

## 1.7: Atomic Structure and Electron Configuration

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As we learned in Section 1.1, modern atomic theory places protons and neutrons in the nucleus of an atom and electrons are placed in a diffuse cloud surrounding this nucleus. As chemists and physicists began examining the structure of atoms, however, it became apparent that all of the electrons in atoms were not equivalent. The electrons were not randomly placed in one massive “cloud”, rather they seemed to be arranged in distinct energy levels and energy was required to move electrons from a lower to a higher energy level. A mathematical model of atomic structure was developed in the early nineteenth century that defined these energy levels as quantum levels, and today this description is generally referred to as quantum mechanics.

According to the quantum model of the atom, electron for the known elements can reside in seven different quantum levels, denoted by the principal quantum number  $n$ , where  $n$  has a value of one to seven. As the quantum number increases, the average energy of the electrons having that quantum number also increases. Each of the seven rows in the [periodic table](#) corresponds to a different quantum number. The first row ( $n = 1$ ) can only accommodate two electrons. Thus an element in the first row of the periodic table can have no more than two electrons (hydrogen has one, and helium has two). The second row ( $n = 2$ ) can accommodate eight electrons and an element in the second row of the periodic table will have two electrons in the first level (it is full) and up to eight electrons in the second level.

Quantum theory also tells us that the electrons in a given energy level are not all equivalent. Within an energy level electrons reside within sublevels (or subshells). The sublevels for any given level are identified by the letters, s, p, d and f and the total number of sublevels is also given by the quantum number,  $n$ . The s sublevel can accommodate two electrons, the p holds six, the d holds 10 and the f can hold 14. The elements in the first row in the periodic table ( $n = 1$ ) have electrons only in the 1s sublevel ( $n = 1$ , therefore there can only be one sublevel). The single electron in hydrogen would be identified as 1s<sup>1</sup> and the two electrons in helium would be identified as 1s<sup>2</sup>. Fluorine, in the second row of the periodic table ( $n = 2$ ), has an atomic number of nine and therefore has nine electrons. The electrons in fluorine are arranged, two in the first level (1s<sup>2</sup>), two in the 2s suborbital (2s<sup>2</sup>) and five 2p suborbital (2p<sup>5</sup>). If we were to write the electron configuration for fluorine, we would write it as 1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>5</sup>. Each of the sublevels in an atom is also associated with an orbital, where an orbital is simply a region of space where the electron is likely to be found.

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