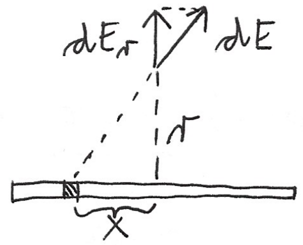
1. PISNI IZPIT

1

- ena palica



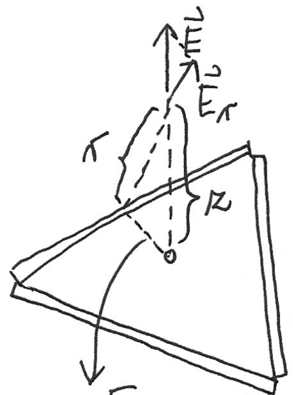
$$dE_r = dE \frac{r}{\sqrt{x^2+r^2}} = \frac{r}{\sqrt{x^2+r^2}} \frac{\mu\, dr}{4\pi\varepsilon_0 (x^2+r^2)}$$

$$dE_r = \frac{\mu r}{4\pi\varepsilon_0} \frac{dr}{(x^2+r^2)^{\frac{3}{2}}}$$

$$E_r = \frac{\mu r}{4\pi\varepsilon_0} \frac{x}{r^2\sqrt{x^2+r^2}} \Bigg|_{-\frac{a}{2}}^{\frac{a}{2}} = \frac{\mu r}{4\pi\varepsilon_0} \frac{a}{r^2\sqrt{\frac{a^2}{4}+r^2}} \qquad \boxed{\frac{e}{3}}$$

$$\underline{E_r = \frac{e}{12\pi\varepsilon_0} \frac{1}{r\sqrt{\frac{a^2}{4}+r^2}}}$$

- tri palice



$$\frac{1}{3}\frac{a\sqrt{3}}{2} = \frac{a\sqrt{3}}{6}$$

$$E = 3\, E_r \frac{z}{\underbrace{\sqrt{z^2+\left(\frac{a\sqrt{3}}{6}\right)^2}}_{r}} = 3 E_r \frac{z}{\sqrt{z^2+\frac{a^2}{12}}}\Big\} r$$

$$E = \frac{e}{4\pi\varepsilon_0} \frac{1}{\sqrt{z^2+\frac{a^2}{12}}\sqrt{z^2+\frac{a^2}{3}}} \frac{z}{\sqrt{z^2+\frac{a^2}{12}}}$$

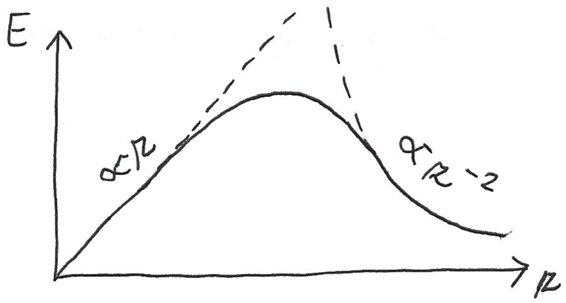
$$\boxed{E = \frac{e}{4\pi\varepsilon_0} \frac{z}{\left(z^2+\frac{a^2}{12}\right)\sqrt{z^2+\frac{a^2}{3}}}}$$

- limitna primera

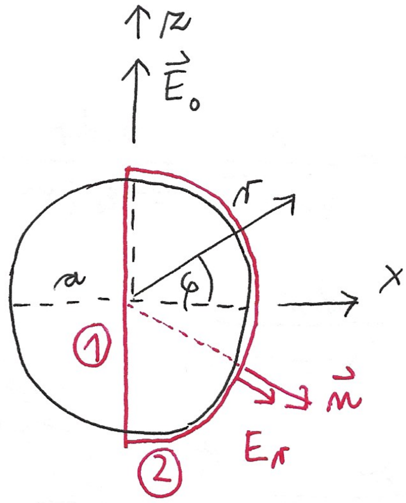
$z \gg a$: $E = \frac{e}{4\pi\varepsilon_0} \frac{z}{z^2 \cdot z} = \underline{\frac{e}{4\pi\varepsilon_0 z^2}}$, kot točkasti naboj

$z \ll a$: $E = \frac{e}{4\pi\varepsilon_0} \frac{z}{\frac{a^2}{12}\frac{a}{\sqrt{3}}} = \underline{\frac{3e\sqrt{3}}{\pi\varepsilon_0 a^3} z}$, linearno

- graf



2



+ $$U(r,\varphi) = \begin{cases} -E_0 r \sin\varphi + \dfrac{B}{r}\sin\varphi, & r > a \\ 0, & r \le a \end{cases}$$

RP: $U(a,\varphi) = 0 \Rightarrow \underline{B = E_0 a^2}$

+ $$\underline{U(r,\varphi) = -E_0 r \sin\varphi + \frac{E_0 a^2}{r}\sin\varphi}$$

+ $$E(a,\varphi) = E_r(a,\varphi) = -\left.\frac{\partial U}{\partial r}\right|_{r=a} = E_0 \sin\varphi + E_0 \frac{a^2}{a^2}\sin\varphi = \underline{2E_0 \sin\varphi}$$

