Scientific Method

Overview:

This lesson builds on the idea of distinguishing legend from scientific theory. After watching the teacher demonstrate an experiment, students generate a list of ideas describing why they believe the experiment worked as it did. This list of ideas is revised to create a testable hypothesis. During the second part of the activity, students use the scientific method to conduct their own experiments.

Objectives:

The student will:

- understand the steps in the scientific method;
- write a testable hypothesis;
- write a conclusion based on experimental data;
- understand the importance of a control in an experiment;
- read a Celsius thermometer; and
- record data.

Materials:

- 2-liter bottle with lid (for Cartesian diver)
- Eye dropper (for Cartesian diver)
- Brass nuts (only if plastic eye dropper is used)
- Hot plate
- Celsius thermometer
- Two 250-milliliter (ml) beakers
- Water (distilled if available)
- 20% salt water solution (see page 13)
- STUDENT WORKSHEET: "Testing a Hypothesis"

The plastic eye dropper above has been weighted with two brass nuts to provide the added weight needed to sink the Cartesian diver.

Answers to Student Worksheet:

Data:

Boiling point of water: answers should be close to 100˚C.
Boiling point of salt water solution: answers should be higher than 100˚C and below 115˚C.

Conclusion: Answers will vary depending on student's hypothesis.

Questions:

1) *Non-salted water acted as the control in the experiment.*
2) *Yes. A 20% salt solution caused water to boil at a higher temperature than non-salted water, so we can assume that more salt (solute) will further increase the boiling point.*

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Activity Preparation:

Before teaching this lesson, the teacher should make a Cartesian diver by following these steps:

1. Fill a 2-liter bottle with water, leaving a small amount of air space at the top of the bottle.
2. Fill an eyedropper with water so that it barely floats. (It is easier to test how much water is needed in the eyedropper in a beaker before putting it into the 2-liter bottle.)

Note: If a plastic eye dropper is used, weight the eye dropper with brass nuts as shown on the Activity Introduction page of this lesson.

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3. Place the eyedropper in the 2-liter bottle and twist on the cap.
4. Squeeze the bottle. The eyedropper should go to the bottom of the bottle and rise again when the bottle is no longer being squeezed.
5. Prepare the 20% salt solution required for the experiment part of this lesson. A 20% salt solution (by mass) is made by adding 20 grams of salt to 80 milliliters (ml) of water.

Activity Procedure:

1. Ask students to tell you the difference between a legend and a science theory. A legend is an explanation that cannot be tested with repeated experiments whereas a science theory can. Explain that today's lesson focuses more on the process of science theory.
2. Demonstrate the Cartesian diver by squeezing the bottle. The eyedropper should go to the bottom of the bottle and rise again when the bottle is no longer being squeezed. Ask students how it works. Write ideas on the board. Ask students to phrase their ideas as a hypothesis, then ask how each could be tested. Try some of the ideas. For example: Does the Cartesian diver experiment work upside down? With the bottle 1/2 full of water? Does the experiment work with the lid off? Ask students to test each hypothesis.
3. Divide students into groups. Distribute two beakers, a hot plate, and a thermometer to each group. Distribute the STUDENT WORKSHEET: "Testing a Hypothesis" to each student. Tell students they will do an experiment to compare the boiling point of tap water to a 20% salt water solution to determine if the salt water solution will boil at the same, greater, or lower temperatures.
4. Ask students to follow the directions on the STUDENT WORKSHEET: "Testing a Hypothesis" to perform the experiment. You also may want to remind students how to read a thermometer.
5. Explain that this experiment demonstrates the importance of a control. If students didn't know the boiling point of water, they will not be able to determine if salt has any effect on the boiling point of the salt water solution. In this experiment, water is the control (the standard for comparison) and the salt water solution is the variable or experimental set up.
6. Ask students how salt affected the boiling point. Explain that adding a solute to a solvent will generally increase the boiling point and decrease the freezing point. The salt solution should boil at a higher temperature.

Inquiry Extension: Ask students to determine if there is a relationship between the amount of salt in a salt water solution and its boiling point. Ask students to determine the boiling point of a 5%, 10%, 15%, and 20% salt solution, then graph the results.

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Name: _____ **Student Worksheet**

Testing a Hypothesis

Directions: Complete the hypothesis below by filling in the correct word.

Hypothesis:

If a 20% saltwater solution boils, then it will be at the/a _____ (same/higher/lower) temperature than water without salt.

Perform the following experiment using the materials provided, then fill in the data and answer the questions below.

Experiment:

Materials:

- 250 milliliter (ml) beaker
- Hot plate
- Celsius thermometer
- Water (distilled if available)
- 20% salt water solution

Procedure:

1. Put 150 milliliters (ml) of water into one beaker.
2. Place the beaker with water on the hot plate.
3. Let the water come to a boil.
4. Record the temperature of the boiling water with the thermometer. Record the data.

Repeat the first four steps of the experiment, using the salt water solution instead of plain water. Record the data.

Data:

Boiling point of water:_____˚C Boiling point of salt water solution:_____˚C

Conclusion:

Was your hypothesis correct? Use a complete sentence. _____

_____

Further Questions:

1. Why was it important to determine the temperature at which water (without salt) boiled?

   _____

   _____

2. Do you think a 30% salt water solution will boil at a higher temperature than a 20% solution? Why?

   _____

   _____

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