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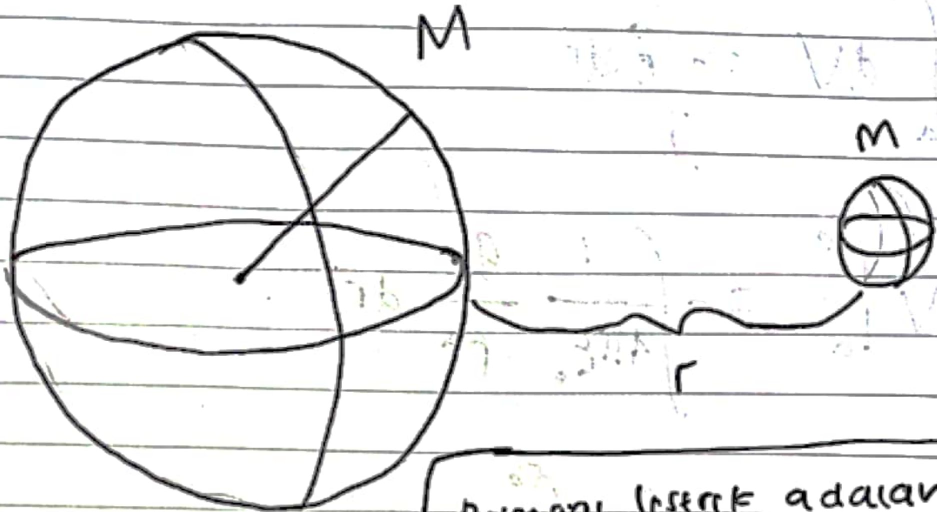
Potensial Listrik (Elektrik Potensial)



Potensial listrik adalah usaha untuk memindahkan satu satuan muatan listrik positif partikel tersebut.

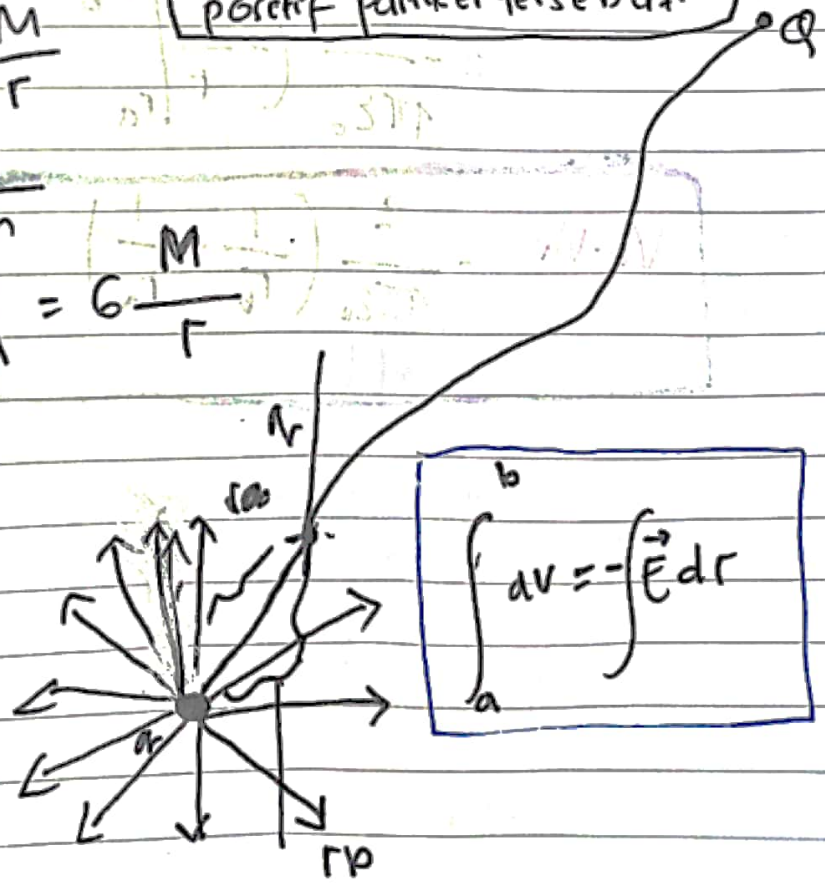
$$W = G\frac{Mm}{r}$$

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

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

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

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



$$\int_a^b dV = -\int \vec{E}\, dr$$

No.

Date

$$\int_a^b dV = -\int \vec{E} \cdot dr$$

$$V \Big|_a^b = -\int \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}\, dr$$

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

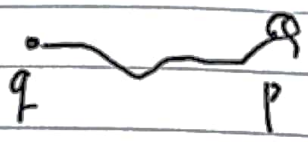
$$= -\frac{q}{4\pi\varepsilon_0} \left(-\frac{1}{r} \Big|_{r_a}^{r_b} \right)$$

$$\boxed{V_b - V_a = \frac{q}{4\pi\varepsilon_0} \left(\frac{1}{r_b} - \frac{1}{r_a} \right)}$$

No.

