

Lesson 1: The Hydrosphere and the Nature of Water

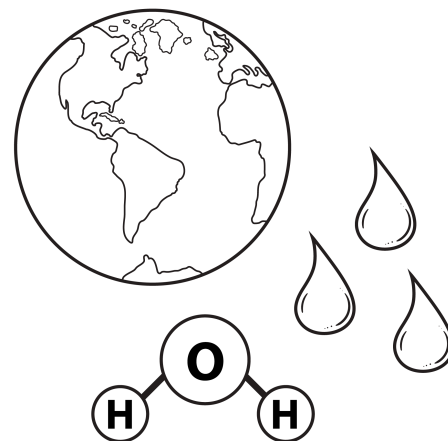
☐ Getting Started

Take a look around you. Water is everywhere: flowing from faucets, filling lakes and oceans, falling from the sky, and even inside your own body. In fact, Earth is often called the "water planet" or "blue planet" because so much of its surface is covered in water. But have you ever stopped to wonder *why* water behaves the way it does?

Why does it form droplets instead of spreading out flat?

Why can some insects walk on it?

Why does ice float instead of sink?



The answers to these questions all begin with something incredibly small: a single water **molecule**.

In this lesson, you'll zoom in to explore what water is made of and how its tiny structure gives it some very powerful and unusual properties. These properties don't just affect a drop of water on a penny; they help shape oceans, support life, and influence the entire **hydrosphere**. By the end of this lesson, you'll start to see water not just as something you use every day, but as a substance with unique characteristics that make life on Earth possible.

Stuff You Need

- *Water: The Story of the Hydrosphere, 2nd Edition* by Lynne Z. Petkovic, M.Ed., J.D.
- clay, Play-Doh, Styrofoam balls, grapes, raspberries, blueberries, cubes of cheese, or other small objects (Option 2)
- cup of water
- cup or shallow bowl of water
- dish soap
- eye dropper (kit)
- ground black pepper
- penny (kit)
- toothpicks, small sticks, wire, paper clips, skewers, dry spaghetti, or similar material (Option 2)

Ideas to Think About

- How do the properties and structure of water impact Earth's systems?

Things to Know

- The **hydrosphere** is the Earth system that includes all the water on Earth, including oceans, lakes, rivers, groundwater, ice, and water in the atmosphere.

- Water is made of molecules, and each water molecule is made of two hydrogen atoms and one oxygen atom (H₂O).
- Water molecules are always moving and are constantly interacting with other water molecules.
- **Polarity** means that a molecule has a slightly positive end and a slightly negative end.
- Water is a polar molecule, which means its positive and negative ends affect how it interacts with other molecules.
- **Cohesion** is the attraction between molecules of the same substance, such as water molecules sticking to each other.
- **Adhesion** is the attraction between molecules of different substances, such as water sticking to glass.
- **Surface tension** is a property of water that allows its surface to resist being broken or stretched.
- Surface tension is caused by cohesion, which pulls water molecules together at the surface.

☐ Reading and Questions

Read Chapter 1 in the book *Water: The Story of the Hydrosphere* and watch the following video. Then, answer the questions.

1. What is the hydrosphere?

2. Why does saltwater have a greater density than freshwater?

3. How do the properties of water help support life on Earth? Use at least one example from the chapter or the video.



How Polarity Makes Water Behave Strangely

www.beyondthepage.com/link/13331/

Activities

☐ Activity 1: The Water Molecule

In today's reading, you learned that water is made of tiny particles called molecules and that those molecules have special properties like polarity, cohesion, and surface tension. But even though water is all around us, we can't actually see a single water molecule. So how do scientists study something that small?

They build models.

Models help scientists visualize and explain things that are too small to observe directly. In this activity, you will develop your own model of a water molecule to better understand how it is structured and why it behaves the way it does. This is exactly what scientists do when they study matter. You will create a model that shows:

- the atoms that make up water
- the shape of the molecule
- and how its positive and negative sides affect how it interacts with other molecules

Ask your parent which option of this activity to complete.

