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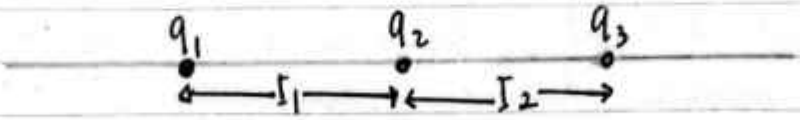
tugas II

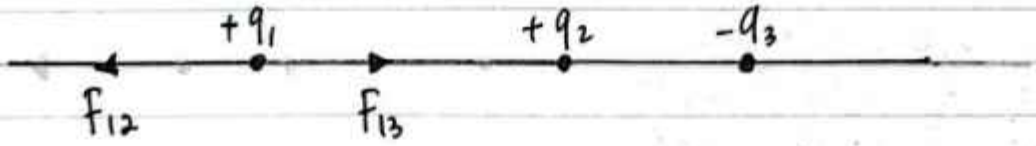
No 3 oktober 2025
Date Jum'at.

1) Tiga buah muatan titik q_1, q_2, q_3 yg masing-masing bermuatan 2.10^{-6} C(positif). 3.10^{-6} (positif), dan 5.10^{-6} C (Negatif) terletak pd sebuah garis lurus. Jika jarak q_1 dan q_2 adalah 3m, dan q_2 dan q_3 adalah 2m. hitung gaya elektrostatika yg dialami oleh q_1 ?

Jawab:



q_1 mengalami gaya tolak menolak dari q_2 karena muatannya sejenis.
q_1 mengalami gaya tarik menarik dari q_3 karena muatannya berlawanan jenis.



Besar gaya antara q_1 dan q_2

$$F_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{l_1^2} = \frac{9.10^9 \times 2.10^{-6} \times 3.10^{-6}}{3^2}$$

$$= \frac{9.10^9 \times 2.10^{-6} \times 3.10^{-6}}{9}$$

$$= 6.10^{9+(-12)} = 6.10^{-3}\ N$$

$$F_{13} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{(l_1+l_2)^2} = \frac{9.10^9 \times 2.10^{-6} \times 5.10^{-6}}{(5)^2}$$

$$= \frac{9.10^9 \times 2.10^{-6} \times 5.10^{-6}}{25}$$

$$= \frac{18.10^{-3}}{5} = 3{,}6.10^{-3}\ N$$

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Resultan gaya dialami oleh q_1 besarnya
$= (6 - 3{,}6) \cdot 10^{-3}$ N
$= 2{,}4 \cdot 10^{-3}$ N, arahnya searah dengan F_{12} (ke arah kiri).

2. Dua buah partikel bermuatan positif dan sama besar terpisah pada jarak $2{,}60 \cdot 10^{-2}$ m dilepaskan dari keadaan diam. sesaat setelah dilepas, partikel 1 yang bermassa $6{,}0 \cdot 10^{-6}$ kg bergerak dengan percepatan $4{,}6 \cdot (0^3\ ms^{-2}$, sedangkan partikel 2 bergerak dengan percepatan $8{,}5 \cdot 10^3\ ms^3$. Tentukan:
a). Besar muatan masing-masing partikel.
b). Massa partikel 2.

Jawab:
Dik:
$r = 2{,}60 \cdot 10^{-2}$ m.
$m_1 = 6{,}0 \cdot 10^{-6}$ kg.
$a_1 = 4{,}6 \cdot 10^3\ ms^{-2}$
$a_2 = 8{,}5 \cdot 10^3\ ms^3$

a) Besar muatan masing-masing partikel.
$q_1 = q_2 = q$

$F = m_1 \times a_1$
$= 6{,}0 \cdot 10^{-6} \times 4{,}6 \cdot 10^3$
$= 2{,}76 \cdot 10^{-2}$ N

