NOVA

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Descent into the Ice

PROGRAM OVERVIEW

NOVA follows glaciologists into the underworld of Mont Blanc, where they search for internal lakes.

The program:

- revisits the 1892 disaster in which a hidden lake burst forth from a glacier on the French side of Mont Blanc, killing more than 100 people.
- features glaciologist Luc Moreau, who explores a "water well" (an ice shaft formed by meltwater) to try to predict future flood events.
- explains how a glacier forms.
- relates some of the problems of being in an unstable environment, where water is always changing from liquid to solid and back again.
- follows Moreau into his lab inside Mont Blanc's Argentiere Glacier, where he measures the movement of the glacier and tries to determine where the water flows.
- introduces Carsten Peter, an ice adventurer who explores and photographs ice caves.
- features Peter's dive into a water well inside the Mer de Glace, the largest glacier on Mont Blanc, and shows all the equipment needed to make a dive at extremely cold temperatures and at high altitude.
- shows the methods Peter and Moreau use to try to determine whether there are any interior lakes.

BEFORE WATCHING

1 Tell students that a glacier is a large mass of ice, air, water, and rock debris. Although glaciers are found on all continents except Australia, they are mostly found at the Poles. Help students locate Mont Blanc on a map and discuss the challenges scientists must overcome to study glaciers.

2 Divide the class into three teams. Assign each team one of the three following topics to take notes on while watching: kinds of equipment scientists use to study the glacier at Mont Blanc, techniques they use, and risks they face.

AFTER WATCHING

1 Have a class discussion about how scientists study the glacier at Mont Blanc. Ask volunteers from each team to report on their notes from the program. (Scientists use a combination of cave-diving and coldwater-diving equipment to explore "water wells." They use ice tools like crampons, ice axes, and ice screws. To measure the movement of a glacier, one scientist uses a bicycle wheel mounted on a cantilever. Risks include swimming in near-freezing water, the possibility that part of the glacier could collapse on top of them, and the possibility of a surge of water drowning them.)

2 Ask students how they would feel living in a village near Mont Blanc. Why do people live in high-risk areas, such as near volcanoes, on the beach, or in an area prone to earthquakes? What steps could be taken in advance to limit the potential losses of a catastrophic event?

CLASSROOM ACTIVITY

Objective

To investigate the phase change of water turning into ice.

Materials for each team

- copy of the "Is It Icy Water or Watery Ice?" student handout
- copy of the "Experiment Data Sheet" student handout
- alcohol thermometer with a low point of –10° C or less
- 2 150-mL beakers
- 20-mL test tube
- 8-oz foam coffee cup
- 16-oz foam coffee cup
- crushed ice
- ice water
- room-temperature water
- salt
- spoons: teaspoon, tablespoon, plastic spoon
- stopwatch
- paper towels
- graph paper

Procedure

1. Understanding water and ice helps scientists study glaciers. Some glaciers contain water wells. Tell students that in this activity, they are going to investigate how ice and water can coexist.
2. Organize students into teams and provide each team with a copy of the student handouts and other materials. Have teams appoint one person to run the experiment, one to be the timekeeper, and one to be the recorder.
3. Have students prepare their ice/salt baths and run the experiment according to directions on their handouts. The student performing the test will pull out the test tube once every minute to check for ice formation. Make sure students do this as quickly as possible so the air does not warm the water in the test tube. Students should run the experiment for 12 minutes.
4. When students are ready to clean up, have them put the test tube in warm water to melt the ice and free the thermometer.
5. Ask students to graph their results with time on the *x*-axis and temperature on the *y*-axis. What did they find? What do the results show about how water turns into ice and why the two may be able to coexist simultaneously?
6. As an extension, repeat the experiment but reverse the procedure. Have students place a thermometer that has been frozen in a test tube in a cool water bath and plot the temperature change as the ice in the test tube melts into water. How do student graphs compare to those in the initial experiment?

