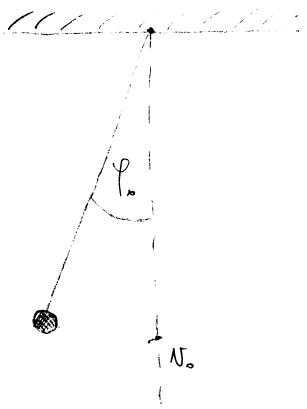
20.2.07

NIHANJE:

Str. 29/NAL. 1



$\varphi_0 = 3{,}5°$

$l = 3\,m$

$t = 15\,s$

$N(15\,s) = ?$

$v_0 = ?$

$v_0(\varphi = 0) = ?$

kotna hitrost

$$\omega_0 = \sqrt{\frac{g}{l}}$$

nihajni čas

$$t_0 = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{l}{g}}$$

$$t_0 = 2\pi\sqrt{\frac{3\,m \cdot s^2}{10\,m}} = 3{,}4\,s$$

$$N(15\,s) = \frac{15\,s}{3{,}4\,s} = 4{,}4$$

$$\omega = \omega_0 \cdot \varphi' \rightarrow \omega = \omega_0(\varphi_0 - \varphi)$$

$$\omega_0 = \sqrt{\frac{10\,m}{s^2 \cdot 3\,m}} = 1{,}82\,s^{-1}$$

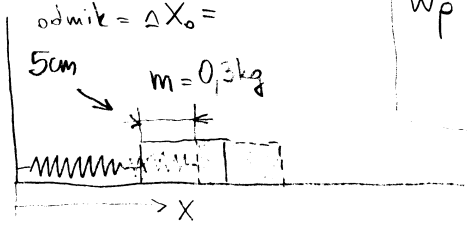
$$v_0 = \omega \cdot l = \omega_0 \cdot \varphi' \cdot l =$$

$$= \omega_0 \cdot l \cdot (\varphi_0 - \varphi) = 1{,}82\,s^{-1} \cdot 3\,m \cdot \left(\frac{3{,}5° \cdot \pi}{180°}\right) = 0{,}3\,m/s$$

($\varphi_0 = 3{,}5°$, $\varphi = 0°$)

$$v_0 = \omega_0 \cdot \varphi_0 \cdot l$$

Str. 29/NAL. 3



$X_0 = 50\,cm$

$k = 30\,N/m$

$X(0{,}2\,s) = ?$

$v(0{,}2\,s) = ?$

$a(0{,}2\,s) = ?$

$a_{max} = ?$

$\Delta X_0 = 5\,cm$

$$W_p = \frac{1}{2} k \Delta x^2$$

$$t = \frac{t_0}{2}$$

$$\omega = \sqrt{\frac{30\,N}{m \cdot 0{,}3\,kg}} = 10\,s^{-1}$$

$$\Delta X = \Delta X_0 \cdot \cos(\omega t)$$

$$\Delta X = 5\,cm \cdot \cos(10\,s^{-1} \cdot 0{,}2\,s) = -2{,}1\,cm$$

$$X(0{,}2\,s) = 50\,cm - 2{,}1\,cm = 47{,}9\,cm$$

$$a(0{,}2\,s) = \frac{-k\Delta X}{m} = \frac{-30\,N \cdot (0{,}021\,m)}{0{,}3\,kg} = 2{,}1\,m/s^2$$

$$\sum F = m \cdot a$$

$$F_{vz} = m \cdot a$$

$$-k\Delta X = m \cdot a$$

$$-k\Delta X = m \cdot \frac{d^2 \Delta X}{dt^2}$$

$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

$$\Delta X = \Delta X_0 \cdot \sin(\omega t)$$

$$-k \cdot X_0 \cdot \sin(\omega t) = m \cdot X_0(-\omega^2) \cdot \sin(\omega t)$$

$$k = m \cdot \omega^2$$

$$\omega = \sqrt{\frac{k}{m}}$$

$$v = \frac{d(\Delta X_0 \cdot \cos(\omega t))}{dt} = \Delta X_0(-\sin(\omega t) \cdot \omega) = -\Delta X_0 \cdot \omega \cdot \sin(\omega t)$$

↑ odvajamo

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$\sin 2 = \omega t \Rightarrow \omega t = 10\,s^{-1} \cdot 0{,}2\,s$

$v = 5\,cm \cdot 10\,s^{-1} \cdot \sin 2 = -45{,}5\,cm/s$

$a_{max} = \frac{|k \cdot \Delta x_0|}{m} = \frac{30\,N \cdot 0{,}05\,m}{m \cdot 0{,}3\,kg} = 5\,m/s^2$

$t_0 = \frac{2\pi}{\omega} = \frac{6{,}28}{10\,s^{-1}} = 0{,}63\,s$

$t = \frac{t_0}{2} = 0{,}315\,s$

formule:

$X = A \cdot \sin \omega t \ (\cos \omega t)$

max $\begin{cases} v_0 = \omega \cdot A \\ a_0 = \omega^2 \cdot A \end{cases}$

A - amplituda

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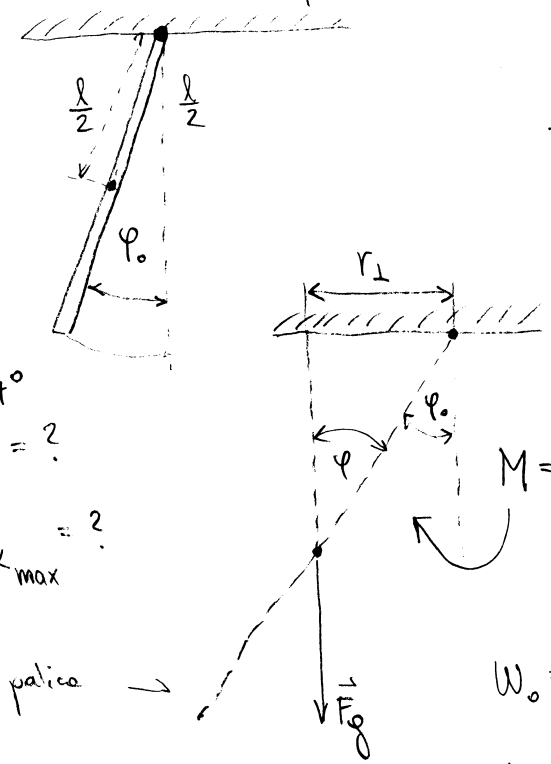
str. 30/NAL.5 $m = 2{,}8\,kg$, $l = 1{,}5\,m$



$\varphi = 4°$

$t_0 = ?$

$W_{k\,max} = ?$

$m \cdot a = F$ → kroženje točkasto telo

$J \cdot \alpha = M$ → -"- togo telo (palica) } NJUTNOV ZAKON

$\frac{1}{3} m \cdot l^2 \cdot \alpha = -F_g \cdot \frac{l}{2} \cdot \sin \varphi$

$\frac{1}{3} m \cdot l \cdot \alpha = -m \cdot g \cdot \frac{\varphi}{2}$

$\alpha = -\frac{3g}{2l} \cdot \varphi$

majhni koti: točkasto telo (vrvica z maso)

$\sin \varphi \approx \varphi$

$\cos \varphi \approx 1$

$\omega_0 = \sqrt{\frac{g}{l}}$

$M = -r_\perp \cdot F = -\frac{l}{2} \cdot \sin \varphi \cdot F$

$\alpha = -\omega_0^2 \cdot \varphi$

$\omega_0 = \sqrt{\frac{3g}{2l}}$

togo telo (palica)

$\omega_0 = \sqrt{\frac{3 \cdot 10\,m}{2 \cdot s^2 \cdot 1{,}5\,m}} = 3{,}16\,s^{-1}$

