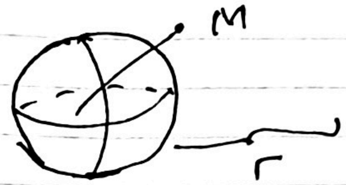
1/4 202

Senin

→ Tanggal 15 UTS KALISMA I → online
L. Soal 2. diskrit 1 kontinue 1

Potensial listrik (elektric potensial)
→ Muatan diskrit

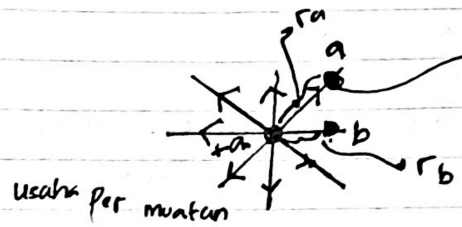


$$W = G\frac{M.m}{r}$$

$$V = G\frac{M}{r}$$ (untuk benda di mars)

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

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



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

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

$$= k\frac{q_1.Q}{r^2}.r / Q$$

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

→ Contoh kasus

q —— Q

$$V = \frac{W}{Q} \rightarrow W = k\frac{q.Q}{r}$$

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

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

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

$$= -\frac{q}{4\pi\varepsilon_0}\int_{ra}^{rb} r^{-2}\,dr$$

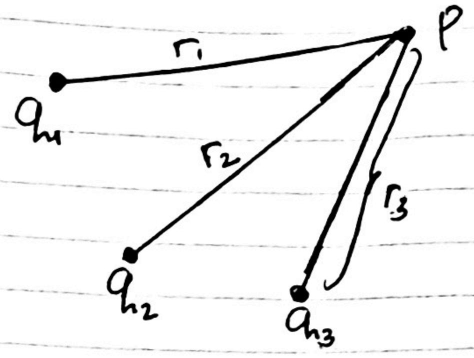
$$= -\frac{q}{4\pi\varepsilon_0}\frac{1}{-2+1}r^{-2+1}\Big|_{ra}^{rb}$$

$$= -\frac{q}{4\pi\varepsilon_0}\frac{1}{-1}r^{-1}\Big|_{ra}^{rb}$$

$$= -\frac{q}{4\pi\varepsilon_0} - r^{-1}\Big|_{ra}^{rb}$$

$$= -\frac{q}{4\pi\varepsilon_0}\cdot -\frac{1}{r}\Big|_{ra}^{rb}$$

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



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

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

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

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

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

→ Muatan yang diluar ⟹ $V = k\frac{Q}{r}$, $r > R$

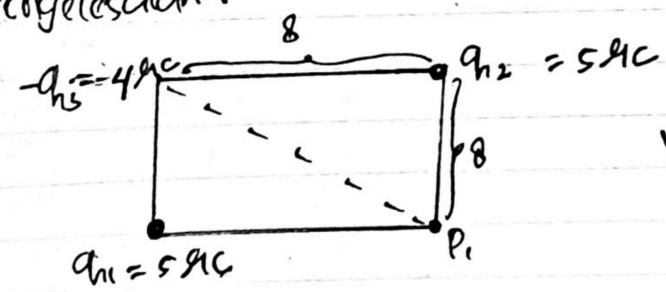
→ Potensial listrik = usaha per satuan muatan. usaha itu kerja untuk memindahkan muatan ke titik tertentu.

Soal !

