

1) What is the Effective Nuclear Charge ( $Z_{\text{eff}}$ )?

Effective nuclear charge is the amount of nuclear charge experienced by the valence electrons after accounting for shielding by the core electrons.

2) How is the effective nuclear charge calculated?

The number of core electrons is subtracted from the number of protons.

3) The shielding electrons are the (**inner core**, outer valence) electrons.

4) Calculate the effective nuclear charge for the following elements: (Show calculation.)

a. Ca  $Z_{\text{eff}} = 20 - 18 = 2$

b. S  $Z_{\text{eff}} = 16 - 10 = 6$

5) The larger the atomic radius, the (**larger**, smaller) the size of the atom.

6) The size or radius of an atom mainly depends on the space (**the nucleus takes up**, **the electrons take up**)

7) Why do the radii of atoms increase as one goes down a family?

*(Make sure to discuss both the effective nuclear charge and the number of main energy levels.)*

As one comes down a column, the nuclear charge increases, but the shielding also increases, so the effective nuclear charge remains constant. The valence electrons are in increasingly higher main energy levels, which are larger and farther from the nucleus. Since the radius is the distance from the nucleus to the outer “edge” of the electrons, the radius increases.

8) Why do the radii of atoms decrease as one goes across to the right in a period?

*(Make sure to discuss both the effective nuclear charge and the number of main energy levels.)*

As one comes across a period left to right, the nuclear charge increases, but since the valence electrons are in the same principle energy level, the core, hence shielding, remains constant. Thus, the effective nuclear charge increases, increasing the attraction of the valence electrons to the nucleus and pulling them close to it. As above, since the radius is the distance from the nucleus to the “edge” of the valence electrons, the radius decreases.

9) Circle the atom of each pair that would have the smaller radius.

a) **Na** or Cs      b) Na or **Cl**      c) Na or **Al**      d) **F** or I      e) Ge or **Ne**

10) Arrange the following elements in order of *increasing* radius: Na, Si, K, O, Cs, F:

**Smallest radius**   F   <   O   <   Si   <   Na   <   K   <   Cs   **Largest radius**

11) Can you determine which of two unknown elements has the larger radius if the only known information is that the atomic number of one of the elements is 20 greater than the other? Explain

No; without information, it is impossible to know where the atoms are relative to each other—they could be 20 apart in one period, or the one atom could be in a lower period, either to the right or left.