



### States of Matter Lesson 1: *The Solve*

#### Student Guide Live Video Phenomenon

#### Part 1. Video Clip of Phenomenon

Either on your own, in a small group, or as a class (your teacher will let you know), watch this [video clip](#).

What are your initial reactions to this video?

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Watch the video again.

Jot down 3–5 observations as you watch this video.

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How do you think the frog is able to survive the freezing, then thawing?

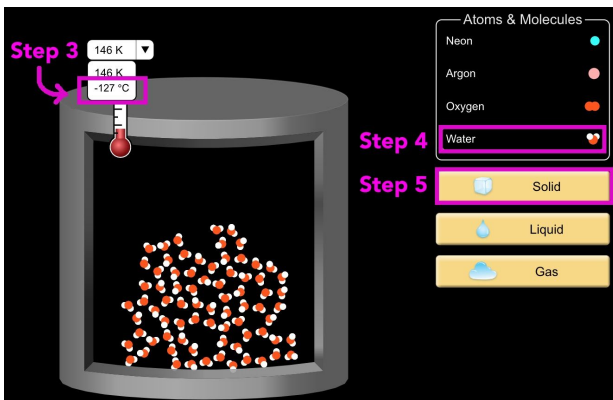
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### Part 2. Let's Explore States of Matter

Let's try to figure out what's happening with these animals. To do so, let's figure out the answer to the question, "What happens when things freeze?"

1. Click here to access the [PhET Simulation](#) on States of Matter.
2. Click on the **States** icon.
3. Change the temperature from Kelvin (K) to Celsius (°C).
4. In the Atoms and Molecules Chart choose **Water**.
5. Click on the **Solid** button. How do water molecules behave?
  - a. Sketch the arrangement of solid water molecules in the appropriate box.
  - b. Record the temperature at which water is solid in the next box.
  - c. Describe how the molecules move as a solid.
6. Repeat step 5 for Liquid and Gas by clicking the **Liquid** and **Gas** buttons respectively. Record data in the appropriate boxes.



**PhET Simulation States of Matter Data Table**

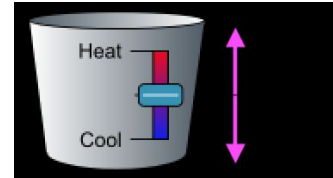
	<b>Sketch arrangement of water molecules</b>	<b>Temp. (°C)</b>	<b>Describe the motion of the molecules</b> (Are they moving slowly, fast, very fast, etc.)
<b>Solid</b>			
<b>Liquid</b>			
<b>Gas</b>			



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7. With water already in the system, click on **Solid**.
  - a. Raise the lever toward **Heat** and hold for 15 seconds. How did the increase in heat (thermal energy) change the behavior of the water molecules?
  - b. Lower the lever toward **Cool** and hold for 15 seconds. How did the decrease in heat (thermal energy) change the behavior of the water molecules?
  
8. So what happens to molecules when a substance freezes?





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### Part 3. Comparing Freezing Points of Substances

During winter months, wood frogs can prevent their blood from freezing, even in subfreezing temperatures. What could prevent something from freezing solid?

Now that we know a bit about how molecules behave during freezing, let's answer this question.

[View the video.](#)

At each 0.5 hour mark, record the states of matter observed in each bag. Record your data in the table below.

	Water Only		Water + Sugar	
Time (hours)	Temp. (°C)	State(s) of Matter Observed <i>Write "Liquid," "Solid," or "Liquid and Solid"</i>	Temp. (°C)	State(s) of Matter Observed <i>Write "Liquid," "Solid," or "Liquid and Solid"</i>
0				
0.5				
1				
1.5				
2				
2.5				
3				
3.5				
4				
4.5				



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### Graph Your Data

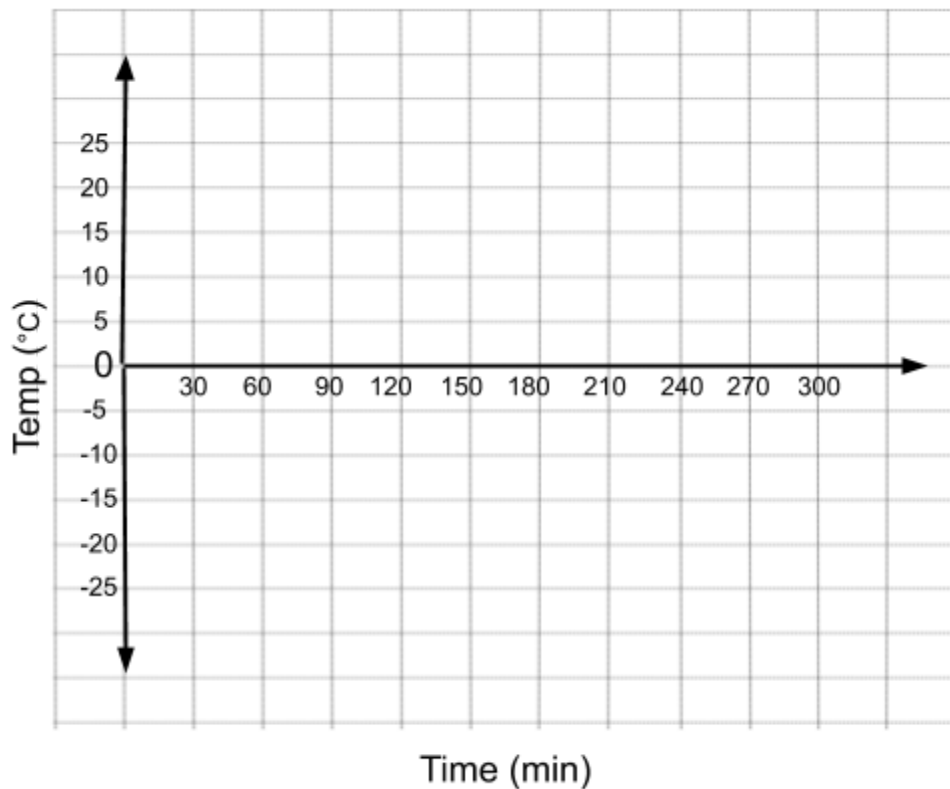
Create a graph that displays the data from the table above as a *double line graph*.