Option 1: Draw a Water Molecule Model

You will create a detailed drawing of a water molecule. Start by drawing one water molecule. Remember that water is made of two hydrogen atoms and one oxygen atom. The oxygen atom is in the center, with the two hydrogen atoms attached. Many students find it helpful to picture a "Mickey Mouse©" shape, where the oxygen is the head and the hydrogens are the ears.

Using the "Water Molecule" (Option 1) activity sheet, you will label the following parts of the water molecule:

- Hydrogen atom (H)
- Oxygen atom (O)

Now add the idea of polarity. Label the oxygen side as slightly negative (–) and the hydrogen side as slightly positive (+). This shows that water is a polar molecule.

Once your single molecule is complete, draw several water molecules (at least four to six). Show how they line up when they are close together. Because opposite charges attract, the positive side of one molecule should be near the negative side of another. As you finish your model, think about what it shows. How does polarity explain why water molecules stick together?

Option 2: Build a Water Molecule Model

Instead of drawing, you will build a three-dimensional model of a water molecule using materials you have at home. For the atoms, you might use clay, Play-Doh, Styrofoam balls, grapes, raspberries, blueberries, cubes of cheese, or other small objects. To connect the atoms, you might use toothpicks, small sticks, wire, paper clips, skewers, dry spaghetti, or similar materials.

Create one water molecule with:

- one oxygen atom in the center
- two hydrogen atoms attached

Once your model is built, label or mark the positive + and negative (–) sides to show polarity. The oxygen side should be slightly negative, and the hydrogen side should be slightly positive.

Now, build or arrange several water molecules together. Position them so that the positive side of one molecule is near the negative side of another. This will help you model how water molecules are attracted to each other through cohesion.

After completing your model, share it with a parent or adult. Explain how your model shows the structure of a water molecule, including the atoms and the positive and negative sides. Then, use your model to explain your answers to the questions: Why do water molecules stick together? How does polarity cause this to happen? As you explain, try to point to specific parts of your model to support your thinking, just like a scientist would when presenting a model.

☐ **Activity 2: How Many Drops Can You Fit? A Surface Tension Investigation**

In the last activity, you drew or built a model of a water molecule and learned that water is polar. You also saw how this polarity causes water molecules to stick to each other, a property called **cohesion**. Now it's time to see that idea in action.

Imagine placing a single drop of water on a penny. Now another. And another. At some point, you might expect the water to spill over the edge, but something

surprising happens. The water actually forms a raised dome before it finally spills! Why does that happen?

Cohesion does more than cause water molecules to stick together. At the surface of water, cohesion creates a thin "skin" called **surface tension**. Surface tension is the tendency of water molecules at the surface to pull toward one another. This allows water to form rounded droplets and helps explain why water can pile up into a dome on top of a penny before spilling.

Dish soap is used in this investigation because it interferes with the attraction between water molecules, reducing cohesion and surface tension. Scientists sometimes study substances like soap because certain pollutants can also change the properties of water, although pollutants affect water in many different ways.

Cohesion is important on a much larger scale than a penny experiment. In clouds, tiny water droplets must stick together and grow larger before they become heavy enough to fall as rain. Without cohesion, it would be much more difficult for water to return to Earth's surface through precipitation, making freshwater less available for plants, animals, and people.

Using the activity page titled "Surface Tension Investigation," you will explore how cohesion creates surface tension and allows water to behave in unexpected ways.

☐ **Activity 3: The Pepper Problem – Breaking Surface Tension (Optional Activity)**

In the last activity, you discovered that water can form a dome on a penny because of **surface tension**. This happens because water molecules are attracted to each other through **cohesion**. But what happens when that attraction is disrupted?

The soap in this investigation will disrupt the attraction between water molecules, causing the surface tension to weaken. In the real world, some forms of pollution can also affect the way water molecules interact. Scientists study these effects because changes in water properties can affect natural systems. Cohesion and surface tension are important for many processes on Earth, including the formation of water droplets in clouds. When water molecules stick together, tiny droplets can grow larger until they become heavy enough to fall as precipitation, returning freshwater to Earth's surface.

In this activity, you'll see surface tension break right before your eyes. Follow the directions on the page titled "The Pepper Problem."

