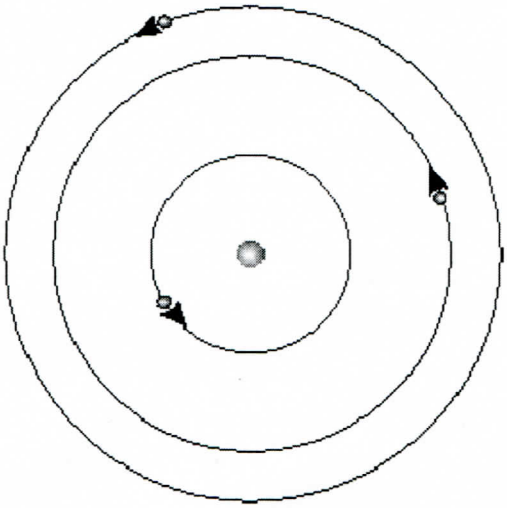
Chemistry Lecture #21: Energy Levels, Energy Sublevels, Orbitals, and the Pauli Exclusion Principle

Energy Levels

In the Bohr model of the atom, electrons circle the nucleus in the same way that planets orbit the sun.

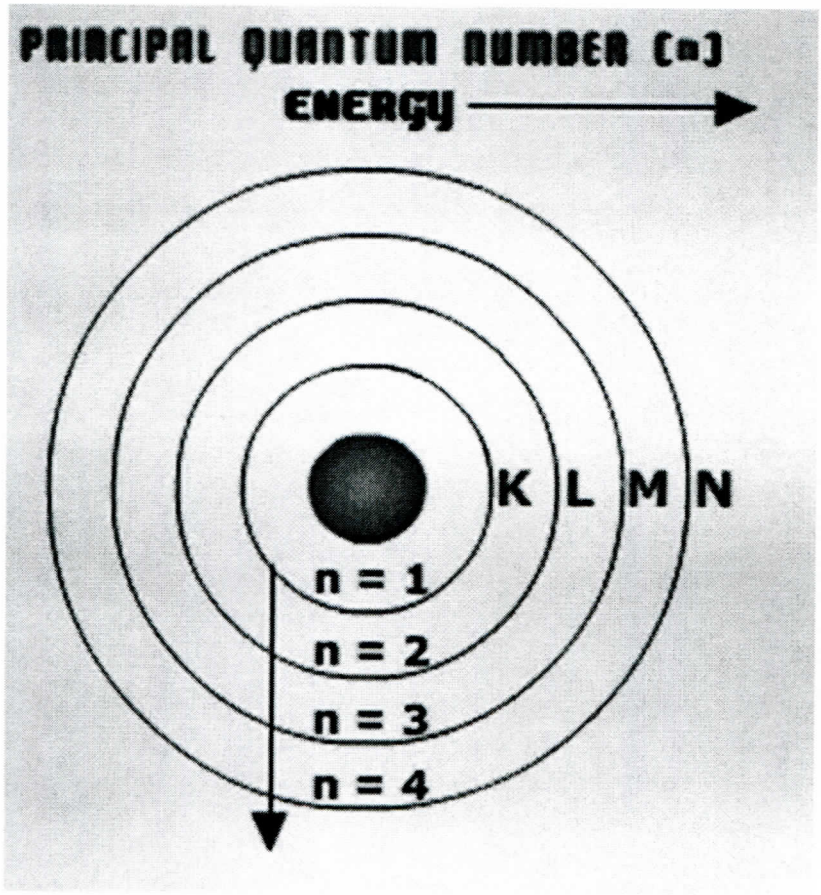


Negative electrons are attracted to the positive nucleus. Consequently, it takes energy to move an electron away from the nucleus to an outer circle.

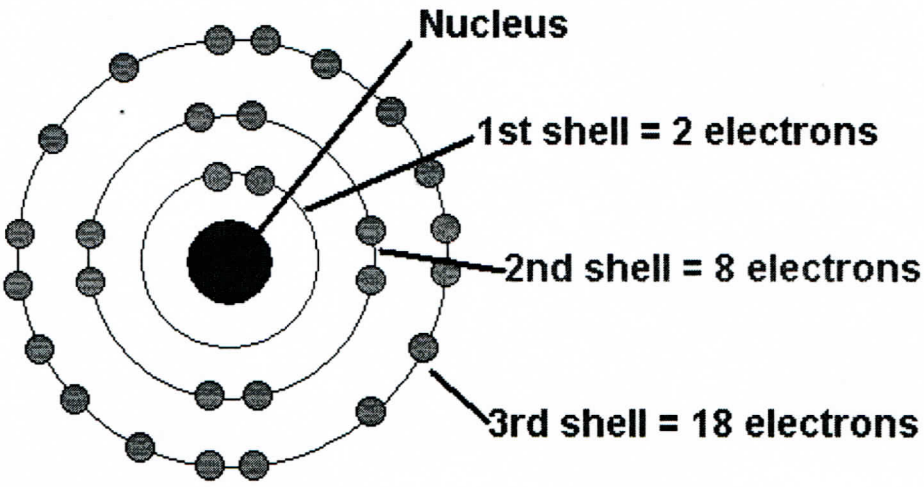
Thus, the circles where the electrons orbit are referred to as energy levels or shells. Electrons in the outermost circles have higher energy since it requires more effort to pull the electron a greater distance from the nucleus.

