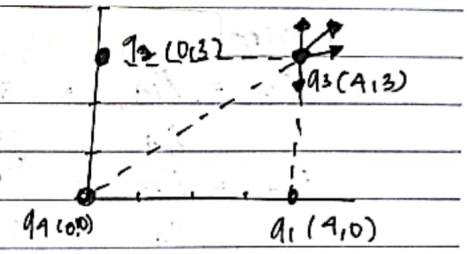
Nama : Yayang Safitri
NPM : 2213022009
Kelas : 22 C

① Empat partikel bermuatan listrik terdistribusi
q_1 (4,0) = 2 stat·C
q_2 (0,3) = 5 Stat·C
q_3 (4,3) = 10 stat·C, dan
q_4 (0,0) = -1 Stat·C



Tentukan : medan listrik pada posisi (0,0), dimana jarak dalam cm, dengan $k = 1$ dyne·cm²/stat·C². Hitung :

a) Gaya coulomb yang dialami oleh muatan q_4
Rumus gaya coulomb 2 muatan :

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

- ~~Gay~~ Jumlah gaya-gaya yang diberikan masing-masing muatan lainnya

$F_{total} = F_{14} + F_{24} + F_{34}$

$F_{14} = \frac{1 \cdot |2(-1)|}{(4^2 + 0^2)} = \frac{2}{16} = \frac{1}{8}$ dyne

$F_{24} = \frac{1 \mid 5(-1)\mid}{(0^2 + 3^2)} = \frac{5}{9}$ dyne

$F_{34} = \frac{1 \mid 10(-1)\mid}{(4^2 + 3^2)} = \frac{10}{25} = \frac{2}{5}$ dyne

Jadi $F_{total} = F_{14} + F_{24} + F_{34}$

$= \frac{1}{8} + \frac{5}{9} + \frac{2}{5}$

$= \frac{45}{360} + \frac{200}{360} + \frac{144}{360}$

$= \frac{45 + 200 + 144}{360}$

$= \frac{389}{360}$

$= 1,0805$

Jadi, gaya coulomb yang dialami oleh q_4 adalah $\frac{389}{360}$ dyne

b). Medan listrik pada titik (0,0) atau muatan q_4

Rumus medan listrik

$$E = \frac{F}{q}$$

∴ Menghitung gaya akibat muatan lainnya

$$E_{1q} = \frac{F_{1q}}{q_4} = \frac{\frac{1}{8}}{-1} = -\frac{1}{8}$$

$$E_{2q} = \frac{F_{2q}}{q_4} = \frac{5/9}{-1} = -\frac{5}{9}$$

$$E_{3q} = \frac{F_{3q}}{q_4} = \frac{2/5}{-1} = -\frac{2}{5}$$

- Nilai E total

$$E_{total} = E_{1q} + E_{2q} + E_{3q} = \left(-\frac{1}{8}\right) + \left(-\frac{5}{9}\right) + \left(\frac{2}{5}\right)$$

$$= -\frac{1}{8} - \frac{5}{9} - \frac{2}{5}$$

$$= -\frac{389}{360}$$

jadi medan listrik pada titik (0,0) adalah $-\frac{389}{360}$ dyne/stat.C

c) potensial listrik pada titik (0,0)

jarak dari q_4 ke titik (0,0) adalah 0cm potensial listrik, disebabkan oleh nilai q_4 dititik (0,0) adalah

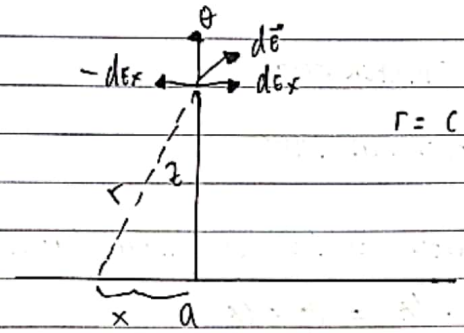
$$V = \frac{k \cdot q_4}{r_4}$$

$$= \frac{1 \cdot (-1)}{0}$$

$$= 0$$

potensial listik menjadi tidak terdefinisi ketika jarak (r) adalah 0. potensial listrik dititik (0,0) dalam kasus ini sangat besar karena total muatan listrik cukup besar dan jaraknya relatif dekat.

