Volume of Snow and Water

Grade Levels: 5th

Length of Lesson Sequence: Two 30 minute periods

Brief Description:
Water and snow do not have the same volume because snowflakes have air pockets trapped inside. When snow melts, the air pockets are released to the atmosphere. In addition, water in the solid form has roughly 9% more volume than in the liquid form because of the way the molecules are bonded together via hydrogen bonds. Therefore, when snow melts, the volume of the water is reduced as air molecules are released and hydrogen bonds are broken. In this activity, students investigate the volume relationship between snow and water, which changes depending on the weather conditions at the time of a snow event and the amount of time since the snow event. Students will use many skills learned regarding making measurements of volume to accomplish this activity, and will understand how much liquid water comes from the snow in one particular event.

Content Statements/ Standards Covered:

IV.1.MS.1 (new) - Describe and compare objects in terms of mass, volume, and density.
IV.1.MS.2 (PME 9) - Explain when length, mass, weight, area, volume, or temperature are appropriate to describe the size of an object or the amount of a substance.
IV.1.MS.4 (PME 12) - Describe the arrangement and motion of molecules in solids, liquids, and gases.
IV.2.MS.1 (PCM 4) - Describe common physical changes in materials: evaporation, condensation, thermal expansion, and contraction.
IV.2.MS.3 (PCM 8) - Explain physical changes in terms of the arrangement and motion of atoms and molecules.
I.1.MS.2 (C 8)- Design and conduct simple investigations.
I.1.MS.4 (C 10) - Use measurement devices to provide consistency in an investigation.

Objectives of Lesson:
At the conclusion of the lesson, students will be able to:
- Identify the volume of snow as greater than the volume of ice
- Calculate the volume ratio of snow:water
- Understand that 1 milliliter of water weighs 1 gram
- Understand the properties of snow and liquid water that cause changes in volume

Materials and Resources

At least 1 graduated cylinder
25 (1 per student) plastic cups of known volume (120 ml with lid works well)
Strategy

Inductive or field inquiry: techniques-observations-patterns-explanations (TOPE)

Introduction/Anticipatory Set

Water and snow do not have the same volume because snowflakes have air pockets trapped inside. When snow melts, the air pockets are released to the atmosphere and the remaining substance is liquid water.

As a class, discuss the following questions.

- What is volume?
- What does ml stand for?
- What is it called when something changes from a solid to a liquid? Liquid to a gas?
- Which will have a higher volume, snow or water?
- How much snow does it take to make 1 ml of water? Choose between 0.5 ml, 1 ml, 2 ml, 5 ml, 10 ml, 20 ml, 50 ml.
- How much does 1 ml of water weigh?

Activities of the Session

- During the first 0.5 hour of the activity, students will be collecting snow and measuring the volume of the snow collected. Therefore, this must be done on a day when the snow is fresh and on the ground.
  - Each student is given a 120 ml plastic cup to use for collection of snow.
  - Use the scientific tape and marker to record your name on the side of the container, being careful not to cover up the graduated marks for volume.
  - Go out into a designated area in the schoolyard to collect the snow.
  - Snow collection is a more delicate process than one would think because collecting the snow will cause the volume of the snow to change from the way it was laying on the ground. Therefore, you should follow the following directions.
    - Don’t ever touch the snow with your hands
    - Use the cup to scoop up a cup-full of snow from the ground without getting any soil or grass
    - Put the lid on the cup if available
    - Shake the cup side to side vigorously ten times to cause the snow to fill in the large air gaps in the cup.
  - Using the graduated marks on the side of the cup, record the volume of snow in milliliters on the datasheet. It may be difficult to get an exact volume because the snow may settle in a pattern that is uneven on the top. Make the best estimate possible.
  - Set the cup aside, with the lid on, to wait for the snow to melt.

- Wait at least 4 hours, preferably the following day, or until the snow in each students cup has completely melted, to do the second half of the lesson. This does not have to be completed within the day or even week. There can be a long gap in between the two time periods if needed.
  - The volume of water left will be less than the snow and easier to get accurate volume measurements, so a graduated cylinder should be used to be precise.
Depending on the number of graduated cylinders available, have each student pour their water from the cup into the graduated cylinder.

- Have them read the volume from the graduated cylinder and record it on their data sheet.
- Dispose of the water in the sink after recording the volume.

**Conclusion**

The students should answer the following questions on their worksheet. They should not be expected to know the answers to all of the questions, but they are designed to get the students to think through the experiment.