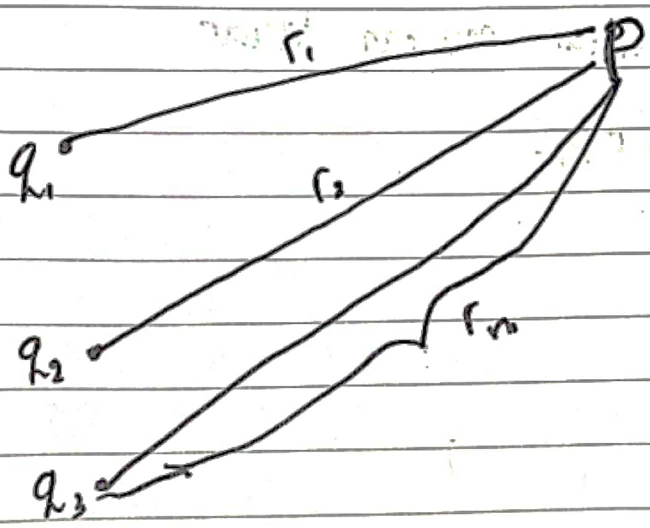
Date

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



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

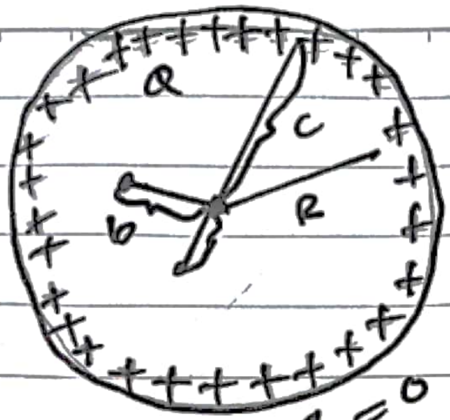
$$V_P = k\frac{q}{r}$$



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

$$V_p = k\left[\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3}\right]$$

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



$$V_b - V_a = \frac{\overset{=0}{q}}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right)$$

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

persamaan untuk muatan diluar

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

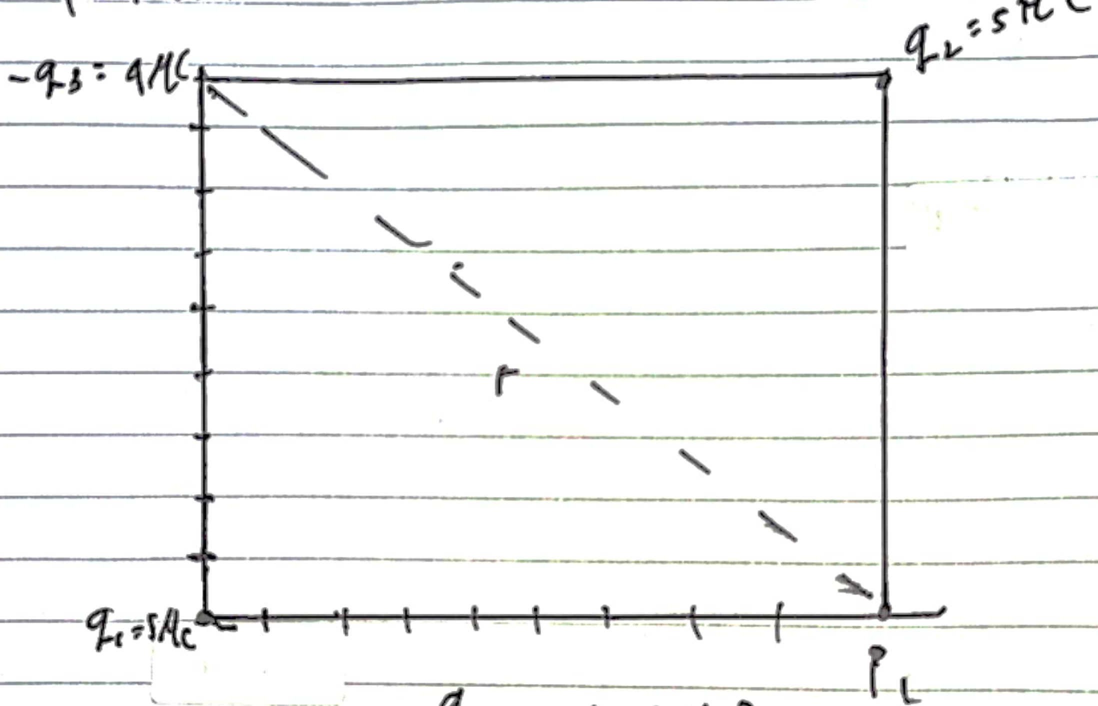
No

Date

Example:

1. Gambarkan kasusnya!
Ada dua buah muatan positif besarnya $5\mu C$ terletak pada sudut berlawanan yang panjang sisinya 8 cm. 1 muatan negatif diletakkan pada sudut yang kosong. Berapa potensial muatan pada sudut yang kosong!

