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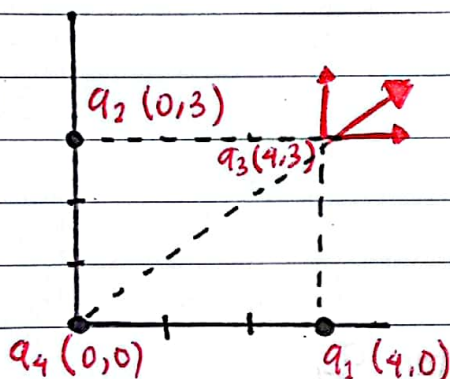
$$①. q_1 (4,0) = +2 \text{ stat} \cdot c$$

$$q_2 (0,3) = +5 \text{ stat} \cdot c$$

$$q_3 (4,3) = +10 \text{ stat} \cdot c$$

$$q_4 (0,0) = -1 \text{ stat} \cdot c$$

$$k = 1 \text{ dyne} \cdot \text{cm}^2 / \text{stat} \cdot c^2$$



* 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

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

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

* Gaya coulomb q_4

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

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

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

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

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

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

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

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

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

Gaya coulomb yang dialami oleh muatan q_4

$$F_{q_4} = f_{q_1} + f_{q_2} + f_{q_3}$$

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

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

$$= \frac{389}{360} = 1,0805$$

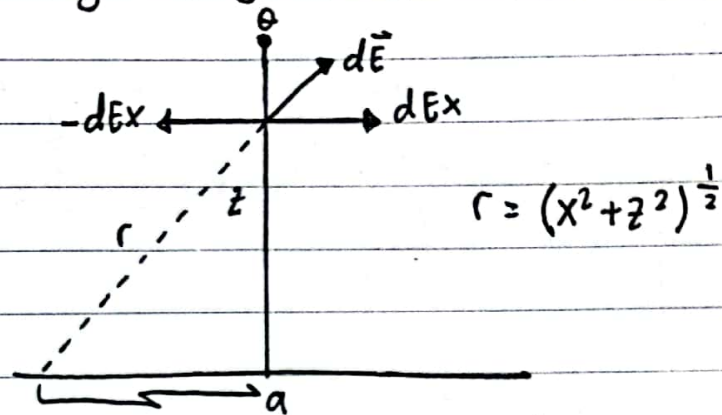
* Potensial listrik pada titik (0,0)

Jarak dari q_4 ke titik (0,0) adalah 0 cm, potensial listrik disebabkan oleh q_4 di titik (0,0) adalah $V = \frac{k q_4}{r_4}$

$$= \frac{1 \cdot (-1)}{0} = \infty \text{ atau } V$$

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

- (2) sebuah kawat lurus panjangnya, membawa muatan seragam λ . Hitung medan listrik di titik P di atas kawat yang berjarak z di tengah-tengah kawat.



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

$$d\vec{E}^n = dE_y$$

$$dE_y = dE \cos \theta$$

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

$$= \frac{1}{4\pi\epsilon_0} \int_0^a \frac{\lambda dx \cos \theta}{(x^2 + z^2)}$$

$$= \frac{xz}{4\pi\epsilon_0} \int_0^a \frac{\lambda dx \cos \theta}{(x^2 + z^2)}$$

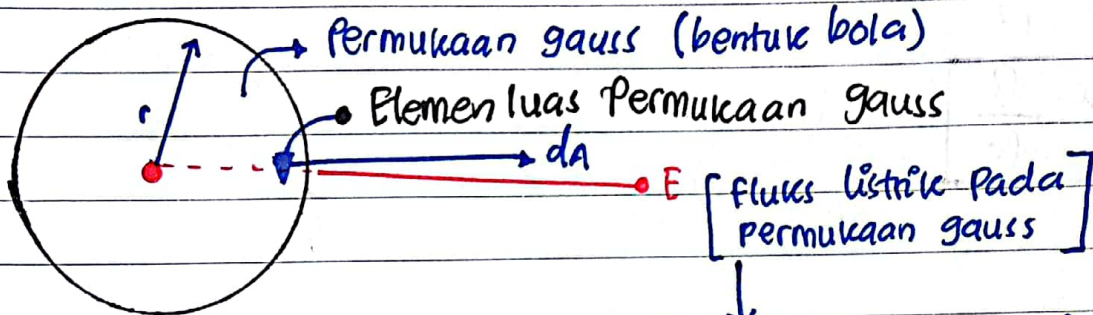
$$= \frac{\lambda z}{4\pi\epsilon_0} \int_0^a \frac{dx}{(x^2 + z^2)^{3/2}}$$

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

$$= \frac{\lambda z}{4\pi\epsilon_0} \left[\frac{a}{z^2 \sqrt{a^2 + z^2}} - 0 \right]$$

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

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



[Fluks listrik pada permukaan gauss]

$$\Phi_c = \oint E \cdot dA : \oint E dA$$

$$= E \oint dA$$

$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$$

$$= \left(\frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \right) (4\pi r^2)$$

$$\oint dA : A$$

$$= 4\pi r^2$$

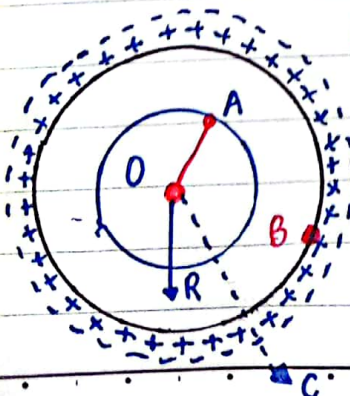
$$\Phi_c = \frac{q}{\epsilon_0}$$

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

Hukum Gauss diterapkan dalam situasi dimana distribusi muatan memiliki simetri tertentu.

Contoh:

Medan listrik kulit bola



Berapakah medan listrik di kulit ?

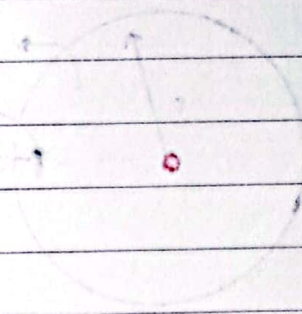
Jawab:

E. Kulit bola (titik B)

$$r = R$$

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

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



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

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

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

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

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

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

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

$$b.) \vec{V}_2 = xy\hat{i} + 2yz\hat{j} + 3xz\hat{k}$$

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

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

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

$$\hat{k} \left(\frac{\partial 2yz}{\partial x} - \frac{\partial xy}{\partial y} \right)$$

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

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