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(a) According to Table 5.2 and 6.6 we have:

$$R_{21}(r) = \frac{1}{\sqrt{6a_0^3}} \frac{r}{2a_0} e^{-r/2a_0}$$

$$Y_{1,\pm 1}(\theta, \varphi) = \mp\sqrt{\frac{3}{8\pi}}\, e^{\pm i\varphi}\ \sin\theta$$

$$\psi(\vec{r}) = A\sqrt{\frac{8\pi}{3}}2a_0\sqrt{6{a_0}^3}R_{21}(r)Y_{11}(\theta,\varphi) = A\sqrt{\frac{8\pi}{3}}2a_0\sqrt{6{a_0}^3}\Psi_{211}(\vec{r})$$

Thus $\psi(\vec{r})$ is eigen function of $\hat{\vec{L}}^2$ and $\hat{L}_z$ and $n = 2, l = 1, m = 1$

(b) $\Psi_{211}(\vec{r})$ is normalize so

$$A = \left(\sqrt{\frac{8\pi}{3}}2a_0\sqrt{6{a_0}^3}\right)^{-1}$$

(c) According to 6.233 and 6.265 we have

$$\langle 21|r|21\rangle = \frac{1}{2}(3\times 2^2 - 1\times 2)a_0 = 5a_0$$

And $r_2 = 2^2 a_0 = 4a_0$

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