Properties of Water

Educator Notes

Learning Objectives

- Identify six properties of water.
- Identify the structure of a water molecule.
- Explain how the structure of a water molecule relates to the properties of water.

Credit: NASA

Safety

- Students should use caution as they move throughout the various investigation stations.

Introduce the Challenge

Ask

- Instruct students to use the Properties of Water handout for notes/drawings while viewing the STEMonstration. Prior to providing the document to students, print it double-sided and direct students to fold the printable in half along the dotted line.
- Show your students the STEMonstration: "Properties of Water" video found at https://www.nasa.gov/stemonstrations.
- After the video, facilitate a large group discussion focused on student observations and the properties of water demonstrated in the video.
  - Invite students to share their initial observations, specifying water properties included in the STEMonstration.
  - Ask students to identify other properties of water that were **not** demonstrated in the STEMonstration.
  - Ask students what they think would happen to a drop of water on the space station: Show the Video: "Moving Water in Space": https://youtu.be/H_qPWZbxFI8
  - Invite students to share additional properties of water demonstrated in the second video.

Facilitate the Challenge

Polarity Overview

Instruct students, in pairs, to talk through the overview questions below to deepen their background knowledge needed for the Investigation Stations. Allow pairs to share responses in large group discussion. Address any gaps in knowledge before proceeding to the Investigation Stations.

- **OVERVIEW: Think-Pair-Share Questions**
  1. What is a polar molecule?
  2. Name the elements that make up water.

Grades 6 to 8 Suggested Pacing

2 class periods

Materials

- ☐ Tap water
- ☐ Rubbing alcohol
- ☐ Scissors
- ☐ Pipettes
- ☐ Pennies
- ☐ Paper towels
- ☐ Graduated cylinders
- ☐ Stopwatches
- ☐ Paperclips
- ☐ Forks
- ☐ Beakers/cups
- ☐ Dish detergent
- ☐ Vegetable oil
- ☐ Ice made with food color
- ☐ Salt
- ☐ Test tubes
- ☐ Ruler
- ☐ Cotton balls
- ☐ Polymer bouncy ball
- ☐ Properties of Water Investigation Worksheet

National STEM Standards

Earth's Systems

- MS-PS1-1
- MS-PS1-4
- MS-PS1-5

3. What charge does the hydrogen atoms have in a molecule of water?
4. What charge does the oxygen atom have in a molecule of water?
5. The _____ atom of one water molecule will bond with _____ atoms of other water molecules.
6. What are the bonds called between two hydrogen atoms?
7. In reference to properties of water, describe the terms **cohesion** and **adhesion.**

Plan (Investigation Station Setup)

- Split students up into groups of three or four and provide each group with a copy of the Properties of Water Investigation Worksheet. Instruct students to rotate through each of the six 10-minute station using the Predicting, Investigating, Observing, and Recording (PIOR) approach. Students should write their observations in the Initial Observations portion of the student worksheet.
  - Note: This is a great opportunity to discuss **science process skills** with your students and why it is important to use them throughout a scientific investigation. Science process skills (review if needed) include **observing qualities, measuring quantities, sorting/classifying, inferring, predicting, experimenting, and communicating.**
- Have students illustrate their predictions inside the foldable. Students may draw or write observations and answer questions.
- Instruct students to discuss with their teams the properties of water observed in each station.

Test (Stations 1-6) *(Do not include the actual property name at the stations)*

Station 1-Adhesion/Cohesion

Station Investigation:

- **Part A: Water**
  1. Rinse a penny in tap water. Dry thoroughly with a paper towel.
  2. Place the penny on a fresh paper towel.
  3. Fill a beaker with 25 mL of tap water.
  4. Using a pipet, slowly drop individual droplets of water onto the surface of the penny.
  5. Count each drop until the water begins to spill over the sides of the penny. Record your observations in a data table. *Note: Watch the penny from above rather than from the side while making observations.*
  6. Repeat steps 1–5 for a total of three trials. Thoroughly dry the penny between each trial.
- **Part B: Alcohol**
  1. Rinse a penny in tap water. Dry thoroughly with a paper towel.
  2. Place the penny on a fresh paper towel.
  3. Fill a beaker with 25 mL of rubbing alcohol.
  4. Using a pipet, slowly drop individual droplets of alcohol onto the surface of the penny.
  5. Count each drop until the alcohol begins to spill over the sides of the penny. Record your observations in a data table. Note: Watch the penny from above rather than from the side while making observations.
  6. Repeat steps 1–5 for a total of three trials. Thoroughly dry the penny between each trial.

Questions:

1.Compare and contrast the data on water droplets vs alcohol. Create a data table to demonstrate a comparison of the number of drops that fit on a penny for either substance.
2. What does the solution look like on the penny for each substance (water and rubbing alcohol)? (draw)
3. Explain which substance allowed more droplets to fit on the penny and why?
4.What property of water allows the water to stick to the penny?
5.What property of water allows the water to form a dome-like structure on top of the penny?
6.Describe an example of cohesion and adhesion that you might observe during your daily life.
7. How many hydrogen bonds can a single water molecule have?