The energy levels are numbered 1, 2, 3, etc. The smaller the number, the closer the energy level is to the nucleus. The letter "n" is used to represent the energy level. The energy level that is closest to the nucleus has a value of n = 1. Sometimes instead of using numbers, we use the letter K, L, M, etc. to represent the numbers 1, 2, 3, and so on.

The value of n is sometimes called the principle quantum number.



Each energy level can only hold a certain number of electrons. The first energy level can only hold 2 electrons, the second can only hold 8, and the third can only hold 18.



Look at the chart below and see if you can detect a pattern.

n	Maximum number of electrons
1	2
2	8
3	18
4	32

As the energy level increases, so does the number of electrons that can fit into the shell. We can use a formula to predict the maximum number of electrons that can fit into an energy level.

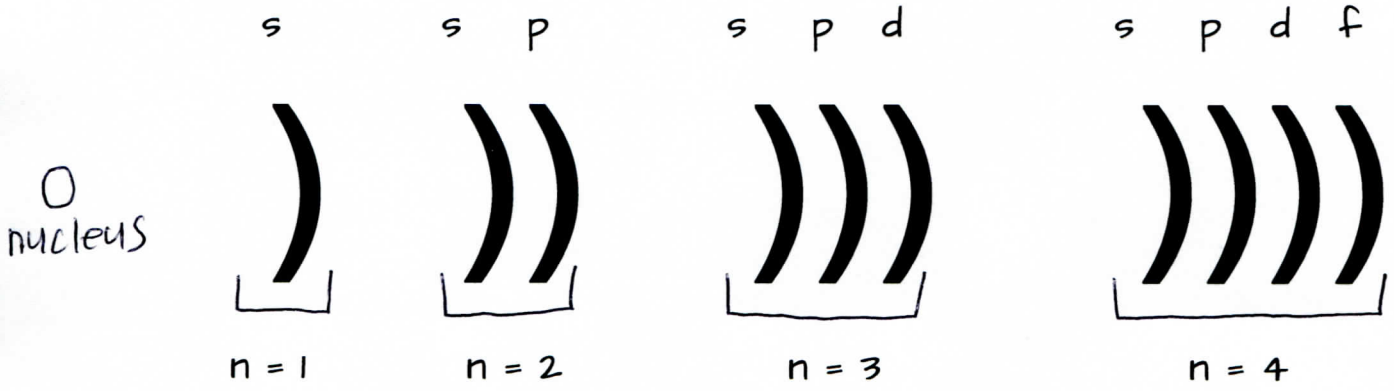
$$\text{Max \# of electrons} = 2n^2$$

For example, the maximum number of electrons that can occupy the 4^{th} energy level is $2(4)^2 = 2(16) = 32$ electrons.

Sublevels

Within each energy level are sublevels. The sublevels are labeled s, p, d, and f. You need to memorize these 4 sublevels.

The first energy level has an s sublevel.
The second energy level has s and p sublevels.
The third energy level has s, p, and d sublevels.
The forth energy level has s, p, d, and f sublevels.



n	sublevels inside
1	s
2	s, p
3	s, p, d
4	s, p, d, f

Notice that the number of sublevels in an energy level = # of the energy level.

