

CAN WATER BE STICKY?

**A STORYTIME ABOUT PROPERTIES OF WATER,
ESPECIALLY ADHESION AND COHESION**

LESSON PLAN



Wisconsin Water Library
UNIVERSITY OF WISCONSIN-MADISON

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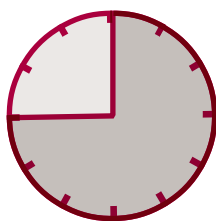
CAN WATER BE STICKY?

A STORYTIME ABOUT PROPERTIES OF WATER, ESPECIALLY ADHESION AND COHESION

LESSON PLAN

The objectives of this lesson plan are to recognize and understand a few important properties of water: adhesion/cohesion, capillary action and surface tension.

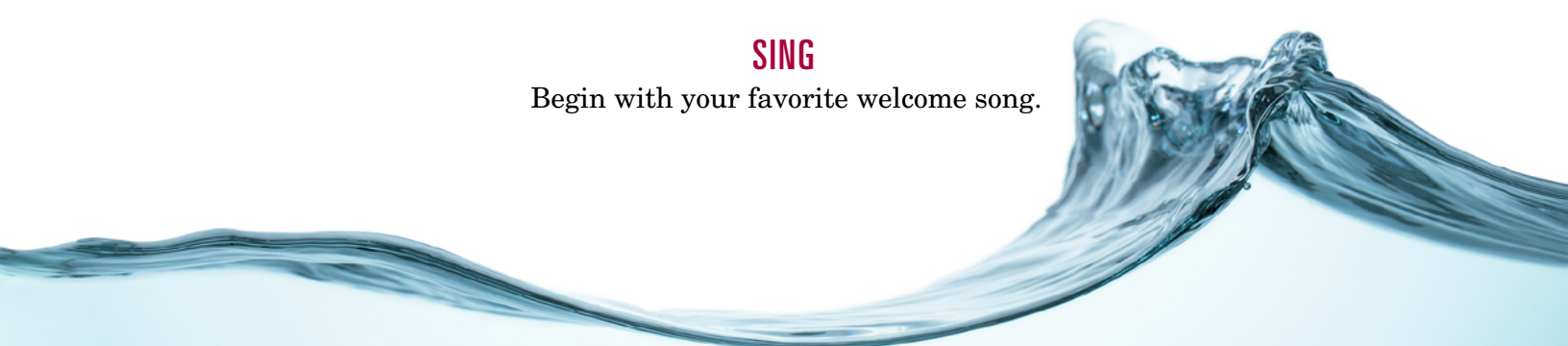
For more information about water, see our other Wisconsin Water Library lesson plans “All the Water in the World” and “Ride the Water Cycle” or our traveling STEM kit “Does It Sink or Float?”



This lesson plan works well with children in preschool through second grade. The lesson lasts from 45 minutes to an hour and a half, based on the number of books read and the number of experiments conducted. To orient the children to what it means to be a scientist, think scientifically and “do science,” use the “[A Scientist Is...](#)” and “[Scientific Method](#)” handouts available at the end of this lesson plan.

SING

Begin with your favorite welcome song.



SCIENCE CHAT

Note for Librarians/Teachers

The basic properties of water — cohesion, adhesion, surface tension and capillary action — are a pretty complex subject for young children, but we’ve found that they do develop a basic understanding of the properties and that exploring the science underlying such an everyday element as water can be inspirational.

Full-page illustrations at the end, pages 17-20, may be useful for display while you chat with the children.

Children at this age sometimes do not know what a “property” is. Discussing the physical properties of the children in the room (curly hair, brown eyes, blond hair, etc.) can help them understand the concept.

What Is Water?

Water isn’t very interesting. It’s just water, right? Then what makes water soak up into a paper towel? Why does it form drops? Could plain water actually be “sticky”?

It turns out that water has many interesting properties — including cohesion, adhesion, capillary action and surface tension. These properties all work together to make water behave the way it does.



Water on a leaf forms the spherical shape of a droplet because of cohesion, and the droplets cling to the leaf because of adhesion.

How Do We Interact With Water?

Think of the shape of a drop of water falling through the air (and see the illustration on page 17). The water molecules are attracted to each other (**cohesion**) to form a spherical shape — a drop. If you spill a glass of water, cohesion (water molecules sticking to themselves) keeps the water in a puddle.



COHESION WATER STICKS TO ITSELF

Water molecules are attracted to each other. This property is what allows water to form a drop that maintains a spherical shape without coming apart.





