

Chemistry Lecture #31: Periodic Chart, Octet Rule, Valence Electrons, & Oxidation Number

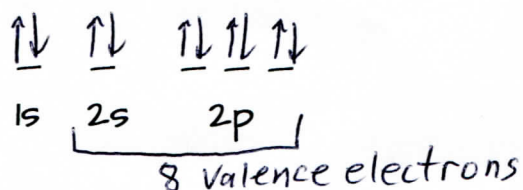
Atoms react with other atoms by losing, gaining, or sharing electrons. When an atom is less reactive, we say that it is stable. Certain electron configurations give atoms more stability.

Atoms are the most stable when they have 8 valence electrons. This is known as the octet rule. An atom with 8 valence electrons is said to have an octet.

In order for an atom to have an octet, the s and p orbitals in the highest energy level must be filled.

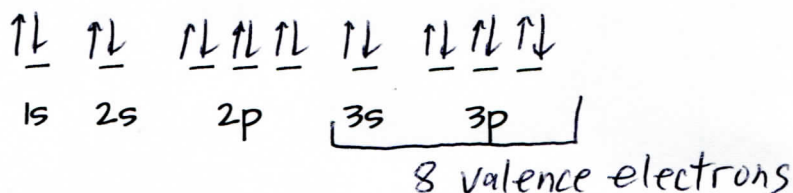
Below is the electron configuration of neon. Notice that there are 8 electrons in the 2nd energy level.

Neon



Here is the electron configuration of argon. Notice that there are 8 electrons in the 3rd energy level.

Argon



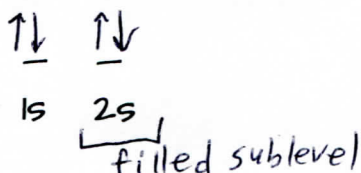
Both neon and argon each have 8 electrons in their outer energy level. They do not want to lose or gain electrons because it would ruin this perfect arrangement of 8. Thus, neon and argon will not chemically react with other elements. You cannot make neon and argon combine with sodium, chlorine, or any other element. Neon and argon are chemically inert.

Neon and argon are in group 8A. All group 8A elements have 8 valence electrons, so they are all chemically inert. This is why elements in group 8A are called the noble gases.

An octet is the highest form of stability, but there are other configurations that are also somewhat stable.

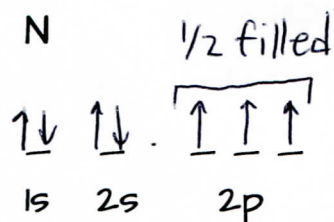
An atom will be more stable if it has a full sublevel. To illustrate, look at the configuration for Be below.

Be



Notice that the 2s sublevel is completely filled. Since the s sublevel is filled it is less likely to steal electrons from other atoms, thus making it less reactive. Be is a group 2A element. All Group 2A elements are less likely to accept additional electrons.

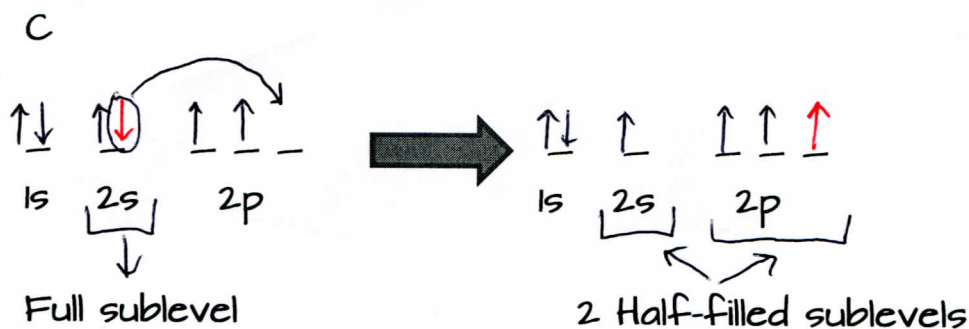
An atom will also be more stable if it has half-filled sublevels. Nitrogen, for example, has a half-filled p sublevel.



If an atom has a half-filled sublevel, it is less likely to lose electrons, making it less reactive and therefore more stable. All group 5A elements, like nitrogen, have half-filled p sublevels.

