Activity Description & Estimated Class Time

Over the course of three 50-minute class periods, students will explore capillary action and determine the effect of temperature on it.

Correlations to NC Science Standards

ESS.8.2.1 Use models to explain the structure of they hydrosphere including: water distribution on earth, local river basins, estuaries, and water availability.

Learning Target

Students will demonstrate knowledge and understanding of the following water properties:

- cohesion
- adhesion
- capillary action

Brief Science Background

Water molecules form bonds of attraction, and they form some of those bonds *between each other.* The bonds are electrical, like the static electric attraction between a balloon and the wall. The hydrogen parts of the molecule have a bit of extra positive charge, and the oxygen part has a little extra negative. These parts are like positive and negative "poles." That's why water is called **polar**. Each end of a water molecule is attracted to the oppositely charged end of another water molecule. This is called **hydrogen bonding**. The hydrogen bonds make water tend to stick to itself, a quality called **cohesion**. Cohesion shapes the way water behaves. It causes water to form drops. It also produces the skin-like surface on top of water called **surface tension**. The static charges can also make water stick to other things (like glass), a quality called **adhesion**. Adhesion, together with cohesion and surface tension, causes the process **capillary action.** Capillary action is the movement of water or "crawling of water" against gravity. It is vital to the movement of water and all of the things that are dissolved in it. Many plants use capillary action to obtain and move water throughout.

Part 1 — How Does Water Climb? Exploration

Materials

Materials for the whole class

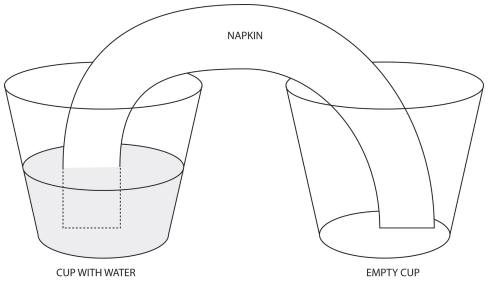
- 4-oz. cup
- blue food coloring
- napkins
- taster spoons
- water (supplied by teacher)
- water climbing document (SD 1)

Materials for groups of 2 students

- 2 4-oz. cups
- blue food coloring (shared amongst 4 students)
- napkin
- taster spoon
- water (supplied by teacher)
- 2 student activity sheets (SD 2)

Procedure

1. Explain that each group will explore how water "climbs."
2. Instruct students to place the two plastic cups side by side.
3. Students will add one to two drops of blue food coloring to **one** of the cups and fill it 1/3 full of water. Stir with the taster spoon.
4. Explain we are going to create a "bridge" to the other cup with our napkin. To do this unfold the napkin and tear it into four equal parts. Three of the pieces will be used later. Fold a piece of the napkin in half **two** times. Place one end of the napkin in a the cup with blue water and fold the other end into the empty cup. Students will draw their set-up on their student activity sheet (SD 2). Project diagram 1 on the water climbing diagram sheet (SD 1).



5. Once the set-up is complete, students should observe it for a few minutes and then predict what they think the set-up will look like after 24 hours.
6. Place the cups in a secure spot.
7. After 24 hours, have students get their set-up, draw it, and record any changes on their student activity sheet.
8. Discuss the students' observations as a class. Explain that the process of water "climbing" is known as capillary action, and would not be possible without water's properties of cohesion, adhesion, and surface tension. Capillary action is vital to the movement of water and all of the things that are dissolved in it.
9. To clean up, students should throw away the napkin, dispose of the water, and rinse and dry the cups and taster spoon to be reused.

