Food Explorations Lab I:
Changing States

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this lesson, you will learn how to calibrate a bimetallic stemmed thermometer. Your teacher will first demonstrate using the boiling water method. Then, you will calibrate a bimetallic stemmed thermometer using the ice water method. During both parts of the lab, you will record temperatures and then construct graphs using this data.

Lab Objectives

In this lab, you will learn how to…

1. Observe and graph the temperature changes that occur during the changes of state for water.

2. Calibrate a bimetallic stemmed thermometer.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Question

How can changes of state be used to calibrate a bimetallic stemmed thermometer?

Because changes of state are related to temperature change, you can use extremes (e.g. freezing, boiling) to calibrate a thermometer with the appropriate temperature.

Observation of State Changes

MATERIALS

Safety goggles
Aprons (optional)
1 thermometer
1 cup filled with ice chips
1 cup filled halfway with water
1 kitchen timer or stopwatch

PROCEDURE

Before you begin your part of the lab investigation, your teacher will heat a pot of water to demonstrate:

a. How to calibrate a thermometer with the Boiling Water Method.

b. Temperature and state changes that occur when heat is applied to water.

1. Record the temperature of the water as it warms every 2 minutes for 10-minutes in Table B.

2. Record any observed state changes in Table A.

3. Create a line graph in Line Graph B on page 37 with your data from Table B. First, label the y-axis in Line Graph B with the appropriate unit of measure. If your thermometer measures °F, create a y-axis ranging from 20° to 250°F. If your thermometer measures °C, create a y-axis ranging from -6° to 126°C. Be sure to use 10° increments.

4. Record each data point on the graph by matching degree of temperature with the minutes the temperature was measured. Connect the temperatures on your graph with a line (left to right) once all five points have been recorded.

5. If the final temperature reached for the boiling water was 212°F or 100°C, the thermometer is calibrated correctly and ready for use. If the final temperature is not correct, you will need to calibrate the thermometer. To calibrate, you should twist the nut below the thermometer head until the dial reaches 212 °F or 100 °C.

6. Next, your group will calibrate a thermometer using the Ice Water Method.

7. Combine the water with the ice chips. Place the thermometer into a cup of ice water. Measure and record the temperature of the water every 20 seconds for 180 seconds in Table C.

   NOTE: Do NOT let the thermometer stem touch the sides or bottom of the cup. When measuring the ice water, the thermometer should stay in the mixture for at least 30 seconds or until the dial stops moving.

8. Record any observed state changes in Table A.

9. Create a line graph in Line Graph C on page 37 with your data from Table C. First, label the y-axis in Line Graph C with the appropriate unit of measure. If your thermometer measures °F, create a y-axis ranging from 20° to 250°F. If your thermometer measures °C, create a y-axis ranging from -6° to 126°C. Be sure to use 10° increments.

10. Record each data point on the graph by matching degree of temperature with the seconds the temperature was measured. Connect the temperatures on your graph with a line (left to right) once all 9 points have been recorded.

11. If the final temperature reached for the ice water was 32°F or 0°C, the thermometer is calibrated correctly and ready for use. If the final temperature is not correct, you will need to calibrate the thermometer. To calibrate, you should twist the nut below the thermometer head until the dial reaches 32 °F or 0 °C.

Table A. Observed State Changes

State	Observed State Changes
Ice Water	Less ice and more water at the end of 10 minutes than at the beginning.
Boiling Water	Steam coming off water, less water at the end of 10 minutes than at the beginning

Table B. Boiling Water Time Table

State	MINUTES				
	2	4	6	8	10
Boiling Water					

Line Graph B. Boiling Water

	Boiling Water				
(°_____)					
	2	4	6	8	10
	Minutes				

Table C. Ice Water Time Table

State	SECONDS								
	20	40	60	80	100	120	140	160	180
Ice Water									

Line Graph C. Ice Water

	Ice Water								
(°_____)									
	20	40	60	80	100	120	140	160	180
	Minutes								

Conclusion:

1. Based on the reading and lab observations, were the thermometers used to measure the boiling water and the ice water calibrated? Support the answer using evidence from the investigation.

   Student responses will vary based on their individual experiment. Example responses may include:

   Yes, because the thermometer read 212°F when I measured the boiling water and/or 32°F when I measured the ice water.

   No, because the thermometer did not read 212°F when I measured the boiling water and/or 32°F when I measured the ice water.

2. Using the graphs, determine the boiling point and melting point of water. Describe the appearance of the graphs that allowed you to make this determination.

   Boiling water → The water began to slowly rise at the end of ten minutes instead of rapidly. Once it reached 212°F, it did not increase anymore. The change in state occurred at 212°F.

   Ice water → The water began to slowly decrease around 160 seconds. Once it reached 32°F, it did not decrease anymore. The change in state occurred at 32°F.

3. Describe how the water molecules' speed will change as the temperature increases and water changes from a solid to a liquid and from a liquid to a gas?

   When the water molecules are converted to gas, they begin to speed up. When they are concerted to solid, they slow down. Heat affects molecular speed. The higher the temperature, the more movement occurs.

4. Explain why it is important that thermometers be calibrated before being used for cooking.

Food can be over- or under-cooked, causing foodborne illness.

5. Describe how the changes of state were used to calibrate the thermometer.

In the Ice Water Method, the change from ice to water allowed the water to absorb the cold temperature until it reached a freezing temperature. This temperature was known (standard) - (32°F). If the temperature on my thermometer did not read 32°F, then I knew that the thermometer was not calibrated properly and needed to be adjusted. The thermometer could not be calibrated with only ice because the ice cannot fully submerge the probe. A similar outcome was observed for the Boiling Water Method. The change of liquid to gas represented another change in state. The known boiling temperature of water (212°F) was compared to the temperature read by the thermometer. Again, if the temperature was anything other than the standard 212°F, I knew the thermometer was not calibrated properly and needed to be adjusted.