Tugas Modul: Gaya Medan Tanggal: 2 Maret 2024 Nama: Farar Hap

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Kelompok : 8

1) Besar gaya elektrostatik antara 2 ion positif identik yang terpisah sejauh $5,0 \times 10^{-10}$ m adalah $3,7 \times 10^{-9}$ N

(a) Berapa muatan masing-masing ion?

(b) Berapa banyak elektron yang hilang dari setiap ion (sehingga memberikan ketidakseimbangan muatan?

Jawab: $F = k \cdot \frac{q_1 \cdot q_2}{r^2}$ #k = $8,99 \times 10^9 \ Nm^2/C^2$

karena identik $= k \cdot \frac{q^2}{r^2}$

$F = k \frac{q^2}{r^2} \rightarrow \frac{q^2}{r^2} = \frac{F}{k}$

$q^2 = \frac{F}{k} r^2$

$q = \sqrt{\frac{F}{k}} \sqrt{r^2}$

$q = r \cdot \sqrt{\frac{F}{k}}$

$= 5 \times 10^{-10} \cdot \sqrt{\frac{3,7 \times 10^{-9} \ N}{8,99 \times 10^9 \ N\,m^2/C^2}}$

(a) $= 3,2 \times 10^{-19}$ C

(b) # Kalau elektronnya hilang muatannya jadi ga stabil / seimbang.

Memisalkan : n = jumlah elektron yg hilang / ion

maka: $ne = q \rightarrow n = q/e$

banyaknya elektron = muatan

$n = \frac{q}{e} = \frac{3,2 \times 10^{-19}}{1,6 \times 10^{-19} C} = 2$ elektron yang hilang dari ion (ketidakseimbangan

2) Hitunglah perbandingan antara gaya elektrostatik & gaya gravitasi u/ 2 partikel identik (misal 2 buah elektron). Berapakah nilai mutlak muatan spesifik (q/m) agar keduanya sama besar)

Jawab: q elektron = e = $1,6 \times 10^{-19}$ C

Massa elektron = $9,1 \times 10^{-31}$ kg

$\frac{F_C}{F_g} = \frac{k \cdot \frac{q_1 \cdot q_2}{r^2}}{G \frac{m_1 m_2}{\ldots}}$ #q=m ...

$$\frac{Fc}{Fg} = \frac{K\frac{q_1 \cdot q_2}{r^2}}{G\frac{m_1 \cdot m_2}{r^2}} = \frac{K \cdot q^2}{G \cdot m^2}$$

$$= \frac{K}{G}\left(\frac{q}{m}\right)^2 = \frac{8,99\times10^{9}}{6,61\times10^{-11}}\left(\frac{1,6\times10^{-19}}{9,1\times10^{-31}}\right)^2$$

$$\frac{Fc}{Fg} = 4\times10^{-6} \;//$$

$$q = 3,2\times10^{-19}\,C$$

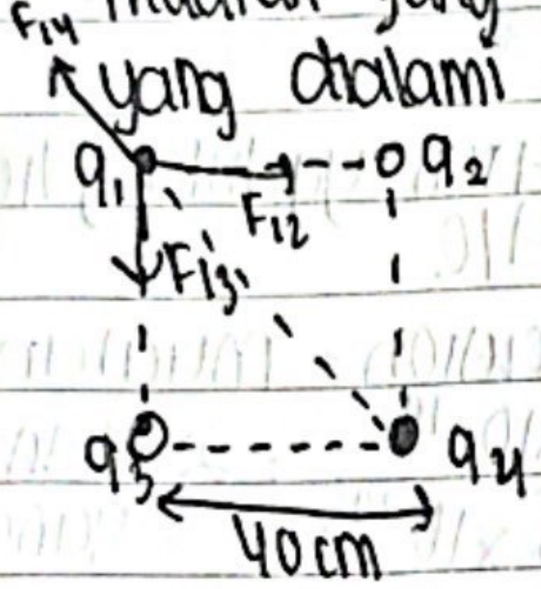
(ii) $Fc = Fg \rightarrow$ nilainya $1 = \frac{K}{G}\left(\frac{q}{m}\right)^2$

$$\left(\frac{q}{m}\right)^2 = \frac{G}{K}$$

$$\left|\frac{q}{m}\right| = \sqrt{\frac{G}{K}} = \sqrt{\frac{6,61\times10^{-11}}{8,99\times10^{9}}}$$

$$\left|\frac{q}{m}\right| = 8,57\times10^{-11} \;//$$

3) 4 buah muatan titik memiliki besar muatan yang sama $|q = 3\mu C$ diletakkan di sudut sebuah bujur sangkar dengan panjang sisi 40 cm. Dua muatan yang terpisah secara diagonal memiliki muatan yang sama ($q_1 = q_4 = -q$ dan $q_2 = q_3 = +q$). Tentukan gaya yang dialami pada q_1!



