7-30 $|S| = \sqrt{s(s+1)}\hbar = \sqrt{3/4}\,\hbar$ $r = 10^{-15}\,m$, $m_e = 9.11\cdot10^{-31}\,kg$

PRETEND THAT SPIN, $|S|$, BEHAVES LIKE CLASSICAL (ORBITAL) ANGULAR MOMENTUM $|L| = I\omega = \left(\frac{2}{5}mr^2\right)\left(\frac{v}{r}\right)$

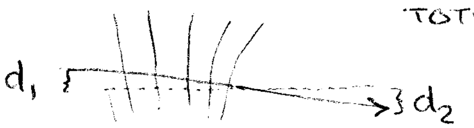
$\Rightarrow v = |L|(5/2)/mr$ $|L| = \sqrt{3/4}\,\hbar = 9.13\cdot10^{-35}\,J\cdot s$

$\Rightarrow$ $\boxed{v = 2.5\cdot10^{11}\,m/s \approx 1000c}$

7-32 $F_z = \mu_z \frac{dB}{dz} = -m_s g_L \mu_B \frac{dB}{dz}$ $F_z = m_{Ag} a_z$ a_z is positive for $m_s = -1/2$

$\Rightarrow a_z = -\frac{m_s g_L \mu_B}{m_{Ag}}\frac{dB}{dz}$ or $\frac{dB}{dz} = -\frac{a_z m_{Ag}}{m_s g_L \mu_B}$

TO FIND a_z, WE LOOK AT THE KINEMATICS OF THE VERTICAL MOTION:



TOTAL DEFLECTION $= d_1 + d_2 = .5\,mm = .5\cdot10^{-3}\,m$

$d_1 = \frac{1}{2}a_z t^2$

FIND t FROM HORIZONTAL MOTION:

$x_1 = v_x t \Rightarrow t = (1m)/250\,m/s = 4\cdot10^{-3}\,s$

$\Rightarrow d_1 = \frac{1}{2}a_z(4\cdot10^{-3}s)^2$

$d_2 = v_z t$ FIND $v_z = a_z t = (4\cdot10^{-3}s)a_z \Rightarrow d_2 = a_z(4\cdot10^{-3}s)^2$

$\therefore d_1 + d_2 = \left(\frac{3}{2}\right)a_z(4\cdot10^{-3}s)^2 = .5\cdot10^{-3}\,m$ SOLVE FOR a_z:

$a_z = 20.8\,m/s^2$. $M_{Ag} = 107.9\,\frac{kg}{mol}\cdot\frac{mol}{6.022\cdot10^{32}\,atom} = 1.791\cdot10^{-25}\,kg$

$\Rightarrow \frac{dB}{dz} = +\frac{(20.8\,m/s^2)(1.791\cdot10^{-25}\,kg)}{(+1/2)(2)\,9.27\cdot10^{-24}\,J/T} = \boxed{1.61\,T/m}$

7-33 (a) $j = 3/2$ THERE ARE $2j+1$ DEFLECTIONS, SO THE # OF LINES IS $2(3/2)+1 = \boxed{4}$

(b) $\ell = 1, s = 0 \Rightarrow j = 1$ SO # OF LINES $= 2(1)+1 = \boxed{3}$

7-34 $\ell = 1, 0$ $s = 1/2$ FOR $\ell = 1$, $j = \frac{1}{2}, \frac{3}{2}$

FOR $\ell = 0$, $j = \frac{1}{2}$ $\Rightarrow 2^2S_{1/2}, 2^2P_{1/2}, 2^2P_{3/2}$

FOR $n = 4$, $\ell = \begin{cases} 3 & j = 5/2, 7/2 \\ 2 & j = 3/2, 5/2 \\ 1 & j = 3/2, 1/2 \\ 0 & j = 1/2 \end{cases}$

