King Fahd University of Petroleum & Minerals
Physics Department
Phys212- Quiz#4

Name: Key ID#:

(a) Calculate the **frequency of revolution** and the **orbit radius** of the electron in the Bohr model of hydrogen for n = 100 and 10000.
(b) Calculate the **photon frequency** of transition from the n to n-1 states for the same values of n as in part (a).
(c) **Calculate** $f_{rev} - f_{photon}$ for each case. What can you conclude?

(a) $f_{rev} = \frac{v}{2\pi r}$ but $mvr = n\hbar \Rightarrow v = \frac{n\hbar}{m_e r}$

$f_{rev} = \frac{n\hbar}{2\pi m_e r^2}$ but $r_n = a_0 n^2 \Rightarrow f_{rev} = \frac{n\hbar}{2\pi m_e a_0^2 n^4}$

$\Rightarrow f_{rev} = \frac{\hbar}{2\pi m_e a_0^2 n^3} = \frac{6.57 \times 10^{15}}{n^3}$

$n = 100$ $\boxed{f_{100,rev} = 6.57 \times 10^{9}\ Hz}$ $n = 10,000$ $\boxed{f_{rev,10000} = 6.57 \times 10^{3}\ Hz}$

$\boxed{r_{100} = 5.3 \times 10^{-7}\ m}$ $\boxed{r_{10000} = 5.3 \times 10^{-3}\ m}$

(b) $f_{photon} = \frac{\Delta E}{h} = \frac{13.6\ eV}{h}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) = 3.1 \times 10^{15}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$n_i = 100 \rightarrow n_f = 99$ $f_{photon} = 3.3 \times 10^{15}\left(\frac{1}{99^2} - \frac{1}{100^2}\right) = \boxed{6.7 \times 10^{9}\ Hz}$

$n_i = 10000 \rightarrow n_f = 9999$ $f_{photon} = 3.3 \times 10^{15}\left(\frac{1}{9999^2} - \frac{1}{10000^2}\right) = \boxed{6.6 \times 10^{3}\ Hz}$

(c) The difference

$n = 100$ $n = 10,000$

$\Delta f = 0.13 \times 10^{9}\ Hz$ (large) $\Delta f = 30\ Hz$

$r_{100} = 530\ nm$ $r_{1000} = 5.3\ mm$

microscopic size huge difference macroscopic size

as n increases $f_{rev} \rightarrow f_{jump}$ $\Rightarrow$ Bohr's Correspondance principle !!!