EXPLORATIONS

Activity 13

Who Says a Watched Pot Never Boils?

Objectives

- To understand what causes phase changes in matter
- To be able to measure the temperature of a substance and identify visual clues to the phase changes

Materials

- TI-73
- Unit-to-unit cable
- CBL 2™
- Temperature sensor
- 400 ml beaker
- Hot plate
- Ring stand with clamp
- Ice
- Water
- Data Collection and Analysis pages (p. 118 - 120)

In this activity you will

- Observe when water changes state from a solid to a liquid and from a liquid to a gas.
- Use the CBL 2™ with a temperature sensor to find the temperatures when water changes state.
- See what happens to the temperature when the water changes state.

Problem

What are the temperatures when water changes state from a solid to a liquid to a gas?

Introduction

Matter changes state as its temperature is increased or decreased. Water is the substance that we are probably most familiar with, and everyone recognizes ice, water, and water vapor (steam) as its states or phases. Ice melts at the same temperature that water freezes, also known as its melting point and freezing point. Water vaporizes (or boils) at the same temperature that water vapor condenses, which is its vaporization (boiling) point or condensation point.

Hypothesis

Before testing, complete the **Hypothesis** section on the **Data Collection and Analysis** page to predict what the temperatures will be when the water changes state.

Procedure: Collecting the Data

1. Put enough ice in the 400 ml beaker to reach the 250 ml line. Add water to the same line. Place the beaker on the hot plate, but DO NOT turn the hot plate on.
2. Place the ring stand and clamp behind the hot plate and put the temperature sensor in the ice water but make sure it is not touching the sides or bottom of the beaker.

   CAUTION: ***Make sure that no part of the temperature sensor touches the hot plate.*** This is very important since the sensor will be ruined if allowed to touch the hot plate for even a short period of time.
3. Plug the temperature sensor into Channel 1 (**CH 1**) on the CBL 2™.
4. Start the DATAMATE program.
5. The Main Screen is displayed. If **CH 1:TEMP(C)** is displayed at the top of the screen, go to step 9. If **CH 1:TEMP(C)** is not displayed, go to step 6.
6. Select **1:SETUP**.
7. Select **CH1**. Select **1:TEMPERATURE**.
8. If you are using the TI stainless steel temperature sensor, select **4:STAINLESS TEMP(C)**. If you are using a different temperature sensor, select the appropriate item from the menu. Select **1:OK** to return to the Main Screen.
9. Select **1:SETUP**. Select **MODE**, and then select **2:TIME GRAPH**.
10. The **TIME GRAPH SETTINGS** are displayed. If the screen shows **TIME INTERVAL: 10**, **NUMBER OF SAMPLES: 90**, and **EXPERIMENT LENGTH: 900**, go to step 12. If not, go to step 11.
11. Select **2:CHANGE TIME SETTINGS**. For **ENTER TIME BETWEEN SAMPLES IN SECONDS**, enter **10**. For **ENTER NUMBER OF SAMPLES**, enter **90**. The **TIME GRAPH SETTINGS** screen reappears, showing the new settings.
12. Select **3:ADVANCED**. If **YMIN** is **-5**, **YMAX** is **110**, and **YSCL** is **5**, select **1:OK** and go to step 14. If the settings are not correct, go to step 13.
13. Select **2:CHANGE GRAPH SETTINGS**. Select **1:CH1 TEMP(C)**. For **YMIN=?**, enter **-5**. For **YMAX=?**, enter **110**. For **YSCL=?**, enter **5**. When the new settings are displayed, select **1:OK**.
14. Select **1:OK** twice to return to the Main Screen.
15. When you are ready to begin, select **2:START**. The CBL 2 beeps twice and displays a graph.
16. Turn the hot plate on and to the setting your teacher wants you to use. At the end of each 10-second interval, the data point is plotted on the graph.

17. Observe the ice and water as the temperature increases. Use the table on the **Data Collection and Analysis** page to record the temperature for any observations you make, such as when the ice is completely melted, when bubbles start to form or rise to the surface, and when the water reaches a full boil.
18. After 90 data samples have been collected and plotted, the CBL 2™ beeps. Turn off the hot plate.
19. A line graph is displayed showing the time and temperature for each 10-second interval. Use ▶ and ◀ to move to each data point to find the melting point and the boiling point. Record the values and sketch the graph on the **Data Collection and Analysis** page.
20. To exit from the DATAMATE program, press ENTER to return to the Main Screen. Select **6:QUIT** and press ENTER.
21. To display the lists showing the results, press LIST. The dissolving times are stored in **L1**. The temperatures are stored in **L2**.

Data Analysis

After you complete the testing, answer the questions on the **Data Collection and Analysis** page to analyze your results.

Data Collection and Analysis

Name _____

Date _____

Activity 13: Who Says a Watched Pot Never Boils?

Problem

What are the temperatures when water changes state from a solid to a liquid to a gas?

Hypothesis

The water will change from a solid to a liquid at _____°C and from a liquid to a gas at _____°C.

