Weather

Introduction

Before completing these investigations, students should learn about clouds and precipitation, as well as weather-related measurements that can be recorded to monitor weather conditions. This investigation will extend the concepts already developed in the first four weather investigations so that students can develop an understanding of the "weather machine" - how air, water, and heat interact to create weather.

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How can you tell the speed of the wind?

Teaching and Learning Focus

In this investigation, students will begin to develop their concept of how the interaction of moving air (wind) and water can affect heat transfer:

- Water will evaporate more quickly when air is moving rapidly over its surface.
- When water evaporates from a surface (such as your hand), heat is also removed from that surface.

Materials Needed

For each student pair:

- large glass or metal tumbler
- water
- container of water large enough to put a hand inside
- battery-operated fan

For the teacher:

- two alcohol thermometers (can be the blank thermometers used in Investigation 2)
- masking tape
- absorbent cotton
- dropper
- glass marking pen

Safety

This investigation is considered generally safe to do with students, but you will need to make sure that the containers they use for water are unbreakable and that you tape thermometers securely for the demonstration. Please review the investigation for your specific setting, materials, students, and conventional safety precautions.

Setting the Scene

Ask students which of them has gone swimming on a cool and breezy day. What did they feel like when they got out of the water? Were they warmer when they got out of the water than when they went in? What made the difference in how they felt? Take some of their answers and record these on the board or a flipchart. Let students know that they will be investigating how moving air, water and heat work together to drive the "weather machine." Revisit their ideas from this first discussion at the end of the investigation.

Presenting the Investigation Question

Introduce students to the investigation question: "*How can wind and water affect temperature?*"

Have students discuss the question in pairs, then in groups, and then as a whole class. Record their answers on the flipchart.

Have students brainstorm ideas about how to investigate this question:

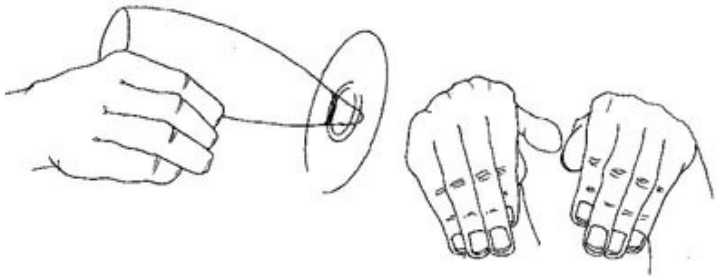
1. Design an experiment that could be used to test the investigation question.
2. What materials would be needed?
3. What would you have to do?
4. What would be measured?
5. How long would the experiment take?

Assessing What Your Students Already Know

Before beginning this set of investigations, review with students the properties of air and the concepts they have developed in the earlier investigations. Recall that they learned about air pressure from the first activity when they noticed that air filled a balloon and made it feel firm and temperature from the second investigation when they learned to measure air temperature with a thermometer. Remind students about air or wind speed and direction from the third investigation. Tell students that in this investigation they will learn how air and water acting together can affect temperature.

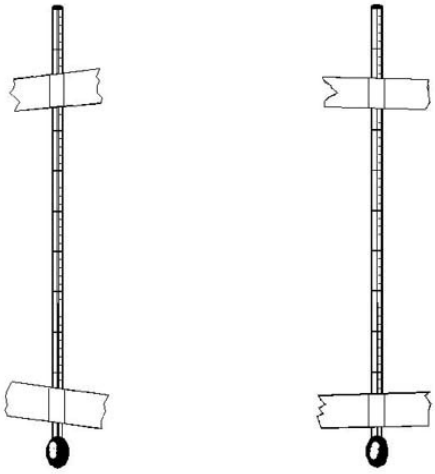
Exploring the Concept

1. Ask students to work in pairs. One student should wet one hand with water and leave the other dry. This student then places both hands in front of him or her. The student's partner then directs the fan on both hands at once for about 30 seconds.



2. After the first student's hands are dry, the students change places and repeat the hand wetting and drying under the fan. Ask the student pairs to talk about their observations of how their hands felt and record them in a few sentences. Ask students to try to explain what they observed. Ask: What do you think would have been the result if you had taken the temperature of each hand after you dried it?