STANDARDS CONNECTION

The "Is It Icy Water or Watery Ice?" activity aligns with the following National Science Education Standards.

GRADES 5–8

Science Standard B:

Physical Science

Properties and changes of properties in matter

- A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

GRADES 9–12

Science Standard B:

Physical Science

Structure and properties of matter

- Solids, liquids, and gases differ in their distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.

Video is not required for this activity.

Classroom Activity Author

James Sammons has taught middle and high school science for 30 years. His teaching practices have been recognized by the National Science Teachers Association, the Soil Conservation Service, and the National Association of Geoscience Teachers.

ACTIVITY ANSWER

In this activity, students see ice and water coexist. It helps them understand how glaciers can have interior lakes.

Students will observe that the temperature of the water drops, then remains constant as the water and ice coexist, and then drops again once the water has turned into ice.

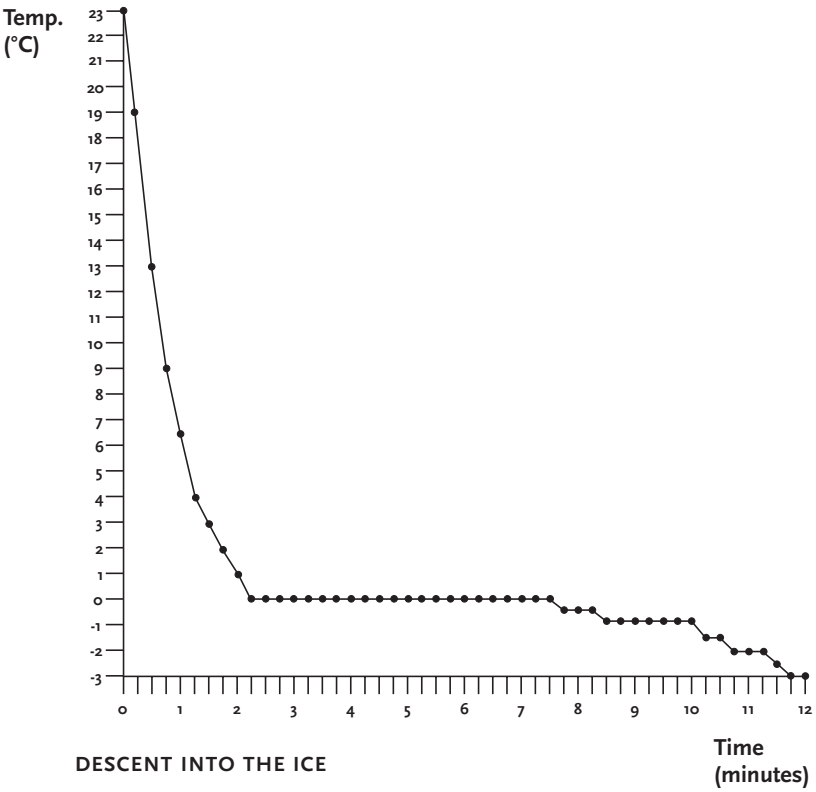
The following process occurs: When energy (heat) is transferred from the water in the test tube to the ice/salt bath mixture, the temperature in the test tube starts to fall. At 0° C, ice crystals begin to form. At this time, the water must lose an additional amount of energy to form ice crystals. The time required to lose this added energy is indicated by the flat section of the graph. During this period, all of the energy is being spent on changing the state of matter (water into ice) and not on changing the temperature. Any decrease in temperature initiates more ice crystal formation, which in turn releases energy that prohibits the temperature from falling below 0° C. Only after all of the water has turned to ice will the temperature again begin to drop.

Students may find that their water freezes at a temperature other than 0° C. This is likely due to thermometer inaccuracy—many thermometers have an uncertainty of plus or minus one or two degrees.

Students may think that their water is frozen, when in fact only the outside edge is frozen. Remind them that as in a natural body such as a lake, the surface freezes first. The sides and bottom also freeze first because in this experiment they are in closest contact with the ice.

