Freezing Temperature of Ocean Water

During winter in the northern hemisphere, Arctic air temperatures often dip below what we normally think of as the freezing point of water. Yet, while freshwater lakes freeze over, much of the ocean stays in liquid form rather than freezing into ice. Why doesn't ocean water freeze at the same temperature as fresh water?

In this experiment, you will use an EasyTemp EasyTemp probe to measure the temperature of water as it cools and then freezes. In Part I, you will collect temperature data as you freeze fresh water and determine its freezing temperature. In Part II you do the same for ocean water. You will then compare the two freezing temperatures and hypothesize why they are different.

OBJECTIVES

In this experiment, you will

- Observe the freezing of fresh water and ocean water.
- Use an EasyTemp EasyTemp probe to measure temperature.
- Determine the freezing temperature of fresh and ocean water.

MATERIALS

TI-84 Plus or TI-84 Plus Silver Edition graphing calculator	salt
	ice
Vernier EasyTemp	plastic spoon
Vernier EasyData application	fresh water
test tube	ocean water
400 mL beaker	ring stand

PRE-LAB QUESTIONS

1. Predict at what temperature fresh water will freeze.

   _____ °C

2. Predict at what temperature ocean water will freeze.

   _____ °C

PROCEDURE

Part I Freezing Fresh Water

1. Turn on your TI-84 Plus (or TI-84 Plus Silver Edition) graphing calculator and make sure that it is on the home screen. Plug the EasyTemp probe into the USB port of
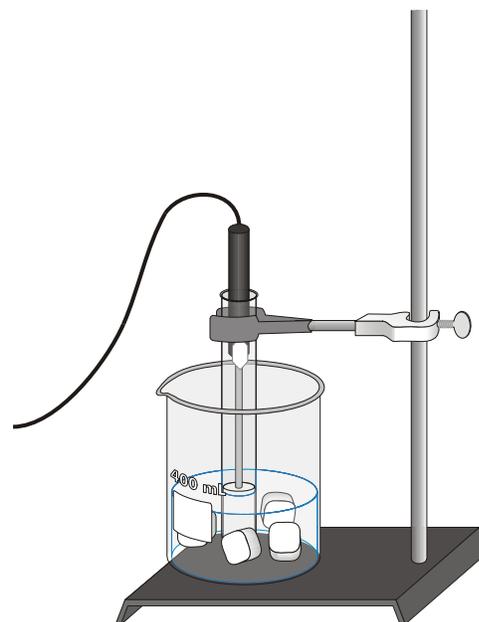

Figure 1

the graphing calculator. The EasyData application will automatically start and the Main screen will be displayed.

2. Set up the data collection.

    a. Select **File** from the Main screen, and then select **New**.
    b. Select ⌗Setup⌗ from the Main screen.
    c. Select **Time Graph…**.
    d. Select ⌗Edit⌗.
    e. Press ⟨CLEAR⟩ on the calculator and type **10** as the time between samples in seconds. Select ⌗Next⌗.
    f. Press ⟨CLEAR⟩ on the calculator and type **90** as the number of samples. Select ⌗Next⌗ The length of the data collection will be 900 seconds (15 minutes).
    g. Confirm that the time graph settings are correct. Select ⌗OK⌗.

3. Fill a 400 mL beaker 1/3 full with ice, then add 100 mL of water as shown in Figure 1.

4. Put 5 mL of fresh water into a test tube and use a utility clamp to fasten the test tube to a ring stand. The test tube should be clamped above the water bath. Place the EasyTemp probe into the water inside the test tube.

5. When everything is ready, select ⌗Start⌗ to begin data collection, and then lower the test tube into the ice-water bath.

6. Soon after lowering the test tube, add 5 spoons of salt to the beaker and stir with the spoon. Continue to stir the ice-water bath.

7. Slightly, but continuously, move the probe during the first 10 minutes of data collection. Be careful to keep the probe in, and not above, the ice as it forms. When 10 minutes have gone by, stop moving the probe and allow it to freeze into the ice. Continue to stir the ice-water bath. Add more ice cubes as the original ice cubes get smaller.

8. Make and record observations as the water freezes.

9. When 15 minutes have passed, data collection will stop and a graph of temperature *vs.* time will be displayed.

10. Analyze the graph to determine the freezing temperature of fresh water. To do this:

    a. Use ⟨▷⟩ to move the cursor to the beginning of the flat section of the curve. Slowly move the cursor to the end of the flat section of the graph and record the average temperature in this area as the freezing temperature. Record this value in your data table.
    b. Sketch the graph as directed by your teacher. Label the graph "Fresh Water" and write the freezing temperature on your graph.
    c. Select ⌗Main⌗ to return to the Main screen.

11. Do not attempt to remove the EasyTemp probe from the ice! Place the test tube into a beaker of warm water to melt the ice, and then remove the EasyTemp probe.

Part II Freezing Ocean Water

12. Repeat Steps 3–11, this time using ocean water instead of fresh water. You may find that you need to add more ice and salt to the ice-water bath to freeze the ocean water.

13. Sketch the graph as directed by your teacher. Label the second graph "Ocean Water" and write the freezing temperature on your graph.

14. When you have completed Part II, select ⌐Main⌐ to return to the Main screen. Select ⌐Quit⌐ from the Main screen. Select ⌐OK⌐ to exit the EasyData application.

OBSERVATIONS

Part I Freezing Fresh Water

Part II Freezing Ocean Water

DATA

	Part I Fresh Water	Part II Ocean Water
Freezing Temperature (°C)		

PROCESSING THE DATA

1. Describe the shape of each graph.

   Part I – Fresh Water

   Part II – Ocean Water

2. What was happening to the water during the flat portion of each graph?

3. Based on your data, which type of water has to get colder in order to freeze, fresh water or ocean water?

4. In some areas, icy roads are "salted" to make them safer for drivers. Use your data to explain why this is an effective method.

EXTENSIONS

1. Ocean water has a salinity of about 35 ppt. Design and conduct an experiment to determine the freezing temperature of water with different concentrations of salt.

2. Freshwater streams and rivers can also stay in liquid form below the normal freezing temperature of water. Design and conduct an experiment to examine this phenomenon.