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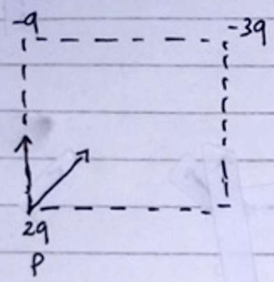
1. a.



b. -q Pada 2q

$$F_1 = k \cdot \frac{|q_1 \cdot q_P|}{r^2}$$

$$F_1 = k \frac{-q \cdot 2q}{(a\sqrt{2})^2}$$

$$F_1 = \frac{2kq^2}{2a^2}$$

$$F_1 = \frac{kq^2}{a^2}$$

-3q Pada 2q

$$F_2 = k \frac{|-3q \cdot 2q|}{(a\sqrt{2})^2}$$

$$= \frac{6kq^2}{2a^2}$$

$$= \frac{3kq^2}{a^2}$$

$$F_{1x} = \frac{-F_1}{\sqrt{2}} = \frac{-kq^2}{a^2\sqrt{2}} \qquad F_{1y} = \frac{F_1}{\sqrt{2}} = \frac{kq^2}{a^2\sqrt{2}}$$

$$F_{2x} = \frac{F_2}{\sqrt{2}} = \frac{3kq^2}{a^2\sqrt{2}} \qquad F_{2y} = \frac{F_2}{\sqrt{2}} = \frac{3kq^2}{a^2\sqrt{2}}$$

$$F_{1x} + F_{2x} = \left(\frac{-kq^2}{a^2\sqrt{2}} + \frac{3kq^2}{a^2\sqrt{2}}\right) = \frac{2kq^2}{a^2\sqrt{2}}$$

$$F_{1y} + F_{2y} = \left(\frac{kq^2}{a^2\sqrt{2}} + \frac{3kq^2}{a^2\sqrt{2}}\right) = \frac{4kq^2}{a^2\sqrt{2}}$$

Resultan gaya total

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

$$= \sqrt{\left(\frac{2kq^2}{a^2\sqrt{2}}\right)^2 + \left(\frac{4kq^2}{a^2\sqrt{2}}\right)^2}$$

$$= \frac{kq^2}{a^2\sqrt{2}} \cdot \sqrt{(2)^2 + (4)^2}$$

$$= \frac{kq^2}{a^2\sqrt{2}} \sqrt{4+16}$$

$$= \frac{kq^2}{a^2\sqrt{2}} \sqrt{20}$$

$$= \frac{kq^2\sqrt{20}}{a^2\sqrt{2}}$$

$$= \frac{kq^2\sqrt{20}}{a^2\sqrt{2}} = \frac{2kq^2 \cdot 2\sqrt{5}}{a^2\sqrt{2}}$$

$$= \frac{2kq^2\sqrt{10}}{a^2}$$

$\vec{F}$ ~~= q total diték P · E~~

$= 2q \cdot \cancel{\frac{kq^2\sqrt{10}}{a^2}}$

$=$

c. Jarak ke titik P : $a\sqrt{2}$

muatan $-3q$

$$E_2 = k \cdot \frac{3q}{(a\sqrt{2})^2} = \frac{3kq}{2a^2}$$

$$E_{2x} = \frac{E_2}{\sqrt{2}} = \frac{3kq}{2a^2\sqrt{2}}$$

$$E_{2y} = \frac{E_2}{\sqrt{2}} = \frac{3kq}{2a^2\sqrt{2}}$$

muatan $-q$

$$E_1 = k \frac{|q|}{(a\sqrt{2})^2} = \frac{kq}{2a^2}$$

$$E_{1x} = \frac{-E_1}{\sqrt{2}}$$

$$= -\frac{kq}{2a^2\sqrt{2}}$$

$$E_{1y} = \frac{E_1}{\sqrt{2}}$$

$$= \frac{kq}{2a^2\sqrt{2}}$$

$$E_x = E_{1x} + E_{2x}$$

$$= -\frac{kq}{2a^2\sqrt{2}} + \frac{3kq}{2a^2\sqrt{2}}$$

$$= \frac{2kq}{2a^2\sqrt{2}}$$

$$= \frac{kq}{a^2\sqrt{2}}$$

$$E_y = E_{1y} + E_{2y}$$

$$= \frac{4kq}{2a^2\sqrt{2}}$$

$$= \frac{2kq}{a^2\sqrt{2}}$$

Resultan medan listrik

$$E = \sqrt{E_x^2 + E_y^2}$$

$$= \sqrt{\left(\frac{kq}{a^2\sqrt{2}}\right)^2 + \left(\frac{2kq}{a^2\sqrt{2}}\right)^2}$$