$4^2F_{5/2}$ $4^2F_{7/2}$

$4^2D_{3/2}$ $4^2D_{5/2}$

$4^2P_{1/2}$ $4^2P_{3/2}$ $4^2S_{1/2}$

7-37

IF $j = \ell + 1/2$ then $\ell = 1$

IF $j = \ell - 1/2$, then $\ell = 2$

7-40 (a) $E = h\nu \quad \nu = c/\lambda \Rightarrow \quad E = hc/\lambda$

$$E_1 = \frac{(4.135\cdot 10^{-15}\ eV\cdot s)(3\cdot 10^8 m/s)}{589.6\cdot 10^{-9} m} = 2.104 eV$$

$$E_2 = \frac{(4.135\cdot 10^{-15}\ eV\cdot s)(3\cdot 10^8 m/s)}{589\cdot 10^{-9} m} = 2.106 eV$$

(b) $\Delta E = .002 eV$

(c) $\mu_B = 5.79\cdot 10^{-5}\ eV/\text{Tesla} \qquad \Delta E = 2\mu_B B \Rightarrow \quad B = \frac{\Delta E}{2\mu_B}$

$$= \frac{(.001 eV)\text{ Tesla}}{(5.79\cdot 10^{-5} eV)} = \boxed{17.3T}$$

7-43 (a) GROUND STATE: PUT 2 e^- IN $n=1$, 2 in $n=2$, 1 in $n=3$

(CANNOT PUT ALL IN $n=1$ STATE DUE TO PAULI EXCLUSION)

$$E = 2E_1 + 2E_2 + E_3 \qquad E_n = \hbar^2\pi^2 n^2/2m_eL^2$$

$$= \frac{\hbar^2\pi^2}{2m_eL^2}\left[2(1)^2 + 2(2)^2 + 3^2\right] = \frac{19\hbar^2\pi^2}{2m_eL^2}$$

$$= \frac{19(\hbar c)^2\pi^2}{2(m_ec^2)L^2} \qquad \hbar c = 197.3 eV\cdot m \quad m_ec^2 = .511\cdot 10^6 eV \qquad = \boxed{7.14 eV}$$

(b) PIONS MUST BE BOSONS IF THEY HAVE SYMMETRIC WAVEFUNCTIONS, SO THEY ARE NOT SUBJECT TO PAULI EXCLUSION. $E = \frac{5E_1}{264} = \boxed{.0071 eV}$

WHERE E_1 IS FOR AN ELECTRON.

7-48 $E_n = -Z_{eff}^2 E_1 / n^2$ $E_n = qV = (-e)(5.14V)$

$(e)(\text{volts}) = 1eV \Rightarrow E_n = -5.14eV \overset{set}{=} Z_{eff}^2 (-1.51eV)$

$\Rightarrow Z_{eff} = \sqrt{5.14/1.51} = 1.84$

7-49 (a) $1s^2 2s^2 2p^6 3s^2 3p^2$

\# OF electrons = $2+2+6+2+2 = 14$

ATOMIC # 14 → SILICON

(b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ # OF e^- = 20

Calcium HAS ATOMIC # 20.

HW 1 ERRATA

I FORGOT TO INCLUDE PROBLEM 7.11 IN THE SOLUTIONS

7.11 (a) $\omega = 2\pi (735) \frac{rev}{min} \cdot \frac{min}{60s} = 77.0$ rev/s

$L = I\omega = 10^{-5}\omega = \boxed{7.7 \cdot 10^{-4}\ kg\,m^2/s}$

(b) $L = \sqrt{l(l+1)}\,\hbar \Rightarrow l(l+1) = \frac{L^2}{\hbar^2} = 5.322 \cdot 10^{61}$

SINCE l IS LARGE, $l \approx l+1$ SO CAN WRITE

$l(l+1) \approx l^2 = 5.322 \cdot 10^{61} \Rightarrow \boxed{l \approx 7.30 \cdot 10^{30}}$