

A different phase change

In physical science, we often use water to demonstrate change of state. However, this teacher demonstration will expose students to unfamiliar substances whose phase changes can be compared to those of water. Subsequently, a phase change that is in reverse of water's heating curve, cooling from liquid to solid, will show students that substances can freeze at room temperature. By observing the final graph, students will be able to observe that the terms *freezing point* and *melting point* are synonymous. Students will also become familiar with the latest technology-based tools that are now available for scientific inquiry.

What follows are the instructions for the teacher demonstration. Due to the hazardous nature of the chemicals, students should not be allowed to conduct this experiment.



Only a trained teacher using a fume hood and wearing appropriate protective clothing and safety goggles can perform this demonstration.

Conclusion

Having students engage in technology-based inquiry activities is an excellent way for teachers to introduce topics that are driven by the *National Science Education Standards* (NRC 1996). Based on Content Standard B, this activity shows middle school students the different characteristic properties of substances. Moreover, by using the TI-73 with a CBL2, students can take accurate measurements and have greater control over their experiments. In addition, the interactive graphs generated by the TI-73/CBL2 help students interpret the results of their experiments and can be used to create professional laboratory reports. Hopefully, this experiment opens the door for teachers to the endless possibilities for the coupling of a TI-73 with a CBL2 in the middle school science classroom.

Reference

National Research Council. 1996. *National Science Education Standards*. Washington, D.C.: National Academy Press.

Resources

Texas Instruments Home Page—education.ti.com
Download TI Connect Software—education.ti.com/us/product/

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Materials (for each group)

- glass test tube
- unknown substance (approximately 5 mL of stearic acid or lauric acid; both are solid at room temperature with a melting point less than 100°C)
- hotplate and GFCI protected electrical receptacle
- 2 medium-sized beakers
- water
- TI-73 graphing calculator (with DataMate software)
- TI Viewscreen (optional) for projecting calculator screen
- CBL2 and cradle
- temperature probe
- unit-to-unit cable
- calculator-to-computer cable
- computer with TI Connect software
- chemical splash goggles
- apron
- hand protection
- fume hood

Procedure

1. Fill half of a medium-sized beaker with water and place on a hot plate. Heat the water until boiling. While waiting for the water to heat, continue setting up the experiment.
2. Assemble the probe system as follows:
 - a. Insert the upper end of the calculator into the cradle.
 - b. Press down on the lower end of the calculator until it snaps into place.

| | |
|------------------|----------|
| applications | |
| 1: finance | |
| 2: area form | 3 |
| 3: cbl /cbr | |
| 4: cabi jr | |
| 5: chem bio | |
| 6: ctlg help | |
| 7↓datamap | |

DataMate is number 7 on this screen.

| | |
|--------------------------|--------------|
| ▶chl: stainless temp (c) | |
| ch 2: | |
| ch 3: | 4B |
| dig: | |
| mode: time graph-100 | |
| <hr/> | |
| 1: ok | 3: zero |
| 2: calibrate | 4: save/load |

Press 1 here.

| | |
|---------------------------|-----------|
| select sensor | |
| <hr/> | |
| 1: temperature | |
| 2: ph | |
| 3: conductivity | 4C |
| 4: pressure | |
| 5: force | |
| 6: heart rate | |
| 7: more | |
| 8: return to setup screen | |

Press 1 here.

| | |
|------------------------------|-----------|
| temperature | |
| <hr/> | |
| 1: dir connect temp (c) | |
| 2: dir connect temp (f) | 4D |
| 3: extra long temp (c) | |
| 4: stainless temp (c) | |
| 5: stainless temp (f) | |
| 6: thermocouple (c) | |

Press 4 here, then press 1.

- c. Slide the back of the cradle onto the front of the CBL2 until it clicks into place.
- d. Plug one end of the 6-inch unit-to-unit cable into the I/O port in the end of the CBL2, and plug the other end of the cable into the I/O port in the end of the calculator.
- e. Attach the temperature probe to channel one.
3. Turn on the calculator. Press the PRGM button. You will see a screen like this: Press the number of the **DataMate** Application.
4. Set the temperature units to Celsius:
 - a. Press **1** for **SETUP**.
 - b. Press **ENTER** to choose the probe in Ch1.
 - c. Press **1** for **TEMPERATURE**.
 - d. Press **4** for **STAINLESS TEMP (C)**
 - e. Press **1** for **OK**
5. Set the experiment time to 20 minutes.
 - a. Press **1** for **SETUP**.
 - b. Move the cursor down to **MODE** and press **ENTER**
 - c. Press **2** for **TIME GRAPH**
 - d. Press **2** to **CHANGE TIME SETTINGS**
 - e. Type **5** as the **TIME BETWEEN SAMPLES IN SECONDS**
 - f. Type **240** as the **NUMBER OF SAMPLES**
 - g. Press **1** for **OK**
 - h. Press **1** for **OK**
6. Obtain a sample of the substance to be identified. Place substance in a glass test tube. Heat the test tube by

