

Ch. 11 HW, Part A (Exam III): #1, 2, 7-10, 11b,c

1. d^2 p^3

$m_l = \bar{1} \bar{0} \bar{1}$

$M_L = 2, 1, 0, -1, -2$

$M_S = +3/2, +1/2, -1/2, -3/2$

$M_L = \pm 2$

$M_S = +1/2, -1/2$

$\begin{matrix} 1 & 1 & 1 \\ 1 & 0 & -1 \end{matrix}$

$M_L = \pm 1$

$M_S = +1/2, +1/2, -1/2, -1/2$

$\begin{matrix} 1 & 1 & 1 \\ 1 & 0 & -1 \end{matrix}$

$\begin{matrix} 1 & 1 & 1 \\ 1 & 0 & -1 \end{matrix}$

$M_L = 0$

$\begin{matrix} 1 & 1 & 1 \\ 1 & 0 & -1 \end{matrix}$

$\begin{matrix} 1 & 1 & 1 \\ 1 & 0 & -1 \end{matrix}$

$\begin{matrix} 1 & 1 & 1 \\ 1 & 0 & -1 \end{matrix}$

$\begin{matrix} 1 & 1 & 1 \\ 1 & 0 & -1 \end{matrix}$

$M_S = +3/2, +1/2, +1/2, +1/2, -1/2, -1/2, -1/2, -3/2$

M_L	$+3/2$	M_S $+1/2$	$-1/2$	$-3/2$
2	X	X	X	
1		X X	X X	
0	X	X X X	X X X	X
-1		X X	X X	
-2		X	X	

$\bigcirc M_L = 0$ $M_S = +3/2$
4S

\triangle MAX $M_L = L = 2$
MAX $M_S = S = 1/2$
2D

\square : MAX $M_L = 1 = L$
MAX $M_S = 1/2 = S$
2P

Ground Term = 4S \rightarrow 4S_{3/2}

b) $p^1 d^1$

$\bar{1} \bar{0} \bar{1}$ $\bar{2} \bar{1} \bar{0} \bar{1} \bar{2}$

$M_L = 3, 2, 1, 0, -1, -2, -3$ $M_S = 1, 0, -1$

$M_L = \pm 3$ $M_S = 1, 0, 0, -1$ $\pm 1/2$

$M_L = \pm 2$ $M_S = 1, 1, 0, 0, 0, 0, -1, -1$ $0 \bar{2}$ $\bar{1} \bar{1}$

$M_L = \pm 1$ $M_S = 1, 1, 1, 0, 0, 0, 0, 0, -1, -1, -1$ $\bar{1} \bar{0}$ $\bar{0} \bar{1}$ $\bar{1} \bar{2}$

$M_L = 0$ $M_S = 1, 1, 1, 0, 0, 0, 0, 0, 0, -1, -1, -1$ $\bar{0} \bar{0}$ $\bar{1} \bar{1}$ $\bar{1} \bar{1}$

$L=3 S=1$ 3F $\bigcirc L=2 S=1$ 3D

$\triangle L=3 S=0$ 1F $\square L=2 S=0$ 1D

$L=1 S=1$ 3P remaining: $L=1 S=0$ 1P

Ground term: 3F \rightarrow 3F₂

M_L	3	2	1	M_S 0	-1
3	X			X X	X
2	X X	X X X X	X X	X X X	X X X
1	X X X	X X X X X X	X X X	X X X X	X X X
0	X X X	X X X X X X X	X X X X	X X X X	X X X
-1	X X X	X X X X X X	X X X	X X X X	X X X
-2	X X	X X X X	X X	X X X	X X X
-3	X			X X	X

#3 not assigned for 2014

3. $(s^1 d^1)$ $m_l = 0$
 $m_l = \pm 2, \pm 1, 0$

	M_S	
$M_L = \pm 2$	$\frac{1}{2}$ $\frac{1}{2}$	$1, 0, 0, -1$
$M_L = \pm 1$	$s=0$	$1, 0, 0, -1$
$M_L = 0$		$1, 0, 0, -1$

M_L	M_S		
	1	0	-1
2	X	XX	X
1	X	XX	X
0	X	XX	X
-1	X	XX	X
-2	X	XX	X

Term 1:
 $L=2$ $S=1 \rightarrow 3D$

Term 2:
 $L=2$ $S=0 \rightarrow 1D$

Lowest energy: $3D$

- 7.
- $2D$ $L=2$ $M_L = -2, -1, 0, 1, 2$ $S = \frac{1}{2}$ $M_S = +\frac{1}{2}, -\frac{1}{2}$
 - $3G$ $L=4$ $M_L = -4, -3, -2, -1, 0, 1, 2, 3, 4$ $S=1$ $M_S = -1, 0, 1$
 - $4F$ $L=3$ $M_L = \pm 3, \pm 2, \pm 1, 0$ $M_S = \frac{3}{2}, \frac{1}{2}, -\frac{1}{2}, -\frac{3}{2}$ $S = \frac{3}{2}$

- 8.
- $J = 5/2, 3/2$ $d^3 = < \frac{1}{2} \text{ full} \rightarrow 2D_{3/2}$
 - d^4 $J = 5, 4, 3$ $< \frac{1}{2} \text{ full} \rightarrow 3G_3$
 - $4F$ d^7 $J = \frac{9}{2}, \frac{7}{2}, \frac{5}{2}, \frac{3}{2}$ $> \frac{1}{2} \text{ full} \rightarrow 4F_{9/2}$

9. $A = \epsilon b c$ $\epsilon = 0.038 \text{ M}^{-1} \text{ cm}^{-1}$ $A = 0.10$ $b = 1.00 \text{ cm}$

$$c = \frac{0.10}{(0.038 \text{ M}^{-1} \text{ cm}^{-1})(1.00 \text{ cm})} = \underline{2.6 \text{ M}}$$

10. a) $\frac{1}{\lambda} = 24900 \text{ cm}^{-1}$ $\lambda = 4.02 \times 10^{-5} \text{ cm} = 402 \text{ nm}$

$$v = \frac{c}{\lambda} = c \bar{\nu} = (24,900 \text{ cm}^{-1})(2.998 \times 10^8 \text{ m/s}) = \underline{7.47 \times 10^{14} \text{ Hz}}$$

b) $E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s})(2998 \times 10^8 \text{ m/s})}{366 \times 10^{-9} \text{ m}} = \underline{5.43 \times 10^{-19} \text{ J}}$

$$\left(366 \text{ nm} \left(\frac{1 \text{ cm}}{1 \times 10^7 \text{ nm}}\right)\right)^{-1} = \underline{27,300 \text{ cm}^{-1} = \bar{\nu}}$$

