



































Periodic Trends: Atomic Radius

(from *Chemistry: Connections to Our Changing World*, pp. 174-175, Prentice-Hall, 1996)

As you have learned, many of an element's properties are determined by its electron configuration. In addition, the periodic table is organized so that elements with similar electron configurations are in the same column. For these reasons, you can use an element's location in the periodic table to predict many facts about it. Many properties of the elements change in a predictable way as you move through the periodic table. These systematic variations are called periodic trends. There are many periodic trends, several of which you will study in this section.

What determines an element's properties? _____

Figure 5-16:

Atomic Radii of Representative Elements (nm)						
1A	2A	3A	4A	5A	6A	7A
 Li 0.152	 Be 0.111	 B 0.088	 C 0.077	 N 0.070	 O 0.066	 F 0.064
 Na 0.186	 Mg 0.160	 Al 0.143	 Si 0.117	 P 0.110	 S 0.104	 Cl 0.099
 K 0.231	 Ca 0.197	 Ga 0.122	 Ge 0.122	 As 0.121	 Se 0.116	 Br 0.115
 Rb 0.244	 Sr 0.215	 In 0.162	 Sn 0.14	 Sb 0.141	 Te 0.137	 I 0.133
 Cs 0.262	 Ba 0.217	 Tl 0.171	 Pb 0.175	 Bi 0.146	 Po 0.14	 At 0.140

Looking at the figure above,

- (a) What is the atomic radius of nitrogen? _____
- (b) Do the atomic radii get bigger or smaller down a family? _____
- (c) Do the atomic radii get bigger or smaller across a row? _____
- (d) What elements are missing? _____

You may already be familiar with the word radius (plural radii). For a sphere or ball, the radius is the distance from the center to the outer edge. Because atoms can be thought of as spheres, they also have a radius. The atomic radius is the distance from the center of an atom's nucleus to its outermost electrons.

Draw a diagram of an atom. Label these parts: nucleus, edge of electron cloud, and atomic radius.

Unfortunately, the definition of atomic radius is not precise. The electron cloud that surrounds the nucleus is spherical, but it does not have an exact boundary. Nevertheless, there are several ways to estimate the radius of an atom. These methods are based on a variety of techniques used to measure the distance between the centers of atoms in various materials. For example, the distance between two chlorine nuclei in a Cl_2 molecule is found to be 0.198 nanometers. Therefore, a value of $0.198 \div 2 = 0.099$ nanometers is a good estimate of the radius of a chlorine atom. Similarly, the distance between carbon atoms in diamond (a form of pure carbon) is 0.154 nanometers. The radius of a carbon atom is $0.154 \div 2 = 0.077$ nanometers.

What is a diamond composed of? _____

You might think that atoms with more electrons would have larger atomic radii. However, this idea is only half true at best. Study Figure 5-16 (see front of this paper), and you will notice two distinct trends:

1. Atoms get larger going down a group. In Group 1A, the atomic radii progress from 0.152 nm for a lithium atom to 0.262 nm for a cesium atom.
2. Atoms get smaller moving from left to right across each period. For example, across the second period, the atomic radii decrease from 0.152 nm for a lithium atom to 0.064 nm for a fluorine atom.

Across a row, atomic radius _____. Down a column, atomic radius _____.

Why do these trends exist? The first trend is the easier to explain. As you move down a group, the principal quantum number of the outermost electrons increases. For example, as you move down Group 1A, the outermost electron resides in orbitals from $1s^1$ to $2s^1$ to $3s^1$ and up to $7s^1$. Electrons with a larger principal quantum number are found in orbitals that extend farther away from the nucleus, which makes the atomic radius larger.

Why does cesium have a larger atomic radius than lithium? _____

The second trend requires a bit more thought to understand. Recall that in any period, the outer electrons of each element are in orbitals with the same principal quantum number. If principal quantum number were the only factor that influenced the size of an orbital, then all elements in a period would have atoms of the same size. So, another factor must be at work.

Recall that as you move from left to right across a period, the atoms' nuclei gain more protons. As a rule, atoms that have more positive charge in their nuclei exert a stronger pull on the electrons in a given principal quantum level. In other words, as you look at the elements from left to right across a period, the atoms' outer electrons are increasingly attracted to the nucleus. A stronger attractive force shrinks the electrons' orbitals and makes the atoms smaller.

Why does one atom have more positive charge in the nucleus than another? _____

What causes atoms to get smaller as you move from left to right across a row? _____