18.5: Ionic Bonding

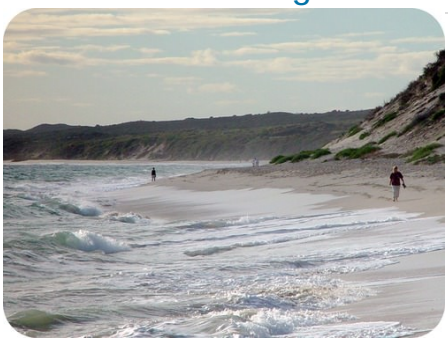

Figure 18.5.1(Public Domain; Leon Brooks via Commons Wikimedia, Waneroo Beach [commons.wikimedia.org])

Does the sea really have salt in it?

We can get common table salt from several sources. It can be mined in the solid form in salt mines, or found as a solid in deposits. We can also get salt from the ocean, but it really does not exist as a salt when in solution. The sodium ions and chloride ions are dissolved, but not combined into a structure until all the water is removed.

Most of the rocks and minerals that make up the Earth's crust are composed of positive and negative ions held together by ionic bonding. An ionic compound is an electrically neutral compound consisting of positive and negative ions. You are very familiar with some ionic compounds, such as sodium chloride (NaCl). A sodium chloride crystal consists of equal numbers of positive sodium ions $\left(\mathrm{Na}^{+}\right)$ and negative chloride ions $\left(\mathrm{Cl}^{-}\right)$.

Ionic Bonds

Oppositely charged particles attract each other. This attractive force is often referred to as an **electrostatic force**. An **ionic bond** is the electrostatic force that holds ions together in an **ionic compound**. The strength of the ionic bond is directly dependent upon the quantity of the charges and inversely dependent on the distance between the charged particles. A cation with a $2+$ charge will make a stronger ionic bond than a cation with a $1+$ charge. A larger ion makes a weaker ionic bond because of the greater distance between its electrons and the nucleus of the oppositely charged ion.

Electron Dot Diagrams

We will use sodium chloride as an example to demonstrate the nature of the ionic bond and how it forms. As you know, sodium is a metal and loses its one valence electron to become a cation. Chlorine is a nonmetal and gains one electron in becoming an anion. Both achieve a noble-gas electron configuration. However, electrons cannot be simply "lost" to nowhere in particular. A more accurate way to describe what is happening is that a single electron is transferred from the sodium atom to the chlorine atom, as shown below.

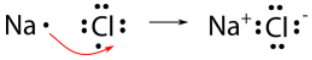

Figure 18.5.2(CC BY-NC 3.0; CK-12 Foundation via CK-12 Foundation)

The ionic bond is the attraction of the Na^+ ion for the Cl^- ion. It is conventional to show the cation without dots around the symbol to emphasize that the original energy level that contained the valence electron is now empty. The anion is now shown with a complete octet of electrons.

For a compound such as magnesium chloride, it is not quite as simple. Because magnesium has two valence electrons, it needs to lose both to achieve the noble-gas configuration. Therefore, two chlorine atoms will be needed.

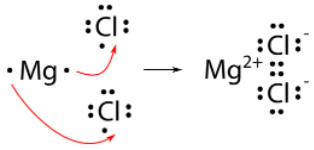

Figure 18.5.3(CC BY-NC 3.0; CK-12 Foundation via CK-12 Foundation)

The final formula for magnesium chloride is $MgCl_2$.

Summary

- An ionic compound contains positive and negative ions.
- An ionic bond is electrostatic in nature.
- Electron dot diagrams can be used to illustrate electron movements and ion formation.

Review

1. What is an ionic compound?
2. What is an ionic bond?
3. Which cation (Na^+ or Ca^{2+}) would form a stronger ionic bond with Cl^-?
