Krane Chapter 7

Problem 1

$n = 4, l = 0 \quad (4,0,0)$
$n = 4, l = 1 \quad (4,1,+1), (4,1,0), (4,1,-1)$
$n = 4, l = 2 \quad (4,2,+2), (4,2,+1), (4,2,0), (4,2,-1), (4,2,-2)$
$n = 4, l = 3 \quad (4,3,+3), (4,3,+2), (4,3,+1), (4,3,0), (4,3,-1), (4,3,-2), (4,3,-3)$

Problem 6

(a) $|L| = \hbar\sqrt{l(l+1)} = \hbar\sqrt{3(3+1)} = \hbar\sqrt{12}$
(b) There are $2l + 1 = 7$ components
$L_z = m_l\hbar = 3\hbar, 2\hbar, 1\hbar, 0\hbar, -1\hbar, -2\hbar, -3\hbar$
(c) $\cos(\theta) = L_z/|L|$
$\theta = \sqrt{3}/2,\ 1/\sqrt{3},\ 1/\sqrt{12},\ 0, -1/\sqrt{12},\ -1/\sqrt{3},\ -\sqrt{3}/2$
$\theta = 30, 55, 73, 90, 107, 125, 150$ degrees

all results are independent from n

Problem 22

Label states for different n as s,p,d,f,g
Then draw all possible lines for which l changes by 1 unit, as n changes.
From the p states, there are 3 direct transitions p states to n=1,s, two direct transitions from p states n=2,s, and 1direct transition from p states to n=3,s. There is one direct transition from p states to n=3,d
etc.

Problem 24

IN the absence of a magnetic field, the 3d to 2p energy difference is
$\Delta E = -13.6057(1/9 - 1/4) = 1.88968$ and therefor
$\lambda = hc/\Delta E = 1239.842/(1.889689) = 656.112nm$
.The change in wavelength due to the B field is
$\Delta\lambda = (\lambda^2/hc)(\delta E_{magnetic})$
$(\delta E_{magnetic}) = (5.79 \times 10^{-5})(3.50)eV$ using the Bohr magneton
This result gives a wavelength shift of
$(\lambda^2/hc)(\delta E_{magnetic}) = \{(656.112)^2/(1239.842)\}(5.79 \times 10^{-5})(3.50) = 0.0703nm$
therefor the Zeeman splitting is
$656.112nm$ and $656.112 \pm 0.0703nm$

(b) The energy of 3s and 3d are the same so the same results are obtained for the 3s to 2p transitions.