

Name _____

Science-Matter on the Move

Date _____

Student # _____

Changes in State

When snow melts after a snowstorm, all three states of water are present. The snow is a solid, the melted snow is a liquid, and the air above the snow and ice contains water vapor, a gas. What causes particles to change state?



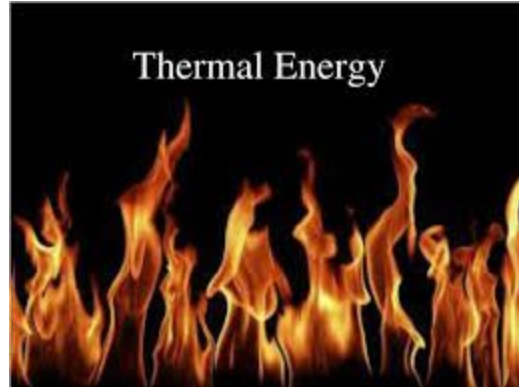
Kinetic Energy

Recall that the particles that make up matter are always moving. These particles have kinetic energy, the energy an object has due to its motion. The faster particles move, the more kinetic energy they have. Within a given substance, such as water, particles in the solid state have the least amount of kinetic energy. This is because they only vibrate in place. Particles in the liquid state move faster than particles in the solid state. Therefore, they have more kinetic energy. Particles in the gaseous state move quickly. They have the most kinetic energy of particles of a given substance.

Temperature is a measure of the average kinetic energy of all the particles in an object. Within a given substance, a rise in temperature means that the particles, on average, are moving at greater speeds. Therefore, the particles have more kinetic energy. For example, water molecules at 25°C are moving faster and have more kinetic energy than water molecules moving at 10°C .

Potential Energy

In addition to kinetic energy, particles have potential energy. Potential energy is stored energy due to the interactions between particles or objects. Think about holding a basketball and then letting it go. The gravitational force between the ball and Earth causes the ball to fall toward Earth. Before you let the ball go, it has potential, or stored energy.



Thermal Energy

Changes in state are caused by changes in thermal energy. Thermal energy is the energy produced by the movement and attractions of molecules within a substance. You can change an object's state of matter by adding or removing thermal energy.

When you add thermal energy to an object, these things can happen:

- Particles move faster.
- Particles get farther apart.

The opposite is true when you remove thermal energy:

- Particles move slower.
- Particles get closer together.

If enough thermal energy is added or removed, a change in state can occur.

Solid to Liquid or Liquid to Solid

After you drink a beverage from an aluminum can, do you recycle the can? Aluminum recycling is one example of a process that involves matter changing from one state to another by adding or removing thermal energy.

Solid → Liquid

Melting

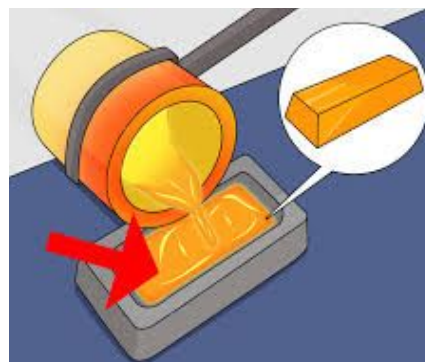
The first part of the recycling process involves melting aluminum cans. To change matter from a solid to a liquid, thermal energy must be added. At first, the thermal energy and the temperature increase. The temperature stops rising when it reaches the melting point of the matter. The melting point is the temperature at which the solid changes to a liquid.



Liquid → Solid

Freezing

After the aluminum melts, it is poured into molds to cool. As the aluminum cools, thermal energy leaves it. If enough energy is removed, the aluminum will freeze. Freezing is the process that is the opposite of melting - liquids change to a solid. The temperature at which matter changes from the liquid state to the solid state is its freezing point.



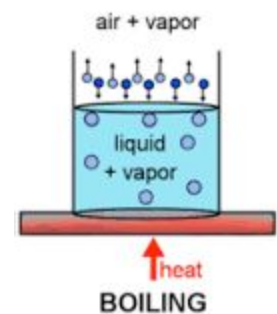
Liquid to Gas or Gas to Liquid

Liquid → Gas

When you heat water, do you ever notice how bubbles begin to form at the bottom and rise to the surface? The bubbles contain water vapor, a gas. As the water heats, it changes from the liquid state to the gaseous state. Vaporization is the change in state of a liquid into a gas. There are two types of vaporization - boiling and evaporation. The two types of vaporization differ in where they take place.

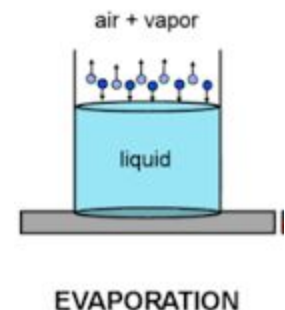
Boiling

Vaporization that occurs within a liquid is called boiling. During boiling, vaporization takes place throughout the liquid. The temperature at which boiling in a liquid is called its boiling point. The kinetic energy of particles increases until the liquid reaches its boiling point. The particles move farther apart until the attractive forces no longer hold them together. At this point, the liquid changes to a gas.



Evaporation

Unlike boiling, evaporation is vaporization that occurs only at the surface of a liquid. A small amount of liquid in an open container will disappear after several days due to evaporation.



Gas → Liquid

Condensation

When a gas loses enough thermal energy, the gas changes to a liquid, or condenses. Condensation is the change of state from a gas to a liquid. Overnight, water vapor often condenses on blades of grass and forms dew.



Solid to Gas or Gas to Solid

A solid can become a gas without turning into a liquid. Also, a gas can become a solid without turning into a liquid.

Solid → Gas

Sublimation

Dry ice is solid carbon dioxide. It turns immediately into a gas when thermal energy is added to it. The process is called sublimation. Sublimation is the change of state from a solid to a gas without going through the liquid state. As dry ice sublimates, it cools and condenses the water vapor in the surrounding air, creating a thick fog.



Gas → Solid

Deposition

Deposition is the change of state of a gas to a solid without going through the liquid state. For deposition to occur, thermal energy must be removed from the gas. Frost on the grass on a fall morning or frost on a car's windshield are often the result of deposition. As water vapor loses thermal energy, it changes into solid frost.

