ACTIVITY 1.1 EXPLORING WATER'S POLARITY

<u>You will need</u>:

- copies of the following pattern pages, one per student or per pair of students if you are using lab partners
- scissors
- the video that goes with this activity (the link should be posted on the lesson page)

<u>Preparation</u>:

Print out the pattern pages. If you want to keep them for future use, consider printing them onto card stock. If color printing is not an option, print them in black and white. (You could add a touch of color using crayons or colored pencils.)

Cut out the molecules. If you have limited time, it will speed up the cutting process if you just approximate the outline, leaving a white edges a few millimeters wide around the outside. (You can watch the first minute of the video to see how they are cut out.)

PART 1: HOW WATER MOLECULES INTERACT WITH EACH OTHER (HYDROGEN BONDING)

Use the first part of the video that goes with this activity. This short written guide might be a help, though.

Each water molecule has a positive side and a negative side What happens when a bunch of water molecules get together? Place your water molecules out on the table and move them around imagining that they are interacting. Like charges repel, opposite charges attract. How will they arrange themselves so that they achieve maximum happiness for everyone?

The attraction between water molecules is called **<u>hydrogen bonding</u>**. It is a weak bond, weaker than the forces that keep the atoms in molecules together. When water boils or evaporates, the hydrogen bonds are broken and individual water molecules go floating off into the air. Hydrogen bonding can occur in other places, too, not just between water molecules. We will see hydrogen bonding when we study DNA.

PART 2: HOW WATER DISSOLVES SALT (SODIUM CHLORIDE)

Use the second part of the video that goes with this activity. These paragraphs will give you a preview of what to expect in the video.

Water is often called the "**<u>universal solvent</u>**" because it dissolves so many things. One of the many things it dissolves is salt. This is relevant to human physiology because your body tissues contain many dissolved salts. Your blood is somewhat salty, and your sweat is even saltier. How does water dissolve things on a molecular level? This activity will help you to figure it out for yourself.

Put the large salt crystal on the table. Then put some water molecules scattered around it. Will the water molecules be attracted to the salt crystal? Look at the positive and negative charges in the crystal. How will the water molecules react to those? Put the water molecules right next to the atoms in the crystal that they are being attracted to. The water molecules will pull at those sodium and chlorine atoms and eventually get them away from the crystal. Then more water molecules will come in and take more sodiums and chlorines away. Eventually the crystal will be gone. We will then say that it "dissolved" into the water.

Now let's see how the water molecules will react to all the individual sodiums and chlorines floating around. If just one water is attached to each sodium or chlorine, what would stop the sodium and chlorines from sticking to each other on the side where there is no water molecule? Nothing. So what can the water molecules do? They need to gang up on the sodiums and chlorines and surround them. Make your water molecules do this. Remember, "like" charges repel, opposites attract.

Water forms little "cages" around the sodium and chlorine atoms. This is good because on their own, sodium and chlorine are very dangerous elements. They are trying to obey that "Octet Rule" and get 8 electrons in their outer shell, but they are more desperate than most other atoms. They'll stop at nothing to give or get an extra electron. They'll even steal electrons from your body's essential molecules. Not good. Fortunately, water keeps them safely restrained. However, their intense reactivity, gives them electrical properties that are necessary for creating electricity in nerve cells. Very good! Sodium and chlorine atoms are dangerous but are also useful. Perhaps you can think of other things that are both good and bad at the same time.

