1.

$2r = 1\,mm$

$l = 5\,cm$

$P = 10\,W$

$T = ?$

Stefan-Boltzmanov zakon:

$$\left[\ \frac{P}{A} = \sigma_{SB}\, T^4\ \right] \qquad \sigma_{SB} = 5.67\cdot 10^{-8}\, W m^{-2} K^{-4}$$

$$\Rightarrow T = \sqrt[4]{\frac{P}{A}\,\frac{1}{\sigma_{SB}}}$$

$$= \sqrt[4]{\frac{10\,W}{1.57\cdot 10^{-4}\,m^2}\cdot\frac{1}{5.67\cdot 10^{-8}\,W m^{-2} K^{-4}}}$$

$$= \sqrt[4]{\underbrace{\frac{1}{1.57}}_{0.637}\cdot\underbrace{\frac{1}{5.67}}_{0.176}\, 10^{13}}\ K$$

Mathematica: $\underline{1029.5\,K}$ $(1024.7\,K)$

(1.123)

$$= \sqrt[4]{1.12\cdot 10^{12}}\ K$$

(0.54)

$$= 1.029\cdot 10^{3}\,K = \underline{1029\,K}$$

žarna nit → valjak

$A = 2r\pi\cdot l$

$= 10^{-3}\,m\,\pi\cdot 5\cdot 10^{-2}\,m$

$= 1.57\cdot 10^{-4}\,m^2$

baza $B = r^2\pi$

$= (0.5\cdot 10^{-3})^2\pi$

$= 7.85\cdot 10^{-7}\,m^2$

$2B = 1.57\cdot 10^{-6}\,m^2$

— zanemarivo

2

$\lambda = 1\,pm$

$\theta = 90^\circ$

$E_\gamma - E_\gamma' = ?$

$\lambda_e' = ?$

COMPTON-ovo raspršenje:

$$\boxed{\lambda' = \lambda + \lambda_c(1-\cos\theta)}$$

$\lambda_c = 2.43 \cdot 10^{-12} m$

$$\lambda' = 10^{-12} + 2.43 \cdot 10^{-12}(1-0)$$

$$= 3.43 \cdot 10^{-12}\,m$$

$$E_\gamma = h\nu = \frac{hc}{\lambda} = \frac{1,240 \cdot 10^{-6}\,eVm}{10^{-12}\,m} = 1,240 \cdot 10^{6}\,eV$$

$\{ = 1.99 \cdot 10^{-13} J$

$$E_\gamma' = h\nu' = \frac{hc}{\lambda'} = \frac{1,240 \cdot 10^{-6}\,eVm}{3.43 \cdot 10^{-12}\,m} = 0,36 \cdot 10^{6}\,eV$$

$\{ = 0.58 \cdot 10^{-8} J$

$\Downarrow$

$$E_\gamma - E_\gamma' = (1,240 - 0,36) \cdot 10^{6}\,eV = 0.88 \cdot 10^{6}\,eV$$

$\{ = 1.41 \cdot 10^{-13} J$

ZOE:

$$E_\gamma + m_e c^2 = E_\gamma' + \overbrace{m_e c^2 + E_k}^{E_e'}$$

$$E_e' = E_\gamma - E_\gamma' + m_e c^2 = 0.88 \cdot 10^{6}\,eV + 0,510 \cdot 10^{6}\,eV$$

$$= 1.39 \cdot 10^{6}\,eV$$

de-BROGLIE-ova relacija

$$p_e = \frac{h}{\lambda_e} \Rightarrow \lambda_e = \frac{hc}{p_e c} = \frac{1.240 \cdot 10^{-6}\,eVm}{1,29 \cdot 10^{6}\,eV} = 0.96 \cdot 10^{-12} m$$

$$= 0.96\,pm$$

$$E_e^2 = (m_e c^2)^2 + p_e^2 c^2$$

(relativistička rel. između E i P)

$$\Rightarrow p_e c = \sqrt{E_e^2 - (m_e c^2)^2} = \sqrt{1,39^2 - 0,51^2} \cdot 10^{6}\,eV = 1.29 \cdot 10^{6}\,eV$$