Have you seen droplets of water on a plant or a window? Those drops stick to plant leaves or windows because the water molecules also stick to other molecules, which is called **adhesion**.

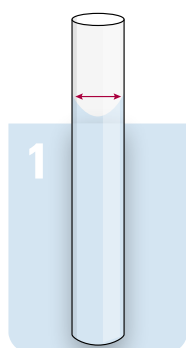
Adhesion (water sticking to other molecules) also lets you mop up spills. (Photo on page 18.)

ADHESION WATER STICKS TO OTHER THINGS

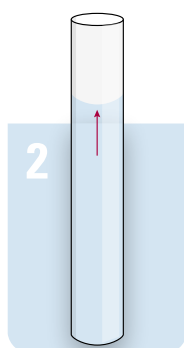
Water molecules are also attracted to other substances. Adhesion causes water to soak into fabric, like clothing or a towel, or cling to plants or windows.



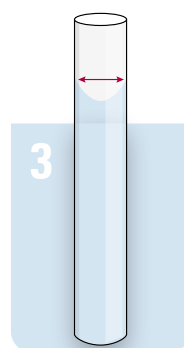
Another property — **capillary action** — is necessary to allow that simple action of wiping up a spill. Have you ever washed your hands and discovered water rising up the fabric of your shirt sleeves? That is capillary action at work. (Photo on page 20.) When the fabric touches the water, the water molecules are attracted to the fabric fibers (adhesion). Imagine that the fibers of the cloth are tiny tubes. The water is sucked into the tube because adhesion means the molecules are attracted to the sides of the tube. Then the water is attracted back to itself, which pulls it into the center of the tube. Then the water is attracted to the sides of the tube, which pulls it up the side of the tube. This cycle repeats until the water is as high as it will go.



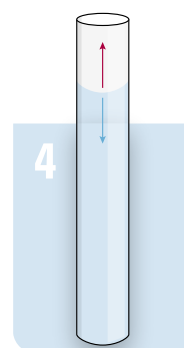
1
Water sticks to the glass walls.



2
Surface tension (water sticking to itself) pulls the liquid up.



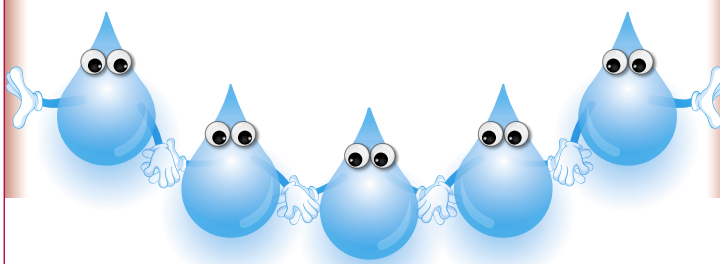
3
As the liquid is pulled up, adhesion to the sides causes it to rise.



4
When the push and pull of surface tension and adhesion are exactly balanced, the water stops rising.

CAPILLARY ACTION A BALANCING ACT

Capillary action is the result of cohesion, adhesion and surface tension. Capillary action occurs when the adhesion to tubular walls is stronger than the cohesive forces between the liquid molecules. The height to which capillary action will take water in a circular tube is limited by surface tension and, of course, gravity.



The way water pulls back as it is attracted to itself is called **surface tension**. Water sticking to itself creates a surface that is strong enough to hold tiny insects and even paper clips. (See page 19.)



SURFACE TENSION WATER STICKS TO ITSELF

Water coheres (sticks to itself) strongly, which means that water has a high surface tension. As those water molecules stick together, they form a surface solid enough that some things (like this paper clip) can't break through, so they float on top.



FACTS AND FIGURES ABOUT WATER

Water is unique in that it is the only natural substance found in all three physical states — liquid, solid, and gas — at the temperatures normally found on Earth.

Water freezes at 32° Fahrenheit (F) and boils at 212°F (at sea level, but 186.4° at 14,000 feet). Water is unusual in that the solid form, ice, is less dense than the liquid form, which is why ice floats.

Air pressure affects the boiling point of water, which is why it takes longer to boil an egg in Denver, Colo., than at the beach. The higher the altitude, the lower the air pressure, the lower the boiling point of water, and thus, the longer time to hard-boil an egg. At sea level water boils at 212°F (100°C), while at 5,000 feet, water boils at 202.9°F (94.9 °C).