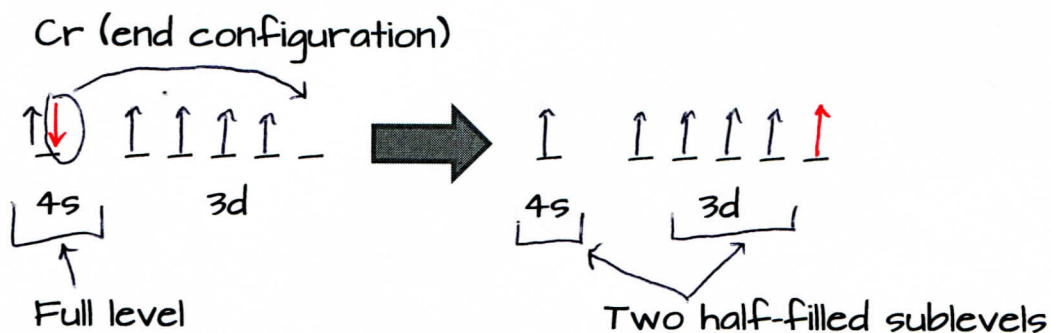
Atoms will sometimes transfer an electron from one orbital to another in order to increase the number of full or half-full orbitals.

Carbon, for example, will transfer an electron from the 2s orbital to the 2p orbital.

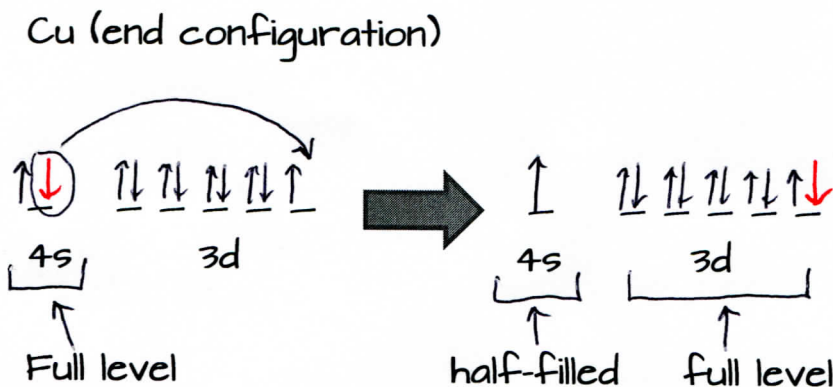


Carbon has gone from having a full 2s orbital, to having two half-filled orbitals (2s and 2p). This is more stable than a single full sublevel.

Chromium will also move an electron from the 4s sublevel to the 3d sublevel to change from one full sublevel (4s) to two half-filled sublevels (4s and 3d).



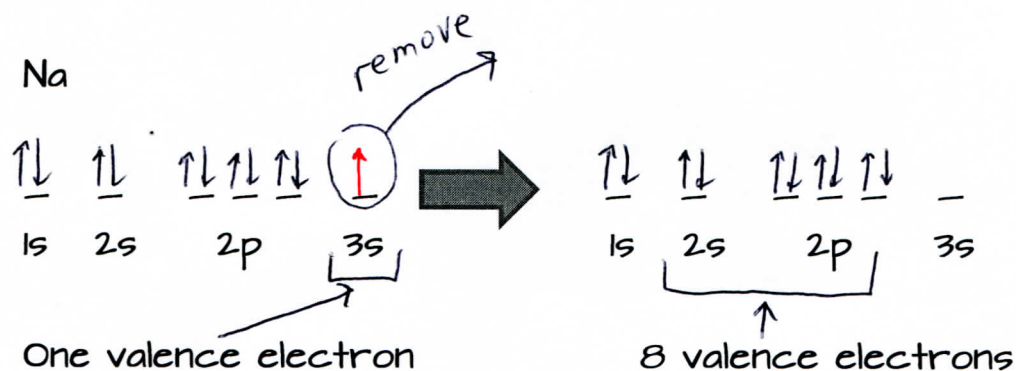
Copper will move an electron from 4s to 3d. This changes the end configuration from a full level (4s) to a half-filled level (4s) and a full level (3d). A full level and a half-filled level are more stable than just a full level.



