

Name: _____ Date: _____

Student Exploration: Phase Changes

Vocabulary: altitude, boil, boiling point, freeze, freezing point, gas, liquid, melt, melting point, phase, solid

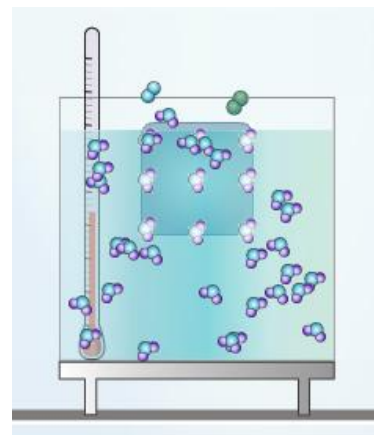
Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

1. A family from Minnesota turns off the heat and flies to Florida for a winter holiday. When they come home, all of their water pipes have burst. What do you think happened?

2. Spaghetti takes about 9 minutes to cook at sea level, but about 14 minutes in the mountains. Why do you think this is so?

Gizmo Warm-up

In the *Phase Changes Gizmo™*, select the **Micro view** and set the **Ice volume** to 50 cc. Click **Play** (▶) and observe molecules in the **solid** (ice), **liquid** (water), and **gas** (air) **phases**.

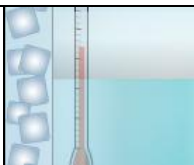


1. In which phase(s) are the molecules held rigidly together?

2. In which phase(s) do the molecules move freely?

3. In which phase(s) are the molecules held in a defined shape? _____

4. In which phase(s) do the molecules take the shape of their container? _____

Activity A: Phase changes	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset (🔄) and select Macro view. • Set Ice volume to 0 cc. 	
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Question: How is temperature related to phase changes?

- Predict: Based on your prior knowledge, predict the following:

 - At what temperature will water change from a liquid to a solid (**freeze**)? _____
 - At what temperature will water change from a solid to a liquid (**melt**)? _____
 - At what temperature will water change from a liquid to a gas (**boil**)? _____

- Investigate: Use the Gizmo to explore phase changes. Use the **Water temperature** and **Add/remove heat energy** sliders to control the water temperature. Record your observations in your notes, then answer the questions below:

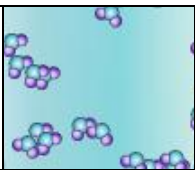
 - At what temperature does water freeze? _____ This is the **freezing point**.
 - At what temperature does ice melt? _____ This is the **melting point**.
 - At what temperature does water boil? _____ This is the **boiling point**.

- Observe: Set up the Gizmo to observe freezing. What do you notice about the temperature while the water is in the process of freezing? _____

- Explore: Use the Gizmo to investigate melting and boiling. Does the temperature change as either of these phase changes is occurring? _____

- Interpret: Select the GRAPH tab to see a graph of temperature vs. time. Click the “-” button until the whole graph is visible. What does the graph look like during a phase change?

- Extend your thinking: Why do you think the temperature does not change much during a phase change? If possible, discuss your answer with your classmates and teacher.

Activity B: Temperature and molecular motion	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset, and select the Micro view. • Set Ice volume to 0 cc. • Set Add/remove heat energy to 0 J/s. 	
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Question: Why do phase changes occur?

1. Compare: Set the **Water temperature** to 0 °C and click **Play**. Observe the water molecules. Click **Reset**, set the **Water temperature** to 100 °C, and click **Play** again.

What do you notice? _____

2. Observe: Click **Reset**. The **mean molecular speed** of the water molecules is displayed below the container. Set the **Water temperature** to 0 °C and **Add/remove heat energy** to 400 J/s. Click **Play**.
 - A. How does the average speed of the water molecules change as they are heated?

- B. Does the mean molecular speed change as much as the temperature as the water heats up? Explain.

3. Explain: How is temperature related to the motions of molecules? _____

4. Observe: Click **Reset**. Set the **Water temperature** to 20 °C and the **Ice volume** to 50 cc. Set **Add/remove heat energy** to 0 J/s. Click **Play**. How do the molecules in the liquid interact with the molecules in the solid?

(Activity B continued on next page)

Activity B (continued from previous page)


5. Observe: Click **Reset**. Set the **Water temperature** to 100 °C and the **Ice volume** to 50 cc. Click **Play**. How does this situation compare to the previous one?

6. Propose a theory: Based on what you have observed, explain why you think phase changes occur. If possible, discuss your theory with your classmates and teacher.

7. Extend your thinking: Click **Reset**. Set the **Water temperature** to 0 °C, the **Ice volume** to 0 cc, and **Add/remove heat energy** to -400 J/s. Click **Play** and wait until *all* the water freezes.

A. What volume of ice is created from 200 cc of water? _____

B. Why do water pipes sometimes burst in the winter? _____

Extension: Altitude and phase changes	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset. • Set Ice volume to 0 cc. • Set the Altitude to 5,000 meters (16,404 feet). 	
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Question: The altitude of a location is its vertical distance above sea level. How does altitude affect phase changes?

1. Form a hypothesis: As altitude increases, the air pressure decreases. How do you think the lower pressure will affect the following? (Circle your answers.)

- | | | | |
|--------------------|----------|---------------|----------|
| A. Freezing point: | Increase | Stay the same | Decrease |
| B. Melting point: | Increase | Stay the same | Decrease |
| C. Boiling point: | Increase | Stay the same | Decrease |

2. Experiment: Use the Gizmo to find the freezing, melting, and boiling points of water at 5,000 meters (16,404 feet). Write these values below.

Freezing point: _____ Melting point: _____ Boiling point: _____

3. Analyze: How did altitude affect the freezing, melting, and boiling points of water?

4. Challenge: Try to explain these results based on the fact that air pressure decreases with altitude. If possible, discuss your ideas with your classmates and teacher.

5. Apply: Why does pasta take longer to cook in the mountains? _____

6. Apply: A pressure cooker allows food to be cooked under high pressure. Why is this useful?