$$= \frac{kq}{a^2\sqrt{2}} \cdot \sqrt{1^2 + 2^2}$$

$$= \frac{kq}{a^2\sqrt{2}} \cdot \sqrt{5}$$

$$= \frac{kq\sqrt{10}}{a^2}$$

d. $\vec{F} = q \cdot \vec{E}$

$$E_{total} = \frac{kq\sqrt{10}}{a^2}$$

$$\vec{F} = q_P \cdot E$$

$$= 2q \cdot \frac{kq\sqrt{10}}{a^2}$$

$$= \frac{2kq^2\sqrt{10}}{a^2}$$

e. $V = k \cdot \frac{q}{r}$

muatan $-q$

$$V_1 = k \cdot \frac{-q}{a\sqrt{2}}$$

$$= \frac{-kq}{a\sqrt{2}}$$

muatan $-3q$

$$V_2 = k \frac{-3q}{a\sqrt{2}}$$

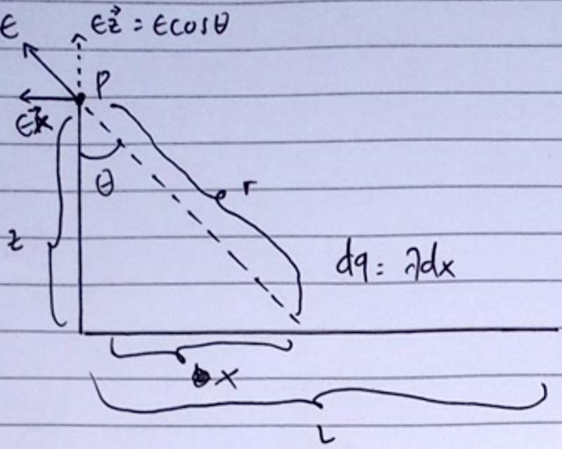
$$= -\frac{3kq}{a\sqrt{2}}$$

$$V_{tot} = V_1 + V_2$$

$$= \frac{-kq}{a\sqrt{2}} + \left(\frac{-3kq}{a\sqrt{2}}\right)$$

$$= -\frac{4kq}{a\sqrt{2}}$$

2. (a)



$$r = \sqrt{x^2+z^2}$$

$$dE = \frac{1}{4\pi\varepsilon_0} \cdot \frac{dq}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{\lambda dx}{\sqrt{x^2+z^2}}$$

$$dE_x = dE \cdot \frac{x}{\sqrt{x^2+z^2}}$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{\lambda x dx}{(\sqrt{x^2+z^2})^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \quad \frac{\lambda x dx}{(x^2+z^2)^{3/2}}$$

$$dE_z = dE \cdot \frac{z}{\sqrt{x^2+z^2}}$$

$$= \frac{1}{4\pi\varepsilon_0} \quad \frac{\lambda z dz}{(x^2+z^2)^{3/2}}$$

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

$$= \frac{\lambda}{4\pi\varepsilon_0} \left[-\frac{1}{\sqrt{x^2+z^2}} \right]_0^L$$

$$= \frac{\lambda}{4\pi\varepsilon_0} \left(\frac{1}{z} - \frac{1}{\sqrt{L^2+z^2}} \right)$$

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

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

$$E_z = \frac{\lambda}{4\pi\varepsilon_0} \cdot \frac{L}{z\sqrt{L^2+z^2}}$$

$$\vec{E_P} = E_x + E_z$$

$$= \frac{\lambda}{4\pi\varepsilon_0} \left[\left(\frac{1}{z} - \frac{1}{\sqrt{L^2+z^2}} \right) \hat{i} + \left(\frac{L}{z\sqrt{L^2+z^2}} \right) \hat{j} \right]$$

(b) $$dE_z = \frac{1}{4\pi\varepsilon_0} \cdot \frac{\lambda z dz}{(x^2+z^2)}$$

$$E_z = \frac{\lambda z}{4\pi\varepsilon_0} \int_{-L/2}^{L/2} \frac{dx}{(x^2+z^2)^{3/2}}$$

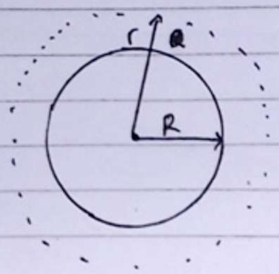
$$= \frac{\lambda z}{4\pi\varepsilon_0} \left[\frac{x}{z^2\sqrt{x^2+z^2}} \right]_{-L/2}^{L/2}$$

$$= \frac{\lambda z}{4\pi\varepsilon_0} \cdot \frac{L}{z^2\sqrt{(L/2)^2+z^2}}$$

$$= \frac{\lambda L}{4\pi\varepsilon_0 z\sqrt{(L/2)^2+z^2}}$$

$$\vec{E_P} = \frac{\lambda L}{4\pi\varepsilon_0 z\sqrt{(L/2)^2+z^2}} \hat{j}$$

(3)



$r < R$ (didalam bola)

$Q_{dalam} = 0$ (tidak ada muatan didalam radius $r < R$)