If students started out with more water in their test tubes, the flat section on the graph would extend, as there would need to be more heat lost before all of the water could freeze.

SAMPLE RESULTS



DESCENT INTO THE ICE

LINKS & BOOKS

Links

NOVA Web Site—Descent into the Ice
www.pbs.org/nova/mtblanc/
In this companion Web site for the NOVA program, find out how Earth's glaciers are holding up, learn about glacial hazards worldwide, explore an ice climber's gear, and follow the life cycle of a glacier.

Glacier
www.glacier.rice.edu/
Provides background information on glaciers and shows what it is like to work at a scientific research center in Antarctica.

The Glacier Story
nsidc.org/glaciers/story/page1.html
Tells how a glacier forms, moves, and retreats.

Book

Hambrey, Michael and Jürg Alean. **Glaciers.** Cambridge, England: Cambridge University Press, 1992.
Discusses how glaciers form and move, outlines the different types of glaciers, and provides photographs of glaciers around the world.

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Is It Icy Water or Watery Ice?

You are familiar with ice and water coexisting—ice on a pond or ice cubes in your drink. But where is the point at which water turns into ice, or ice into water? In this activity you will study the borderline between water and ice.

Procedure

1. Choose one person in your team to run the experiment, one to be the timekeeper, and one to be the recorder.
2. Fill one beaker with ice water and one beaker with room-temperature water. Put ice in the 16-ounce foam cup.
3. Make an ice/salt bath in your 8-ounce foam cup. Put 2 tablespoons of ice water in the cup, add a teaspoon of salt, and stir well with your plastic spoon. Add ice in halfway up the cup and stir well again.
4. Add 3 centimeters of room-temperature water to your test tube. Place the thermometer in the water for 1 minute and then record the temperature in the data table on your "Experiment Data Sheet" handout. Hold the test tube at the top as you do this so that your hand does not increase the temperature of the water.
5. Place the test tube all the way into the foam cup, and have the timekeeper start timing when you do so. Don't let any ice get in the test tube.
6. Record the temperature every 15 seconds. Once each minute, the student running the experiment should quickly pull out the test tube to see if any ice has formed, and the recorder should note the tester's observations.
7. At the end of every 3 minutes, the recorder should add more ice to make up for any ice that has melted. Ice can be added all the way to the top of the cup.
8. Continue the experiment for 12 minutes.
9. When you finish, put the test tube in warm water to melt the ice and free the thermometer.
10. Using your graph paper, graph your results with time on the *x*-axis and temperature on the *y*-axis.

Questions

Write your answers on a separate sheet of paper.

1. What was the temperature of the flat section in your graph?
2. How long did the temperature stay the same? Why do you think it remained the same?
3. Why do you think the temperature began to fall again at the end of the flat section?
4. What can you conclude about the temperature when you had a liquid-only state? A solid-only state? What about when both states coexisted?
5. How would the shape of the graph change if you started with more water in the test tube? Explain your reasoning.

Experiment Data Sheet

Initial temperature_____

Time (min.)	Temp. (°C)	Time (min.)	Temp. (°C)	Time (min.)	Temp. (°C)	Time (min.)	Temp. (°C)
0:15		3:15		6:15		9:15	
0:30		3:30		6:30		9:30	
0:45		3:45		6:45		9:45	
1:00		4:00		7:00		10:00	
Observations:		Observations:		Observations:		Observations:	
1:15		4:15		7:15		10:15	
1:30		4:30		7:30		10:30	
1:45		4:45		7:45		10:45	
2:00		5:00		8:00		11:00	
Observations:		Observations:		Observations:		Observations:	
2:15		5:15		8:15		11:15	
2:30		5:30		8:30		11:30	
2:45		5:45		8:45		11:45	
3:00		6:00		9:00		12:00	
Observations:		Observations:		Observations:		Ice observations:	
ADD MORE ICE		ADD MORE ICE		ADD MORE ICE