

FREEZING TEMPERATURE OF FRESH WATER AND OCEAN WATER



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INTRODUCTION

Freezing temperature is the temperature at which a substance turns from a liquid to a solid. 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 a Temperature sensor to study the freezing of water and find its freezing temperature. 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.

GUIDING QUESTIONS

- At what temperature does fresh water freeze?
- How is the freezing temperature of ocean water (salt water) different?
- Why do you think the different types of water freeze at different temperatures?

SAFETY

Do not try to pull the temperature sensor out of the ice at the end of each part of the experiment. You will risk breaking the test tube. Use warm tap water to melt the ice before removing the sensor.

MATERIALS

Lab Quest with power supply	10 mL graduated cylinder
Temperature sensor	Water
Ring stand	Utility clamp
20 x 150 mm Test tube	400 mL beaker
Salt	Ice
Spoon	Warm water

PROCEDURE

Pre-Lab Question

Predict at what temperature fresh water and ocean water will freeze.

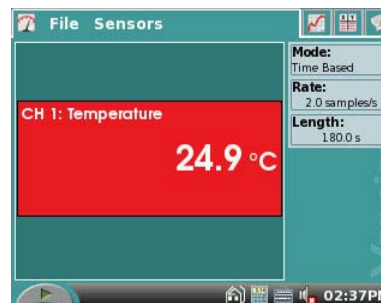
Fresh: _____ °C Ocean: _____ °C

Part I – Freezing Fresh Water

1. Connect the Temperature Probe to LabQuest and choose New from the File menu. If you have an older sensor that does not auto-ID, manually set up the sensor.

- To manually identify the sensor, stay in the Meter mode and select Sensors → Sensor Setup.....
- A sensor set-up screen will appear showing all the available probe ports (*Screen a, below*). Select the channel that the sensor is plugged into (ex. CH1 for channel 1), and tap the arrow to the side of the channel box.
- A list of compatible probes will appear in alphabetical order. Scroll down the list and select “Temperature” and “Stainless Steel”. Do the same for the second temperature sensor. Select to return to the Meter mode screen.
- A red box will now be in this window displaying a real time temperature in degrees Celsius (*Fig. 1*).

Figure 1. LabQuest Meter Screen



- On the Sensor screen, tap Rate. Change the data-collection rate to 0.1 samples/second and the data-collection length to 900 seconds (15 minutes).

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

- Put 5 mL of 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 a Temperature Probe into the water inside the test tube (*Fig. 2*).

- When everything is ready, start data collection. Then lower the test tube into the ice-water bath.

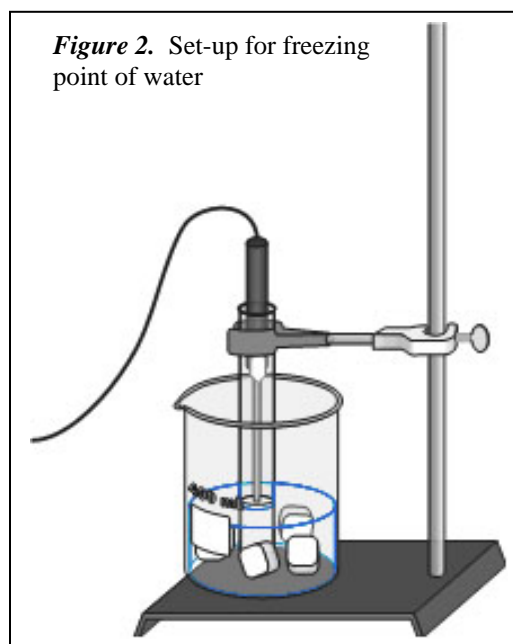



Figure 2. Set-up for freezing point of water

- Soon after lowering the test tube, add 5 spoons of salt to the beaker and stir with a spoon. **Continue to stir the ice-water bath for the first 10 min of the experiment for best results.**
- Slightly, but continuously, move the probe in the test tube 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.
- Make and record observations as the water freezes.

9. When 15 minutes have passed, data collection will stop.
10. Determine and record the freezing temperature of water.
 - a. Identify the flat portion of the graph that represents freezing.
 - b. Tap and drag your stylus across the region that represents the freezing to select the region. A gray shaded area will appear indicating the portion of the graph that will be analyzed.
 - c. Choose Statistics from the Analyze menu. The statistics for the highlighted section will appear to the right of the graph.
 - d. Record the mean (average) temperature (to the nearest 0.1°C) in your data table. This is your value for the freezing temperature of water.
11. Sketch or print the graph as directed by your teacher. Label the freezing temperature on your graph.
12. Store the data from the fresh water experiment by tapping the Cabinet icon  at the upper right of the LabQuest screen.
13. **Do not attempt to remove the Temperature sensor from the ice!** Place the test tube into a beaker of warm water to melt the ice, then remove the Temperature Probe.

Part II. Freezing Ocean Water

14. Repeat Steps 4 – 10, using the ocean water provided by your instructor. You may need to add more ice and another spoonful of salt to the beaker for optimal freezing conditions.
15. A good way to compare the freezing curves is to view both sets of data on one graph.
 - a. Select the gray box on the right of the screen that says **Run 2**. A drop down menu will appear.
 - b. Select All Runs from this menu.
 - c. A graph with the results for both the fresh and ocean water should appear on the LabQuest screen.
16. **Again, thaw the ice in warm water before trying to remove the temperature sensor!**

REFERENCES

Robyn L. Johnson, Gretchen Stahmer De Moss and Richard Sorensen. Earth Science with Calculators. (2002) Vernier Software & Technology, 13797 SW Millikan Way, Beaverton, OR. p.p. 17-1 to 17-3, 17-1T to 17-2T.

Donald L. Volz and Sandy Spartka. Middle School Science with Vernier. (2007)
Vernier Software & Technology, 13797 SW Millikan Way, Beaverton, OR. p.p.14-1 to
14-3, 14-1T to 14-2T.

CREDITS

The lab was adapted and revised by Dr. Stephanie Corrette-Bennett.

DATA SHEET

Name: _____

Group: _____

Date: _____

OBSERVATIONS

Fresh Water:

Ocean Water:

DATA ANALYSIS

1. What is the actual freezing temperature of the fresh and ocean water? Are the temperatures different from your prediction at the beginning of the lab? Explain.

	Fresh Water	Ocean Water
Freezing Temperature (°C)		

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