Water is called the “universal solvent” because it dissolves more substances than any other liquid. This means that wherever water goes, either through the ground or through our bodies, it takes along valuable chemicals, minerals and nutrients.

Pure water, which you won’t ever find in the natural environment, does not conduct electricity. Water becomes a conductor once it starts dissolving substances around it.

Pure water has a neutral pH of 7, which is neither acidic (<7) nor basic (>7).

The water molecule is highly cohesive — it is very sticky. Water is the most cohesive among the non-metallic liquids.

Water has a high specific heat index — it absorbs a lot of heat before it begins to get hot. This is why water is valuable to industries and in your car’s radiator as a coolant. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.

The density of water means that sound moves through it long distances (ask a whale!). In sea water at 30°C, sound has a velocity of 1,545 meters per second (about 3,500 miles per hour).

Some of water’s physical properties:

- Weight: 62.416 pounds/cubic foot at 32°F; 1,000 kilograms/cubic meter
- Weight: 61.998 pounds/cubic foot at 100°F; 993 kilograms/cubic meter
- Weight: 8.33 pounds/gallon; 1 kilogram/liter
- Density: 1 gram/cubic centimeter (cc) at 39.2°F, 0.95865 gram/cc at 212°F

READ

I Get Wet (2002) by Vicki Cobb, illustrated by Julia Gorton.

“Kids who wonder why their fingertips get wrinkly in the bathtub will find the answer to this question and other scientific stumpers in this simple but not simplistic study of the ways of water. In this volume [Cobb] explains the most basic properties of water: how it flows, adheres to itself but not to waxed or oiled surfaces, and how it is absorbed through skin.” (Kirkus Reviews)

For ages 3-6.

Small Elephant's Bathtime (2015) by Tatyana Feeney.

“... Small Elephant loathes bathtime, even when his mommy adds extra bubbles and toys. His boxy body, dot eyes and wide-set ears all telegraph absolute opposition to watery fun in the tub. Bright, bleach-white backgrounds and a limited palette of primary reds, blues and graphite grays make Small Elephant's flat pencil-outlined form and his fierce refusal of bath quite vivid. Charming, brilliant in color and execution, and funny to even the most indignant foot stompers, NO! screamers and bathtime boycotters.” (Kirkus Reviews)

For ages 2-6.

Little Bird Takes a Bath (2015) by Marisabina Russo.

“Little Bird does not like rain at all, so he always hunkers down in his nest on rainy days, thinking about tomorrow. And after a rainy day, tomorrow generally means puddles and the opportunity for Little Bird to take a bath. After he finds just the right puddle, his bath is continually interrupted, first by children playing ball, then by a girl jumping in puddles, and finally by a dog. By the time everyone is gone, so, too, is his puddle, so he has to find another source of water for his bath. Short but lyrical sentences are accompanied by engaging gouache illustrations that show Little Bird as the center of his urban universe.” (CCBC)

For ages 2-4.

Tap Tap, Boom Boom (2014) by Elizabeth Bluemle, illustrated by G. Brian Karas.

“‘Sky grumbles. Rain tumbles. Big weather — you’d better ... get under umbrella! BOOM BOOM.’ A rainstorm in the big city on a summer day means the appearance of umbrellas, a mad dash for the subway, and a spontaneous, generous-spirited gathering belowground. The visual storytelling accompanying the narrative enables readers and listeners to follow a number of individuals as the storm breaks, booms, and eventually moves away. A delight to read aloud, there is ample opportunity for enthusiastic participation with the repetitive onomatopoeia, while the finely crafted rhyming phrases create a satisfying narrative arc.” (CCBC) Honor Book, 2015 Charlotte Zolotow Award.

For ages 3-7.



SING

Use any song you like adapted to the theme of water properties. Here's one suggestion with the theme of bath time, towels and absorption:

“After a Bath” from “The Complete Book of Rhymes, Songs, Poems, Finger Plays and Chants” by Jackie Silberg and Pamela Schiller

After a bath I try, try, try

To wipe myself dry, dry, dry
(rub upper arms with hands)

Hands to wipe and fingers and toes
(hold hands out, palms up, then point to toes)

Two wet legs and a shiny nose
(hands on thighs then point to nose)

Just think how much less time I'd take

If I were a dog and could shake, shake, shake.
(shake body)



MOVE

A watery version of *Simon Says*

Remember:

Cohesion: Water molecules are attracted to each other. This property is what allows water to form a drop that maintains a spherical shape without coming apart.