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

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

$2{,}76 \cdot 10^{-2} = 9 \cdot 10^9 \ \frac{q^2}{(2{,}60 \cdot 10^{-2})^2}$

$2{,}76 \cdot 10^{-2} = 9 \cdot 10^9 \ \frac{q^2}{6{,}76 \cdot 10^{-4}}$

$2,76 \cdot 10^{-2} \times 6,76 \cdot 10^{-4} = 9 \cdot 10^{9} \times q^2$

$18,6576 \cdot 10^{-6} = 9 \cdot 10^{9} \times q^2$

$q^2 = \frac{18,6576 \cdot 10^{-6}}{9 \cdot 10^{9}}$

$q^2 = 20,7 \cdot 10^{-6-9}$

$q^2 = 20,7 \cdot 10^{-15}$

$q = \sqrt{20,7 \cdot 10^{-15}}$

$q = 4,55 \cdot 10^{-8}$ C.

$q_1 = q_2 = 4,55 \cdot 10^{-8}$ C.

b) Massa Partikel 2.

Hk. Newton II : $f = m \cdot a$

$f = m_2 \cdot a_2$

$m_2 = \frac{F}{a_2}$

$m_2 = \frac{2,76 \cdot 10^{-2}}{8,5 \cdot 10^{3}}$

$m_2 = 3,25 \cdot 10^{-6}$ kg.

$m_2 = 3,2 \cdot 10^{-6}$ kg.

Jadi, massa partikel 2 adalah $3,2 \cdot 10^{-6}$ kg.

3) Tentukan gaya yang dialami q_1, jika :

$q_1 (-4,0,0) = 5C$

$q_2 (4,0,0) = 10C$

$q_3 (0,5,0) = 6C$

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Jawab:

Gaya total yang dialami oleh q_1 adalah resultan vektor dari gaya yang diberikan oleh q_2 pada q_1 (F_{12}) dan gaya yang diberikan oleh q_3 pada q_1 (F_{13})

$$r_{12} = \sqrt{(4-(-4))^2 + (0-0)^2 + (0-0)^2}$$
$$= \sqrt{8^2}$$
$$= 8 \text{ m.}$$

$$r_{13} = \sqrt{(0-(-4))^2 + (5-0)^2 + (0-0)^2}$$
$$= \sqrt{4^2 + 5^2}$$
$$= \sqrt{16+25}$$
$$= \sqrt{41} \text{ m.}$$

$$F_{12} = k \frac{q_1 q_2}{r_{12}^2}$$
$$= 9 \cdot 10^9 \frac{5 \cdot 10}{8^2}$$
$$= 9 \cdot 10^9 \frac{50}{64}$$
$$= 7{,}03125 \cdot 10^9 \text{ N.}$$

$$F_{13} = k \cdot \frac{q_1 q_3}{r_{13}^2}$$
$$= 9 \cdot 10^9 \frac{5 \cdot 6}{(\sqrt{41})^2}$$
$$= 9 \cdot 10^9 \frac{30}{41}$$
$$= 6{,}585 \cdot 10^9 \text{ N.}$$

Karena q_1 dan q_2 paitif, F_{12} gayanya tolak-menolak, sehingga arahnya menjauhi q_2 dan searah sumbu x negatif.

Vektor F_{12} adalah $\vec{F}_{12} = (-7{,}03125 \cdot 10^9)\hat{i}$

vektor satuan q_1 dan q_3 adalah $\vec{r}_{13} = \frac{(0-(-4))\hat{i} + (5-0)\hat{j}}{\sqrt{41}}$

$= \frac{4\hat{i} + 5\hat{j}}{\sqrt{41}}$

Arah gaya F_{13} adalah berlawanan dengan $\hat{r}_{13}$, sehingga:

$F_{13} = -F_{13}\hat{r}_{13} = -(6.585 \cdot 10^9)\frac{4\hat{i}+5\hat{j}}{\sqrt{41}}$

$F_{13x} = -(6.585 \cdot 10^9)\frac{4}{\sqrt{41}} = -4{,}118 \cdot 10^9$ N.

$F_{13y} = -(6{,}585 \cdot 10^9)\frac{5}{\sqrt{41}} = -5{,}147 \cdot 10^9$ N.