Jawab: $\vec{F_1} = \vec{F_{12}} + \vec{F_{13}} + \vec{F_{14}}$

(gambarkan arahnya!)

$$\vec{F_{12}} = K\frac{q_1 \cdot q_2}{|r_{12}|^2}\hat{i} = K\cdot\frac{q^2}{(0,4)^2}\hat{i}$$

$$= \frac{9\times10^{9}(3\times10^{-6})^2}{(0,4)^2}\hat{i} = 5\times10^{-1}\,N\,\hat{i}$$

4 arahnya keluar

$\hat{i} \Rightarrow$ kanan

$-\hat{j} \Rightarrow$ bawah

$$\vec{F_{13}} = K\frac{q_1 \cdot q_3}{|r_{13}|^2}(-\hat{j}) = K\cdot\frac{q^2}{(0,4)^2}(-\hat{j})$$

$$\vec{F_{13}} = \frac{9\times10^{9}(3\times10^{-6})}{(0,4)^2}(-\hat{j})$$

$$\vec{F_{13}} = -5\times10^{-1}\,N\hat{j}$$

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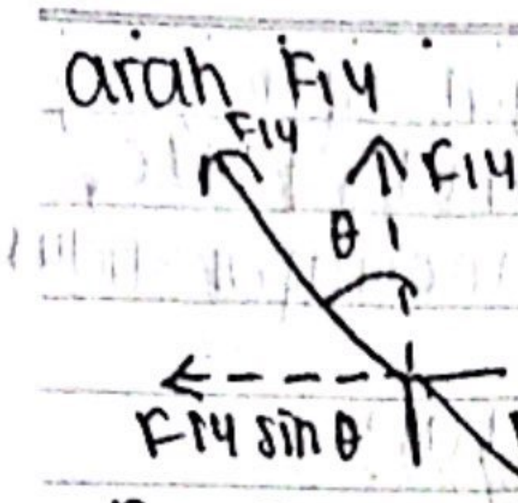


$F_{14} = F_{14}\sin\theta(-\hat{i}) + F_{14}\cos\theta\,\hat{j}$

$|\vec{F}_{14}| = k\cdot q_1\cdot q_4 / |\vec{r}_{14}|^2$

$= 9\times10^9 \,(3\times10^{-6})^2 / (0{,}4\sqrt{2})^2$

$F_{14} = 2{,}5\times10^{-1}\ N$

$F_{14} = 2{,}5\times10^{-1}\,(\sin\theta(-\hat{i})) + F_{14}\cos\theta\,\hat{j}$

↳ $= 2{,}5\times10^{-1}\left(\frac{1}{2}\sqrt{2}\right)(-\hat{i}) + 2{,}5\times10^{-1}\left(\frac{1}{2}\sqrt{2}\right)\hat{j}$

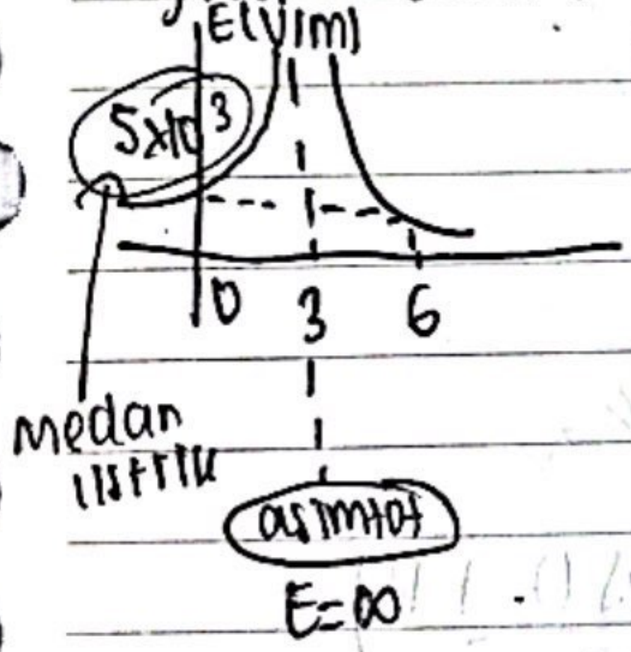
$= (-1{,}0\times10^{-1}\hat{i} + 1{,}0\times10^{-1}\hat{j})\ N$

$\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14}$

$= 5\times10^{-1}\,\hat{i} + (-5\times10^{-1}\,\hat{j}) + (-1{,}0\times10^{-1}\hat{i} + 1{,}0\times10^{-1}\hat{j})$

$= 3{,}2\times10^{-1}\ N\hat{i} - 3{,}3\times10^{-1}\ N\hat{j}$ //

4) Grafik dibawah ini menyatakan medan listrik oleh sebuah muatan titik q yang berada disebuah titik pada sumbu x. Berdasarkan grafik dibawah. Tentukan letak & nilai muatan q!



⇒ sumbu x = jaraknya
sumbu y = medan listrik
↳ Berdasarkan grafik pada x=3 sehingga letak sumber muatan ada di titik tsb.
↳ karena medan listrik ialah garis² gaya / medan yang ditimbulkan oleh sebuah muatan sumber

medan ↑ sumber nya berada di titik itu

$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ ($E = k\cdot\frac{q}{r}$) ← sumber

$q = 4\pi\varepsilon_0 E r^2$

$= 4(3{,}14)(8{,}85\times10^{-12})(5\times10^3)(3)^2$

$q = 5\times10^{-6}\ C$

$q = 5\ \mu C$ ← muatan q

letak

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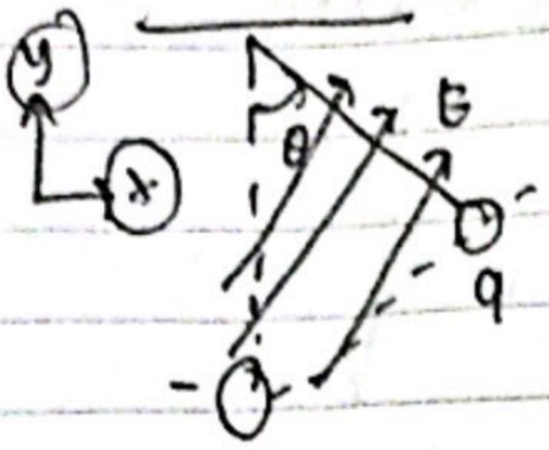
5.) Sebuah bola bermuatan digantung dengan tali sangat tipis yang netral, karena mendapatkan medan listrik $\vec{E} = (A\hat{i} + B\hat{j})$ N/C, sehingga bola berada pada kesetimbangan setelah mencapai sudut θ. A & B = Bilangan positif

a) Berapa jumlah muatan dibola yg tergantung tersebut?

