2.9: Electron-Dot Symbols

Learning Objective

- Draw a Lewis electron dot symbol for a given atom.

In almost all cases, chemical bonds are formed by interactions of valence electrons in atoms. To facilitate our understanding of how valence electrons interact, a simple way of representing those valence electrons would be useful.

A **Lewis electron-dot symbol** (or electron-dot symbol or a Lewis symbol) is a representation of the valence electrons of an atom that uses dots around the symbol of the element. The number of dots equals the number of valence electrons in the atom. These dots are arranged to the right and left and above and below the symbol, with no more than two dots on a side. (It does not matter what order the positions are used.) For example, the electron-dot symbol for hydrogen is simply

$$\mathbf{H}\cdot \tag{2.9.1}$$

Because the side is not important, the electron-dot symbol could also be drawn as follows:

$$\dot{\mathbf{H}} \quad or \quad \cdot\mathbf{H} \quad or \quad \underset{\cdot}{\mathbf{H}} \tag{2.9.2}$$

The electron-dot symbol for helium, with two valence electrons, is as follows:

$$\mathbf{He:} \tag{2.9.3}$$

By putting the two electrons together on the same side, we emphasize the fact that these two electrons are both in the 1*s* subshell; this is the common convention we will adopt, although there will be exceptions later. The next atom, lithium, has an electron configuration of $1s^2 2s^1$, so it has only one electron in its valence shell. Its electron dot diagram resembles that of hydrogen, except the symbol for lithium is used:

$$\mathbf{Li}\cdot \tag{2.9.4}$$

Beryllium has two valence electrons in its 2*s* shell, so its eelectron-dot symbol is like that of helium:

$$\mathbf{Be:} \tag{2.9.5}$$

The next atom is boron. Its valence electron shell is $2s^2 2p^1$, so it has three valence electrons. The third electron will go on another side of the symbol:

$$\dot{\mathbf{B}}\mathbf{e:} \tag{2.9.6}$$

Again, it does not matter on which sides of the symbol the electron dots are positioned.

For carbon, there are four valence electrons, two in the 2*s* subshell and two in the 2*p* subshell. As usual, we will draw two dots together on one side, to represent the 2*s* electrons. However, conventionally, we draw the dots for the two *p* electrons on different sides. As such, the electron-dot symbol for carbon is as follows:

$$\cdot\dot{\mathbf{C}}\mathbf{:} \tag{2.9.7}$$

With N, which has three *p* electrons, we put a single dot on each of the three remaining sides:

$$\cdot\underset{\cdot}{\dot{\mathbf{N}}}\mathbf{:} \tag{2.9.8}$$

For oxygen, which has four *p* electrons, we now have to start doubling up on the dots on one other side of the symbol. When doubling up electrons, make sure that a side has no more than two electrons.

$$\cdot\underset{\cdot}{\ddot{\mathbf{O}}}\mathbf{:} \tag{2.9.9}$$

Fluorine and neon have seven and eight dots, respectively:

$$\mathbf{:}\underset{\cdot}{\ddot{\mathbf{F}}}\mathbf{:} \tag{2.9.10}$$

$$:\ddot{\mathrm{N}}\mathrm{e}: \tag{2.9.11}$$

With the next element, sodium, the process starts over with a single electron because sodium has a single electron in its highest-numbered shell, the $n = 3$ shell. By going through the periodic table, we see that the electron-dot symbol of atoms will never have more than eight dots around the atomic symbol.

Example 2.9.1:

What is the electron-dot symbol for each element?

a. aluminum
b. selenium

Solution

a. The valence electron configuration for aluminum is $3s^2 3p^1$. So it would have three dots around the symbol for aluminum, two of them paired to represent the 3*s* electrons:

$$\dot{A}\dot{l}:$$

2. The valence electron configuration for selenium is $4s^2 4p^4$. In the highest-numbered shell, the $n = 4$ shell, there are six electrons. Its electron dot diagram is as follows:

$$\cdot\dot{\mathrm{S}}\mathrm{e}:$$

Exercise 2.9.1

What is the electron-dot symbol for each element?

a. phosphorus
b. argon

Answer

$$\cdot\dot{\mathrm{P}}:$$

$$:\ddot{\mathrm{A}}\mathrm{r}:$$

Summary

- Lewis electron-dot symbols use dots to represent valence electrons around an atomic symbol.