Resultan gaya pada q_1 adalah:

$|\vec{F}_1| = \sqrt{F_x^2 + F_y^2}$

$= \sqrt{((-7.03125 \cdot 10^9) + (-4.118 \cdot 10^9))^2 + ((-5{,}147 \cdot 10^9) + 0)^2}$

$= \sqrt{(-11{,}14925 \cdot 10^9)^2 + (-5{,}147 \cdot 10^9)^2}$

$= \sqrt{-124{,}30578 \cdot 10^{18} + (-26{,}491609 \cdot 10^{18})}$

$= \sqrt{-150{,}797 \cdot 10^{18}}$

$= 12{,}27 \cdot 10^9$

$= 1{,}22 \cdot 10^{10}$ N

Jadi gaya yang dialami q_1 sebesar $1{,}22 \cdot 10^{10}$ N.

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4) Tiga partikel bermuatan terdistribusi sebagai berikut :

q_1 (0,5,0) = 10 C

q_2 (5,5,0) = 5 C

q_3 (0,5,5) = -10C

Tentukan gaya yang dialami q_3 !

Jawab :

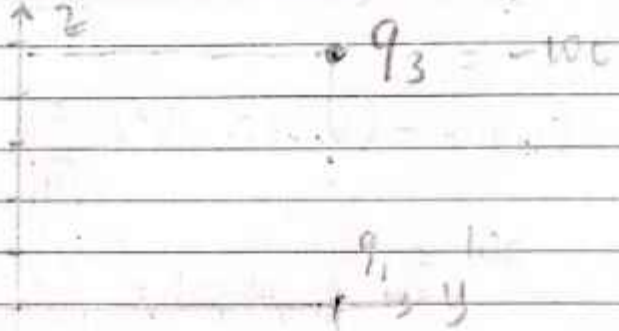
Dik :

q_1 = 10C → (0,5,0)

q_2 = 5C → (5,5,0)

q_3 = +10C → (0,5,5).

$k = 9.10^9\ N.m^2/C^2$



Jarak antara q_3 dan q_1 (r_{13})

$r_{13}^2 = r_3 - r_1$

$= (0,5,5) - (0,5,0)$

$= (0,0,5)$ m

$r_{13} = \sqrt{0^2 + 0^2 + 5^2}$ = $\sqrt{25}$ = 5 m

Vektor satuan $\vec{r}_{13}$ = $(0,0,1)\,\hat{k}$

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jarak antara q_3 dan q_2 (r_{23})

$r_{23} = r_3 - r_2$

$= (0,5,5) - (5,5,0)$

$= (-5, 0, 5)$ m

$r_{23} = \sqrt{(-5)^2 + 0^2 + 5^2}$

$= \sqrt{25 + 25}$

$= \sqrt{50}$ m.

Vektor satuan $\hat{r}_{23} = \left(-\frac{\sqrt{2}}{2}, 0, \frac{\sqrt{2}}{2}\right)$

f_{13} = $-q_3$ dan $+q_1$ akan tarik-menarik.

$f_{13} = k \frac{|q_1 q_3|}{r_{13}^2}$

$= (9 \cdot 10^9) \frac{|(10) \cdot 10|}{5^2}$

$= 9 \cdot 10^9 \frac{100^4}{25}$

$F_{13} = 9 \cdot 10^9 \cdot 4 = 36 \cdot 10^9$ N

Vektor gaya $f_{13} = F_{13} \cdot (-\hat{k}) = -36 \cdot 10^9 \hat{k}$ N

f_{23} = $-q_3$ dan $+q_2$ akan tarik-menarik.

$f_{23} = k \frac{q_2 q_3}{r_{23}^2}$

$= 9 \cdot 10^9 \frac{5 \cdot 10}{(\sqrt{50})^2}$

$= 9 \cdot 10^9 \frac{50}{50}$

$F_{23} = 9 \cdot 10^9$ N

Vektor $F_{23} = F_{23} \cdot (-\hat{r}_{23})$

$= 9 \cdot 10^9 \cdot \left(-\frac{\sqrt{2}}{2}\hat{i} - \frac{\sqrt{2}}{2}\hat{k}\right)$

$= 9 \cdot 10^9 \cdot (0,707\hat{i} - 0,707\hat{k})$

$F_{23} = 6,363 \cdot 10^9 \hat{i} - 6,363 \cdot 10^9 \hat{k}$ N.

