

States of Matter

Thermal Expansion/Contraction, Heat/Temperature, & Changes of State

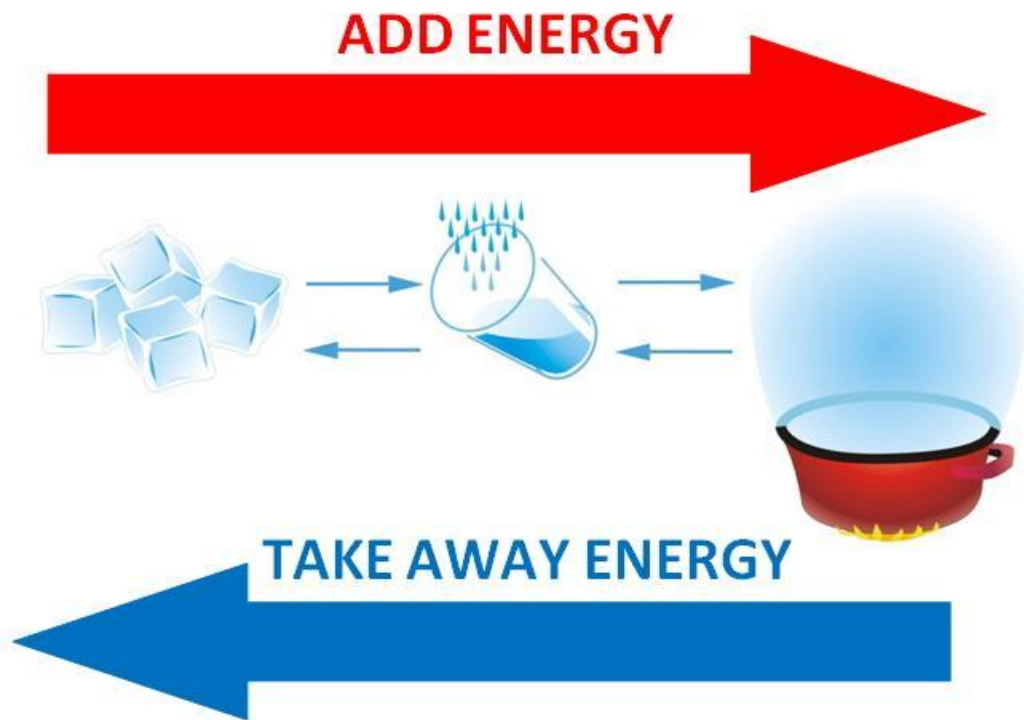
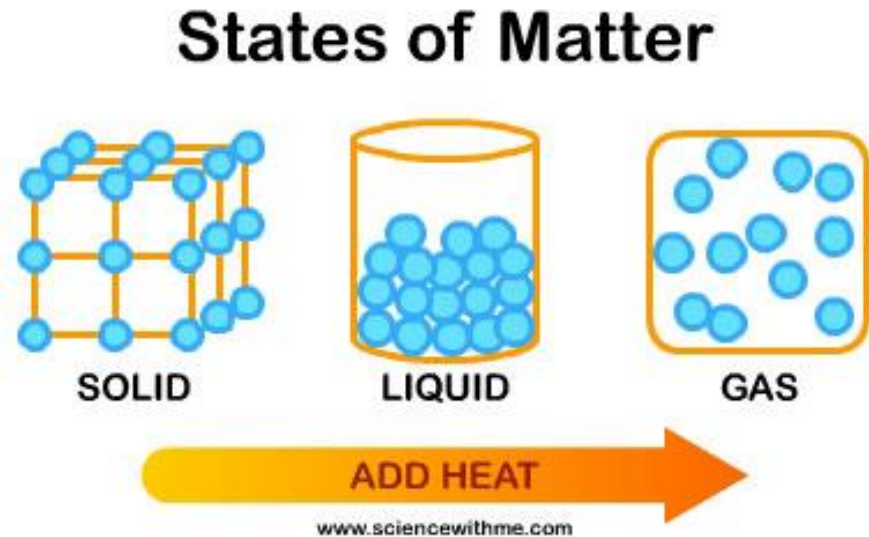
Lesson 24

Recap

- The **particle model of matter** and the **kinetic molecular theory** were developed...
 - to explain what happens to particles of matter in different states and changes of state
- All matter is made up of very small particles (atoms and molecules)
- There is empty space between particles
- Particles are constantly moving. The particles are colliding with each other and the walls of their container
- Energy makes particles move. The more energy the particles have, the faster they can move and the farther apart they can get

