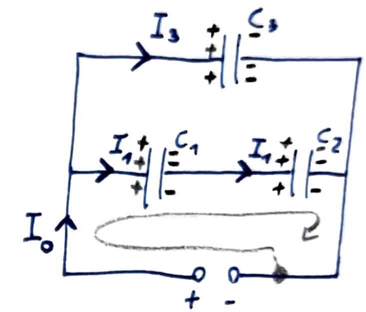
① $C_1 = C_2$

a) $\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{2}{C_1} \quad \Rightarrow \quad C_{12} = \frac{C_1}{2}$

$$\underline{\underline{C_N}} = C_{12} + C_3 = \underline{\underline{\frac{C_1}{2} + C_3}} = 11{,}5\ \mu F$$



b) $\underline{\underline{e_3 = C_3 U}} = 90\ \mu As$

2. Kirchoffov zakon po zanki na sliki :

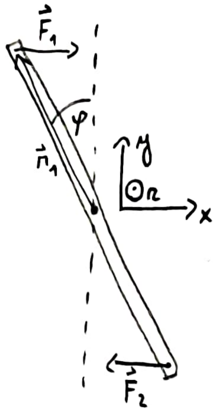
$$U - \frac{e_1}{C_1} - \frac{e_2}{C_2} = 0 \quad , \qquad e_1 = e_2$$

$$\Rightarrow \quad U - \frac{e_1}{C_1} - \frac{e_1}{C_1} = 0 \quad \rightarrow \quad U = 2\frac{e_1}{C_1}$$

$$\left[\begin{array}{l} e_1 = \frac{C_1}{2} U = 25\ \mu As \\ e_2 = e_1 \end{array}\right]$$

c) Iz smeri tokov ob polnjenju kondenzatorjev razberemo $\underline{\underline{+}}$.

(2.)



$$\sum \vec{M} = J\vec{\alpha}$$

↳ Enačba bo neničelna le v z smeri

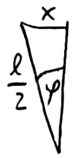
z: $\quad \sum M_z = J\alpha_z \quad ; \quad \alpha_z = \ddot{\varphi} \quad ; \quad J = \frac{m_p \ell^2}{12}$

$$M_{1,z} + M_{2,z} = J\ddot{\varphi} \qquad (1)$$

$|\vec{M}_1| = |\vec{F}_1||\vec{r}_1| \sin\beta$ → Kot med vektorjema $\vec{F}_1$ in $\vec{r}_1$

$$\Rightarrow \beta = \frac{\pi}{2} + \varphi$$

$|\vec{F}_1| = k_1 x$



$\rightarrow x = \frac{\ell}{2}\sin\varphi \qquad |\vec{r}_1| = \frac{\ell}{2}$

$\Rightarrow$ Ko je $\varphi > 0$ je navor $\vec{M}_1$ obrnjen v nasprotno smer osi z!

$$\Rightarrow M_{1,z} = - k_1 \frac{\ell}{2} \sin\varphi \, \frac{\ell}{2} \sin\left(\frac{\pi}{2} + \beta\right)$$

$$M_{1,z} = - k_1 \frac{\ell^2}{4} \sin\varphi \cos\varphi$$

$\vec{M}_2$ povsem analogno (Kaže pa v isto smer kot $\vec{M}_1$!)

$$\Rightarrow M_{2,z} = - k_2 \frac{\ell^2}{4} \sin\varphi \cos\varphi$$

---

(1) $\Rightarrow$

$$- k_1 \frac{\cancel{\ell^2}}{\cancel{4}} \sin\varphi \cos\varphi - k_2 \frac{\cancel{\ell^2}}{\cancel{4}} \sin\varphi \cos\varphi = \frac{m_p \cancel{\ell^2}}{3\,\cancel{12}} \ddot{\varphi}$$

$$-(k_1 + k_2) \sin\varphi \cos\varphi = m_p \ddot{\varphi} \frac{1}{3}$$

$$\ddot{\varphi} = - \frac{3(k_1 + k_2)}{m_p} \sin\varphi \cos\varphi$$

Približek za $\varphi \ll 1$ (majhni koti): $\sin\varphi \approx \varphi \; ; \; \cos\varphi \approx 1$