8. Define cohesion.
9. Define adhesion.

Station 2-Capillary Action

Station Investigation:

1. Cut a paper towel into three different strips with varying widths: 1 cm, 2 cm, 3 cm. Keep the length the same for all the paper towels, and make sure there are no folds in the towels.
2. Fill three graduated cylinders with 20 mL of water. Optional: Add a few drops of food coloring to the water to help with visualization.
3. Place the paper towels in separate graduated cylinders just until the towel touches the water and fold it over the edge of the graduated cylinder.
4. Time the movement of water up the paper towel for one minute.
5. Use a ruler to measure (in centimeters) how far the water moved up each towel.

Questions:

1. What two properties of water contribute to capillary action?
2. How does water move up the thin walls of a tube? Specifically, what is it sticking to?
3. Based on this investigation station, can you explain why it is important for trees/plants to have very small diameter vessels?

Station 3-Surface Tension

Station Investigation:

1. Take a paperclip, and using the fork, place it gently on the surface of the water.
2. Continue adding paper clips and record the maximum number of paperclips you and your partner were able to add without any of the clips falling to the bottom.
3. Repeat the same procedure above, but instead use soapy water.

Questions:

1. How does water hold up materials that are heavier than itself?
2. What property of water gives it a high surface tension?
3. What property of water allows the paper clips to be attracted to the plain water?
4. How did the soap affect the paper clip's ability to float?
5. What kinds of animals have you seen take advantage of water's surface tension?

Station 4-Density

Station Investigation:

- Observe a beaker of water.
- Observe a beaker of vegetable oil.
- Add ice in both beakers and make observations/drawings. (To make the ice stand out, consider adding a few drops of food coloring to the water before freezing.)
- Add a polymer ball to both beakers, then record observations and drawings.

Questions:

1. Why does solid ice float on liquid water?
2. When a lake freezes, how does the density of water prevent all of the living organisms in the lake from freezing as well?
3. Explain why the polymer ball is at the bottom of the vegetable oil.
4. Explain why the ice floats on the water.

5. Apply your knowledge about this investigation to the following scenario: What if ice was more dense than liquid water? How would that change the Earth as we know it?

Station 5-Solubility- Universal Solvent

Station Investigation:

- Shake and observe the test tube that has oil and salt.
- Shake and observe the test tube that has water and salt

Questions:

1. Define mixture.
2. Explain the difference between a heterogeneous and homogeneous mixture.
3. Define solution.
4. Define solvent.
5. Why is water considered the greatest solvent on Earth?

Station 6- High Heat of Vaporization

Station Investigation:

1. At your station you will find two containers with a cotton swab soaking in a liquid.
2. Have your partner swab a small area on the inside of your left arm with the cotton swab soaked in water.
3. Time how long it takes for the water to evaporate.
4. Have your partner swab a small area on the inside of your right arm with the cotton swab soaked in rubbing alcohol.
5. Time how long it takes for the alcohol to evaporate.
6. Repeat the above procedures on the other partner.

Questions:

1. Define heat of vaporization.
2. What causes water to have a high heat of vaporization?
3. What happens to the surface when water evaporates?
4. How does water's high heat of vaporization help you feel cooler when you sweat?
5. Describe the importance of high heat of vaporization to ecosystems.

Share

- For their individual assignment, have students write a one-paragraph summary of the investigation on a clean sheet of notebook paper. Students should include the following in their summary:
  - What is the purpose of this experiment? What question are you trying to answer?
  - Discuss your investigation station observations.
  - Use your observations collected throughout the stations to help you determine your final list of Properties of Water.
  - Make a concluding statement answering the original question: what are the various properties of water that make it so unique and vital to life as we know it?

Extension

- Instruct students to come up with a drawing, story, poem, or song demonstrating the six properties of water.

More to Explore

Follow the Water Experiment:

https://www.nasa.gov/pdf/168049main_Follow_the_Water.pdf

Density: Potato Float

https://aquarius.oceansciences.org/cgi/ed_act.cgi?id=45

Beautiful Earth: Water Density

https://icesat-2.gsfc.nasa.gov/sites/default/files/funzone/ICESat2_TennisBall_Activity.pdf

Newest Water Mission: SWOT Surface Water and Ocean Topography

https://swot.jpl.nasa.gov/

How does climate change affect the ocean?

https://climatekids.nasa.gov/ocean/

Climate Kids: Water

https://climatekids.nasa.gov/menu/water/

The Nature of Salt

https://aquarius.oceansciences.org/cgi/ed_act.cgi?id=46

Properties of Water Investigation Worksheet

Initial Observations for STEMonstration

Date: _____

Property of Water **Demonstration**

Notes/Question Answers

_____ _____

_____ _____

_____ _____

Investigation Station Observations

Station 1

Date: _____

Drawings/Data Tables:

Property of Water **Investigation**

Notes/ Question Answers:

_____ _____

_____ _____

_____ _____

Station 2
Drawings/Data Tables:

Property of Water **Investigation**

Notes/ Question Answers:

Station 3
Drawings/Data Table
Property of Water **Investigation**

Notes/ Question Answers:

Name:_____

Station 4
Drawings/Data Table
Property of Water **Investigation**

Notes/ Question Answers:

Station 5
Drawings/Data Table
Property of Water **Investigation**

Notes/ Question Answers:

Station 6
Drawings/Data Table
Property of Water **Investigation**

Notes/ Question Answers:

Student Name:_____

Group Name:_____

Date:_____

Period:_____

Properties of Water Foldable

Hydrogen Bonding Examples:

Student Name:_____

Group Name:_____

Date:_____Period:_____