

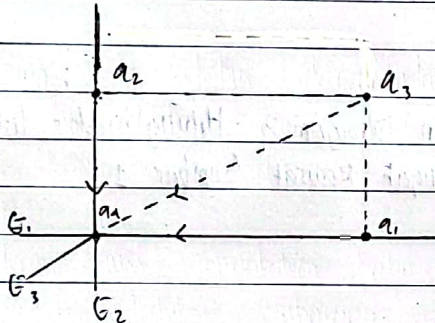
Nama : Nadiyah Safitri

MPM : 2013022046

Kelas : B

1. Empat partikel bermuatan listrik terdistribusi sebagai berikut : $q_1(4,0) = 2 \text{ stat.C}$, $q_2(0,3) = 5 \text{ stat.C}$, $q_3(4,3) = 10 \text{ stat.C}$, dan $q_4(0,0) = -1 \text{ stat.C}$. Tentukan : Medan listrik pada posisi $(0,0)$ dimana jarak dalam centimeter, dengan $k = 1 \text{ dyne.cm}^2/\text{stat.C}^2$. Hitung :
- Gaya coulomb yang dialami oleh muatan q_4
 - Medan listrik pada titik $(0,0)$ atau muatan q_4
 - Potensial listrik pada titik $(0,0)$
 - Berapa besar usaha yang dilakukan untuk memindahkan keempat muatan tersebut.

Penyelesaian:



$$\vec{E}_1 = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1}{r_1^2} \hat{r} = \frac{1}{4\pi\epsilon_0} \cdot \frac{2}{16} (\hat{i})$$

$$\vec{E}_2 = \frac{1}{4\pi\epsilon_0} \cdot \frac{5}{9} (\hat{j})$$

$$\vec{E}_3 = \frac{1}{4\pi\epsilon_0} \cdot \frac{10}{25} \left(\frac{4\hat{i} + 3\hat{j}}{5} \right) = \frac{1}{4\pi\epsilon_0} \left(\frac{40\hat{i} + 30\hat{j}}{125} \right)$$

$$\vec{E}_4 = \frac{1}{4\pi\epsilon_0} \left[\left(\frac{5}{9} + \frac{30}{125} \right) (\hat{j}) + \left(\frac{2}{16} + \frac{40}{125} \right) (\hat{i}) \right]$$

$$\vec{E}_4 = \frac{1}{4\pi\epsilon_0} \sqrt{(0,49)^2 + (0,495)^2}$$

$$\vec{E}_4 = 9 \cdot 10^9 \times 0,90$$

$$= 8,16 \times 10^8 \text{ N/C}$$

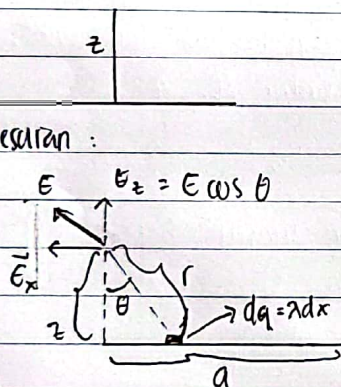
$$\begin{aligned} \vec{F} &= q_4 \cdot k \left\{ \frac{q_2}{r_{02}^2} \hat{r}_{02} + \frac{q_3}{r_{03}^2} \hat{r}_{03} + \frac{q_1}{r_{01}^2} \hat{r}_{01} \right\} \\ &= -1 \cdot 9 \cdot 10^9 \left\{ \frac{5}{9} (-\hat{j}) + \frac{10}{25} \left(\frac{-4\hat{i} - 3\hat{j}}{5} \right) + \frac{2}{16} (-\hat{i}) \right\} \\ &= 9 \cdot 10^9 \left\{ \frac{5}{9} (\hat{j}) + \frac{10}{25} \left(\frac{4\hat{i} + 3\hat{j}}{5} \right) + \frac{2}{16} (\hat{i}) \right\} \end{aligned}$$

$$\begin{aligned}
 &= 9 \cdot 10^9 \left\{ \left(\frac{2}{16} + \frac{40}{125} \right) (i) + \left(\frac{5}{9} + \frac{30}{125} \right) (j) \right\} \\
 &= 9 \cdot 10^9 \{ (0,445 i) + (0,79 j) \} \\
 &= 9 \cdot 10^9 \sqrt{(0,445)^2 + (0,79)^2}
 \end{aligned}$$

② $V = \frac{kq_1}{r_1} + \frac{kq_2}{r_2} + \frac{kq_3}{r_3}$

$$\begin{aligned}
 &= 9 \cdot 10^9 \left(\frac{2}{16} + \frac{5}{9} + \frac{10}{25} \right) \\
 &= 9 \cdot 10^9 (1,08) \\
 &= 9,72 \cdot 10^9
 \end{aligned}$$

2. Sebuah kawat lurus panjangnya a , membawa muatan seragam λ . Hitung medan listrik di titik P diatas kawat yang berjarak z ditengah-tengah kawat Gambar 1.



