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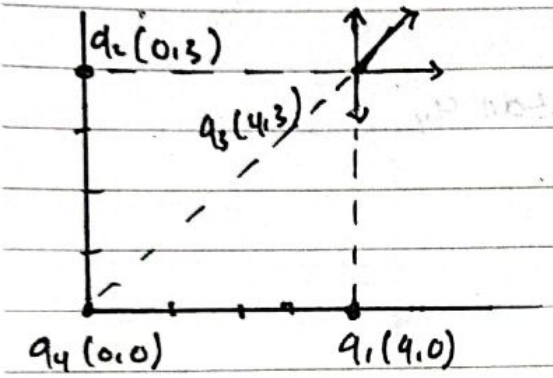
Kalsma (UTS)

1. $q_1(4,0) = +2$ stat·C
   $q_2(0,3) = +5$ stat·C
   $q_3(4,3) = +10$ stat C
   $q_4(0,0) = -1$ stat C

$K = 1$ dyne·cm²/stat·C²



=> Medan listrik pada posisi (0,0)
Jarak dari q_4 ke titik (0,0) adalah 0 cm, maka Medan listrik pada posisi (0,0) adalah

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

$$E_{q4} = \frac{1 \cdot (-1)}{(0)^2} = -\frac{1}{0} = \infty \text{ dyne/stat-C}$$

=> Gaya Coulomb q_4

$$F_{q1} = \frac{K q_4 \cdot q_1}{r^2}$$

$$= \frac{1 \cdot (-1 \cdot 2)}{4^2}$$

$$= \frac{2}{16} = \frac{1}{8} \text{ dyne}$$

$$F_{q2} = \frac{k \cdot q_4 \cdot q_2}{r^2}$$

$$= \frac{1 \cdot (-1 \cdot 5)}{3^2}$$

$$= \frac{5}{9} \text{ dyne}$$

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$$F_{q3} = \frac{k\, q_4 \cdot q_3}{r^2}$$

$$= \frac{1(-1 \cdot 10)}{5^2}$$

$$= \frac{10}{25} = \frac{2}{5} \text{ dyne}$$

Gaya Coulomb yang dialami oleh muatan q_4

$$F_{q4} = f_{q1} + f_{q2} + f_{q3}$$

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

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

$$= \frac{389}{360} \text{ dyne}$$

→ Potensial listrik pada titik (0,0)

Jarak dari q_4 ke titik (0,0) adalah 0 cm, Potensial listrik disebabkan oleh q_4 di titik (0,0) adalah

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

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

$$= \infty \text{ Statv}$$

Potensial listrik yang tak terhingga menunjukkan bahwa ada potensial listrik yang sangat besar di titik (0,0) akibat muatan q_4.

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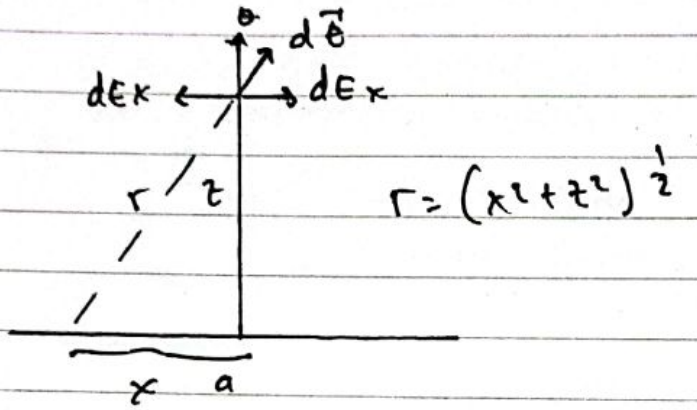
2) Sebuah kawat lurus panjangnya a, membawa muatan seragam λ. hitung medan listrik di titik p diatas kawat yang berjarak z ditengah-tengah kawat.



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

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

$d\vec{E} = dE_y$

$dE_y = dE \cos\theta$

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

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

$$= \frac{xz}{4\pi\varepsilon_0} \int_0^a \frac{\lambda dx}{(x^2+z^2)^{3/2}}$$

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

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

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

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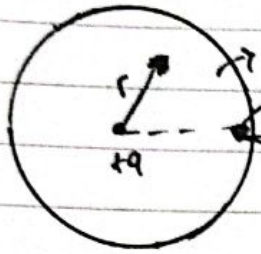
3. Hukum gauss adalah besar fluks atau garis gaya listrik yang keluar dari suatu permukaan tertutup sebanding muatan yang dilingkupi oleh luasan tertutup



→ Permukaan gauss (bentuk bola)
• elemen luas permukaan gauss
dA
E [fluks listrik pada permukaan Gauss]

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

$\oint dA = A$
$= 4\pi r^2$

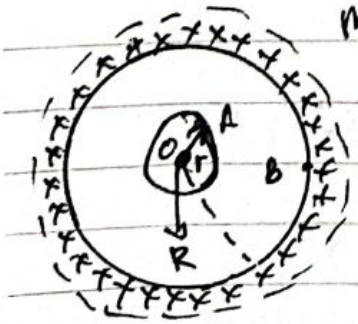
$\Phi_c = \oint E.dA = \oint E dA$
$= E \oint dA$
$= \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}(4\pi r^2)$

$\Phi_c = \frac{q}{\varepsilon_0}$

fluks listrik pada permukaan bola sebanding dengan muatan yang ada di dalamnya.

Hukum Gauss diterapkan dalam situasi dimana distribusi muatan memiliki simetri tertentu

Contohnya



Medan listrik kulit bola

Berapakah medan listrik di kulit?

jawab: E dikulit bola (titik B)

$r = R$

$E = k\frac{Q}{r^2}$

$E = k\frac{Q}{R^2}$

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4. Hitunglah Curl atau rotasi dari fungsi vektor :

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

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

Jawab

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

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

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

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

$$= i(0 - 6xz) + j(2z - 0) - (3z^2 - 0)$$

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

b. $V_2 = xy\hat{j} + 2yz\hat{j} + 3xz\hat{k}$

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

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

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

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

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