$t_0 = \frac{2\pi}{\omega} = \frac{6{,}28}{3{,}16\,s^{-1}} = 2\,s$

$W_{k\,max} = W_{p\,max}$

$W_{p\,max} = m \cdot g \cdot h$

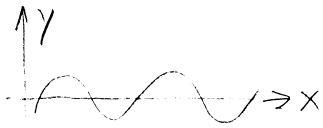
$h = \frac{l}{2} - \left(\frac{l}{2} \cdot \cos \varphi\right) = \frac{l}{2}(1 - \cos \varphi)$

$W_{p\,max} = m \cdot g \cdot \frac{l}{2}(1 - \cos \varphi) = 2{,}8\,kg \cdot 10\,m/s^2 \cdot \frac{1{,}5\,m}{2} \cdot (1 - \cos 4°)$

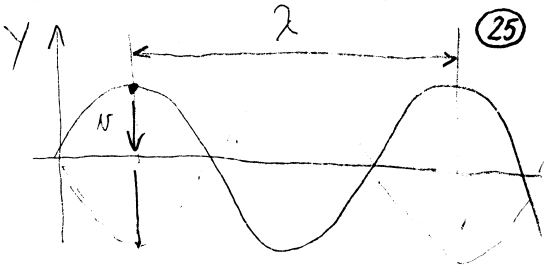
$W_{p\,max} = 0{,}05\,J = W_{k\,max}$

VALOVANJE :

STR. 30 / NAL. 1.



$y(x,t)$



$$y = A \cdot \sin(kx - \omega t)$$

φ - faza valovanja

$$\varphi = \omega t + kx$$

$$\omega = \frac{2\pi}{t_0} \qquad k = \frac{2\pi}{\lambda_0}$$

λ_0 - valovna dolžina

$$y = A \cdot \sin\left(2\pi\left(\frac{t}{t_0} - \frac{x}{\lambda_0}\right)\right)$$

$$c_0 = \frac{\lambda_0}{t_0} = \frac{\omega}{2\pi} \cdot \frac{2\pi}{k} = \frac{\omega}{k} = \lambda_0 \cdot \nu_0$$

c_0 - hitrost valovanja

$$y = A \cdot \sin(kx - \omega t)$$

$$v = -A \cdot \omega \cdot \cos(kx - \omega t)$$

$$a = -A \cdot \omega^2 \cdot \sin(kx - \omega t)$$

$A = 3{,}3\ cm$

$k = 0{,}47\ m^{-1}$

$\omega = 3{,}7\ s^{-1}$

$\lambda = ?$

$t_0 = ?$

$y(20m; 6{,}9s) = ?$

$v_y(20m; 6{,}9s) = ?$

$c = ?$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi\ m}{0{,}47} = 13{,}4\ m$$

$$t_0 = \frac{2\pi}{\omega} = \frac{2\pi \cdot s}{3{,}7} = 1{,}7\ s$$

$$c = \frac{\lambda}{t_0} = \frac{13{,}4\ m}{1{,}7\ s} = 7{,}9\ m/s$$

$$y(20m; 6{,}9s) = 3{,}3\ cm \cdot \sin(0{,}47\ m^{-1} \cdot 20\ m - 3{,}7\ s^{-1} \cdot 6{,}9\ s) = -0{,}92\ cm$$

$$v_y = \frac{dy}{dt} = A \cdot \cos(kx - \omega t) \cdot (-\omega) = 3{,}3\ cm \cdot \cos(-16{,}3)(-3{,}7\ s^{-1}) = 11\ cm/s$$

v_y ↑ odvajamo

STR. 31 / NAL. 4

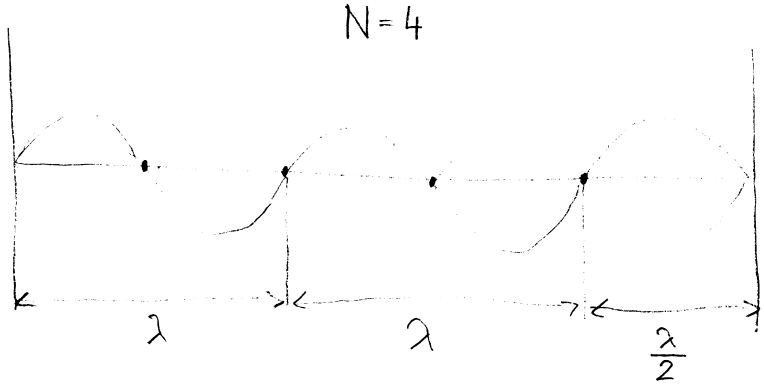
$\nu = 600\ Hz$

$c = 400\ m/s$

$N = 4$

$l = ?$

$m = 5g \,/\, F = ?$



$$l = N \cdot \frac{\lambda}{2}$$

↑ spojimo

$$l = 5 \cdot \frac{\lambda}{2}$$

$$c = \nu \cdot \lambda \Rightarrow \lambda = \frac{c}{\nu} = \frac{400\ m \cdot s}{s \cdot 600} = \frac{2}{3} = 0{,}66\ m$$

$$l = 5 \cdot \frac{0{,}66}{2} = 1{,}65\ m$$

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$$c = \sqrt{\frac{F}{m/l}} = \sqrt{\frac{F \cdot l}{m}}$$

$$c^2 = \frac{F \cdot l}{m} \Rightarrow F = \frac{c^2 \cdot m}{l} = \frac{160000\ m^2 \cdot 0{,}005\ kg}{s^2 \cdot 1{,}65\ m} = 480\,N$$

NAL. 5

$\nu_1 = 500\ Hz$

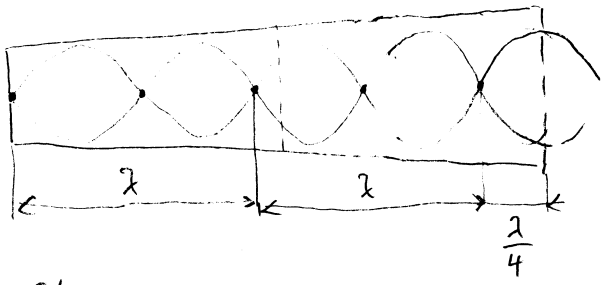
$\Delta l = 0{,}5\ m$

$\nu_2 = ?$

$N = ?$ (šmih.)

$c = 340\ m/s$

$N = 4$



$\lambda + \lambda + \frac{\lambda}{4} = \frac{9}{4}\lambda$

$$\lambda = \frac{c}{\nu_1} = \frac{340\ m}{s \cdot 500\ s^{-1}} = 0{,}68\ m$$

$$l_1 = \frac{9}{4}\lambda = 1{,}53\ m \qquad l_2 = 2{,}03\ m$$

$$\lambda_2 = \frac{4}{9} l_2 = 0{,}9\ m$$

$$\nu_2 = \frac{c}{\lambda_2} = \frac{340\ m}{s \cdot 0{,}9\ m} = 377\ s^{-1}$$

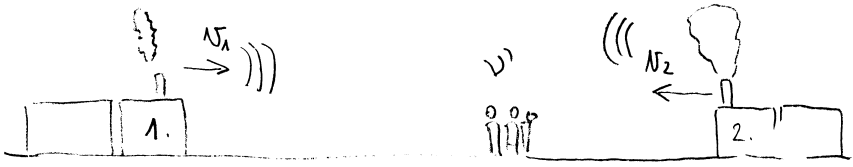
STR 31 / NAL. 8 DOPPLERJEV POJAV

$v = 80\ km/h$

$\nu = 500\ Hz$

a) gibanje izvora / opazovalec miruje

b) gibanje opazovalca



a) $\nu' = \dfrac{\nu}{1 \mp \frac{v}{c}}$ PRIB.: − ODDAL.: +

a) $c' = c$

$c' = \lambda' \cdot \nu' = \lambda \cdot \nu = c$

$\nu' = \dfrac{\lambda \cdot \nu}{\lambda'} =$

$\nu' = \dfrac{\lambda \cdot \nu}{\lambda\left(1 - \frac{v_1}{c}\right)}$

$\nu' = \dfrac{\nu}{1 - \frac{v_1}{c}}$

$\nu' = \dfrac{500\ Hz}{1 - \left(\frac{80\ km \cdot h}{h \cdot 1224\ km}\right)} = 535\ Hz$

