* 1. The first two electrons are in the 1s subshell and have \( \ell = 0 \), with \( m_s = \pm 1/2 \). The third electron is in the 2s subshell and has \( \ell = 0 \), with either \( m_s = 1/2 \) or \(-1/2\). With four particles there are six possible interactions: the nucleus with electrons 1, 2, 3; electron 1 with electron 2; electron 1 with electron 3; or electron 2 with electron 3. In each case it is possible to have a Coulomb interaction and a magnetic moment interaction.

* 2. H: 1s\(^1\), He: 1s\(^2\), Li: 1s\(^2\)2s\(^1\), Be: 1s\(^2\)2s\(^2\), B: 1s\(^2\)2s\(^2\)2p\(^1\), C: 1s\(^2\)2s\(^2\)2p\(^2\), N: 1s\(^2\)2s\(^2\)2p\(^3\), O: 1s\(^2\)2s\(^2\)2p\(^4\), F: 1s\(^2\)2s\(^2\)2p\(^5\), Ne: 1s\(^2\)2s\(^2\)2p\(^6\).

* 4. In the first excited state, go to the next higher level. In argon one of the 3p electrons is promoted to 4s, so the configuration is 3p\(^5\)4s\(^1\). By the same reasoning the first excited state of krypton is 4p\(^5\)5s\(^1\).

* 5. K: [Ar]4s\(^1\), V: [Ar]4s\(^2\)3d\(^3\), Se: [Ar]4s\(^2\)3d\(^{10}\)4p\(^4\), Zr: [Kr]5s\(^2\)4d\(^2\), Sm: [Xe]6s\(^2\)4f\(^6\),
   U: [Rn]7s\(^2\)6d\(^1\)5f\(^3\) where the bracket represents a closed inner shell. For example, [Ar] represents 1s\(^2\)2s\(^2\)2p\(^6\)3s\(^2\)3p\(^6\).

* 7. From Figure 8.4 we see that the radius of Na is about 0.19 nm. We know that for single-electron atoms,

\[
E = -\frac{Ze^2}{8\pi\varepsilon_0 r}
\]

Therefore,

\[
Ze = -\frac{8\pi\varepsilon_0 rE}{e} = \frac{2(0.19 \text{ nm})(-5.14 \text{ eV})}{1.44 \text{ V} \cdot \text{nm}} = 1.36e
\]

11. a) filled 3d: As
   b) filled 4p and 4d: Ag
   c) The 4f shell fills in the lanthanides: Ho

12. \( J \) ranges from \(|L - S|\) to \(|L + S|\) or 2,3,4. Then in spectroscopic notation \( ^{2S+1}L_J \), we have three possibilities: \(^3F_2\), \(^3F_3\), or \(^3F_4\). The ground state has the lowest \( J \) value, or \(^3F_2\). With \( n = 4 \) the full notation is \(^4F_2\).

23. The 2s to 1s transition is forbidden by the \( \Delta L = \pm 1 \) selection rule. The two lines result from the transitions from the two 2p levels to the 1s level.

* 24. As in Example 8.8

\[
\Delta E = \frac{ehB}{m} = \frac{(1.602 \times 10^{-19} \text{ C})(6.582 \times 10^{-16} \text{ eV} \cdot \text{s})(1.7 \text{ T})}{9.109 \times 10^{-31} \text{ kg}} = 1.97 \times 10^{-4} \text{ eV}
\]