1,1) a) $\lambda_m T = 3\times10^{-3}$ mK

$$T = \frac{3\times10^{-3}}{5{,}1\times10^{-7}} \cong \frac{30}{5}\times10^{3} = 6000K$$

1,0 b) $R_T = \sigma T^4$ $\quad \sigma = 5{,}7\times10^{-8}\ W/m^2K^4$

$$R_T = 5.7\times10^{-8}\times 6^4\times10^{12} = 5{,}7\times3{,}6\times3{,}6\times10^{6}\ W$$

$$= 74\times10^{6}\ W/m^2$$

0,3 c) Para que a lâmpada de filamento irradie como o Sol, basta que seu filamento seja aquecido à mesma temperatura da superfície do Sol, ou seja 6000K ($\simeq$ 5700C)

0,2 d) Isso não é possível, pois não há um metal (condutor) capaz de resistir a essas temperaturas. O W p.ex. se funde a $\simeq$ 3500°C.

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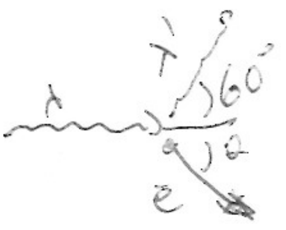
2)



$$\lambda' = \lambda + \frac{h}{m_0 c}(1-\cos 60) \qquad \left(E = \frac{hc}{\lambda}\right) \qquad \lambda = \frac{hc}{E}$$

$$\frac{hc}{E'} = \frac{hc}{E} + \frac{h}{m_0 c}\cdot 0{,}5$$

a) 1,0

$$\frac{1}{E'} = \frac{1}{E} + \frac{1}{2m_0c^2} \qquad \frac{1}{E'} = \frac{1}{100\times10^{3}} + \frac{1}{2\times5\times10^{5}} = \frac{1}{10^{5}} + \frac{1}{10^{6}}$$

$$\frac{1}{E'} = \frac{10^{6}+10^{5}}{10^{5}\cdot10^{6}} = \frac{10+1}{10^{6}} \qquad E' = \frac{10^{6}}{11} \simeq 91\times10^{3}\ eV$$

b) $E' + E_e = E \Rightarrow \boxed{E_e = 9\ keV}$ 0,5

c) $\begin{cases} p_e\cos\theta + p'\cos 60 = p \\ p_e \operatorname{sen}\theta = p'\operatorname{sen}60 \end{cases}$ 0,5 $\Rightarrow \operatorname{tg}\theta = \dfrac{p'\operatorname{sen}60}{p - p'\cos 60} = \boxed{\dfrac{E'\cdot\operatorname{sen}60}{E - E'\cos 60}}$ 0,5

$p = E/c$

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NOTA 4

NOME: __________
PROFESSOR: __________
DATA: __________

(3)

a) $E_e = 50 \times 10^3 eV \quad p_e = \sqrt{2mE_e}$

$\lambda = \frac{h}{p} = \frac{hc}{pc} \quad pc = \sqrt{2mc^2E} = \sqrt{2 \times 5 \times 10^5 \times 5 \times 10^4}$

$pc = \sqrt{5 \times 10^{10}} \cong 2.2 \times 10^5 \; eV$ 0,8

0,2

$\lambda = \frac{12 \times 10^{-7}}{22 \times 10^5} \cong 5.5 \times 10^{-12} \; m \Rightarrow \boxed{\lambda_{min} \simeq 5.5 \times 10^{-12} m}$

b) $\lambda = 0.5 \mathring{A} = 5 \times 10^{-11} m$

0,7

$p = \frac{h}{\lambda} \Rightarrow E = \frac{p^2}{2m} = \frac{p^2c^2}{2mc^2} = \frac{h^2c^2}{\lambda^2 \cdot 2mc^2}$

$pc = \frac{hc}{\lambda}$

$E_n = \frac{12^2 \times 10^{-14}}{25 \times 10^{-22} \times 2 \times 10^9} = \frac{144 \times 10^{-14}}{50 \times 10^{-13}} \simeq 0,3 eV$

0,3

$E_e = \frac{12^2 \times 10^{-14}}{25 \times 10^{-22} \times 5 \times 10^5 \times 2} = \frac{144 \times 10^{-14}}{5 \times 50 \times 10^{-17}} = \frac{144}{25} \times 10^2$

$\boxed{E_e \simeq 600 \; eV}$ (ñ foi perguntado!)

c) $E_f = \frac{hc}{\lambda} = \frac{12 \times 10^{-7}}{5 \times 10^{-11}} = 2,4 \times 10^4 = \boxed{24 \; keV}$

0,5

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NOTA **3**

NOME:
PROFESSOR:
DATA:

4) $\Psi(x,t) = A \,\text{sen}\, \frac{2\pi x}{a} e^{-i\omega t}$

a) $i\hbar \frac{\partial \Psi}{\partial t} = \hbar\omega \Psi(x,t) = E\Psi(x,t) \quad (E = \hbar\omega)$

$-\frac{\hbar^2}{2m}\frac{\partial^2 \Psi}{\partial x^2} = \frac{\hbar^2}{2m}\cdot\left(\frac{2\pi}{a}\right)^2 \Psi(x,t)$

$\Rightarrow$ é solução se $\boxed{E = \hbar\omega = \frac{\pi^2\hbar^2}{2ma^2}\cdot 2^2}$ 0,5

b) $\int_{-a/2}^{a/2} \Psi^*\Psi\, dx = 1 \quad \int_{-a/2}^{a/2} A^*A \,\text{sen}^2 \frac{2\pi x}{a}\, dx = 1$

$A^*A\left(\frac{1}{2}\left(\frac{a}{2}+\frac{a}{2}\right) - \frac{a}{2\pi}\left(\text{sen}\,\pi \cos\pi + \text{sen}\,\pi\cos\pi\right)\right) = A^*A\cdot\frac{a}{2}$

$\Rightarrow A^*A = \frac{2}{a} \Rightarrow \boxed{|A| = \sqrt{2/A}}$ 1,0

c) $\langle x^2\rangle = \int_{-a/2}^{a/2} \Psi^* x^2 \Psi\, dx = A^*A\int_{-a/2}^{a/2} x^2 \,\text{sen}^2\frac{2\pi x}{a}\, dx =$ 0,5

$= \frac{2}{a}\Big\{\left(\frac{1}{6}\left(\frac{a^3}{8}+\frac{a^3}{8}\right) - \frac{a^2}{4(2\pi)^2}\left(\frac{a}{2}(\cos 2\pi - \cos 2\pi)\right)\right.$

$- \frac{1}{8}\left(\frac{a}{2\pi}\right)^3\left[\left(2\left(\frac{2\pi}{a}\right)^2\frac{a^2}{4} - 1\right)\text{sen}\,2\pi - \right.$

$\left.- \left(2\left(\frac{2\pi}{a}\right)^2\frac{a^2}{4} - 1\right)\text{sen}\,{-2\pi}\right)\Big\} = \frac{2}{a}\cdot\frac{1}{6}\frac{a^3}{4} = \boxed{\frac{a^2}{12}}$ 0,5