Nama : Rizka Agustin
Kelas : B

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Gaya Listrik

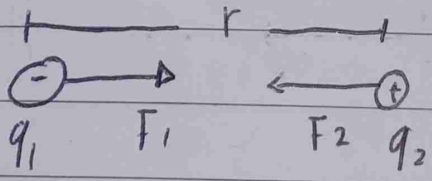
1 Hukum Coulumb

- Gaya yg dilakukan oleh satu muatan titik pada muatan titik lainnya bekerja sepanjang garis yang menghubungkan kedua muatan tersebut. Besarnya gaya berbanding terbalik kuadrat jarak keduanya berbanding lurus dengan perkalian dua muatan.
- Gaya tolak menolak → muatan sama
- Gaya tarik menarik → muatan beda

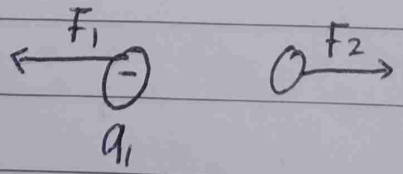
$$F_{12} = \frac{k\, q_1\, q_2}{r_{12}^2}\, \hat{r}_{12}$$

- Dengan $k = 8{,}99 \times 10^9\ N \cdot m^2/C^2$

  $k \approx 9 \times 10^9\ Nm^2/C^2$



» tarik menarik



» tolak menolak

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2 **Listrik Statis**

↳ Suatu fenomena listrik yang ditimbulkan ketika partikel bermuatan ditransfer dari suatu benda ke benda lain, hal ini terjadi karena adanya dua buah benda yang saling bergesekan.

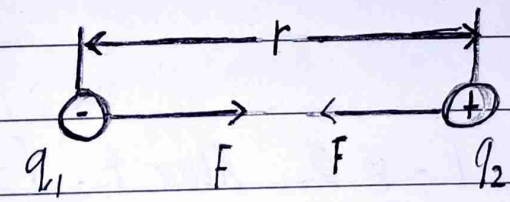
3 **Muatan Listrik**

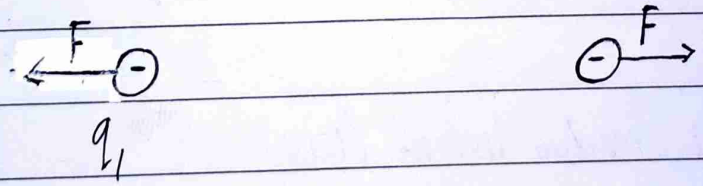
Atom terdiri dari dua bagian, yakni inti atom dan kulit atom

- Inti atom : Proton (+) & Neutron (netral)
- Kulit atom : elektron (-)

Gaya Coulumb

↳ Besarnya gaya listrik yang terjadi antara dua benda yang bermuatan dengan jarak benda / yang memiliki jarak.





$$F = k \frac{q_1 q_2}{r^2}$$

$k = 9 \times 10^9 \ Nm^2/C^2$

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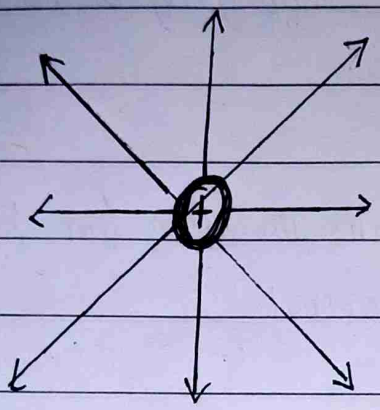
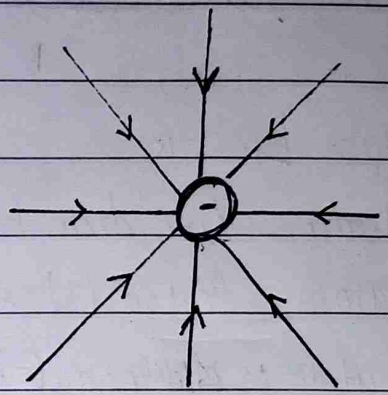
Medan Listrik