(2) Sebuah kawat lurus panjang a, membawa muatan seragan λ. hitung medan listrik di titik p diatas kawat yang berjarak z ditengah-tengah kawat.



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

$d\vec{E} = dE_y + dE_x$

$dE_y = dE_y$

$dE_y = dE \cos\theta$

$$E = \frac{1}{4\pi\varepsilon_0} \int_0^a \frac{\lambda\, dx}{r^2} \cos\theta$$

$$= \frac{1}{4\pi\varepsilon_0} \int_0^a \frac{\lambda\, dx}{(x^2+z^2)} \cos\theta$$

$$= \frac{x\, z}{4\pi\varepsilon_0} \int_0^a \frac{\lambda\, dx}{(x^2+z^2)} \cos\theta$$

$$= \frac{\lambda z}{4\pi\varepsilon_0} \int_0^a \frac{dx}{(x^2+z^2)^{5/2}}$$

$$= \frac{\lambda z}{4\pi\varepsilon_0} \left[\frac{x}{z^2\sqrt{x^2+z^2}} \right] \Big|_0^a$$

$$= \frac{\lambda z}{4\pi\varepsilon_0} \left[\frac{a}{z^2\sqrt{a^2+z^2}} - 0 \right]$$

$$= \frac{\lambda z}{4\pi\varepsilon_0} \left[\frac{a}{z^2\sqrt{a^2+3^2}} \right]$$

4. Hitunglah curl atau rotasi dari fungsi fektor

(a) $V_1 = x^2\vec{i} + 3xz^2\vec{j} - 2xz\vec{k}$

(b) $V_2 = xy\vec{i} + 2yz\vec{j} + 3xz\hat{k}$

jawab

(a) $V_1 = x^2\hat{i} + 3xz\vec{j} - 2xz\vec{k}$

$$\nabla \times V = \left(\frac{\partial}{\partial x}\vec{i} + \frac{\partial}{\partial y}\vec{j} + \frac{\partial}{\partial z}k\right) \times \left(x^2\vec{i} + 3xz^2\vec{j} - 2xz\vec{k}\right)$$

$$= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x^2 & 3xz^2 & -2xz \end{vmatrix}$$

$$= \hat{i}\left(\frac{\partial(-2xz)}{\partial y} - \frac{\partial 3xz^2}{\partial z}\right) + j\left(\frac{\partial(-2xz)}{\partial x} - \frac{\partial x^2}{\partial z}\right) - \vec{k}\left(\frac{\partial 3xz^2}{\partial x} - \frac{\partial x^2}{\partial y}\right)$$

$$= i(0 - 6xz) + \vec{j}(2z - 0) - (3z^2 - 0)$$

$$= -6xz\,(\vec{i}) + 2z\,(\vec{j}) - 3z^2\,(\vec{k})$$

(b) $V_2 = xy\hat{i} + 2yz\vec{j} + 3xz\hat{k}$

$$\nabla \times V = \left(\frac{\partial}{\partial x}\vec{i} + \frac{\partial}{\partial y}\vec{j} + \frac{\partial}{\partial z}\vec{k}\right) \times \left(xy\vec{i} + 2yz\hat{j} + 3xz\vec{k}\right)$$

$$= \begin{vmatrix} \hat{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy & 2yz & 3xz \end{vmatrix}$$

$$= \hat{i}\left(\frac{\partial 3xz}{\partial y} - \frac{\partial 2yz}{\partial z}\right) + \vec{j}\left(\frac{\partial xy}{\partial z} - \frac{\partial 3xz}{\partial x}\right) + \vec{k}\left(\frac{\partial 2yz}{\partial x} - \frac{\partial xy}{\partial y}\right)$$

$$= \hat{i}(0 - 2y) + \vec{j}(0 - 3z) + \vec{k}(0 - x)$$

$$= -2y\,(\vec{i}) - 3z\,(\vec{j}) - x\,(\vec{k})$$