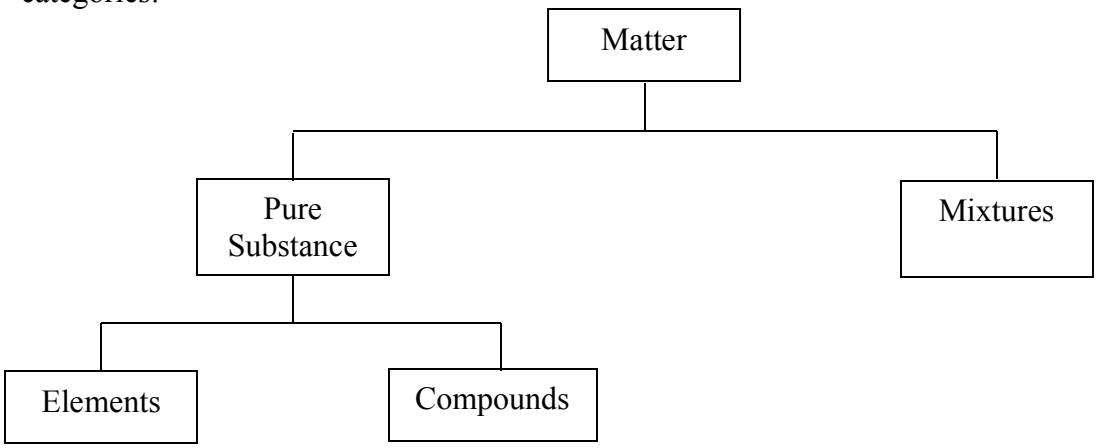
Compounds

Recall
Chemistry is the study of matter and its properties. Matter can be subdivided into several categories:



Element
A pure substance that can't be broken down into simpler substances.

Compound
A pure substance that contains two or more different elements in a fixed proportion. Examples include water (H_2O), carbon dioxide (CO_2), and carbon monoxide (CO).

The key to understanding how compounds are formed is understanding the arrangement of electrons about the nucleus. Electrons have more energy the farther they are from the nucleus (so, valence electrons have the most energy). The more energy an electron has, the more likely it is to be involved in bonding. Thus, **valence electrons are involved in bonding**.

Q. Why do elements form compounds?

A. Elements form compounds because they want to become **stable** (non-reactive).

Q. How does an element become stable?

A. To be stable, an element must have a full outer orbit of electrons. The noble gases already do, so they are naturally stable.

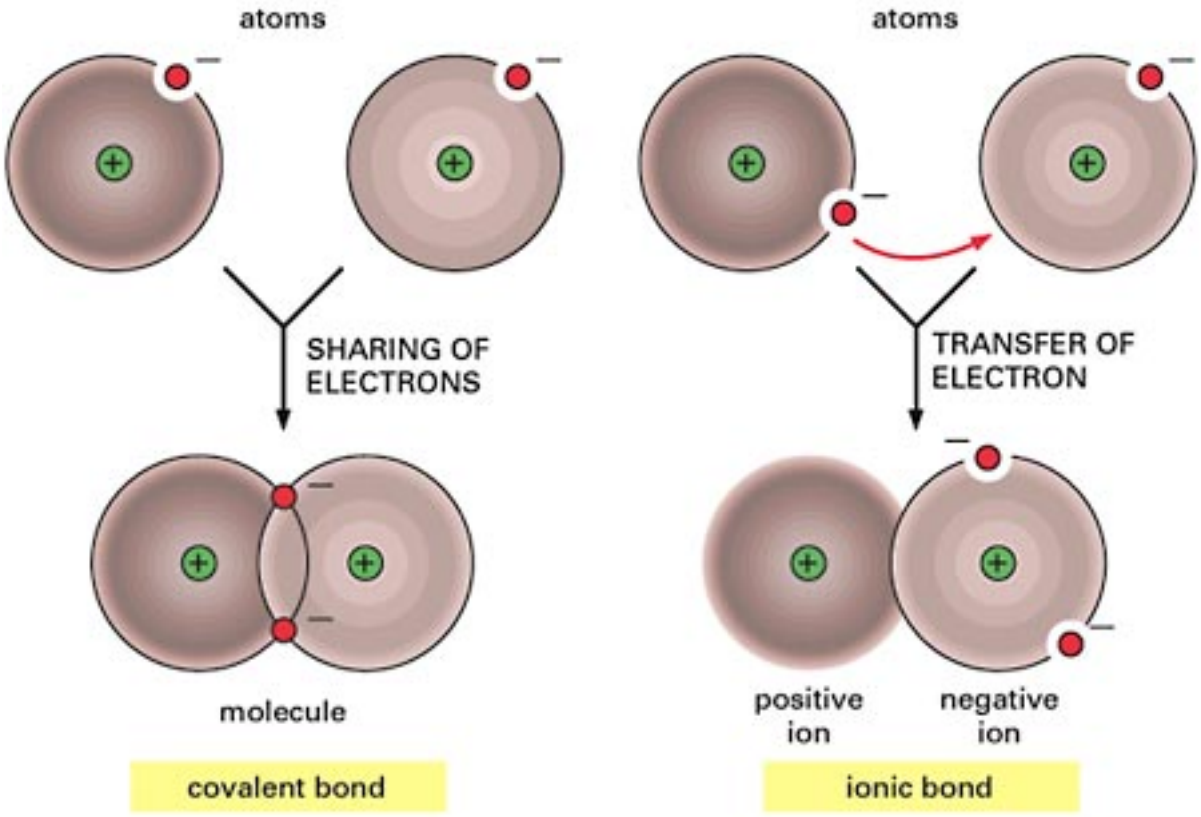
Q. How does an element go about getting a full outer orbit?

