Program Name: Science With Snow
Grade Level(s): 7-9
Curriculum Connection(s): Structures and Forces (Gr.7); Mechanical Systems (Gr.8); Matter and Chemical Change (Gr.9)

Approximate time required: 3 hours (not including travel or eating time)

Key Concepts and Terms:

Load	Levers	Melting
Form	Force	Freezing
Structural Support	Mechanical Advantage	State of Matter

Student Learning Objectives:
Demonstrate the ability to work in groups and follow instructions under minimal supervision. Experiment with structural shapes and materials to see which hold up the best under different loads & forces; examine leverage, mechanical advantage, and force through the use of levers; and experiment with H_2O in its different states of matter.

Brief Description of Program:
A one day program where students work in teams to carry out a series of experiments that work with snow to determine scientific properties and relations. If you wish to focus on a specific unit, different activities can be chosen to focus on structure, form, and load; mechanical advantage, levers, and force; or changing states of matter. You can also pick and choose activities from each category for a more broadly engaging day.

Activities:
Break students into groups and sign out a meter stick and thermometer to each group. Also give each group a Snow Examination Data Recording Sheet and pencil from the Station if students don't have their own. Outside, have students examine snow from different areas (beside the Station, in the forest, on a trail, etc.) to look at depth, texture, debris or discoloration, moisture, and temperature. have them record all of their data. Once every group has collected their data, gather students in the interview room or garage to warm up and have students share what they found in their samples. In their groups, theorize why their snow sample exhibits the characteristics it does and why it may be different than other groups. Have them determine which snow would be the best for building with (sticky, but not icy or too wet is generally the best).

<u>For structure and force emphasis:</u>
Have the entire class build a single snow wall in a set amount of time using the best building snow, as identified in the initial class discussion. Build different sections at different heights and thicknesses. Have students stand a distance away and throw snowballs at the wall to try to knock it over (and then run at the wall and knock it down, if snowballs are ineffective). Which sections stood the longest? What does that say about building structure?

Have students build 'doghouses'- snow piles about three feet high that have to be hollowed out big enough for a large dog to fit in them- in different shapes: square, rounded igloo style, triangular, etc. The hollow inside must be the same shape as the outside, and they should all be roughly the same size for ease of comparison. Stack weight (backpacks, ice chunks, etc.) on each until it breaks. Which shape supported the most weight? What does that say about building structure?

<u>For mechanical systems emphasis:</u>
Have students build snow fulcrums in whatever size and shape they think will be able to throw a snowball the farthest when a board placed on top is used as a catapult-style lever. Make sure the fulcrums are aligned so as to throw snowballs away from buildings. Make a pile of similarly sized and shaped snowballs. Use a board (the same one board repeatedly) to test each fulcrum - place the board overtop of the snow fulcrum, place the snowball on the lowered end of the board, and have students use their hands or one foot (do not let students jump with both feet) to depress the raised end of the board. Measure how far the snowball goes, or doesn't go, with the Station's long measuring tape. Have students record a picture of their setup, approximately to scale, along with the distance the snowball travelled and apparatus alterations they think they should make to improve the next distance on the Snowball Catapult Data Recording Sheet. Have students adjust or make new fulcrums, replace the board (potentially at a different fulcrum junction), and replace the snowball (potentially at a different position on the board, of a different size or weight, etc.). Fire (potentially with different force) and record again. After several rounds of trials and errors, snowballs should start to go farther.
When you feel enough data has been collected (at least 4 rounds per group) go back into the interview room to warm up and examine your class data. Start with the longest distance and draw the setup on the board, followed by the next one or two best distance set ups alongside the shortest distance set ups. Have students compare and contrast the different set ups before coming up with a list of master attributes that would make for the best lever, throwing the snowball the greatest distance.

<u>For state of matter emphasis:</u>
Water is the only substance on Earth that naturally occurs in all three states: solid, liquid, and gas. In the interview room, recap H_2O in each of its phases, including terminology on moving from each phase into each of the others, and draw a phase diagram on the whiteboard, including the temperatures at which phases change. Include the concept of a phase change as an ongoing process. At the temperature where phases change, molecules are going back and forth between states: at 0°C, ice is turning to water at the same rate water is turning to ice. To fully change phases, you must be slightly above or slightly below the phase change temperature.
Discuss how energy required to change the temperature of H_2O in each of its states of matter (its specific heat) is different - that it requires more energy to heat a gram of water 1°C than to heat that same gram of ice or steam by 1°C. Lead a discussion on how H_2O also changes

volume when it changes phases, with water being the least volume per unit mass and gas being the most volume per unit mass. This concept will be tested.

Collect a small pot of snow and bring it inside (after wiping off the exterior). Weigh the pot of snow with your students using the weigh scale in the wet lab, and record the weight. Leave the pot on a towel inside the building throughout the day until the snow melts. Have your students weigh the pot again. What happened to the weight? Why? Use the stove to gently boil the water until its volume is reduced to approximately 1/2. Let the pot cool until just before you leave. Have your students weigh the pot again. What happened to the weight? Why?

