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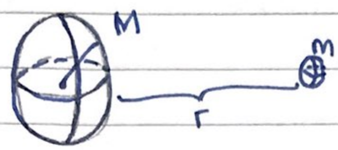
Kelas : 22 A

No. 1 April 2024
Date

Potensial elektric / Potensial listrik → usaha transatuan muatan (memindahkan muatan dari jauh ke titik tertentu) → Perubahan energi

a. Muatan Diskrit



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

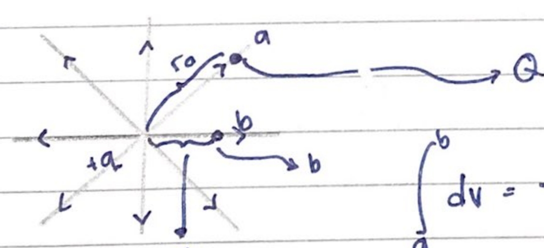
$$V = G \frac{M}{r}$$ (untuk orang berada dimars)

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

$$V = \frac{W}{M} = G \frac{m}{r}$$ (untuk orang berada di bumi)

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

$$= K . \frac{q . q}{r^2} . r \rightarrow V = K \frac{q}{r}$$



Karena melawan medan

$$\int_a^b dv = - \int \vec{E} . dr$$

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

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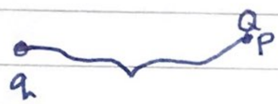
$$= -\frac{q}{4\pi\varepsilon_0}\int_{r_a}^{r_b}\frac{1}{r^2}\,dr$$

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

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

Untuk kasus



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Rumus yang digunakan

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

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

$$= K\frac{q}{r}$$

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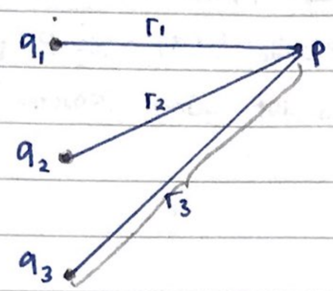

$$V = \frac{W}{q_n} = \frac{\vec{F}.\vec{s}}{q_n} = K\frac{q_n}{r}$$

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

$$= K\sum_{i=1}^{n}\frac{q_1}{r_1}$$

muatan diluar $\longrightarrow V = K\frac{Q}{r}$ dimana $r > R$

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

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

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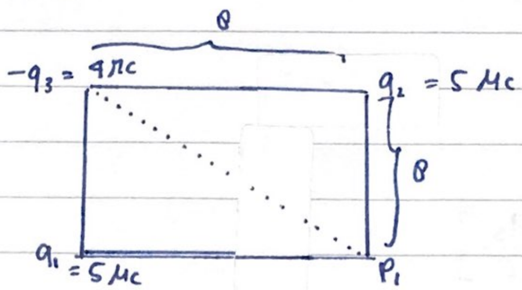
Gambarkan Karunya!

1. Dua muatan titik positif sama besarnya $+5\ \mu C$ pada sudut berlawanan. Yang panjang sisinya 8 cm, 1 Muatan negatif diletakkan pada sudut yang Kosong. Berapa potensial muatan pada sudut yang Kosong!

Penyelesaian!



Note! $\sqrt{8^2+8^2} = \sqrt{128}$

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

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

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

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→ Persamaan Poisson dan Persamaan Lapalace

1). Persamaan Poisson

$E = -\nabla . V$

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

Persamaan Gauss $\nabla . \vec{E} = \dfrac{\rho}{\varepsilon_0}$

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

→ Kajian persamaan Gauss

$\oint_s \vec{E} . d\bar{a} = \int_v (\nabla . E)\, d\bar{\tau}$

Integral lipat 2

Integral lipat 3

2). Persamaan Lapalace

$\nabla^2 V = 0$

→ Medan = Gradien dari sudut P

P = Potensial

Gradien artinya perubahan

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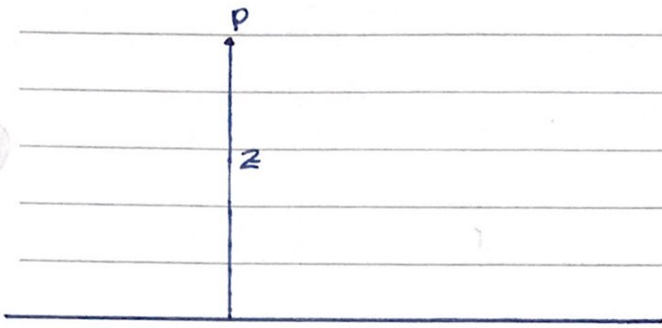
→ Perubahan

Pada Kawat lurus panjang



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

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

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

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

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

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

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

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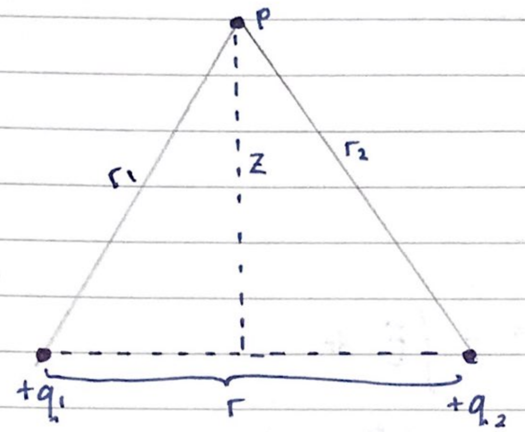
Soal !

Menghitung potensial di P

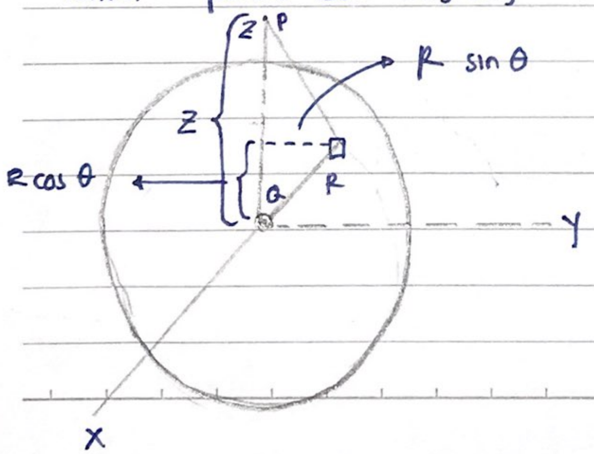


$V_P = ?$

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

Soal !

Tentukan potensi dari cangkang bola seragam bermuatan R jari jari ?



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

$$= \sqrt{R^2\sin^2\theta + Z^2 + R^2\cos\theta^2 - 2ZR\cos\theta}$$

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

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

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

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

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

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

$$V_p = \square\int_0^{\pi}\frac{d(\cos\theta)}{(R^2+Z^2-2RZ\cos\theta)^{1/2}}$$

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

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

$$V_p = \frac{\sigma R 2\pi}{4\pi \varepsilon_0} \cdot 2 \left(R^2+z^2-2Rz\cos\theta\right)^{1/2} \Big|_0^{\pi}$$

$$V_p = \frac{2\sigma R 2\pi}{4\pi \varepsilon_0} \left[(R^2+z^2-2Rz\cos\pi)^{1/2} - (R^2+z^2-2Rz\cos 0)^{1/2} \right]$$