Ministerul Educației și Cercetării al Republicii Moldova

Agenția Națională pentru Curriculum și Evaluare

OLIMPIADA REPUBLICANĂ LA FIZICĂ, EDIȚIA LVII

CHIȘINĂU, 17– 20, martie 2023

Proba teoretică ORF 2023, clasa a 9

Problema 1 (10,0 p)

a) **Total: 0,8 p.**

$t_0 = 0^\circ\,\mathrm{C}$

$Q_1 = m_{01}c_1\left(t_0 - t_1\right)$ **1x 0,4p**

$Q_1 = -277,2\,\mathrm{kJ}$ **1x0,4p**

b) **Total: 0,8 p.**

$Q_2 = m_{02}c_2\left(t_0 - t_2\right)$ **1x0,4p**

$Q_2 = 46,2\,\mathrm{kJ}$ **1x0,4p**

c) **Total: 0,8 p.**

$Q_3 = m_{02}\lambda$ **1x0,4p**

$Q_3 = 363\,\mathrm{kJ}$ **1x0,4p**

d) **Total: 2,4 p.**

m_x – masa de gheață care se va topi

$Q_1 + Q_2 + m_x\lambda = 0$ **1x0,4p**

$m_x = -\dfrac{Q_1 + Q_2}{\lambda}$ **1x0,4p**

$m_1 = m_{01} + m_x = 2,90\,\mathrm{kg}$ **2x0,4p**

$m_2 = m_{02} - m_x = 0,40\,\mathrm{kg}$ **2x0,4p**

e) **Total: 2,0 p.**

$Q_1 = P\Delta\tau$ **1x0,4p**

$Q_2 = \left(m_1 + m_2\right)c_1\left(t_3 - t_0\right) + m_2\lambda$ **1x0,4p**

$Q_1 = Q_2$ **1x0,4p**

$\Delta\tau = \dfrac{\left(m_1 + m_2\right)c_1\left(t_3 - t_0\right) + m_2\lambda}{P}$ **1x0,4p**

$\Delta\tau = 2013\,\mathrm{s}$ **1x0,4p**

f) **Total: 3,2 p.**

$Q = 201,3\,\mathrm{kJ}$ **1x0,4p**

$P_{21} = P_0$ **1x0,4p**

$P_{22} = P_0\left(1,0 - \alpha\tau\right)$ **1x0,4p**

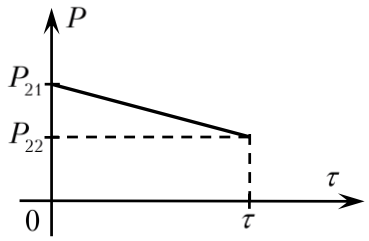
$Q = \dfrac{P_{21} + P_{22}}{2}\tau$ **1x0,4p**

$\alpha P_0\tau^2 - 2P_0\tau + 2Q = 0$ **1x0,4p**

$\tau = \dfrac{P_0 - \sqrt{P_0^2 - 2QP_0\alpha}}{\alpha P_0}$ **1x0,4p**

$\Delta\tau = 1220\,\mathrm{s}$ **1x0,4p**

A doua soluție, pozitivă ($\Delta\tau = 1491\,\mathrm{s}$) nu are sens fizic, așa cum încălzitorul după 1220 s, ar trebui să absoarbă căldură nu să cedeze. **1x0,4p**



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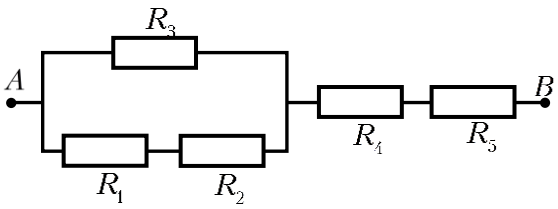
Problema 2 (10,0 p)

