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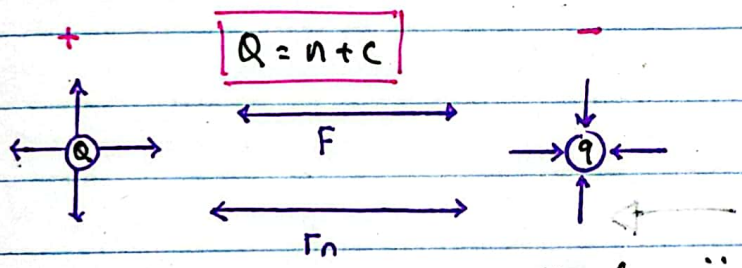
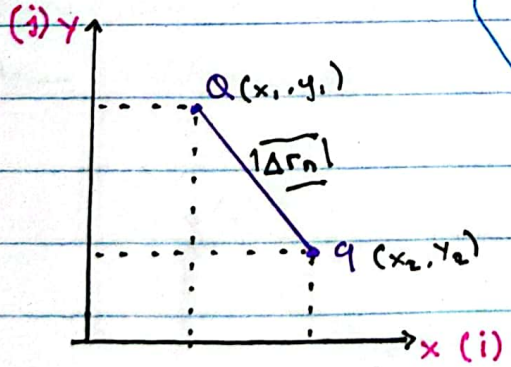
MEDAN LISTRIK

→ adalah daerah sekitar partikel bermuatan listrik yang masih dipengaruhi gaya listrik (gaya Coloumb)



Muatan utama — muatan uji



$$\vec{E_Q} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r^2_{Qq}} \hat{r}_{Qq}$$ → rumus

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

$$|\hat{r}_{Qq}| = r_{Qq} = \sqrt{\Delta x^2 + \Delta y^2}$$

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

$F_q = 0$

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

q = muatan uji — E_Q = medan listrik yang dihasilkan

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

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

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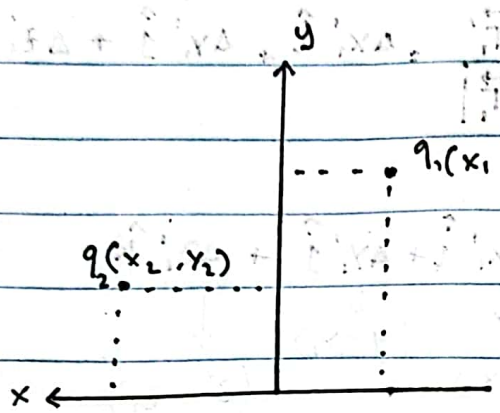
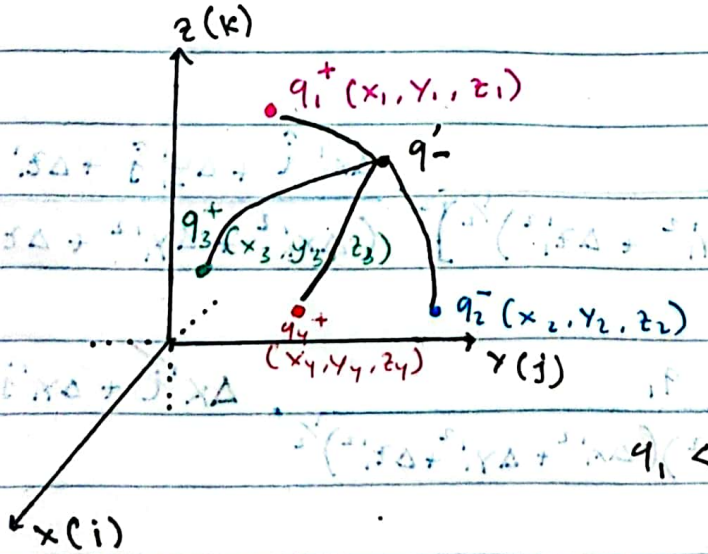


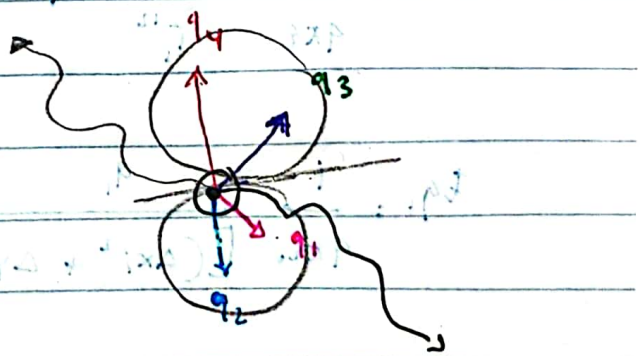
$$\vec{E}_{q_1} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1}{r_{1,2}^2} \cdot \hat{r}_{1,2}$$

$$\vec{E}_{q_2} = \frac{1}{4\pi\varepsilon_0} \frac{q_2}{r_{1,2}^2} \hat{r}_{1,2}$$

- Medan listrik yang dihasilkan oleh banyak muatan
  ↳ (bersama vektor)

jika terdapat sejumlah muatan yang tersebar pada sistem koordinat, maka besarnya medan listrik total pada muatan q' (muatan uji') adlh jumlah vektor listrik yang dilakukan oleh sejumlah muatan lainnya.





