

## How are electrons arranged in atoms?

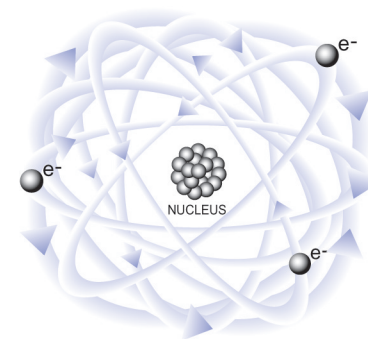
**Neutral atoms have the same number of electrons as protons** Atoms are electrically neutral. An atom of helium has an atomic number of 2 and two protons in its nucleus. A neutral atom of helium would therefore have two electrons, which stay close to the nucleus because the positive protons and the negative electrons attract each other. An atom of silver has an atomic number of 47 and 47 protons in its nucleus. A neutral atom of silver would therefore have 47 electrons. Are these electrons randomly placed or are they organized in some way?

**Electrons are found in the electron cloud** Electrons are never all in one place at the same time. Instead, they literally buzz around the nucleus at a very fast rate, or frequency. Because of this behavior, we can refer to the entire space that electrons occupy as the *electron cloud* (figure 18.13).

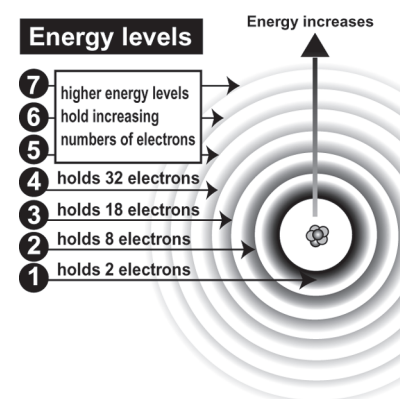
**The electron cloud is divided into energy levels** The current model of the atom describes the area of the electron cloud that each electron occupies as an *energy state*. The farther away from the nucleus the electron is found, the higher its energy state. Therefore, the electron cloud is divided into *energy levels*. The first energy level is closest to the nucleus and has the lowest energy. Electrons that occupy this level are at a lower energy state than electrons that occupy the second energy level, which is farther from the nucleus. Each energy level can hold up to a specific number of electrons (figure 18.14). Sometimes, when energy is added to an atom, electrons can absorb enough energy to “jump” to a higher energy level. When they fall back to their normal energy level, they release light in a characteristic frequency.

Like the layers of an onion, as the energy levels extend farther from the nucleus, they get larger in diameter and can hold more electrons. The maximum number each level can hold is shown in figure 18.14.

**Energy levels can overlap** It is important to note that some energy levels can overlap. In fact, each energy level is subdivided into smaller regions called *orbitals*. Some orbitals in the third energy level may have higher energy than some in the fourth and so on. Scientists have found out exactly which orbitals are occupied, and by how many electrons, in all 111 elements. You will explore this concept in greater detail in future chemistry courses.



**Figure 18.13:** Electrons buzz around the nucleus at a very fast rate.



**Figure 18.14:** Electrons occupy energy levels around the nucleus. The farther away an electron is, the higher the energy it possesses.