Freezing and Melting of Water – ID: 16150

By Texas Instruments

TEACHER GUIDE

Time required
90 minutes

Topic: Phase Changes

- *Relate freezing point and melting point.*
- *Interpret a heating or cooling curve.*
- *Describe how temperature is affected by a phase change.*

Activity Overview

In this activity, students record the temperature of water as it undergoes two phase changes (freezing and melting). They use the data to estimate the melting and freezing points of water.

Materials

To complete this activity, each student will require the following:

- *TI-Nspire™ technology*
- *Vernier EasyTemp™ sensor*
- *10-mL graduated cylinder*
- *400-mL beaker*
- *10-, 15-, or 20-mL test tube*
- *utility clamp*
- *ring stand*
- *stirring rod*
- *small spoon*
- *ice cubes*
- *water*
- *salt*
- *copy of student worksheet*
- *pen or pencil*

TI-Nspire™ Applications

Notes, Data & Statistics, Lists & Spreadsheet, Graphs & Geometry

Teacher Preparation

This investigation requires little background knowledge, but to answer some of the questions, students will need an understanding of potential and kinetic energy changes during phase changes.

- *The screenshots on pages 2–7 demonstrate expected student results.*
- ***To download the .tns file, go to education.ti.com/exchange and enter "16150" in the search box.***

Classroom Management

- *This activity is designed to be **student-centered**, with the teacher acting as a facilitator while students work cooperatively. The student worksheet guides students through the main steps of the activity and includes questions to guide their exploration. Students may record their answers to the questions on blank paper or answer in the .tns file using the Notes application.*
- *The ideas contained in the following pages are intended to provide a framework as to how the activity will progress. Suggestions are also provided to help ensure that the objectives for this activity are met.*
- *In some cases, these instructions are specific to those students using TI-Nspire handheld devices, but the activity can easily be done using TI-Nspire computer software.*

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The following questions will guide student exploration during this activity:

- How does temperature change when water freezes?
- How does temperature change when ice melts?
- How do the freezing and melting points of water compare?

In the first part of the investigation, students record the temperature of water in a test tube as it freezes. In the second part, they record the temperature of the ice as it melts. They compare the freezing and melting temperatures of the water and the ice.

Part 1 – Preliminary Questions

Step 1: Students should open the file **05_FreezingMelting.tns** and read the first two pages. Then, they should answer questions 1–3. The purpose of these questions is to evaluate their existing knowledge.

Q1. How is the freezing point of water related to the melting point?

A. *Freezing point is equal to melting point.*

Q2. How does the temperature of water change as it freezes?

A. *It remains the same.*

Q3. What happens to the kinetic and potential energy of water molecules when ice melts?

A. *Potential energy increases, and kinetic energy remains the same.*

Part 2 – Freezing Point

Step 1: Students should set up the experimental apparatus. First, they should add water and ice cubes to the beaker.

Step 2: Next, students should add water to the test tube and use the utility clamp to hold the test tube in place above the surface of the water in the beaker. They should place the end of the temperature probe in the water in the test tube.

Step 3: Students should move to page 1.6 in the .tns file, and then connect the temperature probe to their handhelds or computers.

Step 4: Next, students should set up the data collection. They should record one point every 5 seconds for 15 minutes (900 seconds).

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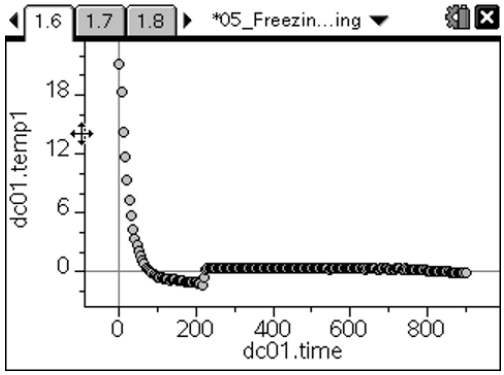
Step 5: Next, students should start the data collection, and then place the bottom of the test tube into the ice water. Make sure none of the ice water gets into the water in the test tube.

