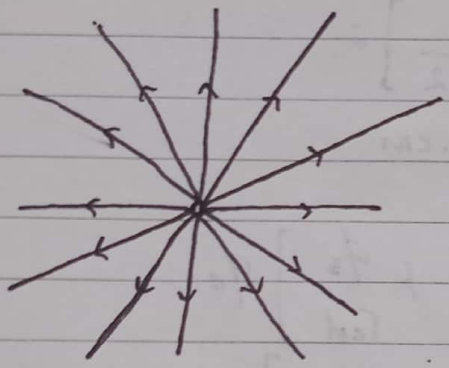
Pertemuan 9.

Usaha & Energi, ① usaha oleh muatan titik q



$$W = \int_A^B \vec{F} \cdot d\vec{l}$$

$$= -q \int \vec{E}\, dl$$

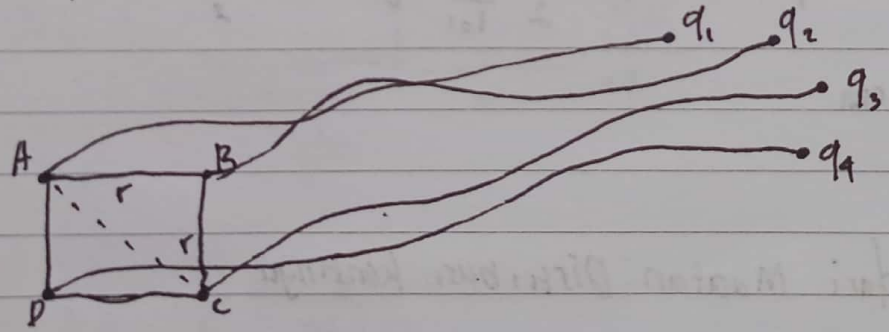
$$= -q \left[\int \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} dl \right]$$

$$= -q \left[-\frac{q}{4\pi\epsilon_0} r \right]$$

$$= Q[V]$$

$$\boxed{W = QV}$$

Example hlm 73.



Solusi

$$W_1 = q_1 V_1 = 0$$

$$W_2 = V_2 q_2 = \left[k \frac{q_1}{r_{ab}} q_2 \right] = 1 \cdot \frac{2}{10} 2 = 0{,}4 \text{ dyne.cm}$$

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$$W_3 = V_3 \cdot q_3 = \left[k\frac{q_1}{r_{ac}} + k\frac{q_2}{r_{bc}} \right] \cdot q_3$$

$$= \left[1\frac{2}{10} + 1\frac{2}{10\sqrt{2}} \right] 2$$

$$= 0,683 \text{ dyne.cm}$$

$$W_{34} = V_4 \cdot q_4 = \left[k\frac{q_1}{r_{ad}} + k\frac{q_2}{r_{bd}} \; k\frac{q_3}{r_{cd}} \right] q_4$$

$$= \left[1\frac{2}{10\sqrt{2}} + 1\frac{2}{10} + \frac{2}{10} \right] \cdot 2$$

$$= 1.08 \text{ dyne.cm}$$

Pers. 2.30

$$W = W_1 + W_2 + W_3 + W_{41}$$

$$= 0 + 0,4 + 0,683 + 1.08$$

$$= 2,165 \text{ dyne.cm}$$

Maka akan diperoleh $W = \frac{1}{2}\sum_{i=1}^{n} q_i V_i = \frac{1}{2}\,2.165$ (Pers 2.33)

$= 1.08$ dyne.cm

② Energi dari Muatan Distribusi kontinyu

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

$$W = \frac{1}{2}\int x V d\ell \quad \text{(garis)}$$

$$W = \frac{1}{2}\int \sigma V ds \quad \text{(luas)}$$

$$W = \frac{1}{2}\int \rho V d\tau \quad \text{(volume)}$$

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

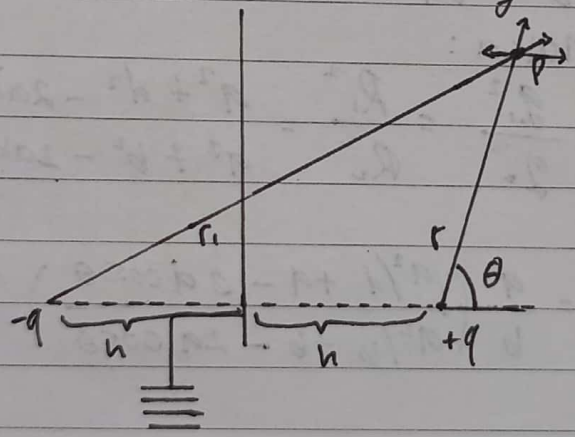
$$\nabla \vec{E} = \frac{\rho}{\varepsilon_0}$$

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

Bab 3 Metode Penentuan Potensial

3.5. Metode Bayangan (hlm 86)

① Muatan titik dan batang konduktor



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

$$V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r} - \frac{1}{r'}\right] \rightarrow r' = (r^2 + 4h^2 + 4hr\cos\theta)^{1/2}$$

$$V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r} - \frac{1}{(r^2 + 4h^2 + 4hr\cos\theta)^{1/2}}\right]$$

$$\frac{dv}{dr} = \left[\frac{1}{r^2} - \frac{\frac{1}{2}(\;)^{-\frac{1}{2}}(2r + 4h\cos\theta)}{(r^2 + 4hr\cos\theta)}\right.$$

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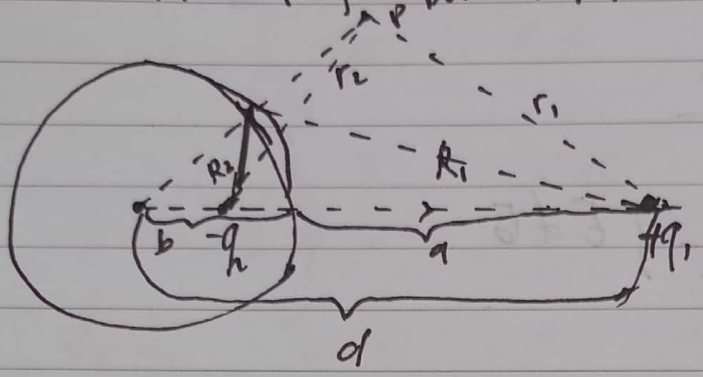
② Muatan titik dengan bola konduktor



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

$$R_1^2 = a^2 + d^2 - 2ad\cos\theta$$
$$R_2^2 = a^2 + b^2 - 2ba\cos\theta$$

Untuk $V = 0$, maka:

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

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