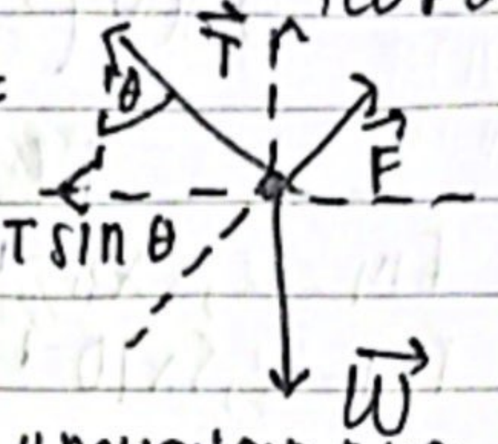
b) Berapa tegangan tali?



⇒ Keadaan setimbang $\Sigma F = 0$ $\Sigma F_x = 0$ $\Sigma F_y = 0$

Mekanika / dinamika

↳ Diagram benda bebasnya:



$\Sigma F_x = 0$

E & F searah

q → positif

$f = qE$

$\boxed{F = q.A\hat{i} + q.B\hat{j}}$

#muatannya positif karena E & F nya searah

$\Sigma F_x = 0$

$-T\sin\theta + qA = 0$

$T = \frac{qA}{\sin\theta}$ ..... ①

Tinjau arah y

↳ $\Sigma F_y = 0$

$T\cos\theta - mg + qB = 0$

↓ bawah

$\frac{qA}{\sin\theta}\cos\theta - mg = -qB$

$-mg = -q\left(A\frac{\cos\theta}{\sin\theta} + B\right)$

$q = \frac{mg}{\left(A\frac{\cos\theta}{\sin\theta} + B\right)} = \frac{mg}{A\cos\theta + B}$ (Coloumb)

↳ q = muatan positif

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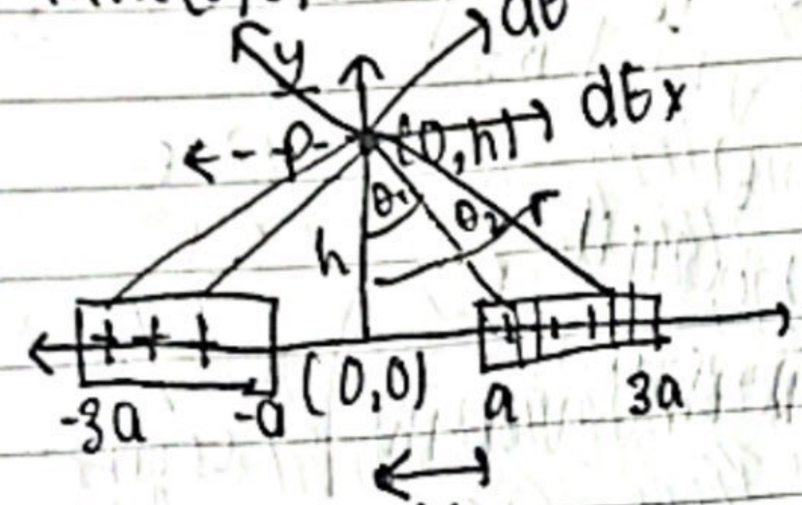
b. Besar tegangan tali:

$$T = \frac{q_A}{\sin\theta} = \frac{mg}{(A\cos\theta + B)} \times \frac{A}{\sin\theta}$$

$$= \frac{mg \times A}{(A\cos\theta B + B\sin\theta)} \; N$$

$\cot = \frac{\cos}{\sin} \times \sin A$

6.) Dua tongkat tipis identik masing-2 a & kedua tongkat tsb membawa muatan sama (uniform) dgn total muatan masing2 +Q yang terdistribusi sepanjang tongkat tersebut. Dua tongkatnya diberikan:
Hitung medan listrik di titik p yang jaraknya h meter dari titik (0,0)!



(kontinu bersambung)

komponen arah x → saling meniadakan

medan listrik

$$\vec{E} = \int_{-3}^{-a} dE_x \hat{i} + \int_{a}^{3} dE_y \hat{j}$$

$$\vec{E} = \int dE_y \hat{j} + \int dE_y = 2\int_{a}^{3a} dE_y$$

$$= 2\int_{a}^{3a} dE \cos\theta$$

$$= 2\int_{a}^{3a} \frac{dq}{r^2} \cos\theta$$

$$= 2\int_{a}^{3a} \frac{\lambda dx}{r^2} \cos\theta$$

$dE = \frac{dq}{r^2}$

$dq = \lambda dx$

$\sec^2 = \frac{1}{\cos^2}$

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

$q = \lambda . L$

$dq = \lambda dL = \lambda dx$

$\tan = \frac{de}{sa} = \frac{x}{h}$

$x = h \tan\theta$

$dx = h \sec^2\theta \, d\theta$

$= h\left(\frac{1}{\cos^2\theta}\right) d\theta$

$dx = h\left(\frac{1}{\left(\frac{h}{r}\right)^2}\right) d\theta$

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Batas integrasi : $x=a \rightarrow \theta=\theta_1$