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{dalam}}{\varepsilon_0}$$

$$\oint \vec{E} \cdot d\vec{A} = \frac{0}{\varepsilon_0}$$

$$\oint \vec{E} \cdot d\vec{A} = 0$$

$r > R$ (diluar bola)

$Q_{dalam} = Q = \sigma \times$ luas permukaan bola

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

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\varepsilon_0}$$

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

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

$$E(r) \times r^2 = \frac{\sigma R^2}{\varepsilon_0}$$

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

$r = R$ (dipermukaan)

$$E = \frac{\sigma R^2}{\varepsilon_0 r^2}$$

$$E = \frac{\sigma \cdot r^2}{\varepsilon_0 r^2}$$

$$E = \frac{\sigma}{\varepsilon_0}$$

$$E(r) = \begin{cases} 0, & r < R \\ \frac{\sigma}{\varepsilon_0}, & r = R \\ \frac{\sigma R^2}{\varepsilon_0 r^2}, & r > R \end{cases}$$

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

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

$E_r = K r^3$

$r^2 E_r = r^2 \times K r^3$

$= K r^5$

$\frac{d}{dr} (K r^5) = 5 K r^4$

$\nabla \cdot E = \frac{1}{r^2} \cdot 5 K r^4$

$\nabla \cdot E = 5 K r^2$

$\frac{\rho}{\varepsilon_0} = 5 K r^2$

$\rho = 5 K \varepsilon_0 r^2$

$\rho = 5 K \varepsilon_0 r^2$

b. $Q = \int \rho \, dV$

$dV = r^2 \sin\theta \, dr \, d\theta \, d\phi$

$Q = \int_0^{2\pi}\int_0^{\pi}\int_0^{R} (5 K \varepsilon_0 r^2)(r^2 \sin\theta \, dr \, d\theta \, d\phi)$

$Q = 5 K \varepsilon_0 \int_0^{2\pi} d\phi \int_0^{\pi} \sin\theta \, d\theta \int_0^{R} r^4 \, dr$

$\int_0^{2\pi} d\phi = 2\pi$

$\int_0^{2\pi} \sin\theta \, d\theta = \left[-\cos\theta\right]_0^{\pi} = -\cos(\pi) + \cos(0) = 2$

$\int_0^{R} r^4 \, dr = \left[\frac{r^5}{5}\right]_0^{R} = \frac{R^5}{5}$

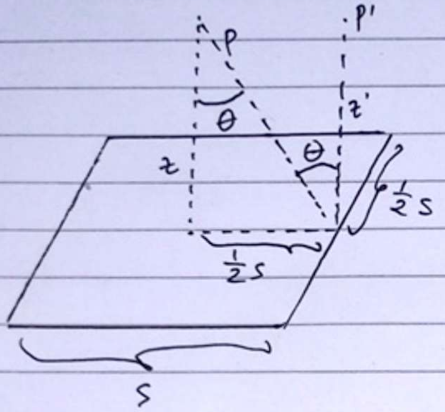
$Q = 5 K \varepsilon_0 \times 2\pi \times 2 \times \frac{R^5}{5}$

$Q = K \varepsilon_0 \times 2\pi \times 2 \times R^5$

$Q = K \varepsilon_0 \times 4\pi \times R^5$

$Q = 4\pi K \varepsilon_0 R^5$

(5).



$P = P'\cos\theta$. Karena ada 4 sisi, maka $P = 4P'\cos\theta$

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{2\lambda L}{z'^2} = 4 \cdot \frac{1}{4\pi\epsilon_0}\frac{2\lambda L}{z'^2}\cos\theta$$

Karena $L = \frac{1}{2}s$ dan $z' = r = \sqrt{z^2 + (\frac{1}{2}s)^2}$ dan $\cos\theta = \frac{z}{\sqrt{z^2+(\frac{1}{2}s)^2}}$, maka

$$\vec{E} = 4 \cdot \frac{1}{4\pi\epsilon_0} \cdot \frac{2\lambda(\frac{1}{2}s)}{\left(\sqrt{z^2+(\frac{1}{2}s)^2}\right)^2} \cdot \frac{z}{\sqrt{z^2+(\frac{1}{2}s)^2}}$$

$$\vec{E} = 4 \cdot \frac{1}{4\pi\epsilon_0} \cdot \frac{2\lambda\frac{1}{2}s \cdot z}{\left(z^2+(\frac{1}{2}s)^2\right)\sqrt{z^2+(\frac{1}{2}s)^2}}$$

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{4\lambda s z}{\left(z^2+\frac{s^2}{4}\right)\sqrt{z^2+\frac{s^2}{4}}}$$

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{4\lambda s z}{\left(z^2+\frac{s^2}{4}\right)\sqrt{z^2+\frac{s^2}{4}}}\,\hat{z}$$