6-8

(a) According to equation related to radius:

$$r_n = \frac{4\pi\varepsilon_0\hbar^2}{\mu e^2}n^2 \,, \frac{1}{\mu} = \frac{1}{m_{muon}} + \frac{1}{m_P}$$

$$r_n = \frac{4\pi\varepsilon_0\hbar^2 n^2}{m_e e^2}\frac{m_e}{\mu} \cong 0.0054 n^2 a_0$$

a_0 is Bohr radius and has the value of 0.053 nm thus

$$r_1 \cong 0.0054 \times 0.053 = 2.9 \times 10^{-13} m$$

(b) According to 6.151

$$E_n = -\frac{m_{muon}(Ze^2)^2}{2\hbar^2}\frac{1}{n^2} = \frac{-207 \times 13.6\, eV}{n^2} = \frac{-2815.2\, eV}{n^2}$$

So, if we mark Energy of the ground state with E_g,Energy of the first excited state with E_{fe}, Energy of the second excited state with E_{se}then

$$E_g = -2815.2\, eV$$

$$E_{fe} = \frac{E_g}{4} = -703.8\, eV$$

$$E_{se} = \frac{E_g}{9} = -302.8\, eV$$

(c) Defining ω_{if} as below

$$\omega_{if} = \frac{E_i - E_f}{\hbar} = \frac{E_g}{\hbar}\left(\frac{1}{{n_i}^2} - \frac{1}{{n_f}^2}\right) = 42.8 \times 10^{17}\left(\frac{1}{{n_i}^2} - \frac{1}{{n_f}^2}\right) Hz$$

$$\omega_{21} = \frac{3}{4} \times 42.8 \times 10^{17} Hz = 32.1 \times 10^{17} Hz$$

$$\omega_{31} = \frac{8}{9} \times 42.8 \times 10^{17} Hz = 38 \times 10^{17} Hz$$

$$\omega_{32} = \frac{5}{36} \times 42.8 \times 10^{17} Hz = 6 \times 10^{17} Hz$$

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