Wrapping Up

Today, you explored what water is made of and why it behaves in such unique ways. You learned how the structure of a water molecule leads to properties like polarity, cohesion, and surface tension, and you even saw those ideas in action. Now, start thinking bigger.

How might these properties affect how water moves, mixes, or is stored on Earth? In the next lesson, you'll build on what you learned today by exploring how density and salinity affect water behavior and how these properties help explain how water moves through oceans and other parts of the hydrosphere.

Life Application: What if Water Changed? A Real-World Science Challenge (Optional)

Consider the following scenario.

You are an ocean scientist (oceanographer) who has discovered a major problem. Water molecules that freeze and form ice no longer float. Instead, they sink. As a result, oceans, lakes, and ponds are beginning to freeze from the bottom up. As you investigate, you discover that the **polarity** of water molecules has changed, and water molecules are no longer polar. What effects do you think this change would have on life on Earth? Think about aquatic ecosystems, weather, freshwater availability, and the survival of plants and animals. Explain your ideas to a parent using evidence from what you have learned about the properties of water.

First, you may want to watch the following video to review the properties of water.



Properties of Water

www.beyondthepage.com/link/13332/

WATER MOLECULE

How does polarity explain why water molecules stick together?

Surface Tension Investigation

PART 1: First Investigation

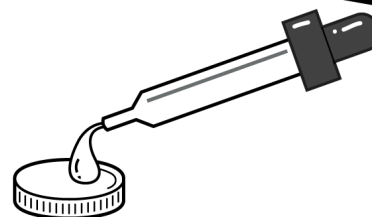
Materials

- Penny
- Dropper
- Cup of water
- Dish soap

1. Make a prediction: How many drops of water do you think a penny can hold? _____
2. Place your penny on a flat surface.
3. Add water one drop at a time. Count each drop carefully.
- 4.

Record how many drops the penny holds before the water spills.

Trial #	# of Drops
1	
2	
3	



5. What did you notice about the shape of the water as it built up on the penny? _____

PART 2: Change a Variable

Dish soap interferes with the attraction between water molecules. By adding soap, you will test what happens when cohesion and surface tension are weakened.

Record how many drops the penny holds before the water spills.

Add 1 drop of dish soap to your cup of water and gently mix.

Trial #	# of Drops (soapy water)
1	
2	
3	



PART 3: Compare Your Results



1. Did the number of drops increase or decrease with soap? _____
2. Why do you think that happened? _____

PART 4: Think Like a Scientist



1. Why does water form a dome on the penny? _____
2. What causes surface tension? _____
3. How does polarity help explain what you observed? _____

The Pepper Problem

Materials

- cup or bowl of water
- black pepper
- dish soap

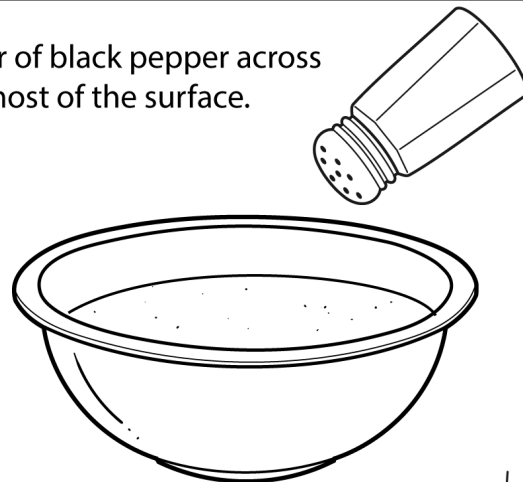
Your Investigation

Fill a cup or shallow bowl with water. Sprinkle a light layer of black pepper across the surface of the water. Try to spread it out so it covers most of the surface.

Look closely. The pepper floats on top of the water instead of sinking. This is because the surface of the water is acting like a thin "skin" due to surface tension.

Now comes the surprising part. Dip your finger in a small drop of dish soap. Then gently touch the center of the water's surface.

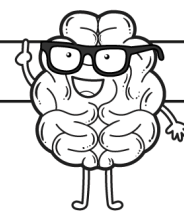
Watch what happens.

