Water's Cohesive Properties

Water is attracted to itself, i.e., one water molecule is attracted through hydrogen bonding to other water molecules. This phenomenon is called cohesion and produces surface tension and contributes to capillarity. Surface tension is the force produced at the surface or interface of a solution with the atmosphere caused by cohesion of the molecules within the solution. Droplets of water and soap bubbles are examples of surface tension. Water droplets form because molecules at the surface of the drop are attracted not only to each other but to water molecules inside the drop. In the absence of gravity a falling water drop would be spherical because all of the molecules of water at the surface of the drop would be pulled equally toward the center of the drop. Surface tension resulting from cohesive forces produces a stable surface on which insects such as the water strider (much denser than water) can move.

Materials:

Small cups, Dixie Cups
Petri dishes
Pepper
Paper clips or straight pins
Pipettes (2)
Beaker (500 mL)
Dish detergent
Water

1. Obtain 3 small cups.
2. Place each cup in a petri dish or petri dish lid.
3. Obtain a scoop of black pepper.
4. Use a beaker to fill each cup, all the way to the top with distilled water. Use a pipette to slowly (drop by drop) add more water to the first cup until the water surface extends above the lip of the cup. Count how many drops you added. The water should visibly extend above the lip of the cup. How many drops did you add? _____________ One mL is approximately 20 drops. How many mL did you add to the cup? ____________
5. Pick up a pinch of black pepper. Slowly drop the pepper onto the surface of the water.

What do you observe? What happened to the pepper? How do you explain your observations?

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6. Return to the materials bench for another pipette. Use this pipette to get a drop or two of detergent. Return to your bench.
7. Carefully dispense one drop of detergent onto the surface of the water (and pepper).

What do you observe? What happened to the pepper? How do you explain your observations?

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8. Use a pipette to slowly (drop by drop) add more water to the second cup until the water surface extends above the lip of the cup. Count how many drops you added. The water should visibly extend above the lip of the cup. How many drops did you add? _____________ One mL is approximately 20 drops. How many mL did you add to the cup? ____________
9. Gently place a pin or paper clip onto the surface of the water. Hold the pin or paperclip horizontally so the long axis of the clip or pin is parallel to the surface of the water in the cup.

What do you observe? What happened to the paper clip/pin? How do you explain your observations?

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10. Gently try to add a second paperclip or pin to the cup.

What do you observe? What happened to the paper clip/pin? How do you explain your observations?

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11. If the paper clip or pin did not sink to the bottom, add a drop of detergent to the cup.

What do you observe? What happened to the paper clip/pin? How do you explain your observations?

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12. If the second paperclip/pin sank to the bottom of the cup, then use a pipette to slowly (drop by drop) add more water to the third cup until the water surface extends above the lip of the cup. Count how many drops you added. The water should visibly extend above the lip of the cup. How many drops did you add? ____________ One mL is approximately 20 drops. How many mL did you add to the cup? ___________
13. Gently place a pin or paper clip onto the surface of the water. Hold the pin or paperclip horizontally so the long axis of the clip or pin is parallel to the surface of the water in the cup.

What do you observe? What happened to the paper clip/pin? How do you explain your observations?

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14. Now add a drop of detergent to the cup containing the floating paperclip/pin.

What do you observe? What happened to the paper clip/pin? How do you explain your observations?

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Water’s Cohesive Properties (cont.)

Materials

Water
Glass or clear container with a straight even lip, a small jar for example
20 quarter-sized coins or metal disks
Paper towels
Beaker (500 mL)

1. Place the glass or jar on a paper towel.

2. Use the beaker to fill the jar/glass to the top. The water level should touch the edge of the container. The surface of the water should be convex (higher on the edge near the lip of the container than in the middle of the surface.

Make a hypothesis: You are going to add coins the container until it overflows. Create a hypothesis about how many coins can be added until the water overflows the container and dampens the paper towel beneath the container. Write your hypothesis here:

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3. Gently add a coin to the container. Hold the coin so that the narrow edge penetrates the surface. Continue adding coins one at a time until the surface water flows down the side of the container.

How many coins were added before the container over flowed? ____________________

Was your hypothesis correct? ______________________ Was your estimate higher or lower than the actual number of coins actually added to the container? ________

Explain how you were able to add so many coins to the container without the water overflowing.

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Water’s Cohesive Properties (cont.)

In the 1800’s the swimming fish trick was common parlor entertainment. The trick works because of the properties of water including surface tension.

Materials

Water
Wide container such as a loaf pan or cake pan or large bowl
Paper fish
Oil
Detergent
Beaker (500 mL)
Timer

You will do 2 trials. One using detergent, the other using oil as the ‘fuel’ to power the fish. Write a hypothesis as to which fuel will produce the longest swim time. Write your hypothesis here.

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1. Use the beaker to fill the container approximately half full with water.
2. Add the paper fish to the surface of the water.
3. Add a drop of detergent to circle cut out in the center of the fish.
4. Start the timer.

What did you observe?

How long did the fish continue to swim? __________________

How do you explain the movement of the fish?

5. Rinse out the container
6. Use the beaker to fill the container approximately half full with water.
7. Add the paper fish to the surface of the water.

8. Add a drop of oil to circle cut out in the center of the fish.
9. Start the timer.

What did you observe?

How long did the fish continue to swim? _________________

Was your hypothesis correct? _______________

How do you explain the difference in swimming time between the oil and detergent trials?

10. Rinse out the container and return it to the supply bench.