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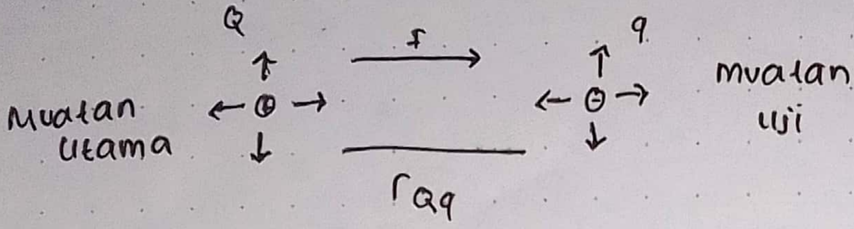
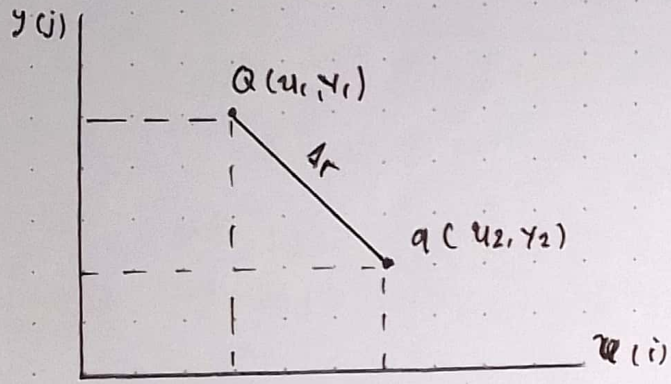
- Medan listrik : Medan yg masih dipengaruhi oleh gaya listrik (gaya coulomb)

Muatan uji ⇒ dilakukan perubahan posisi, Muatan uji dipengaruhi oleh muatan utama.

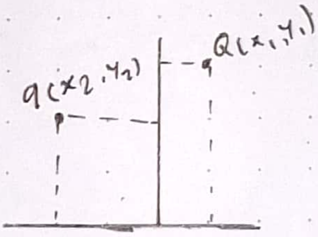




$$\hat{r}_{Qq} = \frac{\Delta x \hat{i} + \Delta y \hat{j}}{\sqrt{\Delta x^2 + \Delta y^2}} = \frac{\vec{r}_{Qq}}{|\vec{r}_{Qq}|}$$

$$F_{Qq} = q \cdot E_Q$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{Qq}{r_{Qq}^2} \cdot \hat{r}_{Qq}$$



$$\cancel{q}\ F_Q = \frac{1}{4\pi\varepsilon_0} \frac{Q\cancel{q}}{r_{Qq}^2} \hat{r}_{Qq}$$

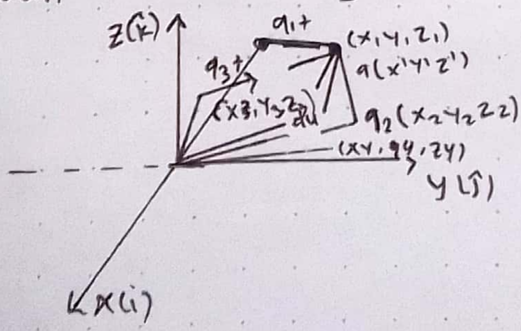
$$E_Q = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r_{Qq}^2} \hat{r}_{Qq}$$

$$E_Q = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r_{Qq}^3} \vec{r}_{Qq}$$

$$E_{q_1} = \frac{1}{4\pi\varepsilon_0} \frac{q_1}{r_{12}^2} \hat{r}_{12}$$

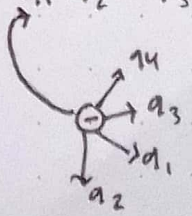
$$E_{q_2} = \frac{1}{4\pi\varepsilon_0} \frac{q_2}{r_{21}^2} \hat{r}_{21}$$