PART 3: HCl AND NaOH

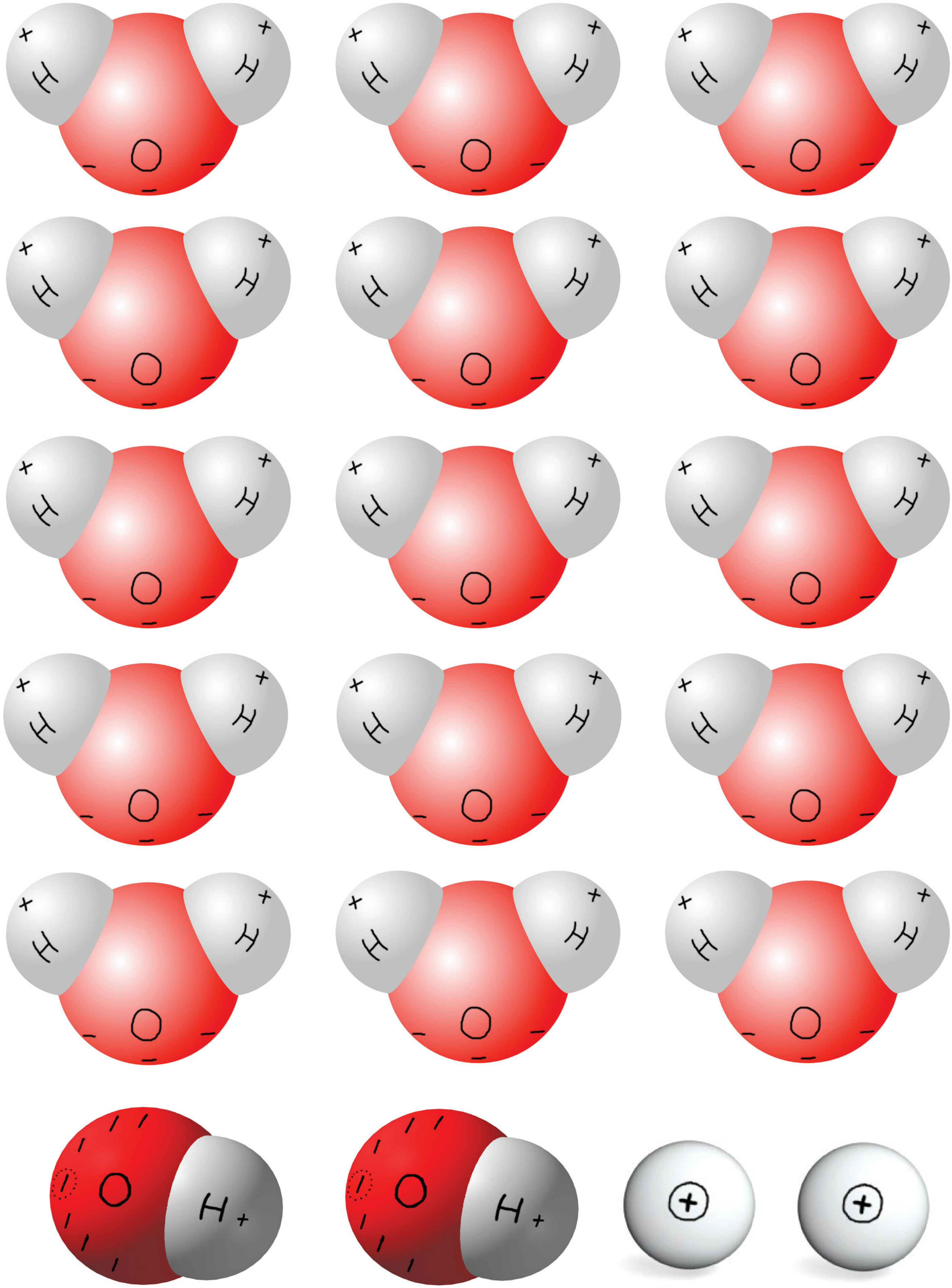
HCl is properly called **<u>hydrogen chloride</u>**, but is often called **<u>hydrochloric acid</u>**. Technically, HCl is not hydrochloric acid until it is dissolved in water, but since that is usually how meet HCl, the letters HCl are often used to represent hydrochloric acid. Your stomach cells make this acid to help your digestive enzymes (pepsins) break apart the proteins you eat. The HCl in your stomach creates a very acidic environment with a very low pH (around 2). When you vomit you get a taste of how acidic your stomach acid is. Hydrochloric acid can also be manufactured by chemical companies and is used to make plastics (especially PVC plastics), cleaning solutions, and food additives. 20 million tons of HCl are produced each year.

HCl is almost always found dissolved in water. Use your paper molecules to show which ends of the water molecules will pull at the H and the Cl. Then replace the HCl with the H+ and Cl- ions. Remember, water molecules form cages around Cl- ions. Surround the Cl- ions with water cages. Will cages form around the H+ ion? No. We learned that these are popping on and off water molecules all the time. They float freely around in and among the regular water molecules.

