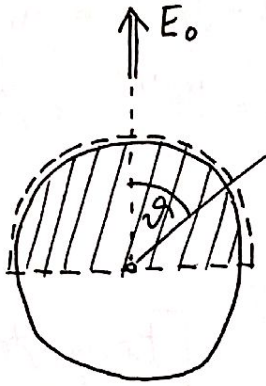
EMP : 2. PISNI IZPIT IZ VAJ

1



$\frac{1}{4}$

$$U(r \to \infty, \vartheta) = -E_0 r \cos\vartheta$$

$\Downarrow$ nastavek

$$U(r, \vartheta) = -E_0 r \cos\vartheta + \frac{B}{r^2}\cos\vartheta$$

$+$

– robni pogoj: $U(a, \vartheta) = 0$

$$-E_0 a + \frac{B}{a^2} = 0 \Rightarrow B = E_0 a^3 \qquad \boxed{\tfrac{1}{4}+}$$

$$\underline{U(r, \vartheta) = -E_0 r \cos\vartheta + \frac{E_0 a^3}{r^2}\cos\vartheta}$$

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

– sila na zgornjo (osenčeno) polovico krogle:

– prerez: $E = 0$, ni prispevka

$+$ – obod: $\vec{E} \parallel \vec{n}$ (kovina), $E = -\frac{\partial U}{\partial r}\Big|_{r=a} = E_0\cos\vartheta + 2E_0\cos\vartheta = \underline{3E_0\cos\vartheta}$

$\Downarrow$

$$\vec{E}(\vec{E}\cdot\vec{n}) - \frac{1}{2}E^2\vec{n} = \frac{1}{2}E^2\vec{n}$$

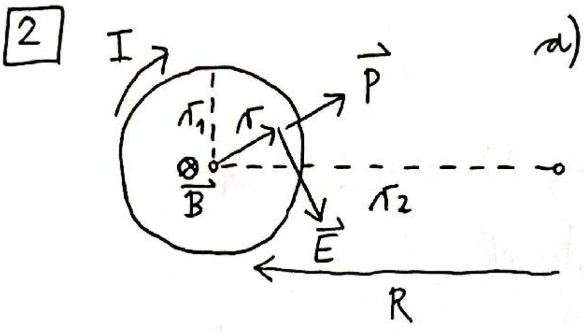
$+$

$$\vec{F} = \varepsilon_0 \int \frac{1}{2}\underbrace{9E_0^2\cos^2\vartheta}_{E^2}\,\vec{n}\,\underbrace{2\pi a^2\, d(\cos\vartheta)}_{dS\,\}+} \qquad \boxed{\tfrac{1}{2}+}$$

$\downarrow$ $\cos\vartheta$ za smer z $\}+$

$$F_z = \varepsilon_0\, 9\pi a^2 E_0^2 \int_{\cos\vartheta = 0}^{1} \cos^3\vartheta\, d(\cos\vartheta) = \boxed{\frac{9}{4}\pi\varepsilon_0 a^2 E_0^2} \quad \}+$$

$\boxed{2}$



a) – magnetno polje v tuljavi

$$\nabla \times \vec B = \mu_0 \vec j \rightarrow B \cdot 2\pi R = \mu_0 N I$$

$$B = \frac{\mu_0 N I}{2\pi R} \approx \underbrace{\frac{\mu_0 N I}{2\pi r_2}}_{(r_2 \gg r_1)}$$

to upoštevamo povsod v nadaljevanju!

– električno polje v tuljavi

$$\nabla \times \vec E = -\frac{\partial \vec B}{\partial t} \rightarrow 2\pi r E = -\dot B \pi r^2$$

$$2\pi r E = -\frac{\mu_0 N \dot I}{2\pi r_2} \pi r^2$$

$$\boxed{E = -\frac{\mu_0 N \dot I r}{4\pi r_2}}$$

$\dot I < 0 \Rightarrow \vec E$ ima tangentno komponento v smeri urinega kazalca (glej sliko)

b) Poyntingov vektor → ima smer ven iz plašča tuljave

$$P = \frac{1}{\mu_0} E B = -\frac{N I}{2\pi r_2} \cdot \frac{\mu_0 N \dot I \overset{\rightarrow \text{površina}}{r_1}}{4\pi r_2} = -\frac{\mu_0 N^2 I \dot I r_1}{8\pi^2 r_2^2}$$

$$\int P \, dS = P \cdot 2\pi r_1 \cdot 2\pi r_2 = \boxed{-\frac{\mu_0 N^2 I \dot I r_1^2}{2 r_2}}$$

c) $$W_m = \frac{B^2}{2\mu_0} \cdot \pi r_1^2 \cdot 2\pi r_2 = \frac{\mu_0 N^2 I^2}{8\pi^2 r_2^2} 2\pi^2 r_1^2 r_2 = \frac{\mu_0 N^2 I^2 r_1^2}{4 r_2}$$

