3.6: The Magic Octet of 8 Outer-Shell Electrons

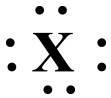
Only one element remains to complete the second period of the abbreviated periodic table. This element is **neon**, atomic number 10, atomic mass 20.18. Although most neon atoms have 10 neutrons in addition to the 10 protons in their nuclei, some have 12 neutrons, and very few have 11. Neon is a gas consisting of individual Ne atoms that constitutes about 2 parts per thousand of the volume of air. Neon is recovered by distillation of liquid air. Its most common use is as a gas in tubes through which an electrical discharge is carried in glowing neon signs.

The total of 10 electrons in the neon atom are contained in two shells with 8 in the outer shell. So the Lewis symbol of neon is

With 8 electrons, the second shell of electrons is a *filled electron shell*. (Recall that helium has a filled electron shell with only 2 electrons.) Because it has a filled outer electron shell, neon is a noble gas that exists as single gas-phase atoms and forms no chemical compounds.

The Special Significance of the Octet

In addition to helium and neon, there are four other noble gas elements. These are argon (atomic number 18), krypton (atomic number 36), xenon (atomic number 54), and radon (atomic number 86). Other than helium, these all share a common characteristic of 8 outer-shell electrons. Such an electron configuration can be shown by the general Lewis symbol,



and is known as an **octet** of electrons, where X is the chemical symbol of the noble gas.

Although only atoms of noble gases have octets as single atoms, many other atoms acquire octets by forming chemical bonds. This tendency of atoms to acquire stable octets through chemical bonding is the basis of the **octet rule**, which is used in this book to predict and explain the chemical bonding in a number of compounds, such as those discussed in Chapter 4. To see a simple application of the octet rule in chemical bonding, consider the bonds involved in molecular elemental nitrogen, N2. Recall the Lewis symbol of the N atoms showing 5 dots to represent the 5 outer-shell electrons in each N atom. Figure 3.6 shows bond formation between 2 N atoms.

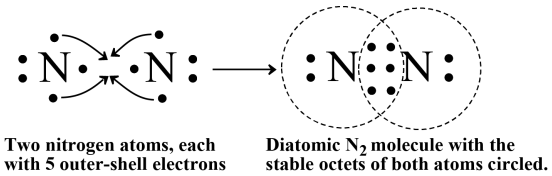


Figure 3.6. Illustration of the octet rule in the covalent bonding together of the 2 N atoms in N2. The six electrons in the bond connecting the two N atoms constitute a triple bond.

Each of the two N atoms in the N2 molecule needs 8 outer-shell electrons, but only 10 electrons are available to provide these electrons (the two inner-shell electrons in each N atom are not available to form bonds). This means that a lot of the electrons will have to be shared to form a bond between the N atoms in the N2 molecule, and, in fact, 6 of the 10 outer-shell electrons available in two N atoms are shared between the N atoms to give a *triple bond* consisting of 3 pairs of shared electrons as shown by the 3 pairs of dots between the 2 N atoms in the molecule of N2 in Figure 3.6.