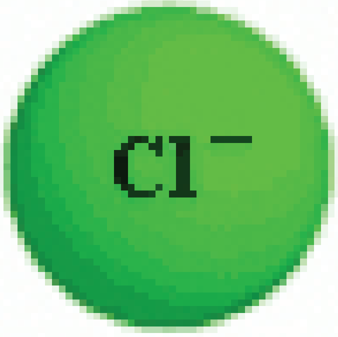
NaOH is **sodium hydroxide** (notice the presence of the hydroxide ion). Sodium hydroxide is NOT a body substance. Its common name is **lye** (or caustic soda) and it often comes in the form of a white powder or white pellets. It is very useful in the manufacturing of paper, textiles, soaps and detergents. Since it neutralizes acids, NaOH can be used to "scrub" the fumes that come out of factories (grabbing and trapping carbon dioxide and sulfuric acid molecules). In fact, it is so useful that 60 million tons of it are produced every year!

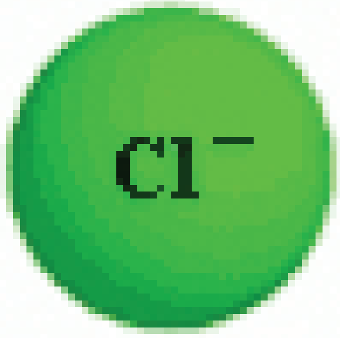
Will NaOH dissolve in water? Use your paper molecules to show which ends of the water molecules will be attracted to the Na side and the OH side. Then you can replace the NaOH molecules with Na+ ions and OH- ions. What will happen to the Na+ ions? They need to be insulated so they don't cause damage. Put water cages around them. Will the OH- ions need to be caged? Of course not. When a hydrogen leaves a water molecule, an OH- is left behind. It will float freely until if finds and H+ to join with.

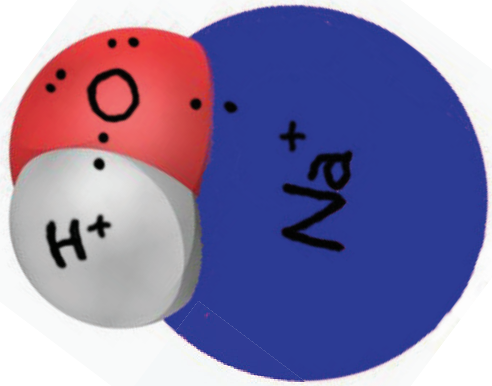
When NaOH dissolves in water, heat is released. You can feel this reaction if you put some dry laundry soap in your hand then add water. The water will feel hot at first, then it will cool down and feel slippery. Soaps are slippery because of their alkaline chemistry (the presence of OH-). Alkaline substances also taste bitter. Lick a bar of soap and you'll taste the bitter flavor of OH-.

