

The Chemistry of Water

1. Water has chemical formula H_2O .
 - *a*. How does the oxygen atom bond with the two hydrogen atoms, that is would you describe the bond as covalent, ionic, or a mixture of the two?
 - b. What type of symmetry do you expect in this molecule?
 - c. In liquid form, how do you expect the individual molecules of water to orient themselves relative to one another? Why is there sufficient attraction between individual molecules of water to form a liquid at room temperature?
 - d. Why do you expect water to *expand* when it freezes?
 - e. If water were to contract rather than expand when it froze, what would the consequences be for fresh water life in the winter?

2. The fact that individual molecules of water are *polar* in nature has many interesting and familiar consequences.
- a. When spilled on a flat surface, water will tend to gather in a small number of puddles. Moreover, if two puddles are allowed to “touch” at a single point, they will join to form one puddle. Why? The property at work here is called *cohesion*.
 - b. When put in a very small glass tube, water will “spontaneously” rise in the tube. Why? This is called *capillary action*.

3. *Hydration* describes the attraction of water molecules to different substances and impacts the solubility of these substances in water.
- a. You know from experience that salt, NaCl, dissolves well in water. Describe what happens at the molecular level as this takes place. What can you conclude about the strength of the chemical bond in NaCl versus the attraction of the Na⁺ and Cl⁻ ions for the water molecules?
 - b. What happens to the saline solution when it is boiled? Why?
 - c. How do you think the solubility of potassium chloride KCl and silver chloride AgCl in water compare to that of salt. Why?

4. Here we will look at some non-ionic compounds and how they react with water.
- a. Do metals such as aluminum, copper, or zinc dissolve in water? What can you conclude about the bonds holding metals together?
 - b. Ethanol (chemical formula $\text{CH}_3\text{CH}_2\text{OH}$) dissolves readily in water. Why? To which part of the ethanol molecule do the water molecules attach themselves? How does this compare/contrast to the chemical reaction which occurs when salt dissolves in water?

5. An example of a chemical reaction which is always fascinating to observe is a *precipitation reaction*. Here is an interesting example to consider.
- a. Silver Nitrate (chemical formula AgNO_3) is soluble in water. Why?
 - b. When a silver nitrate solution is combined with a potassium chloride solution, a white solid appears. What is the solid? What is happening in this reaction and why?