Thermal Expansion and Contraction

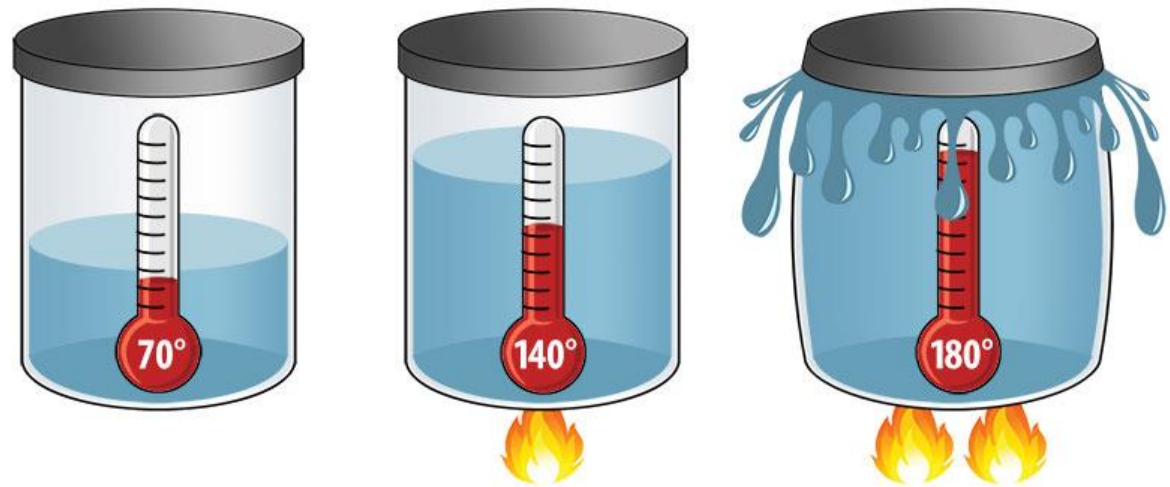
- When you add energy to a material, you increase the kinetic energy of the particles
 - A common way to add energy is to add heat



Thermal Expansion and Contraction

What happens inside a solid, liquid, or gas as its temperature goes up?

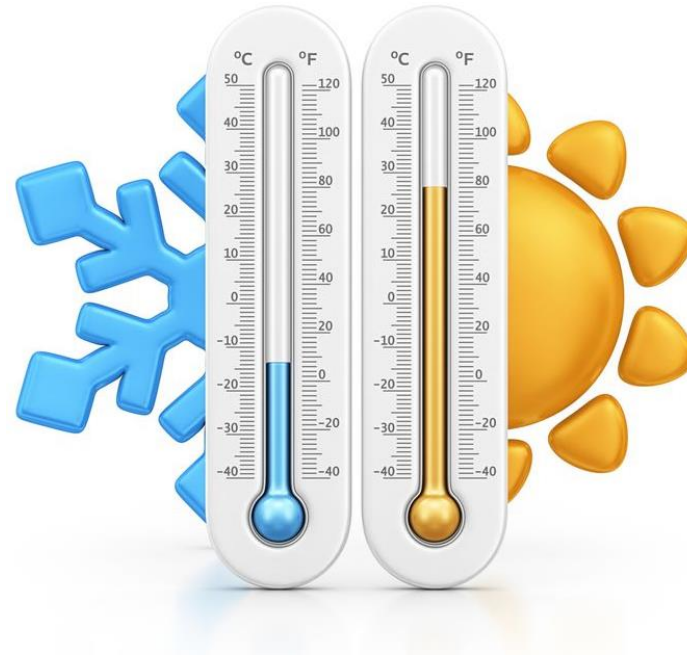
- As temperature increases, the particles move around faster
- Each particle moves over a larger region, which results in more space between particles
- The material that is made up of the particles *expands* or increases in volume
- In general, any kind of matter expands when its temperature increases = **thermal expansion**