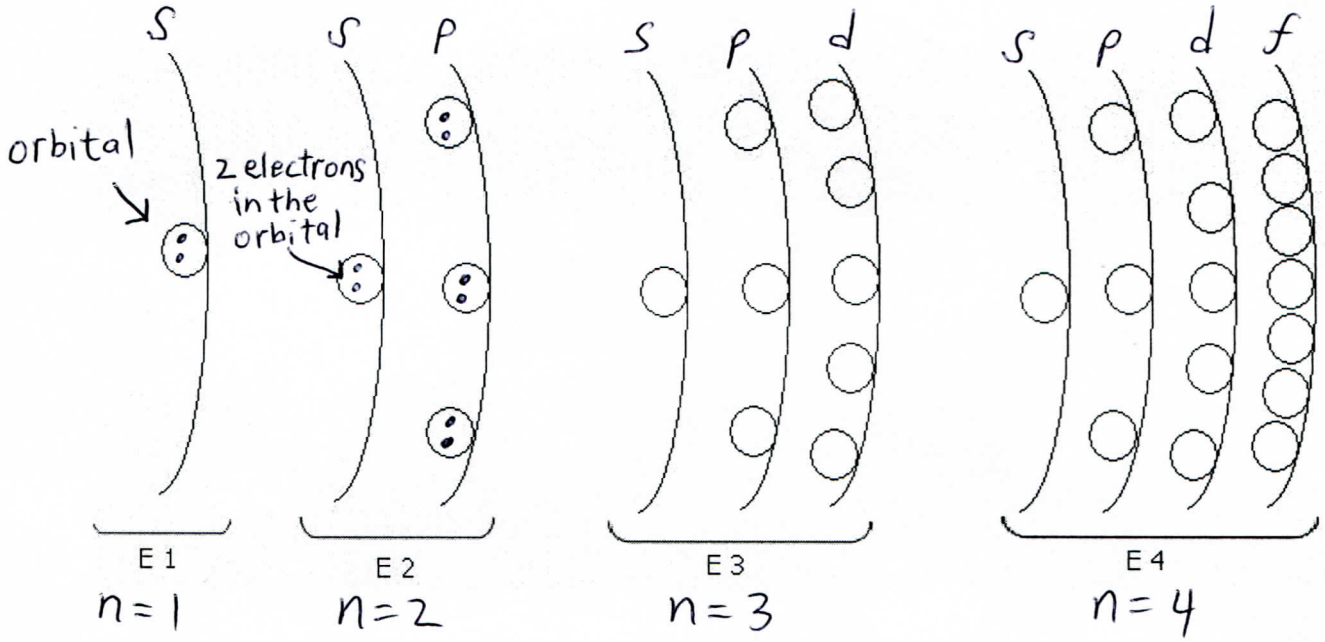
Orbitals

Within each sublevel, there are orbitals. This is the final location where electrons reside.

Each sublevel has a certain number of orbitals.
An s sublevel has 1 orbital.
A p sublevel has 3 orbitals.
A d sublevel has 5 orbitals.
An f sublevel has 7 orbitals.

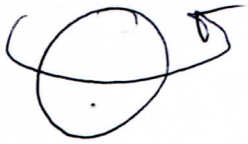
Sublevel	#of orbitals
s	1
p	3
d	5
f	7

A maximum of 2 electrons can occupy an orbital.



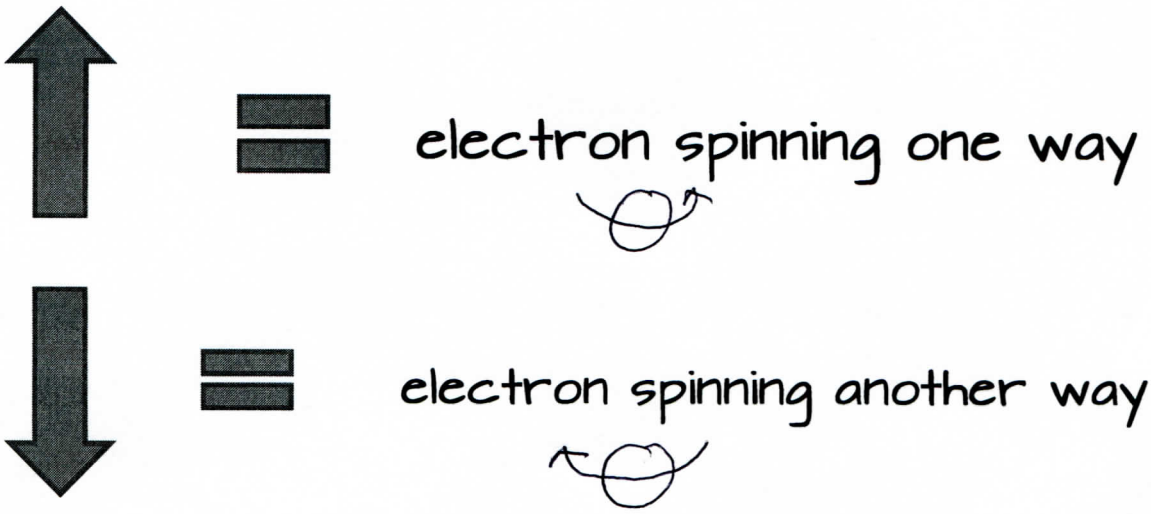
Pauli Exclusion Principle

When electrons occupy orbitals, they spin on their axis.



If two electrons occupy an orbital, the must spin in opposite directions. This rule is called the Pauli Exclusion Principle.

We will be using arrows to symbolize spinning electrons.



General Summary

Electrons orbit the nucleus in circles called energy levels (n).

Inside the energy levels are sublevels (s, p, d, f).

Inside the sublevels are orbitals.

Energy level ⟶ sublevel ⟶ orbital

Be sure to memorize the charts below.

n	sublevels inside
1	s
2	s, p
3	s, p, d
4	s, p, d, f

Sublevel	#of orbitals
s	1
p	3
d	5
f	7