Completing the Quantum Model of the Atom

Passing an electrical current through a spool of wound copper wire generates a magnetic field perpendicular to the coils. When the direction in which the current moves is switched, the direction of the magnetic field also switches. Electrons in atoms also generate magnetic fields and for this reason we describe them as if they are spinning. Note that we don't know if electrons actually are spinning, but we do know that they behave as if they are spinning. To indicate the two possible spin states, we use the terms spin up and spin down.

Two electrons with spins in the same direction will generate a larger magnetic field than a single electron. The magnetic fields for two electrons with opposite spins, however, cancel out giving a net magnetic field of zero. It is relatively easy to determine if an element is magnetic by determining how it reacts to an external magnetic field. An atom in which there is one spin up electron for every spin down electron is said to be *diamagnetic* and is unaffected by the magnetic field. An atom with a least one unpaired electron is attracted to a magnetic field and is said to be *paramagnetic*. The magnitude of the atom's magnetic field is reported as the magnetic moment with units of magnetons. The larger the magnetic moment, the more unpaired electrons the atom must have.

Questions to Ponder

The magnetic moment for hydrogen is 1.7 magnetons, but the magnetic moment for helium is 0. What does this imply about the electrons in each atom. Do you expect lithium to be paramagnetic or diamagnetic? Repeat for beryllium.

The magnetic moments for B, C, N, O, F, and Ne are, respectively, 1.7, 2.8, 3.9, 2.8, 1.7, and 0. What does this imply about the number of unpaired electrons in each element. Using upward pointing arrows and downward pointing arrows to represent the two possible spin states, show how electrons must enter the three degenerate 2p orbitals.