Thermal Expansion and Contraction

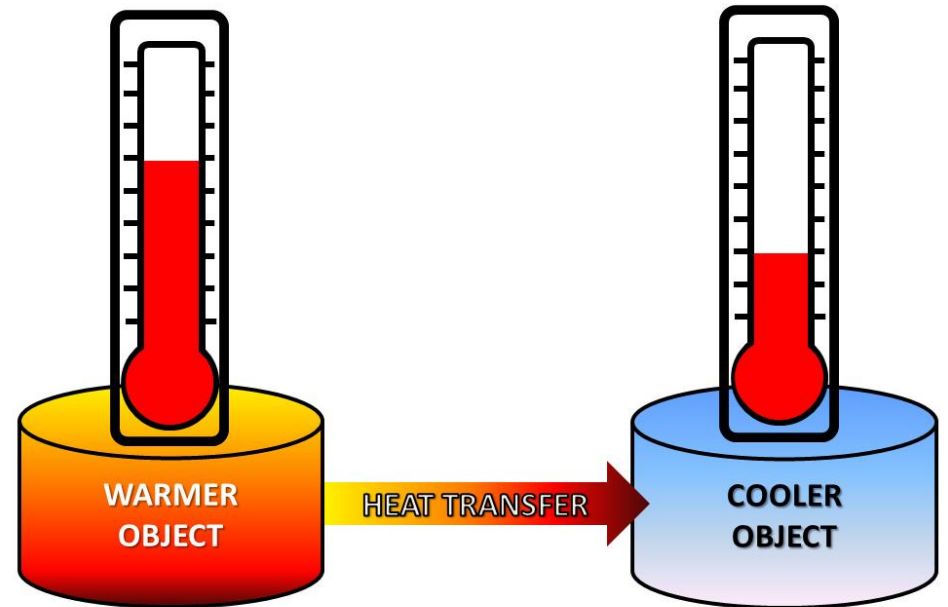
What happens to matter when its temperature decreases?

- The movement of the particles slows down, which means that particles take up less space as they lose energy
- The matter *contracts*, or decreases in volume = **thermal contraction**



The Difference Between Heat & Temperature

- All the kinetic energy of all the particles of a substance (the total amount of energy) = **thermal energy**
 - If two substances with different **thermal energies** come into contact, energy will always flow from high to low thermal energy
- **Heat** = the energy transferred from one material or object to another as a result of a difference in temperature or a change in state
- **Temperature** = a measurement of the average kinetic energy of the particles in a substance



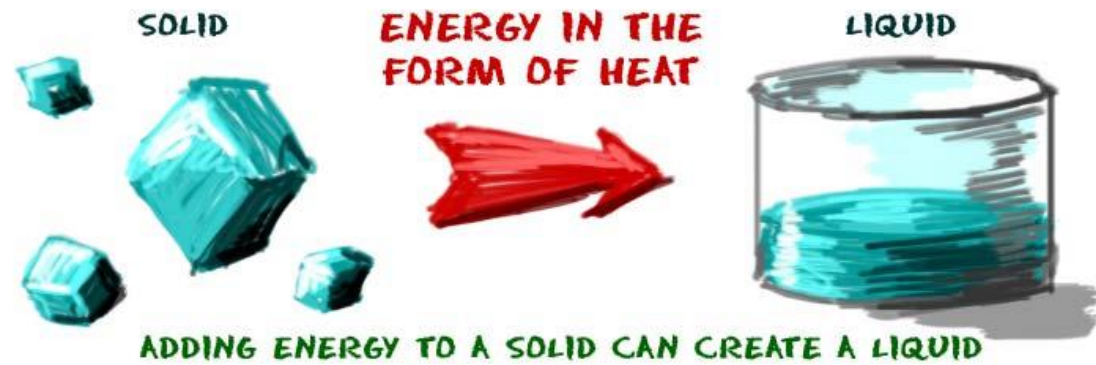
The Difference Between Heat & Temperature

For Example:

- Think about what happens when you touch a warm cup of tea
 - The cup has a higher thermal energy than you
 - When you touch it, you can feel the heat transfer from the cup to your hands