$\lambda' = \lambda - v_1 \cdot t_0$

$\lambda' = \lambda - v_1 \cdot \frac{1}{\nu}$

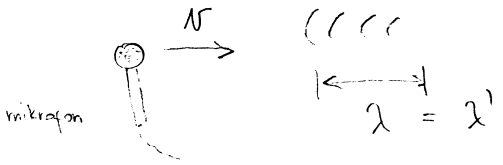
$\nu = \frac{c}{\lambda}$

$\lambda' = \lambda - \frac{v_1}{\left(\frac{c}{\lambda}\right)}$

$\lambda' = \lambda - \frac{v_1 \lambda}{c}$

$\lambda' = \lambda\left(1 - \frac{v_1}{c}\right)$

b)



$$c' = c + v$$

$$\lambda' \cdot \nu' = \lambda \nu + v \qquad \lambda = \frac{c}{\nu}$$

$$\lambda \cdot \nu' = \lambda \cdot \nu + v$$

$$\nu' = \nu + \frac{v}{\lambda} = \nu + \frac{v \cdot \nu}{c}$$

$$\nu' = \nu\left(1 + \frac{v}{c}\right)$$

c)

$$\nu' = \nu\left(1 \pm \frac{v}{c}\right)$$

PRIBL.: +
ODDAL: −

$$\nu'' = \nu \cdot \frac{\left(1 \pm \frac{v_{op.}}{c}\right)}{\left(1 \pm \frac{v_{izv.}}{c}\right)}$$

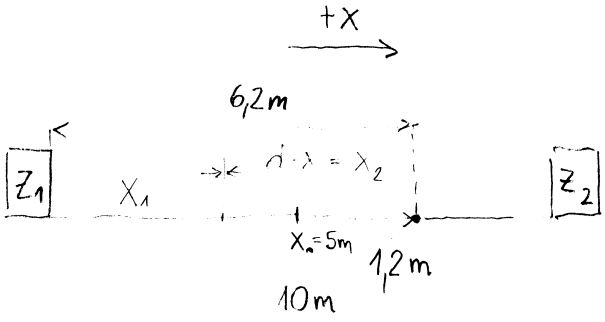
PRIBL.: +
ODDAL.: −
PRIBL.: −
ODDAL.: +

$$\nu'' = \nu \cdot \frac{\left(1 + \frac{v_2}{c}\right)}{\left(1 - \frac{v_1}{c}\right)} = 500\,s^{-1} \cdot \frac{\left(1 + \frac{60\,km/h}{1224\,km/h}\right)}{\left(1 - \frac{80\,km/h}{1224\,km/h}\right)} = 561\,Hz$$

22.02.2007

INTERFERENCA: (stoječe valovanje) SUPERPOZICIJA

STR. 32/ NAL. 9



$\nu = 1\,kHz$

$d = 10\,m$

$c = 340\,m/s$

$N =$

$$y = A \cdot \cos(\omega t \pm kx) \qquad y_1 = A \cdot \cos(\omega t - kx)$$

izberemo, da je $t = 0$

$$y_2 = A \cdot \cos(\omega t + k(x-d))$$

skupno valovanje

$$y = y_1 + y_2 = A\left(\cos(\omega t - kx) + \cos(\omega t + k(x-d))\right)$$

$$\varphi_1 = -kx$$

$$\varphi_2 = k(x-d)$$

ODSLABITEV: $\Delta\varphi = \pi + N \cdot 2\pi$; $\pi(2N+1)$

POGOJ ZA OJAČITEV: $N \cdot 2\pi = \pi(2N) = 2N\pi$

(28)

$\Delta\varphi = \varphi_2 - \varphi_1 = k(x-d) + kx = kx - kd + kx = 2kx - kd$

$2N\pi = 2\cdot\frac{2\pi}{\lambda}x - \frac{2\pi}{\lambda}\cdot d$

$N = \frac{2x}{\lambda} - \frac{d}{\lambda}$

$N\lambda = 2x - d \Rightarrow X = \frac{N\lambda + d}{2} = 5m + \frac{N\lambda}{2}$

$c = \lambda\cdot\nu$

$\lambda = \frac{c}{\nu} = 0{,}34m$

$X = 5m + \frac{N\cdot c}{\nu\cdot 2} = 5m + 0{,}17N$

$N(max) \Rightarrow \quad 6{,}2m = 5m + 0{,}17N$

$1{,}2m = 0{,}17N$

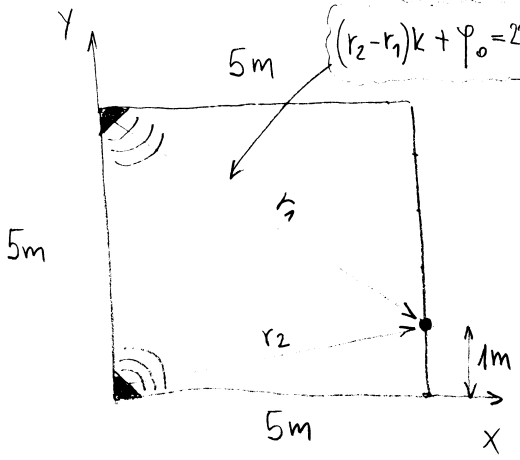
$N = \frac{1{,}2m}{0{,}17} = 7{,}05 = \underline{7}$ ← upoštevati še ojačitev pri ničli $X_0 = 5m$

$N_{OJAČITEV} = 8$

STR. 32 / NAL. 11.

$\nu = 200Hz$

$\varphi_0 = ?$ (fazni zamik)



$(r_2 - r_1)k + \varphi_0 = 2\pi$ $\Delta\varphi = 2N\pi$ (ojačitev) ; izberemo $N = 0$

$\Delta\varphi = 0$

$\Delta\varphi = 0 = -kr_2 + \varphi_0 + kr_1$

$\varphi_0 = kr_2 - kr_1$ $\quad k = \frac{2\pi}{\lambda}$

$\varphi_0 = -4{,}81$ $\quad k = 3{,}7m^{-1}$

$\varphi_1 = -kr_1$

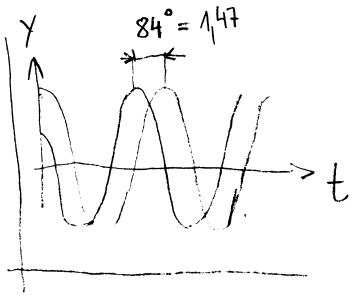
$\varphi_2 = -kr_2 + \varphi_0$

$r_2 = \sqrt{25^2m + 1m^2} = 5{,}1m$

$r_1 = \sqrt{25m^2 + 16m^2} = 6{,}4m$

$\lambda = \frac{c}{\nu} = 1{,}7m$

$\varphi_0 = -4{,}81 + 2\pi = 1{,}47 = 84°$



razlika faz je večkratnik števila π.