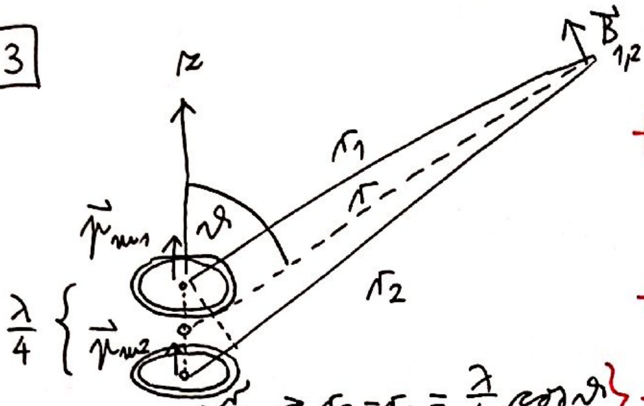
$$\boxed{\dot W_m = \frac{\mu_0 N^2 I \dot I r_1^2}{2 r_2}}$$ isto ✓

(saj je $(I^2)^{\cdot} = 2 I \dot I$)

$\boxed{1}$

$\dot W_e = 0$, saj je $\dot I = \text{konst} \Rightarrow E^2 = \text{konst}$

$\boxed{3}$



$+\left\{ \vec B = -\frac{\mu_0}{4\pi c^2 r}\,\underbrace{\hat e_r \times \left[\hat e_r \times \ddot{\vec p}_m\left(t-\frac{r}{c}\right)\right]}\right.$

$+\left\{ \ddot p_m\left(t-\frac{r}{c}\right)\sin\vartheta\,(-\hat e_\vartheta)\right.$ (glej sliko)

$r_2 - r_1 = \frac{\lambda}{4}\cos\vartheta \}$ +

– oba prispevka imata enako smer, $-\hat e_\vartheta$

$$+\left\{ B = B_1 + B_2 = -\frac{\mu_0}{4\pi c^2 r}\sin\vartheta\left[\ddot p_{m1}\left(t-\frac{r_1}{c}\right) + \ddot p_{m2}\left(t-\frac{r_2}{c}\right)\right]\right.$$

$\frac{1}{4}$

$$p_{m1}\left(t-\frac{r_1}{c}\right) = p_m\cos\omega\left(t-\frac{r_1}{c}\right)$$

$$p_{m2}\left(t-\frac{r_2}{c}\right) = p_m\cos\left[\omega\left(t-\frac{r_2}{c}\right)-\frac{\pi}{2}\right]$$

upoštevamo $\cos\alpha + \cos\beta = 2\cos\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2}$

$$B \propto \sin\vartheta\left[\cos\omega\left(t-\frac{r_1}{c}\right) + \cos\left[\omega\left(t-\frac{r_2}{c}\right)-\frac{\pi}{2}\right]\right] =$$

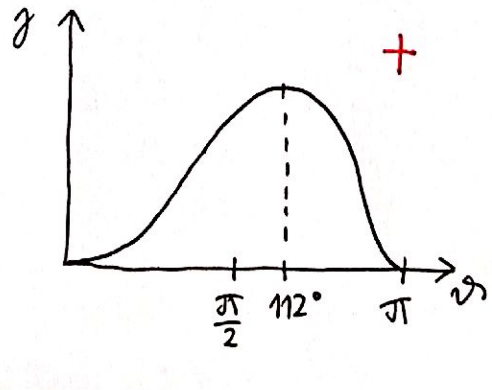
$$= 2\sin\vartheta\cos\left[\omega t - \frac{\omega}{c}\overbrace{\frac{r_1+r_2}{2}}^{r} - \frac{\pi}{4}\right]\cos\left[\frac{\omega}{c}\frac{r_2-r_1}{2}+\frac{\pi}{4}\right] =$$

$$= 2\sin\vartheta\cos\left[\omega\left(t-\frac{r}{c}\right)-\frac{\pi}{4}\right]\cos\left(\underbrace{\frac{2\pi\nu}{c}\frac{1}{2}\frac{\lambda}{4}\cos\vartheta}_{\frac{\pi}{4}\cos\vartheta}+\frac{\pi}{4}\right) =$$

$$= 2\sin\vartheta\cos\left(\omega t_r - \frac{\pi}{4}\right)\cos\left[\frac{\pi}{4}(\cos\vartheta + 1)\right]$$

$$+\left\{ j \propto \langle B^2\rangle = 4\sin^2\vartheta\,\underbrace{\left\langle\cos^2\left(\omega t_r - \frac{\pi}{4}\right)\right\rangle}_{\frac{1}{2}}\cos^2\left[\frac{\pi}{4}(\cos\vartheta+1)\right]\right.$$

$$\boxed{j \propto \sin^2\vartheta\cos^2\left[\frac{\pi}{4}(\cos\vartheta+1)\right]}$$



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$\boxed{1}$