Penyelesaian:



$$V = \frac{k q_1}{r_1} + k\frac{q_2}{r_2} + \frac{k(-q_3)}{r_3}$$

$$= k\left(\frac{5}{8} + \frac{5}{8} + \frac{(-4)}{\sqrt{8^2+8^2}}\right)$$

$$= k\left(\frac{5}{8} + \frac{5}{8} + \frac{(-4)}{\sqrt{128}}\right)$$

Persamamaan posission dan persamaan lapalace

→ Persamaan posisson

$E = -\nabla V$

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

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

persamaan gauss

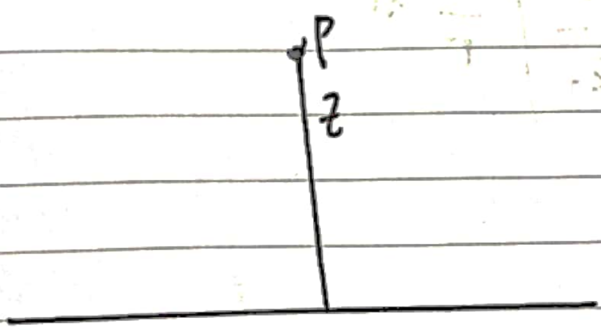
$\nabla^2 V = \frac{\rho}{\varepsilon_0}$ → posisson

$\nabla V^2 = 0$ Lapalace

→ Kajian persamaan gauss

$$\oint_s \vec{E}\, d\vec{a} = \int_v (\nabla \cdot \vec{E})\, dq$$

↳ Pada kawat lurus panjang



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

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

No.

Date

$$\oint \vec{E}\, da = \frac{\lambda \cdot l}{\varepsilon_0}$$

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

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

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

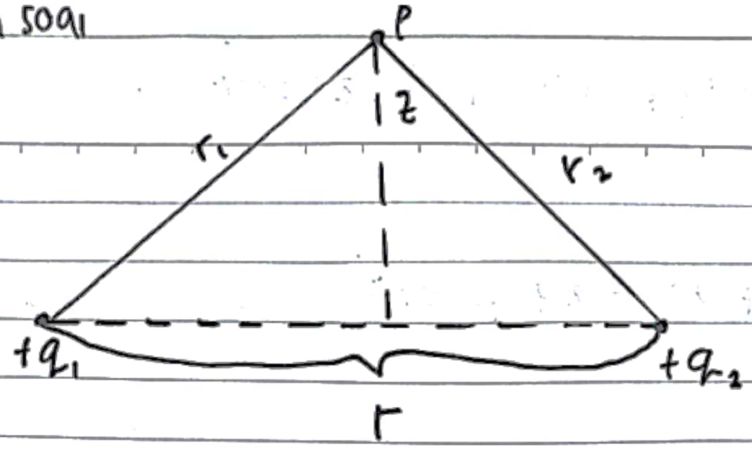
$$= -\int \frac{\lambda}{2\pi \varepsilon_0} \frac{1}{r}\, dr$$

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

No.
Date

Contoh soal

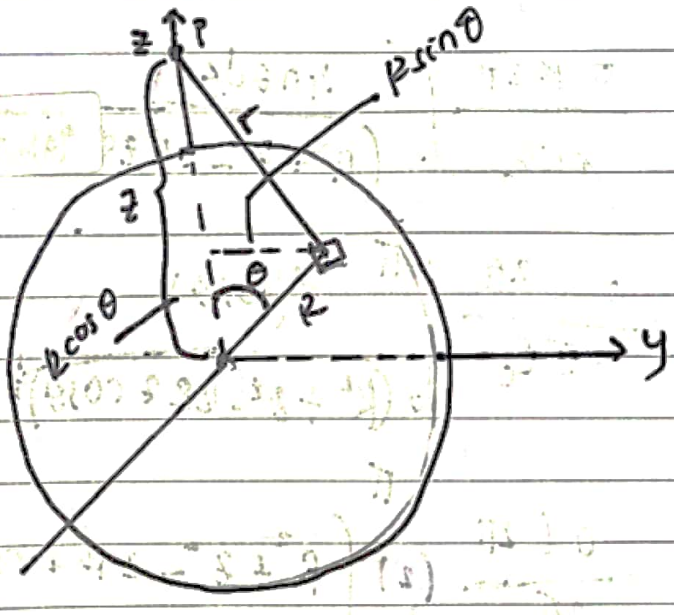
1.



V_P : ?

$$V_P = K\left[\frac{q_1}{\sqrt{(\frac{1}{2}R)^2 + z^2}} + \frac{q_2}{\sqrt{(\frac{1}{2}R)^2 + z}}\right]$$

2.



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

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

No.

Date

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

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

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

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

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

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

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

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

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

No.

Date

$$= \frac{\sigma R 2\pi}{2\pi} (2) \left[(R^2 + z^2 - 2Rz\cos\pi)^{\frac{1}{2}} - R^2 + z^2 - 2Rz \cos 0)^{\frac{1}{2}} \right]$$