Outside, have students form groups of 3-5 and collect half a plastic cup of loose snow, ensuring that all cups are roughly equally filled. Hold a competition to see which team can turn their cup of snow into water the fastest, heating it any way they choose (without going back into and buildings or putting the snow in their mouths), offering magnifying glasses to catch the sun, additional gloves/scarves for insulation, etc. When one team has a cup of water or after a certain amount of time, end the competition. Go back into the Station or garage to discuss results and warm up.
Why did some snow melt more than other snow? What worked to melt the snow faster? What didn't work? What happened to the volume of H_2O in the cups as the snow melted into water? What happened to the weight?
What would happen if you could heat the cups enough to melt all the snow and turn the water into steam? What would happen to the volume of H_2O in the cup? What would happen to the weight? Why are the two sets of answers between solid & liquid and liquid & gas phase changes similar or different?

Next, a snowball contest (not a snowball fight). Have students group into new teams, form their best snowballs, and throw them as far as possible (away from buildings). Measure the farthest throws from each group with the long measuring tape (individuals can visually track and remember their own approximate distances). Have groups form new snowballs, but in a different way - with or without gloves to change the freezing on the snowball crust, sprinkling water on the snowballs to alter their phase composition, making snowballs of different sizes, building a snowball around a core of ice, etc. Rethrow and remeasure the farthest from each group (and have individuals gauge whether their snowballs are going farther or not). Experiment with different kinds of snowballs and different kinds of snow for several rounds to see which can be thrown the farthest.
What characteristics make up the best distance snowballs? Why?

<u>Closing</u>:
Dry all equipment and return it to its proper storage location.
Tidy the Station to its previous condition, collecting all belongings and removing any water or snow from the Station floors with the mop in the mechanical room. Remember to turn off all water and lights, and deposit your key **before** you leave the Station **after** ensuring both exterior doors are locked and windows are closed.

Equipment and Resources Provided:
Station facilities - two washrooms, interview and meeting rooms for discussions and group work, fully equipped kitchen
Meter Sticks
Thermometers
Pots
Catapult board
Long measuring tape
Snow cups
Magnifying glasses

Contact the Station Manager at gth@ualberta.ca for pricing and more details.

Snow Examination Data Recording Sheet

Snow location:____

Snow depth and layers: ____________________
____
____
____

Snow texture (granular, powdery, flakey, etc.):______________________

Snow moisture (slushy, sticky, dry, etc.):________________________

Snow temperature (with units):___________________

Snow colour and debris (grey, mixed gravel, etc.):
____

Notice anything else?

Snow location:____

Snow depth and layers: ____________________
____
____
____

Snow texture (granular, powdery, flakey, etc.):______________________

Snow moisture (slushy, sticky, dry, etc.):________________________

Snow temperature (with units):___________________

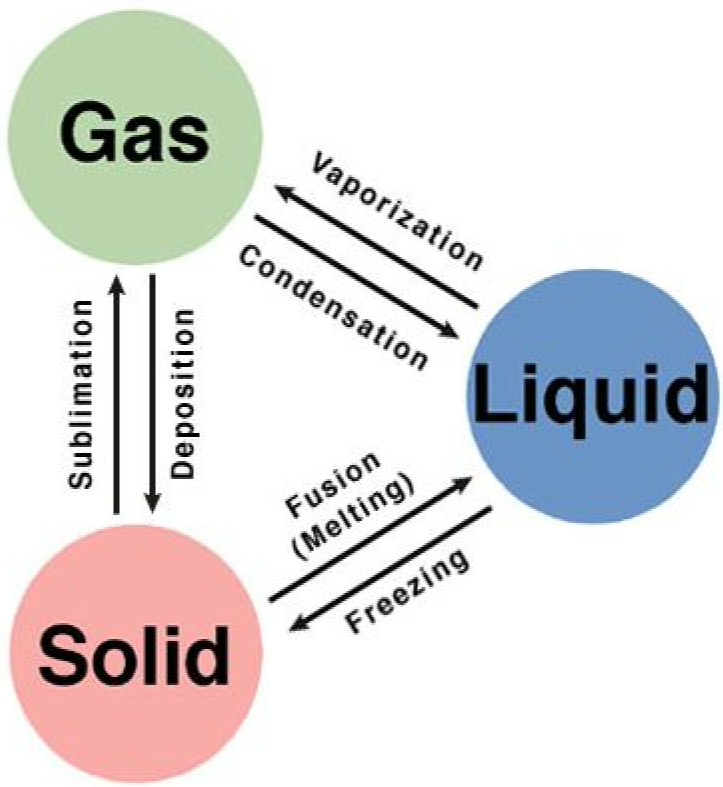
Snow colour and debris (grey, mixed gravel, etc.):
____

Notice anything else?

Snowball Catapult Data Recording Sheet

Set Up (drawn roughly to scale)	Distance (in m)	What will you change next round? Why?

Phase Diagram



http://www.chemistry.wustl.edu/~edudev/LabTutorials/Thermochem/Fridge.html