↳ Daerah disekitar partikel bermuatan listrik yang masih dipengaruhi gaya listrik (gaya Coulumb)



(muatan negatif)



(muatan negatif)

Benda bermuatan yang menghasilkan medan listrik disebut muatan sumber. Sedangkan, muatan lain yang diletakkan dalam pengaruh medan listrik muatan sumber disebut sebagai muatan uji.

$$E = k\frac{Q}{r^2} \quad \text{Atau} \quad E = \frac{F}{q}$$

E = kuat medan listrik (N/C)
Q = besar muatan sumber (C)
q = besar muatan uji (C)
F = Gaya Coulumb

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Potensial Listrik

↳ Usaha per satuan muatan yang dibutuhkan untuk memindahkan satu muatan dari satu titik ke titik lainnya.

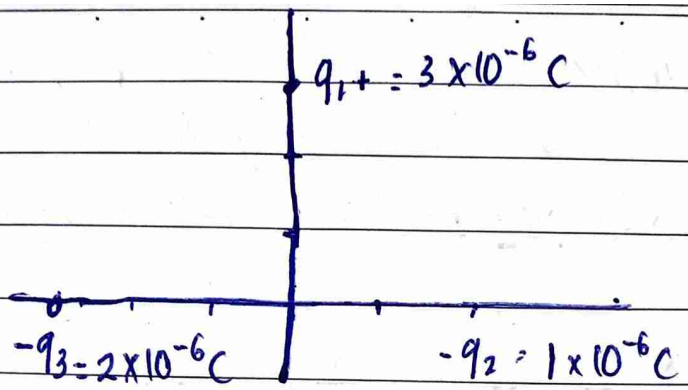
$$V = k\frac{Q}{r}$$

V = Potensial listrik

Energi Potensial Listrik

↳ Energi atau usaha yang dibutuhkan untuk memindahkan muatan listrik dari satu titik ke titik lainnya.

$$\boxed{E_p = k\frac{q_1 q_2}{r}}$$



$$\vec{F}_{13} = k\frac{q_1 q_3}{r_{13}^2}\hat{r}_{13} = k\cdot\frac{3\cdot 2\cdot 10^{-6}\cdot 10^{-6}}{(\sqrt{3^2+3^2})^2}\,\frac{3\hat{j}-3\hat{i}}{\sqrt{3^2+3^2}}$$

$$= 9\times 10^{9}\,N\cdot m^2/C^2\cdot\frac{6\cdot 10^{-6}\cdot 10^{-6}}{18\,m}\,\frac{3\hat{j}-3\hat{i}}{3\sqrt{2}}$$

$$= 9\,10^{-3}\,N\cdot\frac{6\,e^2}{18\,m}\left(\frac{3\hat{j}-3\hat{i}}{3\sqrt{2}}\right)$$

$$= 3\cdot 10^{-3}\,N\cdot\frac{6^1}{18}\left(\frac{3\hat{j}-3\hat{i}}{3\sqrt{2}}\right)$$

$$= 3\cdot 10^{-3}\,N\cdot\left(\frac{3\hat{j}-3\hat{i}}{3\sqrt{2}}\right)$$

$$= \left(\frac{9\hat{j}}{3\sqrt{2}} - \frac{9\hat{i}}{3\sqrt{2}}\right)10^{-3}\,N$$

$$\vec{F}_{23} = k\frac{q_2 q_3}{r_{23}^2}\hat{r}_{23} = k\,\frac{1\cdot 2\cdot 10^{-6}\cdot 10^{-6}}{5^2}\cdot\left(\frac{5\hat{i}-0\hat{j}}{\sqrt{5^2+0^2}}\right)$$

$$= \frac{9\times 10^{9}\,N\cdot m^2/C^2\cdot 2\cdot 10^{-6}\cdot 10^{-6}}{25}\cdot\left(\frac{5\hat{i}}{125}\right)$$