- a. To create the double line graph, select one color to graph the data for **Water Only**.
  - b. Color in the box in the Line Graph key with your selected color. Graph each data point with this color.
  - c. Choose a different color to represent **Water + Sugar**.
  - d. Color in the box in the Line Graph key with your selected color. Graph all data on the same set of axes below.
2. Annotate your Graph
- a. Label directly on the graph the regions that are “liquid,” “liquid + solid,” and “solid.”

### Line Graph Key

= Water Only

= Water + Sugar





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### Reflection Questions

1. What two substances did you analyze in the activity and how did they behave differently at zero degrees?
2. Connecting this graph with the video you viewed, what could the frog have in its blood that would enable it to survive the freezing temperatures?

### Part 4. Constructing an Explanation

1. Annotated Image: Label where you think the listed terms can be seen.



**States of Matter:** Conditions in which matter can exist, such as solid, liquid, or gas.

**Liquid:** A state of matter in which the particles are touching and are able to move freely to collide and glide past each other.

**Solid:** A state of matter in which molecules vibrate in fixed positions.

**Melt:** To change from a solid to liquid state.

**Freeze:** To change from a liquid to solid state.

**Heat (Thermal Energy):** A type of energy that results from the increased movement of particles in a solid, liquid, or gas. Heat can be transferred from one object to another.

2. Reflecting on what you have learned about how things freeze and what can prevent things from freezing completely, how do you think the frog we viewed in



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the video is able to survive the big freeze of winter? Use as many of the above terms as possible in your answer.

### Part 5. Quiz: Check for Understanding

Complete the exit ticket below *or* you can take the quiz online!

**Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

1. All of the following are true regarding solids except for:
  - a. Molecules are tightly packed in a solid.
  - b. Molecules vibrate at a slow speed, in a fixed position.
  - c. Molecules move quickly and freely past one another in a solid.
  - d. A solid has a definite shape and structure.
2. Which of the following correctly describes the action of water molecules in the wood frog's body as winter approaches and temperatures fall?
  - a. Molecules gain thermal energy.
  - b. Molecules change state from a liquid to a gas.
  - c. Molecules increase in speed, spreading farther apart from one another.
  - d. Molecules lose energy, moving closer together.
3. Which of the following states of matter consists of molecules in constant random motion:
  - a. Solid
  - b. Liquid
  - c. Gas
  - d. All of the above
4. In order for thawing and/or melting to occur:
  - a. Thermal energy needs to be added to a substance.
  - b. Thermal energy needs to be removed from a substance.





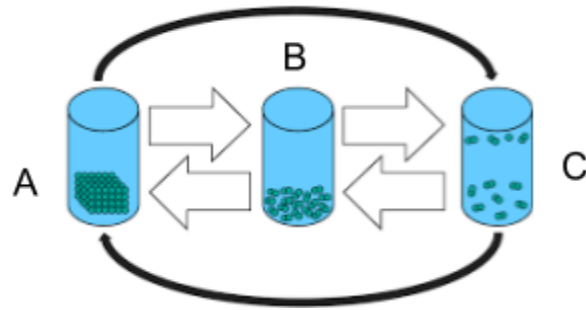
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- c. Water in the atmosphere condenses and falls back to Earth.
  - d. Temperatures must remain at 0 degrees Celsius or below.
5. Study the diagram to the right.

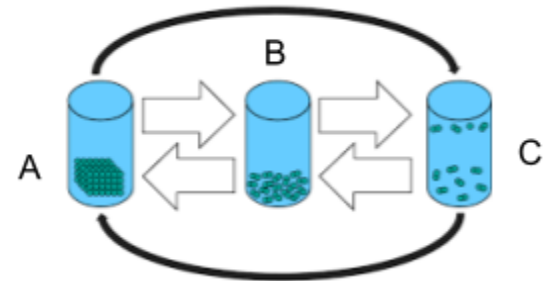
Letter A would represent which of the following?

- a. Solid
- b. Liquid
- c. Gas
- d. Heat energy



6. Refer to the diagram. What is required for A to progress to C?

- a. Ice
- b. Heat (thermal energy)
- c. Glucose
- d. Water



7. Which of the following is true about what occurs when the frog begins to warm? Circle all that apply.
- a. The warmer temperature outside causes thawing.
  - b. Glucose and water in the bloodstream cause cells to remain frozen solid during the thawing process.
  - c. Molecules spread farther apart during the thawing process.
  - d. Molecules move closer together and crystalize during the thawing process.

