

STATES OF MATTER

- *The Four States of Matter*

- Four States

- Solid
- Liquid
- Gas
- Plasma

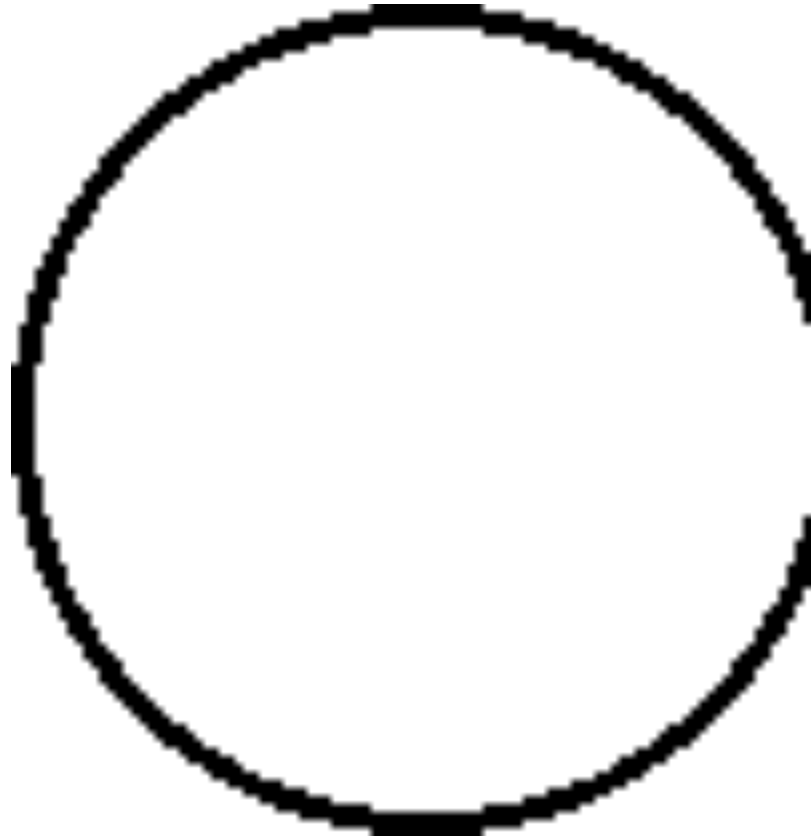
STATES OF MATTER

- What makes a substance a particular state of matter?
 - Based upon particle arrangement
 - Based upon energy of particles
 - Based upon distance between particles

Kinetic Theory of Matter

Matter is made up of particles which are in continual random motion.

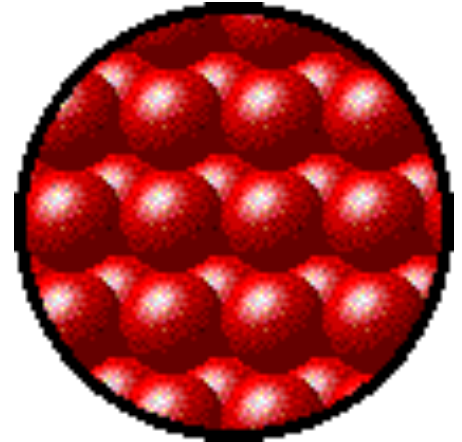
The more kinetic energy = the faster the particles move



STATES OF MATTER

SOLIDS

- **Particles of solids are tightly packed, vibrating about a fixed position.**
- **Solids have a definite shape and a definite volume.**



STATES OF MATTER

LIQUID

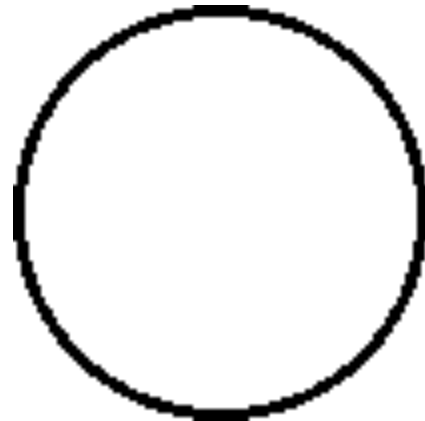
- **Particles of liquids are tightly packed, but are far enough apart to slide over one another.**
- **Liquids have an indefinite shape and a definite volume.**