**What Did You Observe?**

Write down what happened to the pepper when the soap touched the water.

**Think Like a Scientist**

Use what you know about water molecules to explain what you saw:



1. Why was the pepper able to float on the water at first? _____

2. What happened when the soap touched the water? _____

3. Why did the pepper move so quickly away from the soap? _____

Lesson 1: The Hydrosphere and the Nature of Water

Getting Started

✿ Ideas to Think About

- How do the properties and structure of water impact Earth's systems?



Things to Know

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- **Surface tension** is a property of water that allows its surface to resist being broken or stretched.
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Reading and Questions

1. What is the hydrosphere?

The hydrosphere is the Earth system that includes all the water on Earth, including oceans, lakes, rivers, groundwater, ice, and water in the atmosphere.

2. Why does saltwater have a greater density than freshwater?

Saltwater has a greater density because dissolved salts add extra matter to the water. This means more matter is packed into the same amount of space.

3. How do the properties of water help support life on Earth? Use at least one example from the chapter or the video.

Answers will vary. A strong answer might explain that cohesion helps water form raindrops, adhesion helps water move through plants, or surface tension allows small organisms such as water striders to move across the water's surface. These properties help water support living things and connect Earth's systems.

● Skills

- Develop and use a model to describe the atomic composition and structure of a water molecule. (MS-PS1-1) (S)
- Use a model to explain how the arrangement of atoms in a water molecule leads to properties such as polarity, cohesion, and surface tension. (MS-PS1-1) (S)
- Analyze and interpret data from investigations to identify patterns in how water behaves. (Science & Engineering Practice) (S)
- Analyze evidence to explain observations, make inferences and predictions, and develop the relationship between evidence and explanation. (S)

- Identify and create questions and hypotheses that can be answered through scientific investigations. (S)
- Use oral and written language to communicate findings. (S)

Introducing the Lesson

In this lesson, your child will explore the structure of water at the molecular level and how that structure gives water its unique properties. She will learn about concepts such as polarity, cohesion, and surface tension, and investigate how these properties influence the behavior of water in the hydrosphere. Through reading, modeling, and hands-on activities, your child will begin to connect microscopic ideas about molecules to large-scale effects on Earth, building a foundation for understanding how water supports life and shapes Earth's systems.

Special Note: In this unit, your child will complete a final project that involves investigating a local water source. As part of this project, he will need to visit a nearby location (such as a pond, lake, river, canal, or shoreline) and collect a small water sample. You may want to begin thinking about a safe and accessible location in your area and plan a time to visit it later in the unit. Your assistance will be important during the sample collection to ensure it is done safely, especially near deep or moving water.

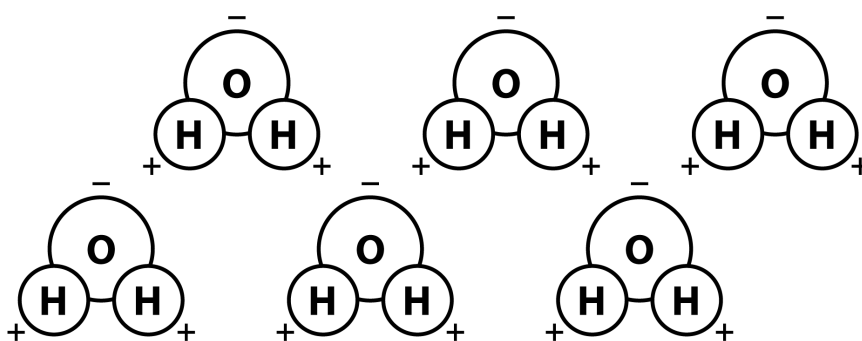
Activities

Activity 1: The Water Molecule

In this activity, your child will develop a model of a water molecule to help them understand its structure and properties. Modeling is an important scientific practice and helps students make sense of ideas that are too small to see directly. There are two options for completing this activity. In Option 1, your child will create a detailed drawing of a water molecule, focusing on identifying the atoms, shape, and positive and negative regions that explain polarity and cohesion. In Option 2, your child will build a physical model, allowing them to explore the same concepts in a more hands-on way and explain their thinking using the model. Option 1 is a great fit for students who enjoy drawing and working carefully with diagrams, while Option 2 is ideal for students who learn best through building and hands-on exploration.

