

8.21

$$E = \hbar \omega = \frac{hc}{\lambda}$$

$$\Delta E = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$$

$$= 1240 \text{ eV nm} \left(\frac{1}{766.41} - \frac{1}{769.90} \right) = \boxed{7.3 \times 10^{-3} \text{ eV}}$$

$$\Delta E = -\vec{\mu}_s \cdot \vec{B} = + \frac{e}{m} \hbar B$$

$$B = \frac{m \Delta E}{e \hbar} = \frac{2m}{e \hbar} \frac{\Delta E}{2}$$

$$= \frac{1}{5.7884 \times 10^{-5} \text{ eV/T}} \cdot \frac{7.3 \times 10^{-3} \text{ eV}}{2}$$

$$= \boxed{63.1 \text{ T}}$$

8.22

Hund's rules \Rightarrow

1S_0 ———

1D_2 ———

3P_2 ———

3P_1 ———

3P_0 ———

there are no $\Delta S = 0$ / $\Delta L = \pm 1$ transitions

9.30

anomalous Zeeman effect is due to both μ_L and μ_S

normal Zeeman effect is due to μ_L only

$\vec{S} = 0 \Rightarrow$ only normal Zeeman effect

true for all levels (both ground and excited states)

an atom could exhibit both (if there are 2 optically active electrons $S=0$ or

$S=1$ for example.)

8.36

see fig 8.16

$$2S_{1/2} \quad g = 2 \quad (\text{p 290})$$

$$2P_{1/2} \quad g = 2/3 \quad (\text{p 290})$$

$$\Delta E = \mu_B B_{\text{ext}} g m_j$$

$$2S_{1/2} \quad \Delta E_1 = \pm 5.7884 \times 10^{-5} \text{ eV/T} \cdot 0.5 \cdot 2 \cdot \frac{1}{2}$$
$$= \pm 2.8942 \times 10^{-5} \text{ eV}$$

$$2P_{1/2} \quad \Delta E_2 = \pm 5.7884 \times 10^{-5} \cdot 0.5 \cdot \frac{2}{3} \cdot \frac{1}{2}$$
$$= \pm 9.6473 \times 10^{-6} \text{ eV}$$

now

$$\Delta E_{\text{short}} = \Delta E_1 + \Delta E_2$$

$$\Delta E_{\text{long}} = -\Delta E_1 - \Delta E_2$$

in both cases

$$\Delta E = \pm \Delta E_1 + \Delta E_2$$

$$= 3.85893 \times 10^{-5} \text{ eV}$$

$$E = \frac{hc}{\lambda}$$

$$\frac{dE}{d\lambda} = -\frac{hc}{\lambda^2}$$

$$\Delta \lambda = \frac{\Delta E \lambda^2}{hc} = \frac{3.85893 \times 10^{-5} \text{ eV} \cdot (589.76 \text{ nm})^2}{1239.8 \text{ eV nm}}$$

$$= 1.082 \times 10^{-2} \text{ nm}$$

difference is 2x this = $2.16 \times 10^{-2} \text{ nm}$

8.37

$$\Delta E = \mu_B B_{\text{ext}} g m_j$$

$${}^2P_{3/2} \Rightarrow m_j = \pm \frac{3}{2}, \pm \frac{1}{2}$$

$$g = 4/3 \quad (\text{p 290})$$

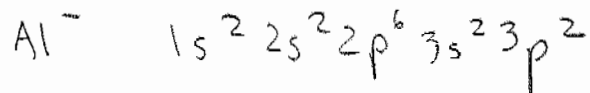
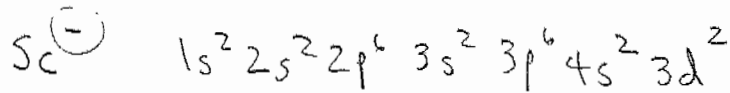
$$\Delta E = 5.7884 \times 10^{-5} \cdot 0.5 \cdot \frac{4}{3} \cdot \frac{1}{2}$$

$$= 1.929 \times 10^{-5} \text{ eV}$$

splitting between states is 2x this

$$= \boxed{3.859 \times 10^{-5} \text{ eV}}$$

8.39



$l=0, 1, 2, 3$
s p d f

for Sc^{-}

$$S_1 = 1/2 \quad S_2 = 1/2 \Rightarrow S = 0, 1$$

$$l_1 = 2 \quad l_2 = 2 \Rightarrow L = 4, 3, 2, 1, 0$$

for $S=1$, L must be odd = 1, 3 for an overall antisymmetric wave function (overall symmetry of space part is -1^L)

for $S=0$, L must be even = 0, 2, 4

Hund's rules \Rightarrow lowest energy for max S

max L

$$\Rightarrow S=1 \text{ and } L=3$$

min J

$$\Rightarrow {}^3F_{4,3,2}$$

\Rightarrow $({}^3F_2)$ is the ground state

for Al^-

$$s_1 = 1/2 \quad s_2 = 1/2 \quad \Rightarrow \quad S = 0, 1$$

$$l_1 = 1 \quad l_2 = 1 \quad \Rightarrow \quad L = 2, 1, 0$$

$$\Rightarrow S = 1 \text{ and } L = 1 \text{ (odd)}$$

$$\Rightarrow {}^3P_{2,1,0}$$

$$\Rightarrow \textcircled{{}^3P_0} \text{ is the ground state}$$