

## Chapter 3 Lesson 2 Notes: Changes of State

### Remember from chapter 2:

- Any **change** in the state of matter requires a change in energy.
- **Thermal Energy:** the total energy (potential and kinetic) of all the particles in an object.
  - **Kinetic:** energy that an object has due to its motion
  - **Potential:** stored energy that results from the position or shape of an object
  - We will visit these types of energy in more detail in physics.
- **Temperature:** a measure of the average energy of motion of the particles of a substance.
  - Particles of a substance at a warmer temperature have more thermal energy than particles of that same substance at a cooler temperature.
  - Heat flows from a warmer substance to a cooler substance.

### 1. Changes Between Solid and Liquid

- a. Particles of a liquid have more thermal energy than particles of the same substance in solid form
  - **Example:** liquid water has more thermal energy than ice, and water vapor has more than liquid water.
- b. The state of matter depends on molecular motion.
- c. Any change in thermal energy means a change in molecular motion.
- d. Freedom of motion of particles increases from solids to liquids to gases.
- e. The balance between the particles' motions and attractive forces **determines** the state of matter.
- f. **Melting:** the change in state from a solid to a liquid.
  - **Melting point** – pure substances melt at a specific temperature.
    - **Example:** water melts at 0°C and salt melts at 800°C.
  - Melting points change with air pressure.
- g. When a substance melts, the particles in the solid vibrate so fast that they break free from their fixed positions.
  - **Example:** the energy to melt ice comes from the air in the room. The molecules begin to vibrate faster and the temperature of the ice increases. At 0°C, the temperature stops increasing **unless** energy is added, causing the crystals to **collide** and **break** from their fixed positions, becoming liquid.
- h. **Freezing:** a change from a liquid to a solid.

- When a substance freezes, the particles in the liquid move so slowly that they begin to take on fixed positions.
  - **Example:** Water loses energy to the cold air when placed in a freezer. The water molecules move more slowly as they lose energy. At 0°C, water freezes.
- i. Physical changes in the states of matter are reversible but not chemical changes.

## 2. Changes Between a Liquid and Gas

- a. **Vaporization:** The change from a liquid to a gas.
- Vaporization takes place where the particles in a liquid gain enough energy to move independently, forming a gas.
  - 2 main types of vaporization: evaporation and boiling
  - **Evaporation:** vaporization that takes place only on the surface of a liquid.
    - Added energy from the ground, air, sun, enables the molecules on the surface of the liquid to escape into the air.
  - **Boiling:** when a liquid changes to a gas below its surface.
    - Vaporized water molecules form bubbles below the surface.
- b. **Boiling Point:** the temperature at which a liquid boils (characteristic property of a substance).
- The boiling point of a substance depends on the pressure of the air above it.
  - The lower the pressure, the less energy needed for the particles of the liquid to escape into the air.
    - Sea level – boiling point is 100°C
    - High elevation – mountainous areas have low pressure, so the boiling point is lower (1600 m, boiling point is 95°C).
- c. **Condensation:** change in state of a gas to a liquid.
- i. During condensation, the particles in a gas lose enough thermal energy to form a liquid.

## 3. Changes Between solid and Gas

- a. **Sublimation:** when the surface particles of a solid gain enough energy that they form a gas (skip the liquid phase).
- b. During sublimation, particles of a solid do not pass through the liquid state as they form a gas.
- **Examples:** dry ice (solid carbon dioxide) and solid room air freshener.