Option 1: Draw a Water Molecule Model

Your child will draw and label a water molecule, showing its atoms and positive and negative sides. She will also draw multiple molecules to show how opposite charges attract, helping explain why water molecules stick together (cohesion). Her drawing may look different than this one. Look for the negatively charged oxygen molecules to be lined up with the positively charged hydrogen molecules. The answer key is to the right.



Polarity causes water molecules to have a positive side and a negative side, and opposite charges attract. This means the positive side of one water molecule is attracted to the negative side of another, causing the molecules to stick together (cohesion).

Option 2: Build a Water Molecule Model

Your child will build a physical model of a water molecule using household materials. For the atoms, she may use items such as clay, Play-Doh, Styrofoam balls, grapes, berries, cubes of cheese, or other small objects. To connect the atoms, she may use toothpicks, small sticks, wire, paper clips, skewers, dry spaghetti, or similar materials. She will use the model to show polarity and how water molecules are attracted to each other. She will explain how the structure of the molecule causes cohesion by pointing to and discussing her model. For support, you can refer to the labeled diagram in Option 1, which shows the correct structure and placement of positive and negative regions.

Activity 2: How Many Drops Can You Fit? A Surface Tension Investigation

In this investigation, your child explores surface tension by testing how many drops of water can fit on a penny. She will collect data, repeat trials, and compare results with and without soap. This activity helps her connect the behavior of water to molecular properties like polarity and cohesion.

Answer Key:**Part 1**

1. Prediction will vary.
2. Results will vary (typically ~25–40 drops for plain water).
3. Water forms a raised dome or bubble shape before spilling.

Part 2

Results will vary, but soapy water should hold fewer drops than plain water.

Part 3

1. The number of drops decreases with soap.
2. Soap breaks the attraction between water molecules, so they do not stick together as well.

Part 4

1. Water forms a dome because the molecules stick together and pull inward.
2. Surface tension is caused by cohesion between water molecules.
3. Polarity creates positive and negative ends, which attract each other and cause water molecules to stick together.

Activity 3: The Pepper Problem – Breaking Surface Tension (Optional Activity)

In this activity, your child uses observations to explain how the structure of water molecules affects their behavior. By seeing how soap disrupts surface tension, she is connecting the model of a water molecule (polarity) to real-world evidence of how water behaves.

Answer Key:

- Observation: *Pepper quickly moves away from the area where soap touches the water.*
- Why does the pepper float at first? *Surface tension holds the pepper on top of the water.*
- What happens when soap is added? *Soap breaks the attraction between water molecules.*
- Why does the pepper move? *The surface tension is disrupted, causing the water to pull away from the soap and carry the pepper with it.*

Wrapping Up

In this lesson, your child explores the structure of water and how its unique molecular design leads to important properties such as polarity, cohesion, and surface tension. She observes how these properties influence the way water behaves in the real world. This foundational understanding prepares her to think more deeply about how water moves, mixes, and is distributed across Earth, setting the stage for the next lesson on density and salinity.

In this life application activity, your child will apply what she learned about water's polarity and properties to a hypothetical scenario. She will consider what would happen if water molecules were no longer polar and ice no longer floated. Using evidence from the lesson, she will explain how this change could affect oceans, freshwater systems, weather, ecosystems, and the survival of living things. Strong responses may include recognizing that ice would sink, bodies of water could freeze from the bottom up, aquatic life would be threatened, and Earth's water systems would be dramatically altered.

Questions to Discuss

- How does the structure of a water molecule explain why water has properties like cohesion and surface tension? (Answer: A water molecule has a slightly positive side and a slightly negative side (polarity). These opposite charges attract each other, causing water molecules to stick together (cohesion). This attraction creates surface tension, which allows water to form droplets and even support small objects on its surface.)

Things to Review

- Review "Things to Know" in this lesson.