

PH 585
AM10

Solutions of HW #5

①

Problem #1 8.10 of B&T

(a)-(b) :

(i) ns n's $\Rightarrow l_1 = l_2 = 0$
 non-equivalent degeneracy: 4 \Rightarrow $^3S_1, ^1S_0$
 $3 + 1 = 4$

(ii) ns n'p $\Rightarrow l_1 = 0, l_2 = 1$
 non-equiv. degeneracy: $2 \cdot 2 \cdot 3 = 12 \Rightarrow$ $^3P_1, ^1P_1$
 $3 \cdot 3 + 3 \cdot 1 = 12$

(iii) ns n'd $\Rightarrow l_1 = 0, l_2 = 2$
 non-equiv. degeneracy: $2 \cdot 2 \cdot 5 = 20 \Rightarrow$ $^3D_1, ^1D_2$
 $5 \cdot 3 + 5 \cdot 1 = 20$

(iv) nd² $\Rightarrow l_1 = l_2 = 2$
 equiv. deg.: $\binom{2+5}{2} = \frac{10!}{8!2!} = 45 \Rightarrow L = 4, 3, 2, 1, 0$
 $S = 0, 1$
 $^3,1S, ^3,1P, ^3,1D, ^3,1F, ^3,1G$

exclude: $m_{e_1} = m_{e_2} = 2$ and $m_{s_1} = m_{s_2} = \frac{1}{2} \Rightarrow$ 3G

$m_{e_1} = m_{e_2} = 0$ and $m_{s_1} = m_{s_2} = \frac{1}{2} \Rightarrow$ 3S

$m_{e_1} = m_{e_2} = 1$ and $m_{s_1} = m_{s_2} = \frac{1}{2} \Rightarrow$ 3D

2 equivalent configurations $(m_{e_1} = \frac{1}{0}; m_{e_2} = \frac{0}{1}$ and $m_{s_1} = \pm \frac{1}{2}, m_{s_2} = \mp \frac{1}{2} \Rightarrow$ 1P
 $(m_{e_1} = \frac{2}{0}; m_{e_2} = \frac{0}{2}$ and " " \Rightarrow 1F

So, the allowed configurations are

$$^1S, ^1D, ^1G, ^3P, ^3F$$

$$1 + 5 + 9 + 3 \cdot 3 + 7 \cdot 3 = 45 \quad \checkmark$$

$$^1S_0, ^1D_{5/2, 3/2}, ^1G_{9/2, 7/2}, ^3P_{2, 1, 0}, ^3F_{4, 3, 2}$$

Problem #2 8.11 of BJ

(a) $n_p n_d$ non-equiv. $l_1=1, s_1=1/2 \Rightarrow j_1=3/2, 1/2$
 $l_2=2, s_2=1/2 \Rightarrow j_2=5/2, 3/2$

$$\left(\frac{3}{2}, \frac{5}{2}\right)_{4, 3, 2, 1}; \left(\frac{3}{2}, \frac{3}{2}\right)_{3, 2, 1, 0}; \left(\frac{1}{2}, \frac{5}{2}\right)_{3, 2}; \left(\frac{1}{2}, \frac{3}{2}\right)_{2, 1}$$

(b) $(nl\ 3/2)^2$ $j_1=j_2=3/2 \Rightarrow j=3, 2, 1, 0$ But: need different m_j 's
 $m_{j_1} = \pm 3/2, \pm 1/2$ $m_{j_2} = m_{j_1}$ $m_{j_2} = \pm 1/2$
 \Rightarrow exclude!

allowed are $(nl\ \frac{3}{2})^2_{2, 0}$