1) Gambarkan kasusnya !
Ada 2 buah muatan positif besarnya 5 μC 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:

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



$$V = \frac{kq_1}{r_1} + \frac{kq_2}{r_2} + \frac{kq_3}{r_3}$$

$$= \frac{k5}{8} + k\frac{5}{8} + \frac{k(-4)}{\sqrt{128}}$$

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

⇒ Persamaan Poisson dan Persamaan Lapalace

1) Persamaan Poisson

$$\vec{E} = -\nabla V$$

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

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

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

→ Kajian Persamaan Gauss :

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

integral lipat 2 — integral lipat 3

2) Persamaan Lapalace

$$\nabla^2 V = 0$$

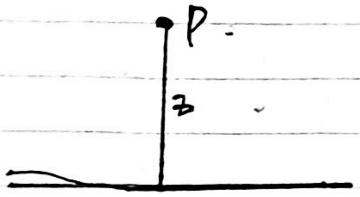
→ Medan = Gradien dari suatu P

P = Potensial

Gradien artinya perubahan

→ Muatan non. diskrit

⇒ Pada kawat lurus panjang



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

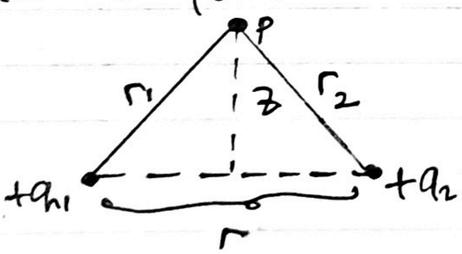
$$= -\int \frac{\lambda}{2\pi\varepsilon_0} \frac{1}{r}\, dr$$

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

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

Soal !

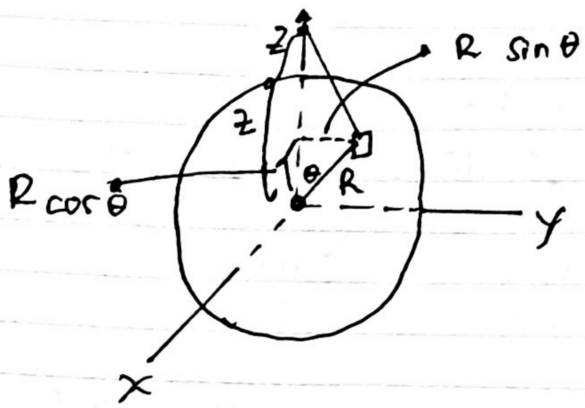
2) Hitung Potensial di P !



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

$V_P = ?$

3. Tentukan potensi dari cangkang bola seragam bermuatan R jari-jari !



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

$$V = \frac{1}{4\pi\varepsilon_0}\int \frac{\sigma\, da}{r}$$
$$= \frac{1}{4\pi\varepsilon_0}\iint \frac{\sigma\, da}{(R^2 + z^2 - 2Rz\cos\theta)^{1/2}}$$
$$= \frac{\sigma}{4\pi\varepsilon_0}\int_0^{\pi}\int_0^{2\pi} \frac{R^2\sin\theta\, d\theta\, d\phi}{(R^2 + z^2 - 2Rz\cos\theta)^{1/2}}$$
$$= \frac{\sigma R\, 2\pi}{4\pi\varepsilon_0}\int_0^{\pi} \frac{\sin\theta\, d\theta}{(R^2 + z^2 - 2Rz\cos\theta)^{1/2}}$$
$$V = \frac{\sigma R\, 2\pi}{4\pi\varepsilon_0}\int_0^{\pi} \frac{d(\cos\theta)}{(R^2 + z^2 - 2Rz\cos\theta)^{1/2}}$$
$$= \frac{\sigma R\, 2\pi}{4\pi\varepsilon_0}\int_0^{\pi} (R^2 + z^2 - 2Rz\cos\theta)^{-1/2}\, d(\cos\theta)$$
$$= \frac{\sigma R\, 2\pi}{4\pi\varepsilon_0} \cdot 2\left(R^2 + z^2 - 2Rz\cos\theta\right)^{1/2}\Big|_0^{\pi}$$
$$= \frac{2\sigma R\, 2\pi}{4\pi\varepsilon_0}\left[(R^2 + z^2 - 2Rz\cos\pi)^{1/2} - (R^2 + z^2 - 2Rz\cos 0)^{1/2}\right]$$