The Three States of Water Demonstration

CONCEPTS

- Water can be found naturally as a solid, a liquid and a gas.
- Water circulates among these three states in the water cycle.

OVERVIEW

Create a simple model of the water cycle.

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Measuring
- Making and recording observations
- Drawing conclusions

MATERIALS

- plastic shoebox with a clear plastic lid (see SETUP)
- 2 cups sand
- measuring cup, 8 oz
- lamp with incandescent bulb if sunny window is not available
- 20 ice cubes (approx.)

Water is one of the few substances that can be found in all three states—solid, liquid and gas—at any given time somewhere on Earth. For example, snow and ice always are present at the poles, as well as on the tops of high mountains. Liquid water is abundant in many places on Earth, including lakes, rivers, oceans, and underground. Water vapor, the gas phase of water, usually makes up a tiny component of the air around us (up to 5%), and can be observed as steam when liquid water is heated.

When talking about this important resource, we usually think of liquid water. However, if water were not continuously cycling among its three states, the world's stores of freshwater quickly would become depleted or too polluted to use. Fortunately, our supply of freshwater continually is collected, purified and redistributed as part of the water cycle. Also known as the hydrologic cycle, this continuous process replenishes our water sources through precipitation (rain, mist, snow and sleet, for example). Some of the water from precipitation soaks into the ground. The rest runs off into streams, lakes and the oceans. Heat from the sun causes water to evaporate from the land and from bodies of water. Water vapor collects in the atmosphere until there is too much for the air to hold in clouds, leading once again to rain or snow.
This activity allows students to explore properties of water that are important to the water cycle.

SETUP

1. Optional: Instead of conducting this activity as a demonstration, divide the students in groups of 4 and direct each group to set up the investigation. Place a container of sand in a central area, so that groups may measure out the quantities they will need.

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2. An alternative to using clear plastic shoe boxes is to line a cardboard shoebox with aluminum foil. Cover the top with plastic wrap and secure with a large rubber band.

PROCEDURE

Part 1: Making the model

1. Obtain a plastic shoebox with a clear lid
2. Ask for a volunteer to measure out two cups of sand and place them in a pile at one end of the box.
3. Have another student volunteer smooth the sand to create a hill at one end of the box, gradually sloping it toward the other end. This will form the land in the model.
4. Place 20 ice cubes on top of the "land" in the box. The ice cubes will be "snow" and "ice" in the model.
5. Cover securely. (If using a cardboard box, cover the top with a sheet of clear plastic wrap and secure it with a large rubber band).
6. Discuss the model with the class. Ask students what they think is the purpose of the demonstration. Encourage student ideas and discussion.
7. Ask students to predict what will happen if the box is place in a sunny location. Encourage them to elaborate and explain the basis for their prediction.
8. Place the box in a sunny window or a under a lamp with an incandescent (not fluorescent) light bulb. If possible, have the students observe the box at intervals throughout the class period and over the next few days. If you are doing this with several different class periods, you may wish to vary the amount and intensity of the heat source.

Part 2: Looking at results

1. Have the students observe the box without removing the cover. Ask them to note the changes that have occurred inside the box. What happened to the ice cubes? What else is different about the inside of the box? In most cases, at least a few drops of water will have condensed on the inside of the covering. Ask, Where did the drops of water come from?
2. Help students understand that all three states of water have been present in the shoebox. Review the different states in which water can be found—ice or snow (solid), liquid water and water vapor. Breathe on a mirror or piece of glass to show students how water vapor condenses on a surface OR boil a small container of water, so that students may observe the cloud of steam. Hold a glass or mirror above the steam.
3. Remove the cover from the box. Ask students to observe the surface of the sand. Has the surface of the sand changed? Encourage students to elaborate.
4. Talk about where the water in the box has gone. Where was all of the water in the box when we started? Where is the water now? If students have not noticed that the surface of the sand is wet, point out that some of the water has run into the bottom of the box to make a "lake" and some has soaked into the sand. Help students understand that the same processes take place outside when it rains and snows.
5. Ask students to compare the prediction they made at the beginning of the demonstration with the observed results.
6. Facilitate a discussion with students as they compare the model with water cycle. Encourage them to think about anything that has an effect on the way water moves through the environment. How could the model be improved?

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6. Challenge students to think about what would happen if other substances (for example, chemicals, oils, etc.) also were present either on the surface or mixed into the sand.

VARIATIONS

- Have students design experiments to test what happens to chemicals in soil by placing drops of food coloring on the sand in the shoeboxes before adding the ice cubes. Ask them to note where the colors end up in the system.
- This activity also can be conducted using plastic re-sealable bags. Add small amounts of sand and ice to each bag, then tape the bags to a window.

QUESTIONS FOR STUDENTS TO THINK ABOUT

What would happen to the water on our planet if the recycling of water through the atmosphere suddenly stopped? What does this teach us about using this resource wisely?

When water evaporates, any dissolved substances are left behind. What do you think eventually happens to manufactured chemicals that have been mixed into water? How could this be avoided?

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