$\{ p = 6,89 \cdot 10^{-22}\,kg\,m/s$
$= 4.3 \cdot 10^{-3}\,eVs/m$

3

$E = 1.6 \cdot 10^{-17}\,J$

$V_0 = 90\,eV$

$R = 2/3$

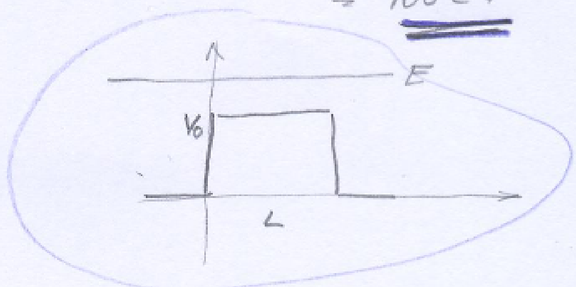
$L = ?$

$e = 1.6 \cdot 10^{-19}\,C$

$E = 1.6 \cdot 10^{-17}\,J = VC$

$= 1.6 \cdot 10^{-17} \frac{e}{1.6 \cdot 10^{-19}}\,V$

$= 100\,eV$



$$V(x) = \begin{cases} 0 & x < 0 \\ V_0 & 0 < x < L \\ 0 & x > L \end{cases}$$

$$[R = 1 - T] \Rightarrow T = 1 - 2/3 = 1/3$$

$$\left[\frac{1}{T} = 1 + \frac{1}{4}\frac{V_0^2}{E(E-V_0)}\sin^2(\varkappa L) \qquad \varkappa = \sqrt{\frac{2m(E-V_0)}{\hbar^2}}\right]$$

$$\Downarrow$$

$$\sin^2(\varkappa L) = \left(\frac{1}{T} - 1\right) \cdot \frac{4E(E-V_0)}{V_0^2}$$

$$= (3-1)\frac{4 \cdot \cancel{100}(100-90)}{\underbrace{90^2}_{=81 \cdot \cancel{100}}}$$

$$= \frac{2}{81} \cdot 40 = \frac{80}{81}$$

$$L = \frac{1}{\varkappa}\arcsin\sqrt{\frac{80}{81}}$$

$$= 6.18 \cdot 10^{-11}\,m \cdot 1.46$$

$$= 9.02 \cdot 10^{-11}\,m$$

$$\varkappa = \sqrt{\frac{2 \cdot 9.1 \cdot 10^{-31}\,kg\ 10 \cdot 1.6 \cdot 10^{-19}\,J}{(1.054 \cdot 10^{-34}\,Js)^2}}$$

$$= \left| \frac{kg\,\cancel{J}}{J^{\cancel{2}} s^2} = \frac{kg}{\cancel{kg}\frac{m^2}{\cancel{s^2}}\cancel{s^2}} = \frac{1}{m^2} \right|$$

$$= 1.62 \cdot 10^{10}\,m^{-1}$$

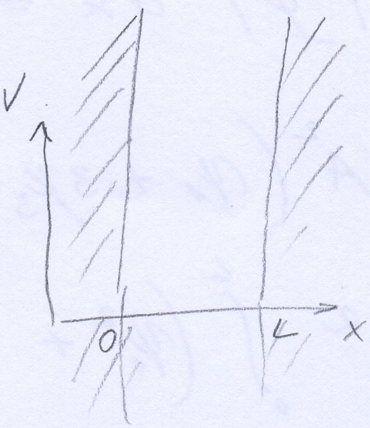
$$\Downarrow\ 1/\varkappa = 6.18 \cdot 10^{-11}\,m$$

$$\arcsin\sqrt{\frac{80}{81}} = 1.46$$

④

$$\Psi = A(\psi_1 + 3\psi_3 + \sqrt{5}\,\psi_5)$$

1D prav. pot. jama
besk.



