ATOMIC THEORY AND PERIODICITY

Key Concepts

Atomic Structure

- Know the location, charge, and relative mass of the 3 subatomic particles. Be able to get this information from a complete atomic symbol. ${}^{15}_{7}N$
- Be able to explain the role of coulombs law in the attraction between a proton and electron. $F = \frac{kq_1q_2}{r}$ (For example: why does an electron further from the nucleus have less attraction?)
- Be able to identify the number of valence electrons and the valence shell number using the periodic table.
- Be able to identify an element or ion as **diamagnetic** or **paramagnetic**.
- Be able to describe electrons using multiple models. For example: complete each of these models for Ni^{+2}
    - Bohr model
    - Electron configuration (using only the periodic table as a guide)
    - Filling diagram (quantum model) (Know what Hund' rule and the Aufbau principle are.)
- Be able to explain how spectroscopy was used to discover quantized energy levels:
    - What is occurring in an atom when light is emitted?
    - How do line spectra prove the existence of quantized energy levels?
    - What does it mean about the electron transition if the light given off is purple instead of red?
- Be able to work with electromagnetic radiation:
    - Know the relative energy inherent in visible light, IR, UV, microwave, radiowave, x-ray, and gamma rays.
    - Be able to convert energy to frequency and wavelength. ($E = h\nu$, $c = \lambda\nu$)

Periodic Table

- Know the periodic family locations (alkali metals, alkaline earth metals, halogens, transition metals, noble gases)
- Be able to use the concepts of **effective nuclear charge** and **shielding** to explain the following periodic trends:
    - Ionization energy (1^{st} ionization energy, 2^{nd} ionization energy, etc.)
    - Electron affinity
    - Electronegativity
    - Atomic radius
- Be able to explain why each successive ionization takes an increase in energy. Be able to use ionization energy tables to identify the element based on where the huge jump in required energy occurs.
- Be able to work with Photoelectron spectra:
    - Be able to identify the element from the spectrum.
    - Be able to explain why a peak may be shifted more to the left or right in a different atom using an understanding of effective nuclear charge and shielding.

Spectroscopy

- Know the impact of each type of spectroscopy on a molecule or atom.
    - IR – bond vibrations in organic molecules
    - UV – electron transitions (jumping up in energy)
    - X-ray/Strong UV – ejection of electrons from the atom. Results in an ion being formed.

The AP Chem test will require you to explain your thinking about periodic trends. This can be the most difficult part of the test because you have to prove that you understand. The answer usually gets no credit without a well thought out and thorough explanation:

What to do:

- *Be sure you are answering the question being asked. This sound obvious but the easiest way to make sure is to repeat the stem of the question in your answer.*
- *ALL periodic trends can be explained by comparing the number of protons in the atom (effective nuclear charge), the number of shells of electrons between the nucleus and the valence electrons (shielding), or repulsions between electrons. Decide which of these is the decisive factor. It is a good idea to say how the atoms being compared are similar and different in terms of number of subatomic particles. Remember to mention both atoms or ions discussed in the problem.*

What not to do:

- *Don't give an answer based on the location of atoms on the periodic table. "Oxygen is more to the right than Nitrogen so…" These are trends but not explanations. AP will not accept "periodic table geography" in any justification.*
- *The AP graders don't do well with inference. "Oxygen has more protons…." They will wonder more than what?*
- *Don't use metaphors. Atoms do not "want to be happy". (They have a full valence shell.) If you can't remember the chemical term, describe it without using metaphors.*