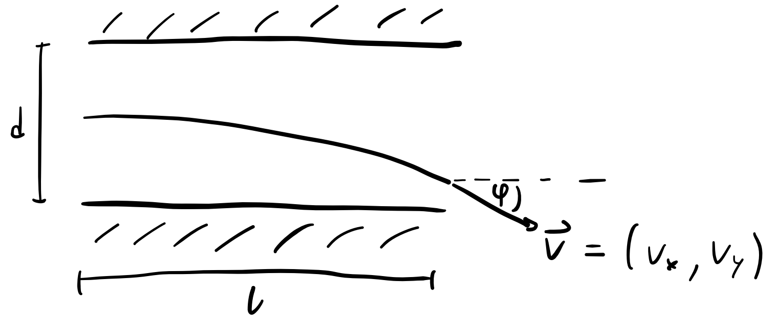
$$\Rightarrow \ddot{\varphi} = - \underbrace{\frac{3(k_1 + k_2)}{m_p}}_{\omega^2} \varphi$$

$$t_0 = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{3(k_1 + k_2)}{m_p}}} = 2{,}25 \text{ s}$$

3.) $W_{ep} = W_k$ ②

$eU_0 = \frac{1}{2} m v_0^2$

$\Longrightarrow \quad v_0 = \sqrt{\frac{2eU_0}{m}}$ ③



v_x: $\quad v_0 \longrightarrow v_x$

$a_x = 0$

v_y:

$F = eE = e \cdot \frac{U}{d}$ ② ③

$a_y = \frac{F}{m}$ ③ $\qquad t = \frac{l}{v_x}$ ②

$v_y = a_y \cdot t = \frac{F}{m} \cdot t = \frac{eU}{md} \cdot \frac{l}{v_x}$

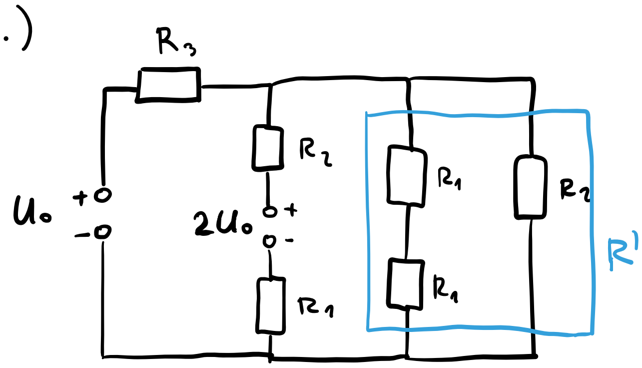
$\tan\varphi = \frac{v_y}{v_x} = \frac{eUl}{md\, v_x \cdot v_x} = \frac{eUl}{md\, v_0^2} = \frac{\cancel{e} U l \cancel{m}}{\cancel{m} d \cdot 2 \cancel{e} U_0} = \frac{Ul}{2dU_0}$ ③ ②

$v_x = v_0$

$\Longrightarrow \quad U = U_0 \frac{2d}{l} \tan\varphi = 10^4\,V \cdot \frac{2 \cdot 4 \cdot 10^{-3}\,m}{5 \cdot 10^{-3}\,m} \cdot \frac{1}{\sqrt{3}} \approx 9240\ V$

③ ②

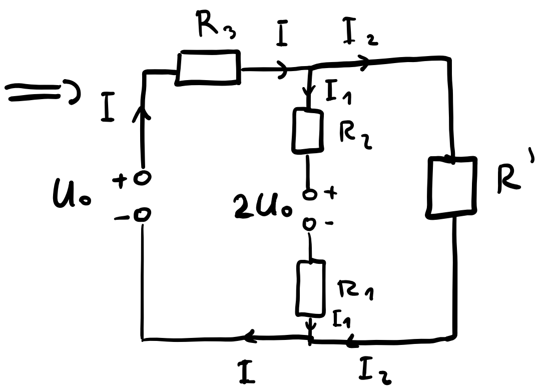
4.)