Data Collection

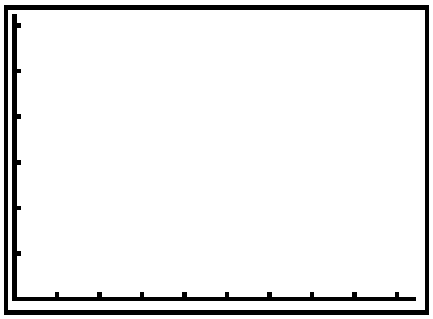
1. As the temperature increases, watch what happens to the ice and the water. Record your observations below

Temperature (°C)	Observation

2. After all 90 data samples have been collected, enter the melting point and boiling point below. Then average your temperatures with the other lab groups in your class.

Activity	Time seconds	Temperature (°C)	Average Temperature (°C)
Ice is completely melted			
Water reaches a full boil			

3. In the space below, sketch the graph or print it on the computer and attach it to this page. Label the axes an show the significant events you observed.



Data Analysis

1. How does your hypothesis compare to the results obtained from your test? Describe any differences.

_____

_____

_____

_____

2. Describe what you observed as the ice melted, as the temperature began to increase, and as the water started boiling.

_____

_____

_____

_____

_____

3. Based on your data, what was the melting point for the water? _____
The boiling point? _____
How do these compare with the known values? If they are different, what could have caused the difference?

_____

_____

_____

_____

_____

4. What do you think was in the bubbles that rose to the surface of the water? Why did they rise to the surface?

_____

_____

_____

_____

_____

5. What happened to the temperature when the water was boiling?

_____

_____

_____

_____

_____

6. What do you think would happen to the temperature if it were measured while the water was freezing? What would happen to the temperature of the ice after the water froze if the temperature in the freezer was -10° C?

_____

_____

_____

_____

_____

Conclusion

The water changed from a solid to a liquid at _____°C and from a liquid to a gas at _____°C.

Teacher Notes

Activity 13

Who Says a Watched Pot Never Boils?

Objectives

- To understand what causes phase changes in matter
- To be able to measure the temperature of a substance and identify visual clues to the phase changes

NSES Standards

- Physical Science: Properties and changes of properties in matter
- Physical Science: Transfer of energy

Preparation

This lab will give students the opportunity to explore what happens to temperature during a phase change. The lab setup using ice and water should give them the chance to see temperature plateaus while the ice melts and the water boils. The plateau at the start of the lab may or may not occur right at 0° C because they are starting with an ice and water mixture. Most students will probably see a small plateau at approximately 3 to 5 °C. The size of this plateau will depend in large part on how long they wait to turn their hot plate or burner on.

Management

- Assign these student jobs for this lab:
  - Materials/setup person (sets up cans/lamp)
  - Tech person (operates CBL 2™ and TI-73)
  - Data recorder (reads off temperatures from the emerging graph on the TI-73 at each collection interval)
  - Runner (brings CBL 2 and TI-73 to the computer to print graphs with TI-GRAPH LINK™ or TI™ Connect and brings **Data Collection and Analysis** pages to the teacher)
- Sticky tack used to hang posters works well to seal the cans. Students like to walk off with this, so manage accordingly.
- Clear covered plastic shoe boxes will hold the CBL 2, temperature sensors, putty, and other equipment neatly at each station.
- Students can record temperature readings in their lab journals as they are displayed on the TI-73. This keeps them engaged throughout the data collection period and if they lose the data/graph later, they can still write up their lab reports. Students can also access the data in the TI-73 lists after data collection. You can send the lists to all students' calculators using APPS **1:Link**:

a. Press APPS.

b. Press ENTER to select **1:Link.**

c. Select **4:List** and press ENTER.

d. Press ▼ to move the ▶ beside the list you wish to send. Press ENTER.

e. Repeat step **d** for each list you wish to send.

f. Set the receiving unit by pressing APPS ENTER ▶ to select **RECEIVE**. Press ENTER. **Waiting…** displays on the TI-73 screen.

g. On the sending unit, press ▶ to select **TRANSMIT** and press ENTER.

For more permanent storage of data, use TI-GRAPH LINK™ or TI™ Connect to save the lists in a computer folder. However, students may inadvertently lose their data or overwrite it in the next trial, so recording data in journals is a good option.

- Students can assess each other using a teamwork rubric after the lab. Provide a check list of positive and negative behaviors. Copy these on quarter sheets of paper.

Extension

To demonstrate the melting point plateau more clearly, place the end of a temperature sensor in a container of water and then freeze it. This Temperature Sensor Popsicle can then be placed in a beaker on a hot plate or over a burner. Set up the CBL 2™ following the procedures in the lab, collect the data while the ice melts around the sensor, and then as the water heats until it boils. The length of time needed to reach boiling and see both plateaus will vary based on the size of the ice cube you begin with, so your data collection time may need to be adjusted to collect data for a longer time period than the lab currently allows. Depending on the number of students performing this lab, you may want to use one of these Popsicles as a class demonstration rather than making up one for each lab group. Use a view screen to display the graph and data. If you wish, the students can use this class data in place of theirs for the beginning of their graphs.