$x=3a \rightarrow \theta=\theta_2$

$$E_y = 2k \int_{\theta_1}^{\theta_2} \frac{\lambda}{r^2} \frac{r^2 \cos\theta \, d\theta}{h}$$

$$= \frac{2k\lambda}{h} \int_{\theta_1}^{\theta_2} \cos\theta \, d\theta$$

$$= \frac{2k\lambda}{h} \left(\sin\theta_2 - \sin\theta_1 \right)$$

$$= \frac{2k\lambda}{h} \left(\frac{3a}{\sqrt{(3a)^2+h^2}} - \frac{a^2}{\sqrt{a^2+h^2}} \right)$$

$$\vec{E_y} = \frac{1}{4\pi\varepsilon_0} \frac{2\lambda a}{h} \left(\frac{3}{\sqrt{(3a)^2+h^2}} - \frac{1}{\sqrt{a^2+h^2}} \right) \vec{j}$$

total muatan:

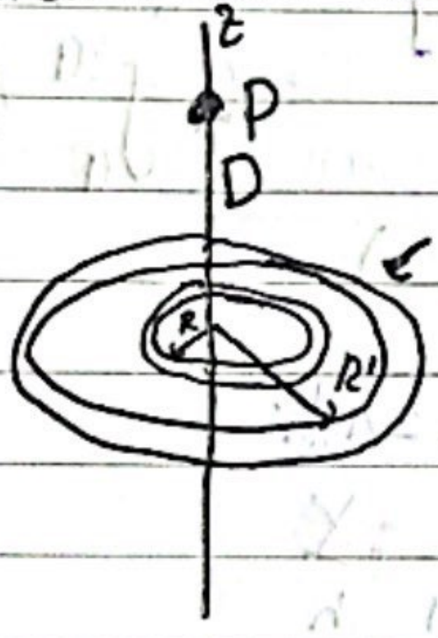
$$+Q = \int_a^{3a} dq = \int_a^{3a} \lambda \, dx = 2\lambda a$$

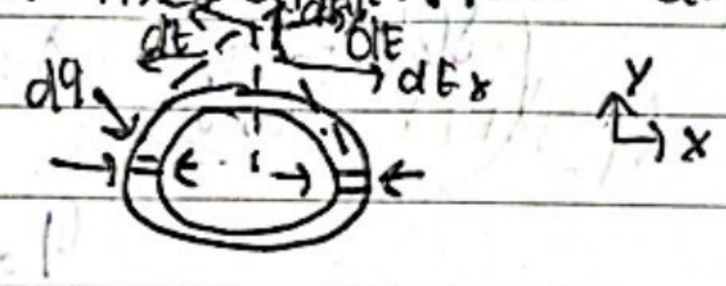
$2\lambda = Q$

$$\vec{E_p} = \frac{1}{4\pi\varepsilon_0} \frac{+Q}{h} \left(\frac{3}{\sqrt{(3a)^2+h^2}} - \frac{1}{\sqrt{a^2+h^2}} \right) \vec{j} \ N/C$$

7.) Gambaran 2 cincin konsentris dengan jari² R dan R = 3,00 R terletak pd bidang yg sama. Titik P terletak pada sumbu z (Pusat) pd jarak D = 2,00 R dari pusat cincin. cincin yg lebih kecil memiliki muatan yg terdistribusi +Q. Tentukan muatan yg terdistribusi merata pada cincin yang > Q jika E P = 0.

∈) medan listrik akibat cincin





Komponen medan listrik arah y → saling menjauhkan

$$\vec{E_P} = \int_{=0} dE_x \hat{i} + \int dE_y \hat{j}$$

$$E_P = \int dE_y \hat{j}$$

$ds = r\,d\theta$ $\quad ds = R\,d\theta$

$$E_P = \int dE_y \hat{j}$$

$$= \int dE \cos\theta$$

$$= \int \frac{k\lambda \, ds}{r^2} \cos\theta \, \vec{j}$$

$E_P = \frac{3a}{x_1}$

λ = muatan / panjang

$$E_P = \int dE_{xy}\,\hat{z}$$
$$= \int dE\cos\theta$$
$$= \int \frac{k\lambda ds}{r^2}\cos\theta\,\hat{z}$$
$$= \frac{\lambda}{4\pi\varepsilon_0}\int \frac{r\,d\theta}{\sqrt{r^2+z^2}}\cdot\frac{z}{\sqrt{r^2+z^2}}\,\hat{z}$$
$$= \frac{Rz\lambda}{4\pi\varepsilon_0}\cdot\frac{1}{(z^2+R^2)^{3/2}}\int_0^{2\pi} d\theta\,\hat{z}$$
$$= \frac{\left(\frac{Q}{2\pi R}\right)Rz}{4\pi\varepsilon_0}\cdot\frac{1}{(z^2+R^2)^{3/2}}(2\pi)\,\hat{z}$$
$$= \frac{Qz}{4\pi\varepsilon_0}\cdot\frac{1}{(z^2+R^2)^{3/2}}\,\hat{z}$$

Medan listrik di P akibat 2 cincin adalah:

$\vec{E_P} = \vec{E}$ cincin kecil + $\vec{E}$ cincin besar

q_A = muatan cincin kecil

q_B = " " besar

E_P = E cincin kecil + E cincin besar

$$= \frac{q_A}{4\pi\varepsilon_0(z^2+R^2)^{3/2}} + \frac{q_B}{4\pi\varepsilon_0(z^2+(3R)^2)^{3/2}} = 0$$

$$q_A = -q_B\,\frac{(z^2+R^2)^{3/2}}{(z^2+9R^2)^{3/2}}$$

$z = D = 2R$

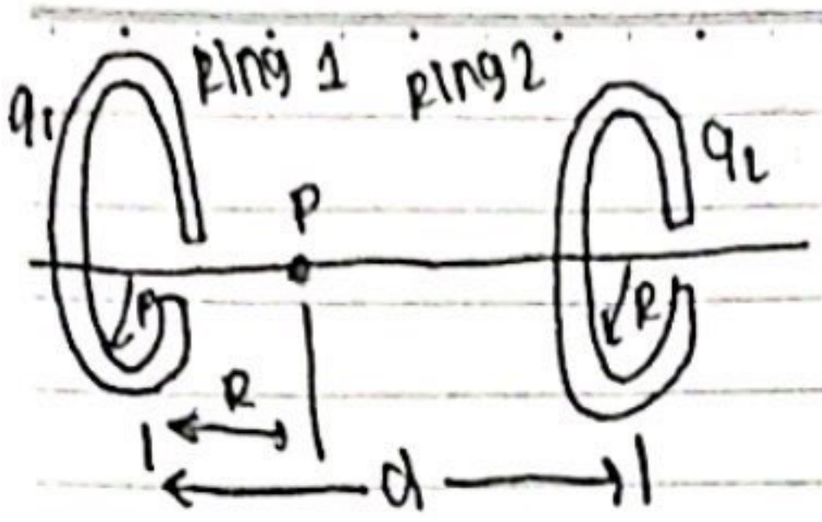
$$= -q_B\left(\frac{5}{13}\right)^{3/2}$$

$q_A = +Q$

$$q_B = -q_a\left(\frac{13}{5}\right)^{3/2}$$

$$q_B = -4{,}19Q$$

8.) Dua cincin non konduktor yg kedunya berjari² sama R & muatannya q_1 & q_2 → terdistribusi secara seragam (merata). kedua cincin terpisah sejauh d=3R. jika Ep yg jaraknya R dari cincin 1 adalah 0, berapakah perbandingan q_1/q_2?



oleh

e) E cincin Termuatan.

Sebuah u dari pusat cincin adalah:

$$\vec{E} = \frac{qx}{4\pi\varepsilon_0 (x^2+R^2)^{3/2}} \cdot \hat{i} \text{ (atas)}$$

asumsikan kedua muatan positif, E berlawanan

$$E_P = E_{kiri} - E_{kanan} = 0$$

#Perbandingan biasanya +

$$\frac{q_1 \cdot R}{4\pi\varepsilon_0 (R^2+R^2)^{3/2}} = \frac{q_2 \cdot (2R)}{4\pi\varepsilon_0 (4R^2+R^2)^{3/2}}$$

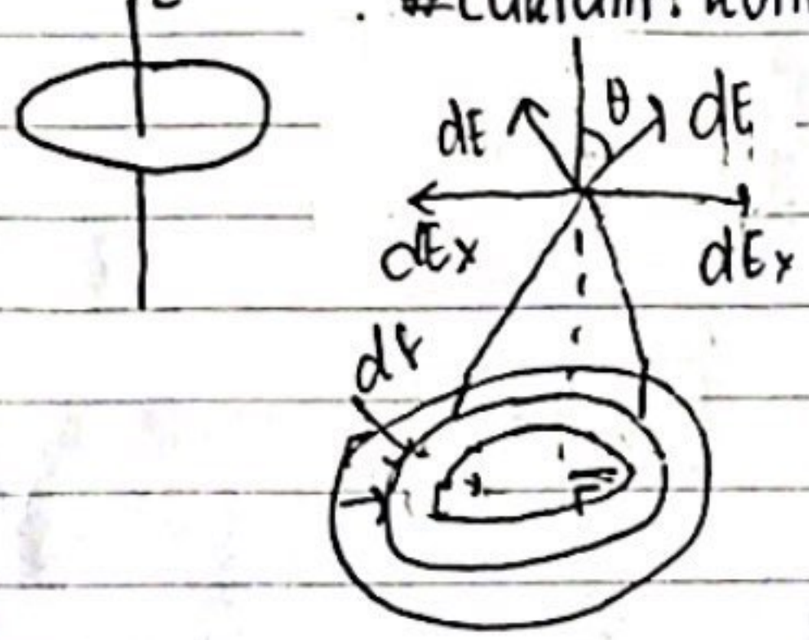
$$\frac{q_1}{q_2} = 2\left(\frac{2}{5}\right)^{3/2}$$

$$\frac{q_1}{q_2} = 0{,}506$$

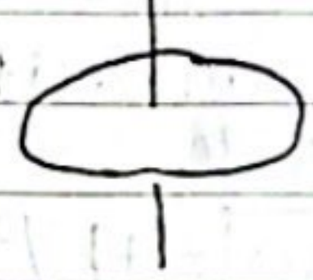
9.) Cakram r = 2,5 cm

permuaannya mempunyai rapat muatan permatuan luas 5,3 nC/m².

