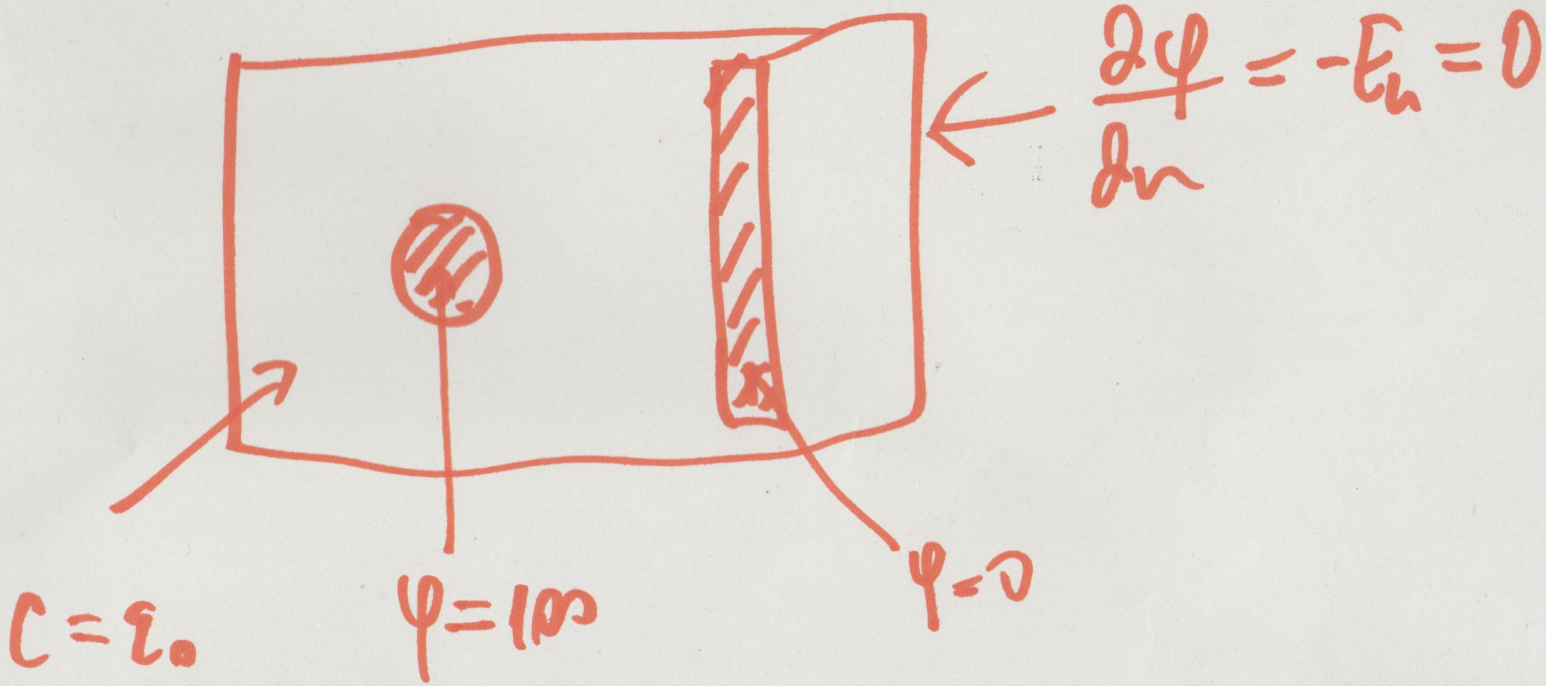
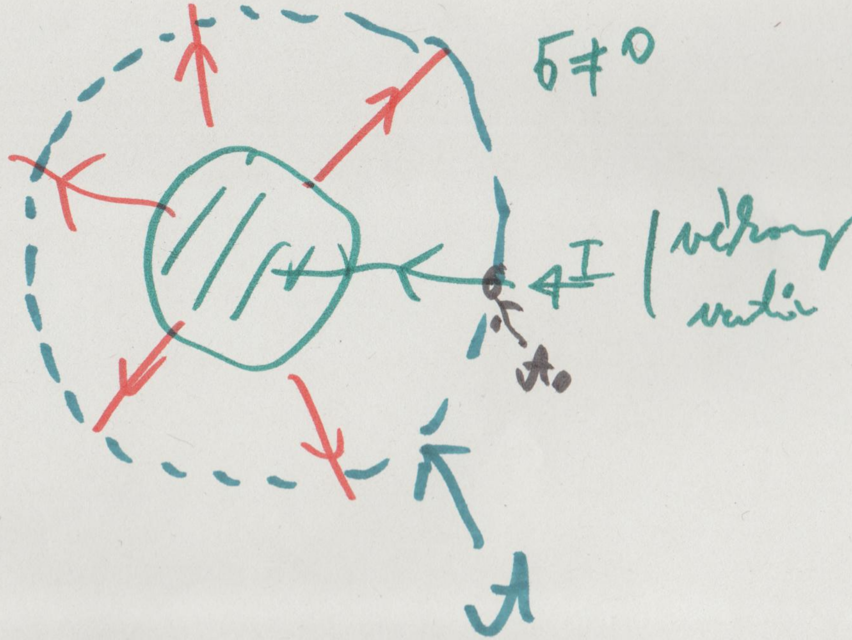
$\operatorname{div} \bar{D} = \rho$ ill. $\operatorname{rot} \bar{E} = 0$