a) **Total: 2,5p**



$\frac{1}{R_p} = \frac{1}{R_a} + \frac{1}{R_b}$ **1x0,25p**

$R_s = R_a + R_b$ **1x0,25p**

$R_{12} = R_1 + R_2 = 2R$ **2x0,25p**

$R_{13} = \frac{R_{12}R_3}{R_{12} + R_3} = \frac{2R}{3}$ **2x0,25p**

$R_{AB} = R_{13} + R_4 + R_5 = \frac{8R}{3}$ **2x0,25p**

$R_{AB} = 96\,\Omega$ **1x0,5p**

b) **Total: 1,0p**

$I = \frac{U}{R_{AB}} = \frac{3U}{8R}$ **2x0,25p**

$I = 0,25\,\text{A}$ **1x0,5p**

c) **Total: 1,5 p**

$U_{13} = IR_{13}$ **1x0,25p**

$I_{12} = \frac{U_{13}}{R_{12}}$ **1x0,25p**

$U_2 = I_{12}R_2 = \frac{U}{8}$ **2x0,25p**

$U_2 = 3,0\,\text{V}$ **1x0,5p**

d) **Total: 2,5p**

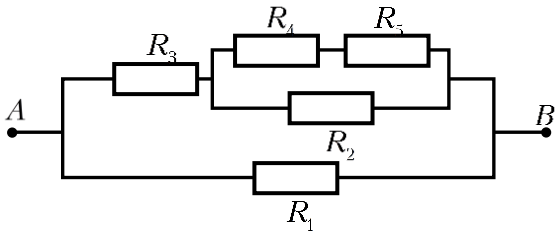
$R_{45} = R_4 + R_5 = 2R$ **2x0,25p**

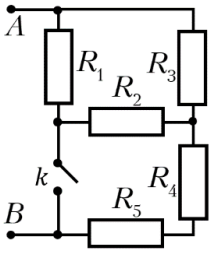
$R_{245} = \frac{R_2R_{45}}{R_2 + R_{45}} = \frac{2R}{3}$ **2x0,25p**

$R_{25} = R_3 + R_{245} = \frac{5R}{3}$ **2x0,25p**

$R_{AB} = \frac{R_1R_{25}}{R_1 + R_{25}} = \frac{5R}{8}$ **2x0,25p**

$R_{AB} = 22,5\,\Omega$ **1x0,5p**





e) **Total: 2,5p**

$I_K = I_1 + I_2$ **1x0,5p**

$I_1 = \frac{U_{AB}}{R_1}$ **1x0,25p**

$I_3 = \frac{U_{AB}}{R_{25}}$ **1x0,25p**

$U_2 = U_{45} = I_3R_{245}$ **1x0,25p**

$I_2 = \frac{U_2}{R_2}$ **1x0,25p**

$I_2 = \frac{2U_{AB}}{5R}$ **1x0,25p**

$I_K = \frac{7U_{AB}}{5R}$ **1x0,25p**

$I_K = \frac{14}{15}\,\text{A} = 0,93\,\text{A}$ **1x0,5p**

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Problema 3 (10,0 p)

a) 1,0 p

$m = \rho_s \times V_s = \rho_s \times (a \times b + (c-d) \times (2a + 2b - 2d))d = 229{,}0$ kg **3x0,2p**

$m_1 = \rho_s \times \frac{V_s}{5^3} = \frac{m}{125} = 1{,}83$ kg **2x0,2p**

b) 1,4 p

$p = \frac{F}{S} = \frac{m+m_a}{a \times b} g =$ **7x 0,2p**

$= \frac{g}{a \times b}\left(\rho_s \times \big(a \times b + (c-d) \times (2a + 2b - 2d)\big)d + \rho_0 \times \left((a-2d) \times (b-2d)\frac{c-d}{2}\right)\right) = 6{,}33$ kPa

$(m + m_a = 229{,}00 \text{ kg} + 404{,}04 \text{ kg} \approx 633{,}34 \text{ kg})$

c) 2,0p

$(p = 30\% = 0{,}3)\ pk = \frac{m_p g}{a \times b}\quad m_p = \frac{a \times b \times p \times k}{g} = 190{,}0$ kg **5x0,2p**

$V_p = (a-2d) \times (b-2d) \times e = 0{,}1097\ \text{m}^3$ **2x0,2p**

$\rho_p = \frac{m_p}{V_p} = \frac{a \times b \times p \times k}{g \times (a-2d) \times (b-2d) \times e} = 1732{,}7\ \text{kg/m}^3$ **3x0,2p**

d) 1,8 p

1) $\rho_{acv\,1} = \frac{m_a + m_p + m_{aer}}{V_a + V_p + V_{aer}}$; $V_{aer} = D \times t = 1{,}0\ \text{L} = 1{,}0 \times 10^{-3}\ \text{m}^3$; **4x0,2p**

