4.2 Ionic Bonds

Vocabulary:

Ion –

Polyatomic ion –

Ionic bond –

Ionic compound –

Chemical formula –

Subscript –

Crystal -

An ion is an atom or group of atoms that has an electric charge.

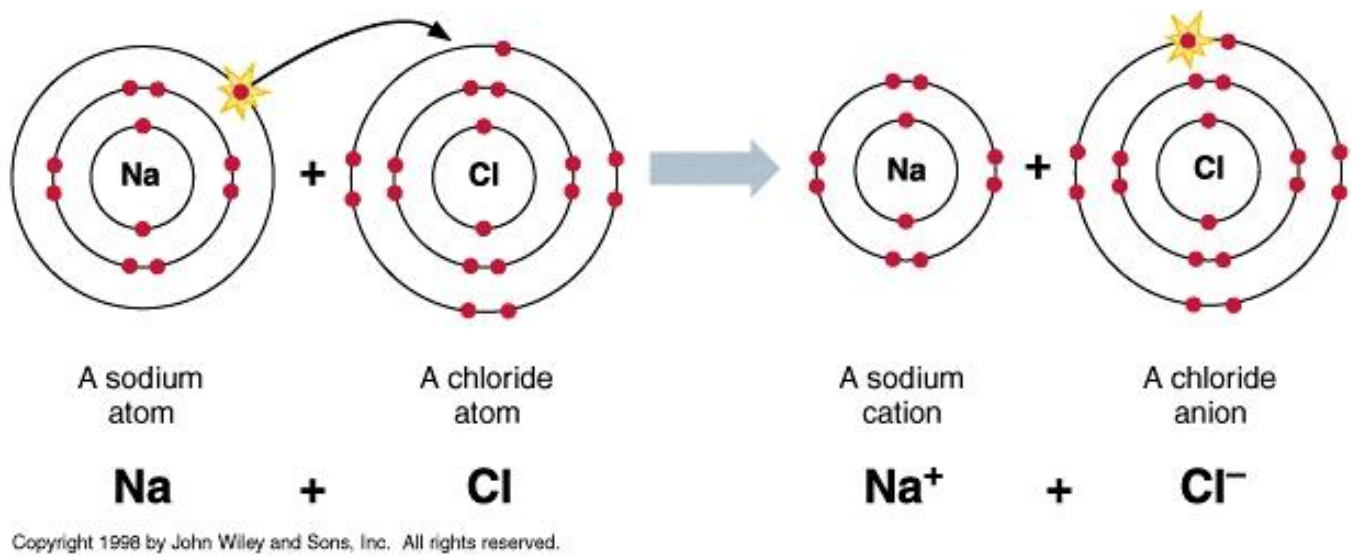
When a neutral atom loses a valence electron, it loses a negative charge. It becomes a positive ion. When a neutral atom gains an electron, it gains a negative charge and becomes a negative ion.

Common Ions:

Name	Charge	Symbol/Formula
Lithium	1+	Li+
Sodium	1+	Na+
Potassium	1+	K+
Ammonium	1+	NH_4+
Calcium	2+	Ca^2+
Magnesium	2+	Mg^2+
Aluminum	3+	Al^3+
Fluoride	1-	F-
Chloride	1-	Cl-
Iodide	1-	I-
Bicarbonate	1-	HCO_3-
Nitrate	1-	NO_3-
Oxide	2-	O^2-
Sulfide	2-	S^2-
Carbonate	2-	CO_3^2-
Sulfate	2-	SO_4^2-

Notice that some ions are made of several atoms. Ammonium is made of 1 nitrogen atom and 4 hydrogen atoms. Ions that are made of more than 1 atom are called polyatomic ions.

<u>Ionic bonds:</u> When atoms that easily lose electrons react with atoms that easily gain electrons, valence electrons are transferred from one type to another. The transfer gives each type of atom a more stable arrangement of electrons.



1. Sodium has 1 valence electron. Chlorine has 7 valence electrons.

2. The valence electron of sodium is transferred to the chlorine atom. Both atoms become ions. Sodium atom becomes a positive ion (Na+) and chlorine becomes a negative ion (Cl-).

3. Oppositely charged particles attract, so the ions attract.

An ionic bond is the attraction between 2 oppositely charged ions. The resulting compound is called an ionic compound. In an ionic compound, the total overall charge is zero because the total positive charges are equal to the total negative charges.

How are Formulas and Names of Ionic Compounds Written?

Compounds can be represented by their chemical formula. A chemical formula is a group of symbols that shows the ratio of elements in a compound.

Example: The formula for magnesium chloride is $MgCl_2$.

The charge on the magnesium is 2+. The charge on each chloride ion is 1-

Two chlorides balance the charge on the magnesium. The number "2" in the formula is a subscript. Subscripts tell the ratio of elements in a compound.

To write the formula for an ionic compound, write the symbol of the positive ion and then the symbol of the negative ion. Add the subscripts that are needed to balance the charges.

For an ionic compound, the name of the positive ion comes first, followed by the name of the negative ion.

The name of the positive ion is usually the name of a metal. But a few positive polyatomic ions exist, such a ammonium ion (NH_4+)

If the negative ion is a single element, the end of its name changes to "-ide." For example, MgO is magnesium oxide. If the negative ion is polyatomic, its name usually ends in "-ate" or "-ite."

Ammonium nitrate (NH_4NO_3) is a common fertilizer for plants.

Name	+ ion	- ion	Formula
Magnesium Chloride	Mg^2+	Cl-	$MgCl_2$
Sodium Bromide	Na+	Br-	NaBr
Lithium oxide	Li+	O^{2-}	Li_2O
Magnesium Sulfide	Mg^2+	S^{2-}	MgS
Aluminum Fluoride	Al^3+	F-	AlF_3
Potassium Nitrate	K+	NO_3-	KNO_3
Ammonium chloride	NH_4+	Cl-	NH_4Cl

Properties of Ionic Compounds

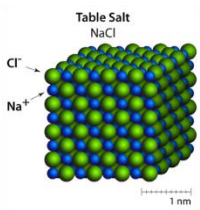
Compounds have properties that are different from their component elements. What are the properties of ionic compounds that form when metals and nonmetals react?

In general, ionic compounds form hard, brittle crystals that have high melting points. They conduct electric current when dissolved in water or melted.

Ionic crystals – ionic compounds form solids by building up repeating patterns of ions. They form an orderly, three-dimensional arrangement called a crystal.

Every ion in an ionic compound is attracted to ions of an opposite charge that surround it. The pattern formed by the ions is the same no matter what the size of the crystal. Many crystals of ionic compounds are hard and brittle due to the strength of their ionic bonds and the attractions among all the ions.

The ions in the crystal have to break apart for an ionic compound to melt. It takes a huge amount of energy to separate the ions in a crystal, because the attraction between the positive and negative ions is so great. As a result, ionic compounds have very high melting points. The melting point of sodium chloride is 801*C.

Electrical Conductivity – electric current is the flow of charged particles. When ionic crystals dissolve in water, the ions are set free to move about, and the solution can conduct current. Likewise, when an ionic compound melts, the ions are able to move freely, and the liquid conducts current.

Ionic compounds in solid form do not conduct current well. The ions in the solid crystal are tightly bound to each other and cannot move from place to place. If charged particles cannot move, there is no current.