$$\frac{1}{R'} = \frac{1}{R_2} + \frac{1}{R_1+R_1} \quad 3$$

$$R' = \frac{R_1 R_2}{R_1 + \frac{R_2}{2}} = 1\,\Omega \quad 2$$

$\Longrightarrow$



5 ... ALI PODOBEN RAZMISLEK

1. KZ: (1) $I = I_1 + I_2$ 2

2. KZ: (2) $U_0 - IR_3 - I_1R_2 - 2U_0 - I_1R_1 = 0$ 3

(3) $U_0 - IR_3 - I_2R' = 0$

$\left(-I_2R' + I_1R_1 + 2U_0 + I_1R_2 = 0\right)$

IŠČEMO I:

(3): $I = \dfrac{U_0 - I_2R'}{R_3}$ (1): $I_2 = I - I_1$

(2): $I_1 = \dfrac{U_0 - IR_3 - 2U_0}{R_1+R_2} = -\dfrac{U_0+IR_3}{R_1+R_2}$

3

(2) $\rightarrow$ (1): $I_2 = I + \dfrac{U_0+IR_3}{R_1+R_2}$

(2) $\rightarrow$ (1) $\rightarrow$ (3): $I = \dfrac{U_0 - IR' - \frac{R'}{R_1+R_2}(U_0+IR_3)}{R_3}$

$$I\left(1+\frac{R'}{R_3}+\frac{R'}{R_1+R_2}\right)=\frac{U_0\left(1-\frac{R'}{R_1+R_2}\right)}{R_3}$$

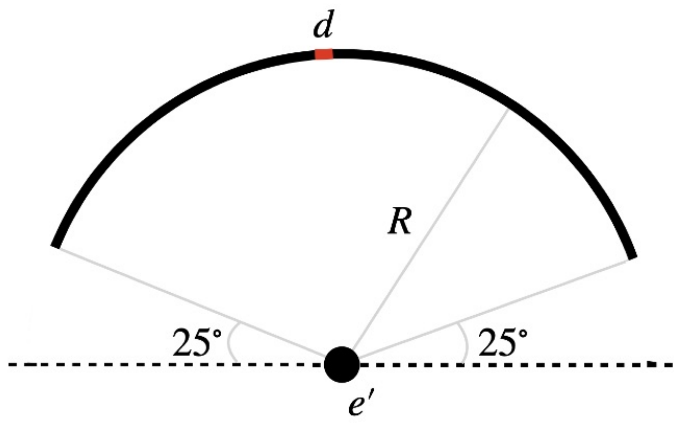
$$\Rightarrow I=\frac{U_0}{R_3}\cdot\frac{1-\frac{R_1}{R_1+R_2}}{1+\frac{R_1}{R_3}+\frac{R_1}{R_1+R_2}} \quad 2 \quad =\frac{2\,V}{3\,\Omega}\cdot\frac{1-\frac{1}{3}}{1+\frac{1}{3}+\frac{1}{3}}=\frac{2}{3}\cdot\frac{2}{\cancel{3}\cdot\frac{5}{\cancel{3}}}\,A=\frac{4}{15}\,A$$

$$P_{R_3}=I^2\cdot R_3=\frac{16}{75}\,W\approx 0.213\,W$$

3 2

MOŽNIH JE VEČ NAČINOV REŠEVANJA, OSTALI EKVIVALENTNO OCENJENI!