- Which was greater, the volume of water or the volume of snow?
- What was the ratio between the volume of snow and the volume of water? (Hint – divide the volume of snow by the volume of water. Write the number you calculate followed by a colon and then the number 1. For example, your answer might look like 8:1, which means that if you have 8 ml of snow it will melt to form 1 ml of water.)
- Why is the volume of snow so much more than the volume of water?
- Imagine it snowing 12 inches tomorrow. Use your snow:water ratio to figure out how much water will result from the melting of the 12 inches of snow. (Hint – Divide 12 by the first number in your ratio. For the example, 12/8 = 1.5 inches of water from 12 inches of snow)
- How much does the water you collected weigh? (Hint – 1 ml of water weighs 1 gram)
- Do you think the ratio you calculated will be the same for every snowstorm?
  - No, it will not. The amount of air trapped in snowflakes will vary depending on the weather conditions
- If there were no air bubbles trapped inside a snowflake, would the volume of snow and water be equal?
  - No, when water freezes, it expands by about 9% when there are no air molecules trapped inside. Water is one of the unique molecules that performs this way, as usually substances contract as they get colder.
- What is one question that you have after doing this experiment?

After answering the questions, take some time to discuss the questions together in class. Calculate a class average ratio between the volume of snow and water.

**Assessment**

The students should be graded based on the completion of their worksheet. They should be able to answer correctly the questions dealing with calculating the volumes of snow, water and the ratio between them. The opinion questions should be answered, but do not have to be correct.

**Extensions (Optional)**

The next time it snows, students can measure the depth of snow around the school using a ruler. They can then take some snow from the event and calculate the volume ratio for that specific snow event. Using the volume ratio between snow and water calculated, they can then calculate the amount of water in inches from the snow event. The snow must be collected soon after it stops snowing to prevent the snow from settling or melting before collecting the data. Placing a container out in the schoolyard to catch the snow as it is falling may make the calculations more accurate.
After obtaining this data, students could share the results with the community, particularly farmers, to help them calculate how much actual precipitation came from the snow event.

**Post-lesson Comments and Reflection**

This lesson worked very well for the students. The students found on average that the ratio between snow volume and water volume was 2.7 : 1. Many fifth graders did not understand what a ratio was, so it took a while to explain. However, I think they understood the fact that snow has a higher volume than water.

The lesson took about the amount of time that it was supposed to. Breaking it up into two thirty minute periods on different days worked very well.

A good follow up activity would be to go out during the next snowstorm and measure the depth of snow. Then, using the ratios the students calculated, the can estimate the amount of liquid water that would result from the snow melting. This would help to put the entire lesson in perspective.
Volume of Snow and Water
Worksheet

1. Follow the instructions listed below to collect and record the volume of snow and water.

a. Use the scientific tape and marker to record your name on the side of the container, being careful not to cover up the graduated marks for volume.

b. Go out into a designated area in the schoolyard to collect the snow.

c. Snow collection is a more delicate process than one would think because collecting the snow will cause the volume of the snow to change from the way it was laying on the ground. Therefore, you should follow the following directions.
   i. Don’t ever touch the snow with your hands
   ii. Use the cup to scoop up a cup-full of snow from the ground without getting any soil or grass
   iii. Put the lid on the cup if available
   iv. Shake the cup side to side vigorously ten times to cause the snow to fill in the large air gaps in the cup.

d. Using the graduated marks on the side of the cup, record the volume in ml of snow in milliliters on the datasheet. It may be difficult to get an exact volume because the snow may settle in a pattern that is uneven on the top. Make the best estimate possible.

e. Set the cup aside, with the lid on, to wait for the snow to melt.

After allowing the snow in your cup to melt, the teacher will provide time to perform the second part of the experiment.

f. The volume of water left will be less than the snow and easier to get accurate volume measurements, so a graduated cylinder should be used to be precise.

g. Pour your water from the cup into the graduated cylinder.

h. Read the volume in ml from the graduated cylinder and record it on your data sheet (water volume).

i. Dispose of the water in the sink after recording the volume.

2. Record the data collected in the spaces below

Snow Volume (ml)________________________  Water Volume (ml)_______________________

3. Draw a picture of what you think the water molecules might look like when they are in the solid form and when they are in liquid form.

Solid | Liquid
4. Answer the following questions using the data from the experiment

- Which was greater, the volume of water or the volume of snow?

- What was the ratio between the volume of snow and the volume of water? (Hint: divide the volume of snow by the volume of water. Write the number you calculate followed by a colon and then the number 1. For example, your answer might look like 8:1, which means that if you have 8 ml of snow it will melt to form 1 ml of water.)

- Why is the volume of snow so much more than the volume of water?

- Imagine it snowing 12 inches tomorrow. Use your snow:water ratio to figure out how much water will result from the melting of the 12 inches of snow. (Hint: Divide 12 by the first number in your ratio. (For the example, 12/8 = 1.5 inches of water from 12 inches of snow))

- How much does the water you collected weigh? (Hint: 1 ml of water weighs 1 gram)

- Do you think the ratio you calculated will be the same for every snowstorm?

- If there were no air bubbles trapped inside a snowflake, would the volume of snow and water be equal?

- What is one question that you have after doing this experiment?