STATES OF MATTER

GAS

- **Particles of gases are very far apart and move freely.**
- **Gases have an indefinite shape and an indefinite volume.**

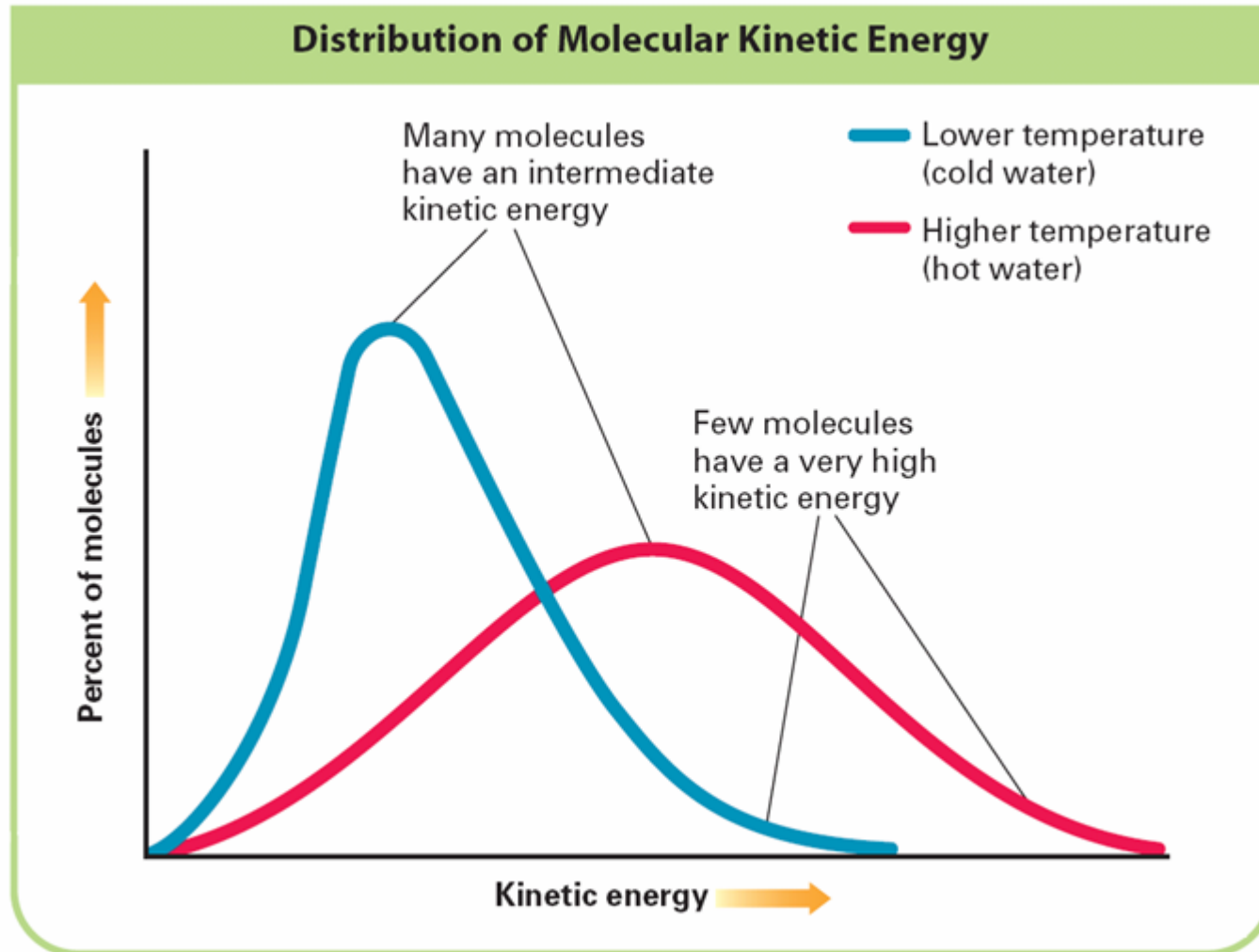


Kinetic Energy and Temperature

–Average Kinetic Energy

- The particles in any collection of atoms or molecules at a given temperature have a wide range of kinetic energies.
- Most of the particles have kinetic energies somewhere in the middle of this range.

