Overview

Students will use measurement tools and mathematics to determine the volume of water contained in snow of a certain density.

Objectives

By the end of this activity, students will be able to:

- Define SWE, density, volume
- Use measurement tools to determine density of snow and compare it to the volume of water contained in snow.
- Understand the need to monitor snowpack

Subjects: Science, math

Grade level: 6-12th

Length of activity

30 min—1 hr

Activity location

Classroom

Materials

Shaved ice maker or real snow from outside, plastic cups, tubs or beakers, ice, cooler or freezer, graduated cylinders 500 - 1000 ml, rulers, balance, hot plate or blow dryer, blank paper for recording data, pencils.

Shaved Ice SWE

Introduction

Snow water equivalent (SWE) is the depth of liquid water in a known volume of snow if it were to be melted. Scientists go out into the field to measure SWE of an area in order to determine the volume of water stored in the snowpack, called a snow survey. Survey personnel use a hollow tube to determine snow depth and density, which can then be used to calculate SWE.

Snow survey staff measuring SWE with a Federal snow tube

California is dependent on the Sierra Nevada snowpack for over 50% of their water needs. Snow surveys are conducted in the Sierra Nevada to determine the amount of water that will be available for use. The state conducts their surveys at the peak of snow accumulation, which is historically April 1st. Measurements taken during these surveys include snow GPS location, density, and depth.

Density of snow in the Sierra Nevada is typically between 10-40%. Newly deposited powdery snow has a much lower density than older, compacted snow. The density of snow in December can be as low as 10% whereas snow in April can be as dense as 40%. Repeated melting and refreezing throughout the day and night causes the density to increase as the winter progresses. Snow with a high density contains more water than snow with a low density.

To get a better idea of how much water is contained in snow, students will be performing a simple experiment to determine SWE and snow density of a known volume using shaved ice.

Activity Description

This activity is used to get students comfortable with SWE and density measurements through an inquiry-based activity. By allowing students to figure out how to determine density on their own, they are using formulas and measurement tools in a practical, hands on way.

The methods of this experiment are very similar to how SWE is measured in the field.

Formulas to introduce or review:

- Density (g/cm^3)=mass (g) / volume (cm^3)
- Snow water equivalent—SWE (cm) = [density (g/cm^3) X depth (cm)] / density of water 1 g/cm^3

1. Introduce SWE, snow surveys and why they are important to conduct. Review density, volume, and mass.
2. Split students into groups of 3.
3. Tell students they need to work in their groups to determine the density of a sample of snow.
4. Have students pick up one of each of the following: ruler, container for snow sample (250 ml beakers, cup or tub), balance and graduated cylinder.
5. Tell students to use the materials provided to determine the density of a snow sample. Record procedure and the data. Possible hints: weigh empty container before obtaining a snow sample, 1 mL water is = 1 cubic cm = 1 g.
6. When filling container with shaved ice, make sure not to pack down and keep a level top. Shaved ice can be made in advance and kept frozen in a cooler or freezer.
7. Discuss procedures after completing the experiment. Repeat if needed.
8. Melt snow sample and measure volume to determine if the density calculation was close (should be within 10%).
9. Discuss how density multiplied by 100 yields a %, which can be used to better visualize volume of snowmelt.
10. How did your meltwater versus calculated volumes compare? Which one was higher? Why? (The calculated volume should be slightly higher since there may be voids in the snow sample, which is true in the field! Visually look at the volume of water in your beaker, does your % density calculation make sense (if your answer was 50%, then is your beaker half full?
11. You can repeat the experiment by packing down the snow to increase density.
12. Shaved ice syrup recipe if you want to provide a snack! Dissolve 2 c sugar, 1 c water and packet of Kool-Aid in a saucepan. Cool and put in a tightly sealed container.

Possible methods for determining density

a. Volume of container:

- Fill container with water, measure volume (1 ml water = 1 cubic cm).

- Weigh container filled with water (1 g water = 1 cubic cm).
- Record volume written on beaker

b. Mass snow:

- Record mass empty container. Fill with snow and reweigh.

c. Measure depth of snow using a straw and measure straw with a ruler, record depth. Repeat measurement in different areas if using a tub or large container.

d. Calculate density and SWE

Assessment

⇒ Go around and check students' data sheets and methods as they work.

⇒ After the activity, have students write down the formulas and units for density and SWE.

Extensions

⇒ Have students determine the density of ice cubes or other objects.

⇒ Many western states forecast a daily SWE on the web. What is the SWE of the day at the closest location to the school? Look up this information using one of the web sites listed below under Resources.

Resources

California Department of Water Resources snow survey site: http://cdec.water.ca.gov/snow/

Natural Resources Conservation Service (NRCS) climatic data in the Western United States SNOTEL (for SNOwpack TELemetry) site:

http://www.wcc.nrcs.usda.gov/snow/

California State Science Standards

6th grade: 7.b, 7.e

7th grade: 7.a, 7.b

8th grade: 8.a, 8.b, 9.b, 9.f

High school

Earth Science: 9.c

Investigation and Experimentation: 1.a, 1.c, 1.d