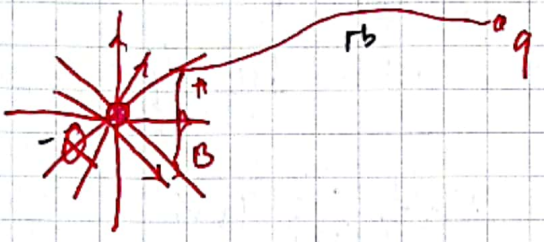
USAHA DAN ENERGI

Karena melawan medan yang melewati (-)



$$W = \int -\vec{F}\, dl$$

$$= -q \int \vec{E}\, dl \quad (dl \rightarrow dr)$$

$$= -q \int \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}\, dr$$

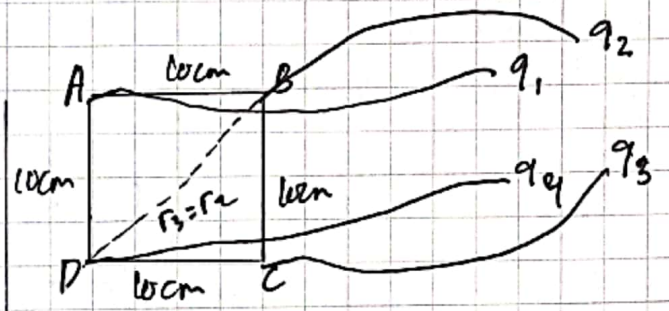
$$= -q \left[\frac{q}{4\pi\varepsilon_0 r} \right]$$

$$= Q\,[V]$$

$$= QV$$

Diketahui

q_1 Pindah ke A
q_2 Pindah ke B
q_3 Pindah ke C
q_4 Pindah ke D
Muatan = 2 μC
Panjang: 10 cm
$r_3 = r_2$



$W_1 = q_1 V_1 = 0$ (karena belum ada muatan)

$$W_2 = q_2 V_2 = q_2 \left[k \frac{q_1}{r_1} \right]$$

$$W_2 = q_2 V_2$$

$$W_3 = q_3 V_3$$

$$= q_3 \left[k \frac{q_1}{r_1} + k \frac{q_2}{r_2} \right]$$

$$= q$$

$$W_4 = q_4 V_4 = q_4 \left[k \frac{q_1}{r} + k \frac{q_2}{\sqrt{2} r} + k \frac{q_3}{r} \right]$$

$$W_t = W_1 + W_2 + W_3 + W_4$$

$$= k \frac{q_1 q_2}{r} + k \frac{q_1 q_3}{r} + k \frac{q_2 q_3}{r} + \dots$$

Persamaan ini menjadi

$$W = \frac{1}{2} \sum_{i=1}^{n} q_i V_i$$

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$$= \frac{1}{2}\int \rho V \, dv$$

$$= \frac{1}{2}\int \sigma V \, ds$$

$$= \frac{1}{2}\int \rho V \, d\tau$$

~~$\rho = \varepsilon_0 (\nabla \cdot \vec{E})$~~

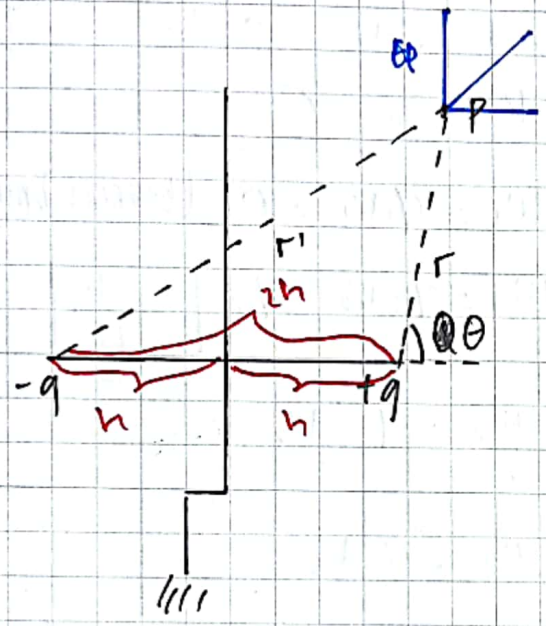
$\rho = \varepsilon_0 |\nabla \vec{E}|$

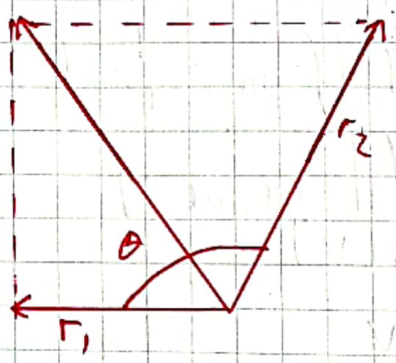
$$\nabla \vec{E} = \frac{\rho}{\varepsilon_0}$$

$$W = \frac{\varepsilon_0}{2}\int \vec{E}^2 \, d\tau$$

$$W = \frac{1}{2}\sum_{i=1}^{n} q_i V_i$$

$$W = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{1}{r_{2i}}\sum_{j\neq i}^{m}\frac{q_i q_j}{r_{ij}}$$





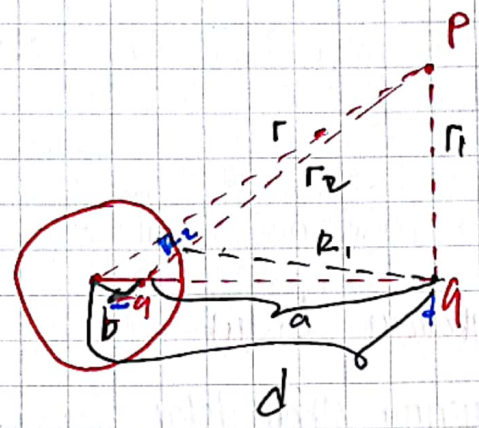
$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} + \frac{-q}{4\pi\varepsilon_0 r'}$$

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r} - \frac{1}{r'}\right]$$

$r' = (r^2 + 4h^2 + 4hr\cos\theta)^{\frac{1}{2}}$

$$E_p = \frac{dV}{dr} = k\left[\frac{1}{r} - \frac{\frac{1}{2}}{(r^2+4h^2+4hr\cos\theta)^{\frac{1}{2}}}\right]$$

$$= k\left[\frac{1}{r^2} - \frac{\frac{1}{2}(r^2+4h^2+4hr\cos\theta)^{-\frac{1}{2}}\,(2r+4h\cos\theta)}{(r^2+4h+4hr\cos\theta)}\right]$$



$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{R_1} - \frac{q_2}{R_2}\right) = 0$$

$$R_1^2 = a^2 + d^2 - 2ad\cos\theta$$

$$R_2^2 = a^2 + b^2 - 2ba\cos\theta$$

Untuk $V = 0$, maka:

$$\frac{q_1}{R_1} = \frac{q_2}{R_2} \Rightarrow \frac{q_1^2}{q_2^2} = \frac{R_1^2}{R_2^2} = \frac{a^2 + d^2 - 2ad\cos\theta}{a^2 + b^2 - 2ab\cos\theta}$$

$$\left(\frac{q_1}{q_2}\right)^2 = \left(\frac{R_1}{R_2}\right)^2 = \frac{d}{b}\left(\frac{a^2/d + a - 2a\cos\theta}{a^2/b + b - 2a\cos\theta}\right)$$