Kinetic Energy and Temperature



Kinetic Energy and Temperature

- The temperature of a substance is directly proportional to the average kinetic energy of the particles of the substance.
- The higher the avg. kinetic energy = the higher the temperature

Celsius and Kelvin

- Scientists use either Celsius or Kelvin.
- $K = ^\circ C + 273$
- 0K is absolute zero
- No negative temps with Kelvin!

Evaporation

- Evaporation

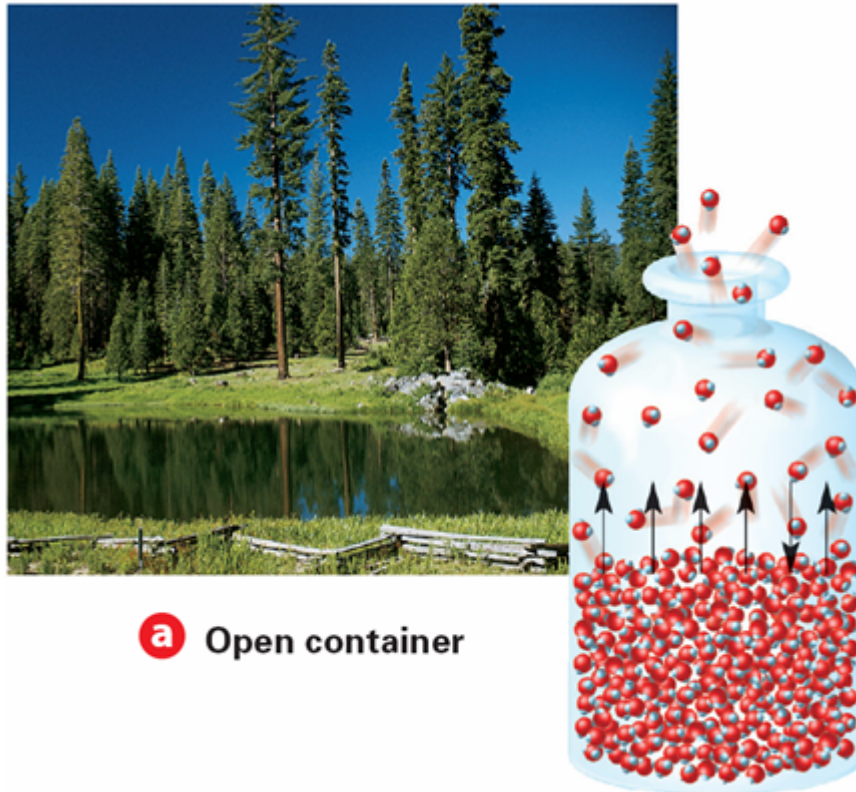
- What is the relationship between evaporation and kinetic energy?

Evaporation

- The conversion of a liquid to a gas or vapor is called **vaporization**.
- Two types of vaporization : boiling and evaporation.
- When such a conversion occurs at the surface of a liquid that is not boiling, the process is called **evaporation**.

Evaporation

- In an open container, molecules that evaporate can escape from the container.



Evaporation

- In a closed container, the molecules cannot escape. They collect as a vapor above the liquid. Some molecules condense back into a liquid.