$$\nabla(\underset{c}{\varepsilon}\nabla\underset{u}{\varphi}) = -\underset{f}{\rho} + \cancel{a\varphi}$$



3



$$\oint_A \bar{J}\, d\bar{A} = \underbrace{\int_{A-A_0} \bar{J}\, d\bar{A}}_{\approx A \text{ (itt a csalás)}} + \underbrace{\int_{A_0} \bar{J}\, d\bar{A}}_{-I} = 0$$

<u>analógia</u>

$$\oint_A \bar{J}\, d\bar{A} = I \qquad \bar{J} \to \bar{D}$$

$$I \to Q$$

$$\oint_A \bar{D}\, d\bar{A} = \int_V \rho\, dV = Q \qquad \bar{J} = \sigma \bar{E} \quad \bar{D} = \varepsilon \bar{E}$$

$$\bar{E} \to \bar{E}$$

$$\sigma \to \varepsilon$$

1

Áramlási →

időben állandó töltésáramlás

σ vezetőképesség

$\sigma = 0$ tök. szigetelő

$\sigma \to \infty$ tök. vezető

$\sigma = 10^{-2} \div 10^{-3}$ jó szigetelő

$\sigma = 10^{7}$ S/m Cu, Au, Ag

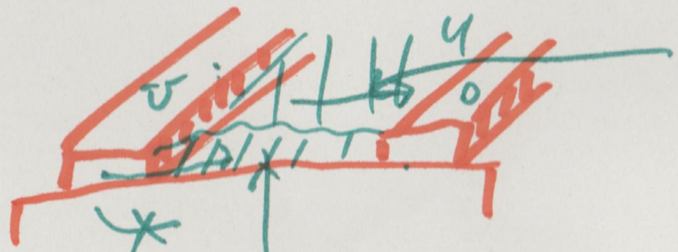
$$\operatorname{div} \bar{J} = 0$$

$$\operatorname{div} \bar{J} = \frac{dq}{dt}$$

folytonossági egyenlet 2

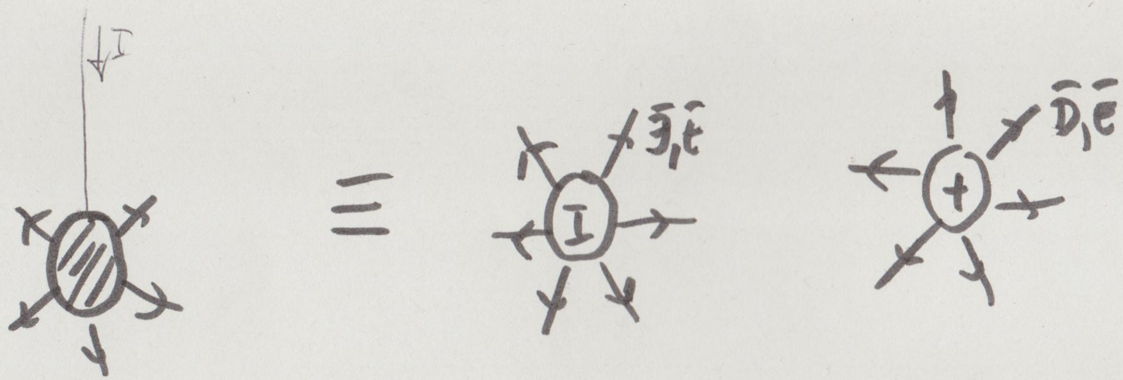
$$\underbrace{\oint_A \bar{j}\, d\bar{A}}_{\text{ami bemegy} - \text{ami kijön}} = \underbrace{-\frac{d}{dt}\iiint_V \rho\, dV}_{\text{belül lévő töltés}}$$

