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Potensial listrik

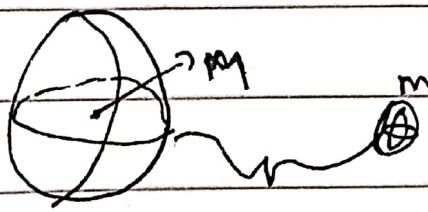
1. Pengenalan potensial melalui analogi

Potensial listrik analogikan sebagai potensial gravitasi yang didefinisikan sebagai perubahan energi potensial persatuan massa.

$$V = \frac{W}{m} = G\frac{M.m}{r} = G\frac{m}{r}$$

Potensial gravitasi merupakan besaran skalar, yaitu suatu besaran yang hanya memiliki nilai saja tanpa arah, jika ada lebih dari satu massa benda sumber, maka potensial gravitasinya adalah:

$$V = G\frac{m_1}{r_1} + G\frac{m_2}{r_2} + \dots G\frac{m_n}{r_n} = \sum_{i=1}^{n} G\frac{m_i}{r_i}$$



$$V = G\frac{M_m}{r}$$

$$v = G\frac{m}{r}$$

$$v = \frac{W}{m}$$

$$v = \frac{W}{M}$$

$$G = \frac{m}{r} \rightarrow \text{dibuang.}$$

$$\frac{V = W}{q} = \frac{F.r}{q}$$

$$= \frac{kq.q_2}{r^2}\,r \Big/ q$$

$$V = k\frac{q}{r}$$

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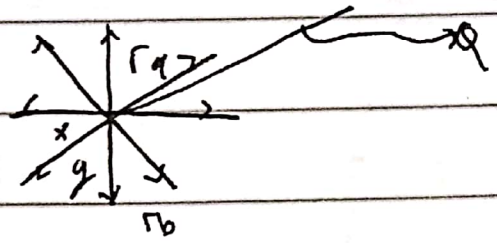


$$\int_q dV = -\int \bar{E} \cdot dr.$$

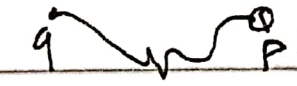
$$V\Big|_a^b = -\int \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} dr$$

$$= \frac{q}{4\pi\epsilon_0} \int_a^b \frac{1}{r^2} dr.$$

$$= \frac{-q}{4\pi\epsilon_0} \left(-\frac{1}{r} \Big|_a^b \right)$$

$$= \boxed{V_b - V_a = \frac{q}{4\pi\epsilon_0} \left(\frac{1}{r_b} - \frac{1}{r_a} \right)}$$

$$\boxed{V = k\frac{q}{r}}$$



$$V = \frac{W}{q}$$

$$p = k\frac{q}{r}$$

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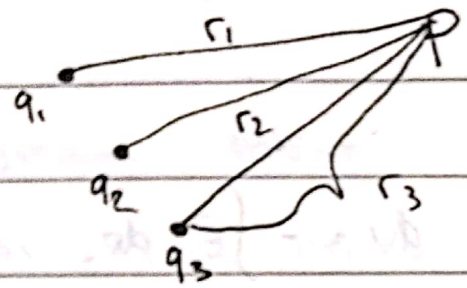
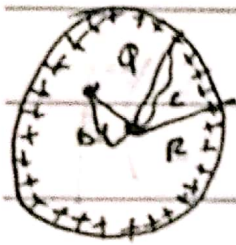


$$V = \frac{W}{q} = \frac{\vec{F} \cdot \vec{S}}{q} = k \frac{q}{r}$$

$$V_p = k \left[\frac{q_1}{r_1} + \frac{q_2}{r^2} + \frac{q_3}{r_2} \right]_n$$

$$= k \sum_{i=1} \frac{q_i}{r_i}$$



$$V_b - V_a = \frac{q}{q \text{ atau } 0} = 0 \left(\frac{1}{r_b} - \frac{1}{r_a} \right.$$

$$V_b = k \frac{Q}{R}$$

$$V = k \frac{Q}{r}, \quad r > R$$

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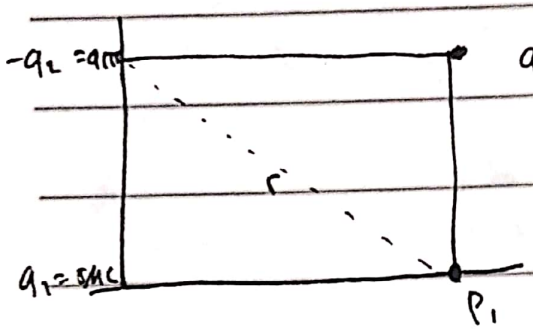
Contoh Soal 1 :

Gambarkan Step up Model pada kasusnya.



$$V = \frac{kq_1}{r_1} + \frac{kq_2}{r_2} + \frac{k(-q_3)}{r_3}$$

$$= k\left(\frac{5}{8} + \frac{5}{8} + \frac{(-q)}{\sqrt{8^2+8^2}}\right)$$

$$= k\left(\frac{5}{8} + \frac{5}{8} + \frac{(-q)}{128}\right)$$

$E = -\nabla V$

$\nabla . E = -\nabla^2 V$

$\nabla . \vec{E} = \frac{\rho}{\varepsilon_0}$ ⟶ Hukum Gauss

$\nabla^2 V = -\frac{\rho}{\varepsilon_0}$ Persen

$\oint_S \vec{E} . d\vec{q} = \int_0 (\nabla . \vec{E})\, dB$

$\nabla^2 V = 0$ Laplace.

