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Lintang Nimas K

Tugas II

1. Diket : $q_1 = +2 \times 10^{-6}$ C

$q_2 = +3 \times 10^{-6}$ C

$q_3 = -5 \times 10^{-6}$ C

r q_1 dan q_2 : $r_{12} = 3$ m

$r_{23} = 2$ m

$k = 9 \times 10^9$ N $\cdot m^2/C^2$

Besar $F_{21} = k \dfrac{|q_1 q_2|}{r_{12}^2}$

$= (9 \times 10^9 \text{ N} \cdot m^2/C^2) \cdot \dfrac{(2 \times 10^{-6} C)(3 \times 10^{-6} C)}{(3m)^2}$

$= (9 \times 10^9) \dfrac{6 \times 10^{-12}}{9}$ N

$= (1 \times 10^9)(6 \times 10^{-12})$ N

$= 6 \times 10^{-3}$ N

Besar $F_{31} = k \dfrac{|q_1 q_2|}{r_{13}^2}$

$F_{31} = (9 \times 10^9 \text{ N} \cdot m^2/C^2) \dfrac{(2 \times 10^{-6} C)(5 \times 10^{-6} C)}{(5m)^2}$

$= (9 \times 10^9) \dfrac{10 \times 10^{-12}}{25}$ N

$= \dfrac{90}{25} \times 10^{-3}$ N $= 3.6 \times 10^{-3}$ N

$F_{21} = -6 \times 10^{-3}$ N

$F_{31} = +3.6 \times 10^{-3}$ N

$F_1 = F_{31} + F_{21}$

$= (+3.6 \times 10^{-3} N) + (-6 \times 10^{-3} N)$

$= (3.6 - 6) \times 10^{-3}$ N

$= 2.4 \times 10^{-3}$ N

Jadi q_1 mengaruh ke kiri (menjauhi q_2)

2. Diket :

$r = 2.60 \times 10^{-2}$ m

$1 = 2 : q_1 = q_2 = q$

$1 : m_1 = 6.0 \times 10^{-6}$ kg

$1 : a_1 = 41.6 \times 10^3$ m/s^2

$2 : a_2 = 0.5 \times 10^3$ m/s^2

$k = 9 \times 10^9$ N.m^2/C^2

A. $F_E = m_1 a_1$

$F_E = k \frac{|q_1 q_2|}{r^2} = k \frac{q^2}{r^2}$

$k \frac{q^2}{r^2} = m_1 a_1 \longrightarrow q^2 = \frac{m_1 a_1 r^2}{k}$

$q = \sqrt{\frac{m_1 a_1 r^2}{k}}$

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$$q = \sqrt{\frac{(6.0\times10^{-6}\,kg)\times(4.6\times10^{3}\,m/s^2)\times(2.60\times10^{-2}\,m)^2}{9\times10^{9}\,N\cdot m^2/C^2}}$$

$$q = \sqrt{\frac{(6.0\times4.6)\times(10^{-6}\times10^{3})\times(6.76\times10^{-4}}{9\times10^{9}}}\,C$$

$$q = \sqrt{\frac{27.6\times6.76\times10^{-7}}{9\times10^{9}}}\,C$$

$$q = \sqrt{\frac{186.696\times10^{-16}}{9}}\,C$$

$$q = \sqrt{20.744\times10^{-8}}\,C$$

$$q = 4.55\times10^{-8}\,C$$

B. $F_{E_1} = F_{E_2}$

$$m_1 a_1 = m_2 a_2$$

$$m_2 = \frac{m_1 a_1}{a_2}$$

$$m_2 = \frac{(60\times10^{-6}\,kg)\times(4.6\times10^{3}\,m/s^2)}{8.5\times10^{3}\,m/s^2}$$

$$m_2 = \frac{6.0\times4.6\times10^{-6}\,kg}{8.5}$$

$$m_2 = \frac{27.6\times10^{-6}\,kg}{8.5}$$

$$m_2 = 3,247\times10^{-6}\,kg$$

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3. Dik

$q_1 = 5\,C$

$q_2 = 10\,C$

$q_3 = 6\,C$

$r_1 = (-4, 0, 0)\,m$

$r_2 = (4, 8, 0)\,m$

$r_3 = (0, 5, 0)\,m$

$k = 9 \times 10^9\ N \cdot m^2/C^2$

a. $r_{21} = r_1 - r_2 = (-4-4, 0-0, 0-0)\,m$

$= (-8, 0, 0)\,m$

$r_{21} = \sqrt{(-8)^2 + 0^2 + 0^2} = 8\,m$

b. $F_{21} = k \dfrac{q_1 q_2}{r_{21}^2} \cdot \hat{r}_{21}$

$\hat{r}_{21} = \dfrac{r_{21}}{r_{21}} = \dfrac{(-8, 0, 0)}{8} = (-1, 0, 0) = -\hat{i}$