Penyelesaian :

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

$$\vec{E}_z = \frac{1}{4\pi\epsilon_0} \int_0^a \frac{dq}{r^2} = \frac{1}{4\pi\epsilon_0} \int_0^a \frac{\lambda dx}{r^2} \cos \theta \Rightarrow \cos \theta = \frac{z}{r}$$

$$\begin{aligned}
 \vec{E}_z &= \frac{1}{4\pi\epsilon_0} \int_0^a \frac{z \lambda dx}{r^3} = \frac{1}{4\pi\epsilon_0} \int_0^a \frac{z \lambda dx}{(z^2 + x^2)^{3/2}} \\
 &= \frac{z \lambda}{4\pi\epsilon_0} \int_0^a \frac{dx}{(z^2 + x^2)^{3/2}} \\
 \int_0^a \frac{dx}{(z^2 + x^2)^{3/2}} &= \frac{1}{z^2} \frac{x}{\sqrt{z^2 + x^2}} \Big|_0^a
 \end{aligned}$$

$$= \frac{1}{4\pi\epsilon_0} \lambda z \left[\frac{1}{z^2} \frac{x}{\sqrt{z^2 + x^2}} \right]_0^a$$

$$\vec{E}_z = \frac{\lambda z}{4\pi\epsilon_0} \frac{a}{z^2 \sqrt{z^2 + x^2}} = \frac{\lambda}{4\pi\epsilon_0} \frac{a}{z \sqrt{z^2 + x^2}}$$

$$\vec{E}_z = - \frac{1}{4\pi\epsilon_0} \int_0^a \frac{\lambda dx}{r^2} \sin \theta = - \frac{\lambda}{4\pi\epsilon_0} \int_0^a$$

$$= -\frac{\lambda}{4\pi\epsilon_0} \cdot \frac{1}{2} \int_0^a \frac{dx^2}{(z^2+x^2)^{3/2}}$$

$$= -\frac{\lambda}{4\pi\epsilon_0} \cdot \frac{1}{2} \left[-2 \frac{1}{(z^2+x^2)^{1/2}} \right]_0^a$$

$$= -\frac{\lambda}{4\pi\epsilon_0} \left[-\left(\frac{1}{\sqrt{z^2+x^2}} - \frac{1}{z} \right) \right]$$

$$\vec{E}_x = -\frac{\lambda}{4\pi\epsilon_0} \left[\frac{1}{z} - \frac{1}{\sqrt{z^2+x^2}} \right]$$

$$\therefore \vec{E} = \vec{E}_z + \vec{E}_x$$

$$= \frac{\lambda}{4\pi\epsilon_0} \cdot \frac{a}{z\sqrt{z^2+x^2}} + \left(-\frac{\lambda}{4\pi\epsilon_0} \left[\frac{1}{z} - \frac{1}{\sqrt{z^2+x^2}} \right] \right)$$

4. Apa yang Anda ketahui tentang Hukum Gauss. (Jelaskan secara verbal, lalu gambar permukaan Gauss, dan jelaskan secara simbolik (rumus) sesuai definisi dan gambar yang anda kemukakan. Dimana Hukum Gauss diterapkan dan diberikan.

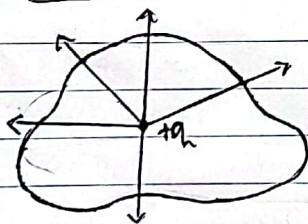
Jawab:

Hukum Gauss menyatakan bahwa: Fluks medan listrik yang ke luar dari suatu permukaan tertutup sembarang yang melingkupi muatan-muatan $q_1, q_2, \dots$

$$\phi_E = \oint_A \vec{E} \cdot d\vec{A} = \oint_A E_n dA = \frac{Q_{int}}{\epsilon_0}$$

dengan: $Q_{int} = \sum q_i$ (di dalam A), dan A dinamakan luasan Gauss

Contoh:



$$\phi = \frac{q}{\epsilon_0}$$

medan listrik dari muatan listrik akan menembus bidang.