Evaporation

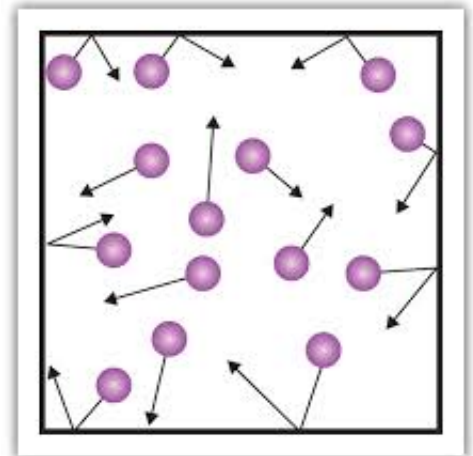
- During evaporation, only those molecules with a certain minimum kinetic energy can escape from the surface of the liquid.
- This is why evaporation is a cooling process!
 - What are some examples you can think of?

Gas Pressure

- What causes gas pressure?

Gas pressure is caused by gas particles hitting the sides of their containers.

More collisions = more pressure

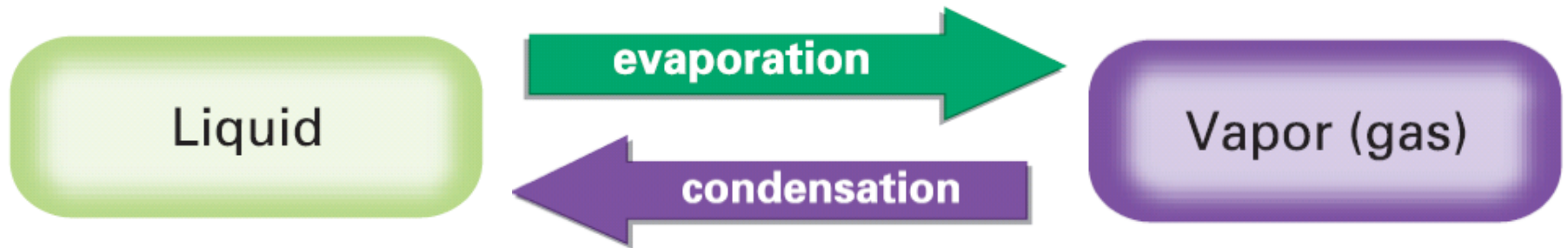


Vapor Pressure

- Vapor Pressure

Vapor Pressure

- **Vapor pressure** is a measure of the force exerted by a gas above a liquid.



Vapor Pressure

- Vapor Pressure and Temperature Change
 - An increase in the temperature of a contained liquid increases the vapor pressure.
 - The particles in the warmed liquid have increased kinetic energy. As a result, more of the particles will have the minimum kinetic energy necessary to escape the surface of the liquid.

Vapor Pressure

Table 13.1

**Vapor Pressure (in kPa) of Three Substances
at Different Temperatures**

	0°C	20°C	40°C	60°C	80°C	100°C
Water	0.61	2.33	7.37	19.92	47.34	101.33
Ethanol	1.63	5.85	18.04	47.02	108.34	225.75
Diethyl ether	24.70	58.96	122.80	230.65	399.11	647.87

- Substance with high vapor pressure evaporate more easily!

Boiling Point

- Boiling Point

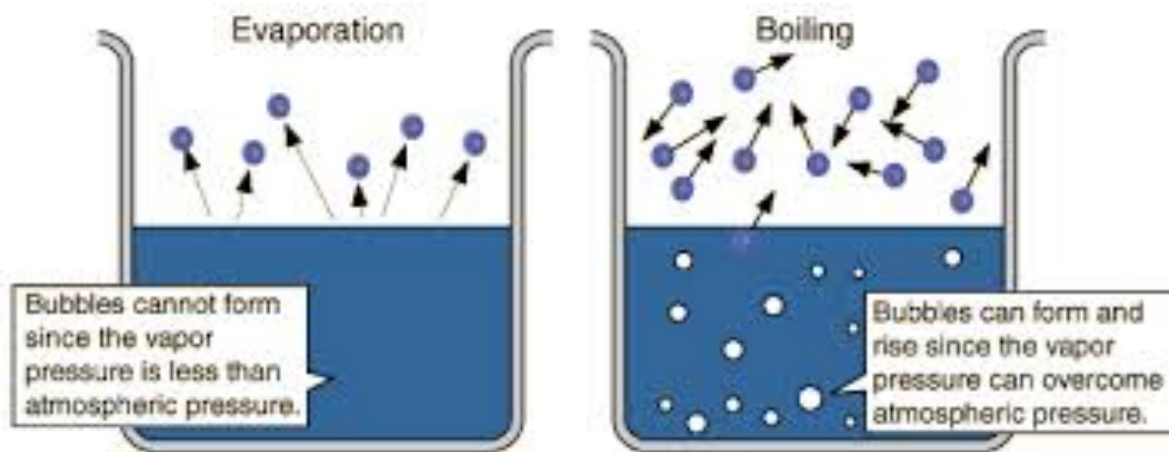
- Under what conditions does boiling occur?

