Activity Sheet Answers

Chapter 2, Lesson 4
Changing State—Freezing

DEMONSTRATION

1. In the video, you saw a round metal container filled with water and placed in a very cold liquid mixed with dry ice. What happened when the water inside the container froze? What caused this to happen?
   When the water in the container freezes, the container suddenly bursts. This happens because when water freezes, it takes up more room than the same amount of liquid water. The frozen water pushes so hard against the inside of the container that the container breaks.

2. Use the example of what happens to the metal container to explain why roads are likely to develop potholes during cold winters?
   During a cold winter, potholes form because water that is in little cracks in the road freezes and expands and makes the cracks bigger. Cars and trucks going over these cracks make them even bigger, and more water gets in and freezes. Eventually, a pothole forms.

EXPLAIN IT WITH ATOMS & MOLECULES

3. Look at and touch the outside of the can. What do you observe?
   After adding ice and salt to the can and stirring, the outside of the can has frost and water on it.

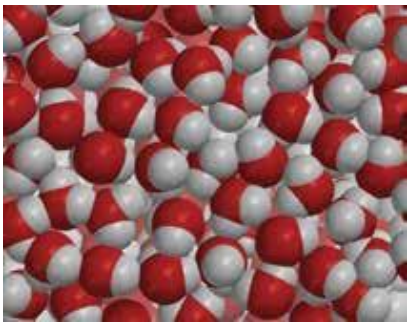
4. Describe what happened to the water vapor in the air when it came in contact with the cold surface of the can. Be sure to mention how the molecules change speed and how they are attracted to each other.
   When water vapor molecules from the air contacted the cold can, they transferred some of their energy to the can which caused the water vapor molecules to slow down. Their slower motion allows their attractions to bring them together as liquid water. If they slow down enough they can form ice.

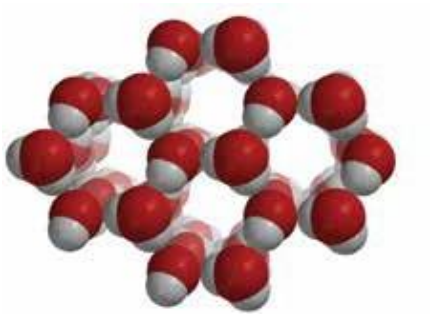
5. Your can might have some water and some ice on the outside of it. Explain how this can be possible.
   The water was near the top of the can and the ice was below. The water is at the top because it is not quite as cold so the water does not become ice.

6. You have seen molecular model animations of water and ice. Fill out the chart to compare how the molecules move in water and ice. Select one of the options in each row and write it under "Water" or "Ice" in the chart.

Compare molecules in water and ice		
	Water	**Ice**
Speed of molecules	Faster	Slower
Amount of movement	Move past each other	Remain in fixed positions
Arrangement of molecules	Random and unorganized	Very organized
Distance between molecules	Closer together	Slightly further apart

7. Write captions under the pictures to explain how the movement and position of molecules changes as the water freezes to become ice.





Water molecules are attracted to each other and move past each other. As they get colder, they slow down and their attractions bring them together into fixed positions. In the crystal structure of ice, the water molecules are spread a little farther apart than in liquid water.

8. The temperature at which a substance freezes is called the freezing point. Different liquids have different freezing points. Here are a few examples.

Water	0 °C
Corn oil	about –20°C
Isopropyl alcohol	–88.5 °C

Why do you think different liquids have different freezing points?

Liquids have different freezing points because the molecules of different liquids attract each other by different amounts. It takes a different low temperature to cause the molecules of different substances to attract each other to the point where they no longer can slide past each other and instead, be held in fixed positions as a solid.

9. Nitrogen is a gas at room temperature. It needs to be cooled to –196 °C to condense to a liquid and freezes at –210 °C. Do you think the attractions between nitrogen molecules are strong or weak? Why?
   The attractions between nitrogen molecules must be weak because they have to be cooled so much to be slowed down enough that their attractions can hold them together.

TAKE IT FURTHER

10. Freezing is the process that occurs when a liquid changes to a solid. Frost forms through a process called *deposition*. What happens during the process of deposition?
    During deposition, a gas changes directly to a solid without changing first to a liquid.