3. It is safest to do this next part of the investigation as a demonstration, as you will be taping thermometers to the wall. Tape two thermometers securely to the wall, side by side. You could also tape the thermometers to a cookie sheet or the side of a box. If the thermometers are unmarked, make a small mark directly on each stem with a glass marking pen at the level of the liquid inside the tube. (*If the thermometers are graduated in degrees, students can record the initial temperature registered by each thermometer*).



4. Cover the bulb of one thermometer with absorbent cotton and tape it in place. Now, direct air from the battery-operated fan at the two thermometers at once. At the end of one minute, ask a student volunteer to check the levels of liquid in each thermometer. Did the temperature change in either one? Ask students to record this result. (*At this point, the thermometers will probably continue to register the same temperature.*)

5. Using the dropper filled with water, soak the cotton on the base of the thermometer. (*Ask students to think about their experiences with the wet hand. Ask for a*

prediction of what will happen when you direct the fan on the two thermometers.) Repeat using the battery-operated fan from Step 2. After one minute, mark or record the temperature in each thermometer. Ask students: Did the temperatures remain the same? (*This time, students will probably notice that the dry thermometer stayed the same and the thermometer with wet cotton registered a lower temperature.*)

6. Ask students to write a few sentences or draw a picture of what they observed in this experiment with the two thermometers.

Applying Students' Understanding

Ask the students why they think that their wet hand felt cooler when the wind (air) blew. Their explanation will probably simply restate the fact that the wind was blowing. You will need to ask: "What happened to the water that was on your hand?" ("It disappeared" is the most likely response.) Help students to refine this response to one that explains that liquid water can become part of the air by the process called evaporation. In this investigation, we found that as liquid evaporates, it removes heat from the surface, lowering the temperature. (A sophisticated explanation involving the energy required for the breaking of hydrogen bonds between water molecules is well beyond the scope of elementary learning goals.) With the evaporation model in mind, students can think about sweating on a hot day, dogs panting to cool their wet tongues, and even the fact that it is not possible to make a fire with wood or paper that is soaking wet.

Next, encourage students to explain their observations of the two thermometers in the second part of the investigation. Why did the thermometer with the wet cotton on its base show a cooler temperature when the fan blew on it? They should be able to connect what they have learned about evaporation to these observations.

Revisiting Investigation Question 1

Complete this investigation by asking students to reflect on this question and how their ideas, which you recorded at the beginning of this investigation, may have changed.

How does temperature affect air pressure?

Teaching and Learning Focus

In this investigation, students will explore the effect of temperature on air pressure:

- Changing air temperature changes the space taken up by the air.
- Changing air temperature changes the pressure exerted by air.

Materials Needed

For the teacher:

- three identical new tennis balls
- access to a refrigerator
- Flip chart and markers
- 2 small toy balloons, same size but different colors
- tape measure or a piece of string long enough to encircle an inflated balloon
- bowl of ice water
- bowl of water at room temperature

Setting the Scene

Put two tennis balls into the refrigerator for two hours. Keep the third ball at room temperature. Take one ball out of the refrigerator and show it to students with the room temperature ball. Tell them which is which and ask them to observe what happens to the balls when you drop them. Drop the balls at the same time from several feet up. Ask students which ball bounced higher and why. Next, drop the second ball from the refrigerator, but don't let the students know if it is warm or cold. Ask them to infer from the ball's behavior whether it has been in the refrigerator or not.

Presenting the Investigation Question

Introduce students to the investigation question: "*How does temperature affect air pressure?*" Have students discuss the question in pairs, then in groups, and then as a whole class. Record their answers on the flipchart.

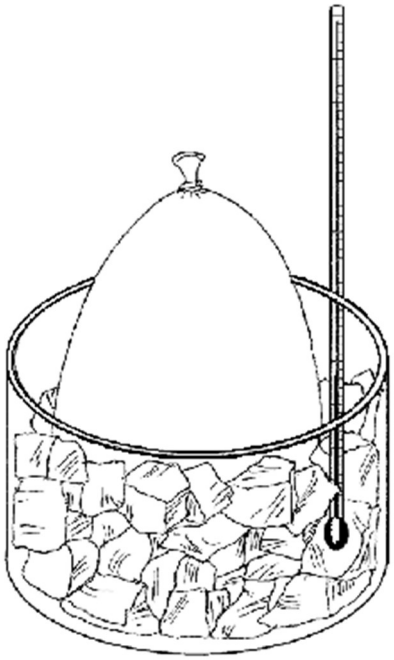
Have students brainstorm ideas about how to investigate this question:

1. What materials would be needed?
2. What would you have to do?
3. What would be measured?
4. How long would the experiment take?