a) $$\int_{-\infty}^{\infty} |\Psi|^2 \, dx = 1$$

$$\int_0^L |\Psi|^2 \, dx = 1$$

$$\left[\psi_n(x) = \sqrt{\frac{2}{L}} \sin\frac{n\pi x}{L} \quad , n = 1, 2, 3, \dots \right]$$

stacionarno stanje

$$\left[\int_0^L \psi_n^2 \, dx = 1 \right]$$

$$\int_0^L \psi_n \psi_m \, dx = \frac{2}{L} \int_0^L \sin\frac{n\pi x}{L} \sin\frac{m\pi x}{L} \, dx$$

$$= \frac{2}{L}\frac{1}{2} \int_0^L \left[\cos\frac{(n-m)\pi x}{L} - \cos\frac{(n+m)\pi x}{L} \right] dx$$

$$\overset{\text{za } n \neq m}{=} \frac{1}{L} \left[\frac{L}{(n-m)\pi} \sin\frac{(n-m)\pi x}{L} - \frac{L}{(n+m)\pi} \sin\frac{(n+m)\pi x}{L} \right]\Bigg|_0^L$$

$$= \frac{1}{(n-m)\pi} \big(\overset{0}{\sin(n-m)\pi} - \sin 0\big) - \frac{1}{(n+m)\pi} \big(\sin$$

$$- \frac{1}{(n+m)\pi} \underbrace{\sin(n+m)\pi}_{0} - \sin 0 = 0 \checkmark$$

$$\Rightarrow \int_0^L \psi_n \psi_m \, dx = \begin{cases} 1 & n = m \\ 0 & n \neq m \end{cases} \checkmark \Longrightarrow$$

$$\int_0^L |\Psi|^2 dx = 1$$

$$\int_0^L A^2 \left(\psi_1 + 3\psi_3 + \sqrt{5}\,\psi_5\right)^2 dx = 1$$

$$A^2 \int_0^L \left(\psi_1^2 + 9\psi_3^2 + \sqrt{5}\,\psi_5^2 + \text{miješani članovi čiji int. je } 0\right) dx = 1$$

$$A^2 (1 + 9 + 5) = 1$$

$$A^2 = \frac{1}{15}$$

$$A = \frac{1}{\sqrt{15}}$$

b) Možemo izmjeriti

$$\left(E_n = \frac{\hbar^2\pi^2}{2mL^2} n^2\right)$$

$$E_1 = \frac{\hbar^2\pi^2}{2mL^2}$$

$$E_3 = \frac{\hbar^2\pi^2}{2mL^2} 3^2 = 9\frac{\hbar^2\pi^2}{2mL^2}$$

$$E_5 = \frac{\hbar^2\pi^2}{2mL^2} 5^2 = 25\frac{\hbar^2\pi^2}{2mL^2}$$

s vjerojatnošću $P(E_n) = |b_n|^2 \frac{\overbrace{\langle \psi_n | \psi_n \rangle}^{=1}}{\underbrace{\langle \Psi | \Psi \rangle}_{=1}}$

$$\Psi = A\psi_1 + 3A\psi_3 + \sqrt{5}A\psi_5$$

$b_1 = \frac{1}{\sqrt{15}}$ $b_3 = \frac{3}{\sqrt{15}}$ $b_5 = \frac{\sqrt{5}}{\sqrt{15}} = \frac{1}{\sqrt{3}}$

$$P(E_1) = b_1^2 = \frac{1}{15}$$

$$P(E_3) = b_3^2 = \frac{9}{15} = \frac{3}{5}$$

$$P(E_5) = b_5^2 = \frac{5}{15} = \frac{1}{3}$$

$\} \; P(E_1) + P(E_3) + P(E_5) = 1$