pi\varepsilon_0 r} \Big|_{\infty}^{r}$

$\boxed{V = \frac{q}{4\pi\varepsilon_0 r}}$ $= -\int \vec{E}\, dQ + \int_R^r \vec{E}\, d\rho = \frac{Q}{4\pi\varepsilon_0 R}$

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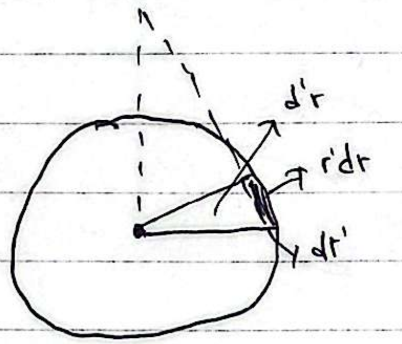

$$V = \frac{1}{4\pi\varepsilon_0} \iint \frac{\sigma\, da}{r}$$

$$da = r'\, dr$$

$$V = \frac{1}{4\pi\varepsilon_0} \int_0^R \int_0^{2\pi} \frac{r'\, dr'\, d\theta}{(r'^2 + z^2)^{1/2}}$$

$$= \frac{2\pi}{4\pi\varepsilon_0} \sigma \int_0^R \frac{r'\, dr'}{(r'^2 + z^2)^{1/2}}$$

$$= \frac{2\pi}{4\pi\varepsilon_0} \sigma \int_0^R r' (r'^2 + z^2)^{-1/2}\, dr'$$

$$= \frac{2\pi}{4\pi\varepsilon_0} \sigma \int_0^R \frac{(r'^2 + z^2)^{-1/2}\, dr'^2}{2}$$

$$= \frac{2\pi}{4\pi\varepsilon_0} \sigma \int_0^R (r'^2 + z^2)^{-1/2}\, dr^2$$

$$\int x^n\, dx$$

$$= \frac{1}{2} \sigma \frac{2\pi}{4\pi\varepsilon_0} \left[\frac{(r^2 + z^2)}{-\frac{1}{2} + 1} \right]^{-1/2 + 1}$$

$$= \frac{1}{2} \sigma \left[\frac{r'^2 + z^2}{\frac{1}{2}} \right]^{1/2}$$

$$= \sigma \frac{2\pi}{4\pi\varepsilon_0} \left[(r'^2 + z^2)^{1/2} \right]_0^R$$

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$$= \sigma \frac{2\pi}{4\pi\varepsilon_0} (R^2+z^2)^{1/2} + (r^2+z^2)^{1/2}$$

$$= \sigma \frac{2\pi}{4\pi\varepsilon_0} (R^2+z^2)^{1/2} + z$$