A. Elements can get a full outer orbit by forming compounds with other elements. In the process of **bonding**, each element either gains, loses, or shares some electrons.

Types of Compounds

1. **Ionic Compounds**
   - an ionic compound results when two or more atoms **transfer** electrons from one to the other (i.e. one loses, the other gains)

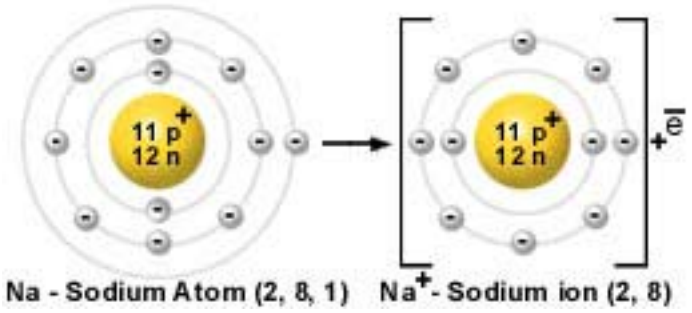
2. **Covalent Compounds**
   - a covalent compound results when two or more atoms **share** some electrons



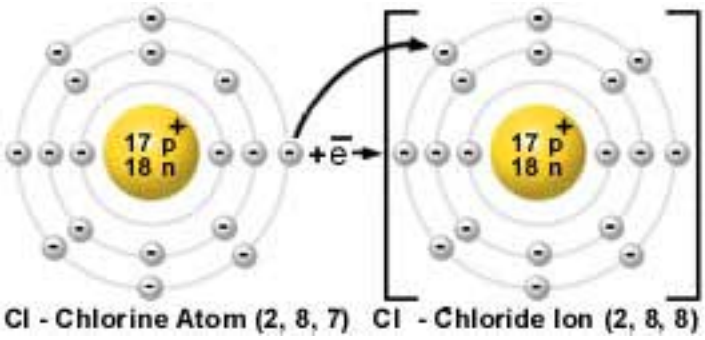
Ionic Compounds

One way to form compounds is by either giving up or gaining electrons. When a neutral atom loses or gains electrons, it becomes charged. Any atom or group of atoms that carries an electric charge is called an **ion**.

Example 1
The diagram below illustrates the formation of a sodium ion.

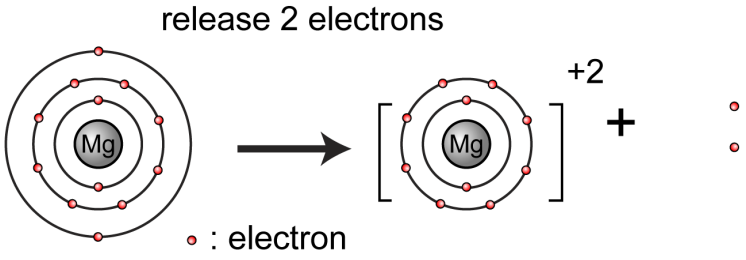


Example 2
The diagram below illustrates the formation of a chlorine atom.