Assessing What Your Students Already Know

Students may have had experiences with sports balls (soccer or beach balls) that get smaller and less firm in the winter time. They may have also noticed that tennis balls don't bounce as high in cold weather as they do in warmer weather. They may not, however, have connected this with air pressure and temperature. This investigation will help them to make that connection.

Exploring the Concept



1. This is best to do as a demonstration with student help. Blow up both balloons to the same size. Show the students how to use the tape measure to measure the circumference of each balloon. (*Alternatively, mark a piece of string with the circumference of one balloon, and attempt to duplicate the circumference on the second balloon.*) The balloons should be as identical as possible in circumference before tying the tops.

2. On the board or flip chart, ask a student volunteer to record the circumference in inches for each balloon using the balloon color for identification.

3. Immerse one of the balloons in the bowl of ice water and the other balloon in the bowl at room temperature. Wait 10 minutes.

4. Ask a student to re-measure the circumference of each balloon, and record this measurement using the color of each balloon for identification. (*The balloon in cold water will be noticeably smaller in size.*)

5. Ask students to write down any ideas they might have to explain what they saw.

Applying Students' Understanding

To assess students' understanding, ask them what they think will happen when you place warm water in your metal cup. (*Empty and dry the cup before filling it with warm water. This time, air will not be cooled, and it will not form liquid condensation on the surface.*)

Revisiting Investigation Question 2

Complete this investigation question by asking students to reflect on "How can clouds form?" and how their answers may have changed as a result of this investigation.

Revisit the Concepts of Weather

Explain to the students that weather describes their surroundings for a short time. Their journals will serve as an excellent record of weather conditions for a given interval of time. Climate, on the other hand, describes a more established pattern of weather conditions. Climate is the long-term average of weather. It is observed over many years and many seasons. The two most important factors in describing the climate of an area are temperature and precipitation.

Climates differ for various locations on Earth. The differences are often related to the proximity to the equator or to the poles, the nearness to oceans and related currents, the position of mountain ranges, and the prevailing wind patterns.

Older students might report on climate patterns for selected locales. A Web search for a country's tourist information generally supplies annual climate statistics for assisting potential travelers in their planning. Related images give clues to the kind of vegetation and animal life in the region.

Digging Deeper

Atmospheric Pressure

Air consists of gas molecules, which are combinations of two or more atoms. Although you cannot see them with your eyes, the molecules are constantly moving this way and that at very high speeds. As they move, they collide with one another and with solid surfaces. The temperature of the air is a measure of how quickly the molecules are moving. The more energy of motion the molecules have, the higher the temperature you feel in the air.
Air temperature is measured with thermometers. Common thermometers consist of a glass rod with a very thin tube in it. The tube contains a liquid that is supplied from a reservoir, or "bulb," at the base of the thermometer. Sometimes the liquid is mercury, and sometimes it is red-colored alcohol. As the temperature of the liquid in the bulb rises, the liquid expands. As the liquid expands, it rises up in the tube. The tube is marked with a scale, in degrees Fahrenheit or in degrees Celsius.

Large masses of air, as much as a thousand miles across, take on certain weather characteristics when they stay at high latitudes (near the poles) or at low latitudes (near the equator) for several days at a time. They may be very cold or very warm, or they may be very humid or very dry. Then, as they move into other areas, they can affect the weather there very strongly. The coldest winter weather in much of the United States is at times when a bitter cold air mass from the high arctic regions of northeastern Asia, Alaska, or northern

Canada sweeps down into the southern parts of North America. At other times, a flow of warm and humid air from the tropics causes unusually warm weather in the eastern United States.

The boundaries between air masses are often zones of very rapid changes in temperature and moisture. Enormous swirling storms tend to develop along these zones of rapid change. On weather maps, cold fronts are shown as lines with triangular teeth. These show where the cold air mass is wedging under the warm air mass. As the warm air is lifted along the front, heavy rain from thunderstorms is common. Warm fronts are shown on weather maps as lines with half-circular teeth. These show where the warm air masses are moving up over the cold air masses. Broad areas of rain are often associated with warm fronts.