Gaya total F_3

$F_3 = F_{13} + F_{23}$

$= (0\hat{i} + 0\hat{j} - 36 \cdot 10^9 \hat{k}) + (6,363 \cdot 10^9 \hat{i} + 0\hat{j} - 6,363 \cdot 10^9 \hat{k})$

$= 6,363 \cdot 10^9 \hat{i} + 0\hat{j} + (-36 \times 6,363) 10^9 \hat{k}$

$= 6,363 \cdot 10^9 \hat{i} - 42,363 \cdot 10^9 \hat{k}$ N.

$F_3 = \sqrt{F_{3x}^2 + F_{3y}^2}$

$= \sqrt{(6,363 \cdot 10^9)^2 + (-42,363 \cdot 10^9)^2}$

$= \sqrt{(40,49 + 1794,6) 10^{18}}$

$= \sqrt{1835,09 \cdot 10^{18}}$

$F_3 = 42,84 \cdot 10^9$ N

5) Berapa gaya yang dialami muatan $q = 10$ C di $(0,0,0)$ karena pengaruh muatan:

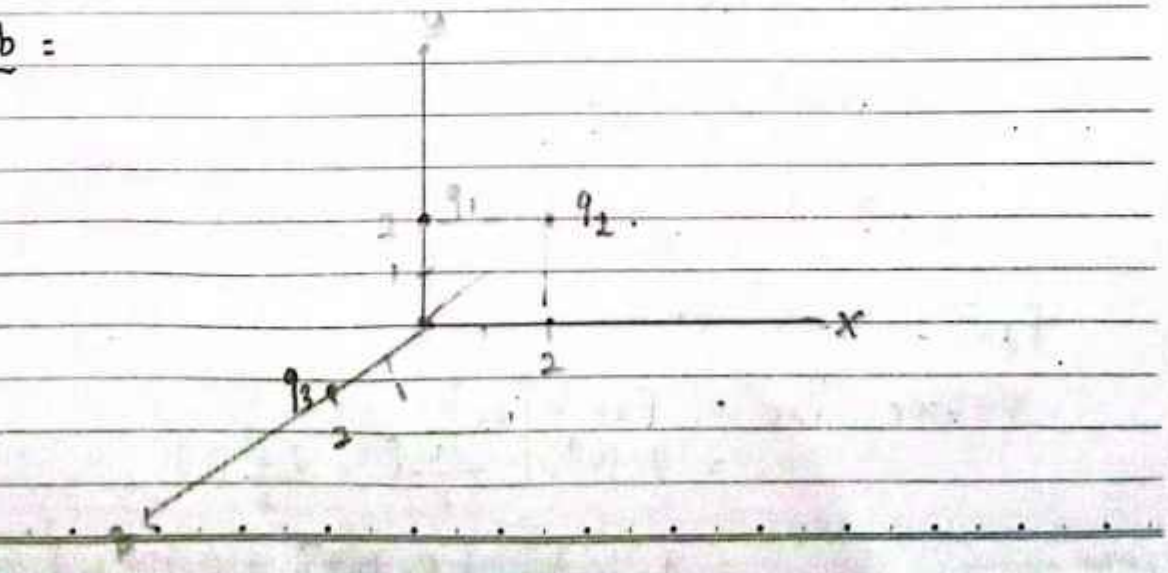
$q_1 = 2$ C di $(0,2,0)$

$q_2 = 4$ C di $(2,2,0)$

$q_3 = 5$ C di $(0,2,2)$

$q_4 = -5$ C di $(2,2,2)$

Jawab =



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• Dari q_1 = 2C di (0, 2, 0) ke q di (0, 0, 0)

r_1 = (0, 0, 0) - (0, 2, 0)

= (0, -2, 0) m. = 2 m.