E pd titik z = 12 cm pd pusat cakram!



cakram : kumpulan cincin



$$\sigma = \frac{q}{A}$$

$$q = \sigma A$$

$$dq = \sigma\, dA$$

$$dq = \sigma\, 2\pi r dr$$

$$dE = \frac{1}{4\pi\varepsilon_0}\frac{dq}{r^2} = \frac{\sigma 2\pi r dr}{4\pi\varepsilon_0 r^2}$$

$$\vec{E_P} = \int dE_x \hat{i} + \int dE_y \hat{j}$$

$$\vec{E_P} = \int dE_y \hat{j} = \int dE \cos\theta\, \hat{j}$$

$$= \frac{\sigma\, 2\pi r dr}{4\pi\varepsilon_0 r^2} \cdot \frac{z}{\sqrt{z^2+r^2}}$$

$$= \frac{\sigma\, 2\pi r dr}{4\pi\varepsilon_0 (z^2+r^2)} \cdot \frac{z}{\sqrt{z^2+r^2}} \cdot \hat{j}$$

$$= \frac{\sigma 2\pi}{4\pi\varepsilon_0} \int \frac{z\, r}{(z+r)^{3/2}}\, dr$$

$$\left(\begin{array}{l} u = z^2+r^2 \\ du = 2r dr \end{array}\right) = \frac{\sigma\pi z}{4\pi\varepsilon_0} \int \frac{2r dr}{(z^2+r^2)^{3/2}}$$

$$\vec{E}P = \int dE_y \hat{j} = \int dE \cos\theta \, \hat{j}$$

$$= \frac{\sigma 2\pi r dr}{4\pi\varepsilon_0 r^2} \cdot \frac{z}{\sqrt{z^2+r^2}}$$

$$= \frac{\sigma 2\pi r dr}{4\pi\varepsilon_0 (z^2+r^2)} \cdot \frac{z}{\sqrt{z^2+r^2}} \cdot \hat{j}$$

$$= \frac{\sigma 2\pi}{4\pi\varepsilon_0} \int \frac{z}{(z^2+r^2)^{3/2}} r \cdot dr$$

$u = z^2 + r^2$
$du = 2r dr$

$$= \frac{\sigma \pi z}{4\pi\varepsilon_0} \int \frac{2r dr}{(z^2+r^2)^{3/2}}$$

$$= \frac{\sigma z}{4\varepsilon_0} \int \frac{du}{u^{3/2}}$$

$$= \frac{\sigma z}{4\varepsilon_0} \left(\frac{u^{-1/2}}{-1/2} \right)_0^R$$

$$= \frac{\sigma z}{2\varepsilon_0} \left(\frac{1}{\sqrt{u}} \right)_0^R$$

$$= -\frac{\sigma z}{2\varepsilon_0} \left(\frac{1}{\sqrt{z^2+r^2}} \right)_0^R \hat{j}$$

$$= -\frac{\sigma z}{2\varepsilon_0} \left(\frac{1}{\sqrt{z^2+R^2}} - \frac{1}{\sqrt{z^2}} \right) \hat{j}$$

$$= -\frac{\sigma z}{2\varepsilon_0} \left(\frac{1}{\sqrt{z^2+R^2}} - \frac{1}{z} \right) \hat{j}$$

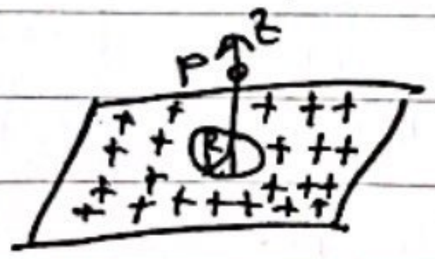
$$= \frac{\sigma}{2\varepsilon_0} \left(1 - \frac{z}{\sqrt{z^2+R^2}} \right) \hat{j}$$

$$= \frac{5{,}3\times10^{-6}}{2(8{,}85\times10^{-12})} \left(1 - \frac{12}{\sqrt{12^2+(2{,}5)^2}} \right) \hat{j}$$

$$E_P = 6{,}3\times10^{3} \text{ N/C}$$

10.) Sebuah lubang ungkaran berjari² $R = 1{,}80$ cm dibuang ditengah² permukaan datar non konduktor $\sigma = 4{,}50$ pC/m².

Medan listrik di titik P $z = 2{,}56$ cm.



Medan listrik di P = E lempeng + E lubang

$\sigma = 4{,}5\times10^{-12}$ C/m²

$\int \sigma dA = \int$ utuh + $\int$ kiri + $\int$ radial

$= 0$

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$E(2A) = \frac{q}{\varepsilon_0}$

$E = \frac{\delta A}{2\varepsilon_0} = \frac{\delta}{2\varepsilon_0}$

*) Medan listrik oleh lubang kecil (cakram)

$$|\vec{E}| = \frac{\delta}{2\varepsilon_0}\left(1 - \frac{z}{\sqrt{z^2+R^2}}\right)$$

•) Medan listrik di P:

$\vec{E_P} = \vec{E}$ lembaran + $\vec{E}$ lubang

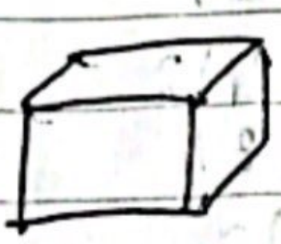
$$= \frac{\delta}{2\varepsilon_0}\hat{k} + \left(-\frac{\delta}{2\varepsilon_0}\left(1 - \frac{z}{\sqrt{z^2+R^2}}\right)\right)\hat{k}$$

$$= \frac{\delta z}{2\varepsilon_0}\frac{1}{\sqrt{z^2+R^2}}\hat{k}$$

$$= \frac{(4{,}5\times10^{-12})\,2{,}56\times10^{-2}}{2(8{,}85\times10^{-12})\sqrt{(2{,}56\times10^{-2})^2+(1{,}80\times10^{-2})^2}}$$

