State of Ice

Unit: Henry as Naturalist
Topic: Observation, natural phenomena, states of matter

Thoreau Quote

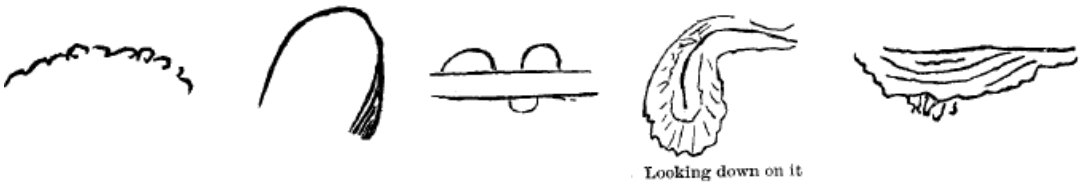
"The ice in the pond at length begins to be honeycombed, and I can set my heel in it as I walk."

—*Walden*, "Spring" (1854)

"At the fall on Clematis Brook the forms of the ice were admirable. The coarse spray had frozen as it fell on the rocks, and formed shell-like crusts over them, with irregular but beautifully clear and sparkling surfaces like egg-shaped diamonds, each being the top of a club-shaped and branched fungus icicle."

—*Journal*, January 26, 1853

In the January 26, 1853 journal entry above, Thoreau goes on to further describe the ice, and even does some drawings of the different ice formations he observes:



Background

Thoreau explored the outdoors, interacted with Nature, and noted his observations in every season and every weather condition. He writes extensively about ice, in fact. He observes the formations it creates as it freezes and melts, how it interacts with objects around it, what time of year it begins to melt, and even the sounds it makes as it melts.

Objectives

1. To observe ice closely, through the process of melting
2. To understand the different states of matter
3. To write a thoughtful summary of observations

Method

Students will collect pieces of ice (from outside, if possible) and use their field notebooks to make observations about the ice in a frozen state and about the changes it undergoes as it melts to a liquid state.

Time Required

45-60 minutes

Materials

- Pieces of ice (no larger than an inch or two on any side); if you live in a cold climate, this exercise is best done with pieces of ice that the students can collect on school grounds during the winter. If not, bringing in ice made in an ice tray or by some other means will work.
- Plate or tray that is at least 4 inches round or square, with a lip, so as to collect liquid (best if it is a solid, dark color)
- Hair dryers, optional
- Measuring cups for liquids (or science beaker with measurement marks)
- Rulers or measuring tape
- Field notebooks and pencils

Procedure

1. Break class into groups of 2-5 students each.
2. If in a cold climate with recent snow or access to ice that can be easily broken off into sizes no larger than about half of their palm, take students out to where they will be able to collect pieces. Before they go indoors, have them write observations about their piece of ice as they found it: Where was it found? What surrounded it? What were the weather conditions that day? Have them describe their piece of ice and even draw a picture of it in their field notebook. Before going indoors, make sure you have collected as many pieces of ice as there are groups.
3. Once inside, please each piece of ice on a tray/dish that will collect water (solid, dark colors are best for this).
4. Ask students to measure their piece of ice, as accurately as possible.
5. Have students watch the piece of ice as it (slowly!) melts before their eyes.
6. Experiment with how noticeable changes are when they are watching the piece constantly as opposed to when they look away for 5 or so minutes.
7. Every five minutes (or other increment), ask them to write in their notebooks about the changes that are taking place. Make sure they record the time along with their observations. (You can give them the tip that they might hear sounds associated with the melting or let them discover this on their own.) You might ask them to draw a picture of the ice every five (or so) minutes, as well.

8. When each group's ice is fully (or mostly) melted, have each group of students measure the amount of water that melted by pouring it into a beaker or measuring cup. Have them plot all of the data on a graph and compare the results of each piece of ice (3rd grade). Have the students convert their measurements to different units within the same measurement system (4th grade). Have the students convert their measurements into a different measurement system (5th grade).
9. Have the students share their observations.

Reflect and Explain

- Did you observe the "honeycomb" appearance that Henry David Thoreau observed on the pond? Did you observe any other shapes/designs in the ice formation? Did you hear sounds from the ice?
- What can they glean about ice and the melting process from those observations? What happened to the size and shape of the ice as it melted? Do molecules move faster or slower and are they closer or further apart when the ice melts into water?
- Why would paying attention to ice formation and freezing be important during Thoreau's time? Why might it be important for us today?

Extensions

1. As the pieces of ice are melting, have the members of each group rotate so each group gets a chance to see each other piece of ice. Ask them to compare and contrast what was happening with the different pieces. What might have caused any differences that they observed?
2. Include a lesson about ice cutting in Thoreau's time. (Handout forthcoming)
3. Allow the water to sit for a few days and bring them back to the plates/dishes to discuss evaporation and gasses.

Vocabulary

condensation – changing from a gas phase to liquid phase.

deposition – moving from the gas to the solid state/phase.

freezing – moving from the liquid to the solid state.

freezing point - the temperature at which a liquid turns into a solid when cooled.

fusion - the act or process of melting or making fluid by heat.

melting - moving from the solid state/phase to the liquid state/phase

melting point - the temperature at which a solid melts.

phase of transition – The period when a material is changing from one state of matter to another, which is usually because of temperature or pressure change. A phase transition is a physical change (or reaction).

states of matter - the physical state of the molecules and atoms; they can also be called phases of matter. The states of matter are solid, liquid, and gas. Solids are often hard and brittle. Liquids are fluid, can move around a little, and fill up containers. Gases are always around you, but the molecules of a gas are much farther apart than the molecules in a liquid.

sublimation - moving from the solid to the gas state/phase.

vaporization – changing from a liquid phase to a gas.

Common Core Standards

English Language Anchor Standards (all grades)

- CCSS.ELA-LITERACY.CCRA.W.2
  Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
- CCSS.ELA-LITERACY.CCRA.W.7
  Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- CCSS.ELA-LITERACY.CCRA.SL.1
  Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- CCSS.ELA-LITERACY.CCRA.SL.2
  Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
- CCSS.ELA-LITERACY.CCRA.SL.4
  Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
- CCSS.ELA-LITERACY.CCRA.L.1
  Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
- CCSS.ELA-LITERACY.CCRA.L.3
  Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
- CCSS.ELA-LITERACY.CCRA.L.6
  Acquire and use accurately a range of general academic and domain-specific

words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

Math Practice Standards (all grades)

- CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.

Grade 3 Content Standards

- CCSS.MATH.CONTENT.3.MD.A.1
  Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.
- CCSS.MATH.CONTENT.3.MD.A.2
  Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).[1] Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.

Grade 4 Content Standards

- CCSS.MATH.CONTENT.4.MD.A.1
  Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...*

Grade 5 Content Standards

- CCSS.MATH.CONTENT.5.MD.A.1
  Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.