$\hat{r}_1$ = (0, -1, 0)

$F_1 = K \cdot \frac{q \cdot q_1}{r_1^2}$

$= 9 \cdot 10^9 \frac{10 \cdot 2}{2^2}$

$= 9 \cdot 10^9 \frac{20^5}{4}$

$= 9 \cdot 10^9 \times 5$

$= 45 \cdot 10^9$ N

Vektor gaya $\hat{F}_1 = F_1 \cdot (\hat{r}_1)$

$= 45 \cdot 10^9 \cdot (0, -1, 0)$

$= (0, -45 \cdot 10^9, 0)$ N.

• Dari q_2 = 4C di (2, 2, 0) ke q di (0, 0, 0)

r_2^2 = (0, 0, 0) - (2, 2, 0)

= (-2, -2, 0) m

$r_2 = \sqrt{(-2)^2 + (-2)^2 + 0^2}$

$= \sqrt{4+4}$

$= \sqrt{8} = 2\sqrt{2}$ m.

$\hat{r}_2 = \left(\frac{-1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}, 0\right)$

$\vec{F_2} = K \cdot \frac{q \cdot q_2}{r_2^2}$

$= 9 \cdot 10^9 \frac{10 \cdot 4}{(\sqrt{8})^2}$

$= 9 \cdot 10^9 \frac{40^5}{8}$

$= 45 \cdot 10^9$ N

Vektor gaya $\hat{F}_2 = F_2 \cdot (\hat{r}_2)$

$= 45 \cdot 10^9 \left(\frac{-1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}, 0\right)$

$= \frac{-45 \cdot 10^9}{\sqrt{2}}, \frac{-45 \cdot 10^9}{\sqrt{2}}, 0$

$= (-31,82 \cdot 10^9, -31,82 \cdot 10^9, 0)$ N.

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- Dari $q_3 = 5C$ di $(0,2,2)$ ke q di $(0,0,0)$

$\vec{r}_3 = (0,0,0) - (0,2,2)$

$= (0,-2,-2)$

$r_3 = \sqrt{0^2+(-2)^2+(-2)^2}$

$= \sqrt{4+4}$

$= \sqrt{8} = 2\sqrt{2}$ m.

$\hat{r}_3 = \left(0, \frac{-1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}\right)$

$F_3 = k\frac{q.q_3}{r_3^2}$

$= 9.10^9 \frac{10.5}{(\sqrt{8})^2}$

$= 9.10^9 \frac{50}{8}$

$= 56,25.10^9$ N

Vektor gaya $\vec{f}_3 = f_3.(\hat{r}_3)$

$= 56,25.10^9 \left(0, \frac{-1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}\right)$

$= \left(0, \frac{-56,25.10^9}{\sqrt{2}}, \frac{-56,25.10^9}{\sqrt{2}}\right)$

$= (0, -39,77.10^9, -39,77.10^9)$ N.

- Dari $q_4 = -5C$ di $(2,2,2)$ ke q di $(0,0,0)$

$\vec{r}_4 = (0,0,0) - (2,2,2)$

$= (-2,-2,-2)$

$r_4 = \sqrt{(-2)^2+(-2)^2+(-2)^2}$

$= \sqrt{4+4+4}$

$= \sqrt{12} = 2\sqrt{3}$ m.

$\hat{r}_4 = \left(\frac{-1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}\right)$

$F_4 = k.\frac{q.q_4}{r_4^2}$

$$F_4 = 9 \cdot 10^9 \frac{10 \cdot (-5)}{(\sqrt{12})^2}$$

$$= 9 \cdot 10^9 \frac{-50}{12}$$

$$= 37{,}5 \cdot 10^9 \text{ N}$$

Vektor gaya $\vec{F}_4 = F_4 \cdot (\hat{r}_4)$

$$= 37{,}5 \cdot 10^9 \cdot \left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}} \right)$$

$$= \left(\frac{37{,}5 \cdot 10^9}{\sqrt{3}}, \frac{37{,}5 \cdot 10^9}{\sqrt{3}}, \frac{37{,}5 \cdot 10^9}{\sqrt{3}} \right)$$

$$= (21{,}65 \cdot 10^9, 21{,}65 \cdot 10^9, 21{,}65 \cdot 10^9) \text{ N}$$

$F_{total} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$

$F_x = -31{,}82 \cdot 10^9 + 21{,}65 \cdot 10^9 = -10{,}17 \cdot 10^9$ N

$F_y = -45 \cdot 10^9 - 31{,}82 \cdot 10^9 - 39{,}77 \cdot 10^9 + 21{,}65 \cdot 10^9$

$= -94{,}94 \cdot 10^9$ N.

