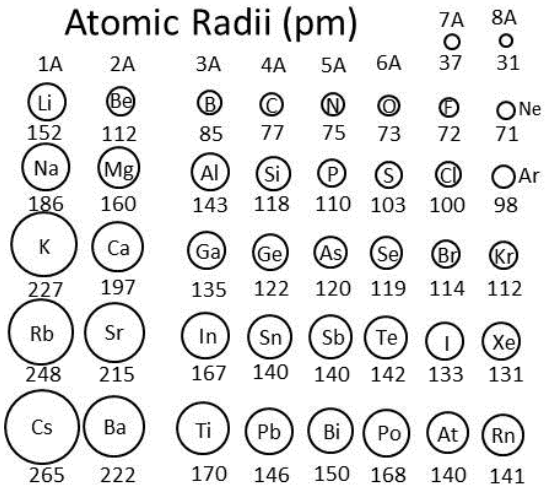
Effective Nuclear Charge (Z_{eff}) and Atomic Radius

Chemical properties of an element are largely determined by their valence electrons. Elements with similarly filled valence shells have similar properties. For example, all the alkali metals have a electron configuration ns^1. All the halogens have an electron configuration ending with ns^2np^5. What is a common characteristic shared by all the halogens?

What is a common characteristic shared by the noble gasses? What is their generic configuration?

We now explore trends in chemical properties that are related to electron configuration and valence shells.



1. Consider the chart of atomic radii to the left. As you move down a group (for example, the alkali metals) does the atomic radius increase or decrease?

2. Explain the trend you observed in question 1 in terms of quantum number n (principle energy level).

3. As you move across a period (row) does the atomic radius increase or decrease?

In order to understand the periodic trend of atomic radius across a row, we need to understand the concept of effective nuclear charge (Z_{eff}). Z_{eff} is the charge that **valence electrons experience** after core electrons shield the nuclear charge. Valence electrons do not shield each other from the charge. Z_{eff}=is calculated using the following equation:

Z_{eff} = Atomic number(Z) - core electrons (S)

Complete the table and calculate Zeff for the following elements.

	Na	Al	P	Cl	Ar
Electron configuration					
# Valence electrons					
# Core electrons					
# protons	11	13	15	17	18
Z_{eff}					

4. As you go across a row (period) in the periodic table, does the positive charge experienced by the valence electrons (Z_{eff}) increase decrease, or stay the same?

5. Would the attraction of valence electrons of argon to its nucleus be the same, greater than, or less than the attraction of the valence electrons of sodium to a sodium nucleus?

6. Write electron configurations for the transition metals Sc (atomic # 21) and Ti (atomic #22). Calculate Z_{eff} for these two transition metals.

7. The atomic radii of transition metals do not decrease significantly across a row. As you add electrons to the d-orbital are you adding core electrons or valence electrons?

8. Does Z_{eff} increase, decrease or stay the same for transition metals in a row?

9. Contrast the radius trend for transition metals across a row with that of the main group elements across a row.

Informal Writing Task – Answer the following questions using grammatically correct English sentences.

A) Explain the physical reasons for the trends in atomic radii down a column in the periodic table.

B) Considering the trend of Z_{eff} (effective nuclear charge) explain the trend of atomic radius across a period in terms of effective nuclear charge and Coulombic attraction (positive is attracted to negative).