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Chapter 6 Chemical Bonds

Section 6.1 Ionic Bonding

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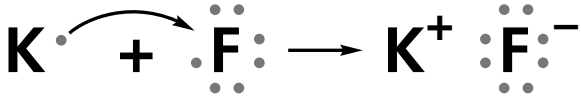
Determining the Size and Mass of Atoms and Ions

Content and Vocabulary Support

Electron Configuration

The configuration of the electrons in an atom refers to the number of electrons at different energy levels. It includes the number of valence electrons, which are electrons at the highest energy level. Atoms of different elements may have different numbers of valance electrons. For example, atoms of potassium (K) have one valence electron, and atoms of fluorine (F) have seven valence electrons. Valence electrons are represented by dots in an **electron dot diagram**, such as the one shown here for potassium.

Atoms of elements that do not have a complete set of valence electrons are somewhat unstable. They tend to react with other elements and become more stable. Some elements become more stable by transferring electrons between atoms. The diagram shows the transfer of electrons between potassium and fluorine.



Ions

Electrons have a negative charge. Thus, when an atom gains electrons, it also becomes negative in charge. Similarly, when an atom loses electrons, it becomes positive in charge. An atom that has a negative or positive charge is called an **ion**. If the charge is negative, the ion is called an **anion**. If the charge is positive, the ion is called a **cation**. A cation is given the same name as the element name. For example, a potassium cation is called *potassium*. An anion is given a name based on the element name but with the suffix *-ide* added. The fluorine anion, for example, is called *fluoride*.

Size of Atoms and Ions

Scientists consider atoms and ions to be more or less spherical in shape. They use the radius of an atom or ion as a measure of its size. The radius is the distance from the center to the outer edge. It is such a tiny distance that it is expressed in a unit called a *picometer* (pm), which is just one-billionth of a millimeter.

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Data

Table 1 is part of a periodic table of the elements. For each element, the table shows atomic number (top), symbol (middle), and electron configuration (bottom).

Table 1. Electron Configurations of Atoms

Radii of Atoms and Ions			
1A	**2A**	**6A**	**7A**
11 **Na** 2-8-1	12 **Mg** 2-8-2	16 **S** 2-8-6	17 **Cl** 2-8-7
19 **K** 2-8-8-1	20 **Ca** 2-8-8-2	34 **Se** 2-8-18-6	35 **Br** 2-8-18-7
37 **Rb** 2-8-18-8-1	38 **Sr** 2-8-18-8-2	52 **Te** 2-8-18-18-6	53 **I** 2-8-18-18-7
55 **Cs** 2-8-18-18-8-1	56 **Ba** 2-8-18-18-8-2	84 **Po** 2-8-18-32-18-6	85 **At** 2-8-18-32-18-7

Table 2 is part of another periodic table. In addition to the symbol for each element, this table shows the radius of an atom (upper right), the radius of an ion of that atom (lower right), and the number of electrons the atom gains or loses in becoming the ion (lower left).

Table 2. Radii of Atoms and Ions

Radii of Atoms and Ions			
1A	**2A**	**6A**	**7A**
152 **Li** $^{1+}$ 60	112 **Be** $^{2+}$ 31	66 **O** $^{2-}$ 140	64 **F** $^{1-}$ 136
186 **Na** $^{1+}$ 95	160 **Mg** $^{2+}$ 65	103 **S** $^{2-}$ 184	99 **Cl** $^{1-}$ 181
227 **K** $^{1+}$ 133	197 **Ca** $^{2+}$ 99	117 **Se** $^{2-}$ 198	114 **Br** $^{1-}$ 195

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Questions

1. a. **Describing** Based on Table 1, how do the electron configurations of atoms within each period change as you go from lower to higher atomic number? How do the electron configurations change as you go across the table from one period to another within a row?

b. **Identifying** Identify the number of valence electrons that characterize each of the four different periods shown in Table 1.

c. **Predicting** In order to become more stable, predict whether atoms of elements in periods 1A and 2A in Table 1 would gain or lose electrons. Make a similar prediction about the atoms of elements in periods 6A and 7A in Table 1.

2. a. **Comparing and Contrasting** Check your predictions from question 1c by looking at Table 2 and finding the number of valence electrons gained or lost by atoms when they become ions. Compare periods 1A and 2A with periods 6A and 7A. For example, how many electrons are gained or lost by lithium (Li)? By oxygen (O)?

b. **Drawing Conclusions** In general, how does an atom's radius change when it becomes a cation? An anion?

c. **Predicting** The last element in Period 1A is francium (Fr). It is not shown in either table. Predict how many valence electrons francium has, whether it gains or loses electrons to become an ion, and how its radius changes when it becomes an ion.