Throughout the guide teaching tips are in red.

Activity Description and Estimated Class Time

In this 1-day activity, students use drops of food coloring in trays of water to explore how convection drives wind between areas of different temperature. Students experience the motion of food coloring in a tray of water that is subjected to heat and cold at opposite ends. To connect convection to wind, it helps to immediately follow this activity with Land and Sea Breezes.

Objectives

Students will develop an understanding of the following ideas and content:

- Different temperatures at different locations in air will cause it to move.
- Students will use measurements to determine position.

Students demonstrate understanding of these ideas by:

- Predicting the motion of air subjected to heating and cooling,
- Explaining that moving air by means of convection requires different areas to be at different temperatures.

Correlations to NC Science Standards

7.E.1.5 Explain the influence of convection, global winds and the jet stream on weather and climatic conditions.

Brief Science Background

The evening breeze, ocean currents, and steam rising over a stove are all driven by uneven heating in a gas or liquid. Any gas or liquid that is hotter in one place than another produces a current. The NC Grade 7 weather standards do not address underlying reasons for convection (variation in density and buoyancy). These are covered in lessons about heat transfer in other units at other grade levels. Instead, NC Essential Science Standard 7.E.1.5 focuses on the influence of convection. To understand this, it is enough for students to know that hot air rises and cold air sinks. What might come as a surprise is that air rising and sinking creates air currents not only up and down, but also across the earth. We experience that movement as breezes, winds, or even storms.

Materials

Materials for the whole class or the teacher

- 24 deli trays (4” x 6”)
- 16 small foam cups
- a permanent marker
- 8, 32-oz plastic containers
- a hotpot
- a thermos
- two ice cube trays
- two food coloring dropper bottles, one red and one blue
- 8 thermometers
- *a sink or dishpan

*supplied by teacher

Materials for groups of 4 students

- two 4x6 deli trays containing tap water
- one 4 x 6 deli tray empty
- one small foam cup labeled “C” containing ice water
- one empty small foam cup labeled “H”
- a thermometer
- 4 copies of SD-2

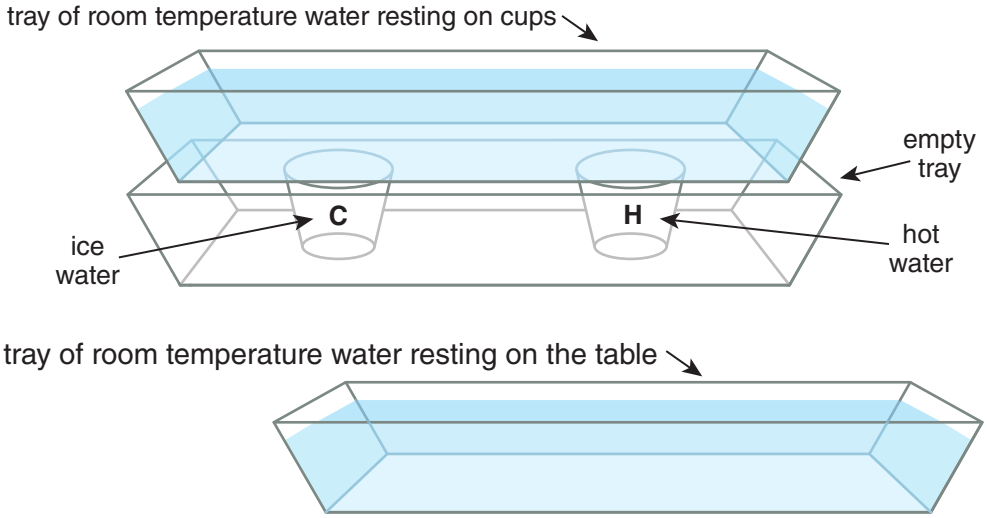
Preparation

1. Fill eight 32-oz containers with tap water. Have these available for students to replenish water in their trays. Either freeze ice in the trays provided in the kit or obtain a bag of ice.
2. On the day of the activity, fill two deli trays per team with tap water to ½ inch from the top of the tray. **These trays will be reused with each class.**
3. On the day of the activity, fill the thermos with 130˚ F water. Heat to boiling in the hotpot and adjust with cold. A thermos holds 3 hotpots worth of water. During the activity, you will pour 130˚ F water from the thermos into a foam cup at each team’s station.
4. Be sure a sink or dishpan is available for teams to dispose of used water.
5. Use a marker to label one foam cup “C” and one “H” per team. Just before the activity, fill the “C” cups with ice and add water **to the brim so that ice protrudes above the lip.** Place these and the empty “H” cups in the trays as shown in SD-1. **These cups will be reused with each class.**
6. Place materials for groups of 4, listed above, at each station. Place both trays of tap water on the table top. If your tables are dark, put white paper under the setup. Results are more visible over a white background.

