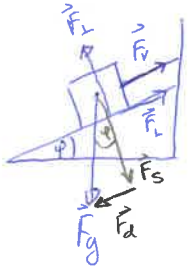
① $m = 5\,kg$, $\varphi = 25^\circ$, $k = 0{,}2$

a) $F_v = ?$ A) $a = ?$ b) $s = ?$



a) $F_{\parallel}: F_v + F_L = F_d$ 3T

$F_{\perp}: F_{\perp} = F_S$ 2T

$F_S = mg\cos\varphi$ 2T $\qquad F_L = k_L \cdot F_{\perp}$ 2T

$F_d = mg\sin\varphi$ 2T

$F_v = F_d - F_L = mg\sin\varphi - k_L \cdot mg\cos\varphi = mg(\sin\varphi - k_L\cos\varphi) = 11{,}8\,N$ 3+1

b) $\sum_1 F_{\parallel} = m \cdot a_{\parallel}$

$m a_{\parallel} = F_d - F_L \rightarrow a_{\parallel} = \frac{11{,}8\,N}{5\,kg} = 2{,}37\,m/s^2$ 4+1

c) $s(t=2s) = \frac{a t^2}{2} = 4{,}74\,m$ 4+1

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② $B = 1{,}37\,T$, $R = 7{,}3\,cm$, $m = 6{,}65 \cdot 10^{-23}\,kg$, $e = 1e_0$

a) $U = ?$ b) $v = ?$

$R = \frac{mv}{eB} \rightarrow v = \frac{ReB}{m} = 2.4 \cdot 10^5\,m/s$ 5T 5T 3T

$\Delta W = 0 = \Delta W_k + \Delta W_e = \frac{mv^2}{2} - eU$ 5T

$v = \sqrt{\frac{2eU}{m}} \qquad \frac{mv^2}{2e} = U$ 5T

$U = 12{,}0\,kV$ 2T

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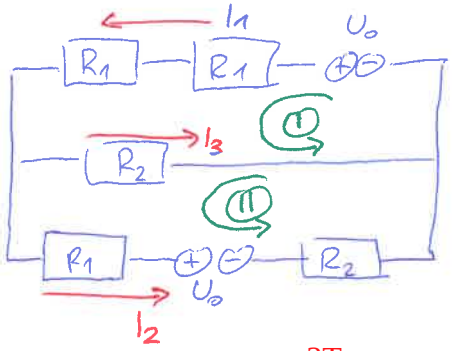
③ $R_1 = 1{,}2\,\Omega$, $R_2 = 3{,}4\,\Omega$, $U_0 = 5{,}6\,V$



$R_{1N} = 2R_1$

a) $U_{ab} = ?$

b) $P_{R_2} = ?$

3T

I) $U_0 - R_{1N} \cdot I_1 - R_2 I_3 = 0$

II) $-U_0 + R_2 I_3 - \underbrace{R_1 I_2 - R_2 I_2}_{-R_{2N} I_2} = 0$ 3T

III) $I_1 = I_2 + I_3$, $I_3 = ?$ 3T

I + II: $R_{1N} I_1 + R_{2N} I_2 = 0 \Rightarrow I_1 = -\frac{R_{2N}}{R_{1N}} I_2$ IV) 1T

IV → III: $-\frac{R_{2N}}{R_{1N}} I_2 = I_2 + I_3 \Rightarrow I_2 = -\frac{I_3}{1 + \frac{R_{2N}}{R_{1N}}}$ V) 1T

I + V: $-U_0 + R_2 I_3 + R_{2N} \frac{I_3}{1 + \frac{R_{2N}}{R_{1N}}} \Rightarrow I_3 = \frac{U_0}{R_2 + \frac{1}{\frac{1}{R_{2N}} + \frac{1}{R_{1N}}}} = 1{,}125\,A$ 3T+1T

$U_{ab} = R_2 I_3 = 3.825\,V$ 4+1T

$P_{R_2} = UI = R_2 I_3^2 = 4.30\,W$ 4+1T

4.

a) Navori:

$M_p = m_p g \frac{L}{2}$ 3T

$M_b = m_b g (a + \frac{b}{2})$ 3T

$M_v = -F_v L$ 3T

ravnovesje $\sum M = 0$ 2T

$M_p + M_b + M_v = 0$

$m_p g \frac{L}{2} + m_b g (a + \frac{b}{2}) = F_v L$

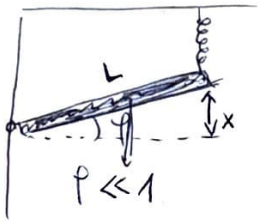
$F_v = \frac{g}{L}\left(m_p \frac{L}{2} + m_b (a + \frac{b}{2})\right)$ 1T

$= \frac{9{,}8\,m/s^2}{1{,}1\,m}\left(0{,}7\,kg \cdot \frac{1{,}1\,m}{2} + 0{,}5\,kg \cdot (0{,}4\,m + \frac{0{,}16\,m}{2})\right)$

$= 6{,}55\,N$ 1T

a) $\Sigma = 13$ T

b)



