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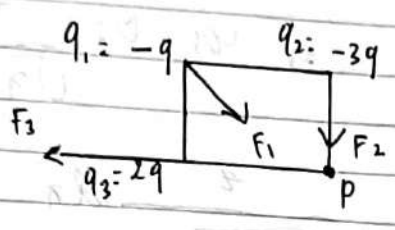
UTS Elektrodinamika

Jawaban UTS

1.

a.



(B) gaya dari muatan $-q$ (di titik A)

$r_{AP} = \sqrt{(L-0)^2 + (0-L)^2} = \sqrt{L^2+L^2} = L\sqrt{2}$

$F_{AP} = k\frac{-q \cdot Q}{r_{AP}^2} = k\frac{q \cdot Q}{(L\sqrt{2})^2} = k\frac{q \cdot Q}{2L^2}$

gaya dari $-q = F_{AP_x} = -k\frac{q \cdot Q}{2L^2}\cdot\frac{1}{\sqrt{2}}$ $F_{AP_y} = -\frac{kqQ}{2L^2}\cdot\frac{1}{\sqrt{2}}$

gaya dari $-3q = F_{BP_x} = \frac{k\,3q \cdot Q}{L^2}$ $F_{BP_y} = 0$

gaya dari $+2q = F_{CP_x} = k\frac{2qQ}{L^2}$ $F_{CP_y} = 0$.

(C.) Medan listrik

- E_A dari $-q \Rightarrow E_A = k\,q/r^2_{AP} = k\,q/(L\sqrt{2})^2 = k.\,q/2L^2$
- E_B dari $-3q \Rightarrow E_B = k\,3q/r^2_{BP} = k\,3q/L^2$
- E_C dari $+2q \Rightarrow E_C = k\,2q/r^2_{CP} = k\,2q/L^2$

komponen x

$E_{total} = \frac{1}{2}(k\,q/2L^2) + 0 + k\,2q/L^2 = k\left(q/2\sqrt{2L^2} + 2q/L^2\right)$.

komponen y

$E_t = -\frac{1}{\sqrt{2}}(k\,q/2L^2) - k\,3q/L^2 = -k\left(q/2\sqrt{2L^2} + 3q/L^2\right)$.

(D.) • Medan listrik $-q = E_A = k\,q/2L^2$ komponen $x = E = k\left(\frac{q}{2\sqrt{2L^2}} + \frac{2q}{L^2}\right)$

$-3q = k\,3q/L^2$

$+2q = k\,2q/L^2$ komponen $y = -k\left(\frac{q}{2\sqrt{2L^2}} + \frac{3q}{L^2}\right)$.

$$E_{total} = \sqrt{\left[k\left(\frac{q}{2\sqrt{2L^2}} + \frac{2q}{L^2}\right)\right]^2 + \left[-k\left(\frac{q}{2\sqrt{2L^2}} + \frac{3q}{L^2}\right)\right]^2}$$

KIKY

(E) $V_1 = k(-q)/r_1$

$V_2 = k(-3q)/r_2$

$V_3 = k(2q)/r_3$

$$V = k\left(\frac{-q}{r_1} + \frac{-3q}{r_2} + \frac{2q}{r_3}\right)$$

$$= kq\left[\frac{-1}{r_1} - \frac{3}{r_2} + \frac{2}{r_3}\right]$$

KIKY

2. (a) $E = \frac{1}{4\pi\varepsilon_0}\int \frac{\lambda\, dz}{(z^2+x^2)^{3/2}}$

$dE = \frac{1}{4\pi\varepsilon_0}\cdot\frac{\lambda\, dx}{(x^2+z^2)}\cdot\cos\theta \quad \Rightarrow \cos\theta = \frac{z}{\sqrt{x^2+z^2}}$

$E = \int dE = \int_0^L \frac{\lambda}{4\pi\varepsilon_0(x^2+z^2)}\cdot\frac{z}{\sqrt{x^2+z^2}}\, dx$

