

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF PHYSICS

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Physics 212 - Quiz #3a
Chapter 3

1. A hydrogen atom is in its first excited state ($n = 2$). What is the speed of the electron in this orbit? ($\epsilon_0 = 0.529 \text{ \AA}$, $k = 9 \times 10^9 \text{ N m}^2/\text{C}^2$, $m_e = 9.1 \times 10^{-31} \text{ kg}$, $e = 1.6 \times 10^{-19} \text{ C}$).

Use Bohr quantization of the angular momentum

$$m_e v_n r_n = n \hbar \Rightarrow v_n = \frac{n \hbar}{m_e r_n}$$

$$r_n = n^2 r_0 \Rightarrow v_n = \frac{n \hbar}{m_e n^2 r_0} = \frac{\hbar}{n m_e r_0}$$

$n = 2$

$$v_2 = \frac{\hbar}{2 m_e r_0} = \frac{h}{4 \pi m_e r_0} = \frac{6.63 \times 10^{-34}}{4 \pi (9.1 \times 10^{-31})(0.529 \times 10^{-10})}$$

$$\boxed{v_2 = 1.1 \times 10^6 \text{ m/s}}$$

2. What is the wavelength of the photon emitted by Li^{2+} when the electron makes a transition from the $n = 3$ state to the $n = 2$ state. (For lithium atom, $Z = 3$)

$$E_n = -\frac{13.6 Z^2}{n^2} \text{ (eV)}$$

$$\Delta E = E_f - E_i = -13.6 Z^2 \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$|\Delta E| = +13.6 (9) \left(\frac{1}{4} - \frac{1}{9} \right) = 17 \text{ eV}$$

$$|\Delta E| = hf = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{\Delta E} = \frac{12400 \text{ eV} \cdot \text{\AA}}{17 \text{ eV}} = \boxed{729.4 \text{ \AA}}$$