$m_{aer} = V_{aer} \times 1{,}05\ \rho = 1{,}37 \times 10^{-3}$ kg; $\rho_{acv\,1} = \frac{m_a + m_p + m_{aer}}{V_a + V_p + V_{aer}} = 1237{,}63\ \text{kg/m}^3$ **2x0,2p**

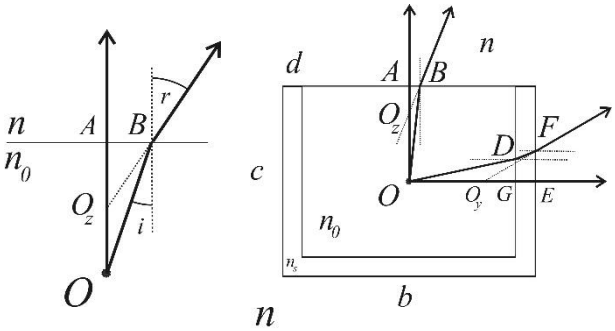
2) $m_{aer} = const \Rightarrow V_{aer} \to V_{aer} = \frac{m_{aer}}{(\rho + 1.05\rho)/2} = 1.02 \times 10^{-3}\ \text{m}^3$;.... $\rho_{acv\,2} = 1237{,}55\ \text{kg/m}^3$ **3x0,2p**

e) 1,2 p

$\frac{\sin i}{\sin r} = \frac{n}{n_0} \approx \frac{\text{tg}\, i}{\text{tg}\, r} = \frac{AB}{OA} : \frac{AB}{O_z A} = \frac{O_z A}{OA}$ **4x0,2p**

$z = OO_z = OA - OA\frac{n}{n_0} = \frac{c}{2}\left(1 - \frac{n}{n_0}\right) = 112$ mm **2x0,2p**

Dacă $n = n_0$ poziția aparentă a punctului coincide cu poziția reală, deci $z = 0$)



f) 2,0 p

$\frac{\sin i_0}{\sin r_s} = \frac{n_s}{n_0} \approx \frac{\text{tg}\, i_0}{\text{tg}\, r_s}\qquad i = r_s$ **3x0,2p**

$\frac{\sin i}{\sin r} = \frac{n}{n_s} \approx \frac{\text{tg}\, i}{\text{tg}\, r}$ **2x0,2p**

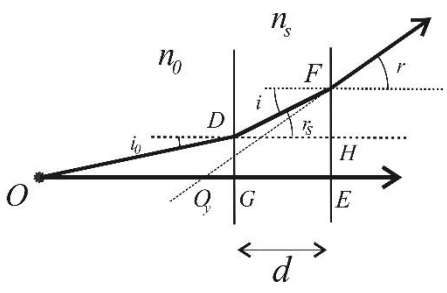
$y = OO_y = OE - O_y E = \frac{b}{2} - \frac{FE}{\text{tg} r}$ **2x0,2p**

$FE = FH + HE = DH\ \text{tg}\, r_s + OG\ \text{tg}\, i_0$ **2x0,2p**

$y = \frac{b}{2} - d\frac{\text{tg}\, i}{\text{tg}\, r} - \left(\frac{b}{2} - d\right)\frac{\text{tg}\, i_0}{\text{tg}\, r} =$

$= \frac{b}{2} - d\frac{n}{n_s} - \left(\frac{b}{2} - d\right)\frac{n}{n_0} = \frac{b}{2}\left(1 - \frac{n}{n_0}\right) - d\left(\frac{n}{n_s} - \frac{n}{n_0}\right) = 51$ mm **1x0,2p**

Dacă $d \to 0$ sau $n_s = n_0$ și $b = c$ trebue să se obțină rezultatul punctului e)



g) 0,6 p

$\text{tg}\, i_l = \frac{x}{c/2}\qquad x = \frac{c}{2}\text{tg}\, i_l = 0.51$ m **3x0,2p**