Elements of Chemistry
Solids, Liquids, and Gases
Teacher's Guide

Grade Level: 9–12	**Curriculum Focus**: Physical Science	**Lesson Duration:** Two class periods

Program Description

Investigate the different states of matter to understand the kinetic-molecular theory and which variables determine the state of an element or substance.

Lesson Summary

Students consider the differences between melting glaciers and melting icebergs and predict whether they have a different effect on the potential for rising sea levels. Then they conduct a simple investigation to observe what happens when ice submerged in water melts. They note that the water level does not change significantly. By applying this finding to the real world, students conclude that melting icebergs, which float on the water, will not have as much of an impact on rising sea levels as glaciers, which move slowly across the land.

Onscreen Questions

Part 1, "The Gaseous State," "A Matter of Fact," and "Liquids, Solids, and Something in Between"

- What are some characteristics of gases?
- What are some characteristics of water?

Part 2, "Understanding Ice"

- How has ice shaped Earth's surface?
- What is the effect of melting glaciers and ice caps?

Lesson Plan

Student Objectives

- Predict whether melting icebergs have the same impact on rising sea level as melting glaciers.
- Conduct an experiment to discover the effect of melting icebergs on sea level.
- Write a conclusion about the role of melting glaciers and icebergs on rising sea level.

Materials

- *Elements of Chemistry: Solids, Liquids, and Gases* video
- computer with Internet access
- newsprint and markers
- paper and pencils

Decide beforehand how you would like to handle distributing the materials for the investigation. One student from each group can come up to a central area to collect the materials, or you can hand out the materials to each group. Each group will need the following:

- graduated cylinder
- water
- one chip of ice

Procedures

1. Begin the lesson by asking students to write on a piece of scrap paper whether they think there is a difference between ice melting on land, or glaciers, and ice melting on water, or icebergs. If possible, have students write down any scientific evidence they know of in support of their ideas. Then ask students to put the piece of paper away until the end of the lesson.
2. Pose this question to students:

   Scientists are worried about the effect of polar ice melting. The melting ice will cause ocean cooling and a decrease in the saltiness of the water. Also, melting ice will raise the sea level and could flood low-lying areas, including cities. However, scientists are less concerned about melting icebergs than about melting glaciers. Why is this the case?

3. Tell students that they will work in small groups to answer the question. Then divide the class into groups. Give them a few minutes to think about the question and discuss their initial ideas. Ask students to predict why melting glaciers are more serious than melting icebergs. You may want to give students the following hint: *Glaciers are on land, and icebergs float on water. Why does this make a difference?*
4. Explain to students that they will conduct a short experiment to help them answer the question. Make sure that the groups have the necessary materials and ask them to follow these directions:

   - Put water in a graduated cylinder.
   - Then put a piece of ice in the water. Note what happens.

- Observe the ice. What happens when it melts?
- Observe the level of the water. Has it changed?
- What does this experiment tell you about icebergs?

5. After students have completed the investigation, give them time in class to think more about what the experiment shows and what it tells them about melting glaciers and icebergs. To add to their knowledge, have them watch the segment "Understanding Ice" in the video *Elements of Chemistry: Solids, Liquids, and Gases*. Students also visit the following Web sites for additional information.

- http://www.uncw.edu/tc/antarctica/questions2_8.htm
- http://www.factmonster.com/ipka/A0781668.html
- http://www.nasa.gov/centers/goddard/news/topstory/2003/1023esuice.html
- http://whyfiles.org/238earthday/index.php?g=2.txt

6. During the next class, have a discussion about the question posed at the beginning of the lesson and the investigation. Make sure students understand the following:
   - The melting of glaciers is of greater concern to scientists than the melting of icebergs because they are on the land. While heat from the sun is reflected equally by ice on the land and on the water, the land tends to hold onto the heat longer than the water does. As a result, the loss of ice on land is more significant because sunlight that previously had been reflected by the ice is now absorbed. As the planet absorbs more heat, the temperature rises, causing more melting and more heat. The end result is a warmer planet with greater potential for rising sea levels.
   - Icebergs floating on the water create a different situation. Because much of the iceberg is underwater, the sea level doesn't rise significantly as it melts. The ice in the graduated cylinders was a good model. But if the temperatures increased enough to cause significant melting of icebergs, glaciers on land would melt, resulting in higher sea levels.
7. During the next class period, spend more time reviewing the experiment and what it reveals about the effect of melting on ice in water. Give students time to ask questions and discuss these ideas.
8. Conclude the lesson by asking students to revisit the notes they recorded at the beginning of the lesson. Now that students know more about ice and how it melts on land and water, ask them to consider modifying their initial ideas. Do students have any new ideas they would like to add to their sheet?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Students made a thoughtful prediction about the difference between melting glaciers and melting icebergs; conducted the experiment carefully and made precise observations; and applied conclusions from the experiment accurately to a real-world situation.
- 2 points: Students made a reasonable prediction about the difference between melting glaciers and melting icebergs; conducted the experiment satisfactorily and made some observations; and applied conclusions from the experiment somewhat accurately to a real-world situation.
- 1 point: Students had difficulty making a prediction about the difference between melting glaciers and melting icebergs; had difficulty conducting the experiments and making observations; and had difficulty applying conclusions from the experiment to a real-world situation.

