# Learning Targets for "Electronic Structure of the Atom" Unit

1) Students will be able to describe the dual nature of light (particle-like and wave-like behaviors), and will be able to describe the relationships among the speed of light (c), wavelength ($\lambda$), frequency ($\nu$), and the energy (E) of the light.

- **a)** I can give examples of how light behaves both like a particle (called a photon) and like a wave.
- **b)** I can label the parts of a wave and define the terms *wavelength, frequency,* and *wave speed*, and give the unit that measures each quantity.
- **c)** I know the speed of light in units of meters/second.
- **d)** I can convert the wavelength of light from meters to nanometers and vice versa.
- **e)** I can calculate the wavelength of light if I'm given its frequency (or vice versa).
- **f)** I can calculate the energy of a photon of light, given either its wavelength or its frequency.
- **g)** I can describe the 7 regions of the electromagnetic spectrum in order, and compare them in terms of wavelength, frequency, and energy.

2) Students will be able to define the ground state as the condition where all of an atom's electrons are in their lowest possible energy states, and that movement of an electron between energy levels depends upon the absorption or emission of specific amounts of light energy corresponding to the differences in energy between energy levels within the atom.

- **h)** I can correlate an atom absorbing or emitting light with the proper direction of movement of the electrons in the atom.
- **i)** I can describe the relationship between the distance an electron jumps and the type or color of light that is emitted.

3) Students will be able to describe the arrangement of electrons within an atom (quantum mechanical model) into energy levels (shells), sublevels (subshells), and orbitals.

- **j)** I can explain why we use a statistical approach in describing where electrons are within an atom, in other words, I can explain Heisenberg's Uncertainty Principle
- **k)** I can calculate the number of electrons an energy level can hold, and correlate the numbers of electrons in each energy level to the structure of the periodic table. See #6 below.
- **l)** I can state the number of and type(s) of sublevels within in each energy level, and correlate those sublevels to the 4 blocks of the periodic table.
- **m)** I can recognize the shapes of the 4 different types of sublevels.
- **n)** I can state the number of orbitals and the maximum number of electrons within each type of sublevel.
- **o)** I can state in what way the electrons that reside in the same orbital differ from one another.
- **p)** I can explain the Pauli Exclusion Principle.

4) Students will be able to write the electron configuration for any atom using the principles described immediately above and the Aufbau chart (diagonal rule chart).

- **q)** I can write the electron configuration, in either long form or shorthand notation, for any atom on the periodic table, using a Diagonal Rule chart.
- **r)** I can write the electron configurations for two elements which are exceptions to the normal pattern.
- **s)** I can draw an orbital filling diagram for any element on the periodic table, orienting the arrows properly so as to comply with Hund's Rule.

5) Students will be able to relate the arrangement of electrons within atoms to the structure of the periodic table and its blocks or regions (s, p, d, and f).

- **t)** I can calculate the number of electrons an energy level can hold, and correlate the numbers of electrons in each energy level to the structure of the periodic table. See #4 above.

**u)** I can state the number of and type(s) of sublevels within in each energy level, and correlate those sublevels to the 4 blocks of the periodic table.

6) Students will be able to correlate the electron configuration of an atom to that atom's chemical properties, and describe how similarities in the electron configurations of elements within a chemical family result in similarities in chemical properties including reactivity and bonding to other atoms.

**v)** I can demonstrate how all of the atoms in a family of the periodic table have electron configurations which end similarly, and so behave in a similar manner chemically.

**w)** I can predict how many electrons an element will gain or lose in order to become an ion, from that element's electron configuration.

7) Students will be able to describe that both families and periods on the periodic table have predictable trends of chemical properties, including but not limited to atomic radii, ion sizes, ionization energies, electron affinities, electronegativities, metallic character, and valences or oxidation states.

**x)** I can interpret a graph of ionization energy to determine which elements on the periodic table are most chemically reactive.

**y)** I can interpret a graph of atomic radii and correlate the sizes of the atoms to their electron configurations.

**z)** I can interpret a graph of electronegativities to determine which atoms on the periodic table are most likely to gain or to lose electrons, or to share electrons when chemical bonds are formed.

**aa)** I can explain why, when atoms become ions, their sizes change…and predict how the size of an atom will compare to the size of the ion it becomes.

8) Students will be able to identify how many valence electrons an element has, based upon its position within the periodic table. Students will also be able to identify which of the electrons in an element's electron configuration are the valence electrons.

**bb)** I can define the term "valence electron" and determine which electrons in an element's electron configuration are its valence electrons.

**cc)** I can predict how many valence electrons any element has, based on its electron configuration or on its position in the periodic table. I can determine how many kernel electrons an element has.

**dd)** I can define the term "full octet" and determine how many electrons an element will gain or lose in order to have a full octet, and therefore what kind of ion it will become.

**ee)** I can write the Lewis Dot Diagram for any element on the periodic table.