$$\frac{d}{dt} = 0 \rightarrow \oint_A \bar{j}\, d\bar{A} = 0$$



vezetési drót

nem tökéletes szigetelő



Eltemetett gömb

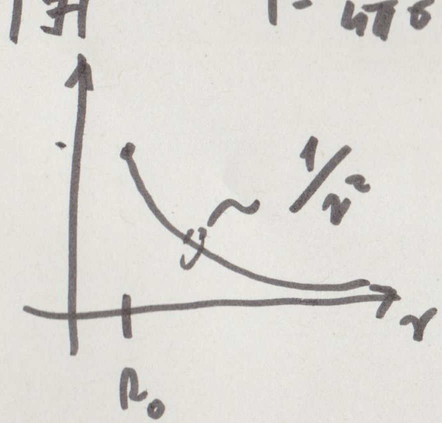
$$\oint \bar{J}\, d\bar{A} = I \quad = J \cdot 4\pi r^2 = I$$

$$\bar{J}(\bar{r}) = \bar{e}_r \cdot \frac{I}{4\pi r^2}$$

$$\varphi(r) = \int_r^{r_0} \bar{E}\, dr$$

$$\bar{E} = \frac{\bar{J}}{\sigma} \rightarrow E = \frac{I}{4\pi\sigma} \cdot \frac{1}{r^2}$$

$$\varphi = \frac{I}{4\pi\sigma} \cdot \frac{1}{r}$$

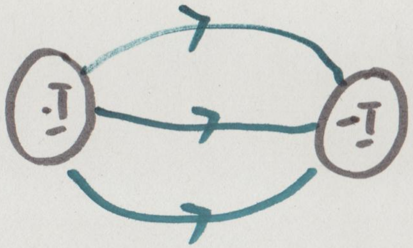


$$U = \varphi(r = R_0) = \frac{I}{4\pi\sigma} \cdot \frac{1}{R_0}$$

elméleti vezetése (ellenállás)

$$G = \frac{I}{U} = \frac{I}{\frac{I}{4\pi\sigma} \cdot \frac{1}{R_0}} = \boxed{4\pi\sigma \cdot R_0}$$

G → G analógia az elektrosztatikával

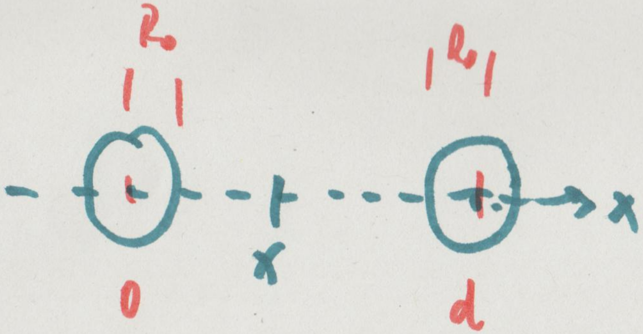


G mérés elrendezés után

$U = \cancel{\varphi} = U_+ - U_-$

a baloldali gömb pot.

jobboldali gömb pot.



$$\varphi(x) = \varphi_I + \varphi_{-I} = \frac{I}{4\pi\sigma}\cdot\frac{1}{x} + \frac{-I}{4\pi\sigma}\cdot\frac{1}{d-x} =$$

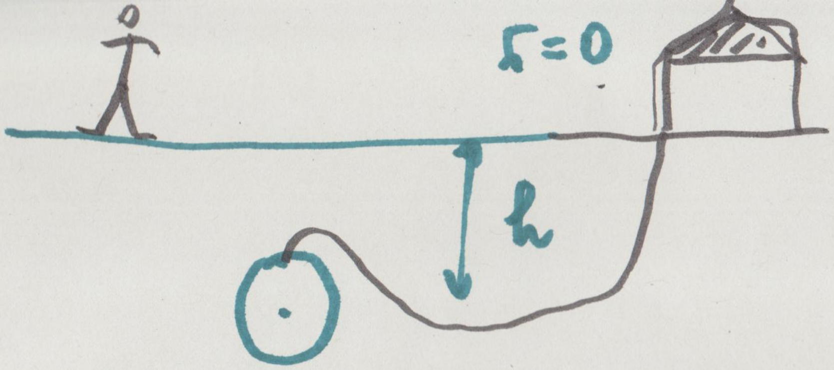
$$= \frac{I}{4\pi\sigma}\cdot\left(\frac{1}{x} - \frac{1}{d-x}\right)$$