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$$= 9 \cdot 10^{-3}\ N \cdot \frac{2}{25} \left(\frac{3i}{5}\right)$$

$$= \frac{90 \cdot 10^{-3}\ N}{25 \cdot 5}$$

$$= \frac{90\ 10^{-3}\ N}{125} = \frac{18\ i}{25} \times 10^{-3}\ N$$

$$F_3 = F_{13} + F_{23}$$

$$= \left(\frac{9\hat{j}}{3\sqrt{2}} - \frac{9\hat{i}}{3\sqrt{2}}\right) 10^{-3}\ N + \left(\frac{18\ i}{25}\right) 10^{-3}\ N$$

$$= \left(\frac{9\hat{j}}{3\sqrt{2}} - \frac{9\hat{i}}{3\sqrt{2}} + \frac{18i}{25}\right) 10^{-3}$$

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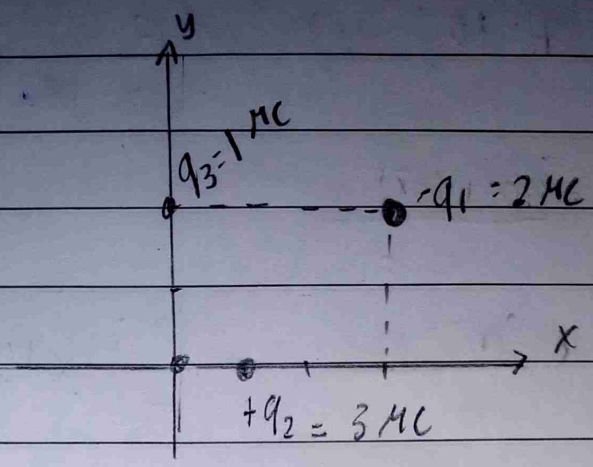

$$F_{21} = k \frac{q_2 \cdot q_1}{r_{21}^2} \hat{r}_{21}$$

$$= 9 \times 10^9\ N\,m^2/C^2 \cdot \frac{2 \cdot 3 \cdot 10^{-6} \cdot 10^{-6}\ C^2}{(\sqrt{2^2+2^2})^2} \frac{2\hat{i}+2\hat{j}}{\sqrt{2^2+2^2}}$$

$$= 9 \times 10^9\ N\,m^2/C^2 \cdot \frac{3}{8} \cdot 10^{-6} \cdot 10^{-6}\ C^2 \frac{2\hat{i}+2\hat{j}}{\sqrt{8}}$$

$$= 9 \times 10^{-3}\ N \cdot \frac{3}{4} \left(\frac{2\hat{i}+2\hat{j}}{\sqrt{8}} \right)$$

$$= \frac{27}{4} 10^{-3} N \cdot \frac{2\hat{i}+2\hat{j}}{2\sqrt{2}}$$

$$= \left(\frac{54\hat{i}}{4 \cdot 2\sqrt{2}} + \frac{54\hat{j}}{4 \cdot 2\sqrt{2}} \right) 10^{-3}\ N$$

$$F_{31} = k \frac{q_3 \cdot q_1}{r_{31}^2} \hat{r}_{31}$$

$$= 9 \times 10^9\ N\,m^2/C^2 \cdot \frac{1 \cdot 2 \cdot 10^{-6} \cdot 10^{-6}\ C^2}{3^2\ m^2} \frac{3\hat{i}}{\sqrt{3^2}}$$

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$$= \frac{18}{9} \cdot 10^{-3} N \quad \frac{3\hat{i}}{3}$$

$$= \frac{18}{9} \hat{i} \times 10^{-3} N$$

$$= 2\hat{i} \times 10^{-3} N$$

$$F_1 = F_{21} + F_{31}$$

$$= \left(\frac{54\hat{i}}{4.2\sqrt{2}} + \frac{54\hat{j}}{4.2\sqrt{2}} \right) 10^{-3} N + 2\hat{i} \cdot 10^{-3} N$$

$$= \left(\frac{54\hat{i} + 54\hat{j}}{4.2\sqrt{2}} + 2\hat{i} \right) 10^{-3} N$$

