

Chapter 3
Atomic Structure: Explaining the Properties of the Elements
Learning Objectives

8.2.2021

To satisfy the minimum requirements for this course, you should be able to:

1. Explain the nature of electromagnetic radiation by:
 - describing its wave properties: wavelength (λ), frequency (ν) and speed (c)
 - know the relative frequencies/energies of infrared, visible, and UV regions; and the energies of the colors in the visible spectrum (ROYGBIV)
 - performing calculations using the relationship $\lambda\nu = c$ (speed of light)
 - performing calculations using the equation $E = h\nu$ (the energy of a single quantum, photon, of light)
 - calculate the energies and wavelengths of photons absorbed or emitted by electronic transitions of a hydrogen atom (Rydberg equation, Eqn 3.8)
2. Describe the quantum mechanical model of the atom including:
 - the concept of an allowed energy state as it relates to the quantum theory and line spectra
 - electron's wave properties, Heisenberg's uncertainty principle, orbitals, electron density, and probability
 - recognizing the shapes of the s , p , and d orbitals
 - the difference between excited and ground states
3. Discuss how quantum mechanics can be used to explain the arrangement of electrons in an atom and the magnetic properties of atoms, ions, and molecules. Specifically:
 - give the number and types of orbitals within each shell and subshell
 - write the ground state electron configuration and orbital diagram for atoms or ions of elements up to $Z = 36$ using the Aufbau principle, Hund's rule, and the Pauli exclusion principle (found in Appendix 3, Table A3.1, p. APP-9-11)
 - discuss what is meant by the s , p , d , and f blocks of elements in the periodic table
4. Explain that the relationship between valence electron configurations and the organization of the periodic table
5. Write the electron configuration for ions up to $Z = 36$, including ions of representative elements as well as transition metal cations
6. Use the periodic trends to illustrate the following:
 - metals form cations and non-metals form anions in ionic compounds
 - upon ion formation, atoms tend to gain or lose electrons until they become isoelectronic with the nearest noble gas
7. Explain periodic trends. You should be able to:
 - explain how and why the effective nuclear charge (Z_{eff}) felt by the valence electrons varies across a period and down a group in the periodic table
 - use effective nuclear charge and the distance of valence electrons from the nucleus to explain how and why atomic radius and ionization energy vary across a period and down a group in the periodic table
8. Understand and explain the observed changes in values of the successive ionization energies for a given atom (Table 3.2)
9. Define electron affinity and be able to recognize a chemical equation for this process