Adhesion: Water molecules are also attracted to other substances. Adhesion causes water to soak into fabric, like clothing or a towel, or cling to plants or windows.

To play the game:

- ① Explain that each player's hands have turned into water molecules.
- ② The directions to the players will be to cohere (clap) or adhere (hands on hips) their "water hands."

Simon says, "cohere."
(*clap hands together*)

Simon says, "adhere."
(*touch hands to hips*)

- * To make the game more challenging, add an object/body part that the player is supposed to adhere to.

Example: Simon says, "adhere, nose."
(*Touch hands to nose*)

DO SCIENCE

EXPERIMENT #1: ESCAPING WATER AND CAPILLARY ACTION

Review the information about capillary action on page 5.

Source: sciencekids.co.nz/experiments/escapingwater

Supplies needed:

Water

Food coloring

Paper towels

Short glasses



How to:

- ① Twist a couple of pieces of paper towel together until they form something that looks a little like a piece of rope. This will be the “wick” that will absorb and transfer the water (a bit like the wick on a candle transferring the wax to the flame).
- ② Place one end of the paper towel rope into the glass filled with water and the other into the empty glass.
- ③ Your paper towel rope will start getting wet. After a few minutes you will notice that the empty glass is starting to fill with water, and it will continue filling until there is an even amount of water in each glass. How does this happen?

What’s happening?

Through capillary action, the water moved along the tiny gaps in the fiber of the paper towels. It occurs due to the adhesive force between the water and the paper towel being stronger than the cohesive forces inside the water itself.

EXPERIMENT #2: PEPPER, SOAP AND SURFACE TENSION

Water coheres to itself in what is called surface tension. This creates a “tough” surface that some things (like pepper) can’t break through, so they float on top.

Source: education.com/science-fair/article/pepper-and-soap-experiment

Supplies needed:

Water

Pepper

Dish soap

Toothpicks

Plates for soap

Bowls

How to:

- ① Pour an inch or so of water into a bowl and sprinkle pepper evenly across the surface.
- ② Place a dab of soap on a plate and touch the tip of the toothpick to the soap (you only need a tiny amount).
- ③ Touch the toothpick to the center of the surface of the water.



What's happening?

Why do the flakes float on top of the water? Water molecules like to stick together. They line up in a certain way that gives the top of the water surface tension. Because pepper flakes are so light, surface tension keeps them floating on top.

Why does the pepper shoot to the sides when soap touches the water? Soap is able to break down the surface tension of water — that's part of what makes soap a good cleaner. As the soap moves into the water, and the surface tension changes, the pepper no longer floats on top. But the water molecules still want to keep the surface tension going, so they pull back away from the soap, and carry the pepper along with them.

CRAFT

WATERCOLOR & SALT

This art project will give us another chance to observe how water interacts with another substance ... salt! Think about how salt may interact with water. What do you think will happen? How do you feel after eating salty chips or popcorn? (thirsty) For the project we'll paint a picture using watercolor paints then sprinkle different kinds of salt on it to test our hypothesis.

Supplies needed:

Watercolor paints and paint brushes

Cups of water

A variety of salt (table, coarse, rock, etc.)

Paper

Set-up:

Distribute paper to all participants and place watercolor paints and containers of the different kinds of salt where everyone can reach. Start painting!

What's happening?

Salt absorbs the water but leaves the colored pigment behind.
Did it look different on dry paint compared with wet paint?
Did different types of salt look different?



LEARN MORE ABOUT

THE PROPERTIES OF WATER

Water Properties by the U.S. Geological Survey

water.usgs.gov/edu/waterproperties

How Water Works

science.howstuffworks.com/environmental/earth/geophysics/h2o

YouTube Crash Course on the properties of water

youtube.com/watch?v=HVT3Y3_gHGg

“Properties of Water” short video by the Amoeba Sisters

youtube.com/watch?v=3jwAGWky98c

SCIENTIFIC METHOD



A SCIENTIST IS SOMEONE WHO...

