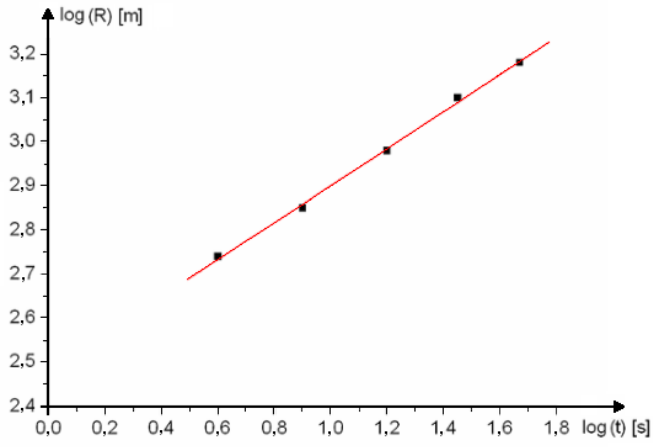
Barem de evaluare si de notare

Oricare altă rezolvare care conduce la rezultate corecte va fi punctată corespunzător

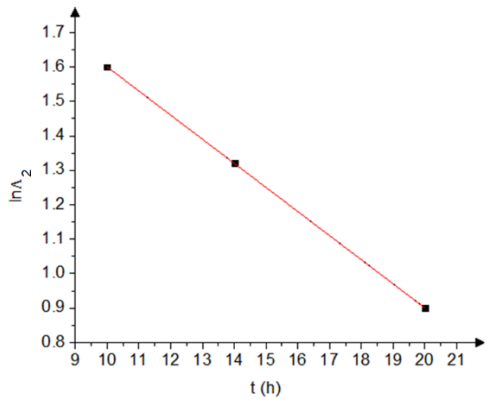
Problema I

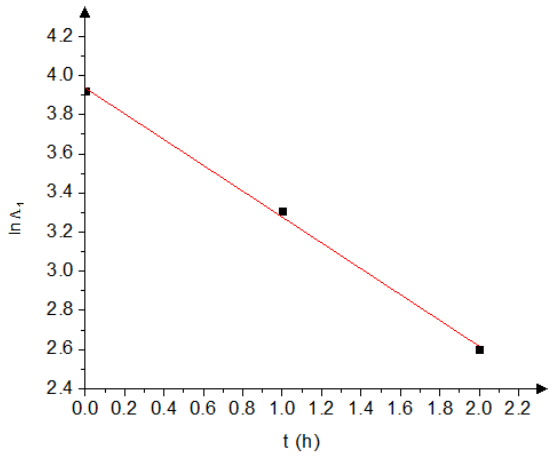
Despre radioactivitate

Nr. item	*Sarcina de lucru nr.1 – Estimarea realizată de Sir Geoffrey I. Taylor*		*Punctaj*
1.a.	Expresia razei norului radioactiv $R = C \cdot t^{\alpha} \cdot E^{\beta} \cdot \rho^{\gamma}$	0,2p	**0,5p**
	$R = C \cdot t^{\frac{2}{5}} \cdot \left(\frac{E}{\rho}\right)^{\frac{1}{5}}$	0,3p	
1.b.	$R = t^{\frac{2}{5}} \cdot \left(\frac{E}{\rho}\right)^{\frac{1}{5}} \quad \log R = \frac{2}{5} \cdot \log t + \frac{1}{5} \cdot \log \frac{E}{\rho}$	0,2p	**1,0p**
	$y = A \cdot x + B \quad \begin{cases} A = \frac{2}{5} \\ B = \frac{1}{5} \log \frac{E}{\rho} \end{cases}$	0,2p	
	 $\begin{cases} A = 0{,}42 \\ B = 2{,}48 \end{cases}$	0,4p	
	$E \approx 3 \cdot 10^{12}\ J$	0,2p	