Changes of State



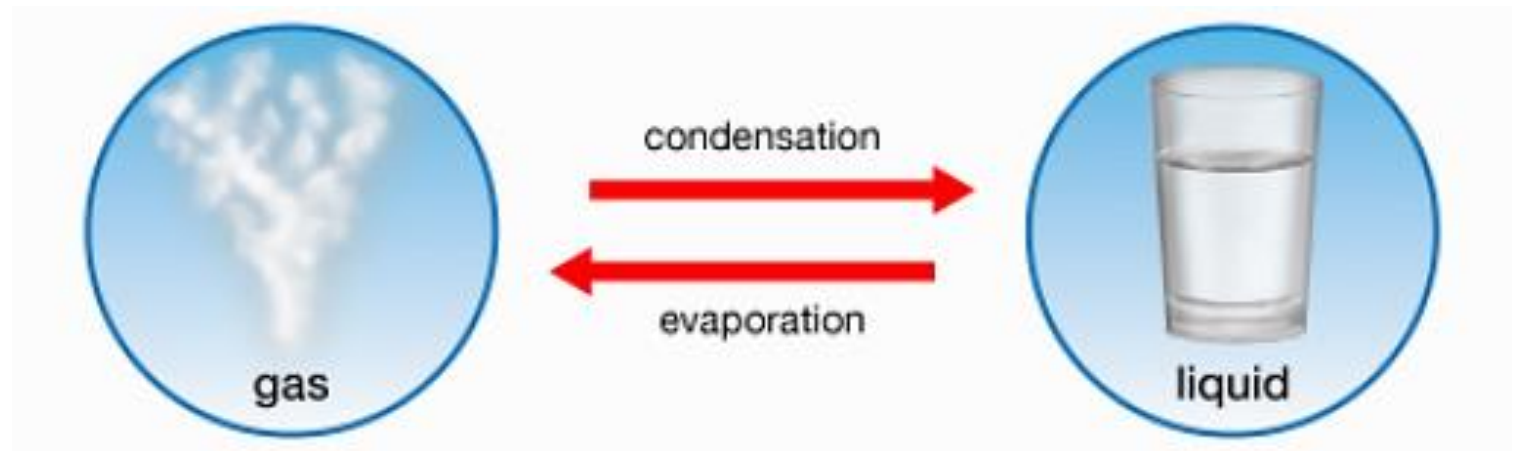
- What happens to matter if its temperature continues to rise or fall?
 - As the space changes between the particles, so does the state of matter
- When the temperature of a solid is raised...
 - The particles become more energetic, and move farther and farther apart
 - If enough energy is added, the solid **melts**
- **Melting** = the change of state of a substance from a **solid** form to a **liquid** form

Changes of State

- **Evaporation** = the change of state of a substance from a **liquid** form to a **gas** form
 - When the temperature of a liquid is raised, the liquid evaporates
- **Condensation** = the change of state of a substance from **gas** form to **liquid** form
 - When the temperature of a gas is lowered, the gas condenses