- Observes and wonders
- Asks questions
- Listens to ideas of others
- Conducts experiments
- Shares their ideas and discoveries
- Explores the world around them
- Uses tools to solve problems

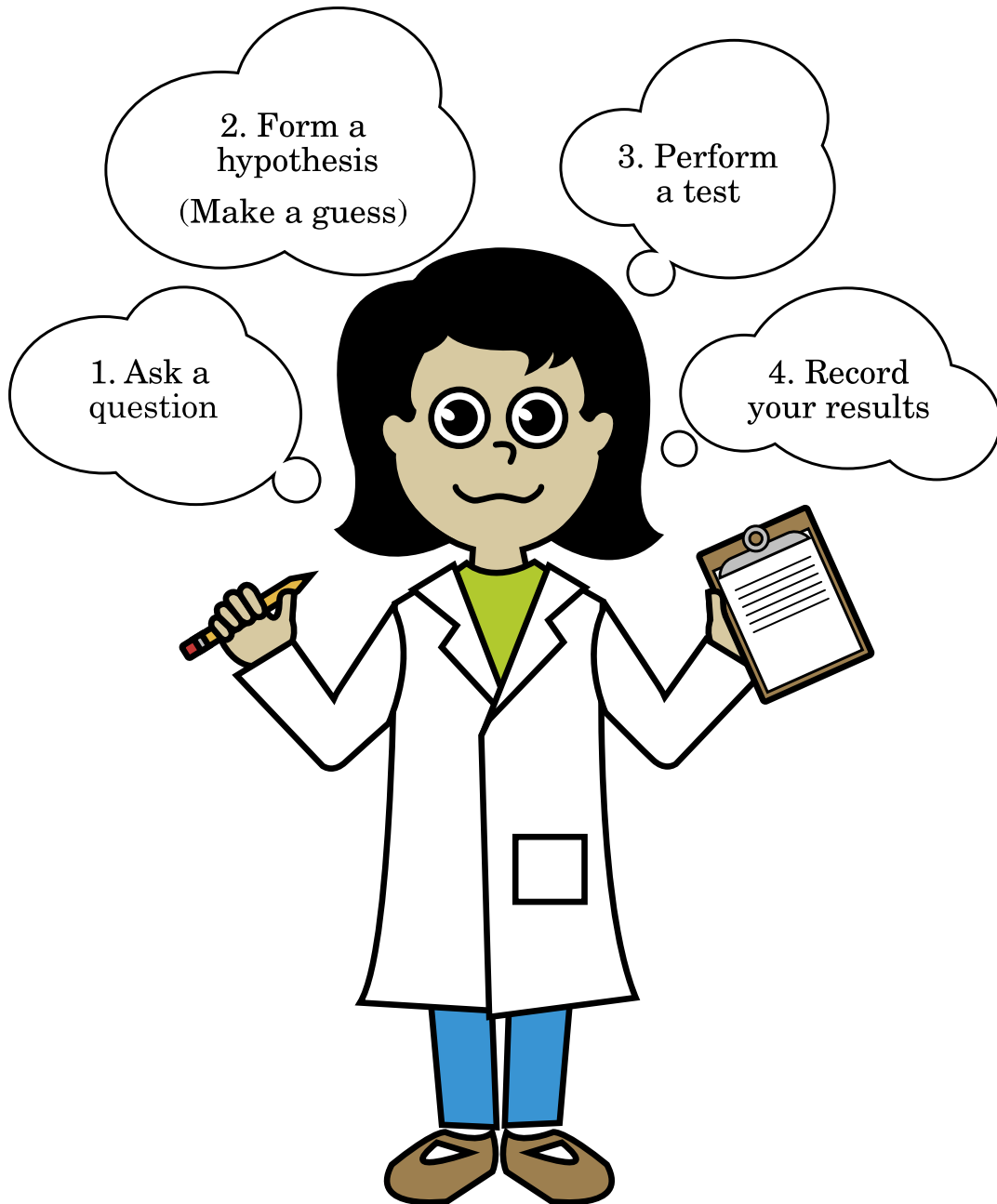
A SCIENTISTS SAYS...

- I agree with you because...
- I disagree with you because...
- Why do you think that?
- So, what you're saying is...
- Can you tell me more?
- Can you give me an example?
- How could we test that?
- That reminds me of...



SCIENTIFIC METHOD

THINK LIKE A SCIENTIST





Cohesion

Water coheres to itself to form a drop shape.



Adhesion

A mop or a rag works to absorb water because adhesion causes water molecules to stick to other surfaces, like the mop or rag.



Surface Tension

Because water coheres (sticks to itself), the water molecules form a surface solid enough so that some things can float on top.



Capillary Action

Look closely and you can see where the fabric on this person's pants is darkened with water absorbed by capillary action. Capillary action is caused by a combination of adhesion and surface tension (which is caused by cohesion). Adhesion causes the water molecules to cling to the fabric, and surface tension causes the water to move back toward itself. This tension between the properties causes water to rise.



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