Energijski zakoni, nihanje, gibalna količina, tekočina – Bernoullijeva enačba, hidrostatika, gravitacijski zakoni, prožnost snovi, kroženje – radialni pospešek, navpični met – poševni met,

TERMODINAMIKA:

STR. 33 / NAL. 2

$T_0 = 10°C$

$l_{Cu} = 2005\,mm$

$l_{Zn} = 2000\,mm$

$\alpha_{Cu} = 1{,}67 \cdot 10^{-5}\,K^{-1}$

$\alpha_{Zn} = 3{,}0 \cdot 10^{-5}\,K^{-1}$

$$\frac{\Delta l}{l} = \alpha \cdot \Delta T \quad ; \quad \Delta l = l \cdot \alpha \cdot \Delta T$$

$$l'_{Cu} = l'_{Zn}$$

$$l_{Cu} + l_{Cu} \cdot \alpha_{Cu} \cdot \Delta T = l_{Zn} + l_{Zn} \cdot \alpha_{Zn} \cdot \Delta T$$

$$l_{Cu} - l_{Zn} = l_{Zn}\alpha_{Zn} \cdot \Delta T - l_{Cu}\alpha_{Cu}\Delta T$$

$$l_{Cu} - l_{Zn} = \Delta T(l_{Zn}\alpha_{Zn} - l_{Cu}\alpha_{Cu})$$

$$\Delta T = \frac{l_{Cu} - l_{Zn}}{l_{Zn}\alpha_{Zn} - l_{Cu}\alpha_{Cu}} = \frac{5\,mm}{2000\,mm(3 \cdot 10^{-5}\,K^{-1} - 1{,}67 \cdot 10^{-5}\,K^{-1})}$$

$$\Delta T = 188\,K$$

$$T_1 = \Delta T + T_0 = 198°C$$

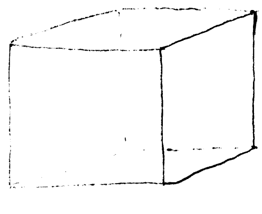
STR. 33 / NAL. 3

$V_0 = 5\,m^3$

$\Delta T = 23\,K$

$\beta_N = 9{,}5 \cdot 10^{-5}\,K^{-1}$

$\alpha_{Fe} = 1{,}1 \cdot 10^{-5}\,K^{-1}$



$$V_{Fe} = a^3$$

$$V'_{Fe} = a^{3\,\prime} = (a + a\alpha_{Fe} \cdot \Delta T)^3 =$$

$$= a^3(1 + \alpha_{Fe} \cdot \Delta T)^3 \Rightarrow$$

$$\approx a^3(1 + 3\alpha_{Fe}\Delta T) =$$

$$= a^3(1 + \beta_{Fe}\Delta T)$$

$$\Delta l = l \cdot \alpha \cdot \Delta T$$
$$\Delta V = V \cdot \beta \cdot \Delta T$$

$$\beta_{Fe} = 3\alpha_{Fe}$$

$$\Delta V = V'_N - V'_{Fe}$$

$$\Delta V = a^3 + a^3\beta_N \cdot \Delta T - (a^3 + a^3\beta_{Fe} \cdot \Delta T)$$

$$\Delta V = a^3 \Delta T(\beta_N - \beta_{Fe})$$

$$\Delta V = 5000\,l \cdot 23\,K(9{,}5 \cdot 10^{-5}\,K^{-1} - 3 \cdot 1{,}1 \cdot 10^{-5}\,K^{-1})$$

$$\Delta V = 7{,}1\,l$$

PLINSKA ENAČBA: (30)

STR. 33/NAL. 1

izohora → volumen konst.
izoterma → temp. konst.
izobara → pritisk (tlak) konst.

$V_1 = 5\,l$

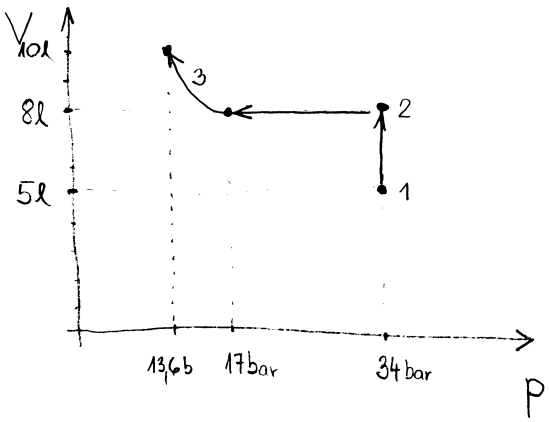
$m = 0{,}2\,kg$

$T_1 = 296\,K = 23°C$

$V_2 = 8\,l$

$p_3 = \frac{p_1}{2}$

$V_4 = 10\,l$



izobarna sp.

$M = 29\,kg/kmol$

$R = 8314\,J/kmol\,K$

a) $p \cdot V = \frac{m \cdot R \cdot T}{M}$ ideal. plinska enač.

$$p_1 = \frac{m_1 \cdot R \cdot T_1}{M \cdot V_1} = \frac{0{,}2\,kg \cdot 8314\,J \cdot 296\,K\,kmol}{kmol\,K \cdot 29\,kg \cdot 0{,}005\,m^3} = 3{,}4 \cdot 10^6\,N/m^2\,[Pa]$$

$$= 34\,bar = p_2$$

izohorna sp.

b) $p_2 = p_1$ $\quad \frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow T_2 = \frac{V_2 \cdot T_1}{V_1} = 474\,K$$

c) izohorna sprememba

$V_3 = V_2$ $\quad \frac{p_2 V_2}{T_2} = \frac{p_3 V_3}{T_3} \Rightarrow$ $\quad p_3 = \frac{p_1}{2} = 17\,bar$

$$T_3 = \frac{p_3 T_2}{p_2} = 237\,K$$

d) izotermna sprememba: $T_3 = T_4$ $\quad \frac{p_3 V_3}{T_3} = \frac{p_4 V_4}{T_4}$

$$p_4 = \frac{p_3 V_3}{V_4} = 13{,}6\,bar$$

STR. 34/ NAL. 2:

$h_2 = 0{,}2\,m$

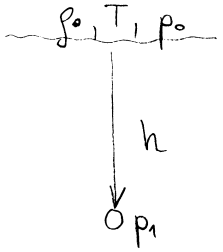
$T = 294\,K$

$p_0 = 1{,}02\,bar$

$\rho = ?$

$h_2 = ?$ ($\rho = 2\cdot\rho_0$) — zraka na gladini

$\rho_{H_2O} = 1000\,kg/m^3$



$p_1 = p_0 + \rho_{H_2O} g h$

$p_1 = 1{,}02\,bar + 1000\,kg/m^3 \cdot 10\,m/s^2 \cdot 0{,}8\,m$

$p_1 = 1{,}02\cdot 10^5\,N/m^2 + 0.08\cdot 10^5\,N/m^2$

$p_1 = 1{,}1\cdot 10^5\,Pa = 1{,}1\,bar$

$$\frac{p_1 \cdot V_1}{T_1} = \frac{m \cdot R}{M} \;/\cdot V_1$$

$$\frac{p_1}{T_1} = \frac{m \cdot R}{V_1 \cdot M} = \frac{R}{M}\cdot\rho \qquad \rho = \frac{m}{V_1}$$

$$\boxed{\rho = \frac{p \cdot M}{R \cdot T}}$$

$$\rho = \frac{p_1 \cdot M}{T_1 \cdot R} = \frac{1{,}1\cdot 10^5\,Pa \cdot 29\,kg \cdot kmol\,K}{kmol \cdot 294\,K \cdot 8314\,J} = 1{,}3\,kg/m^3$$

