STEM IN THE LAB

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MAKE COLORFUL WALKING WATER!

Imagine this challenge: You have two glasses of water—one empty and one full. You want to pour half of the full glass into the empty one. The twist? You aren't allowed to pick up either glass! Can you get the water to "walk" between the glasses using nothing but a paper towel? Try this activity to find out!

At Idaho National Laboratory, chemistry is used frequently just like it is in this activity. For example, some chemists at INL use supercritical carbon dioxide, a sustainable solvent, to extract and separate targeted metals from various materials such as used nuclear fuel and end-of-life electronics.

GRADE LEVELS: K-8

VOCABULARY

Gravity- *the force that attracts a body toward the center of the earth, or toward any other physical body having mass.*

Surface tension*- the tension of the surface film of a liquid caused by the attraction of the particles in the surface layer by the bulk of the liquid, which tends to minimize surface area.*

Capillary action- *the ability of a liquid to flow in narrow spaces without the assistance of, or even in opposition to, external forces like gravity.*

MATERIALS

- *Odd number of clear glasses or cups (at least three)*
- *Water*
- *Food coloring*
- *Spoon*
- *Half-sheet paper towels (at least three)*

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PROCEDURE

PREP WORK

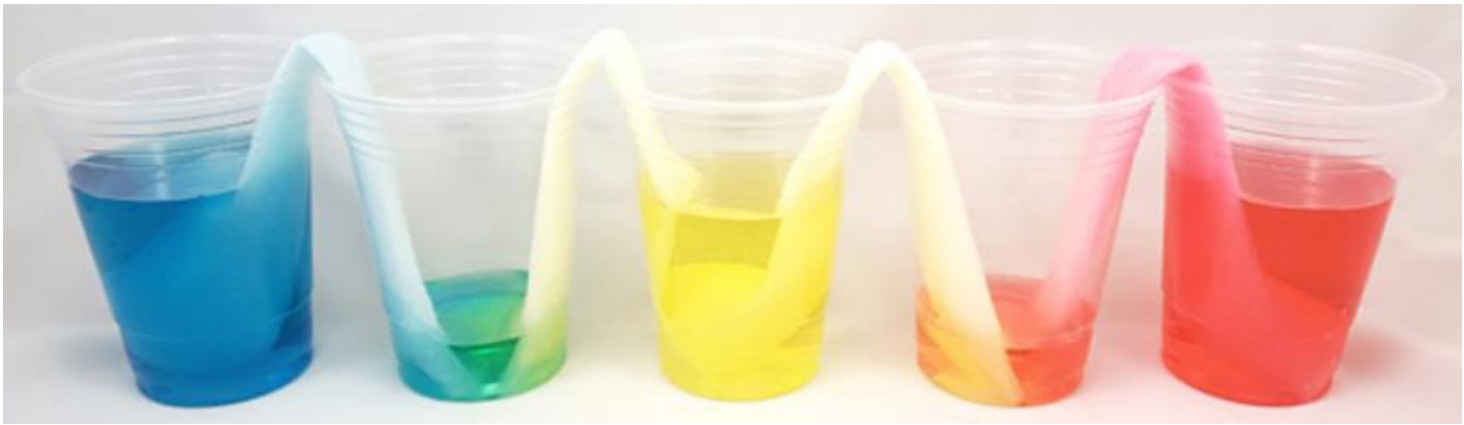
1. *Line up all your glasses in a row.*
2. *Starting with a glass on one end, fill every other glass with water.*
3. *Put a few drops of food coloring in each water-filled glass. You can choose what colors to use, but do not use the same color twice in a row.*
4. *Use the spoon to mix the food coloring in each glass. Use a paper towel to wipe off the spoon in between glasses, so you do not transfer the colors.*

INSTRUCTIONS

1. *Fold each half-sheet paper towel (except the one you used to clean the spoon) into a narrow strip about one inch wide.*
2. *Fold each paper towel in half lengthwise to form a "V" shape. The V should be only slightly taller than your glasses. If necessary, rip or cut a little bit off each end of the V to make it shorter.*
3. *Use one paper towel to connect each pair of adjacent glasses. (Flip the V shape upside-down and put one end in each cup.)*
4. *Look closely at the ends of the paper towels that are in the glasses with water. What do you notice?*
5. *Take a break! This experiment goes very slowly. Come back in 15 or 20 minutes. What do you see now?*
6. *Keep checking on your setup over the next couple of hours. What happens?*
7. *Let your test sit overnight and check on it the next day. What does it look like now?*

WHAT HAPPENED?

As soon as you place the paper towels in the glasses, you should notice they start to absorb some of the water. The water starts getting sucked up the paper towel due to something called capillary action (described in more detail in the Science Behind It section) and eventually starts going down the other side into the empty glass. This process happens very slowly though—it is like watching paint dry or grass grow! You might need to go do something else for a couple hours before you can start seeing water accumulate in the empty glasses. The water will eventually stop flowing when the water level in all the cups is even—but you will probably have to let it sit overnight before this happens. When two different colors of water mix, the food-coloring dyes combine to form a third color.



THE SCIENCE BEHIND IT

You've probably used paper towels to clean up spilled water or other liquids. Have you ever wondered exactly how they soak up so much water? Paper towels are made of many small fibers that have gaps in between them. Water gets pulled into these gaps by capillary action—the same phenomenon that allows trees to suck water out of the ground. This action is partially fueled by surface tension, which is caused by cohesion (water molecules being attracted to one another). Surface tension is what allows water to form beads instead of spreading out, and for some small insects to walk on water. It also allows water to get sucked up into narrow tubes or gaps in materials. The absorption process is also aided by adhesion (the attraction between different types of molecules). The paper towel fibers are made of cellulose, which also comprises wood and many plants. These fibers are polar, meaning they have a slight positive charge on one end and a slight negative charge on the other. Water molecules are also polar. Because opposite electric charges are attracted to each other, this results in the water molecules being attracted to the cellulose fibers. Ultimately, this means the water molecules can be sucked up through the paper towel and into an adjacent cup. After going over the top, the way back down is a little easier since this time they are aided by gravity. As you noticed, this process is very slow!

EXTENSIONS

- *Try placing your cups in different arrangements instead of a straight line. For example, what happens if you connect three cups, initially filled with water, to an empty fourth, central cup?*
- *What happens if you use a paper towel to connect two cups that are initially filled to different heights with water?*

RESOURCES

- *https://www.sciencebuddies.org/stem-activities/walking-water#summary*
- *https://www.sciencebuddies.org/stem-activities/dyed-flowers-capillary-action*

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