

OLCG Supplementary Unit on Snow
Snow Pits Lesson Plan

Topic: Snow

Target Level: 4th grade

Performance Standards:

Alaska Science A2-Level 2 - Students observe physical and chemical properties of common substances and observe changes to those properties (note - this lesson deals only with physical properties i.e. temperature, shape, size, color, density, hardness)

Alaska Science B1-Level 2 - Students observe, measure and collect data from experiments and use this information in order to classify, predict and communicate about their everyday world

Alaska Math Measurement Ages 8-10 - estimate and measure weights, lengths, and temperatures to the nearest unit using the metric and standard systems.

Alaska Math Statistics and Probability Ages 8-10 - (1) collect organize and display data creating a variety of visual displays including tables, charts and line graphs; (2) present the data using a variety of appropriate representations and explain the meaning of the data

Target Concept:

The physical properties of snow can change due to heating, cooling, and physical forces such as pressure and friction

Teacher Background Information:

Snowflakes begin as delicate crystals but are soon transformed into the granular crystals and lumps of ice that are found within and at the bottom of layers of snow. The process by which snow crystals change in composition or structure is known as *snow metamorphism*. Pressure and temperature are the two most influential agents of change.

Pressure: Snow crystals change due to the physical compaction of snow under its own weight as well as under the weight of human or animal traffic on top of the snow. During such *pressure metamorphism*, snow crystals get pressed together and interlock more closely resulting in decreased snow pack thickness and increased snow pack density and strength.

Observing Locally, Connecting Globally

Temperature: Obviously, melting and re-freezing cause changes in snow crystals, but snow changes even when temperatures are relatively constant. Constant molecular activity causes “evaporation of the many fine points that form angles between the delicate crystals. This evaporation makes the air around the crystals very moist. The moisture re-condenses (because of the coldness) and deposits particles of ice onto the flatter, smoother surfaces of the crystals. It is this continuous evaporation from sharper points and condensation onto flat places which transforms the crystals into little lumps of ice.”¹

Temperature Gradient: Often there is a difference in temperature between the snow at the bottom and top layers of the snow pack. In winter, when air is very cold, the snow at the surface of the snow pack is colder than the snow near the ground. This is because snow is a very good insulator, insulating the ground from the colder air temperatures. When the ground is warmer than the snow above it, water vapor is produced. This vapor can then rise and re-condense, creating characteristic, large, cup-shaped crystals known as *depth hoar*. In the spring, the temperature gradient may be reversed, with temperatures warmest at the top of the snow pack and colder at the bottom. Warmer conditions may also cause the temperatures to be consistent throughout the snow pack.

Snow Layers: As snow accumulates and changes over time, it develops layers of snow marked by their physical differences and reflecting the “life history” of the snow pack. . These layers are often broadly classified as *new snow*, *firn* and *depth hoar* (but careful observers often distinguish other layers within these categories) In general the *new snow layer* consists of new sharp crystals lying loosely on the top of the snow bank and slowly being compacted by additional falling snow. Just below the *new snow* is a layer called *firn*. The firn consists of crystals that have lost their sharp edges due to evaporation, freezing and compaction. They are now rounded into more sphere-like shapes, in time becoming particles of ice. This snow is dense and the grains are more closely bonded together, which increases the mechanical strength of the firn layer. At the bottom of the snow bank is the *depth hoar* layer consisting of snow crystals that have metamorphosed into lumps of ice through evaporation, condensation and compaction. This layer is more weakly bonded than either the firn or new snow layers. The depth hoar layer is loose and grainy. The crystals sift through your fingers and it is often nicknamed “sugar snow.”

Snow Density: Through most of the winter, snow density will usually increase deeper into the snow pack, until reaching layers where depth hoar has formed. Since the depth hoar layer is loose and grainy, these layers have lower densities. When warmer temperatures occur, the strength and density of the entire snow pack increases due to compaction.

¹ Minnesota Environmental Sciences Foundation, Inc., *Snow and Ice - An Environmental Investigation* National Wildlife Federation, p. 7

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Affects on Animals: Small mammals such as mice, voles and lemmings depend upon the insulating value of snow. Although at least 3 feet of snow assures adequate warmth, as little as 6 inches provides some advantage. Small mammals can easily tunnel through loosely packed depth hoar crystals formed at the base of the snow pack and thereby take advantage of warm temperatures in the snow / ground interface. This “subnivian” environment reduces the effect of wind, extreme temperature variations and predation. Food such as roots, stems, buds and carrion are abundant.