$$U = \varphi(x=R) - \varphi(x=d-R) =$$

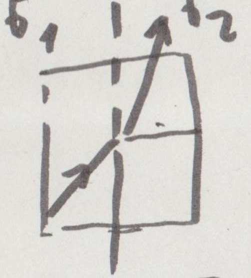
$$= \underbrace{\frac{I}{4\pi\sigma}\left(\frac{1}{R} - \frac{1}{d-R}\right)}_{U_{bal}} - \underbrace{\frac{I}{4\pi\sigma}\left(\frac{1}{d-R} - \frac{1}{R}\right)}_{U_{jobb}} =$$

$$= \frac{I}{4\pi\sigma}\left(\frac{2}{R} - \frac{2}{d-R}\right) = \frac{I}{2\pi\sigma}\left(\frac{1}{R} - \frac{1}{d-R}\right)$$

$$G = \frac{I}{U} = 2\pi\sigma\cdot\frac{1}{\frac{1}{R} - \frac{1}{d-R}}$$



σ=0 - nál nincsen analógja el. stat.



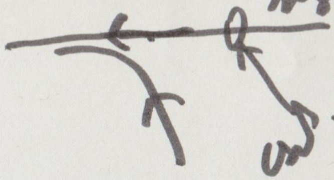
Határfeltétel

$\vec{J}_{1n} = \vec{J}_{2n}$

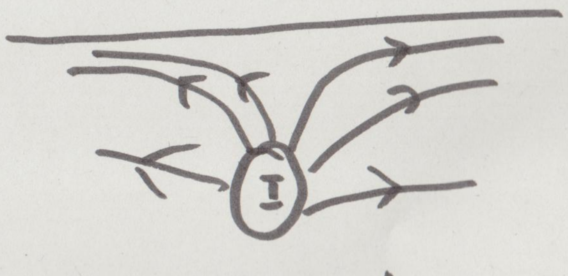
$\sigma_1 \cdot E_{1n} = \sigma_2 \cdot E_{2n}$

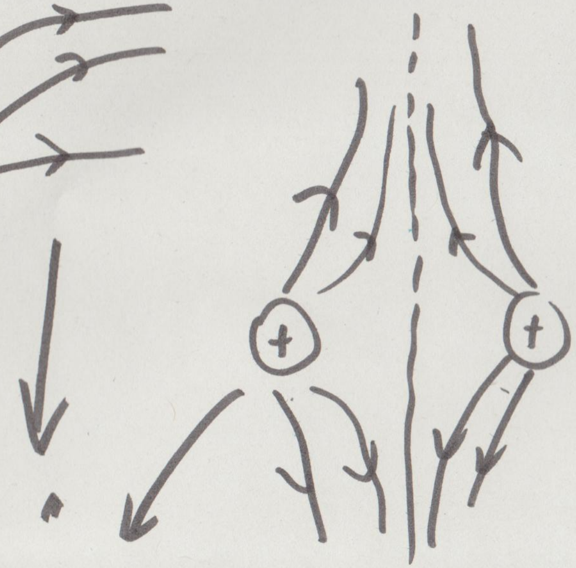
ha $\sigma_2 = 0 \to E_{1n} = 0$

σ=0 (tökéletes szigetelő)

