(a)

In Bohr model we have the Bohr radius $a = \frac{h^2\varepsilon_0}{\pi m e^2} \sim 52.92\ [pm]$ ... **2**

$r = a_D \frac{n^2}{Z} = \frac{h^2\varepsilon_0 n^2}{\pi m e^2}\frac{n^2}{Z}$... **2**

$Z = 1\,, r \sim 52.92n^2\ [pm]$ ... **1**

(b)

$E_D = -\frac{me^4}{8h^2\varepsilon_0^2}\frac{1}{n^2} = E_H \sim -\frac{13.61\ eV}{n^2}$ ... **2**

$\mathrm{E_0(n = 1) \sim -13.61eV, E_2(n = 3) \sim -1.51eV}$ ... **2**

$\Delta E \geq E_2 - E_0 \sim 12.10\ eV \sim 1.94 \cdot 10^{-18}\ J$ ... **1**

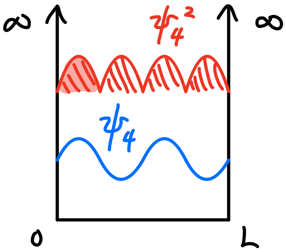
Q.2 An electron, which is in third excited state, is trapped in the 1D infinity potential well of width $L = 10^{-10}\ m$. **(a)** What is the probability that the electron can be detected in the left one-quarter of the well? (5 points) **(b)** If the electron is de-excited to first excited state by emitting a light, what is the wavelength of that light? (5 points)

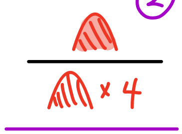
(a) $L = \frac{n\lambda}{2}$, $n = 1, 2, 3, \cdots$

third excited state $\Rightarrow n = 4 \Rightarrow \lambda = \frac{L}{2}$ (1)

$\Rightarrow \psi_{(x)} = A \sin(kx) = A \sin\left(\frac{2\pi}{\lambda}x\right) \Rightarrow \psi_4 = A \sin\left(\frac{4\pi}{L}x\right)$ (1)

method 1 :



$P_{(0\sim\frac{L}{4})} =$  (2) $= \frac{1}{4}$ (1)

method 2 :

$\int_0^L \psi_{(x)}^2\, dx = 1 \Rightarrow A = \sqrt{\frac{2}{L}}$ (1)

$\Rightarrow P_{(0\sim\frac{L}{4})} = \int_0^{\frac{L}{4}} \psi_4^2\, dx$ (1) $= \frac{1}{4}$ (1)

(b) $E_n = \left(\frac{h^2}{8mL^2}\right) n^2$, $n = 1, 2, 3, \cdots$ (1)

$E_4 - E_2 = \left(\frac{h^2}{8mL^2}\right) \cdot (16 - 4)$ (1)

$= 12 \cdot 6.031 \times 10^{-18}\ J$

$\lambda = \frac{hc}{\Delta E}$ (1) $= \frac{(6.63\times10^{-34}\ J\cdot s)\cdot(3\times10^{8}\ m/s)}{12 \cdot 6.031 \times 10^{-18}\ J} \approx 2.748\ nm$ (2) ※