- placing it in a water bath until melted and then continue heating one more minute.
7. Remove the test tube from the water bath and place in the second empty beaker. Place the temperature probe into the substance to be identified.
8. Press **2** to **START** collecting data. Data collection will take 20 minutes.
9. When data collection is complete, a graph of the data will appear.
10. When a substance is changing states (i.e., liquid to solid), there will be a small period of time where the temperature will actually remain constant. On a graph, this will appear as a section nearly horizontal.
11. Use the arrow keys on the calculator to move the cursor to the “change of state” or freezing point. The coordinates of this exact point should appear concurrently on the screen.
12. *Without changing the viewing screen*, attach the calculator to the computer. Open the TI Connect icon on the desktop. Choose TI Screen Capture. When the screen appears, copy and paste the image into a Word document.
13. Center and enlarge the graph and add a title and axis labels. Also include the following: student name(s), approximate freezing point, and unknown number (if more than one substance is used in the classroom.) Print out this document.
14. Copies of this page should be distributed to students for analysis. As an alternative, you can hook your computer up to a projector to share the results onscreen at the front of the room.

```
ch 1: temp (c) 24.5
mode: time graph-180 5A
-----
1: setup  4: analyze
2: start  5: tools
3: graph  6: quit
```

Press 1 here.

```
ch1: stainless temp (c)
ch 2:
ch 3:
dig:
mode: time graph-100 5B
-----
1: ok      3: zero
2: calibrate 4: save/load
```

Move cursor to MODE and press enter here.

```
enter time
between samples
in seconds: 5 5E
█
```

Type 5 here.

```
enter time
between samples
in seconds: 30 5F
enter number
of samples: 240
```

Type 240 here.

```
select mode
-----
1: log data
2: time graph 5C
3: events with entry
4: single point
5: selected events
6: return to setup screen
```

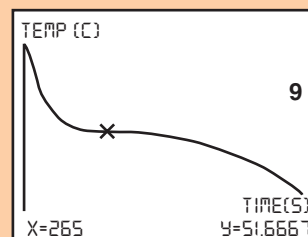
Press 2 here.

```
time graph settings
time interval : 1 5D
number of samples: 180
experiment length: 180
-----
1: ok      3: advanced
2: change time settings
```

Press 2 here.

```
ch 1: temp (c) 24.5
mode: time graph-180 8
-----
1: setup  4: analyze
2: start  5: tools
3: graph  6: quit
```

Press 2 here.



The cursor marks the change of state (melting/freezing point).

[accessory/connectivity/download/download.html](#)
 Free CBL 2 Tutorial—[education.ti.com/us/training/online/freecbl2tutorials.html](#)
 Handbook of Chemistry and Physics—[www.hbcnetbase.com](#)
 ChemFinder—[chemfinder.cambridgesoft.com](#)
 The MSDS HyperGlossary: Freezing Point—[www.ilpi.com/msds/reffreezingpoint.html](#)
 General Chemistry—Liquids (Purdue University)
[chemed.chem.purdue.edu/genchem/topicreview/bp/ch14/liquidsframe.html](#)
 Heating Curve (U. of Waterloo)—[www.science.uwaterloo.ca/~cchieh/cact/c123/heating.html](#)
 CBL 2 Getting Started Guidebook—[education.ti.com/downloads/guidebooks/eng/cbl2-eng.pdf](#)
 Download TI Connect Software—[education.ti.com/us/product/accessory/connectivity/download/download.html](#)
 Chemical Safety Database Searcher—[ptcl.chem.ox.ac.uk/MSDS/msds-searcher.html](#)

Science Content Standards: 5–8

Science as Inquiry

CONTENT STANDARD A

As a result of activities in grades 5–8, all students should

develop abilities necessary to do scientific inquiry.

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Physical Science

CONTENT STANDARD B

As a result of their activities in grades 5–8, all students should develop an understanding of

- properties and changes of properties in matter, and
- transfer of energy.

Science and Technology

CONTENT STANDARD E

As a result of activities in grades 5–8, all students should develop an understanding of

- science and technology.

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- Share ideas that you have tested in your classroom. Ideas that sound great but have not been tried in the real world are not useable.



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