Problema 1, Clasa a IX-a

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

$t = \frac{d}{v}$ 1x0,5p

$t_1 = \frac{AC}{v_1} + \frac{CB}{v_2} = 220$ s 2x0,5p

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

$AB = \sqrt{AC^2 + BC^2}$ 1x0,5p

$t_2 = \frac{AB}{v_1} = 40\sqrt{109} = 417{,}6$ s 2x0,5p

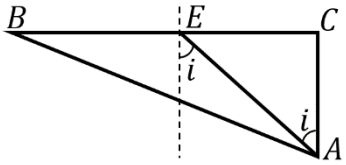
c) **Total: 1,5p**

$AD = \sqrt{AC^2 + DC^2}$ 1x0,5p

$t_2 = \frac{AD}{v_1} + \frac{BD}{v_2} = 260$ s 2x0,5p

d) **Total: 3,25p**

$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = \frac{v_1}{v_2} = \frac{1}{4}$ 2x0,5p



$\sin r = 1$ 1x0,25p

$\sin^2 i + \cos^2 i = 1$ 1x0,25p

$\tan i = \frac{\sin i}{\cos i} = \frac{1}{\sqrt{15}}$ 1x0,25p

$CE = AC \tan i = 2\sqrt{15}$ m $= 7{,}75$ m 2x0,25p

$AE = \frac{AC}{\cos i}$ 1x0,25p

$BE = BC - CE$ 1x0,25p

$t_{min} = \frac{AC}{v_1 \cos i} + \frac{BC - AC \tan i}{v_2} = 216{,}2$ s 2x0,25p

e) **Total: 2,25p**

Față de apă:

$v_{r2} = v_2 + v_a$ 1x0,5p

$\sin i = \frac{v_1}{v_2 + v_a}$ 1x0,5p

$\cos i = \frac{\sqrt{(v_2 + v_a)^2 - v_1^2}}{v_2 + v_a}$ 1x0,25p

$CE = \frac{AC}{v_1 \cos i}(v_a - v_1 \sin i)$ 3x0,25p

$CE = 55{,}8$ m 1x0,25p

Problema 2, Clasa a IX-a

a) **Total: 0,5 p**

$R = \rho \frac{l}{S}$ 1x0,25p

$R = 5{,}0\ \Omega$ 1x0,25p

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

$R_{AB} = \frac{R_1 R_2}{R_1 + R_2}$ 2x0,25p

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

$I_{AB} = 4{,}8\ \mathrm{A}$ 1x0,25p

c) **Total: 2,25 p**

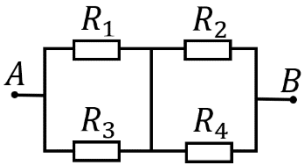
$R_1 = R_3 = \frac{\rho x}{S}$ 2x0,25p

$R_2 = R_4 = \frac{\rho (l-x)}{S}$ 2x0,25p

$R_{13} = \frac{R_1}{2},\ R_{24} = \frac{R_2}{2}$ 2x0,25p

$R_{AB} = R_{13} + R_{24} = \frac{R}{2}$ 2x0,25p

$I_{AB} = 4{,}8\ \mathrm{A}$ 1x0,25p



Pentru scrierea rezultatului final corect, fără demonstrare, se acordă **0,5 p**

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

$R_1 = R_4 = \frac{\rho x_1}{S} = \frac{R}{4}$ 3x0,25p

$R_2 = R_3 = \frac{\rho x_2}{S} = \frac{3R}{4}$ 3x0,25p

$R_{13} = R_{24} = \frac{3R}{16}$ 2x0,25p

$R_{AB} = \frac{3R}{8}$ 1x0,25p

$I_{AB} = 6{,}4\ \mathrm{A}$ 1x0,25p

e) **Total: 1,75 p**

$U_{13} = U_{24} = \frac{U_{AB}}{2}$ 2x0,25p

$I_1 = \frac{2U_{AB}}{R}$ 1x0,25p

$I_2 = \frac{2U_{AB}}{3R}$ 1x0,25p

$I_c = I_1 - I_2 = \frac{4U_{AB}}{3R}$ 2x0,25p

$I_c = 3{,}2\ \mathrm{A}$ 1x0,25p

f) **Total: 2,0 p**

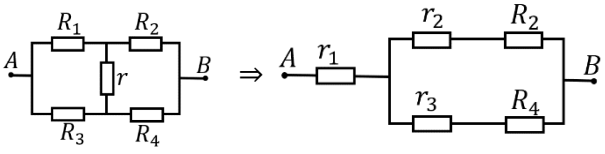
$r_1 = \frac{R_1 R_3}{R_1 + R_3 + r} = \frac{3R}{20}$ 1x0,25p