Instead of shifting electrons, atoms will sometimes steal or lose electrons to get an octet, which is the highest form of stability.

For example, group 1A elements have one valence electron. But if an element loses its one valence electron, it will then have 8 outer electrons.

Look at the configuration of sodium below. It has 1 electron in the 3s energy level. But when it gets rid of the electron, it now has 8 electrons in the 2nd energy level.



When Na loses an electron, it gains a positive charge. Sodium started with 11 positive protons and 11 negative electrons, and $+11 + (-11) = 0$. But if it loses an electron, it now has 10 negative electrons, and $+11 + (-10) = +1$. So sodium now has a +1 charge.

This plus one charge is the oxidation number of the atom. The oxidation number of an atom is the charge it will have after losing or gaining an electron.

Group 1A elements tend to lose electrons to get an octet, and have a +1 oxidation number.

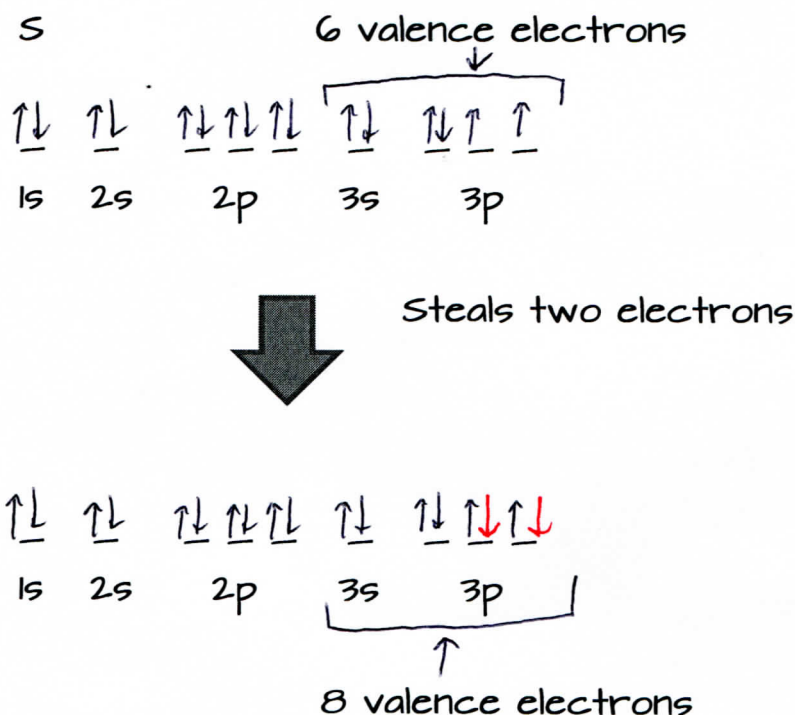
Groups 2A and 3A also tend to lose electrons to obtain an octet.

Group 2A elements will lose 2 electrons and have a +2 charge.

Group 3A will lose 3 electrons and have a +3 charge.

We'll skip group 4A since these elements neither lose nor steal electrons. They tend to share electrons.

Groups 5A, 6A, and 7A tend to steal electrons to obtain an octet. For example, sulfur has 6 valence electrons, but will steal two to get 8 electrons.



It is easier for sulfur to steal two electrons to get an octet, rather than lose 6 electrons.

When sulfur steals two electrons, it will have an oxidation number of -2. Originally, sulfur has 16 negative electrons, but after stealing two, it will have 18 negative electrons. 16 positive protons plus 18 negative electrons gives $+16 + (-18) = -2$.

After stealing electrons to obtain an octet, group 5A will have an oxidation number of -3. Group 6A will have an oxidation number of -2. And group 7A will have an oxidation number of -1.

Group 8A elements already have an octet. They will neither steal or lose electrons, so the oxidation number of elements in group 8A is zero.

Group	Valence Electrons	Oxidation Number
1A	1	+1
2A	2	+2
3A	3	+3
4A	4	variable
5A	5	-3
6A	6	-2
7A	7	-1
8A	8	0