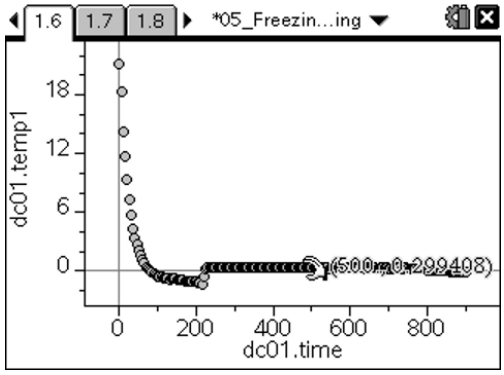
Step 6: Students should add salt to the ice water in the beaker. Make sure they do not add any salt to the water in the test tube. The salt causes the temperature of the ice water to decrease. You can use any common salt; sodium chloride and calcium chloride are both effective.

Step 7: Students collect data for 15 minutes. After 10 minutes, they should stop moving the probe tip around inside the test tube and allow the water to freeze around the tip of the probe.

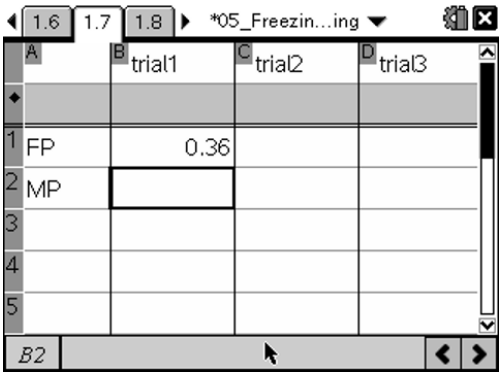
Step 8: Once data collection has stopped, students should leave the probe, test tube, and beaker as they are. Make sure they do not remove the probe from the test tube or the test tube from the beaker.



Step 9: The *Data & Statistics* application on page 1.6 should show the data set students collected. Students should use the graph to determine the freezing point of the water.



Step 10: Students should record the freezing point in the *Lists & Spreadsheet* application on page 1.7.

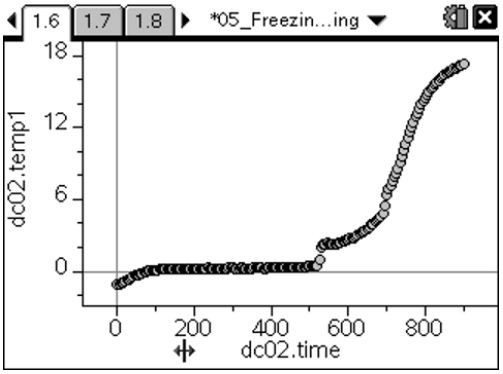


Part 3 – Melting Point

Step 1: Next, students should restart the data collection. They should save the previous data run when prompted.

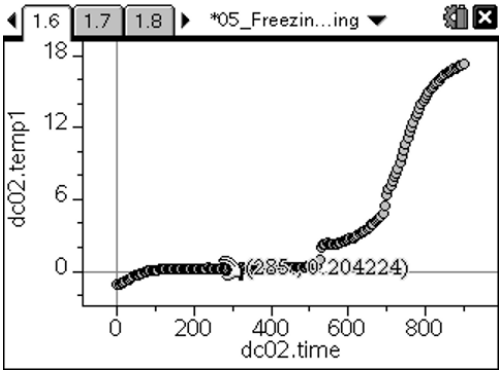
Step 2: After data collection begins, students should remove the test tube from the beaker and use the utility clamp to hold the test tube on the ring stand. Make sure they do not disturb the temperature probe.

Step 3: Students should dispose of the salt water in the beaker. If you used sodium chloride or calcium chloride, you should be able to pour the water down the drain. However, check your district's disposal guidelines to ensure that you are adhering to all requirements. After students empty the salt water, they should rinse the beaker and then add warm water to it.



Step 4: Students should let the test tube stand at room temperature for 12 minutes. Then, they should lower the test tube into the beaker. Make sure none of the warm water gets into the test tube.

Step 5: Students should examine the temperature graph on page 1.6 and determine the melting point of the ice.