$F_z = -39{,}77 \cdot 10^9 + 21{,}65 \cdot 10^9 = -18{,}12 \cdot 10^9$ N.

$F_{total} = -10{,}17 \cdot 10^9 \hat{i} - 94{,}94 \cdot 10^9 \hat{j} - 18{,}12 \cdot 10^9 \hat{k}$

Besar gaya $\vec{F} = \sqrt{(F_x^2 + F_y^2 + F_z^2)}$

$$= \sqrt{(-10{,}17 \cdot 10^9)^2 + (-94{,}94 \cdot 10^9)^2 + (-18{,}12 \cdot 10^9)^2}$$

$$= 96{,}9 \cdot 10^9 \text{ N.}$$

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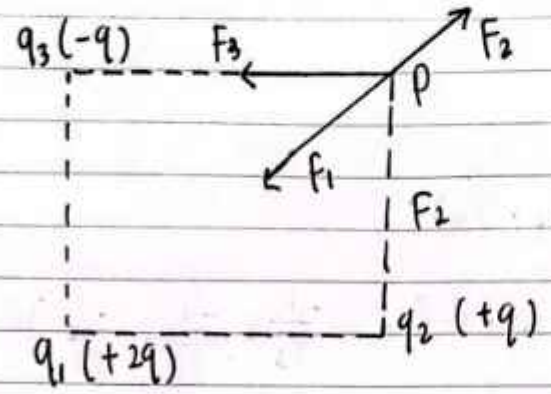
6.) a. Gambar Gaya-gaya pada muatan 3q.

F_1 (+2q) = tolak-menolak, arah diagonal ke kiri bawah.

F_2 (+q) = tolak-menolak, arah ke atas $(+\hat{j})$

F_3 (-q) = tarik-menarik, arah ke kiri $(-\hat{i})$



b. Hitung besar gaya

- Hitung vektor gaya

F_2 (jarak s, arah $+\hat{j}$)

$$F_2 = k \cdot \frac{3q \cdot q}{s^2}$$

$$= 3k'$$

$$= 3k'\hat{j}$$

F_3 (jarak s, arah $-\hat{i}$)

$$F_3 = k \cdot \frac{(3q)-q}{s^2}$$

$$= 3k' = 3k'\hat{j}$$

F_1 (jarak $s\sqrt{2}$, arah $-\hat{i}, -\hat{j}$)

$$F_1 = k \cdot \frac{3q \cdot 2q}{(s\sqrt{2})^2}$$

$$= k\frac{6q^2}{2s^2}$$

$$= 3k'$$

$$= 3k' \cdot \frac{1}{\sqrt{2}}(-\hat{i}, -\hat{j})$$

$$F_1 = -\frac{3k'}{\sqrt{2}}\hat{i}, -\frac{3k'}{\sqrt{2}}\hat{j}$$

- Besar gaya total

$$F_{total} = \sqrt{F_x^2 + F_y^2}$$

$$= 3k'\sqrt{\left(-1-\frac{1}{\sqrt{2}}\right)^2 + \left(1-\frac{1}{\sqrt{2}}\right)^2}$$

$$= 3k'\sqrt{1+1+\frac{1}{2}+\frac{1}{2}}$$

$$F = 3k'\sqrt{3} = 3\sqrt{3} \cdot k\frac{q_2}{s^2} \;//.$$

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c. Hitung medan listrik.