$$\frac{p_2 \cdot M}{R \cdot T} = \frac{2 \cdot p_0 \cdot M}{R \cdot T}$$

$p_2 = 2\,p_0 = 2{,}04\,bar$

$p_2 = 2{,}04\,bar = p_0 + \rho g h_2 = 1{,}02\,bar + \rho g h_2$

$$h_2 = \frac{1{,}02\,bar \cdot m^3/s^2}{1000\,kg \cdot 10\,m} = 10{,}2\,m$$

NAL. 4 $h = 1000\,m$

$p_0 = 0{,}9\,bar$

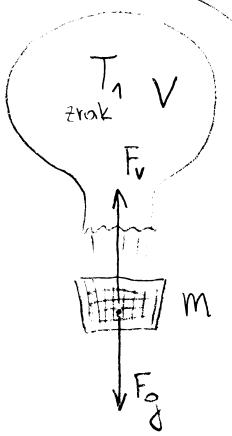
$T_0 = 283\,K$

$T_1 = 318\,K$

$m = 200\,kg$

$m_{zraka} = ?$

izpodrinjeni zrak



p_0

$F_{vzg} = F_g$ → $m_{balona} + m_{zraka\ v\ kupoli}$

$m_z' \cdot g = m_t \cdot g + m_z \cdot g$

$m_z' - m_z = m_t$

$m_H - m_v = m_t$ — Hkadm. vrači tovor

$$\frac{p \cdot V}{T} = \frac{m \cdot R}{M} \Rightarrow m = \frac{pVM}{RT}$$

$$\frac{p_0 \cdot V \cdot M}{R T_H} - \frac{p_0 V \cdot M}{R T_v} = m_t$$

$$\frac{p_0 V M}{R}\left(\frac{1}{T_H} - \frac{1}{T_v}\right) = m_t \Rightarrow V = \frac{m_t \cdot R}{\left(\frac{1}{T_H} - \frac{1}{T_v}\right)\cdot M\, p_0} = \frac{0{,}64\,m^3 K}{3{,}9\cdot 10^{-4} K}$$

$$V = 1650\,m^3$$

7. 3. 2007 (32)

STR. 34 / NAL. 1 :

$C = 800\ J/K$

$m_V = 1\ kg$

$T_V = 20°C$

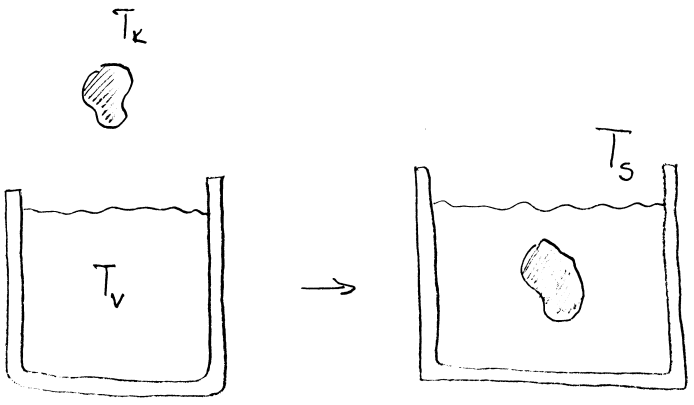
$m_K = 1{,}5\ kg$

$T_K = 500°C$

$T_S = 90°C$

$c_{V_1} = 4200\ J/kgK$

$c_{V_2} = ?$



oddana — prejeta

$Q_o = Q_p$

splošna formula

$Q = m \cdot c_V \cdot \Delta T$

$Q = C \cdot \Delta T$

STR 35/ NAL. 3

$C = 750\ J/K$

$m_v = 1{,}5\ kg$

$T_v = 20°C$

$m_{Fe} = 2{,}5\ kg$

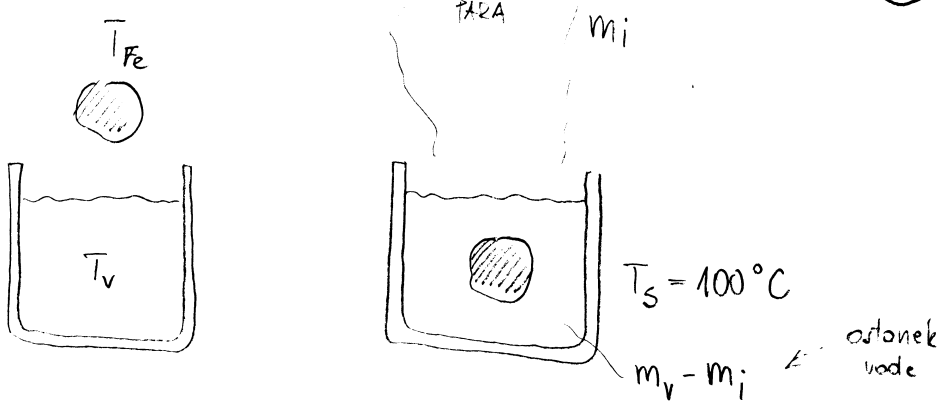
$T_{Fe} = 800°C$

$m_i =$

$c_{v_1} = 4200\ J/kgK$

$q_i = 2{,}2\ MJ/kg$

$c_{v2} = 457\ J/kgK$



$Q_o = Q_p$ (POSODA, VODA, PARA)

$$m_{Fe} \cdot c_{v_2} \cdot (T_{Fe} - T_S) = C \cdot (T_S - T_v) + m_v \cdot c_{v_1} (T_S - T_v) + m_i \cdot q_i$$

$$m_i \cdot q_i = m_{Fe} \cdot c_{v_2} (T_{Fe} - T_S) - (T_S - T_v)(C + m_v c_{v_1})$$

$$m_i \cdot q_i = 2{,}5\,kg \cdot 457\,J/kgK \cdot 700K - 80K \cdot 7050\,J/K$$

$$m_i q_i = 236\,kJ$$

$$m_i = \frac{236\,kJ}{2200\,kJ/kg} = 107\,g$$

STR 35/ NAL. 4

$m = 1\,g$

$T_o = 0°C$

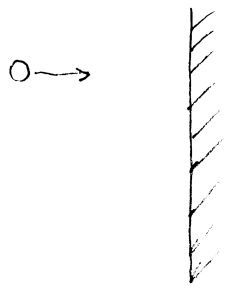
$\eta = 0{,}75$

$c_v = 130\ J/kgK$

$T_T = 327°C$

$q_T = 22{,}5\ kJ$

$v = ?$



$$\eta \cdot \Delta W_k = Q_p$$

$$0{,}75 \cdot \frac{1}{2} m \cdot v^2 = m \cdot c_v \cdot T_T + m \cdot q_T$$

$$v^2 = \frac{2 \cdot m \cdot c_v \cdot T_T + m \cdot q_T}{0{,}75 \cdot m}$$

$$v^2 = \frac{2 \cdot 130\,J/kgK \cdot 327K + 22{,}5 \cdot 10^3\,J}{0{,}75}$$

$$v^2 = 173400\,m^2/s^2$$

$$v = 416\,m/s$$

STR. 37 / NAL. 1 (34)

$S_1 = 35\,m^2$

$P = 4\,kW$

$T_z = -20\,°C$

$\lambda = 0{,}4\,W\,m^{-1}K^{-1}$

$d = 0{,}15\,m$

$T_{N_1} = ?$

$S_2 = 25\,m^2$

$P_0 = 1800\,W$

$\Delta T_{N_2} = ?$

$j = \frac{P}{S}$ toplotni tok — gostota toplotnega toka

$j = \lambda \cdot \frac{\Delta T}{d}$

$P = \lambda \cdot \frac{\Delta T}{d} \cdot S_1$

$\Delta T = \frac{P \cdot d}{\lambda \cdot S_1} = \frac{4000\,W \cdot 0{,}15\,m \cdot m \cdot K}{0{,}4\,W \cdot 35\,m^2} = 42{,}8\,K$

$T_{N_1} = T_z + \Delta T = 22{,}8\,°C$

$P = \lambda \cdot \frac{\Delta T}{d} \cdot S_2 + P_0$

$\Delta T = \frac{P - P_0}{\lambda \cdot S_2} \cdot d = \frac{2200\,W \cdot 0{,}15\,m \cdot m \cdot K}{0{,}4\,W \cdot 25\,m^2} = 33\,K$