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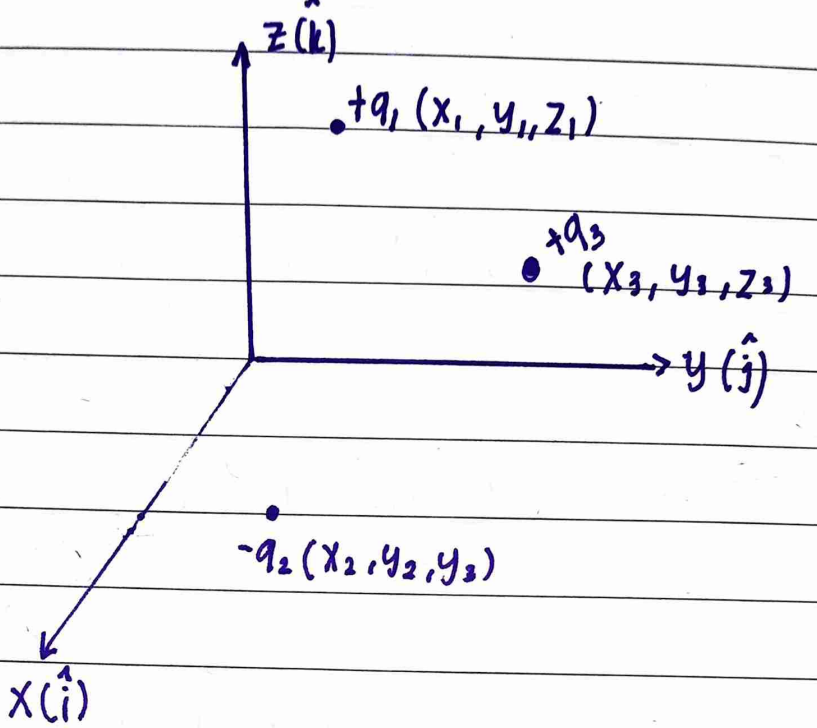
Pada 3 dimensi



$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r_{12}^2} \hat{r}_{12}$$

$$r_{12} = \Delta x\, i + \Delta y\, j$$

$(x_2 - x_1)$ $(y_2 - y_1)$

$$r_{12} = \frac{\Delta x\, i + \Delta y\, j}{\sqrt{\Delta x^2 + \Delta y^2}}$$

misal berapakah nilai dari F_{12}

$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_3}{|r_{12}^2|} \left(\frac{\Delta x\, i + \Delta y\, j}{\sqrt{\Delta x^2 + \Delta y^2}} \right) \rightarrow r_{12} = \sqrt{|\vec{r}_{13}|}$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_3}{|r_{12}^3|} \cdot \Delta x\, i + \Delta y\, j$$

$$\sqrt{\Delta x^2 + \Delta y^2}$$

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$\Delta x = x_3 - x_1$

$\Delta y = y_3 - y_1$

$\Delta z = z_3 - z_1$

$$F_{13} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_3}{r_{13}^2} \cdot \frac{\Delta x_{13}\hat{i} + \Delta y_{13}\hat{j} + \Delta z_{13}\hat{k}}{\sqrt{\Delta x_{13}^2 + \Delta y_{13}^2 + \Delta z_{13}^2}}$$

$$F_{13} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_3}{r_{13}^2} \frac{(\Delta x_{13}\hat{i} + \Delta y_{13}\hat{j} + \Delta z_{13}\hat{k})}{|\vec{r}_{13}|} \quad |r_{13}| = \sqrt{\Delta x_{13} + \Delta y_{13} + \Delta z_{13}}$$

$$= (\Delta x_{13}^2 + \Delta y_{13}^2 + \Delta z_{13}^2)$$

$$\boxed{F_{13} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_3}{(r_{13})^3} (\Delta x\,\hat{i} + \Delta y\,\hat{j} + \Delta z\,\hat{k})} \qquad (r_{13})^3 = (\Delta x_{13}^2 + \Delta x_{13}^2 + \Delta z_{13}^2)$$

$$F_{23} = \frac{1}{4\pi\varepsilon_0} \frac{q_2 q_3}{(r_{23})^2} \frac{\Delta x_{23}\hat{i} + \Delta y_{23}\hat{j} + \Delta z_{23}\hat{k}}{|r_{23}|}$$

$$\boxed{= \frac{1}{4\pi\varepsilon_0} \frac{q_2 q_3}{|r_{13}|^3} \Delta x_{23}\hat{i} + \Delta y_{23}\hat{j} + \Delta z_{23}\hat{k}}$$

