Physics 3740 HW No 7 Answers

Chapter 6:

(55) (b) $E = \frac{3\hbar^2}{2mL^2}$ (c) ψ_1 is the first excited state

(57) (a) $T \approx 2.23 \times 10^{-17}$ (b) $T \simeq 0.0725$

Chapter 7:

(5) (a)

n_1	n_2	n_3	E
1	1	1	1.313 E_0
1	1	2	1.500 E_0
1	1	3	1.813 E_0
1	2	1	2.063 E_0
1	1	4	2.250 E_0
1	2	2	2.250 E_0
1	2	3	2.563 E_0
1	1	5	2.813 E_0
1	2	4	3.000 E_0
1	3	1	3.3125 E_0

(b) 1, 1, 4 and 1, 2, 2

(9) (a) 0, 1, 2

(b) For $\ell = 0$, $m = 0$

For $\ell = 1$, $m \in \{-1, 0, 1\}$

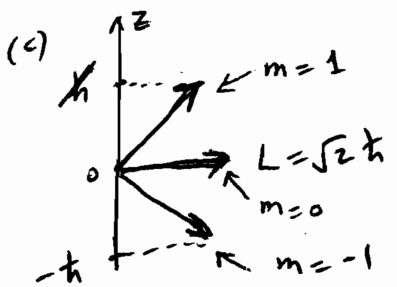
For $\ell = 2$, $m \in \{-2, -1, 0, 1, 2\}$

(c) There are 18 (in general, it is $2n^2$).

(14) (a) $L = \sqrt{2}\,\hbar = 1.49 \times 10^{-34}$ J.s

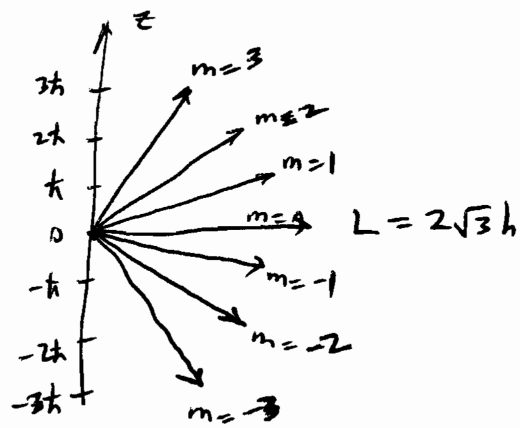
(b) $m = -1, 0,$ or 1

(c)



(d) $L = \sqrt{12}\,\hbar = 2\sqrt{3}\,\hbar \simeq 3.65 \times 10^{-34}$ J.s

$m = -3, -2, -1, 0, 1, 2,$ or 3



(15) Start with the definition $\vec{L} = \vec{r} \times \vec{p}$ and then differentiate with respect to time, using the product rule and what you know about cross products.

(17) (a) $n = 6$, $\ell = 3$ (b) -0.38 eV (c) $2\sqrt{3}\,\hbar = 3.65 \times 10^{-34}$ J.s

(d) $L_z = m\hbar = -3\hbar, -2\hbar, -\hbar, 0, \hbar, 2\hbar,$ or $3\hbar$.

(19) (a) $\psi_{100} = \dfrac{e^{-1}}{\sqrt{\pi a_0^3}}$ (b) $|\psi_{100}|^2 = \dfrac{1}{\pi a_0^3} e^{-2}$ at $r = a_0$

(c) $\dfrac{4}{a_0} e^{-2}$ at $r = a_0$

(22) $C_{210} = \sqrt{\dfrac{Z^3}{32\pi a_0^3}}$. (This is the same as the value of the constant C_{200}, which is given incorrectly in problem 25.)

(24) (The constant A turns out to be

$$A = 4\pi \, |C_{210}|^2 \left(\frac{Z^2}{a_0^2}\right).\ )$$

(25) All evaluated at $r = a_0$.

(a) $\psi_{200} = \dfrac{1}{\sqrt{32\pi e \, a_0^3}}$ (Note: $C_{200} = \dfrac{1}{\sqrt{32\pi}} \left(\dfrac{Z}{a_0}\right)^{3/2}$, not the value given in the textbook.)

(b) $|\psi_{200}|^2 = \dfrac{1}{32\pi e \, a_0^3}$

(c) $P(r) = |\psi_{200}|^2 \, 4\pi r^2 = \dfrac{1}{8 e a_0} \simeq \dfrac{0.046}{a_0}$.