→ Medan listrik yang dihasilkan oleh banyak muatan



Terombang ambing oleh medan listrik yang terendah maka

$q_1\ q_2\ q_3\ q_4$



$$E_{q_1} = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_1'^2}\hat{r}_1' \quad \rightarrow \quad q_1 < q_2 < q_3 < q_4$$

$$E_{tot} = E_q' = E_{q_1} + E_{q_2} + E_{q_3} + E_{q_4}$$

$$E_{q_2} = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{r_2'^2}\hat{r}_2' \qquad \hat{r}_1' = \frac{\vec{r}_1'}{|\vec{r}_1'|} = \frac{\Delta x_1'\hat{i} + \Delta y_1'\hat{j} + \Delta z_1'\hat{k}}{\sqrt{\Delta x_1'^2 + \Delta y_1'^2 + \Delta z_1'^2}}$$

$$E_{q_3} = \frac{1}{4\pi\varepsilon_0}\frac{q_3}{r_3'^2}\hat{r}_3' \qquad \vec{r}_1' = \Delta x_1'\hat{i} + \Delta y_1'\hat{j} + \Delta z_1'\hat{k}$$

$$\Downarrow$$

$$E_{q_4} = \frac{1}{4\pi\varepsilon_0}\frac{q_4}{r_4'^2}\hat{r}_4' \qquad (x'-x_1)\ (y'-y_1)\ (z'-z_1)$$

- $$E_{q_1} = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_1'^2}\hat{r}_1'$$

$$E_{q_1} = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{((\Delta x_1'^2 + \Delta y_1'^2 + \Delta z_1'^2)^{1/2})^2} = \frac{\Delta x_1'\hat{j} + \Delta y_1'\hat{j} + \Delta z_1'\hat{k}}{(\Delta x_1'^2 + \Delta y_1'^2 + \Delta z_1'^2)^{1/2}}$$

$$E_{q_1} = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{(\Delta x_1'^2 + \Delta y_1'^2 + \Delta z_1'^2)(\Delta x_1'^2 + \Delta y_1'^2 + \Delta z_1'^2)^{1/2}} = \Delta x_1\hat{j} + \Delta y_1\hat{j} + \Delta z\hat{k}$$

- $$E_{q_2} = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{r_2'^2}\hat{r}_2'$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_2}{((\Delta x_2'^2 + \Delta y_2'^2 + \Delta z_2'^2)^{1/2})^2} \cdot \frac{\Delta x_2'\hat{i} + \Delta y_2'\hat{j} + \Delta z_2'\hat{k}}{(\Delta x_2'^2 + \Delta y_2'^2 + \Delta z_2'^2)^{1/2}}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_2}{(\Delta x_2'^2 + \Delta y_2'^2 + \Delta z_2'^2)(\Delta x_2'^2 + \Delta y_2'^2 + \Delta z_2'^2)^{1/2}}(\Delta x_2'\hat{i} + \Delta y_2\hat{j} + \Delta z_2\hat{k})$$

- $$E_{q_3} = \frac{1}{4\pi\varepsilon_0}\frac{q_3}{r_3'^2}\hat{r}_3$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_3}{((\Delta x_3'^2 + \Delta y_3'^2 + \Delta z_3'^2)^{1/2})^2} \cdot \frac{\Delta x_3'\hat{i} + \Delta y_3'\hat{j} + \Delta z_3'\hat{k}}{(\Delta x_3'^2 + \Delta y_3'^2 + \Delta z_3'^2)^{1/2}}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_3}{(\Delta x_3'^2 + \Delta y_3'^2 + \Delta z_3'^2)(\Delta x_3'^2 + \Delta y_3'^2 + \Delta z_3'^2)^{1/2}} \cdot \Delta x_3'\hat{j} + \Delta y_3\hat{j} + \Delta z_3\hat{k}$$

- $$E_{q_4} = \frac{1}{4\pi\varepsilon_0}\frac{q_4}{r_4'^2}\hat{r}_4$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_4}{((\Delta x_4'^2 + \Delta y_4'^2 + \Delta z_4'^2)^{1/2})^2} \cdot \frac{\Delta x_4'\hat{i} + \Delta y_4'\hat{j} + \Delta z_4'\hat{k}}{(\Delta x_4'^2 + \Delta y_4'^2 + \Delta z_4'^2)^{1/2}}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_4}{(\Delta x_4'^2 + \Delta y_4'^2 + \Delta z_4'^2)(\Delta x_4'^2 + \Delta y_4'^2 + \Delta z_4'^2)} \Delta x_4'\hat{j} + \Delta y_4\hat{j} + \Delta z_4\hat{k}$$