$$\vec{E} = \frac{F_{total}}{3q}$$

$$= \frac{3F' \frac{q^2}{s^2}\left[\left(-1-\frac{1}{2}\right)\hat{i} + \left(1-\frac{1}{\sqrt{2}}\right)\hat{j}\right]}{3q}$$

$$= k\frac{q}{s^2}\left[\left(-1-\frac{1}{\sqrt{2}}\right)\hat{i} + \left(1-\frac{1}{\sqrt{2}}\right)\hat{j}\right] //.$$

d. $E = \frac{13kq}{9r^2}$ arah ke kiri. //

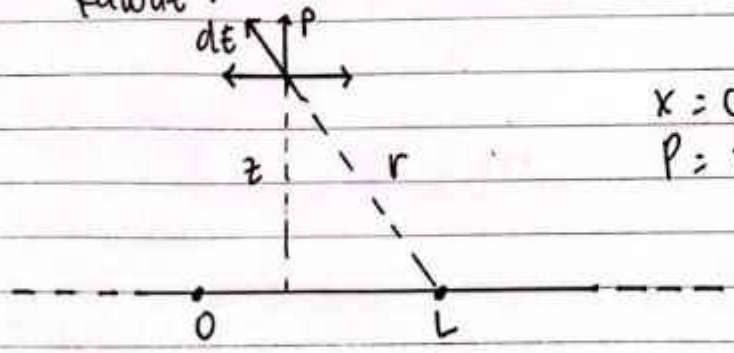
e. $V = k\,\xi\,\frac{q_i}{r_i}$

$$= k\left(\frac{-q}{r} + \frac{2q}{r} + \frac{q}{2r}\right)$$

$$= k\left(\frac{-q + 2q + 0{,}5q}{2}\right)$$

$$= k\,\frac{1{,}5q}{r} = \frac{3kq}{2r.} //$$

7.) Sebuah batang panjangnya L, rapat muatan persatuan panjang adalah λ.
Hitung:
a. kuat medan listrik dititik P yg berjarak z diatas ujung kawat.



$x = 0$ hingga $x = L$
$P = x = L + z$.

$$d\vec{E} = k\frac{dq}{r^2} = k\frac{\lambda dx'}{((L+z)-x')^2}$$

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$$\vec{E} = \int_0^L k\lambda \frac{dx'}{((L+z)-x')^2}$$

gunakan $u = (L+z) - x'$

maka, $du = -dx'$

untuk $x' = 0$, $u = L+z$

untuk $x' = L$, $u = z$

$$\vec{E} = k\lambda \int_{L+z}^{z} \frac{-du}{u^2}$$

$$= -k\lambda \left[-\frac{1}{u} \right]_{L+z}^{z}$$

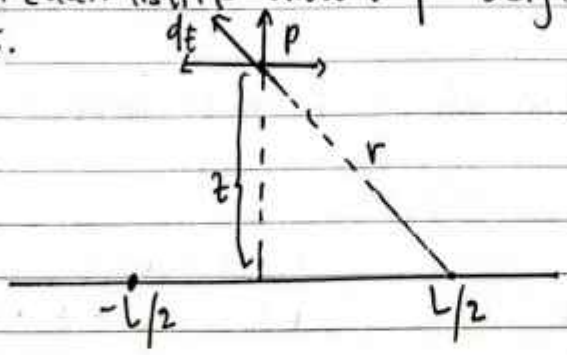
$$= k\lambda \left[\frac{1}{u} \right]_{L+z}^{z}$$

$$= k\lambda \left(\frac{1}{z} - \frac{1}{L+z} \right)$$

$$= k\lambda \left(\frac{(L+z)-z}{z(L+z)} \right)$$

$$\vec{E} = k\lambda \frac{L}{z(L+z)}$$

b. Kuat medan listrik dititik P berjarak z ditengah-tengah kawat.