$r_{31} = r_1 - r_3 = (-4-0, 0-5, 0-0) = (-4, -5, 0)\,m$

$= \sqrt{(-4)^2 + (-5)^2 + 0^2} = \sqrt{16+25} = \sqrt{41}\,m$

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$$F_{31} = k \frac{q_1 q_3}{r_{31}^2} \cdot \hat{r}_{31}$$

$$F_{31} = k \frac{q_1 q_3}{r^3} \cdot r_{31}$$

$$F_{31} = (9 \times 10^9) \frac{(5)(6)}{(\sqrt{41})^3} \cdot (-4, -5, 0)$$

$$= (9 \times 10^9) \frac{30}{41\sqrt{41}} \cdot (-4, -5, 0)$$

$$= (9 \times 10^9) \frac{30}{41 \times 6.403} \cdot (-4, -5, 0)$$

$$= (9 \times 10^9) \frac{30}{262.523} \cdot (-4, -5, 0)$$

$$= (9 \times 10^9) \cdot 0.1142 \cdot (-4, -5, 0)$$

$$= 1.0278 \times 10^9 \cdot (-4, -5, 0) \text{ N}$$

$$F_{31} = (-4.1112 \times 10^9 \hat{i}) + (-5.1390 \times 10^9 \hat{j}) \text{ N}$$

$$F_{total} = F_{21} + F_{31}$$

$$= (-7.03175 \times 10^9 \hat{i}) + [(-4.1112 \times 10^9 \hat{i}) + (-5.1390 \times 10^9 \hat{j})]$$

$$F_{total} = [(-7.03125) + (-4.1112)] \times 10^9 \hat{i} + (-5.1390 \times 10^9 \hat{j})$$

$$= (-11.1425 \times 10^9 \hat{i}) + (-5.1390 \times 10^9 \hat{j}) \text{ N}$$

$$F_{total} = \sqrt{(F_{total,x})^2 + (F_{total,y})^2}$$
$$= 10^9 \sqrt{(-11.1425)^2 + (-5.1390)^2}$$
$$= 10^9 \sqrt{150.56}$$
$$= 12.27 \times 10^9 \text{ N}$$

4. Dik : q_1 (0,5,0) = 10 C
q_2 (5,5,0) = 5 C
q_3 (0,5,5) = −10 C

a. Gaya dari q_1 ke q_2

$r_{13} = 5$ m

$F_{13} = 9 \times 10^9 \dfrac{(10)(10)}{5^2} = 3.6 \times 10^{10}$ N

Tanda muatan berlawanan → tarik - menarik
arah dari q_3 ke q_1 (arah negatif sumbu z)

b. Gaya dari q_2 ke q_3

$r_{23} = \sqrt{(5-0)^2 + (5-5)^2 + (0-5)^2} = 7.07$ m

$F_{23} = 9 \times 10^9 \dfrac{(5)(10)}{7.07^2} = 9 \times 10^9 \times \dfrac{50}{50} = 9 \times 10^9$

muatan berbeda-beda → tarik - menarik
arah dari q_2 ke q_3 (arah diagonal ke kanan bawah)

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5 Diket : $q = 10\,C$ di $(0,0,0)$