Nr. item	*Sarcina de lucru nr. 2 – Studiul a două transmutatii nucleare succesive*		*Punctaj*
2.a.	Expresia legii de variaţie în timp a numărului de nuclee de tip A $N_A(t) = N_0 \cdot e^{-\lambda_A \cdot t}$	0,5p	**0,5p**
2.b.	Variaţia dN_B a numărului de nuclee din specia nucleară B, în intervalul de timp dt $dN_B = N_A(t) \cdot \lambda_A \cdot dt - N_B(t) \cdot \lambda_B \cdot dt$	0,4p	**1,0p**
	$\frac{dN_B}{dt} = N_0 \cdot e^{-\lambda_A \cdot t} \cdot \lambda_A - N_B(t) \cdot \lambda_B$	0,2p	
	$\frac{d}{dt}\left(N_B \cdot e^{\lambda_B \cdot t}\right) = N_0 \cdot \lambda_A \cdot e^{-(\lambda_A - \lambda_B) \cdot t}$	0,2p	
	$N_B(t) = \frac{N_0 \cdot \lambda_A}{\lambda_B - \lambda_A} \cdot \left[e^{-\lambda_A \cdot t} - e^{-\lambda_B \cdot t}\right]$	0,2p	
2.c.	$\frac{d}{dt}\left[N_B(t)\right] = 0$	0,2p	**0,5p**
	$t_{N_{B,\max}} = \frac{1}{\lambda_B - \lambda_A} \cdot \ln \frac{\lambda_B}{\lambda_A}$	0,3p	
2.d.	$dN_C = N_B(t) \cdot \lambda_B \cdot dt$	0,3p	**1,0p**
	$dN_C = \frac{N_0 \cdot \lambda_A \cdot \lambda_B}{\lambda_B - \lambda_A} \cdot \left[e^{-\lambda_A \cdot t} - e^{-\lambda_B \cdot t}\right] \cdot dt$	0,4p	
	$N_C(t) = N_0 \cdot \left[\frac{\lambda_B \cdot e^{-\lambda_A \cdot t}}{\lambda_A - \lambda_B} + \frac{\lambda_A \cdot e^{-\lambda_B \cdot t}}{\lambda_B - \lambda_A} + 1\right]$	0,3p	

Nr. item	*Sarcina de lucru nr. 3 – Studiul a trei transmutatii nucleare succesive*		*Punctaj*
3.a.	Expresia variaţiei dN_C a numărului de nuclee din specia nucleară C, în intervalul de timp dt $dN_C = N_B(t) \cdot \lambda_B \cdot dt - N_C(t) \cdot \lambda_C \cdot dt$	0,3p	**1,0p**
	$\frac{d}{dt}\left(N_C \cdot e^{\lambda_C \cdot t}\right) = \frac{N_0 \cdot \lambda_A \cdot \lambda_B}{\lambda_B - \lambda_A} \cdot \left[e^{-(\lambda_A - \lambda_C) \cdot t} - e^{-(\lambda_B - \lambda_C) \cdot t}\right]$	0,2p	
	$N_C(t) = N_0 \cdot \lambda_A \cdot \lambda_B \cdot \left[\frac{e^{-\lambda_A \cdot t}}{(\lambda_B - \lambda_A) \cdot (\lambda_C - \lambda_A)} + \frac{e^{-\lambda_B \cdot t}}{(\lambda_A - \lambda_B) \cdot (\lambda_C - \lambda_B)} + \frac{e^{-\lambda_C \cdot t}}{(\lambda_A - \lambda_C) \cdot (\lambda_B - \lambda_C)}\right]$	0,3p	
	$\Lambda_C(t) = N_C(t) \cdot \lambda_C$ $\Lambda_C(t) = N_0 \cdot \lambda_A \cdot \lambda_B \cdot \lambda_C \cdot \left[\frac{e^{-\lambda_A \cdot t}}{(\lambda_B - \lambda_A) \cdot (\lambda_C - \lambda_A)} + \frac{e^{-\lambda_B \cdot t}}{(\lambda_A - \lambda_B) \cdot (\lambda_C - \lambda_B)} + \frac{e^{-\lambda_C \cdot t}}{(\lambda_A - \lambda_C) \cdot (\lambda_B - \lambda_C)}\right]$	0,2p	

