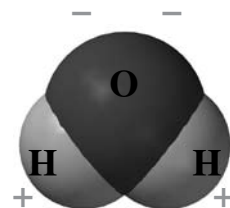


## What's going on here?

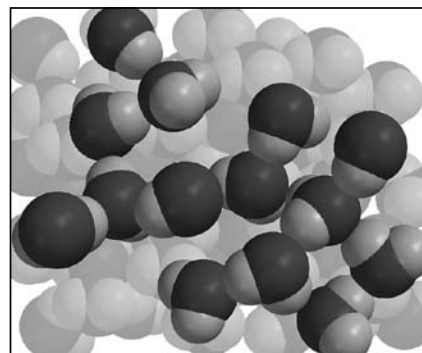
In this investigation you saw that, even though liquids may look very similar, they can act differently when you compare them on different types of paper. You placed the different liquids on wax paper, paper towel, and other papers and saw that you could see some differences between them based on how they clung together and beaded up or absorbed into the paper. You also mixed yellow liquids with blue water and saw differences in the way each liquid mixed with water. To understand why the liquids acted differently from one another, you have to think about them on the molecular level.

Because of the characteristics of oxygen and hydrogen and how they are bonded together in the water molecule, the area around the oxygen atom has a slight negative charge and the area around the hydrogen atoms has a slight positive charge. Since opposite charges attract, the positive part of one water molecule is attracted to the negative part of another water molecule.



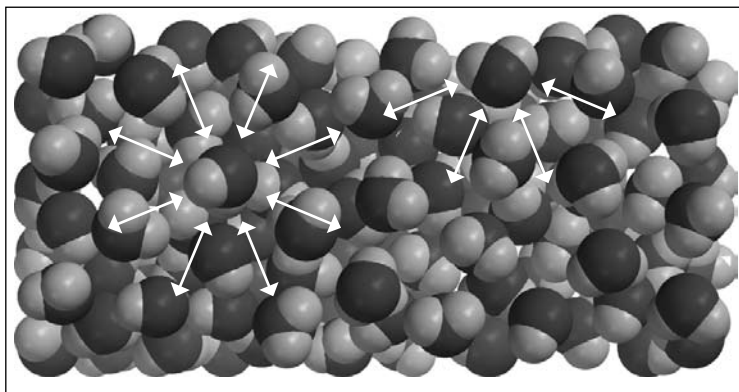
### The shape of things to come

In addition to having an area of positive and negative charge, a water molecule also has a very particular shape. It is kind of spread out like a wide “V”. The charged areas of the water molecule and this “V”-like shape allow a single water molecule to attract multiple water molecules at the same time. This allows water molecules to have a lot of attractions for each other. This combination of water's charged areas, unique shape, and attractions is what gives water some of its very interesting qualities.



### Why do water and salt water bead up on wax paper?

Water molecules are attracted in every direction by other water molecules and are more attracted to each other than they are to the wax paper. Also, the water molecules at the surface of a drop have no water molecules attracting them from above. These surface molecules can only be attracted down and in. Since they are attracted in a more uniform or consistent direction, they form a more stable arrangement at the surface called surface tension. Water's attraction to itself and its strong surface tension causes water to bead up instead of spreading out on the wax paper.



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

Salt water is made up mostly of water molecules, but it also contains dissolved salt. When salt dissolves, it separates into tiny positively and negatively charged particles called *ions*. These ions are very attracted to water. Since salt water beads up on wax paper, we know that the ions do not interfere with water's surface tension.

### **Why don't isopropyl alcohol and detergent solution bead up on wax paper?**

The isopropyl alcohol and the detergent solution used in this activity both contain water. Both the alcohol and detergent molecules have parts that are attracted to water. But they also have parts, made up of carbon and hydrogen atoms bonded together, which are not particularly attracted to water. These parts interfere with the interactions water molecules have for each other. This disrupts the water's surface tension and keeps these solutions from beading up on wax paper the way that water and salt water do.

### **Why do the liquids absorb into different papers in different ways?**

The way a liquid absorbs into a piece of paper has to do with the properties of the liquid and the properties of the paper. For example, one type of paper could have more or bigger pores than another. One reason why water-based liquids absorb into paper is because water is attracted to one of the main substances paper is made of—cellulose. The ability of a liquid to absorb into paper depends on how much the molecules of the liquid are attracted to the paper and how much the molecules of the liquid are attracted to each other. Each of the liquids is made up of different molecules, so they absorb into the papers differently.

### **Why do liquids evaporate at different rates?**

You may have observed the liquids evaporating at different rates from the different papers. Evaporation occurs when molecules of a liquid gain enough energy to break away from the rest of the liquid and move into the surrounding air. One of the main factors that affects the rate of evaporation is the amount of attraction the molecules of the liquid have for each other. When the liquids have absorbed into another material, in this case paper, the attraction between the molecules of the liquid and the molecules that make up the paper will also affect the rate of evaporation. The combination of these factors determines the different rates of evaporation for each liquid. Because each of the liquids is made up of different molecules, they evaporate at different rates.

### **Why do liquids look different when they combine with water?**

There are different reasons why mixing the yellow liquids with blue water looks different for each liquid. The yellow liquids are water, and solutions made from water mixed with salt, alcohol, or detergent. These solutions each have unique characteristics based on the interaction of water with the substance in the solution. They also have their own characteristic densities. When these solutions are then combined with water, they will mix with water in characteristic ways.

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

1. Why does water bead up on wax paper?

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2. Why doesn't detergent solution bead up on wax paper the way that water does?

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3. What are some of the factors that affect the rate a liquid evaporates from a surface?

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### **Cool factoid**

There is a famous “meeting of the waters” in Brazil where two rivers with very different colors run together for miles without apparently mixing. The faster, more powerful, and more dense brown river slips beneath the black river. The waters of these rivers eventually mix further downstream.