Procedure

Exploration

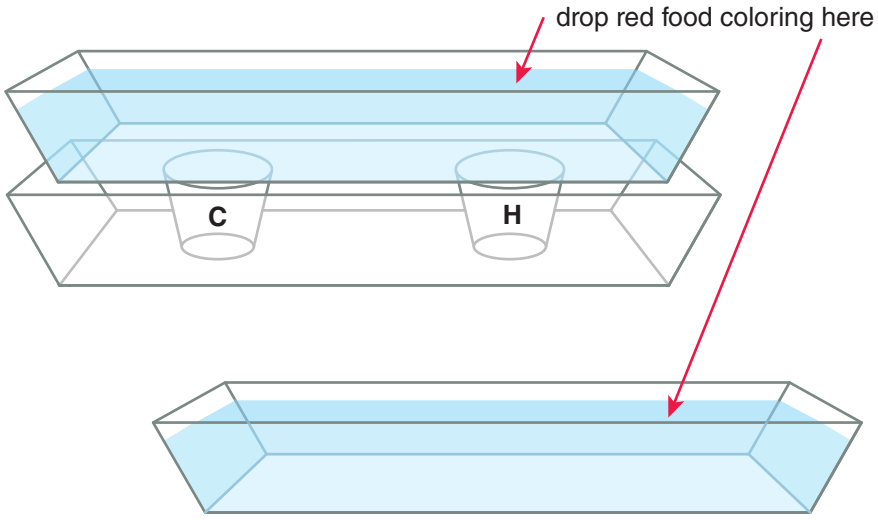
1. Explain that each team will explore what happens to drops of food coloring that are placed in two different trays of water. Ask them to carefully observe both trays and to record in their notebooks what is different about them throughout the activity.
2. Demonstrate using the thermometer. Ask students to measure and record water temperature in ˚F in both trays.
3. Pour hot water into all teams’ H cups near to the top but not to the brim. Ask them to take the temperature of the hot water and record it in their notebooks.
4. Project SD-1 and ask students to set up as in the diagram. Important: Ice in the C cups should touch the tray of room temperature water resting on the cup. The C cups should be filled so that some ice protrudes above the cup. When the tray of water is placed on the cup, a little water should spill from the C cup into the empty tray. Ask teams to leave this undisturbed and avoid jarring the table or the setup. Inform students that the temperature of the ice water is about 33˚ F. Ask them to record this in their notebooks.



5. Explain that, in a few minutes, we will put food coloring in the tray of water over the H cup. As a class discussion, ask what students think might happen to that food coloring after it is in the water.

6. Give the setups a few minutes to settle, then circulate and add 3 drops of red food coloring to the trays of water just over the H cup at each station. Drip near the surface but not touching. In the tray on the tabletop, drop the food coloring at the same relative location. Allow teams 3-4 minutes to observe. When teams finish, ask them to respond to the following notebook prompt.

   Notebook Prompt: Using arrows, make a drawing that shows how the food coloring moved in both trays. Describe what the food coloring does in both trays and compare them.