$\vec{M} = \vec{F} \times \vec{r} \rightarrow |\vec{M}| = Fr\sin\varphi$

$x = L\sin\varphi$

Navori: $M_p = m_p g \frac{L}{2} \sin(\frac{\pi}{2} + \varphi) = m_p g \frac{L}{2} \cos\varphi \approx m_p g \frac{L}{2}(1 - \frac{\varphi^2}{2})$

podobno $M_b = \dots \approx m_b g (a + \frac{b}{2})(1 - \frac{\varphi^2}{2})$

$M_v = -k x_0 L \sin(\frac{\pi}{2} + \varphi) - k x L \sin(\frac{\pi}{2} + \varphi)$

x_0: raztezek vzmeti v ravnovesnem stanju; x: dodaten raztezek pri nihanju

$\approx -k x_0 L (1 - \frac{\varphi^2}{2}) - k x L (1 - \frac{\varphi^2}{2})$

za majhne odmike od ravnovesne lege je sprememba navora

$M_v = -kL^2 \sin\varphi \approx -kL^2\varphi$ 3T

$J = \frac{1}{3} m_p L^2 + \frac{1}{12} m_b b^2 + m_b (a + \frac{b}{2})^2$

2T 2T 2T

$J \frac{d^2\varphi}{dt^2} = -kL^2\varphi$ (2. NZ za navore)

$\frac{d^2\varphi}{dt^2} + \frac{kL^2}{J}\varphi = 0$ (nihajna enačba)

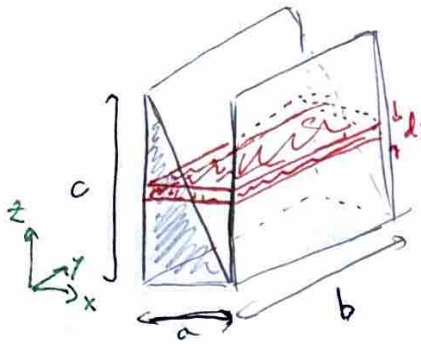
2T

$\omega^2 = \frac{kL^2}{J} \rightarrow t_0 = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{kL^2}{J}}} = 2\pi\sqrt{\frac{m_p L^2/3 + m_b b^2/12 + m_b(a + \frac{b}{2})^2}{kL^2}}$

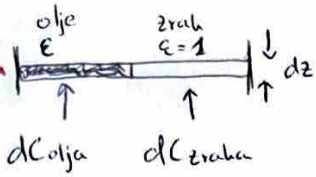
$= 0{,}24\,Hz$ 1T

b) Σ 12T

$$x_{olja}(z) = \left(1 - \frac{z}{c}\right) a \quad 5T$$



5T



zaporedno: $\frac{1}{dC} = \frac{1}{dC_{olja}} + \frac{1}{dC_{zraka}}$ 5T

$$dC_{olja} = \frac{\varepsilon \varepsilon_0 b\, dz}{x_{olja}(z)} \qquad dC_{zraka} = \frac{\varepsilon_0 b\, dz}{a - x_{olja}(z)}$$

$$\frac{1}{dC} = \frac{x_{olja}}{\varepsilon\varepsilon_0 b\, dz} + \frac{a - x_{olja}}{\varepsilon_0 b\, dz} = \frac{x_{olja} + \varepsilon(a - x_{olja})}{\varepsilon\varepsilon_0 b\, dz}$$

$$dC = \frac{\varepsilon\varepsilon_0 b\, dz}{x_{olja} + \varepsilon(a - x_{olja})} = \frac{\varepsilon \varepsilon_0 b}{a} \frac{dz}{1 - (1-\varepsilon)\frac{z}{c}} \quad 5T$$

$$\left(1 - \frac{z}{c}\right) a + \varepsilon a - \varepsilon\left(1 - \frac{z}{c}\right) a$$

$$= (1-\varepsilon)\left(1 - \frac{z}{c}\right) a + \varepsilon a =$$

$$= a - \frac{z}{c} a - \varepsilon a + \varepsilon \frac{z}{c} a + \varepsilon a$$

$$= a\left(1 - \frac{z}{c} + \varepsilon \frac{z}{c}\right) = a\left[1 - (1-\varepsilon)\frac{z}{c}\right]$$

$$\int_0^c dC = \frac{\varepsilon\varepsilon_0 b}{a} \int_0^c \frac{dz}{1 - (1-\varepsilon)\frac{z}{c}}$$

$u = 1 - (1-\varepsilon)\frac{z}{c}$

$du = -(1-\varepsilon)\frac{dz}{c}$

$u(z=0) = 1$

$u(z=c) = \varepsilon$

$$C = \frac{\varepsilon\varepsilon_0 b}{a} \int_1^{\varepsilon} \frac{-du \cdot c/(1-\varepsilon)}{u}$$

$$= \frac{\varepsilon\varepsilon_0 bc}{a} \frac{1}{\varepsilon - 1} \int_1^{\varepsilon} \frac{du}{u} = \frac{\varepsilon\varepsilon_0 S}{a} \frac{\ln\varepsilon}{\varepsilon - 1}$$

$$= \ln\varepsilon - \ln 1 = \ln\varepsilon$$

$$C = \frac{5 \cdot 8{,}85 \cdot 10^{-12}\,\mathrm{F} \cdot 0{,}05\,\mu\mathrm{m} \cdot 0{,}08\,\mu\mathrm{m}}{\mu\mathrm{m} \cdot 0{,}005\,\mu\mathrm{m}} \frac{\ln 5}{5-1} = 1{,}4 \cdot 10^{-11}\,\mathrm{F} = 14\,\mathrm{pF} \quad 5T$$