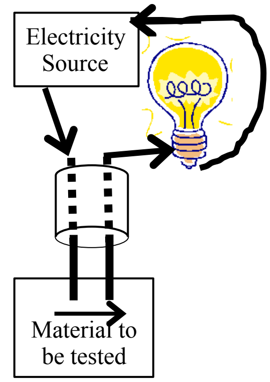
NS G8 (pg 1 of 2) Electrolytes

Name________________________Per___

What substances conduct electricity?



Let's describe electricity as the flow of electrons. This flow is sometimes called current. You use electricity every day to flow through your phone, lights, hair dryer, etc to provide the energy to power whatever you need.

A. **conductor** a material that allows electricity to flow from one point to another.

B. **insulator** a material that does not allow the flow of electricity

C. **electrolyte** a substance that when dissolved in water, will conduct electricity

D. **nonelectrolyte** a substance that when dissolved in water, will *not* conduct electricity

We used the lightbulb apparatus in class to detemine if a material or solution would conduct electricity.

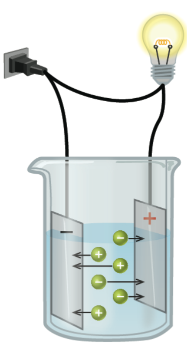
As you already knew, metals conduct electricity, and would be called conductors. Refer back to NoteSheet G7 to review the atomic structure of metals and how the loose valence electrons in metals give rise to metals' ability to conduct electricity. Further you can review the structure of bonding within metals and how metals conduct by watching the short video about metallic bonding on the Unit G video page.

In addition, we found that graphite, which is made of only carbon atoms, also conducted electricity, yet carbon is not a metal. The structure of carbon atoms in graphite also has loose mobile electrons. Carbon in the form of diamonds or charcoal does not conduct electricity, but the atom structure in graphite is different and has mobile electrons that conducts electricity.

We also tested several insulators to find that that these substances do not conduct electricity; glass, plastic, and wood. The electrons in these compounds are tied up in the covalent bonds of the compound, and are unable to move and thus can not conduct electricity.

Electrolytes

We learned that distilled water, which is very pure conpared to tap water, does not conduct electricity, yet tap water did conduct electricity a little bit, lighting the tiny 7 watt bulb. Yet when we dissolved NaCl into the water, the solution conducted electricity just as well as the metal scoop did. This is because NaCl is an electrolyte. An electrolyte is a compound that dissolves in water and can conduct electricity. *How does the electrolyte conduct?* All soluble (able to dissolve) ionic compounds break apart into ions. The presence of the ions (charged particles) is able to carry the current through the water solution.



Ionic compounds dissolved in water, break apart into charged particles.

Molecular compounds dissolved in water, separate but do NOT break apart into charged particles.

You should be able to look at a chemical formula and identify the compound as ionic or molecular. You can review this on NoteSheet G6

Tap water contains very small amount of electrolytes in the water. The tap water may include compounds containing sodium, chloride, phosphate, calcium, and magnesium.

Further we tested acids to find out that acids are also electrolytes. Examples of common acids are listed in the table to the right. The chemical formula of these acids indicate that they are molecular compounds, and shouldn't conduct electricity upon dissolving, however these compounds interact with water and produce H+ ions and a negative anion.

Symbolically we can represent the dissolving and dissociation of acid compounds as follows. More on weak acids on the back.

strong acid: $HCl \rightarrow H^+ + Cl^-$ weak acid: $HC_2H_3O_2 \rightleftarrows H^+ + C_2H_3O_2^-$

strong acid: $HNO_3 \rightarrow H^+ + NO_3^-$ weak acid: $HNO_2 \rightleftarrows H^+ + NO_2^-$

Common Acids	
hydrochloric	HCl
nitric	HNO_3
sulfuric	H_2SO_4
acetic	$HC_2H_3O_2$
phosphoric	H_3PO_4

Remember that the more concentrated the solution was, the better that solution conducted electricity.

More on the symbolic representation of ionic compounds dissolving on the back →

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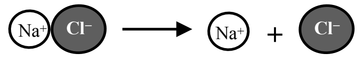
What happens to ionic compounds as they dissolve in water?

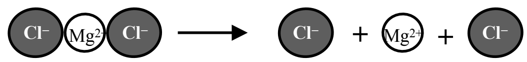
Take the time to compare and contrast the following symbolic and particulate representations of the dissolving and separation of ionic compounds in water.