5. Tanka ločna podkev, kot je prikazana na skici, s polmerom $R = 5\,\mathrm{cm}$ je enakomerno naelektrena z nabojem $e = 100\,\mu\mathrm{A\,s}$. V njeno središče postavimo točakst naboj z $e' = 3\,\mu\mathrm{A\,s}$. Kolikšna je velikost sile med točkastim nabojem in majhnim, $d = 1\,\mathrm{mm}$ dolgim, izsekom podkve (označen rdeče na skici)? S kolikšno silo pa deluje cela podkev (črn polkrožni del na skici) na točkast naboj in v kateri smeri?



a) velikost sile med "d" in e'

→ naboj na "d" = e_d

$$e_d = \lambda \cdot d$$

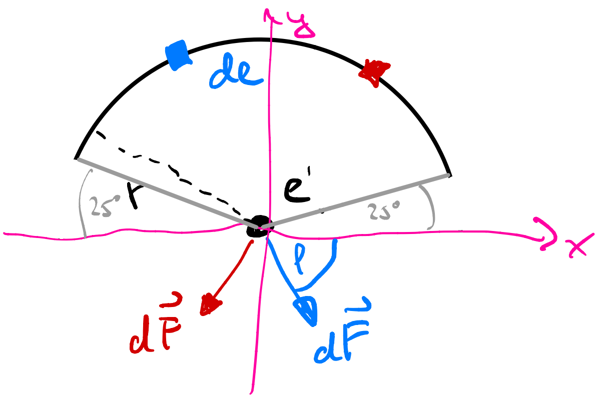
$$\lambda = \frac{e}{L} = \frac{e}{\frac{130°}{180°} \cdot \pi R} = \frac{100\,\mu As}{0.1134\,m} = \underline{\underline{881{,}5\,\frac{\mu As}{m}}}$$

$$e_d = \underline{\underline{0{,}8815\,\mu As}}$$

$$F_{e'd} = \frac{e_d\, e'}{4\pi\varepsilon_0 R^2} = \frac{0.8815 \cdot 10^{-6}\,As \cdot 3 \cdot 10^{-6}\,As}{4\pi \cdot 8.85 \cdot 10^{-12}\,\frac{(As)^2}{Nm^2}\,(0.05\,m)^2}$$

$$= \underline{\underline{9.51\,N}}$$

b)



I

$$d\vec{F} = \frac{e'\,de}{4\pi\varepsilon_0 R^2}\,\hat{e}_r$$

$$dF_x = |d\vec{F}|\cos\varphi \quad \rightarrow \quad F_x = \int dF_x = \int \frac{e'\,de\,\cos\varphi}{4\pi\varepsilon_0 R^2}$$

$$dF_y = |d\vec{F}|\sin\varphi \quad \rightarrow \quad F_y = \int dF_y = \int \frac{e'\,de\,\sin\varphi}{4\pi\varepsilon_0 R^2}$$

$$de = R\lambda\,d\varphi$$

$$F_x = \int_{25^\circ}^{155^\circ} \frac{e'\,\lambda R\cos\varphi\,d\varphi}{4\pi\varepsilon_0 R^2} = \frac{e'\lambda}{4\pi\varepsilon_0 R}\int_{25^\circ}^{155^\circ}\cos\varphi\,d\varphi$$

$$F_x = \frac{e'\lambda}{4\pi\varepsilon_0 R}\,\sin\varphi\,\Big|_{25^\circ}^{155^\circ} = \underline{0}$$

$$F_y = \frac{e'\lambda}{4\pi\varepsilon_0 R}\int_{25^\circ}^{155^\circ}\sin\varphi\,d\varphi = -\frac{e'\lambda}{4\pi\varepsilon_0 R}\,\cos\varphi\,\Big|_{25^\circ}^{155^\circ}$$

$$= -\frac{e'\lambda}{4\pi\varepsilon_0 R}\left(-0{,}906 - 0{,}906\right) = \frac{e'\lambda}{2\pi\varepsilon_0 R}\,2\cdot 0{,}906$$

$$= \underline{\underline{1723\ \text{N}}}$$