Part 2 — How Does Water Climb? Predict and Test

Materials

Materials for the whole class

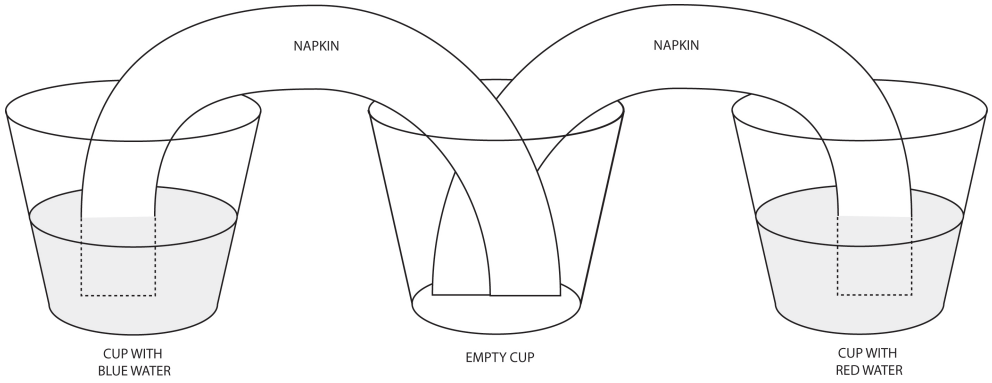
- 4-oz. cup
- blue food coloring
- red food coloring
- napkins
- taster spoons
- water (supplied by teacher)
- water climbing diagram (SD 1)

Materials for groups of 2 students

- 3 4-oz. cups
- blue food coloring (shared amongst 4 students)
- red food coloring (shared amongst 4 students)
- napkin
- taster spoon
- water (supplied by teacher)
- 2 student activity sheets (SD 2)

Procedure

1. Instruct students to place three plastic cups side by side.
2. Students will add one to two drops of blue food coloring to **the cup farthest to the left** and fill it 1/3 full of water. Stir with the taster spoon.
3. Students will add one to two drops of red food coloring to **the cup farthest to the right** and fill it 1/3 full of water. Stir with the taster spoon. **The middle cup should not have water in it.**
4. Project diagram 2 on the water climbing diagram (SD 1). Have students predict what will happen.



5. Students will create two bridges: one from the the blue water to the empty cup and one from the red water to the empty cup.
6. Once the set-up is complete, students should observe it for a few minutes and draw the setup on their student activity sheet (SD 2).
7. Place the cups in a secure spot.
8. After 24 hours, have students get their set-up, draw it, and record any changes on their student activity sheet. How did their results compare to their prediction?
9. Discuss the students observations as a class.
   Both blue and red water used capillary action to crawl across the two napkin bridges into the middle cup, creating purple water. Students may also note that the water level in all three cups is the same.
10. To clean up, students should throw away the napkin, dispose of the water, and rinse and dry the cups and taster spoon to be reused.

Part 3 — Effect of Temperature on Capillary Action

Materials

Materials for the whole class

- 4-oz. cup
- blue food coloring
- red food coloring
- napkins
- taster spoons
- timers
- ice cubes
- water (supplied by teacher)

Materials cont.

Materials for groups of 2 students

- 4 4-oz. cups
- blue food coloring (shared amongst 4 students)
- red food coloring (shared amongst 4 students)
- napkin
- taster spoon
- timer
- ice cubes
- water (supplied by teacher)
- 2 student activity sheets (SD 2)

Preparation

Freeze a full ice tray, enough ice so each team of two has 2-3 ice cubes.

Procedure

1. Take two plastic cups. Label one hot and one cold. Ask students "How do you think the temperature will affect how fast capillary action occurs?
2. Have students place 2-3 ice cubes into the cup labeled cold and fill the cup to about 1/4 inch from the top with cold water. They will place an empty cup next to it.
3. Place one to two drops of blue food coloring into the cold cup and have students stir with a taster spoon.
4. Students will create a napkin bridge from the cold cup to the empty cup. As soon as the students place the napkin in the cup with water, have them start the timer. Students will record how long it takes from the water to make it to the empty cup on their student activity sheets (SD 2).
5. Have students fill the cup labeled hot about 1/4 inch from the top with hot water from the tap. They will place an empty cup next to it.
6. Place one to two drops of red food coloring into the hot cup and have students stir with a taster spoon.
7. Students will create a napkin bridge from the hot cup to the empty cup. As soon as the students place the napkin in the cup with water, have them start the timer. Students will record how long it takes from the water to make it to the empty cup on their student activity sheets (SD 2).
8. Have students discuss their observations.
   The cold water takes longer to crawl across the napkin bridge.

Content Connection

1. Inform students that cold water has less energy than hot water. Adding heat to the water adds energy, causing the molecules in warm water to move faster than molecules in cold water.
2. Ask students to explain how temperature affects capillary action using evidence from their investigation.

