



### Science Objectives

- Students will observe how the particle movement changes as a substance changes state.
- Students will relate this information to a graph of change of state.
- Student will ascertain the melting and boiling points of each substance.

### Vocabulary

- absolute zero
- boiling point
- change of state
- freezing point
- gas
- heat of fusion
- heat of vaporization
- liquid
- melting point
- solid

### About the Lesson

- This lesson visually shows the behavior of particles in a substance as the temperature changes.
- As a result, students will:
  - Understand the behavior of particles as substances change state.
  - Identify the melting and boiling points of 3 substances by reading a graph.



### TI-Nspire™ Navigator™

- Send out the *Where\_is\_the\_Heat.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

### Activity Materials

- Compatible TI Technologies:  TI-Nspire™ CX Handhelds,  TI-Nspire™ Apps for iPad®,  TI-Nspire™ Software



### Tech Tips:

- This activity includes class captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

### Lesson Files:

- Student Activity*
- Where\_is\_the\_Heat\_Student.doc
  - Where\_is\_the\_Heat\_Student.pdf
- TI-Nspire document*
- Where\_is\_the\_Heat.tns



### Discussion Points and Possible Answers



#### TI-Nspire Navigator Opportunities

If you are using TI-Nspire Navigator, students can answer questions throughout the activity in the .tns document. Then, you can retrieve the file to assess understanding.

Use Quick Poll on any page with a question to check for understanding during the course of the activity. For students using iPad or those teachers without the TI-Nspire Navigator, the questions are set up in in Self-Check. Teachers with TI-Nspire Navigator should change questions to Exam mode for assessment and to discuss using the Review Workspace after the file is collected. On any question page select the Teacher Tool Palette. Then select Question Properties. Change the Document Type from Self-Check to Exam. Then send the file to the students.

Have students read the background information on matter and changes of state. Students should already have some background on the states of matter.

#### Move to pages 1.2 – 1.4.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q1. Matter is usually considered to exist in one of \_\_\_\_\_ state(s).

**Answer:** C. three

Q2. All molecular motion is believed to stop at \_\_\_\_\_.

**Answer:** C. 0 K

Q3. The atoms of which state of matter rest in relatively fixed positions?

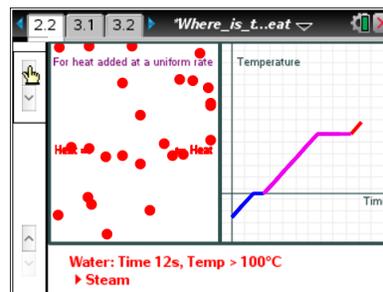
**Answer:** D. solid



### Move to pages 2.1 and 2.2.

Students will look at three Experiments and see the temperature at which the substances changes state. The three substances are (1) water (HOH), (2) ethyl alcohol (C<sub>2</sub>H<sub>5</sub>OH), and (3) iron (Fe).

1. Students will choose Experiment 1.
2. They raise or lower the temperature of the ice and choose how long to heat the sample using the slider for time. They observe the effect on the behavior of the particles.
3. Students record the **melting point** in the data table on page 2.2.
4. Students record the **boiling point** in the data table.
5. Students find and record the heat of fusion for ice (in kJ/mol).
6. Students find and record the heat of vaporization for water (in kJ/mol).
7. Students complete the table for Experiment 2 and Experiment 3 following the same steps.



**Data Table**

Data	Experiment 1 (HOH)	Experiment 2 (C <sub>2</sub> H <sub>5</sub> OH)	Experiment 3 (Fe)
Melting point	0°C	-114°C	1535°C
Boiling point	100°C	78°C	2750°C
Heat of Fusion	6.01 kJ/mol	4.6 kJ/mol	13.8 kJ/mol
Heat of Vaporization	40.7 kJ/mol	39.7 kJ/mol	349.6 kJ/mol



**Tech Tip:** You may want students to change the Time variable back to 0 before moving between Experiments. If the time is not set to 0, the next Experiment starts at the current Time.

### Move to pages 3.1 – 3.6.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q4. The melting point for the substance in Experiment 2 is \_\_\_\_\_.

**Answer:** A. -114°C

Q5. The boiling point for this substance in Experiment 2 is \_\_\_\_\_.

**Answer:** D. 78°C



Q6. When the temperature is  $-273^{\circ}\text{C}$ , the particles of a substance \_\_\_\_\_.

**Answer:** theoretically have no movement (absolute zero)

Q7. As the temperature increases, the amount of movement of the particles increases \_\_\_\_\_.

**Answer:** A. always

Q8. In the liquid state, most of the movement of particles is \_\_\_\_\_.

**Answer:** A. horizontal

Q9. How does the temperature change during any change of state? Explain.

**Answer:** Temperature remains constant during any change of state. Energy is used to break or form bonds between molecules, so changes of state are constant temperature processes.



### TI-Nspire Navigator Opportunities

Use TI-Nspire Navigator to capture screen shots of student progress and to retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolio.

## Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions in the Review Workspace.

## Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Review Workspace will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.