$\vec{E_P} = 0{,}208\ N/C\ \hat{k}$

11.) Hukum gauss: $\oint E\,dA = \frac{q_{enc}}{\varepsilon_0}$ ← hukum gauss



$Q_1 = 6\times10^{-12}\,C$

$Q_2 = -2\times10^{-12}\,C$

Φ = Fluks listrik

$$\Phi_{listrik} = \frac{\sum q_{terlingkupi}}{\varepsilon_0} = \frac{Q_1+Q_2}{\varepsilon_0}$$

$$= \frac{6\times10^{-12}\,C + (-2\times10^{-12}\,C)}{8{,}85\times10^{-12}\,C^2/Nm^2}$$

$$\Phi_{listrik} = \frac{4\times10^{-12}}{8{,}85\times10^{-12}} = 0{,}45\ N\,m^2/C$$ //

12.) panjang sisi = 2 m

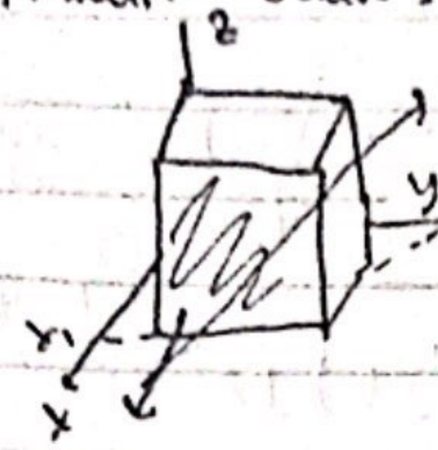
$x_1 = 5$ m

$y_1 = 4$ m

$\vec{E} = (-3\vec{i} - 4y^3\vec{j} + 3\vec{k})\ N/C$ y = meter

total muatan listrik?

Hukum Gauss : $\Phi_{total} = \frac{\Sigma q_{enc}}{\varepsilon_0}$



$-3\hat{i}$

arah sumbu x & z $\Phi = 0$

↳ Pada sumbu x (bidang yz)

sisi yang depan : $\Phi = E.A\hat{n}$ → kedepan

$= -3\hat{i} \cdot (2\times2)\hat{i}$

$\Phi_1 = -12$ Weber

sisi yang belakang = $\Phi = E.A\hat{n}$

$= -3\hat{i}.4(-\hat{i})$

$= 12$ Webber

$\Phi_{total} = \Phi_1 + \Phi_2$

$= -12 + 12 = 0$

o) Arah sumbu z (bidang xy)

sisi atas $\Phi_1 = \vec{E}.A_n$

$= 3\hat{k} \cdot 4\hat{k}$

$= 12$ Webber

Φ sisi bawah :

$\Phi_2 = E.A_n = 3\hat{k}(4)(-\hat{k})$

$= -12$

$\Phi_{total} = 12 - 12 = 0$

~pada sumbu x (bidang x=1, medan listrik x konstan

#sisi kiri :

$\Phi_1 = \vec{E}.A\vec{i}$

$= 4y^2\hat{j}\ 4(-\hat{j})$

$= 16y^2$

$\Phi_1 = 16(4) = 64$ Nm/C²

#sisi kanan :

$\Phi_2 = E.A\hat{n}$

$= -4y^2\hat{j}(16)\hat{j}$

$= -4(16)(16)$

$\Phi_2 = -256$ Nm/C²

$\Phi_{total} = \Phi_1 + \Phi_2 = 64 - 256$

$= -192$ Nm/C²

Berdasarkan hukum gauss

$\Phi_{total} = \frac{q_{enc}}{\varepsilon_0}$

$q_{enc} = \varepsilon_0 \Phi_{total} = 8{,}85\times10^{-12}(-192)$

$q_{enc} = -1{,}70\times10^{-9}$ C

13.) untuk r=0, tdk ada muatan

$\oint EdA = \frac{q_{enc}}{\varepsilon_0}$

$\oint EdA = \frac{0}{\varepsilon_0} \rightarrow E_0$

b) untuk $r = \frac{a}{2}$ (tdk ada muatan) $\rightarrow E = 0$

c) untuk $r = a$ (tdk ada muatan) $\rightarrow E = 0$

d) $r = 1{,}5\,a$

untuk daerah $a \le r \le b$, $q_{enc} = \rho\left(\frac{4\pi r^3}{3} - \frac{4\pi a^3}{3}\right)$

sehingga $\oint E\,dA = \frac{q_{enc}}{\varepsilon_0}$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q_{enc}}{r^2}$$

$$= \frac{\rho}{4\pi\varepsilon_0}\left(\frac{4\pi r^3}{3} - \frac{4\pi a^3}{3}\right) = \frac{\rho}{3\varepsilon_0}\frac{r^3 - a^3}{r^2}$$

maka $r = 1{,}5\,a$

$$E = \frac{\rho}{3\varepsilon_0}\frac{(1{,}5a)^3 - a^3}{(1{,}5a)^2}$$

$$E = \frac{\rho a}{3\varepsilon_0}\left(\frac{2{,}375}{2{,}25}\right)$$

$$E = \frac{(1{,}84\times10^{-9}\ C/m^3)\,(9{,}100\ m)}{3\,(8{,}85\times10^{-12}\ C^2/N.m^2)}\left(\frac{2{,}375}{2{,}25}\right)$$

$$E = 1{,}32\ N/C$$

e) untuk $r = b = 2a$

medan listrik:

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

$$E = \frac{\rho a}{3\varepsilon_0}\left[\frac{7}{4}\right]$$

$$E = \frac{1{,}84\times10^{-9}\ C/m^3\,(0{,}100\ m)}{3\,(8{,}85\times10^{-12}\ C^2/N\,m^2)}\left(\frac{7}{4}\right)$$

$$E = 12{,}1\ N/C$$

f) Untuk $r \ge b$, maka:

$$\oint E\,dA = \frac{q_{enc}}{\varepsilon_0}$$

$$E.4\pi r^2 = \frac{q_{total}}{\varepsilon_0}$$

$$E = \frac{q_{total}}{4\pi\varepsilon_0 r^2}$$

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

$$= \frac{\rho}{3\varepsilon_0}\frac{b^3 - a^3}{r^2}$$

$q_{total} = \rho.V$

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

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jadi $r = 3b = 6a$

$$E = \frac{\rho}{3\varepsilon_0} \frac{(6a)^3 - a^3}{(6a)^2}$$

$$E = \frac{\rho a}{3\varepsilon_0}\left(\frac{7}{36}\right)$$

$$= \frac{(1{,}84\times10^{-9}\ C/m^3)(0{,}100\ m)}{3(0{,}05\times10^{-12}\ C^2/N.m^2)}\left(\frac{7}{30}\right) = 1{,}35\ N/C$$

(14) Bola konduktor tak bermuatan = bola konduktor netral

netral artinya → jumlah muatan positif = jumlah muatan negatif

a) (i) medan listrik di $r < r_1$

Dengan menerapkan hukum Gauss:

$$\oint E\,dA = \frac{q_{enc}}{\varepsilon_0}$$

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

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

(ii) medan listrik di $r_1 < r < r_2$

daerah didalam bola konduktor, medan listrik harus 0.

$$\oint E\,dA = \frac{q_{enc}}{\varepsilon_0}$$

$$E\,4\pi r^2 = \frac{q-q}{\varepsilon_0} \rightarrow E = 0$$

(iii) untuk daerah $r_1 > r_2$

$$\oint E\,dA = \frac{q_{enc}}{\varepsilon_0}$$

$$E\,4\pi r^2 = \frac{q-q+q}{\varepsilon_0}$$

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

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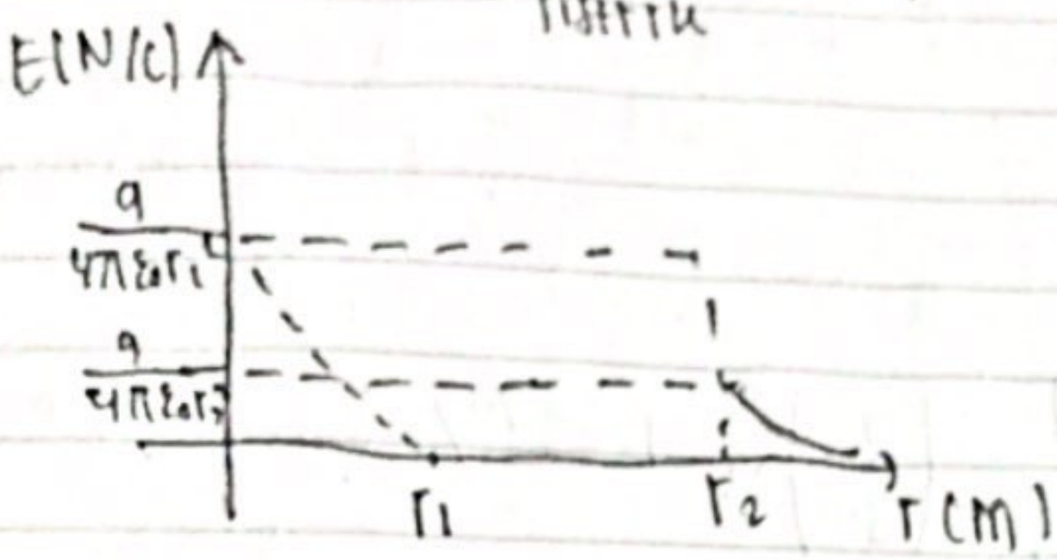
b) grafik Medan terhadap r



(S) a) Medan listrik di dalam (yaitu) antara silinder pejal & silinder tipis (luar))

pada saat r = 3,5 cm adalah:

$E_{dalam} = \frac{\lambda}{2\pi\varepsilon_0 r} = 1000\ N/C$ ↳ dapat dilihat grafik

•) Medan listrik di luar silinder tipis, $r \geq 3,5\ cm$

$E_{luar} = \frac{\lambda}{2\pi\varepsilon_0 r} + \frac{\lambda'}{2\pi\varepsilon_0 r} = -2000\ N/C$ ↳ lihat grafik

•) Jika selisih ΔE (λ') maka:

$E_{luar} - E_{dalam} = \left(\frac{\lambda}{2\pi\varepsilon_0 r} + \frac{\lambda'}{2\pi\varepsilon_0 r}\right) - \frac{\lambda}{2\pi\varepsilon_0 r}$

saat $r = 0,035\ m$

$-2000 - 1000 = \frac{\lambda'}{2\pi\varepsilon_0 r} \rightarrow \lambda'$

$-3000 = \frac{\lambda'}{2\pi\varepsilon_0 (0,035\ m)}$ $\quad \frac{1}{4\pi\varepsilon_0} = 9\times10^9$

$-3\times10^3 = \frac{\lambda' (18\times10^9)}{0,035}$ $\quad \frac{1}{2\pi\varepsilon_0} = 18\times10^9$

$\frac{-3\times10^3 (0,035)}{18} \times 10^{-9} = \lambda'$

$\lambda' = -5,8\times10^{-9}\ C/m$