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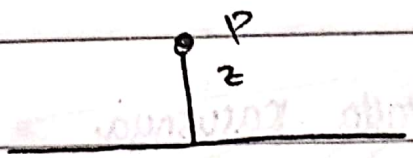

$$\vec{E} = \frac{\lambda}{2\pi \varepsilon_0 r}$$

$$\oint E \cdot dq = \frac{\lambda \cdot l}{\varepsilon_0}$$

$$\vec{E}\,(2\pi r l) = \frac{\lambda \cdot l}{\varepsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi \varepsilon_0 r}$$

$$V = -\int \vec{E}\, dr$$

$$V = -\int \frac{\lambda}{2\pi \varepsilon_0} \frac{1}{r}\, dr$$

$$= -\frac{\lambda}{2\pi \varepsilon_0} \int \frac{1}{r}\, dr .$$

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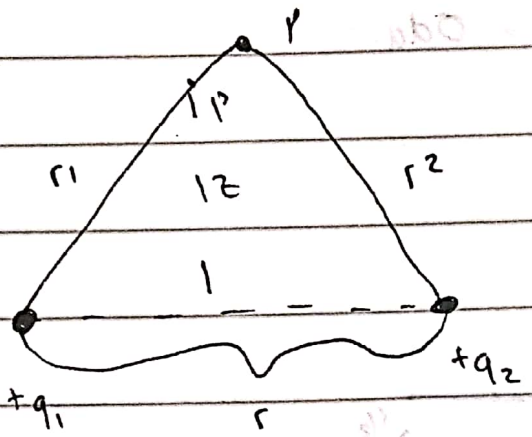
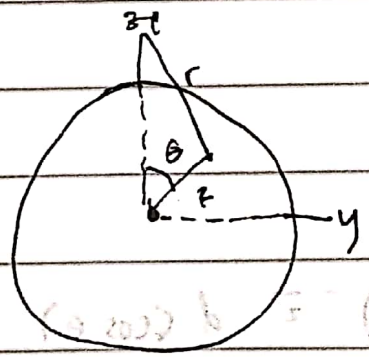
Contoh Soal:



$V_P = ?$ $\quad k\left[\frac{q_1}{\sqrt{(+r)^2+z^2}} \quad \frac{+q^2}{\sqrt{(+r)^2+z^2}}\right]$

Contoh Soal:



$$V_{(P)} = \frac{1}{q_1 \pi \varepsilon_0} \int \frac{\sigma}{r} \, dq$$

$$r^2 = R^2 + Z^2 - 2RZ \cos\theta$$

$$r = \sqrt{R \sin\theta)^2 + (z - R\cos\theta)^2}$$

$$= \sqrt{R^2(\sin^2\theta + z^2 + R^2 \cos\theta^2 - 2zR\cos\theta}$$

$$= \sqrt{R^2(\sin^2\theta + \cos\theta^2) + z^2 - 2z R \cos\theta}$$

$$= \sqrt{R^2 + z^2 - 2 z R \cos\theta}$$

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$R^2 \sin\theta \, d\theta \, d\phi$

$$V = \frac{1}{4\pi\varepsilon_0} \int \frac{\sigma da}{r} \qquad dq = \sigma da.$$

$$= \frac{1}{4\pi\varepsilon_0} \iint \frac{\sigma da}{r}$$

$$= \frac{1}{4\pi\varepsilon_0} \iint \frac{\sigma da}{(R^2 + z^2 - 2Rz\cos\theta)^{1/2}}$$

$$= \frac{\sigma}{4\pi\varepsilon_0} \int_0^a \int_0^{2\pi} \frac{r^2 \sin\theta \, d\theta \, d\phi}{(R^2 + z^2 - 2Rz\cos\theta)^{1/2}}$$

$$= \frac{\sigma R 2\pi}{4\pi\varepsilon_0} \int_0^{\pi} \frac{\sin\theta \, d\theta}{(R^2 + z^2 + 2Rz\cos -\theta)^{\frac{1}{2}}}$$

$$V_1 = \square \int_0^{\pi} \frac{d(\cos\theta)}{(R^2 + z^2 - 2Rz\cos\theta)^{\frac{1}{2}}}$$

$$= \square \int_0^{\pi} (R^2 + z^2 - 2Rz\cos\theta)^{-\frac{1}{2}} \, d(\cos\theta)$$

$$= \square \frac{1}{2} (R^2 + z^2 - 2Rz\cos\theta)^{\frac{1}{2}} \Big|_0^{\pi}$$