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Instructor: Dr. A. Mekki

Name: _____ Key _____ Id#: _____

1. A hydrogen atom is in its third excited state (n = 3). What is the speed of the electron in this orbit? ($a_0 = 0.529$ Å, $k = 9 \times 10^9$ N m^2/C^2, $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C).

$$L = m_e v r = n\hbar \quad \text{and} \quad r_n = n^2 a_0$$

$$\Rightarrow v_n = \frac{n\hbar}{m_e r_n} = \frac{n\hbar}{m_e a_0 n^2} = \left(\frac{\hbar}{m_e a_0}\right) \frac{1}{n}$$

Third orbit $\Rightarrow n = 3 \Rightarrow v_3 = \frac{\hbar}{3 m_e a_0} = \frac{1.055 \times 10^{-34}}{3 \times 9.1 \times 10^{-31} \times 0.529 \times 10^{-10}}$

$$\boxed{v_3 = 7.3 \times 10^5 \text{ m/s}}$$

2. What is the photon wavelength of the emitted electromagnetic radiation when the electron in a Be^{3+} ion jumps from the n = 3 state to the n = 1 state. (For Be atom, Z = 4)

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) Z^2$$

$$= R_H \left(1 - \frac{1}{9}\right)(16)$$

$$= \frac{8 \times 16 \times R_H}{9} = 14.2 \, R_H$$

$$\lambda = \frac{1}{14.2 \, R_H} = \frac{1}{14.2 \times 1.097 \times 10^7} = 6.4 \times 10^{-9} \text{ m}$$

$$\boxed{\lambda = 6.4 \text{ nm}}$$