5.73

Quiz 28 ANSWERS

1.

Bohr radius $r_n = a_0 n^2$

Rydberg Equation $E_n = -\frac{\Re}{n^2}$

Amplitude of wavefunction inside core: $\psi_n(r) \propto n^{-3/2}$ (innermost lobe)

$$E_{n+\delta/2} - E_{n-\delta/2} = \frac{2\delta\Re}{n^3}$$

A. How does the transition probability $\left(\text{proportional to } |\langle 1s|r|np\rangle|^2\right)$ for the $1s \rightarrow np$ Rydberg series scale with n? [**HINT**: $1s$ is *entirely* inside the core; only the innermost lobe of np is inside the core.]

$$\langle 1s|r|np\rangle \propto n^{-3/2}$$

$$|\langle 1s|r|np\rangle|^2 \propto n^{-3}$$

B. The transition probability density (proportional to $|\langle 1s|r|np\rangle|^2 / [E_{n+1/2} - E_{n-1/2}]$) is supposed to be constant as n $\rightarrow \infty$ and beyond into the ionization continuum. Show that this is true. [**HINT**: Use the n-scaling of the numerator from Part A; use the n-scaling of the denominator from the box above.]

$$E_{n+1/2} - E_{n-1/2} = \frac{2\Re}{n^3} \text{ because } \delta = 1$$

$$\frac{|\langle 1s|r|np\rangle|^2}{E_{n+1/2} - E_{n-1/2}} \propto \frac{n^{-3}}{\frac{2\Re}{n^3}} = \frac{1}{2\Re} \text{ independent of } n$$