$NaCl \rightarrow Na^{+} + Cl^{-}$



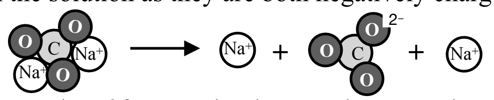
Note that the charges are shown on the ions, but not within the ionic compound.

$MgCl_2 \rightarrow Mg^{2+} + 2\ Cl^{-}$



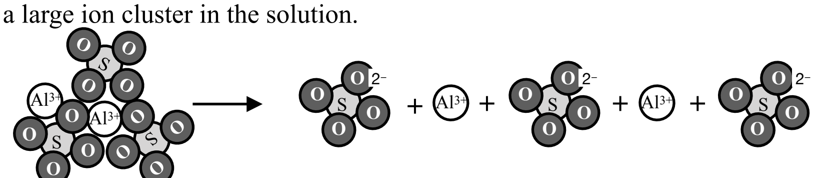
Note that the two chlorides separate from the compound *and* from each other. It may be tempting to think that you should leave the two chlorides together as Cl_2^{-} because you have learned that chlorine is diatomic. However chlorine is diatomic *as an element*, *not as ions*. The chlorides are attached to opposite sides of the magnesium ion, and when separated by the action of the water, the Cl^{-} ions would not re-attach to each other in the solution as they are both negatively charged.

$Na_2CO_3 \rightarrow 2\ Na^{+} + CO_3^{2-}$



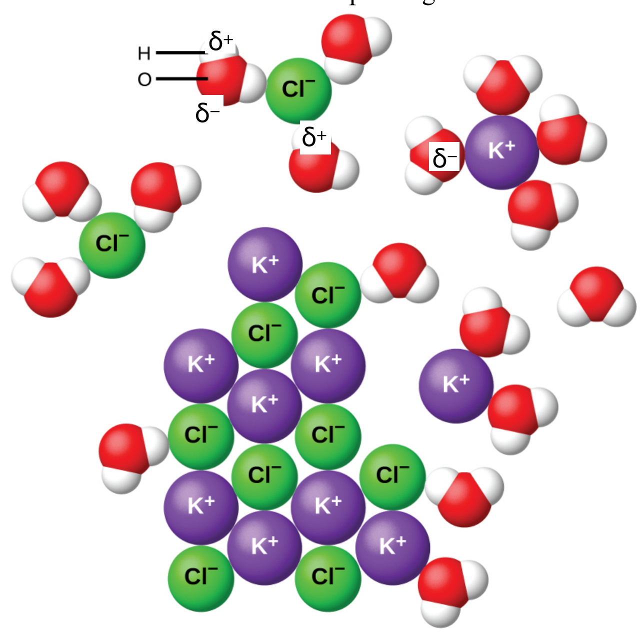
The two sodium ions separate from the compound *and* from each other. Further, note that the polyatomic ion CO_3^{2-} does *not* separate into separate parts because the polyatomic ion is made of atoms inside which are held together by covalent bonds. The atoms in the polyatomic ions stay together as a large ion cluster in the solution.

$Al_2(SO_4)_3 \rightarrow 2\ Al^{3+} + 3\ SO_4^{2-}$



Like the example above,the two aluminum ions separate from the compound and from each other. Further, note that the polyatomic ion SO_4^{2-} does not separate into separate parts, but the three polyatomic ions separate from each other.

Because water is a polar molecule, meaning that while water is *not* ionic, water does have slightly positive and negative ends. In the diagram below notice which end of water carries the partially positive charge (δ+), and which end of water carries the partially negative charge (δ–). Pay close attention to how the water surrounds the ions in different orientations depending if the ion is positive potassium ions or the negative chloride ions.



Weak Acid vs Strong Acids

In this course, we will only consider *soluble* acids. But remember that only strong acids dissociate completely when dissolved in water.

$HCl \rightarrow H^{+} + Cl^{-}$

$H_2CO_3 \rightarrow 2\ H^{+} + CO_3^{2-}$

Weak acids do not dissociate completely, in fact most of the acid molecules will remain as molecules, not ions, when dissolved in water. This means weak acids are weak electrolytes.

$HC_2H_3O_2 \rightleftarrows 2\ H^{+} + CO_3^{2-}$

$HF \rightleftarrows H^{+} + F^{-}$ ***OR*** $HF \rightleftarrows {\scriptstyle H^{+}} + {\scriptstyle F^{-}}$

We use the double arrow to indicate that the reaction does proceed very far towards the dissociated products. The smaller H^{+} and F^{-} in the second HF reaction gives a good visual for only partial dissociation..