SD 1

Crawling Water Graphics

Diagram 1

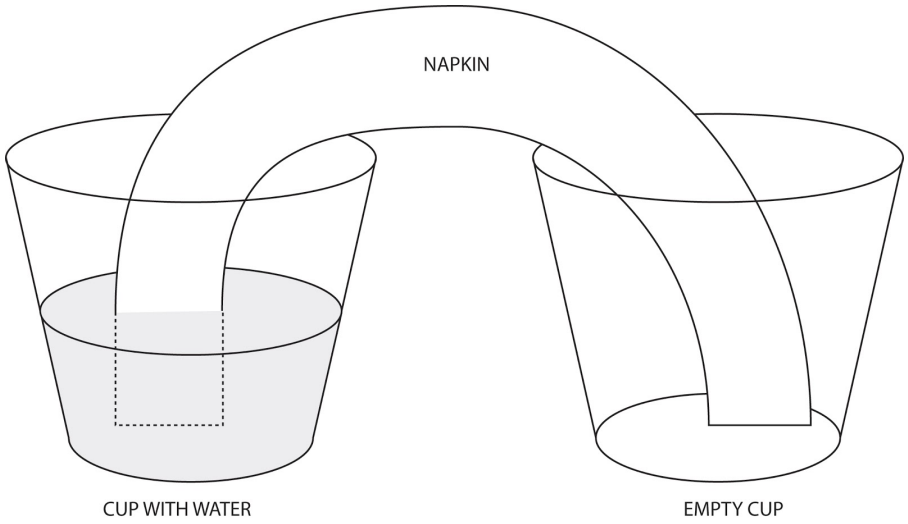
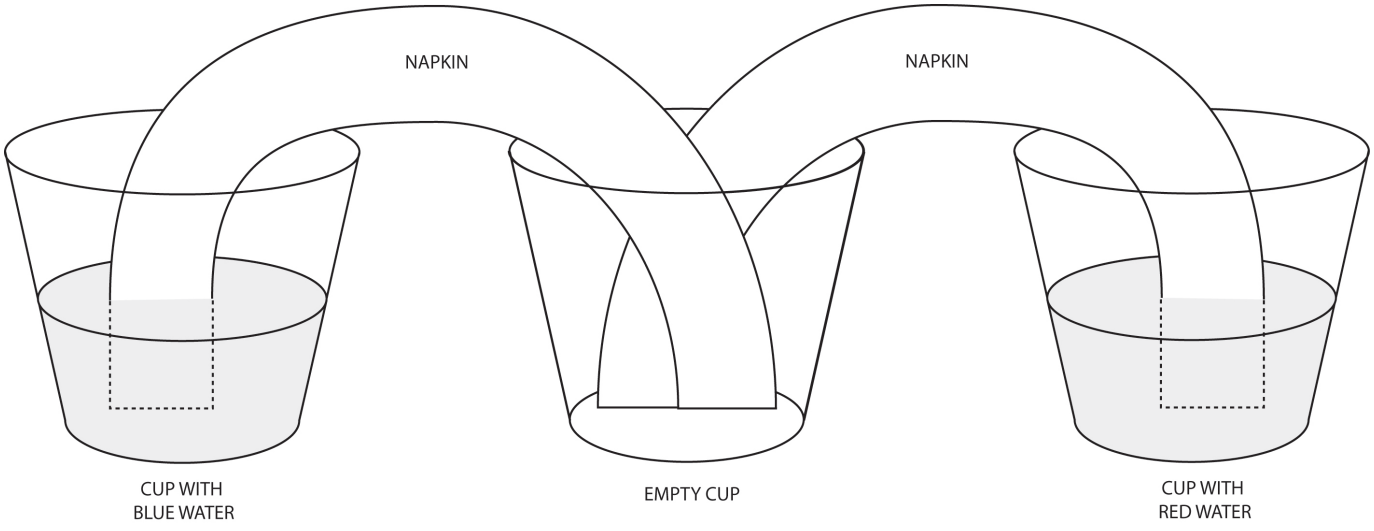


Diagram 2



SD 2

Crawling Water Student Activity Sheet

Name:

Part 1

1. Drawing of the initial set-up

Drawing of set-up after 24 hours.

2. Record all changes that have occurred.

Part 2

1. Drawing of the initial set-up

Drawing of set-up after 24 hours.

2. Record all changes that have occurred.

Part 3

1. Record the time for both cold and hot water below.

   Cold Water: _____

   Hot Water: _____

2. Explain how temperature affects capillary action using evidence from your investigation.