$T_{N_2} = T_z + \Delta T = 13\,°C$

$\Delta T' = T_{N_1} - T_{N_2} = 22{,}8\,°C - 13\,°C = 9{,}8\,°C$

STR. 39 / NAL. 1

$R = 5{,}3 \cdot 10^{-11}\,m$

$e_0 = 1{,}6 \cdot 10^{-19}\,As$

$m_e = 9{,}1 \cdot 10^{-31}\,kg$

$R_{pp} = 4 \cdot 10^{-15}\,m$

$F_{pe} = ?$

$v = ?$

$F_{pp} = ?$

$\varepsilon_0 = 8{,}85 \cdot 10^{-12}\,As/mV$

$\vec{F} = \frac{e_1 \cdot e_2}{4\pi\varepsilon_0 \cdot R^2} \cdot \left(\frac{\vec{R}}{R}\right)$ smer

$F = \frac{e_1 \cdot e_2}{4\pi\varepsilon_0 \cdot R^2}$ velikost

$F_g = \frac{m_1 \cdot m_2 \cdot G}{R^2}$

$F_{pe} = \frac{(1{,}6 \cdot 10^{-19}\,As)^2 \cdot m \cdot V}{4\pi (5{,}3 \cdot 10^{-11}\,m)^2 \cdot 8{,}85 \cdot 10^{-12}\,As}$

$[V] = \left[\frac{kg\,m}{A\,s^3}\right]$

$F_{pe} = 8{,}2 \cdot 10^{-8}\,N$

$F_{pe} = \frac{m \cdot v^2}{R} \Rightarrow v^2 = \frac{F_{pe} \cdot R}{m}$

$v = 2{,}2 \cdot 10^6\,m/s$

$$F_{pp} = \frac{e_1 \cdot e_2}{4\pi\varepsilon_0 \cdot R^2} = \frac{(1{,}6 \cdot 10^{-19}\,As)^2\, Vm}{4\pi \cdot 8{,}85 \cdot 10^{-12}\,As\,(4 \cdot 10^{-15}\,m)^2} = \underline{14{,}4\,N}$$

STR. 39 / NAL. 2

$e_1 = 3\mu As$

$e_2 = -5\mu As$

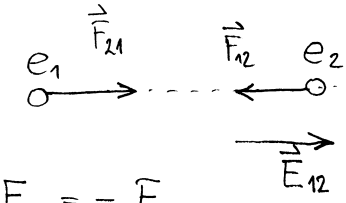
$d = 5\,cm$

$\vec{E}_{12} = ?$

$\vec{F}_{12} = ?$

$d_2 = 10\,cm$

$A = ?$



$F_{12} = -F_{21}$

$\vec{E} = \frac{\vec{F}}{e}\ [V/m]$

potencial

če gledamo v neskončnost

$U = \frac{e}{4\pi\varepsilon_0 \cdot R}$

$F = e \cdot E$

$A = e \cdot \Delta U$

elekt. potencial → $\Delta U\ [V]$

$$E_{12} = \frac{e_1}{4\pi \cdot \varepsilon_0 \cdot R^2} = \frac{3 \cdot 10^{-6}\,As \cdot Vm}{4\pi \cdot 8{,}85 \cdot 10^{-12}\,As \cdot (0{,}05)^2\,m^2} = \underline{1{,}08 \cdot 10^7\,V/m}$$

$$F_{12} = E_{12} \cdot e_2 = 1{,}08 \cdot 10^7\,V/m \cdot (-5 \cdot 10^{-6}\,As) = \underline{-54\,N}$$

$A = \Delta W_{pe}$; $W_{pe} = U_1 \cdot e_2 = W_{pe}(0{,}1\,m) - W_{pe}(0{,}05\,m)$

$A = U_1(0{,}1\,m) \cdot e_2 - U_1(0{,}05\,m) \cdot e_2 = e_2\,(U_1(0{,}1\,m) - U_2(0{,}05\,m))$

$A = -5 \cdot 10^{-6}\,As\,(270\,kV - 540\,kV)$

$\underline{A = 1{,}35\,J}$

$U = \frac{e_1}{4\pi\varepsilon_0 \cdot R} = \underline{270\,kV}$

STR. 40 / NAL. 7

$g = 9{,}8\,m/s^2$

$R_z = 6400\,km$

$m_{Lune} = 1/80\ m_z$

$m_H = 1{,}66 \cdot 10^{-27}\,kg$

$m_z = ?$

$$g = \frac{G \cdot m_z}{R_z^2} \Rightarrow m_z = \frac{g \cdot R_z^2}{G} = \frac{9{,}8\,m \cdot 6400 \cdot 10^3\,m^2 \cdot kg\,A^2}{s^2 \cdot 6{,}67 \cdot 10^{-11}\,m^3}$$

$\underline{m_z = 6 \cdot 10^{24}\,kg}$

$\underline{m_L = 7{,}5 \cdot 10^{22}\,kg}$

(36)

$$F_{ee} = F_g$$

$$\frac{e^2}{4\pi\varepsilon_0 R^2} = \frac{m_z \cdot m_L \cdot G}{R^2}$$

$$e^2 = G\, m_L\, m_z \cdot 4\pi\varepsilon_0 = 3{,}34 \cdot 10^{27}\,(As)^2$$

$$\underline{\underline{e = 5{,}8 \cdot 10^{13}\,As}}$$

$$e_1 = 2 \cdot e = 1{,}15 \cdot 10^{14}\,As$$

$$N = \frac{e_1}{e_0} = \frac{1{,}15 \cdot 10^{14}\,As}{1{,}6 \cdot 10^{-27}\,As} = \underline{7{,}2 \cdot 10^{32}}$$

$$m = m_H \cdot N = 1{,}66 \cdot 10^{-27}\,kg \cdot 7{,}2 \cdot 10^{32}$$

$$\underline{\underline{m = 1200\,t}}$$

STR. 41 / NAL. 1

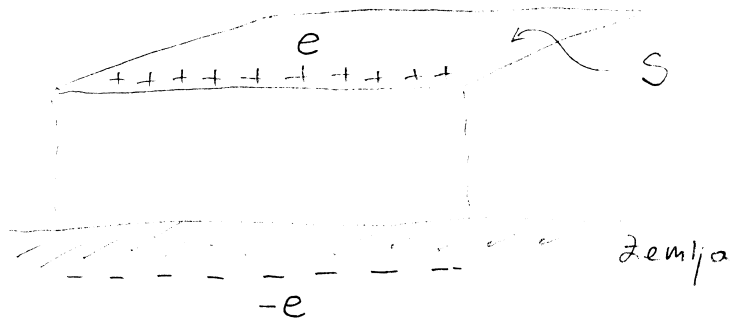
$h = 500\,m = d$

$e = 10\,As$

$U = ?$

$S = 4\,km^2 = 4 \cdot 10^6\,m^2$

$E = ?$



$$e = C \cdot U$$

$$C = \frac{\varepsilon_0 S \varepsilon_r}{d}$$ ← relativna dielektrična konst.

$$U = \frac{e}{C}$$

$$C = \frac{\varepsilon_0 \cdot S}{d}$$

$$C = \frac{8{,}85 \cdot 10^{-12}\,As \cdot 4 \cdot 10^6\,m^2}{mV \cdot 500\,m} = \underline{7{,}1 \cdot 10^{-8}\,F}$$

$$U = \frac{e}{C} = \frac{10\,As \cdot V}{7{,}1 \cdot 10^{-8}\,As} = \underline{1{,}4 \cdot 10^8\,V}$$

$$E = \frac{\Delta U}{\Delta l} = \frac{U}{d} = \frac{1{,}4 \cdot 10^8\,V}{500\,m} = 282\,kV/m$$