- izračun sile

+ 1 $\vec{F}_e = 0$, ker ni polja

2 $\vec{E} \parallel \vec{n} \Rightarrow \vec{E}(\vec{E}\cdot\vec{n}) = E^2 \vec{n}$

$$\vec{F}_e = \varepsilon_0 \int\left[\vec{E}(\vec{E}\cdot\vec{n}) - \frac{1}{2}E^2\vec{n}\right] dS = \underline{\frac{\varepsilon_0}{2}\int E^2 \vec{n}\, dS}$$

+ $$\vec{n} = \begin{bmatrix} \cos\varphi \\ \sin\varphi \end{bmatrix}, \quad dS = l\,a\,d\varphi, \quad E = 2E_0 \sin\varphi$$

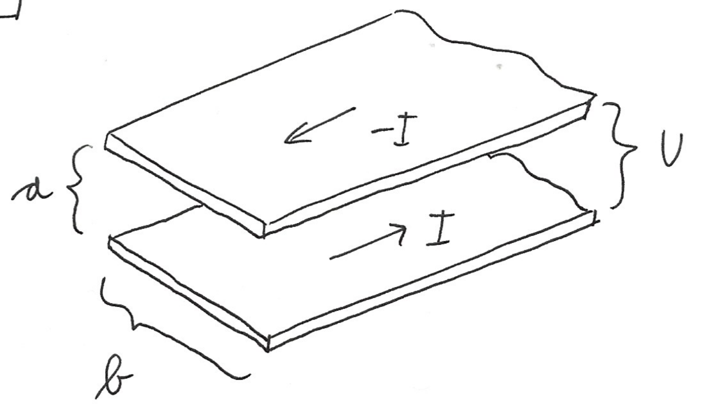
1/4
$$\vec{F}_e = \frac{\varepsilon_0}{2}\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} 4E_0^2 \sin^2\varphi \begin{bmatrix} \cos\varphi \\ \sin\varphi \end{bmatrix} l\,a\,d\varphi =$$

$$= 2\varepsilon_0 E_0^2 l a \int_{\varphi=-\frac{\pi}{2}}^{\frac{\pi}{2}} \begin{bmatrix} \sin^2\varphi \, d(\sin\varphi) \\ -(1-\cos^2\varphi)\, d(\cos\varphi) \end{bmatrix} = 2\varepsilon_0 E_0^2 l a \begin{bmatrix} \left.\frac{1}{3}\sin^3\varphi\right|_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \\ \left.\left(-\cos\varphi + \frac{1}{3}\cos^3\varphi\right)\right|_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \end{bmatrix} =$$

$$= 2\varepsilon_0 E_0^2 l a \begin{bmatrix} \frac{2}{3} \\ 0 \end{bmatrix} = \frac{4}{3}\varepsilon_0 E_0^2 a l \, \hat{e}_x$$

+ $$\boxed{\frac{\vec{F}_e}{l} = \frac{4}{3}\varepsilon_0 E_0^2 a \cdot \hat{e}_x}$$ $\Rightarrow$ polovici valja se ODBIJATA!

3



a) $\omega = k c = k \dfrac{c_0}{\sqrt{\varepsilon}}$

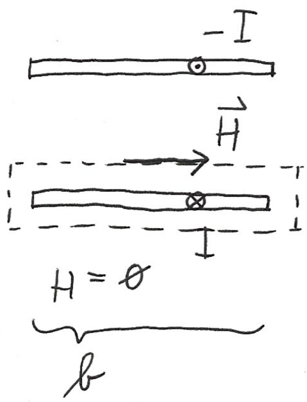
$\varepsilon = 1 - \dfrac{\omega_p^2}{\omega^2}$ +

$$\omega = \frac{k c_0}{\sqrt{1-\frac{\omega_p^2}{\omega^2}}}$$

$$\to \omega^2 - \omega_p^2 = k^2 c_0^2$$

$$\boxed{\omega = \sqrt{\omega_p^2 + k^2 c_0^2}}$$ +

b) $Z = \dfrac{U}{I}$



- Ampere za posamezno ploščo:

$\underline{I = H b} \Rightarrow H = \dfrac{I}{b}$ +

- napetost med ploščama:

$\underline{U = E d} \Rightarrow E = \dfrac{U}{d}$ +

+ $Z = \dfrac{U}{I} = \dfrac{E d}{H b}$, potrebujemo še razmerje $\dfrac{E}{H}$

+ $H = \dfrac{\sqrt{\varepsilon}}{Z_0} E \Rightarrow \dfrac{E}{H} = \dfrac{Z_0}{\sqrt{\varepsilon}}$ → impedanca vakuuma

+ $$\boxed{Z = \frac{d}{b} Z_0 \frac{1}{\sqrt{1-\frac{\omega_p^2}{\omega^2}}}}$$

+ - primer $Z = Z_0$: $\sqrt{1-\dfrac{\omega_p^2}{\omega^2}} = \dfrac{d}{b}$

$$\frac{\omega_p^2}{\omega^2} = 1 - \left(\frac{d}{b}\right)^2$$

$$\boxed{\omega = \frac{\omega_p}{\sqrt{1-\left(\frac{d}{b}\right)^2}}} > \omega_p$$ kot mora biti!

1