3.b.	Expresia legii de variaţie în timp a activităţii celui de-al n-lea produs radioactiv $\Lambda_n(t)=\left[\sum_{i=1}^{n}\frac{e^{-\lambda_i\cdot t}}{\prod_{\substack{j=1\\ j\neq i}}^{n}(\lambda_j-\lambda_i)}\right]\cdot N_0\cdot\prod_{k=1}^{n}\lambda_k$	0,5p	**0,5p**
Nr. item	*Sarcina de lucru nr. 4 – Activitatea unui preparat raioactiv*		*Punctaj*
4.a.	$\Lambda_\beta=\lambda_1\cdot\frac{m\cdot N_A}{A_{Bi}}\cdot e^{-\lambda_1\cdot t}$	0,2p	**1,0p**
	$\Lambda_\beta=5{,}8\cdot10^{11}s^{-1}$	0,2p	
	$\Lambda_\alpha=\frac{\lambda_1\cdot\lambda_2}{\lambda_2-\lambda_1}\cdot\frac{m\cdot N_A}{A_{Bi}}\cdot\left(e^{-\lambda_1\cdot t}-e^{-\lambda_2\cdot t}\right)$	0,3p	
	$\Lambda_\alpha=2{,}9\cdot10^{11}s^{-1}$	0,3p	
Nr. item	*Sarcina de lucru nr. 5 – Sursă cu două materiale radioactive diferite*		*Punctaj*
5.a.	Expresia activității totale a sursei radioactive $\Lambda(t)=\Lambda_1(t)+\Lambda_2(t)$ $\Lambda(t)=\Lambda_{01}\cdot e^{-\lambda_1\cdot t}+\Lambda_{02}\cdot e^{-\lambda_2\cdot t}$	0,2p	**2,5p**
	<table><tr><td>t</td><td>0</td><td>1</td><td>2</td><td>3</td><td>5</td><td>7</td><td>10</td><td>14</td><td>20</td></tr><tr><td>$\ln\Lambda$</td><td>4,10</td><td>3,60</td><td>3,10</td><td>2,60</td><td>2,06</td><td>1,82</td><td>1,60</td><td>1,32</td><td>0,90</td></tr><tr><td>Δt</td><td></td><td>1</td><td>1</td><td>1</td><td>2</td><td>2</td><td>3</td><td>4</td><td>6</td></tr><tr><td>$\Delta(\ln\Lambda)$</td><td></td><td>0,50</td><td>0,50</td><td>0,50</td><td>0,54</td><td>0,24</td><td>0,22</td><td>0,28</td><td>0,42</td></tr><tr><td>$\frac{\Delta(\ln\Lambda)}{\Delta t}$</td><td></td><td>0,50</td><td>0,50</td><td>0,50</td><td>0,27</td><td>0,12</td><td>0,07</td><td>0,07</td><td>0,07</td></tr></table>	0,4p	
	Pentru durate mari de timp, activitatea uneia dintre surse se poate neglija $\Lambda(t)=\Lambda_{02}\cdot e^{-\lambda_2\cdot t}$ $\ln\Lambda_2=-\lambda_2\cdot t+\ln\Lambda_{02}$	0,3p	
	 $\lambda_2=0{,}07h^{-1}$ $\Lambda_{02}=9{,}97dez\cdot h^{-1}$	0,4p	

	t | 0 | 1 | 2 | 3 | 5 | 7 | 10 | 14 | 20 $\ln\Lambda$ | 4,10 | 3,60 | 3,10 | 2,60 | 2,06 | 1,82 | 1,60 | 1,32 | 0,90 Λ | 60,34 | 36,60 | 22,20 | 13,46 | 7,85 | 6,17 | 4,95 | 3,74 | 2,46 Λ_2 | 9,97 | 9,30 | 8,67 | 8,08 | 7,03 | 6,11 | 4,95 | 3,74 | 2,46 $\Lambda - \Lambda_2 = \Lambda_1$ | 50,37 | 27,30 | 13,53 | 5,38 | 0,82 | 0,06 | | | $\ln\Lambda_1$ | 3,92 | 3,31 | 2,60 | 1,68 | -0,99 | -2,81 | | |	0,4p	
	 $\ln\Lambda_1(t) = -\lambda_1 \cdot t + \ln\Lambda_{01}$ $\lambda_1 = 0{,}66\,h^{-1}$ $\Lambda_{01} \cong 51{,}4\ dez \cdot h^{-1}$	0,4p	
	$T_1 = 1{,}05\,h$ $T_2 = 9{,}90\,h$	0,4p	
5.b.	$\frac{N_{01}}{N_{02}} = \frac{\Lambda_{01}}{\Lambda_{02}} \cdot \frac{\lambda_2}{\lambda_1}$	0,3p	**0,5p**
	$\frac{N_{01}}{N_{02}} = 0{,}54$	0,2p	
TOTAL			**10p**

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