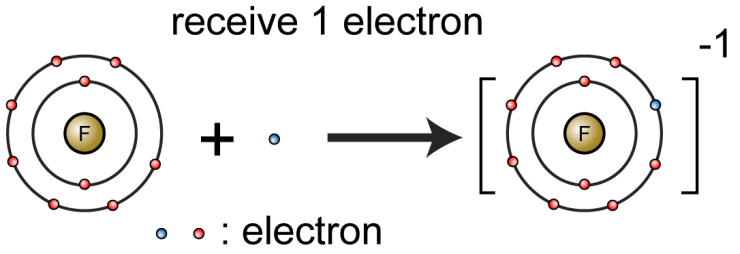


Types of Ions

1. **Cation**
   - a positively charged ion
   - formed when an element loses electrons

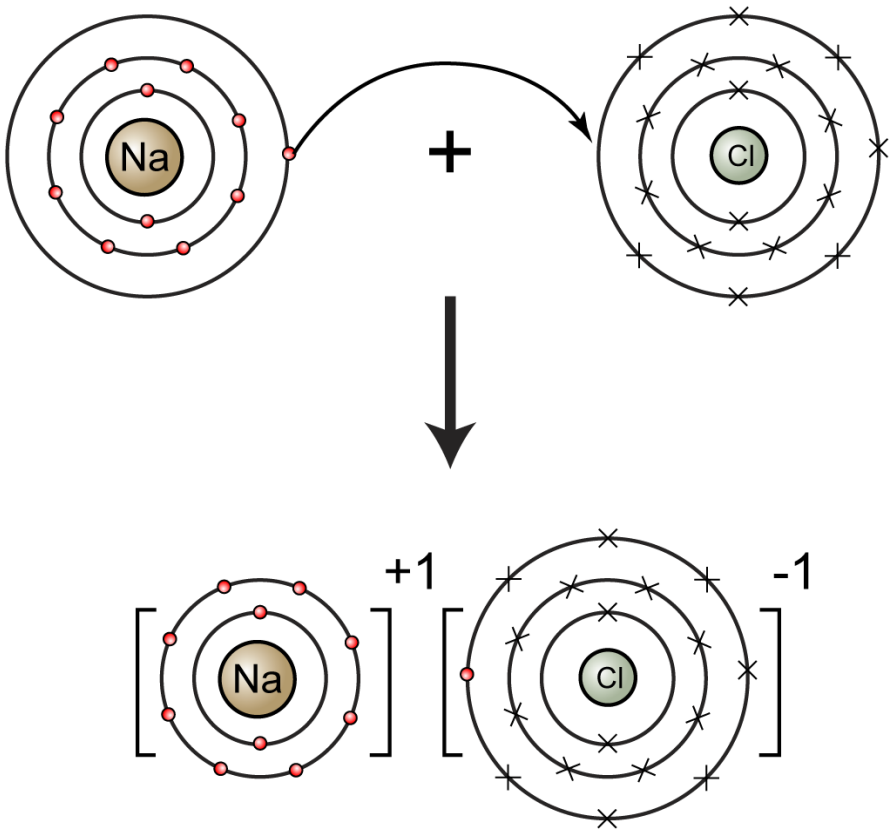


2. **Anion**
   - a negatively charged ion
   - formed when an element gains electrons