Boiling Point

- When a liquid is heated to a temperature at which particles throughout the liquid have enough kinetic energy to vaporize, the liquid begins to boil.

Boiling Point

- The temperature at which the vapor pressure of the liquid is just equal to the external pressure on the liquid is the **boiling point (bp)**.



Boiling Point

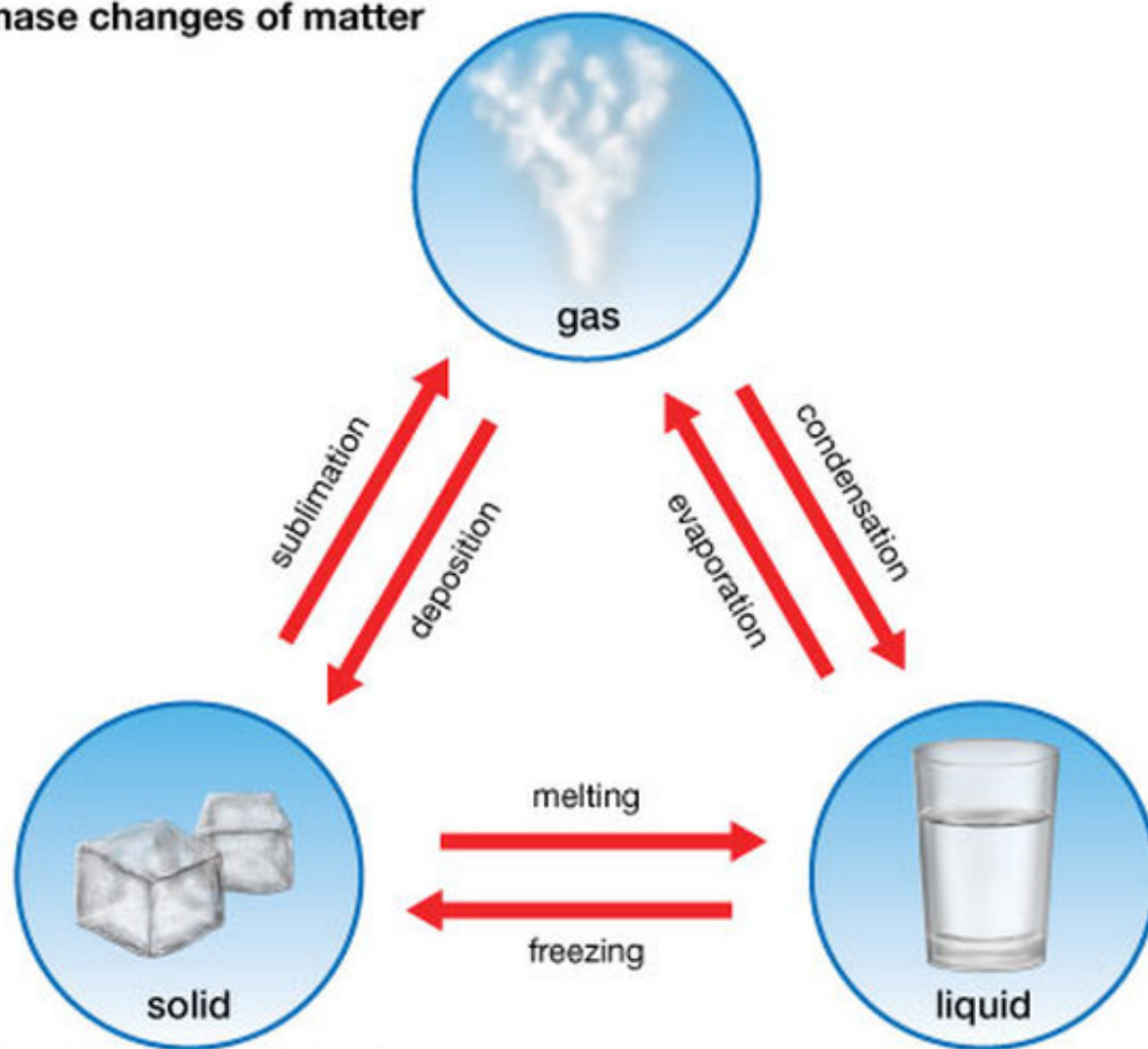
–Boiling Point and Pressure Changes

- Because a liquid boils when its vapor pressure is equal to the external pressure, liquids don't always boil at the same temperature.
 - At a lower external pressure, the boiling point decreases.
 - At a higher external pressure, the boiling point increases.
 - What happens to boiling point of water at our altitude vs. sea level?

