3.5 Quantum Numbers

- Bohr's planetary model was wrong and it had to be revised. Using spectra it was determined that 4 numbers could give you a probable location for each electron.
- These numbers are used to describe the probable location of an electron.

Pauli Exclusion Principle:

- No two electrons in a given atom have the same set of quantum numbers. (These numbers identify the electron and give each of them an address.)

The Principal Quantum Number (n)

- The energy level in which the electron is found is based on Bohr's orbits.
- The value for the energy level or orbital of an e^- (n= 1, 2, 3 to ∞).
- The principle quantum number relates primarily to the main energy of an electron.

The Secondary Quantum Number (ℓ)

- Divides the energy levels into sub-levels or orbital types (smaller spaces or shapes) called s, p, d and f. It also explains the shape of the periodic table.
- Based on the observation that bright-line spectra were actually multiple lines closely spaced.
- To determine the shape: **ℓ = 0 to n – 1** (0 = s, 1 = p, 2 = d, 3 = f)
- The secondary quantum number relates primarily to the shape of the electron orbit.

The Magnetic Quantum Number (m_ℓ)

- When a discharge tube is near a magnet, the lines from a bright-line spectrum will split into multiple lines.
- The magnet causes the division of the sub-levels into individual orbitals. Direction of orientation (pointing) for p, d and f orbital types (i.e. p_x, p_y, p_z)
- To determine the direction: **m_ℓ = –ℓ to +ℓ** (if n = 2; ℓ = 0, 1; m_ℓ = –1, 0, +1)

- The magnetic quantum number relates primarily to the direction of the electron orbit. The number of values for m_ℓ is the number of independent orientations of orbits that are possible.

The Spin Quantum Number (m_s)

- Pauli suggested that the spin of an electron contributes to magnetism.
- Ferromagnetism (iron, cobalt and nickel) is due to the spin of the valence electrons and explains magnetism for a group of atoms.
- Paramagnetism is the magnetism of individual atoms. As an electron spins it generates a magnetic field. There are only 2 directions it can spin (up or down)
- An electron can spin in only 2 directions, $\mathbf{m_s = + ½ \text{ or } – ½}$
- The spin quantum number relates to a property of an electron that can best be describes as its spin.

Homework

- Practice 1,2,3,4
- Questions 1,2,3,4,5,6,7