Tertarik - antara oleh Medan listrik terendah

$$q_1 < q_2 < q_3 < q_4$$

$$E_{total} = E_{q'} = E_{q_1} + E_{q_2} + E_{q_3} + E_{q_4}$$

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

$$\hat{r}_1' = \frac{\vec{r}_1'}{|\vec{r}_1'|} = \Delta x_1' \hat{i} + \Delta y_1' \hat{j} + \Delta z_1' \hat{k}$$

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

$$\vec{r}_1' = \Delta x_1' \hat{i} + \Delta y_1' \hat{j} + \Delta z_1' \hat{k}$$

$\Delta x_1'$: $(x' - x_1)$, $\Delta y_1'$: $(y' - x_1)$, $\Delta z_1'$: $(z' - z_1)$

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

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

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

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

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

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- Medan listrik yang dihasilkan Distribusi medan

	Cartesian (x,y,z)	Cylindrical (ρ,ϕ,z)	Spherical (r,θ,ϕ)
dl Panjang	dx, dy, dz	$d\rho, \rho d\phi, dz$	$dr, r d\theta, r\sin\theta d\phi$
dA Luasan	$dxdy, dydz, dzdx$	$d\rho dz, \rho d\phi dz, \rho d\phi d\rho$	$r dr d\theta, r\sin\theta dr d\phi, r^2\sin\theta d\theta d\phi$
dv Volume	$dxdydz$	$\rho d\rho d\phi dz$	$r^2\sin\theta dr d\theta d\phi$

Ket = dl → Panjang

dA → luasan

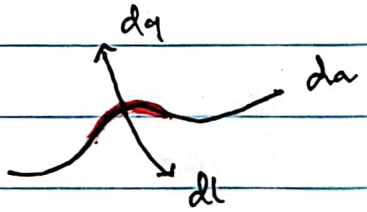
dv → volume

Rapat muatan = suatu muatan listrik yang terdistribusi dalam suatu bidang tertentu & ruang tertentu

Example

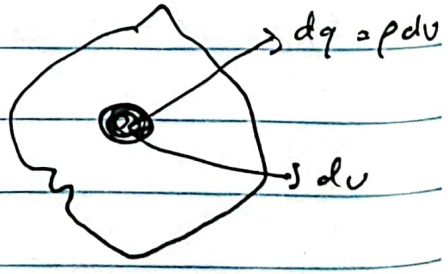
1. Rapat muatan panjang (ds') atau (dl')

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



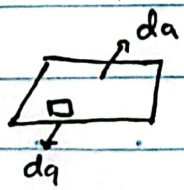
2. Rapat muatan volume (ds') atau (dv')

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



3. Rapat muatan luas (da)

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



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MEDAN LISTRIK PADA MUATAN CINCIN

$$L = 2\pi r$$

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

$$\lambda = \frac{q}{2\pi r} \rightarrow \lambda = \frac{q}{L}$$

$$\lambda = \frac{\partial q}{\partial L}$$

$$\partial q = \lambda \partial L$$

$$EQ = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

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

$$E\partial q = \frac{1}{4\pi\varepsilon_0}\frac{\lambda 2L}{(r^2+x^2)}$$

$$E\partial q = \frac{1}{4\pi\varepsilon_0}\int\frac{\lambda 2L}{(r^2+x^2)}$$

$$E\partial q = \frac{1}{4\pi\varepsilon_0}\int\frac{\lambda 2L}{(r^2+x^2)}$$

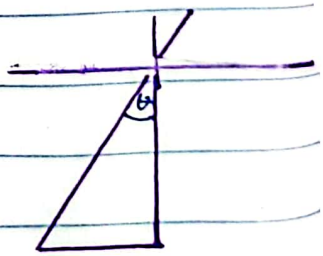
$$E\partial q_y = E\partial q \cdot \sin\theta$$

$$= \frac{1}{4\pi\varepsilon_0}\int\frac{\lambda \partial L}{(r^2+x^2)} \cdot \sin\theta$$

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

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

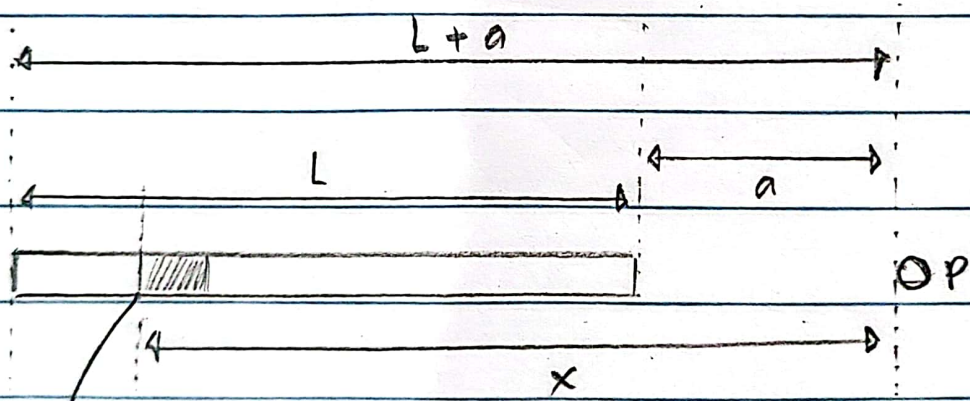
$$\cos\theta = \frac{x}{(r^2+x^2)^{1/2}}$$



Jika N (pembagian sampelnya) sangat besar dl' sangat kecil sehingga tiap bagian dl' dapat dipandang sebagai muatan titik. Kita lihat elemen di batang yang jaraknya x dari dq' ke titik P.

Muatan sampel (dq') yang dikandung elemen tersebut adlh:

$$dq' = \lambda\, dx$$



$$dq' = \lambda\, dl'$$

medan listrik yang ditimbulkan oleh batang.