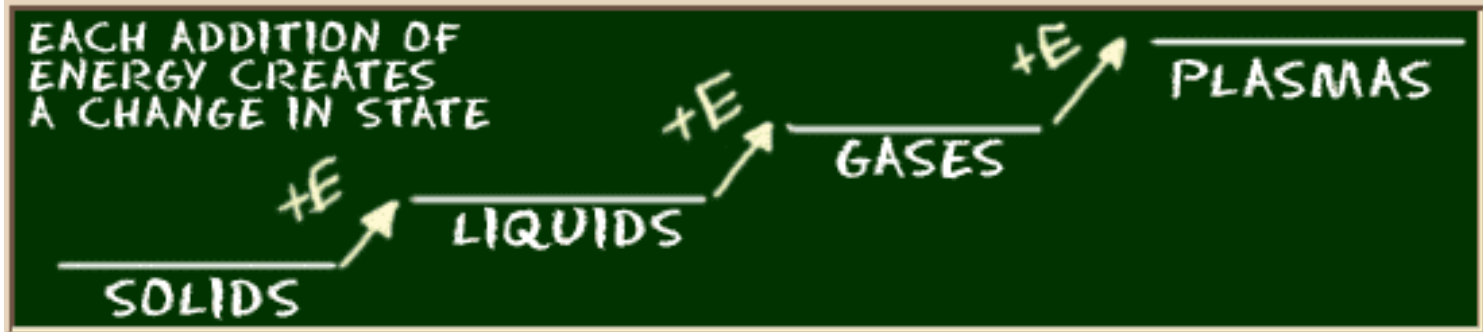
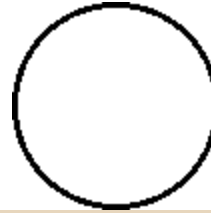
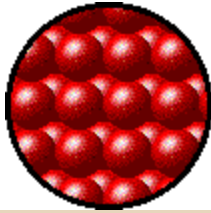
Sublimation

- When a substance changes from a solid to a gas without going through the liquid phase.
- Solids with a high vapor pressure can do this readily. (e.g. iodine, carbon dioxide)

Phase changes of matter



STATES OF MATTER Recap



SOLID

Tightly packed, in a regular pattern
Vibrate, but do not move from place to place

LIQUID

Close together with no regular arrangement.
Vibrate, move about, and slide past each other

GAS

Well separated with no regular arrangement.
Vibrate and move freely at high speeds

PLASMA

Has no definite volume or shape and is composed of electrical charged particles