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

$\int \frac{dx}{(x^2+z^2)^{3/2}} = \left[\frac{x}{z^2\sqrt{x^2+z^2}}\right]_0^L = \frac{L}{z^2\sqrt{L^2+z^2}} - \frac{0}{z^2\sqrt{z^2}} = \frac{L}{z^2\sqrt{L^2+z^2}}$

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

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

(b) $E\int_{-L/2}^{L/2} dE_z = \int_{-L/2}^{L/2}\frac{1}{4\pi\varepsilon_0}\cdot\frac{\lambda z}{\left(\frac{L^2}{4}+z^2\right)^{3/2}}\, dx$

$E = \frac{\lambda z}{4\pi\varepsilon_0}\left(\frac{2L}{\left(\frac{L^2}{4}+z^2\right)^{3/2}}\right) = \frac{\lambda L}{2\pi\varepsilon_0\left(\frac{L^2}{4}+z^2\right)}$

$E = \frac{\lambda L}{2\pi\varepsilon_0\left(\frac{L_2}{4}+z^2\right)}$

KIKY

3. • Luar Bola konduktor $(r > R)$.

$Q = \rho \frac{3}{4} \pi R^3$

$\oint E \cdot dA = \frac{Q}{\epsilon_0}$

• Permukaan bola $4\pi r^2$

$E \cdot 4\pi r^2 = \frac{Q}{\epsilon_0}$

$E \cdot 4\pi r^2 = \frac{\rho \frac{3}{4} \pi R^3}{\epsilon_0}$

$E = \frac{\rho R^3}{3\epsilon_0 r^2}$

$E_{luar} = \frac{\rho R^3}{3\epsilon_0 r^2} \quad (r > R)$

• Dalam Bola konduktor $(r \leq R)$

$E_{dalam} = 0 \quad (r \leq R)$

* di luar bola $(r > R)$: $E = \frac{\rho R^3}{3\epsilon_0 r^2}$

• di dalam bola $(r \leq R) : E = 0$.

4. (a.) $\oint \vec{E} \cdot d\vec{A} = \frac{Q_{total}}{\epsilon_0}$

$E = kr^n$

$\Phi E = E \cdot A$

$= (kr^n)(4\pi r^2)$

$= 4\pi k r^{n+2}$

$Q_{total} = \rho \cdot V \quad = 0 \quad V = \frac{4}{3}\pi r^3$

$Q_{total} = \rho \, 4/3 \, \pi r^3$, maka

$4\pi k r^{n+2} = \frac{\rho \, 4/3 \, \pi r^3}{\epsilon_0}$

$kr^{n+2} = \frac{\rho r^3}{3\epsilon_0}$

$\boxed{\rho = 3\epsilon_0 k r^{n-1}}$

(b.) $\Phi E = E \cdot A = (kR^n)(4\pi R^2) = 4\pi k R^{n+2}$

$4\pi k R^{n+2} = \frac{Q_{tot}}{\epsilon_0}$

$Q_t = 4\pi \epsilon_0 k R^{n+2}$

$Q_t = 4\pi \epsilon_0 k R^{n+2}$

KIKY

(5.) Kawat lurus panjang $E = \frac{\lambda}{2\pi\varepsilon_0 r}$
Jarak dari P ke kawat $r = \sqrt{\left(\frac{s}{2}\right)^2 + z^2}$

$$dE = \frac{\lambda}{2\pi\varepsilon_0}\frac{dx}{r^2}$$

$$dE_z = dE \cdot \cos(\theta) = dE \cdot \frac{z}{\sqrt{r^2+z^2}}$$

$$E_z = 2\int dE_z$$

$$E_z = 2\frac{\lambda}{2\pi\varepsilon_0}\int_{-s/2}^{s/2} \frac{z}{\left(\frac{s}{2}\right)^2 + z^2}\, dx$$

$$E_{total} = \frac{\lambda z}{\pi\varepsilon_0\left(\frac{s^2}{2} + z^2\right)}\int$$

$$E_{total} = \frac{\lambda s z}{\pi\varepsilon_0\left(\left(\frac{s}{2}\right)^2 + z^2\right)^{3/2}}$$

KIKY