$q_1 = 2\,C$ 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 $(2,1,2)$

Gaya total pada muatan $q = 10\,C$ yang berada di $(0,0,0)$ akibat keempat muatan

$$F = k\frac{q\,q_1}{r^2}\,(r_q - r_1$$

a) $q_1 = 2C$ di $(0,2,0)$ $r = 2,0\,m$

$$F_1 = 9\times10^9\,\frac{(10)(2)}{r^2}$$

$$= 9\times10^9\,\frac{(20)}{4} = 4,5\times10^{10}\,N$$

b) $q_2 = 4C$ di $(2,2,0)$ $r = \sqrt{8} = 2,8284\,m$

$F_2 = 4,50\times10^{6}\,N$

c) $q_3 = 5C$ di $(0,2,2)$ $r = \sqrt{8} = 2,8284\,m$

$F_3 = 5,6625\times10^{10}\,N$

d) $q_4 = -5C$ di $(2,2,2)$ $r = \sqrt{12} = 33,4641\,m$

$F_4 = 3,75\times10^{10}\,N$

Komponen $F_1 = 10, - 4,500000000\times10^{10},01\,N$

$F_{2x} = -3,1819005\times10^{10}\,N$

$F_{2y} = -3,1819805\times10^{10}\,N$

$F_{27} = 0$

$F_{3x} = 0$

$f_{3y} = -3,977475 \times 10^{10}$ N

$F_{3z} = -3,977475 \times 10^{10}$ N

$F_{4y} = 2,16506350 \times 10^{10}$ N

$F_{4y} = 2,16506350 \times 10^{10}$ N

$f_{47} = 2,16506350 \times 10^{10}$ N

$F_x = -1,01691700 \times 10^{10}$ N

$F_y = -9,4943925 \times 10^{10}$ N

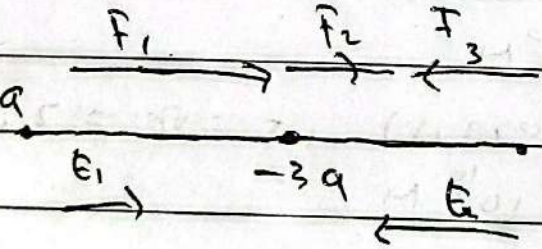
$F_z = -1,81241213 \times 10^{10}$ N

$F_{total} = (-1,01691700 \times 10^{10}\,\hat{i} - 9,4943925 \times 10^{10}\,\hat{j} - 1,81241213 \times 10^{10}\,\hat{k})$ N

$|F| = \sqrt{F_x^2 + F_y^2 + F_z^2} = 9,7197794 \times 10^{10}$ N

6.

a).



$F_{total} = -\frac{39}{4} k q \frac{2 \cdot 2}{r^2}$ (arah kekanan)

$F_{total} = -\frac{13}{4} k q \frac{q}{r^2}$ (arah - sumbu x)

$V = -\frac{3}{2} kq$

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b. $F_1 = k \frac{|-3q \times -q|}{r^2} = \frac{3kq^2}{r^2}$

$F_2 = k \frac{|-3q - 2q|}{r^2} = \frac{6kq^2}{r^2}$

$F_3 = k \frac{|-3q \times q|}{(2r)^2} = \frac{3kq^2}{4r^2}$

$F_{total} = F_1 + F_2 + F_3$

$= \frac{3kq^2}{r^2} + \frac{6kq^2}{r^2} + \frac{3kq^2}{4r^2}$

$= \frac{39kq^2}{4r^2}$ arah ke kanan

c. $E_1 = \frac{kq}{r^2}$

$E_2 = \frac{2kq}{r^2}$

$E_3 = \frac{kq}{(2r)^2} = \frac{kq}{4r^2}$

$E_{total} = E_1 + E_2 + E_3$

$= \frac{kq}{r^2} + \frac{2kq}{r^2} + \frac{kq}{4r^2}$

$= \frac{13kq}{4r^2}$ ke kiri

d. $E = \frac{13kq}{4r^2}$ arah kiri

$E = k \sum \frac{q_i}{r_i}$

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

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8.

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

1. $(r < R)$ $Q_{enc} > 0$

$E(r) \cdot 4\pi r^2 \cdot \frac{Q_{enc}}{\varepsilon_0} > 0 \rightarrow E(r) > 0$ $(r < R)$

(Tidak ada medan listrik)

2. $(r > R)$ $Q = 4\pi R^2 \sigma$

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

$= \frac{Q}{4\pi \varepsilon_0 r^2} = \frac{4\pi R^2 \sigma}{4\pi \varepsilon_0 r^2} = \frac{\sigma R^2}{\varepsilon_0 r^2}$

$(r > R)$

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

3. $r = R$

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

$E_{dalam} = 0$

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

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

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

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

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

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

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

b. $Q = \int_v \rho \, dv$

$dv = 4\pi r^2 dr$

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

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

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

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

$Q_r = 4\pi\varepsilon_0 kR^5$