STR 41 / NAL. 2

$S = 100\,cm^2$

$d = 2\,mm$

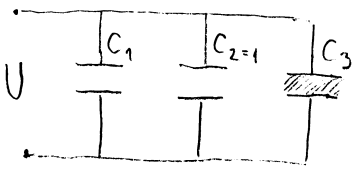
$U = 9V$

$\varepsilon_r = 3$

b) zapor $e_1, e_2, e_3 = ?$

a) vzpor. $e_1, e_2, e_3 = ?$

b)



$U_1 = U_2 = U_3 = 9V$

$e = U \cdot C \qquad C = \frac{\varepsilon_r \varepsilon_0 \cdot S}{d}$

$C_1 = \frac{\varepsilon_0 \cdot S}{d} = \frac{8{,}85 \cdot 10^{-12}\,As \cdot 0{,}01\,m^2}{Vm \cdot 2 \cdot 10^{-3}\,m} = 4{,}43 \cdot 10^{-11}\,F$

$C_2 = 4{,}43 \cdot 10^{-11}\,F$

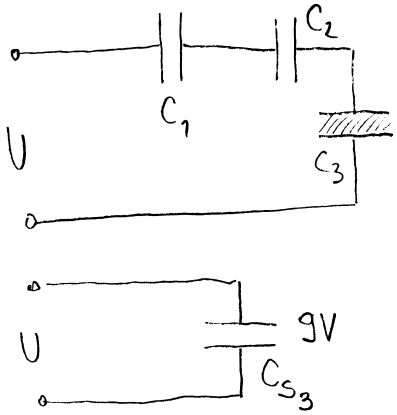
$C_3 = 4{,}43 \cdot 10^{-11} \cdot 3 = 1{,}33 \cdot 10^{-10}\,F$

$e_1 = 9V \cdot 4{,}43 \cdot 10^{-11}\,F = 4 \cdot 10^{-10}\,As$

$e_2 = 4 \cdot 10^{-10}\,As$

$e_3 = 3 \cdot 4 \cdot 10^{-3}\,As = 1{,}2 \cdot 10^{-9}\,As$

a)



$e_1 = e_2 = e_3 \qquad \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$C_{12} = \frac{C_1 \cdot C_2}{C_1 + C_2} = \frac{(4{,}43 \cdot 10^{-11}\,F)^2}{4{,}43 \cdot 10^{-11}\,F + 4{,}43 \cdot 10^{-11}\,F} = 2{,}27 \cdot 10^{-11}\,F$

$C_{s3} = \frac{C_8 \cdot C_3}{C_8 + C_3} = \frac{2{,}27 \cdot 10^{-11}\,F \cdot 1{,}33 \cdot 10^{-10}\,F}{2{,}27 \cdot 10^{-11}\,F + 1{,}33 \cdot 10^{-10}\,F} = 1{,}94 \cdot 10^{-11}\,F$

$e_{s3} = C_{s3} \cdot U = 1{,}94 \cdot 10^{-11}\,F \cdot 9V = 1{,}7 \cdot 10^{-10}\,As$

$W_e = \frac{1}{2} C U^2 = \frac{1}{2} \frac{e^2}{C}$ → elekt. energija v kondenzatorju!

STR 42 / NAL. 5

$S = 0{,}012\,m^2$

$d_1 = 0{,}002\,m$

$U_1 = 200V$

$d_2 = 0{,}004$

$C_2 = \frac{1}{2} C_1$

$U_2 = ?$

$A = ?$

$e_1 = e_2$

$U_1 \cdot C_1 = U_2 \cdot C_2$

$U_2 = \frac{U_1 C_1}{C_2} = \frac{U_1 \varepsilon_1 2}{\varepsilon_1} = 400V$

(38)

$$C_1 = \varepsilon_0 \frac{S}{d} = 8{,}85 \cdot 10^{-12}\,As/Vm \cdot \frac{0{,}012\,m^2}{0{,}002\,m} = 5{,}3 \cdot 10^{-11}\,F$$

$$C_2 = 2{,}66 \cdot 10^{-11}\,F$$

$$\Delta We = A \quad \Rightarrow \quad \frac{1}{2} C_2 U_2^2 - \frac{1}{2} C_1 U_1^2 = A$$

$$\frac{1}{2} \cdot 2{,}66 \cdot 10^{-11}\,F \cdot (400V)^2 - \frac{1}{2} \cdot 5{,}3 \cdot 10^{-11}\,F \cdot (200V)^2 = A$$

$$A = 1{,}07\,\mu J$$

STR. 42/NAL. 2

$R_1 = 10\,\Omega$

$R_2 = 20\,\Omega$

$R_3 = 50\,\Omega$

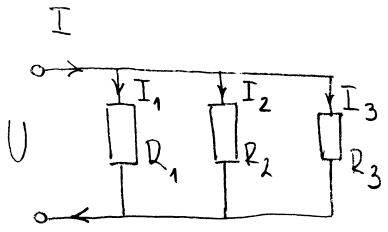
a) vzpor.

b) zapor.

$U = ?$

$I = 0{,}5\,A$

a)



$$U_1 = U_2 = U_3$$

$$I = I_1 + I_2 + I_3$$

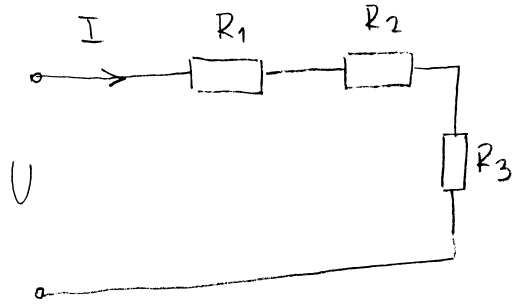
$$U = R \cdot I$$

$$R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{200\,\Omega^2}{30\,\Omega} = 6{,}67\,\Omega$$

$$R_{123} = \frac{R_{12} \cdot R_3}{R_{12} + R_3} = \frac{6{,}67\,\Omega \cdot 50\,\Omega}{6{,}67\,\Omega + 50\,\Omega} = 5{,}9\,\Omega$$

$$U = R_{123} \cdot I = 5{,}9\,\Omega \cdot 0{,}5A = 2{,}95V$$

b)



$$R_n = R_1 + R_2 + R_3 = 80\,\Omega$$

$$U = R_N \cdot I = 80\,\Omega \cdot 0{,}5A = 40V$$

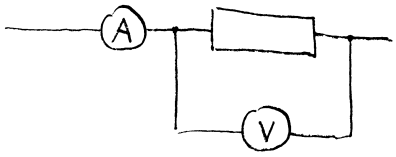
STR 43/ NAL. 5

$R = 300\,\Omega$

$R_A = 25\,\Omega$

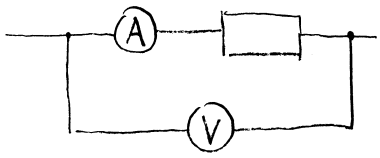
$R_V = 800\,\Omega$

a) 1. vezava



$P = U \cdot I$

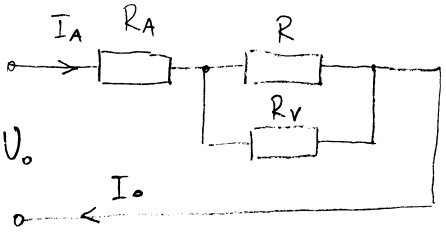
b) 2. vezava



izmerjena

a) $P_i = U_V \cdot I_A$

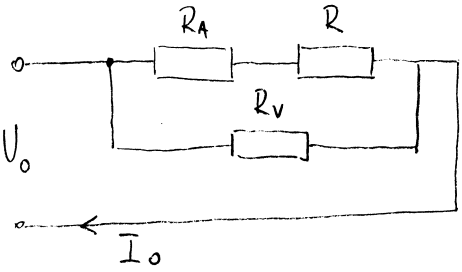
a)



