

What's going on here?

In this investigation, you saw that the amount of a substance that dissolves in water is different for different substances. You can begin to understand why this is by looking at both water and the substances being dissolved on the molecular level.

Dissolving

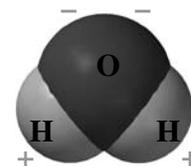
The first thing to understand about dissolving is that you have to look at the liquid doing the dissolving (*solvent*) as well as the substance being dissolved (*solute*). Dissolving depends on the interaction between the molecules of the solvent and the molecules of the solute.

Since you used water to dissolve the different substances and since dissolving occurs on the molecular level, you need to first look at the molecular structure of water.

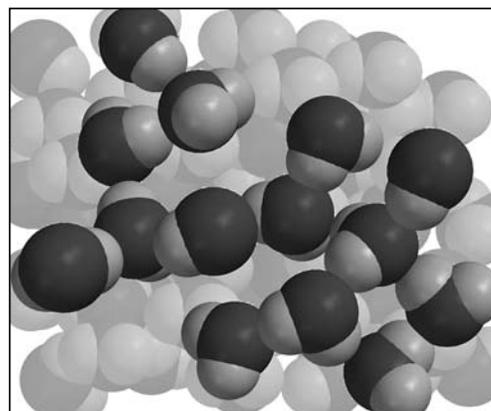
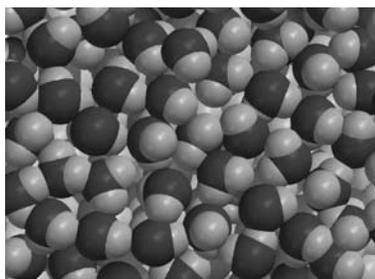
Water molecules

A water molecule is made of two hydrogen atoms bonded to one oxygen atom. All atoms, including hydrogen and oxygen, have one or more *protons* in the center, or *nucleus*, of the atom. Atoms also have *electrons* that move around the nucleus. Protons have a positive electric charge, and electrons have a negative electric charge. An atom has the same number of electrons as it has protons.

Because of the characteristics of oxygen and hydrogen and how they are bonded together in the water molecule, there is a slight positive charge near the hydrogen atoms and a slight negative charge near the oxygen atom.



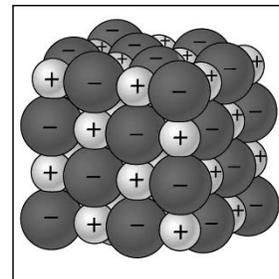
The smaller illustration to the right shows that the molecules in liquid water associate very closely with one another. The larger illustration shows how the water molecules tend to orient themselves according to their opposite charges. Notice how the positive area of one water molecule is attracted to the negative area of another.



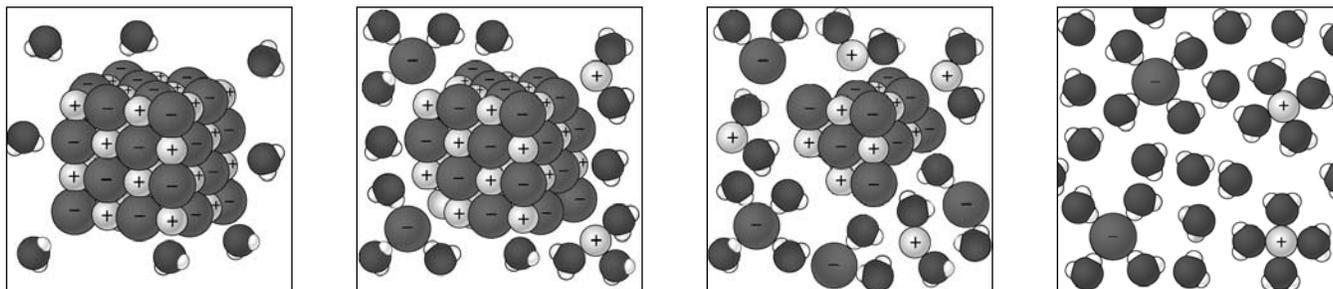
Salt is made from positive and negative ions

Regular table salt is called sodium chloride. Its chemical formula is NaCl. *Na* stands for sodium and *Cl* stands for chlorine. When the sodium atom and the chlorine atom react, the sodium ends up with a positive charge and the chlorine ends up with negative charge. The positive sodium and the negative chloride are called *ions*. Because positive and negative attract, the sodium (Na^+) and chloride (Cl^-) ions attract each other and bond together. This is what keeps the sodium and chloride ions together to make a piece of salt.

This illustration is a model of a salt crystal drawn to give you a basic idea of what a salt crystal looks like. However, you should know that there are far more ions in a single salt crystal than this picture shows. The approximate number of sodium (Na^+) and chloride (Cl^-) ions in a typical crystal of ordinary table salt is actually around 1 million trillion of each.

***How water dissolves salt***

When salt is placed in water, the positive and negative ends of the water molecules are attracted to the negative chloride and positive sodium ions. When the attraction that the water molecules and an ion have for each other overcomes the attraction that the ion has for the other ions in the salt, that ion is pulled away and dissolves. So when water dissolves salt, it pulls away individual sodium and chloride ions.