Vocabulary

calving

Definition: The breaking off a piece of ice from a glacier, which often lands in the sea and becomes a floating iceberg

Context: Calving can result in icebergs in the ocean, which can pose danger to ships.

glacier

Definition: A large body of ice that moves slowly over the land, changing its surface

Context: During very cold periods known as ice ages, large glaciers covered much of the surface of Earth.

global warming

Definition: The slow increase in Earth's temperature thought to be caused by human activities; the release of large amounts of gases that trap the sun's heat, resulting in change in climate

Context: While some scientists are convinced that global warming is taking place, others think that the increase in temperature is a result of natural fluctuations in climate.

iceberg

Definition: A large ice mass floating in the sea

Context: Because icebergs are about 90 percent submerged in water, their melting does not cause a significant rise in sea level.

rising sea level

Definition: An occurrence that could take place as a result of the rising temperatures on Earth and the melting of glaciers; less ice means that more heat is absorbed, causing the water levels in the sea to rise

Context: The rising sea level is of great concern because it could affect coastal topography and the people living in many areas.

Academic Standards

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K–12 to promote scientific literacy. To view the standards, visit this Web site: http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following national standards:

- Physical Science: Properties and changes of properties in matter
- Physical Science: Structure and properties of matter

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K–-12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/.

This lesson plan addresses the following national standards:

- Earth Sciences—Understands atmospheric processes and the water cycle
- Language Arts—Viewing: Uses viewing skills and strategies to understand and interpret visual media

DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How To Use the DVD

The DVD starting screen has the following options:

***Play Video*—**This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

***Video Index*—**Here the video is divided into sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video from start to finish. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

***Curriculum Units*—**These are specially edited video segments pulled from sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

***Standards Link*—**Selecting this option displays a single screen that lists the national academic standards the video addresses.

***Teacher Resources*—**This screen gives the technical support number and Web site address.

Video Index

I. The Gaseous State (6 min.)
Examine the properties and characteristics of gases and learn about the scientific laws describing their behavior.

II. A Matter of Fact (4 min.)
Explore the assumptions behind the kinetic-molecular theory of matter and see how it explains the behavior of matter in each of its three states.

III. Liquids, Solids, and Something In-Between (5 min.)
Learn about the unique properties and characteristics of water in its three states while investigating other solids, liquids, and gases.

IV. Understanding Ice (33 min.)
Discover the scientific discoveries that Antarctic ice samples have revealed, how melting sea ice affects the climate, and how some frogs have adapted to surviving a deep freeze.

Curriculum Units

1. History and Properties of Gases
Pre-viewing question
Q: What are some uses of different gases?
A: Answers will vary.

Post-viewing question
Q: What four variables influence the behavior of gases?
A: Pressure, volume, temperature, and amount of gas

2. Solids, Liquids, and Gases
Pre-viewing question
Q: What are the differences between solids, liquids, and gases?
A: Answers will vary.

Post-viewing question
Q: What are the three basic assumptions of the kinetic-molecular theory of matter?
A: The kinetic-molecular theory examines the intermolecular forces between the particles and the energy they possess. The theory relies on three basic assumptions: 1. matter is composed of small particles (either atoms or molecules), and the distance between the particles determines the state of the substance; 2. particles are in constant motion; and 3. motion is different for each state of matter.

3. Water and Other Matter
Pre-viewing question
Q: What are some uses of water in its solid, liquid, and gaseous states?
A: Answers will vary.

Post-viewing question
Q: Why does water have a higher boiling point than other liquids?
A: Relative to other liquids, water has a high boiling point thanks to its strong intermolecular bonds. A water molecule is two hydrogen atoms linked with an oxygen atom, and inside is a strong bond. A strong attraction also occurs between water molecules because hydrogen atoms in one water molecule are attracted to atoms of oxygen in another. Because this intermolecular force is so strong, a lot of heat is required to pull apart the water molecules to become a gas.

4. Monitoring Sea Ice
Pre-viewing question
Q: How would you describe ice?
A: Answers will vary.

Post-viewing question
Q: How have the conditions of ice north of the Arctic Circle changed?
A: Over the past few decades the amount of sea ice in the Arctic has decreased by more than five percent, and in general the ice has thinned.

5. Glacial Changes
Pre-viewing question
Q: What are some characteristics of glaciers?
A: Answers will vary.

Post-viewing question
Q: What are glaciers? How does snowfall affect their movement?
A: Glaciers are rivers of ice powered by gravity that are always on the move. When chilled water molecules find something to grab onto, ice crystals are created. When enough snow piles on a mountain over time, it compacts into a mound of ice that is forced to move. The more snow accumulating on a glacier, the more the glacier advances. Less snow and more melting mean that a glacier is likely to shrink or retreat.

6. The Threat of Icebergs
Pre-viewing question
Q: Why are icebergs considered dangerous?
A: Answers will vary.

Post-viewing question
Q: How can an iceberg float?
A: When liquid water freezes, it takes up more space but its given volume does not weigh as much. So ice is buoyant and able to float in the heavier liquid water.

7. Surviving a Deep Freeze
Pre-viewing question
Q: Describe frostbite and its effects.
A: Answers will vary.

Post-viewing question
Q: How can wood frogs survive a deep freeze?
A: Unlike most living creatures, a wood frog's system can handle and produce massive quantities of glucose. The frog breaks down stored compounds and makes glucose when ice enters its body; large amounts pour out of its cells into the blood, where they are moved to

tissues and organs. This glucose keeps ice from forming, which protects the cells and allows it to thaw from the inside out.

8. Icy Signs
Pre-viewing question
Q: What do scientists learn from studying Antarctic ice?

A: Answers may include how the climate and atmosphere have changed over time or how to predict future global changes.

Post-viewing question
Q: Describe changes that have occurred in the West Antarctic ice sheet.
A: Over the last 20,000 years, it lost two-thirds of its mass and raised sea level by about 33 feet.