

States of Matter

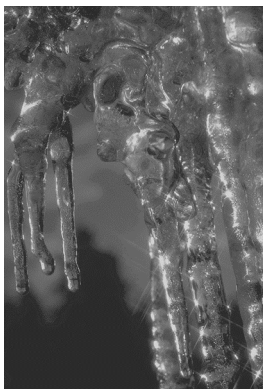
Phase Changes

Supply list:

- Ice
- Small saucepan
- Hand mirror
- Ice tray



All matter has physical and chemical properties. One physical property of a substance is its physical state. When we speak of physical state we are talking about whether the substance is a gas, a liquid, or a solid. A substance's physical state is determined by how tightly its molecules cling to each other and the amount of energy necessary to make the molecules move apart.



In a solid, the molecules are packed tightly together and do not move very much. They are strongly attracted to each other. As energy, usually in the form of heat, is added to the substance, the molecules begin to move; their kinetic energy increases. Kinetic energy is the energy of motion or moving particles. As more heat is added, the molecules eventually gain enough energy to move away from each other. When the forces pulling them together equal the



forces pushing them apart, the substance changes from a

solid to a liquid.



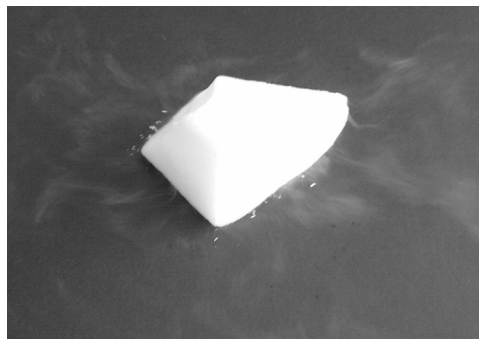
If more energy is added to the liquid, the molecules move even faster. Eventually they gain enough energy to break free of the other molecules and become a gas. In a gas, the molecules are far apart from each other and move very quickly.

Similarly, if molecules lose energy, if heat is transferred to something else like cooler air, the molecules will slow down. A gas will become a liquid or a liquid will become a solid when it loses enough energy for the molecules to become attracted to each other again.

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When a substance changes from one physical state to another it is called a phase change. When a solid becomes a liquid we say that it has melted. The temperature at which the substance melts is called the melting point. When a liquid becomes a gas it has evaporated. The temperature at which a liquid begins to evaporate is called the boiling point. When a gas becomes a liquid it has condensed, and when a liquid becomes a solid we say it has frozen.

Some substances can change directly from a solid into a gas or directly from a gas into a solid without going through a liquid phase. This phase change is called sublimation. Two of the most common substances that experience sublimation are carbon dioxide and mothballs. Dry ice, shown here, is frozen carbon dioxide. When it is placed in a warm environment it quickly sublimates directly into a gas without leaving any liquid behind. This makes it very popular in the food industry for keeping foods frozen while being transported.



The vast majority of substances on earth are solids at normal temperature and pressure. Water is one very important substance that occurs in all three states depending on the weather. And several substances, including oxygen and nitrogen naturally occur as gases on earth. The fact that the earth is made of substances that are solid is another example of God's provision for life on earth. Many of the planets in our solar system are made of hydrogen and other elements that are naturally gases and would not be able to support life, but earth was designed perfectly for life.



Observing Phase Changes:

1. Have your child observe a piece of ice. How does it feel? (Hard, cold, smooth)

2. Now, place a few pieces of ice in a small saucepan and melt it over medium heat just until most of the ice is melted. Remove the pan from the heat and have your child observe the liquid water. How does the liquid compare to the solid? (It is warmer, can be moved easier, wet)
3. Return the pan to the stove on medium heat. Have your child watch as the water begins to boil. **Do not have your child put his/her hand in the steam. He/she could be burned.** What did you notice as the water began to boil? (Little bubbles came up from the bottom of the pan. Steam rose from the water.)
4. Place a hand mirror in the steam and watch as some of the steam condenses on the mirror. How does the water on the mirror feel? (Cool and wet)
5. Remove the pan from the stove. Pour the water into an ice tray and place the tray in the freezer. After 1-2 hours have your child observe the water again. How does the water look and feel now? (Cold, hard, and smooth.)

You have now seen the phase changes of water. Review the names of each phase change:

Solid to Liquid – Melting

Liquid to Gas – Evaporation

Gas to Liquid – Condensation

Liquid to Solid – Freezing

You did not observe sublimation; the changing of a solid directly to gas or a gas directly to a solid.



What did we learn?

What are the three physical states of most matter? (Solid, liquid, gas)

What is the name for each phase change? (Solid to liquid is melting, liquid to gas is evaporation, gas to liquid is condensation, liquid to solid is freezing, and for those substances that can go directly from solid to gas or gas to solid the phase change is called sublimation.)

What is required to bring about a phase change in a substance? (The addition or removal of energy – primarily in the form of heat)

Taking it further

Name several substances that are solid at room temperature. (The answers are endless. Some ideas include the floor, wood, plastic, many foods, people, animals, etc.)

Name several substances that are liquid at room temperature. (Some ideas include water, juice, tea, honey, rubbing alcohol, and syrup.)

Name several substances that are gas at room temperature. (Some ideas include air, nitrogen, oxygen, hydrogen, carbon dioxide, carbon monoxide, propane, and natural gas.)