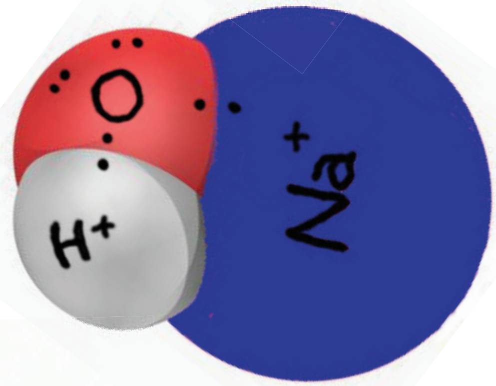


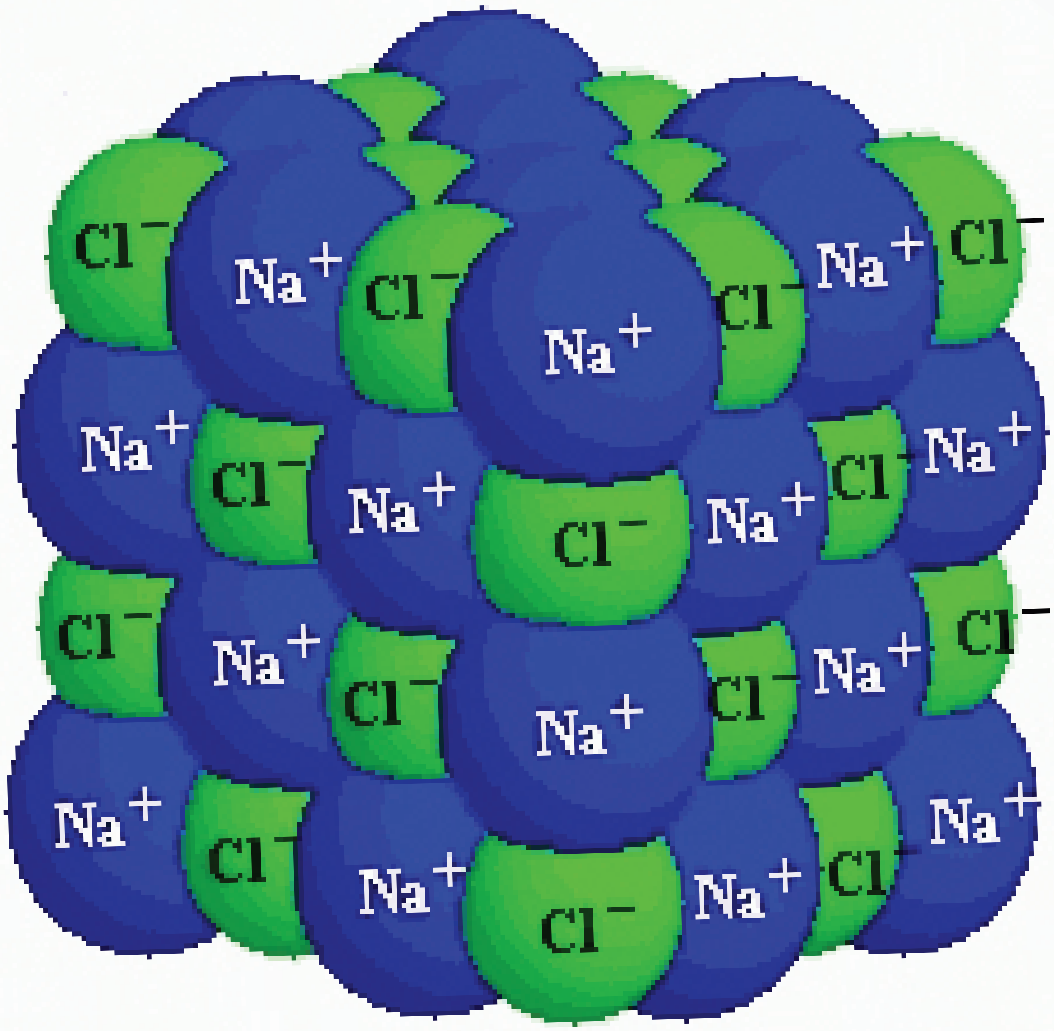
CUT THESE OUT AND SAVE THEM IN A PLASTIC BAG OR ENVELOPE FOR FUTURE USE.

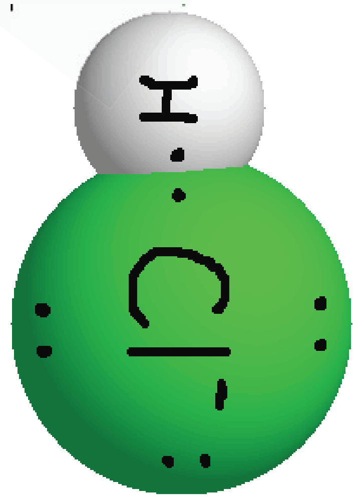


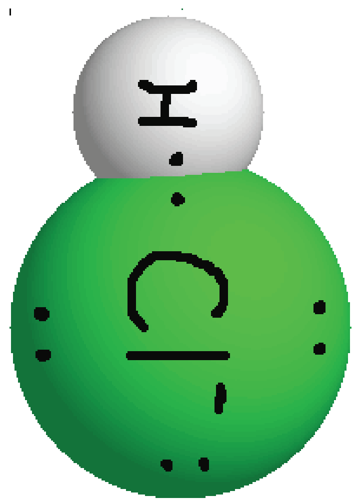












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