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$E_{total} = Eq_1 = Eq_1 + Eq_2 + Eq_3 + Eq_4$

$$Eq' = \left(\frac{1}{4\pi\varepsilon_0} \frac{q_1}{(\Delta x_1'^2 + \Delta y_1'^2 + \Delta z_1'^2)(\Delta x_1'^2 + \Delta y_1'^2 + \Delta z_1'^2)^{1/2}} (\Delta x_1 \hat{i} + \Delta y_1 \hat{j} + \Delta z_1 \hat{k})\right)$$

$$+ \left(\frac{1}{4\pi\varepsilon_0} \frac{q_2}{(\Delta x_2'^2 + \Delta y_2'^2 + \Delta z_2'^2)(\Delta x_2'^2 + \Delta y_2'^2 + \Delta z_2'^2)^{1/2}} (\Delta x_2' \hat{i} + \Delta y_2' \hat{j} + \Delta z_2' \hat{k})\right)$$

$$+ \left(\frac{1}{4\pi\varepsilon_0} \frac{q_3}{(\Delta x_3'^2 + \Delta y_3'^2 + \Delta z_3'^2)(\Delta x_3'^2 + \Delta y_3'^2 + \Delta z_3'^2)^{1/2}} (\Delta x_3' \hat{i} + \Delta y_3' \hat{j} + \Delta z_3' \hat{k})\right)$$

$$+ \left(\frac{1}{4\pi\varepsilon_0} \frac{q_4}{(\Delta x_4'^2 + \Delta y_4'^2 + \Delta z_4'^2)(\Delta x_4'^2 + \Delta y_4'^2 + \Delta z_4'^2)^{1/2}} (\Delta x_4' \hat{i} + \Delta y_4' \hat{j} + \Delta z_4' \hat{k})\right)$$

→ Medan listrik yang dihasilkan distribusi muatan

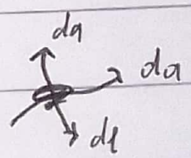
	cartesian (x, y, z)	cylindrical (ρ, ϕ, z)	spherical (r, θ, ϕ)
dl	$dx,\ dy,\ dz$	$d\rho,\ \rho d\phi,\ dz$	$dr\ r d\theta\ r\sin\theta\ d$
dA	$dx\,dy,\ dy\,dz,\ dz\,dx$	$d\rho dt,\ \rho d\phi dz,\ \rho d\phi d\rho$	$r\,dr\,d\theta,\ r\sin\theta\,dr\,d\phi,$
			$r^2\sin\theta\,d\theta\,d\phi$
dv	$dx,\ dy,\ dz$	$\rho d,\ \rho d\phi\ dz$	$r^2\sin\theta\,dr\,d\theta\,d\phi$

Ket: dl = panjang
dA = luas
dv = volume

Rapat muatan → suatu muatan listrik yang terdistribusi dalam suatu bidang tertentu dan ruang tertentu.

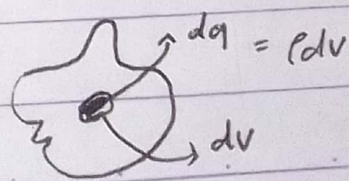
→ example

1) rapat muatan panjang (ds') atau (dl)



$$\lambda = \frac{dq'}{dl'} \quad \text{atau} \quad \lambda = \frac{dq}{dl}$$

2) Rapat muatan volume (dr') atau (dv')



$$\rho = \frac{dq}{dv}$$

$$\rho = \frac{dr}{dq}$$

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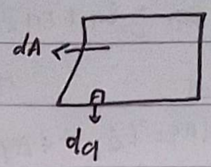
3) Rapat muatan luas (da')

$$G = \frac{dq}{dA}$$



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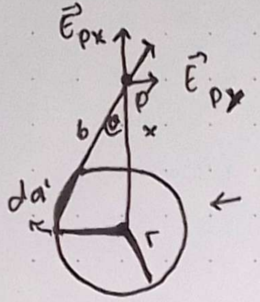
KALISMA

