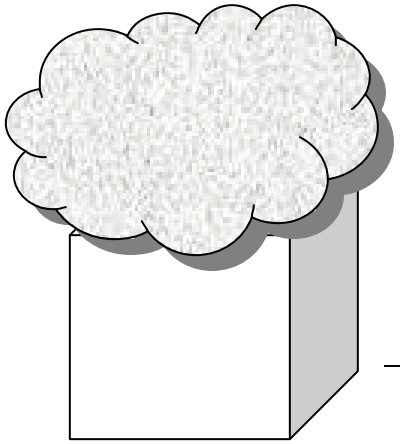
Name _____

Temperature Change and the States of Matter

How is dry ice like "wet" ice? How is it different?

Dry Ice
Watch the dry ice that your teacher has provided for observation. (Do not touch it.) Dry ice is made from carbon dioxide. Can you compare it to ice made from water?



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Thinking about Matter

Use your logic to explain these everyday happenings as scientifically as you can:

1. You go into the freezer and find a burger that has been there for two months. It is gray and dry.

_____

_____

2. On Tuesday it snows 14 inches. On Wednesday and Thursday it is very sunny but very cold. But the snow piles get a little smaller each day.

_____

_____

3. You take a long shower and sing an entire Beatles album. When you open the bathroom door the mirror is dripping with water.

_____

_____

4. Your neighbor keeps his boat in a canal all winter. She uses a "bubbler" to keep the water stirred so that it does not freeze around the hull of the boat.

_____

_____

5. Your ice skates slide smoothly over the ice.

_____

_____

Investigating Changes of State

Procedure:

6. Obtain four Styrofoam cups from your instructor. You will also need a thermometer, salt, a graduate, and a beaker.

7. Into one cup put 100 ml of very cold water and crushed ice. Swirl the mixture a little and measure its temperature. Measure its temperature every minute for the next 15 minutes. (Never stir with your thermometer.) Your data will go on the table found on the next page and you will graph the data on the graph grid on the next page.

Temperature of Crushed Ice/Water Mixture	
Time	Temp

8. What is colder, the room or the ice/water mixture?_____

9. Is the temperature of the ice/water mixture changing over time?_____

10. Explain the shape of your graph and what is happening in terms of particles:_____

_____

_____

11. Into each of your remaining three Styrofoam cups place exactly 100 ml of cold water. Into one of the cups place 5 g of salt. Swirl carefully. Measure the temperature of each cup. Mark your group's initials on the cups.

12. Place two of your cups on a tray, to be put in a freezer for 24 hours.

13. When 24 hours have elapsed, carefully measure the volume in each of your cups. To measure the volume of ice, you will have to use this procedure *quickly*. Peal the Styrofoam off the ice, and then place it in the bottom of a beaker. Fill the beaker to the very top with water. Then record the difference between the amount of water you added and the amount of water the beaker will hold. (Do not write down the number on the side of the beaker—check it.)

14. Does the ice have a greater or smaller volume than the water in the cup in the room?_____

15. Explain your answer to #14 in terms of particles: _____

_____

16. Did the ice with salt added freeze?_____

17. Explain why or why not: _____

_____

18. Did the addition of salt change the volume?_____

19. Why or why not?_____

_____

Changes of State

When a substance is heated, its molecules move faster. When a substance is cooled, its molecules move slower. The average speed of the molecules in a substance determines its state.

The molecules of a solid are locked in a rigid array, only vibrating but not moving past each other. The molecules of a liquid are free to move past each other, even though they are held together closely. With this in mind, we can explain what happens to molecules when a substance melts or freezes. To melt a solid, it must be heated. This makes its molecules move faster. When the molecules move fast enough to break free from being locked in a rigid position, the substance becomes a liquid. The energy that is used to break the forces among the molecules does not make the temperature rise—it can only be used once. So while a substance is melting, its temperature remains constant.

When a liquid is heated, its molecules move faster and faster until they move fast enough to break free from the force that holds them close together. The particles fly off the surface of the liquid and the substance evaporates. Evaporation can occur in even very cold liquids. But if a liquid is cold, while some of the particles are gaining energy and breaking free, others are losing energy and falling back into the liquid state. Remember, the energy that is moving into the liquid can either change the forces between the molecules or raise the temperature, not both. So while water is boiling, it stays at the same temperature.

The particles of a gas have a high energy level. They move so quickly that the forces between them are very weak. Cooling a gas reduces the speed of its molecules so that they bind together, forming a liquid. This process is called condensation. If a gas comes in contact with a surface that is much cooler, the energy transfer happens quickly. Condensation occurs more rapidly on cold mirrors or blades of grass near the ground than on warmer surfaces like your skin. Clouds form when water molecules condense onto very small pieces of colder dust or dirt. Solidification or freezing of a liquid occurs when the molecules of a liquid slow down enough so that the force that always exists between them binds them together in a rigid array.

Some substances go directly from a solid to a gas, or from a gas to a solid, without ever being a liquid. These processes are both called sublimation. “Dry ice” (solid carbon dioxide) sublimates, as does snow in the cold winter air. Sublimation may even occur in your freezer at home. Sometimes the water contained in frozen foods sublimates and consequently dries out the food. In order for sublimation to occur, a huge input or output of energy must occur rapidly. The molecules must move quickly away from the surface of the solid, so that the forces in the solid do not capture them again. Dry ice sublimates in a warm room. Snow often sublimates in direct sunlight.

Every substance melts, freezes, or boils at its own characteristic temperature. The melting point of a substance is the temperature at which the solid form turns into a liquid (or the liquid form solidifies – both happen at the same temperature). A liquid’s boiling point is the temperature at which boiling begins to occur in the substance. The boiling point and freezing point are two specific properties that can be used to identify an unknown substance.