Activity 6.3
Condensation

Does cooling water vapor increase the rate of condensation?

In the previous activity, students design and conduct experiments and see that heating water increases the rate of evaporation. In this activity, students explore the reverse process—*condensation*. After seeing water vapor condense, students will help design a test to see if cooling water vapor has an effect on the rate of condensation.

Materials needed for each group

Hot tap water
Cold water
Ice cubes
3 Tall clear plastic cups
3 Wide clear plastic cups
Magnifier
Paper towels

Notes about the materials

- **Be sure you and the students wear properly fitting goggles.**
- **Hot tap water is sufficiently hot for the activity. Students should use care when handling hot tap water.**
- This activity calls for both tall and wide clear plastic cups. Be sure the cups fit together as shown.

Activity sheet

Copy *Activity sheet 6.3—Condensation*, pp. 353–354, and distribute one per student when specified in the activity.

Assessment

An assessment rubric for evaluating student progress during this activity is on pp. 372–373. For this formative assessment, check a box beside each aspect of the activity to indicate the level of student progress. Evaluate overall progress for the activity by circling either "Good", "Satisfactory", or "Needs Improvement".

Activity 6.3
Condensation

Question to investigate

Does cooling water vapor increase the rate of condensation?

1. Discuss with students some of their own experiences with condensation.

Ask students about their experiences with condensation using questions such as the following:

- Did you ever notice that if you have a cold drink on a humid day, the outside of the cup or can gets wet?
- Where do you think this moisture comes from?
- You may have made a cold window "cloudy" by breathing on it and then drawn on the window with your finger. Where do you think that cloudiness comes from?
- A cloud is made up of tiny droplets of water. Where do you think they come from?

Help students realize that the moisture in all of these examples came from water vapor in the air. Remind students that water vapor is one of the gases that makes up air.

Distribute *Activity sheet 6.3—Condensation* and have students list two examples of tiny drops of water appearing on a cold surface.

2. Have students conduct an experiment to observe the process of condensation.

Procedure

1. Fill a wide clear plastic cup about ⅔ full of hot tap water. Place a taller clear plastic cup (with a smaller rim) over the top as shown.
2. Watch the cups for 1–2 minutes.
3. Use a magnifier to look at the sides and top of the top cup.
4. Take the top cup off and feel the inside surface.

***Expected results*: The top cup will become cloudy-looking as small drops of liquid water collect on the inside surface of the cup.**

3. Discuss with students what they think is happening inside the cups.

Ask students questions like the following:

- What do you notice about the top cup?
- What do you think is on the inside of the top cup?
- Do you think that some of the water from the bottom cup is evaporating?
- Would you expect there to be more water vapor in the air inside the cups or outside the cups in the classroom air?
- How do you think the drops of water on the inside of the top cup got there?
- When water changes from a liquid to the gas water vapor, we say that it *evaporates*. Since *condensation* is the opposite of *evaporation*, explain what changes take place when water *condenses*.

Students should agree that the inside of the top cup is coated with tiny drops of liquid water. Since students saw in the last activity that heating water increases the rate of evaporation, they should realize that some of the hot water must have been evaporating pretty quickly, filling the air inside the cups with the gas water vapor. As water vapor moves away from the hot water it cools. It also cools when it comes in contact with the inside surface of the top cup. When the water vapor cools enough, it changes state, becoming tiny drops of liquid water. The process of changing from a gas to a liquid is called *condensation*.

4. As a class, discuss an experimental design that could investigate whether cooling water vapor increases the rate of condensation.

Remind students that they discovered that *heating* water increases the rate of *evaporation*. Now ask them if they think the reverse is true: Does *cooling* water vapor increase the rate of *condensation*?

Ask questions such as the following so that students better understand the experimental design described in the procedure below:

- We will need some water vapor in this experiment. How can we get some?
- How will we cool the water vapor?
- Will we need more than one sample of water vapor?
- Should we cool one sample of water vapor, but not the other?

Students may suggest collecting water vapor as described on the previous page or collecting it over a pot of boiling water. Students may have many ideas for cooling water vapor, like using ice, placing a sample in a refrigerator or cooler filled with ice, or placing a sample of water vapor outside if the weather is cool enough. Students should realize that they will need 2 samples of water vapor, one of which is cooled. By comparing the size of the drops in both samples, students can determine whether cooling water vapor increases the rate of condensation.

5. Have students do an activity to find out whether cooling water vapor increases the rate of condensation.

Procedure

1. Fill two wide clear plastic cups about ⅔ full of hot tap water.
2. Quickly place taller clear plastic cups (with smaller rims) upside down on each cup, as shown.
3. Place a piece of ice on top of one of the cups.
4. Wait 2–3 minutes.
5. Remove the ice and dry the place where the ice was with a paper towel.
6. Use a magnifier to examine the tops of the two upper cups.

***Expected results*: There will be bigger drops of water on the top of the cup with ice.**

6. Discuss students' observations and draw conclusions.

Ask students questions such as the following:

- Which top cup appears to have more water on it?
- What does the amount of water have to do with the rate of condensation?
- Does cooling water vapor increase the rate of condensation?

Students should realize that the bigger drops on the cold top cup indicate a greater amount of water and therefore more condensation. Because the water vapor in both sets of cups was condensing for the same length of time, the water vapor in the cooler top cup must have condensed at a faster rate.