Carilah nilai F_3 !!

$$F_3 = \frac{1}{4\pi\varepsilon_0} \left[\frac{q_1 q_3}{|r_{13}|^3} (\Delta x_{13}\hat{i} + \Delta y_{13}\hat{j} + \Delta k_{13}\hat{z}) \right] +$$

misal a

$$\left[\frac{q_2 q_3}{|r_{23}|^3} (\Delta x_{23}\hat{i} + \Delta y_{23}\hat{j} + \Delta k_{23}\hat{z}) \right]$$

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$$F_3 = \frac{1}{4\pi\varepsilon_0}\left[(a\Delta x_{13} + b\Delta x_{23})\hat{i} + (a\Delta y_{13} + b\Delta y_{23})\hat{j} + (a\Delta z_{13} + b\Delta z_{23})\hat{k}\right]$$

$$F_3 = k\left[\left(\frac{q_1 q_3}{|r_{13}|^3}\Delta x_{13} + \frac{q_2 q_3}{|r_{23}|^3}\Delta x_{23}\right)\hat{i} + \left(\frac{q_1 q_3}{|r_{13}|^3}\Delta y_{13} + \frac{q_2 q_3}{|r_{23}|^3}\Delta x_{23}\right)\hat{j} + \left(\frac{q_1 q_3}{|r_{13}|^3}\Delta z_{13} + \frac{q_2 q_3}{|r_{23}|^3}\Delta z_{23}\right)\hat{k}\right]$$

Carilah Nilai F_3 jika diketahui $+q_1(1,2,4)$, $-q_2(1,2,0)$, $+q_3(1,4,2)$

$$\bar{F}_3 = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1 q_3}{|\vec{r}_{13}|^3}(\Delta x_{13}i + \Delta y_{13}\hat{j} + \Delta z_{13}k) + \frac{q_2 q_3}{|r_{23}|^3}(\Delta x_{23}i + \Delta y_{23}\hat{j} + \Delta z_{23}k)\right)$$

$$= \frac{1}{4\pi\varepsilon_0}\left[(a\Delta x_{13} + b\Delta x_{23})\hat{i} + (a\Delta y_{13} + b\Delta y_{23})\hat{j} + (a\Delta z_{13} + b\Delta z_{23})\hat{k}\right)$$

$$= k\left[\left(\frac{q_1 q_3}{|\vec{r}_{13}|^3}\Delta x_{13} + \frac{q_2 q_3}{|\vec{r}_{23}|^3}\right)\hat{i} + \left(\frac{q_1 q_3}{|\vec{r}_{13}|^3}\Delta y_{13} + \frac{q_2 q_3}{|\vec{r}_{23}|^3}\Delta y_{23}\right)\hat{j} + \left(\frac{q_1 q_3}{|\vec{r}_{13}|^3}\Delta z_{13} + \frac{q_2 q_3}{|\vec{r}_{23}|^3}\Delta z_{23}\right)\hat{k}\right]$$

$$= kq_3\left[\left(\frac{q_1}{|\vec{r}_{13}|^3}\Delta x_{13} + \frac{q_2}{|\vec{r}_{23}|^3}\Delta x_{23}\right)\hat{i} + \left(\frac{q_1}{|\vec{r}_{13}|^3}\Delta y_{13} + \frac{q_2}{|\vec{r}_{23}|^3}\Delta y_{23}\right)\hat{j} + \left(\frac{q_1}{|\vec{r}_{13}|}\Delta z_{13} + \frac{q_2}{|\vec{r}_{23}|^3}\Delta z_{23}\right)\hat{k}\right]$$