SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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Student Materials

Learning Sequence Item:

909

Phase Changes of Water

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Contents

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Student Sheet

Science as Inquiry

Water, Water Everywhere

How do the densities of ice and water differ?

Overview:

What happens when you put ice cubes in a glass of water? Why is the density relationship between water and ice important? In this activity you'll measure the mass and volume of both liquid water and ice and then calculate their densities.

Procedure:

Construct a data table that will contain all the information needed to calculate the density of water and ice.

For the liquid water, take the mass of an empty graduated cylinder and then fill it with some water. Measure and record the volume of the water as well as the mass. The mass is found by taking the total mass of the cylinder plus water and subtracting the mass of the empty graduated cylinder. Now calculate the density in grams/cm^3.

Next, measure the mass and volume of a small ice cube. Determine the mass first using a balance. You will need to place the cube on a cold bottle cap to prevent the ice from melting while it is on the balance. If you are using a digital scale, simply place the cold cap on the scale, read the mass, and then quickly take the mass of the two together. If you are using a pan balance, you will need to take some extra steps. First place a room-temperature bottle cap on the scale and balance it. Replace the warm bottle cap with a cold cap from the ice chest, adjust the balance, and record the mass of the cold cap. Next, place an ice cube on the cold cap and take the mass of the two together. Record your measurements in your table.

Now quickly do the volume measurement before melting begins. To find the volume of the ice cube, first record the level of alcohol in a cold graduated cylinder of alcohol from the ice chest. Then submerge the ice cube in the same cylinder, recording the level of alcohol plus ice cube. Once the volume is determined you should pour the alcohol into an empty graduated cylinder in the ice chest, catching the ice cube with your fingers as it comes out and disposing of it.

Complete your data table, showing any calculations as necessary, and determine density in grams/cm^3.

Questions:

1. How do your data explain what happens when you put ice cubes into a glass of water?

2. When measuring the volume of the ice cube, why did we use alcohol in the graduated cylinder instead of water?

3. Why is the density relationship between water and ice important to fish living in lakes that freeze in the winter?

Science as Inquiry

How Does the Density of Water Vary?

How does the density of water vary in the liquid and solid states?
Is warm water more or less dense than cold water?

Overview:

A container of ice and water is filled to the rim. Will the water overflow when the ice melts? What happens when a vial of colored hot water is placed in a container of cold water? What happens when a colored ice cube is placed in a container of hot water? What do these demonstrations tell us about the density of water?

Procedure:

Make predictions before each demonstration, observe the demonstration, and reach conclusions about the density of water.

Demonstration A: Ice cubes are placed in a large glass container and water is added to the rim. Predict what will happen as the ice melts. Explain in terms of the density of ice and water.

Demonstration B-1: A vial with a narrow mouth is filled with hot water containing a vegetable dye. A large beaker is filled with ice water (with the cubes removed). Predict what will happen after the vial is set at the bottom of the beaker of ice water. Explain in terms of the density of hot and cold water.

Demonstration B-2: The same vial with a narrow mouth is filled with ice water and colored with vegetable dye. It is then placed in a container of hot water. Predict what will happen when the small vial is set at the bottom of the hot water container. Explain in terms of the density of hot and cold water.

Demonstration C: Some food coloring is added to water and frozen into ice cubes. One of the ice cubes is then placed in a container of hot water. Predict what will happen as the ice cube melts. Explain in terms of the density of ice, cold water and hot water.

Questions:

1. How does the density of ice compare to that of water?

2. How does the density of cold water compare to that of hot water?

3. Explain each of the demonstrations in terms of density.

4. Explain how the density of ice as compared to that of liquid water helps preserve marine life.

Student Sheet

Science as Inquiry

It's Just a Phase You're Going Through

What is the temperature of water when it freezes? When it boils?

Overview:

At what temperature does water first begin to freeze? How long does it take? How hot is water when it boils? In this activity you'll measure changes in the temperature of water as it freezes and boils.

Procedure:

Construct a data table in which you'll record the temperature of water as it freezes and comes to a boil. Place 5–8 mL of water in the test tube and insert the thermometer. Wait one minute and record the starting temperature of the water. Then place the test tube in the Styrofoam cup and surround it with ice and rock salt. Take the temperature of the water every 30 seconds until the water completely freezes in the test tube, continuing to record temperatures until the temperature no longer drops. After you have collected your data, carefully remove the test tube and run cool water over it to melt the ice and recover the thermometer.

Next measure 200 mL of water into the beaker. Place the thermometer in the beaker, wait one minute, and record the initial water temperature. Then turn on the hot plate and record the temperature every 30 seconds until the water boils. Continue to record the temperature for two minutes after the water has begun to boil.

After collecting and recording your data, plot both parts of the experiment on a line graph of time vs. temperature.

Questions:

1. Examine the freezing line on your graph. At what temperature did the water first begin to freeze? How long did it take for the water to completely freeze?

2. Using your graph, explain how you know when the water was completely frozen into ice.

3. What was the highest temperature that the water reached during the boiling part of the lab? Explain why it did not go any higher.

4. You are on a frozen lake in the middle of Iowa, ice fishing. The air temperature is –5 °C. What would the temperature of the top layer of ice most likely be? What would the temperature of the water underneath be? Explain how you know.