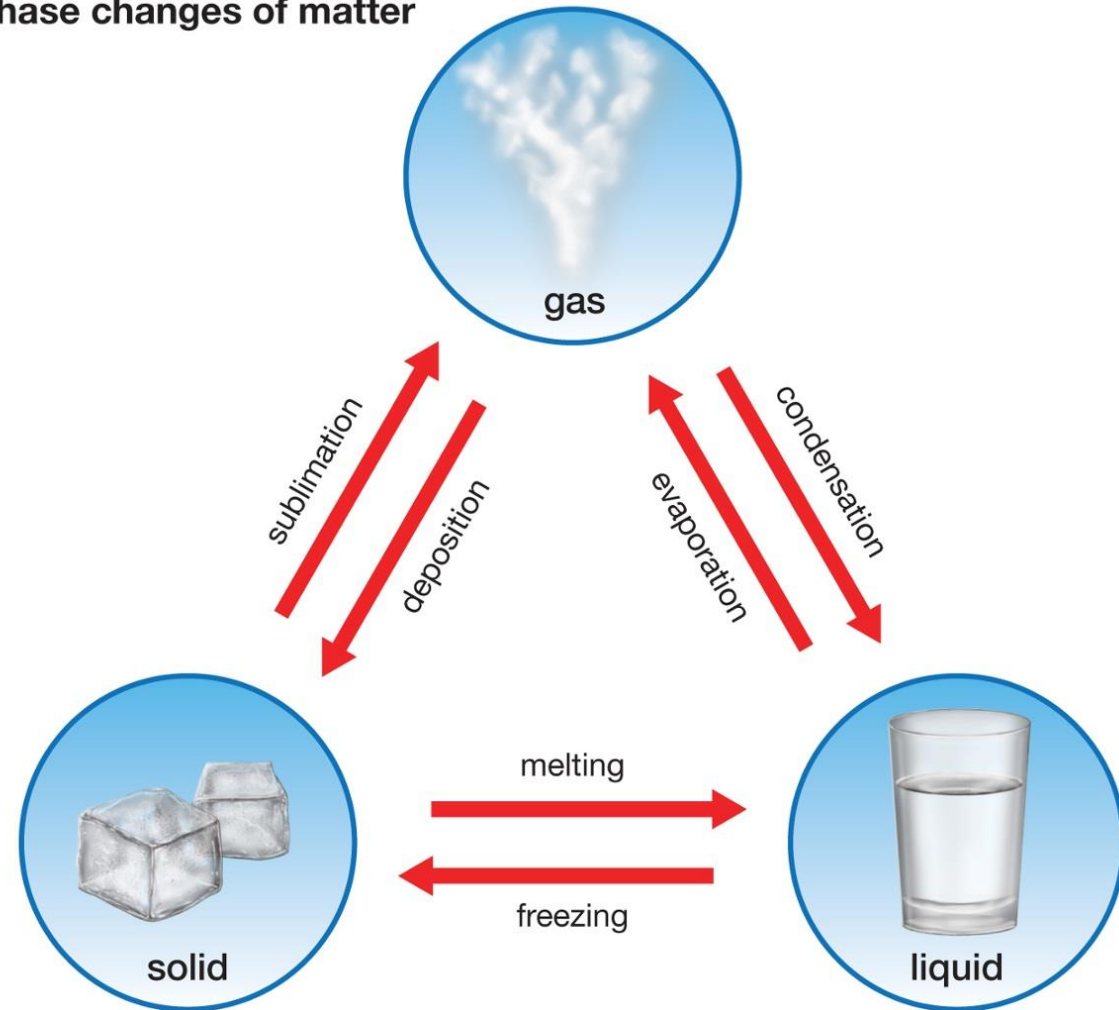
ENERGY FROM A STOVE
HEATS UP LIQUID WATER
AND CREATES STEAM



Changes of State

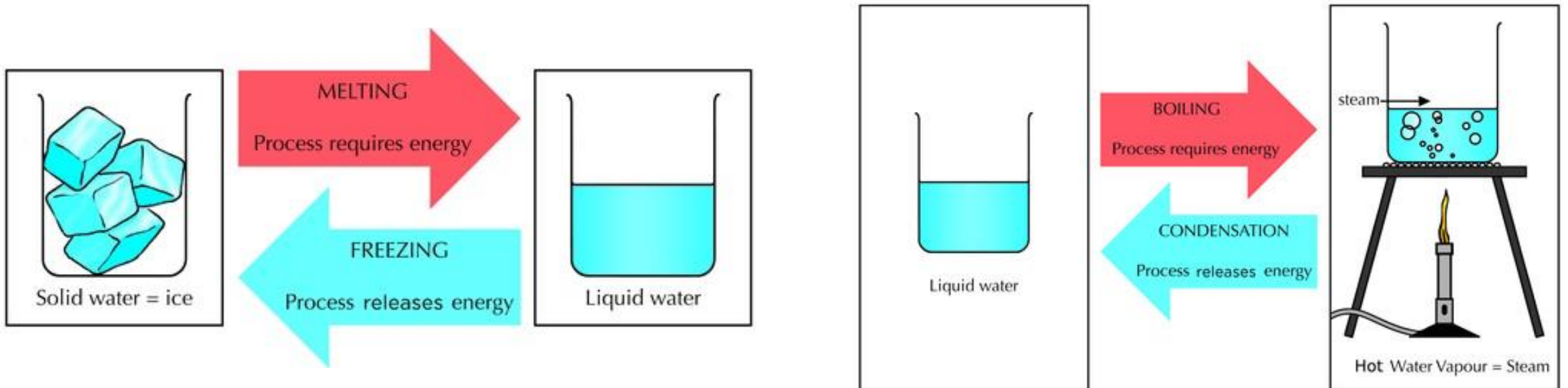
- **Solidification** (freezing) = the change of state of a substance from **liquid** form to **solid** form
 - If enough energy is removed from a liquid, it solidifies (e.g. ice)
- **Sublimation** = the change of state of a substance directly from a **solid** form to a **gas** form. E.g. dry ice
- **Deposition** = The opposite of sublimation. The change of state of a substance directly from **gas** form to **solid** form. E.g. when frost forms on windows on very cold days.

Phase changes of matter



Changes of State

- All substances have different specific temperatures at which they change state
- The **melting point** is the temperature at which a *solid* turns to *liquid*
- The **boiling point** is the temperature at which a *liquid* turns to *gas*



Summary

When energy is added or removed, changes in the state of matter take place:

Increase Energy – e.g. add heat

- Solid → liquid → gas
- Thermal expansion
- Melting
- Evaporation
- Sublimation

Decrease Energy – e.g. remove heat

- Gas → liquid → solid
- Thermal contraction
- Condensation
- Solidification (freezing)
- Deposition

Check your understanding!

1. What happens to matter when its temperature increases? (think about the particles, spacing, movement)
2. What happens to matter when its temperature decreases? (think about the particles, spacing, movement)
3. What is the difference between heat and temperature?
4. How does matter change from one state to another? List all the possibilities.
5. What is the difference between evaporation and sublimation?

Review Q on **Tues. Feb. 4, 2020** on lessons 23 and 24.