

209_ionic_combinations_activity

Background

When ions come together to form ionic compounds, the positively charged cations and negatively charged anions are attracted in a ratio determined by the charges on the ions. As an example we will discuss sodium oxide. A sodium ion has a charge of positive one (1+), while an oxygen ion has a charge of negative two (2-). Each oxygen ion will attract an average of two sodium ions because its charge is twice that of sodium. Therefore we write the chemical formula for sodium oxide as Na_2O , indicating that for every two sodium ions there is one oxide ion. In this activity you will explore this concept more fully.

Note that a polyatomic ion is simply a group of atoms attached together that has an overall charge, meaning that if you counted all of the protons and all of the electrons within the atoms of the polyatomic ion, there would be an unequal number of protons and electrons, and therefore an overall charge. In ionic bonding, you can think of a polyatomic ion as similar to a monatomic (single atom) ion in the way it behaves. This means that in this activity you can treat a sulfate ion (SO_4^{2-}) the same way you treat an oxide ion (O^{2-}).

It is important to understand that while the positive and negative charges in an ionic compound balance each other out on a macroscopic level, the charges themselves still exist. This means that when you dissolve NaCl in water, even though the sodium chloride crystals are neutral overall, the individual sodium ions are still positively charged and the individual chloride ions are still negatively charged.

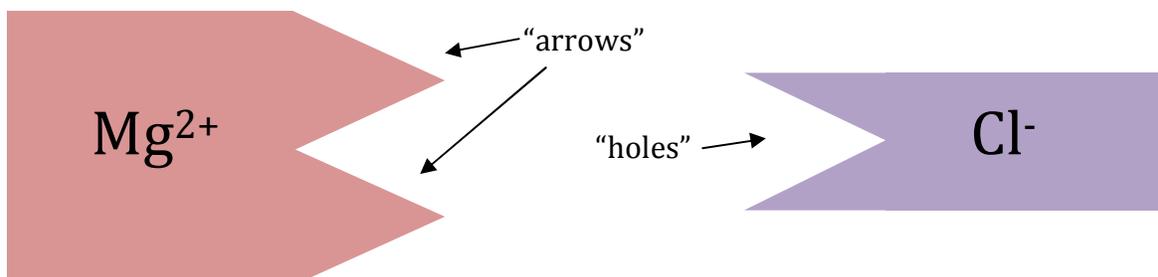
Materials:

Student handout
Scissors

Directions for Activity II:

You will use cutout representations of positively and negatively charged ions to learn how ions come together to form neutral ionic compounds, or salts.

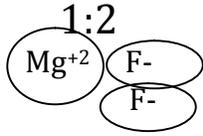
1. Cut out all of the ions provided. Using these cutouts, combine positive and negative ions to make the compounds listed in the table below, obeying the simple rule that you can leave no "arrows" on the positive ions without a "hole" on the negative ions, and no "holes" without an "arrow".



Note: If you do not know the names or symbols of the polyatomic ions or elements, refer to the tables in your textbook.

To receive credit:

- *Write all answers in your bound journal*
- *-2pt if you do not title the entry*
- *-2pt if you do not date the entry*
- *Be sure to complete the discussion questions*

Compound	How many positive ions were used?	How many negative ions were used?	What is the ratio of positive to negative ions?	What is the chemical formula of the compound?
Magnesium fluoride	1	2	1:2 	MgF ₂
Calcium oxide				
Sodium chloride				
Sodium sulfide				
Sodium phosphate				
Ammonium chloride				
Ammonium phosphate				
Aluminum oxide				
Aluminum phosphate				

2. Now see if you can come up with some other compounds using the ions provided. Write the names and chemical formulas for these compounds.

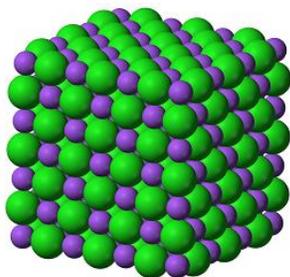
Name	Chemical Formula

It is important to recognize that these cutout ions are simply a representation, or model, used to illustrate the concept of formulas for ionic compounds. As with all models, there are constraints on how well this represents reality.

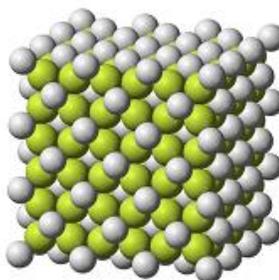
Discussion Questions

1. How is this model helpful in understanding chemical formulas for ionic compounds?
2. What are some limitations of this model in accurately representing ionic compounds?
3. How can this model be improved to better illustrate the concept of chemical formulas for ionic compounds?

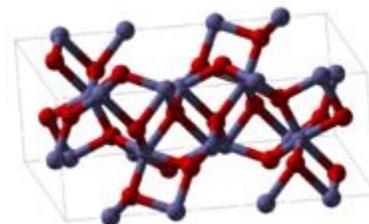
While you have just looked at a model for determining the ratio of ions within an ionic compound, a difficult concept to understand is that within an ionic crystal each ion is surrounded by oppositely charged ions creating an extensive lattice of connected ions. The activity you just did allows you to figure out the ratio of these oppositely charged ions yet it is important to understand the actual 3-dimensional nature of how these ions interact in a solid crystal. Several examples of ionic compounds are illustrated below.



NaCl (1:1 ratio of ions)
http://www.human-existence.com/blog/?page_id=262/



CaF₂ (1:2 ratio of ions)
<http://commons.wikimedia.org/wiki/File:Calcium-fluoride-3D-ionic.png>



Fe₂O₃ (2:3 ratio of ions)
http://en.wikipedia.org/wiki/Iron%28III%29_oxide