Materials:

For the Field	In class
<ul style="list-style-type: none">• Flat snow shovels• Thermometers• Felt boards• Soft paintbrushes• Meter Stick• Markers for layers• Data Sheet/Clipboard• Pencils• Hand lenses	<ul style="list-style-type: none">• Completed Data Sheets• Chart-size Copy or Overhead Transparency of Data Sheet• Chart-size Copy or Overhead Transparency of Snow Height/Temp Graph• Colored Felt Markers

Procedure:

Gear Up:

Explain that students will be exploring the properties of snow by investigations in snow pits. Ask and record what they already know or think they know about snow. Prompt with questions such as: Do you think that the snow will be the same temperature at all levels? Do you think that snow will have the same shape and consistency throughout? Do you think that the air, snow or ground level will be the same temperature?

Make a sketch of the schoolyard on the board and either assign or let teams choose a site to investigate. Indicate roughly where these sites will be on the map and identify teams. Before teams go outside, pass out task cards and go over so that students understand their jobs. Be sure a recorder is chosen for each team. After all the data are collected, return to class for the generalize/apply discussions.

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Explore #1 - Site Preparation

1. Dig a ~ 1 x 1.5 m pit out to ground level being sure that one wall faces south.
2. Cut the south wall of the pit trench carefully. Try to keep it vertical. This will be the observation site.
3. List the main qualities (vegetation type and slope) of the site on the data sheet.

Generalize: (indoors)

Ask the students to describe their sites. Ask them how the sites are Alike/different? Ask them how these differences might affect physical properties of snow?

Explore #2 - Snow depth:

1. Measure the depth of your snow bank from the ground level to the top using your meter stick.
2. Measure and record the depth in three different places along the wall of your trench.
3. Determine and record average depth on data sheet.

Generalize: (indoors)

Assign a pen color to each team and create legend identifying Site/pen color. Ask students to record snow depth information on class chart using appropriate pen color. . Ask what they you notice about depth at different sites? Which has the deepest snow? The most shallow? Is there anything about the nature of your site that might relate to these differences?

Explore #3 - Snow Temperature

1. General directions – insert the thermometer horizontally into the snow pack and let the thermometer equilibrate for 3 minutes at each location. Quickly read and record temperature readings on the data sheet each time you remove a thermometer.
2. Start at the ground level. Gently place thermometer into the snow bank, as close to the ground as possible. Try to keep thermometer as close to horizontal as possible.
3. Snow pack: Take snow temperatures every 20 centimeters by completely inserting the thermometer into the wall of the trench.
4. Surface: Slide thermometer beneath the surface of snow, so it is just covered. Shade with shovel.
4. Air: let thermometer dangle in the air of the trench shaded from the sun.

Generalize:

Ask a team representative to graph their teams snow temps vs. depth on class chart using appropriate color pen.

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After all teams have graphed their data on the class chart, ask what they notice about the snow temperatures at different heights? Sites? Was the temperature at the bottom of the snow pack warmer? Is there any consistency between sites with regard to snow depth and snow temperature? Were the results consistent with student predictions? How might you explain these data?

Explore #4 - Snow Layers/Hardness

1. Use your eyes to carefully observe the layers of your wall. How many layers can you see? How are the layers different? Alike? Record observations.
2. Slowly "slice" the wall of your trench from top to bottom with your stake, paying close attention to changes in resistance.
 - Did the snow feel the same all the way down?
 - Was it harder or easier to slice at any particular place?
 - Did you meet any resistance which could indicate an ice layer?
3. Insert stakes horizontally at the top of each layer.
4. Measure the height of the top of each layer from the ground surface up. . This may work best with two people; one person holds a meter stick while the other reads and records the measurement.
5. Record an "H" on the profile sheets for any layer that felt hard.

Generalize: (indoors)

Ask teams to record their measurements and observations on the class data sheet.

Ask: What did you observe about snow layers with your eyes? When you sliced through the snow bank? Were any hard layers discernable? How might you explain these layers?

Explore #5 - Snow Crystals

1. Observe and draw snow crystals within each layer of the snow pit. Use paintbrush to move crystals onto black felt board and examine crystals with hand lens.
2. Try to draw accurate pictures of the crystals. Measure them if appropriate.
3. Record observations. If there are several different types of crystals in one layer, record the most common.

Generalize:

Ask teams to enter data on the class data sheet.

Ask: What do you observe about snow crystals in the different layers. What kinds of crystals could you identify? Did snow crystal types within layers seem to be homogeneous? What is your evidence?

What kinds of events/forces might explain the changes you observe?

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Apply/Assess:

1. Pretend you are a snowflake and tell your life story beginning with falling to the ground. Consider including:

- What you look like as you fall and land.
- Where you land in the snow bank. (Are you part of the first fall snow storm or part of a spring storm, or somewhere in between)
- How you affect the snow around you and how it affects you?
- Who or what has walked over, under or through you.
- What the temperatures have been and how temperatures have affected you.
- How your appearance has changed and why.

You may write, sing, draw or act out your story.

2. How do you suppose well-packed snow machine trails affect living things?
3. If you were stuck outdoors without water, which layer of snow would you choose to melt for drinking and why?