



### Science Objectives

- Students will describe the three states of matter.
- Students will analyze changes of state graphically.
- Students will ascertain the melting and boiling points of different substances.

### Vocabulary

- absolute zero
- boiling point
- change of state
- freezing point
- gas
- 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 *Changing\_States.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 Materials:

#### Student Activity

- Changing\_States\_Student.doc
- Changing\_States\_Student.pdf

#### TI-Nspire document

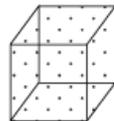
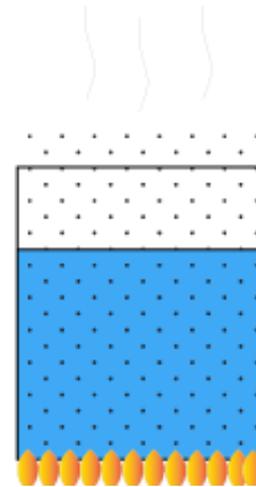
- Changing\_States.tns



### Discussion Points and Possible Answers

Have students read the background information on matter and changes of state on the student activity sheet. Students should already have some background on the states of matter. If you place the water in a pan and heat it at a high temperature, the water begins to boil and create steam. Steam is a gas.

So, for matter to change from liquid to gas, energy (in the form of heat) needs to be added. Matter is generally considered to exist in three states: solid, liquid, and gas. The particles that make up matter are in continual motion. This motion varies from vibrations in a more or less fixed position (solid), to sliding over one another (liquid), to freely moving in all directions (gas).



Solid



Liquid



Gas

At **absolute zero** ( $-273^{\circ}\text{C}$  or  $0\text{ K}$ ), matter has its lowest kinetic energy.

### Move to pages 1.2 – 1.4.

Have students answer questions 1 – 3 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

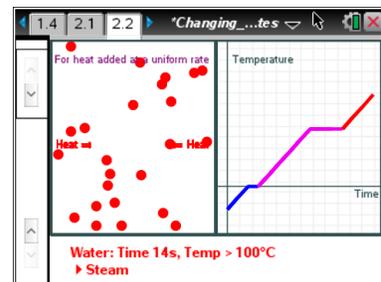
Q3. The atoms of which state of matter rest in relatively fixed positions?

**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 by using the lower up/down arrows until experiment 1 appears (if it is not already chosen).
2. They can raise the temperature by using the upper time slider and then observe the effect on the behavior of the particles.



Have students answer questions 4 – 6 on their activity sheet only.

Q4. What happens to the particles as more energy is added?

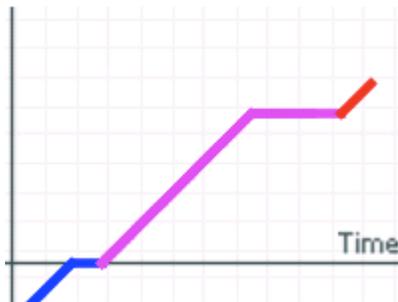
**Answer:** The particles begin to move farther apart.

Q5. What happens to the temperature of the substance as more heat is added?

**Answer:** It increases.



- Q6. Look at the portions of the graph where the temperature remains constant (where the line is flat), even though heat is still being added. Describe what is happening here.



**Answer:** The substance is absorbing heat but not increasing in temperature, while the material changes state.

- Students record the **melting point** in the data table below.
- Students record the **boiling point** in the data table below.
- Students complete the Data Table below 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



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

**Move to pages 3.1 – 3.6.**

Have students answer questions 7 – 12 on either the handheld, on the activity sheet, or both.

- Q7. The melting point for the substance in Experiment 2 is \_\_\_\_\_.

**Answer:** A. -114°C



Q8. The boiling point for this substance in Experiment 2 is \_\_\_\_\_.

**Answer:** D. 78°C

Q9. When the temperature is  $-273^{\circ}\text{C}$ , the particles of a substance \_\_\_\_\_.

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

Q10. As the temperature increases, the amount of movement of the particles increases \_\_\_\_\_.

**Answer:** A. always

Q11. In the liquid state, most of the movement of particles is \_\_\_\_\_.

**Answer:** A. horizontal

Q12. 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, retrieve the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

## Assessment

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