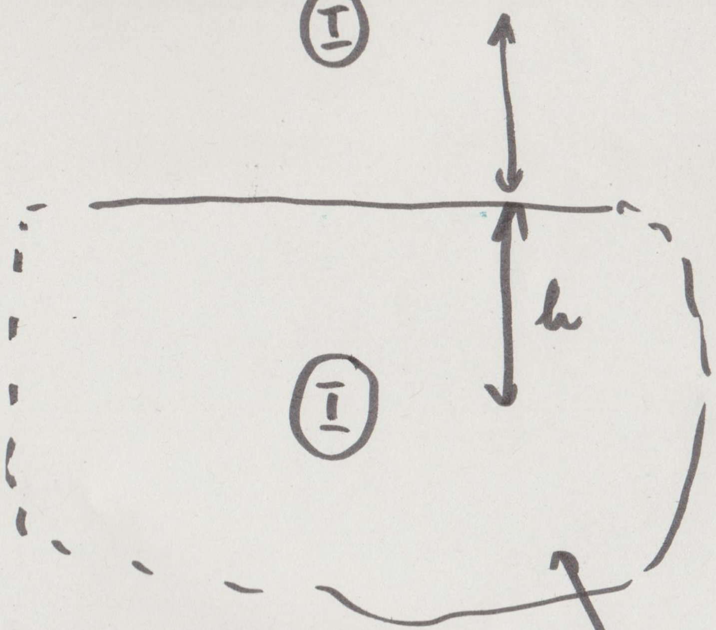


ott felülettel párhuzamos E van!

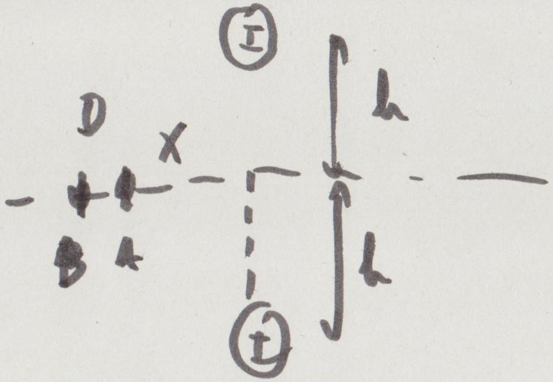


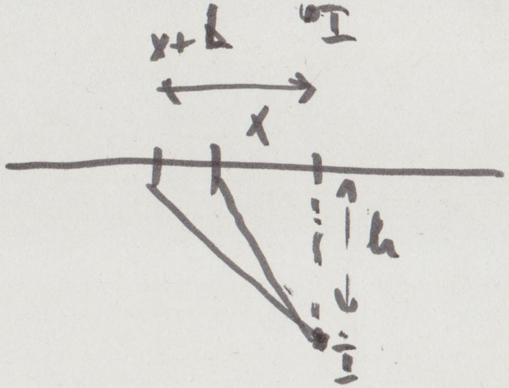


Speciális "Tükrözés"



jó a megoldás





$$U_{AB} = \varphi_A - \varphi_B = \frac{I}{2\pi\sigma}\cdot\left(\frac{1}{\sqrt{x^2+h^2}}\right) - \frac{I}{2\pi\sigma}\frac{1}{\sqrt{(x+b)^2+h^2}}$$

$U_{AB} = !$ $\quad G = ?$

U a gömb felületén

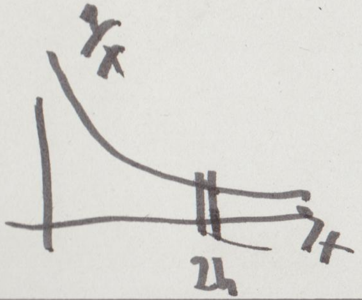
$$\bar{J} = \bar{J}_I + \bar{J}_{tükör}$$

$$\varphi = \varphi_I + \varphi_{tükör}$$

$$\varphi = \frac{I}{4\pi\sigma}\left(\frac{1}{\sqrt{x^2+h^2}}\right) + \frac{I}{4\pi\sigma}\frac{1}{\sqrt{x^2+h^2}} = \frac{I}{2\pi\sigma}\frac{1}{\sqrt{x^2+h^2}}$$

$$U_{lépés} = \frac{I}{2\pi\sigma}\left(\frac{1}{\sqrt{x^2+h^2}} - \frac{1}{\sqrt{(x+L)^2+h^2}}\right)$$

$$U_I = \frac{I}{4\pi\sigma}\cdot\frac{1}{R} + \frac{I}{4\pi\sigma}\cdot\underbrace{\frac{1}{2h-R}}_{\approx \frac{1}{2h}} \cong \frac{I}{4\pi\sigma}\left(\frac{1}{R}+\frac{1}{2h}\right)$$



ha $R \ll h$

(kissugarú közelítés)

$$\boxed{G = \frac{I}{U} = \frac{4\pi\sigma}{\frac{1}{R}+\frac{1}{2h}}}$$