The Science of Snow

Experiment

Studying snow and the snowpack is an engaging, hands-on winter activity for students. It is fascinating for them to identify a freshly fallen crystal, record the temperature profile, or measure the depth of new snow to compare it with the season's evolving snowpack. This activity provides the resources you need to make snow study easy and accessible, no matter where you live.

Materials:

☐ **Datasheet:** Printed copies of the Snowpack Investigation Datasheet

☐ **Snow Study Equipment**: Loupes or Magnifying glasses, snow crystal plates, snow measuring tapes or metre sticks, digital thermometers)

☐ **Shovels**: small avalanche shovels work best

Instructions:

1. **Plan for Replication**: Though this can work as a stand-alone activity it is best executed as a series of snow profiles. Begin your observations early in the winter and then replicate the study two or three times (or more) to track changes.

2. **Create Student Crews**: Break your class into working groups of about four students each. This size creates an efficient crew for digging the snow pit, collecting and recording observations.

3. **Record the Weather**: Examining the weather is a core component of the datasheet. These observations have been simplified to accommodate the dynamic nature of teaching outdoors (and to account for cold fingers writing down data). Students will assess four weather factors that affect the quality and integrity of the snowpack: **Sky, Surface Conditions, Wind and Precipitation**.

4. **Dig a Demonstration Pit**: At first glance the snow might look completely uniform; however, close observation reveals distinct layers, densities, and characteristics. It is best to dig a demonstration pit down to ground with a smooth, clean back wall. Gather students around this demo pit to explain each of the five core areas of study and how to use the **snow study equipment.**

5. **The Snowpack Investigation Observation Datasheet** is divided into 5 columns and areas of study include: Snow depth, Temperature, Crystal Size, Cystal Shape, and Snow Density.

a. **Snow Depth:** Have your students record the total depth of the snowpack and identify any obvious layers. These layers can be measured separately and may represent significant weather events, distinct densities, or varying levels of hardness.
    i. **Simplification:** For a simpler track, students can focus purely on the top, middle and bottom of the snowpack. Note, if you have a ideep snowpack and are interested in identifying all the layers consider using popsicle sticks to clearly mark each section. Remember that the ground is always 0 cm and the surface is the maximum snow height.

b. **Snow Temperature**: This test provides fascinating results in deep snowpacks because the ground temperature will almost always be close to 0°C, even if the air temperature drops to -20°C. Monitoring temperatures is important because temperature gradients directly influence how snow crystals change over time.

c. **Crystal Size**. Evaluating crystal size encourages students to look closely at the variations within the snow profile. If you're using a grid-lined snow study screen, students can determine whether crystals fit into 1 mm, 2 mm or 3 mm quadrants. In a Rocky Mountain snowpack, large crystals usually represent faceted snow found at the bottom of the snowpack.

d. **Cystal Shape**: Use this column in tandem with the crystal size grid and magnifying loupes to classify structural types as rounded grains, plates, or facets.

e. **Snow density (hardness or resistance):** Students will test each individual layer (or the upper, mid and lower zones if using the simplified option) and record its designated value. Students love this tactile test because they can physically 'feel' the changes.

   To test (always performed with a glove on), apply gentle pressure to the snow face using the targets below, moving down the list if the snow resists:

   - Fist – Soft, fluffy, no resistance
   - 4 fingers – stiffer than fist
   - 1 finger – stiffer than 4 fingers
   - Pencil – stiffer than 1 finger
   - Knife – very hard, often indicating an ice layer (caused by sun or rain)

Discussion (Avalanche Forecasting)

Avalanche forecasters for Alberta Parks dig snowpits to inform their daily winter avalanche safety bulletins. They dig these pits on slopes representative of the terrain people ski, using the data to determine public risk levels. The data sheet used in this activity mirrors the real-world methods of these field professionals.

What does the snowpack tell us? If you repeat this study throughout the winter, have students compare their periodic datasheets by asking: What changes have occurred? You can guide the exploration using these key concepts:

- **Tracking Layers**: *How have the individual layers changed in thickness, harness, and grain type since the last observation?* This reveals whether the snow is stabilizing (rounding) or becoming more unstable (faceting or creating weak layers like depth hoar)
- **Temperature Gradient:** *What does the temperature profile of the snowpack look like from the ground to the surface? Is there a strong temperature gradient that might be driving faceting?* A large temperature difference over a short distance indicates can indicate more unstable snow structure development.

- **Identifying Persistent Weak layers:** *Are there any buried crusts or ice, surface hoar, or facet layers that have persisted over time?* These hidden layers are responsible for some of the more unpredictable and dangerous avalanches. Tracking them may help determine if a skier can trigger a collapse.
- **Correlating Weather Events**: *How do the changes in the snowpack correlate with recent weather events (e.g., heavy snowfall, high winds, rain-on-snow, or prolonged cold snaps)?* Alberta Parks Mountain Rescue professionals use these correlations daily, and they encourage the public to always monitor weather changes when recreating.
- **Stability Test Results**: If you choose to demonstrate professional stability tests (like a Compression Test or Extended Column Test), discuss how the structural failures impact your understanding of the slope. Tracking how these test failures change over the winter bridges the gap between raw data numbers and human risk assessment.

Discussion (Winter Ecology)

By evaluating the temperature profile and layer density from our snowpit, we can piece together clues about how wild animals survive Alberta's harsh winters.

The Winter Thermostat: *Where is the snowpack warmest?* Look at the temperature data from the air down to the soil. Even when the air is a freezing -15°C, the temperature at the bottom of the pit right next to the soil usually hovers right around 0°C. This insulated, hidden environment is called the **subnivean zone** (*sub* = under, *nivean* = snow). The snow acts like a giant down comforter that traps heat radiating from the Earth. Small mammals like mice, voles, and shrews spend nearly their entire winter down here, sleeping and foraging for seeds safely out of the freezing wind.

Snow Fluffiness: *Where is the snowpack least dense?* Look at your density measurements. Fresh surface snow is light and airy, while the older snow at the very bottom often breaks down into loose, large, sugar-like grains (depth hoar). Middle layers might feature hard wind crusts.

- *For large animals* (deer, elk, wolves), low-density snow is exhausting; they sink straight to the bottom and waste vital energy wading through it.

- *For tiny animals*, that loose, sugary snow at the bottom is perfect. Because it is not tightly packed, mice and voles can easily bulldoze and tunnel through it to build extensive subnivean highway systems.

Extension Resources from Nature Source

Winter Wildlife Game: Play this game with your students to explore the real-world implications of snow conditions during high-stakes predator-prey dynamics.

"Mousicles" Activity: Download this activity to help students experience and understand the critical protective implications of snow depth from a mouse's perspective.