$$d\vec{E} = k \cdot \frac{\lambda dx'}{(z-x')^2}$$

$$\vec{E} = \int_{-L/2}^{L/2} k\lambda \frac{dx}{(z-x')^2}$$

gunakan subsitusi $u = z - x'$, maka $du = -dx'$

untuk $x' = -\frac{L}{2}$, $u = z + L/2$

untuk $x' = -\frac{L}{2}$, $u = z - \frac{L}{2}$

$$\vec{E} = k\lambda \int_{z+L/2}^{z-L/2} \frac{-du}{u^2}$$

$$= -k\lambda \left[-\frac{1}{u}\right]_{z+L/2}^{z-L/2}$$

$$= k\lambda \left[\frac{1}{u}\right]_{z+L/2}^{z-L/2}$$

$$= k\lambda \left(\frac{1}{z-L/2} - \frac{1}{z+L/2}\right)$$

$$= k\lambda \left(\frac{(z+L/2) - (z-L/2)}{(z-L/2) - (z+L/2)}\right)$$

$$\vec{E} = k\lambda \frac{L}{z^2 - (L/2)^2} \quad //.$$

b) Diketahui: σ = rapatan muatan permukaan (C/m^2)
R = jari-jari bola konduktor (m)
$Q = \sigma$. luas permukaan $= \sigma \cdot 4\pi R^2$

Ditanya = $\vec{E}_{(r)}$? (medan listrik didalam dan diluar bola konduktor?)

Jawab = $\oint_{Gauss} \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$

- Untuk daerah didalam bola konduktor ($r < R$)
  $Q_{enc} = 0$

$$\vec{E}(r) \cdot 4\pi r^2 = \frac{Q_{enc}}{\varepsilon_0} = 0 \Rightarrow \vec{E}(r) = 0 \quad (r < R)$$

artinya didalam bola konduktor tidak ada medan listrik.

- Untuk daerah di luas bola konduktor $(r > R)$

$Q = 4\pi R^2 \sigma$

menggunakan hukum Gauss

$$E(r) \cdot 4\pi R^2 \sigma = \frac{Q}{\varepsilon_0}$$

$$\vec{E}_{(r)} = \frac{Q}{4\pi \varepsilon_0 r^2}$$

$$\vec{E}_{(r)} = \frac{4\pi R^2 \sigma}{4\pi \varepsilon_0 r^2}$$

$$= \frac{\sigma R^2}{\varepsilon_0 r^2} \qquad (r > R)$$

Arah medan listrik radial ke luar jika $\sigma > 0$

- Tepat dipermukaan bola $r = R$

$$E_{luar} - E_{dalam} = \frac{\sigma}{\varepsilon_0}$$

$$E_{dalam} = 0$$

$$E_{permukaan} = \frac{\sigma}{\varepsilon_0}$$

jadi, $\vec{E}_{(r)} \begin{cases} 0 & r < R \\ \dfrac{\sigma R^2}{\varepsilon_0 r^2} & r \geq R \end{cases}$ dan $Q = 4\pi R^2 \sigma$

9.) Bila kuat medan listrik $\vec{E} = Kr^3 \hat{r}_0$ dalam koordinat bola, dengan K = konstan.

a. hitung rapat muatannya.

b. cari muatan total yg terdapat dalam suatu bola dengan jari-jari R berpusat di O.

Jawab :

Diketahui : $E = Kr^3 \hat{r}^0$ dalam koordinat bola.

K = konstanta

Ditanya = a.) ρ ?
b.) Qtotal ?

Jawab = a) hukum Gauss (divergensi) $E_r = kr^3$

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$$

$$= \frac{1}{r^2} \cdot \frac{d}{dr}(r^2 E_r)$$

$$= \frac{1}{r^2} \cdot \frac{d}{dr}(r^2 \cdot kr^3)$$

$$= \frac{1}{r^2} \cdot \frac{d}{dr}(kr^5)$$

$$= \frac{1}{r^2}(5kr^4)$$

$$= 5kr^2$$

maka, $\frac{\rho}{\varepsilon_0} = 5kr^2$

$\therefore \rho = 5\varepsilon_0 kr^2$ //

b) muatan total dalam bola jari R.

$$Q = \int_V \rho \, dv$$

dalam koordinat bola
$dv = 4\pi r^2 dr$

$$Q = \int_0^R \rho 4\pi r^2 dr$$

$$= \int_0^R (5\varepsilon_0 kr^2)(4\pi r^2) dr$$

$$= 20\pi\varepsilon_0 k \int_0^R r^4 dr$$

$$= 20\pi\varepsilon_0 k \left[\frac{r^5}{5}\right]_0^R$$

$Q_{total} = 4\pi\varepsilon_0 kR^5$ //