7-17 2s $R(r) = \frac{1}{(2a_0)^{3/2}}\left(2 - \frac{r}{a_0}\right)e^{-r/2a_0}$

so

$$P(r) = r^2|R|^2 = \frac{r^2}{8a_0^3}\left(4 - \frac{4r}{a_0} + \frac{r^2}{a_0^2}\right)e^{-r/a_0}$$

$$\langle r \rangle = \int_0^\infty dr\, r\, P(r) = \int_0^\infty dr\, \frac{r^3}{8a_0^3}\left(4 - \frac{4r}{a_0} + r^2/a_0^2\right)e^{-r/a_0}$$

$$= \frac{1}{8a_0^3}\int_0^\infty dr\, r^3\left(4 - \frac{4r}{a_0} + \frac{r^2}{a_0^2}\right)e^{-r/a_0}$$

Use $\int_0^\infty x^n e^{-ax} = \frac{n!}{a^{n+1}}$ where $a = \frac{1}{a_0}$

$$\langle r \rangle = \frac{1}{8a_0^3}\left[4\cdot 3!\cdot a_0^4 - 4\cdot 4!\, a_0^4 + 5!\, a_0^4\right]$$

$$= a_0\left[\frac{4\cdot 3! - 4\cdot 4! + 5!}{8}\right]$$

$$= a_0\left[\frac{4\cdot 6 - 4\cdot 24 + 120}{8}\right] = 6a_0$$

2p $R(r) = \frac{1}{\sqrt{3}(2a_0)^{3/2}}\frac{r}{a_0}e^{-r/2a_0}$

$$\Rightarrow P(r) = \frac{1}{24a_0^3}\frac{r^4}{a_0^2}e^{-r/a_0}$$

$$\langle r \rangle = \frac{1}{24a_0^5}\int_0^\infty dr\, r^5 e^{-r/a_0}$$

$$= \frac{1}{24a_0^5}\cdot 5!\, a_0^6 = \frac{5!}{24}a_0 = 5a_0$$