$P_o = I_o \cdot U_o$

$\frac{P_i}{P_o}$

b)



$P = I^2 \cdot R = \frac{U^2}{R}$

$R_{1,2} = \frac{R R_V}{R + R_V}$

$R_{1,2} = \frac{300\,\Omega \cdot 800\,\Omega}{1100\,\Omega} = \underline{\underline{220\,\Omega}}$

$P_o = \frac{U_o^2}{R_{1,2,3}}$

$R_{1,2,3} = R_A + R_{1,2} = \underline{\underline{245\,\Omega}}$

$U_V = U_o - R_A \cdot I_o = U_o - R_A \frac{U_o}{R_{1,2,3}}$

$U_V = U_o \left(1 - \frac{R_A}{R_{1,2,3}}\right)$

$P_i = U_V \cdot I_o =$

$= U_o \left(1 - \frac{R_A}{R_{1,2,3}}\right) \cdot \frac{U_o}{R_{1,2,3}}$

$\frac{P_i}{P_o} = \frac{U_o \left(1 - \frac{R_A}{R_{1,2,3}}\right) \cdot \frac{U_o}{R_{1,2,3}}}{\frac{U_o^2}{R_{1,2,3}}} = 1 - \frac{R_A}{R_{1,2,3}} = 1 - \frac{25\,\Omega}{245\,\Omega} = \underline{\underline{90\,\Omega}}$

$\frac{P_i}{P_o}$ ↑ dojansta

b) $R_{1,2} = R_A + R = \underline{325\,\Omega}$

$R_{1,2,3} = \frac{R_{12} \cdot R_V}{R_{12} + R_V} = \underline{231\,\Omega} = R_s$

$P_o = I_o \cdot U_o = \frac{U_o^2}{R_s}$ $\quad P_i = \frac{U_o^2}{R_{12}}$

$\frac{P_i}{P_o} = \frac{\frac{U_o^2}{R_{12}}}{\frac{U_o^2}{R_s}} = \frac{231\,\Omega}{325\,\Omega} = 71\%$

(40) $\eta_1 = \frac{P_i}{P_o} = \frac{\frac{U_0^2}{R}\left(1-\frac{R_A}{R_S}\right)\cdot\frac{1}{R_S}}{\frac{U_0^2}{R}} = \frac{R\left(1-\frac{R_A}{R_S}\right)}{R_S} = \frac{300\,\Omega\left(1-\frac{25\,\Omega}{245\,\Omega}\right)}{245\,\Omega} = 1{,}09$

STR 44 / NAL. 1

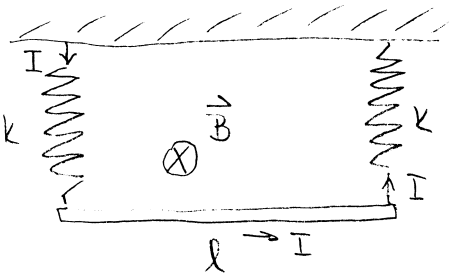
$B = 0{,}3\,T$

$l = 0{,}5\,m$

$m = 0{,}3\,kg$

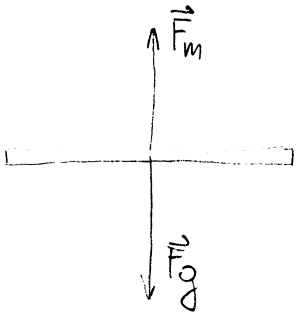
$k = 200\,N/m$

$\vec{F}_m = I\,\vec{l} \times \vec{B}$



$F_g + F_m = 0$

$F_g = F_m$



a) $I_1 = ?$

$I_2 = 8\,A$

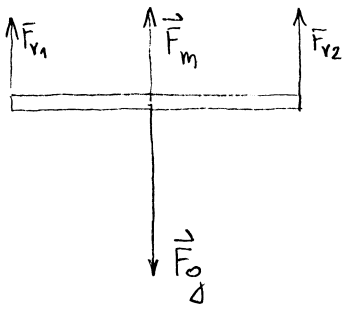
$x = ?$

$m \cdot g = I_1 \cdot l \cdot B$

$I_1 = \frac{m \cdot g}{l \cdot B}$

$I_1 = \frac{0{,}3\,kg \cdot 9{,}81\,m}{s^2 \cdot 0{,}5\,m \cdot 0{,}3\,T} = 19{,}62\,A$

b)



$F_g = F_m + 2 \cdot F_v$

$m \cdot g = I_2 \cdot l \cdot B + 2 \cdot kx$

$x = \frac{mg - I_2 l B}{2k}$

$x = \frac{0{,}3\,kg \cdot 9{,}81\,m - 8\,A \cdot 0{,}5\,m \cdot 0{,}3\,T \cdot m}{s^2 \cdot 2 \cdot 200\,N} = 0{,}0045\,m$

$= 4{,}5\,mm$

STR. 45 / NAL. 4

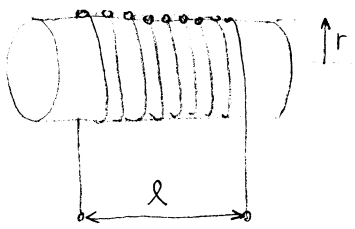
$\lambda = 100\,m$

$d = 2\,mm$

$r = 3{,}5\,cm$

$I = 5\,A$

$B = ?$



$l = N \cdot d$

$l = 455 \cdot 0{,}002\,m$

$l = 0{,}91\,m$

$B = \frac{\mu_0 \cdot N \cdot I}{l}$

$\lambda = N \cdot 2\pi r$

$N = \frac{\lambda}{2\pi r} = \frac{100\,m}{2\pi \cdot 0{,}035\,m} = 455$

$B = \frac{1{,}26 \cdot 10^{-6}\,N \cdot 455 \cdot 5\,A}{A^2 \cdot 0{,}91\,m}$

$B = 3{,}15 \cdot 10^{-3}\,T$

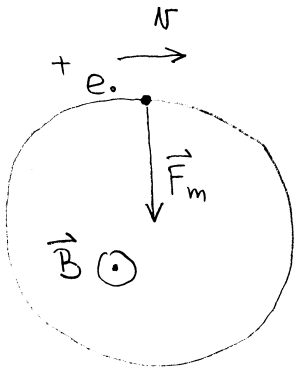
STR. 46/ NAL. 8

$$\vec{F}_m = e \cdot \vec{v} \times \vec{B}$$

$B = 0{,}5\ T$

$R = 25\ cm$

$m = 3{,}32 \cdot 10^{-27}\ kg$



$F_{cp} = F_m$

$$\frac{m v^2}{R} = e \cdot v \cdot B$$

$$v = \frac{R \cdot B \cdot e}{m}$$

$$v = \frac{0{,}25\,m \cdot 0{,}5\,T \cdot 1{,}6 \cdot 10^{-19}\,As}{3{,}32 \cdot 10^{-27}\,kg}$$

$v = 6 \cdot 10^6\ m/s$

$$t_o = \frac{2\pi R}{v}$$

$$t_o = \frac{2\pi \cdot 0{,}25\,m \cdot s}{6 \cdot 10^6\,m}$$

$t_o = 2{,}6 \cdot 10^{-7}\ s$

$A = \Delta W_k$

$A = W_k$

$A = P \cdot t = UI \cdot t = U \cdot e$

$$U e_o = \frac{m \cdot v^2}{2}$$

$$U = \frac{m \cdot v^2}{2 \cdot e_o} = \frac{3{,}32 \cdot 10^{-27}\,kg \cdot 36 \cdot 10^{12}\,m^2}{2 \cdot 1{,}6 \cdot 10^{-19}\,As \cdot s^2} = 374\,kV$$