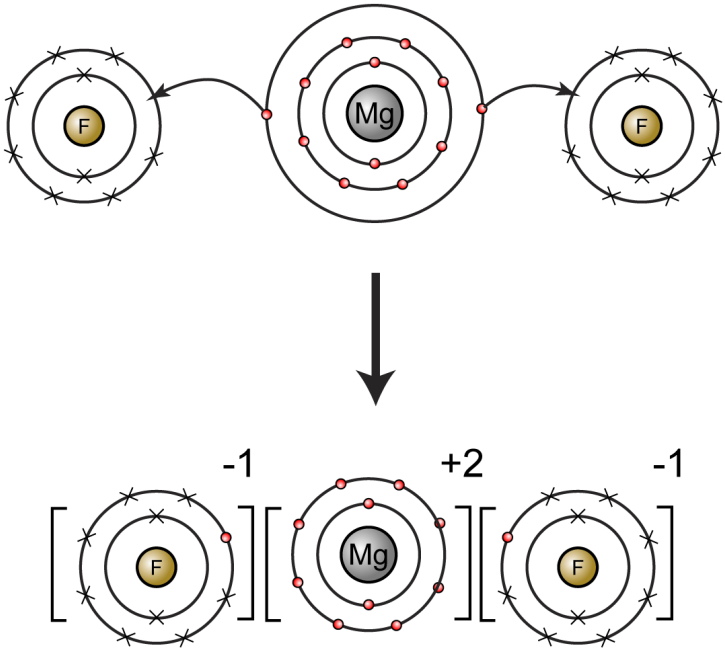


Ionic bonding occurs when one atom gives electrons to another atom. The atom that gives an electron becomes a cation. The one that gains an electron becomes an anion. These two oppositely charged ions are attracted to one another (through static electricity), forming an **ionic bond**.

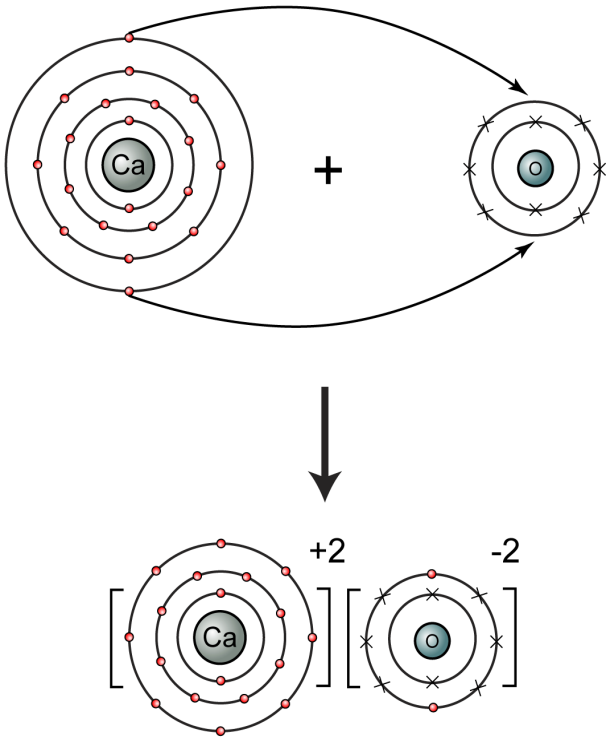
Example 3
The diagram below illustrates the formation of the ionic compound sodium chloride (table salt).



Example 4
The diagram below illustrates the formation of the ionic compound magnesium chloride.



Example 5
The diagram below illustrates the formation of the ionic compound calcium oxide.



Q. How can you tell if an atom will gain or lose electrons?

A. Each atom will do what requires the least amount of energy (what is easiest). For example, it is easier for sodium to lose 1 electron than gain 7.

Notice: Ionic bonds typically form between a metal and a non-metal.

Q. Is there a quick way to determine how many electrons an atom will gain or lose?

A. Yes, by looking at its combining capacity. The **combining capacity** of an element is the number of electrons it will gain (if negative) or lose (if positive) when forming a compound.

For many elements, the combining capacity is determined by what family (column) they are located in on the periodic table. For example, each of the alkali metals has a combining capacity of $1+$, since they all have one valence electron (and thus will tend to lose one electron).

It should also be noted that the combining capacity of an element is the same as the charge that its ion will have.

The table below lists the combining capacities for some common elements:

Group	Atoms that commonly form ions	Combining Capacity
1	H, Li, Na, K, Rb, Cs	$1+$
2	Be, Mg, Ca, Sr, Ba	$2+$
15	N, P, As	$3-$
16	O, S, Se, Te	$2-$
17	F, Cl, Br, I	$1-$

Groups 13 and 14 were not included in this table because the atoms in those groups have a large variation in their ionic charges.