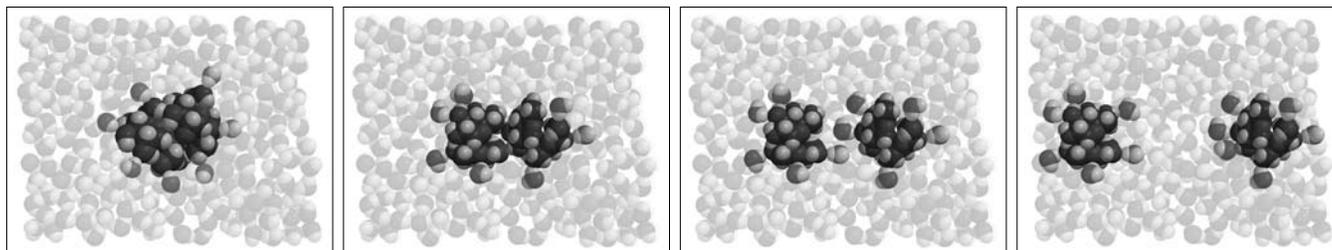
Sodium chloride dissolving in water

Water can dissolve many substances made from ions

MSG and Epsom salt are also made of ions with a positive and negative charge. The ions that make up these different substances all have a different size, weight, strength of attraction, and overall structure. Because of this, they pack together differently to form their crystal shape. When water molecules interact with these substances, all these differences make it either easier or harder for the water molecules to pull the ions away and dissolve them. That's why these substances dissolve to different extents and why you see some differences in how much is left undissolved of each substance.

Dissolving sugar

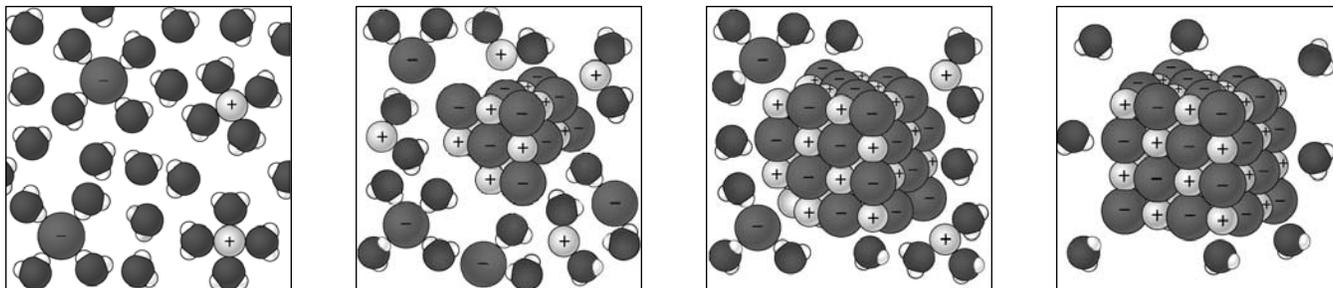
The kind of sugar you used in the activities is called *sucrose*. The chemical formula for sucrose is $C_{12}H_{22}O_{11}$. In the sucrose molecule, there are many positive and negative areas. Sucrose molecules are attracted to other sucrose molecules and line up next to each other because of the attraction of opposite charges. This is what keeps sucrose molecules together in a piece of sugar.



When sucrose is placed in water, the positive and negative ends of the water molecules attract the negative and positive parts of the sucrose molecule. When the attractions that the water molecules have for the sucrose molecule become stronger than the attractions the sucrose molecule has for the other sucrose molecules, the sucrose molecule is pulled away and surrounded by water molecules. At that point it is *dissolved*. So, when water dissolves sucrose, entire sucrose molecules are pulled away from each other. But, when water dissolves salt, Epsom salt, or MSG, individual ions are separated from each other.

Recrystallizing

Another test you did to identify the unknown was the recrystallization test. You saw that as the water evaporated, some of the original substances recrystallized. You also saw that the different substances looked different when they recrystallized.

***Sodium chloride recrystallizing from salt water***

When the different substances dissolve, their ions or molecules are surrounded by water. This makes it hard for them to come together to begin to form a crystal. But as the water evaporates, there are fewer water molecules surrounding the ions or molecules. This makes it easier for them to come together and bond according to their positive and negative charges, or to recrystallize.

Once the solutions have evaporated, the resulting crystals look different from one another. This is because they are made of different ions with different structures and sizes that bond together in different arrangements. Both the unknown (coarse kosher salt) and the table salt look alike when they recrystallize because they are both sodium chloride.

What's going on here? *(continued)*

1. Explain why water is able to dissolve salt (sodium chloride).

2. Explain why the amount of salt and kosher salt that dissolved was so similar.

3. Why do you think the salt and kosher salt looked similar when they recrystallized but looked different from the other substances?

Cool factoid

In the *Think about it* section, you read that salt is a good preservative for food. Well it's also a good preservative of people. Ancient Egyptians used sodium chloride and other types of salt to make a paste for preparing mummies. Also, well-preserved bodies of people who lived over 2,000 years ago have been found in salt deposits in different parts of the world.