$r_2 = \frac{R_1 r}{R_1 + R_3 + r} = \frac{R}{20}$ 1x0,25p

$r_3 = \frac{R_3 r}{R_1 + R_3 + r} = \frac{3R}{20}$ 1x0,25p

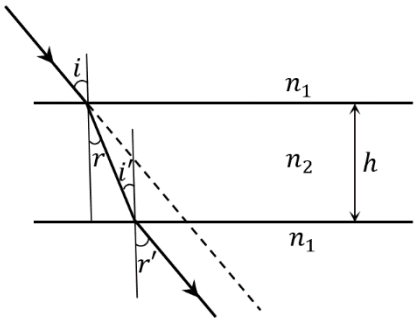
$R_{AB} = r_1 + \frac{(r_2 + R_2)(r_3 + R_4)}{r_2 + r_3 + R_2 + R_4} = \frac{5\,R}{12}$ 4x0,25p

$I_{AB} = \frac{144}{25}\ \mathrm{A} = 5.8\ \mathrm{A}$ 1x0,25p



Problema 3, Clasa a IX-a

a) **Total: 2,0 p**



Desen corect (raza incidentă, refractată, emergentă, normale în punctele de refracție) - 4x0,25p

$\frac{\sin(i)}{\sin(r)} = \frac{n_2}{n_1}$ 1x0,25p

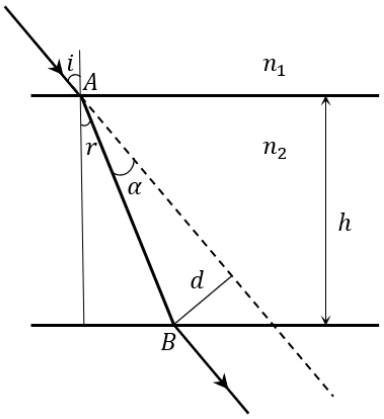
$i' = r$ 1x0,25p

$\frac{\sin(i\prime)}{\sin(r\prime)} = \frac{n_1}{n_2}$ 1x0,25p

$r' = i \Rightarrow$ 1x0,25p

Raza emergentă și incidentă sunt paralele.

b) Total: 2,5p



Desen corect (distanța dintre raze) - 1x0,25p

$n_2 = n, n_1 = 1$ 2x0,25p

$\sin(r) = \frac{\sin(i)}{n}$ 1x0,25p

$\cos(r) = \sqrt{1 - \frac{\sin^2 i}{n^2}}$ 1x0,25p

$\alpha = i - r$ 1x0,25p

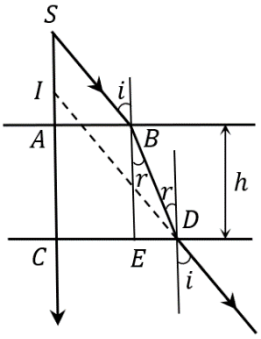
$\frac{d}{AB} = \sin(\alpha)$ 1x0,25p

$AB = \frac{h}{\cos r}$ 1x0,25p

$d = h \sin(i) \left(1 - \frac{\cos i}{\sqrt{n^2 - \sin^2 i}}\right)$ 1x0,25p

$d = 0.58$ cm 1x0,25p

c) Total: 3,25p



Desen corect (mersul a două raze de la sursa punctiformă și prezentarea imaginii la intersecția prelungirilor razelor) - 3x0,25p

$SI = h + SA - IC$ 2x0,25p

$tgi = \frac{AB}{SA} \Rightarrow SA = \frac{AB}{tgi}$ 1x0,25p

$tgi = \frac{DC}{IC} \Rightarrow IC = \frac{DC}{tgi}$ 1x0,25p

$DC - AB = DE$ 1x0,25p

$DE = h \tan(r)$ 1x0,25p

$SI = h - \frac{DC - AB}{tgi} = h - \frac{DE}{tgi}$

$SI = h \left(1 - \frac{tg\, r}{tg\, i}\right) \approx h \left(1 - \frac{\sin r}{\sin i}\right)$ 2x0,25p

$SI = h \left(1 - \frac{1}{n}\right) = 1{,}0$ cm 2x0,25p

d) Total: 0,75p

$H = h - h \left(1 - \frac{1}{n}\right) = \frac{h}{n} = 2{,}0$ cm 3x0,25p

e) Total: 1,5p

$y_1 = h_1 \left(1 - \frac{n_2}{n_1}\right)$ 1x0,25p

…

$y_i = h_i \left(1 - \frac{n_{i+1}}{n_i}\right)$, pentru $i = 1 \ldots m$ 1x0,25p

$n_{m+1} = 1$ 1x0,25p

$y = y_1 + y_2 + \cdots + y_m$ 1x0,25p

$H = h_1 + h_2 + \cdots + h_m$ 1x0,25p

$d = H - y = \frac{h_1 n_2}{n_1} + \frac{h_2 n_3}{n_2} + \cdots + \frac{h_m}{n_m}$ 1x0,25p