Ch 28 Assigned Homework

PHYS 1Cb

2014 Spring

2. (b)

3. Before scattering, $f_0 = \frac{E}{h}$ and $\lambda_0 = \frac{c}{f_0} = \frac{hc}{E}$

After scattering, the energy of photon will decrease ⇒ frequency will decrease : $f' < f_0 = \frac{E}{h}$

⇒ wavelength will increase : $\lambda' > \lambda_0 = \frac{hc}{E}$ ⇒ momentum $= \frac{h}{\lambda}$ will decrease ∴ (b)

4. $P_{4-7} = \int_{x=4}^{7} |\psi(x)|^2 dx$ ∵ $\psi(x)$ is constant in this inteval ⇒ let $\psi(x) = C$

$\Rightarrow P_{4-7} = \int_{x=4}^{7} |\psi(x)|^2 dx = \int_{x=4}^{7} |C|^2 dx = |C|^2 \int_{x=4}^{7} dx = |C|^2 \cdot (7-4) = 3|C|^2 = 0.48$

$\Rightarrow |C|^2 = 0.16$ ∴ 0.4 is a solution for C ⇒ $\psi(x) = 0.4$ from $x = 4$ to 7 nm // (e)

5. de Broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{mv} \propto \frac{1}{m}$ (if v are fixed)

∵ $m_{helium} > m_{proton} > m_{electron}$, ∴ $\lambda_{electron} > \lambda_{proton} > \lambda_{helium}$ //

8. Kinetic energy $K = -\Delta U = -(-e)\cdot V = 1.6\times10^{-19} \times 50 = 8\times10^{-18}$ (J)

∵ $K = \frac{p^2}{2m_e}$ ⇒ $p = \sqrt{2\times9.11\times10^{-31}\times8\times10^{-18}} = 3.82\times10^{-24}$ (kg·m/s)

∴ $\lambda = \frac{h}{p} = \frac{6.626\times10^{-34}}{3.82\times10^{-24}} = 1.74\times10^{-10}$ (m) $= 0.174$ nm // (c)

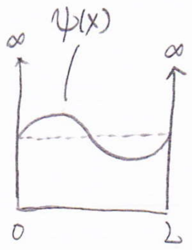
9. $E_n = \frac{h^2}{8mL^2} n^2$ (a) $n=1, m=m_1, L=3$ nm ⇒ $E_a = \frac{h^2}{8m_1 \cdot 3^2}$

(b) $n=2, m=m_1, L=3$ nm ⇒ $E_b = \frac{h^2}{8\cdot m_1 \cdot 3^2} \cdot 4$ (c) $n=1, m=2m_1, L=3$ ⇒ $E_c = \frac{h^2}{8\cdot 2m_1 \cdot 3^2}$

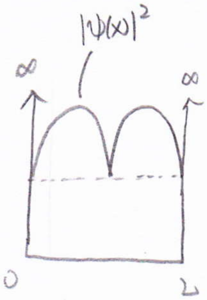
(d) $n=0$ ⇒ $E_d = 0$ (e) $n=1, m=m_1, L=6$ ⇒ $E_e = \frac{h^2}{8\cdot m_1 \cdot 6^2}$

∴ b > a > c > e > d //

10.



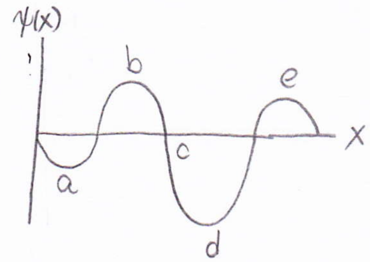
Probability can be obtain by squaring the $\psi(x) \rightarrow |\psi(x)|^2$:



$\therefore$ The particle is most likely to be found at $x = \frac{L}{4}$ and $\frac{3}{4}L$. (d)

12. Scattered photon has lower energy E. $\because E = hf$ $\therefore f$ decreases. (a)

15.



The probability to find the particle is proportional to $|\psi(x)|^2$ at that location. From the figure, $\psi(d)$ is farthest from x-axis $\Rightarrow |\psi(x)|^2$ will be largest at $x=d$ ($|\psi(d)|^2$ is maximum) $\therefore$ d //

16. $\begin{cases} \Delta x \Delta p \geq \frac{h}{4\pi} \\ \Delta E \Delta t \geq \frac{h}{4\pi} \end{cases}$ $\therefore$ (a), (c) //

17. (a) $E = 3eV = 4.8 \times 10^{-19}$ J, $E = hf = \frac{hc}{\lambda}$ $\therefore \lambda = \frac{hc}{E} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4.8 \times 10^{-19}} = \underline{4.14 \times 10^{-7} m}$

(b) $E = 3eV = 4.8 \times 10^{-19}$J. $E = \frac{p^2}{2m_e}$ $\Rightarrow p^2 = 2 \times 9.11 \times 10^{-31} \times 4.8 \times 10^{-19} = 8.75 \times 10^{-49}$

$\Rightarrow p = 9.35 \times 10^{-25}$ kg·m/s $\therefore \lambda = \frac{h}{p} = \frac{6.626 \times 10^{-34}}{9.35 \times 10^{-25}} = \underline{7.09 \times 10^{-10} m}$

(c) $E = 3eV = 4.8 \times 10^{-19}$ J, $E = \frac{p^2}{2m_p}$ $\Rightarrow p = 4 \times 10^{-23}$ kg·m/s $\Rightarrow \lambda = \frac{h}{p} = \underline{1.65 \times 10^{-11} m}$

(d) $E = 0.3eV = 4.8 \times 10^{-20}$ J $\Rightarrow \lambda = \frac{hc}{E} = \underline{4.14 \times 10^{-6} m}$

(e) $p = \frac{3eV}{c} = \frac{4.8 \times 10^{-19}}{3 \times 10^8} = 1.6 \times 10^{-27}$ kg·m/s $\Rightarrow \lambda = \frac{h}{p} = \underline{4.14 \times 10^{-7} m}$

$\therefore d > e = a > b > c$

18. $\Delta p = m \Delta v$, $\Delta x \Delta p \geq \frac{h}{4\pi}$ $\Rightarrow \Delta x \geq \frac{h}{4\pi m \Delta v} \propto \frac{1}{m}$ if Δv is fixed

$\because m_{electron} < m_{proton}$ $\therefore (\Delta x)_{min, electron} > (\Delta x)_{min, proton}$ (c) //