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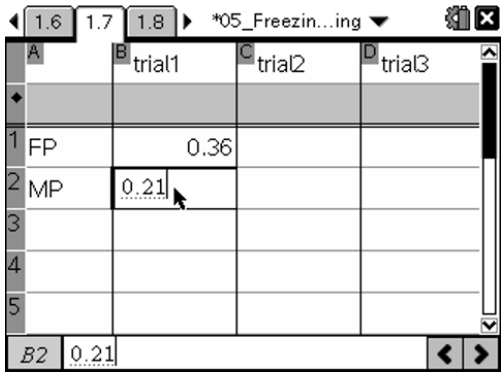
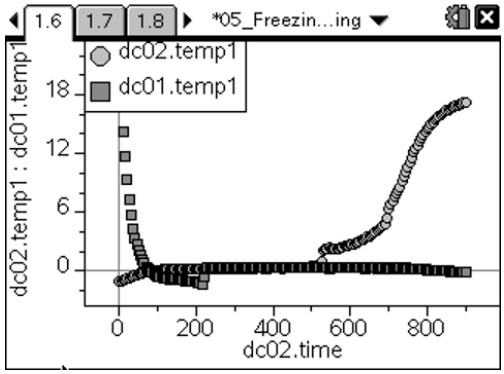
Step 6: Next, students should record the melting point on page 1.7.



Step 7: Next, students should use the *Data & Statistics* application to compare the graphs of freezing and melting.

Step 8: Students should now repeat Part 2 and Part 3 two more times. (If time is short, one trial is sufficient.) After students have completed three trials, they should answer questions 4–12.



Q4. According to your data, what is the freezing temperature of water?

A. *Answers will vary, but should be close to 0°C.*

Q5. According to your data, what is the melting temperature of ice?

A. *Answers will vary, but should be close to 0°C.*

Q6. What happened to the water temperature during the portion of the cooling curve where freezing took place?

A. *It remained constant.*

Q7. What happened to the water temperature during the portion of the heating curve where melting took place?

A. *It remained constant.*

Q8. According to your data, how do the freezing point and melting point of water compare?

A. *Answers will vary, but the two temperatures should be nearly identical.*

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Q9. What happens to the kinetic energy of the water molecules in the test tube during Part 2?

A. *As the temperature decreases, kinetic energy decreases. As the water freezes, kinetic energy remains the same.*

Q10. What happens to the kinetic energy of the water molecules in the test tube as the temperature of the water rises?

A. *As temperature increases, kinetic energy increases.*

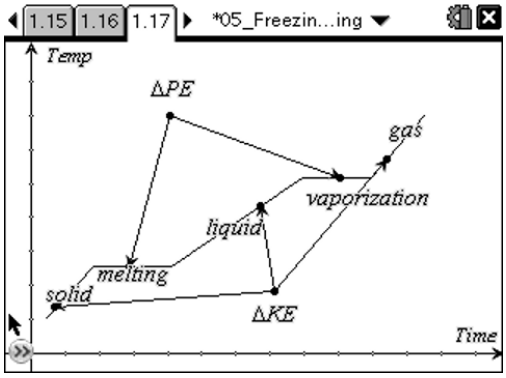
Q11. What happens to the kinetic energy of the water molecules when the temperature of the water remains constant?

A. *Temperature is a measure of kinetic energy, so if temperature is not changing, average kinetic energy is not changing.*

Q12. In general, what happens to the temperature of a substance during a phase change?

A. *The temperature of a substance remains constant during a phase change.*

Step 9: Students should move to page 1.17, which shows a heating curve for water. They should drag the *solid*, *liquid*, and *gas* labels to the appropriate points on the curve, and use the **Vector** tool to identify where on the curve kinetic and potential energy are changing.



TI-Nspire™ Navigator Opportunity: *Live Presenter*
Live Presenter can be used here to allow one student to share his or her labeled curve. Have a student volunteer demonstrate as he or she draws in the vectors that label the states of matter and energy changes along the curve. The student should explain the reasoning for each label along the curve. Then, ask the rest of the class to confirm or challenge the labeled curve. Clarify any misunderstandings that students may have about the meaning of different points along the curve.

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Step 10: Finally, students should repeat Step 9 for the cooling curve on page 1.18.