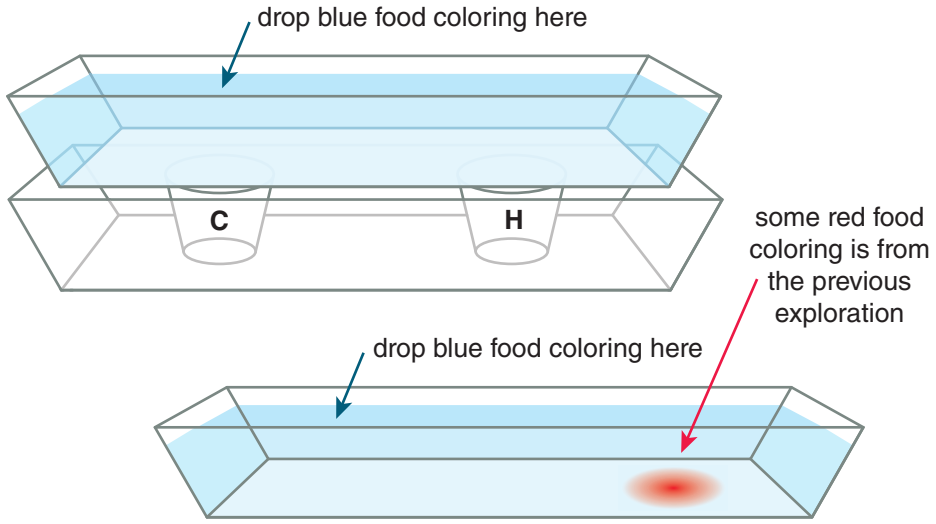


7. Ask students to leave the tray on the tabletop untouched, remove the tray resting on the cups, and empty it in a dishpan. Ask teams to refill it with water from a 32-oz container. Place the tray on the cups as before.

   Notebook Prompt: Describe what you think will happen to the blue food coloring when it is placed over the cup containing ice water and in the tray on

the table. If you think it will move, using arrows, sketch the pattern of how you think it will move in both trays.

8. After the class completes the notebook entry, circulate and add 3 drops of blue food coloring over the center of the C cup. Also add 3 drops at the same relative location in the tray on the tabletop. Ask students to observe for 3 minutes.



9. Leaving both trays untouched, discuss with the whole class:
   - How the blue food coloring moved in both trays,
   - How results compare with predictions,
   - Possible explanations for what happened to the blue food coloring in both trays? Ask students to refer to their measurements of water temperature in the cups and in the trays.

10. Ask students to leave the tray on the tabletop untouched, now with blue and red blobs at opposite ends. Ask them to empty the tray that was sitting on the cups, again refill it with clean room temperature water, and place it back on the cups as before. While the tray is off the cups, pour out a little water from the H cups and add new hot water to bring the temperature back up to about 130˚F. Be sure there is still ice protruding above the rim in the C cups.

11. **Notebook Prompt:** Predict how red and blue food coloring would move if some were placed over both cups at the same time. Encourage students to sketch out their ideas using arrows.

12. Circulate among teams with food coloring to place 3 drops of red over H cups and 3 drops of blue over C cups. Add **no** food coloring to the tray on the table top. Ask students to observe for 3-4 minutes.

    Notebook Prompt: Using arrows, make a drawing that shows how the food coloring moved. Compare what happened to the red and blue food colorings in both trays. Give possible reasons for what you see.

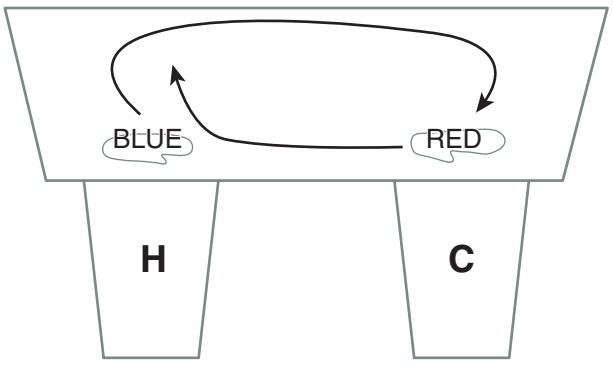
    Empty all plastic trays and Styrofoam cups into the sink, rinse, and reuse for the next class.

Wrap-Up

1. Ask students for temperatures they measured in the tray over the cups and record a few of these for all to see. Ask the class what they notice about how the temperatures in the two cups changed over time. Ask for some reasons for these changes.
2. Ask the class what they know about convection. **It makes hot air or water rise and cold air or water sink.** Ask the class to describe the motion of the food coloring in the tray. **It rose and sank, but it also moved toward the other color of dye.** Point out that this is more than just rising and sinking, and ask what they think is causing it. **Students might say that it seemed to be "attracted" toward where the other color dye was but not be able to explain much more. Try to get them to come up with ideas or guesses. It is not important to teach about this now, only that students notice the horizontal movement. They will get a fuller explanation after the next activity about sea breezes and land breezes.**
3. Point out the horizontal movement of the red and blue food coloring. Explain that when warmer water rose in the tray above the hot cup, other water took its place as it moved up. Ask where students think the water replacing it might have come from. **It came from all around, but more came from the direction of the cold water, because the cold water was sinking and couldn't go below the bottom of the tray.** Point out that, likewise, cold water sinking above the C cup had to be replaced as it moved down. Ask where water replacing it might have come from. **It came from all around, but more came from the direction of the warm water, because water was welling up above the hot cup and couldn't rise above the surface of the water. Air behaves the same way.**
4. Ask students to do the following:

   Use SD-2 to draw arrows that show how you think the food coloring would move if the cups were placed opposite the way we did it, with the H cup under the blue and the C cup under the red. Use the lines below the diagram to explain each change of direction of the food coloring. **This prompt is intended to determine whether students think the color of the food coloring or the positioning of the cups makes any difference. The food coloring moves in the same way, regardless of color and the hot and cold cups exert the same influence, regardless of where they are placed.**

Answer Key

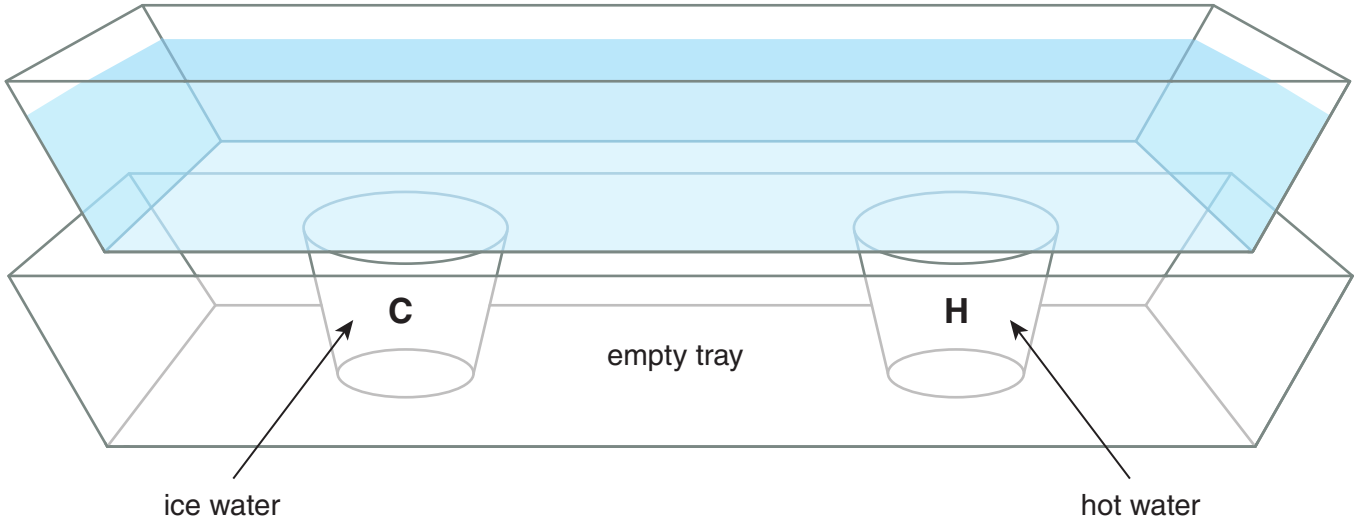


Reasons for each change of direction:

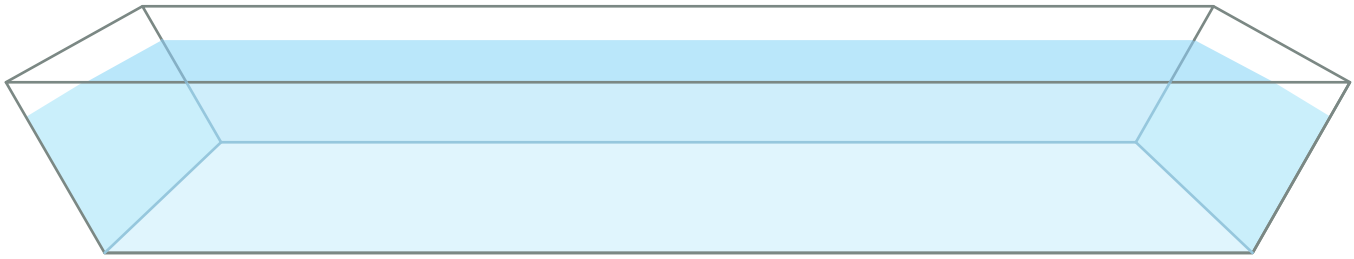
The water that has red in it is taking the place of water rising over the hot cup, so it moves to the left. When it reaches the warming area, it rises. The water that has blue in it rises because it is warming. Once it reaches the top, it moves to the right to take the place of water sinking above the cold cup. When it reaches the cooling area, it sinks.

Support Document 1

tray of room temperature water resting on cups



tray of room temperature water resting on the table



Support Document 2

Name _____