

Mecânica Quântica I - 4302403

Respostas da 6ª lista

2) a)

$$R_{21}(r) = \frac{r}{4a^2} e^{-r/2a} c_0, \quad c_0 = \sqrt{\frac{2}{3a}}$$

$$\Psi_{210}(r, \theta, \varphi) = R_{21}(r) Y_1^0(\theta, \varphi) = \frac{1}{\sqrt{2\pi a}} \frac{r}{4a^2} e^{-r/2a} \cos \theta$$

$$\Psi_{21\pm 1}(r, \theta, \varphi) = R_{21}(r) Y_1^{\pm 1}(\theta, \varphi) = \mp \frac{1}{\sqrt{\pi a}} \frac{r}{8a^2} e^{-r/2a} \sin \theta e^{\pm i\varphi}$$

b)

$$R_{30}(r) = \frac{c_0}{3a} \left[1 - \frac{2r}{3a} + \frac{2}{27} \left(\frac{r}{a} \right)^2 \right] e^{-r/3a}$$

$$R_{31}(r) = \frac{c_0 r}{9a^2} \left(1 - \frac{r}{6a} \right) e^{-r/3a}$$

$$R_{32}(r) = \frac{c_0 r^2}{81a^3} e^{-r/3a}$$

5) a)

$$\Psi(\vec{r}, t) = -\frac{i}{\sqrt{2\pi a}} \frac{r}{4a^2} e^{-r/2a} \sin \theta \sin \varphi e^{-iE_2 t/\hbar}, \quad E_2 = -\frac{m}{8\hbar^2} \left(\frac{e^2}{4\pi\epsilon_0} \right)^2$$

6) a) $\langle H \rangle = E_2$

b) $\text{Prob}(l=0) = \frac{2}{5}$ e $\text{Prob}(l=1) = \frac{3}{5}$.

c) $\text{Prob}(l=1, m=1) = \frac{1}{5}$, independente do tempo.

7) a) $s > -7$.

11)

$$E_n(Z) = Z^2 E_n, \quad E_1(Z) = Z^2 E_1, \quad a(Z) = \frac{a}{Z}, \quad R(Z) = Z^2 R$$

A série de Lyman para $Z = 2, 3$ fica no ultravioleta.