- Medan listrik oleh muatan cincin



← Medan listrik disumbu

$L = 2\pi r$

$\partial L = 2\pi\, \partial \cdot r$

$$E_Q = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$$

$\lambda = \frac{q}{l}$ atau $\lambda = \frac{q}{2\pi r}$

$\lambda = \frac{\partial q}{\partial l} \rightarrow \partial q = \lambda \cdot \partial l$

$$E_{\partial Q} = \frac{1}{4\pi\varepsilon_0} \frac{\partial q}{b^2}$$

$$E_{\partial Q} = \frac{1}{4\pi\varepsilon_0} \frac{\lambda \cdot \partial l}{(r^2+x^2)}$$

$$\sin\theta = \frac{r}{(r^2+x^2)^{1/2}}$$

$$\cos\theta = \frac{x}{(r^2+x^2)^{1/2}}$$

$$* \; \vec{E}_{py} = \vec{E}_p \sin\theta = \frac{1}{4\pi\varepsilon_0} \int \frac{\lambda\, \partial l}{(r^2+x^2)} \sin\theta$$

$$= \frac{1}{4\pi\varepsilon_0} \int \frac{\lambda\, \partial l}{(r^2+x^2)} \frac{r}{(r^2+x^2)^{1/2}}$$

$$* \; \vec{E}_{px} = \vec{E}_p \cos\theta = \frac{1}{4\pi\varepsilon_0} \int \frac{\lambda\, dl}{(r^2+x^2)} \frac{x}{(r^2+x^2)^{1/2}}$$

$$\vec{E}_p = \frac{1}{4\pi\varepsilon_0} \frac{\lambda x}{(r^2+x^2)^{3/2}} \int \partial l$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{\lambda x}{(r^2+x^2)^{3/2}} \int_0^r 2\pi\, \partial r$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{\lambda}{(r^2+x^2)^{3/2}}\, 2\pi \int_0^r \partial r$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{(\lambda 2\pi r)x}{(r^2+x^2)^{3/2}}$$

$q = \lambda \cdot 2\pi r$

$$= \frac{1}{4\pi\varepsilon_0} \frac{qx}{(r^2+x^2)^{3/2}}$$

$b^3 = ((r^2+x^2)^{\frac{1}{2}})^3$

$$\vec{E}P_x = \frac{1}{4\pi\varepsilon_0} \frac{qx}{((r^2+x^2)^{1/2})^3}$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{qx}{b^3}$$

$$= \frac{1}{4\pi\varepsilon_0} q \frac{1}{b^2} \frac{x}{b}$$

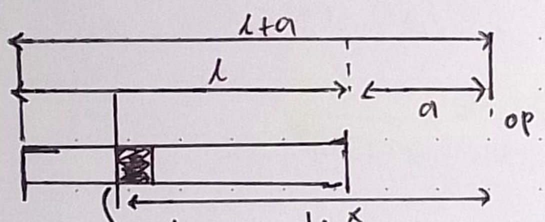
$$= \frac{1}{4\pi\varepsilon_0} q \frac{1}{b^2} \frac{x}{b} \frac{r^2}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2} \frac{r^2}{b^2} \frac{x}{b}$$

sin θ   cos θ

$$\vec{E}P_x = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2} \sin\theta \cos\theta$$

•) Medan listrik oleh muatan batang.



$da' = \lambda \cdot dl$

$$\vec{E}P = k \int \frac{da}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \int \frac{\lambda \partial l}{x^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \lambda \int_a^{l+A} \frac{\partial x}{x^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \lambda \int_a^{l+A} \left(\frac{1}{x^2}\right) dx$$

$$= \frac{1}{4\pi\varepsilon_0} \lambda \left[-\frac{1}{x}\right]_a^{l+a}$$

$$= \frac{1}{4\pi\varepsilon_0} \lambda \left[\left(\frac{1}{a}\right) - \left(\frac{1}{l+a}\right)\right]$$

$$\vec{E}P = \frac{1}{4\pi\varepsilon_0} \lambda \left[\frac{(l+a)-a}{a(l+a)}\right]$$

$$\vec{E}P = \frac{1}{4\pi\varepsilon_0} \lambda \left[\frac{l}{a(l+a)}\right]$$

$$\vec{E}P = \frac{1}{4\pi\varepsilon_0} \frac{\lambda l}{(al+a^2)}$$

$$\vec{E}P = \frac{1}{4\pi\varepsilon_0} \frac{q}{(al+a^2)}$$

Dipindai dengan CamScanner