CHAPTER 3 STATES OF MATTER

Ms. Liu

3.1 THREE STATES OF MATTER: SOLID, LIQUID, OR GAS?

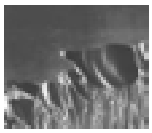
- Steam rising from hot chocolate on a stove next to a blazing fire.

- Particles are made of atoms and molecules.
- Particles are always moving.

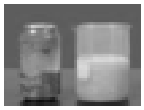
SOLID

- State of matter – with definite shape and volume
- Particles are fixed in place by strong attractions
- 2 kinds:
  - Crystalline

  - Amorphous



LIQUID



- State of matter – volume same but shape changes
- Particles are sort of attracted but slide past each other.
- Characteristics:
  - Surface tension

  - Viscosity (gooeyness)
    - Does honey or water have more viscosity?

GAS

- State of matter – with no definite shape or volume
  - Think of perfume
- Particles are loosely bound, bumping and moving fast!

3.2 Behavior of Gases

- How much space does helium take up?
- Temperature's effect?

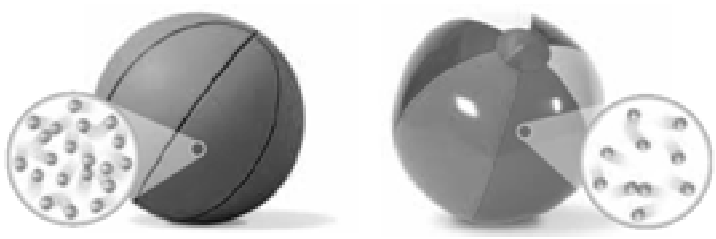
3.2 TEMPERATURE

- Temperature ( ) = measure of how fast particles are moving
  - Related to particles' energy
- On a hot day, the particles are moving slower/faster and hitting the sides with less/more force, so you need less/more helium to fill the balloon.
- On a cold day, the partides are moving slower/faster, and hitting the sides with less/more force, so you need less/more helium to fill the balloon.

- Volume ( ) = how much space a thing takes up
- Pressure ( ) = how much force per unit area

WHICH ONE HAS MORE VOLUME?

WHICH ONE HAS MORE PRESSURE?



A GAS LAW: BOYLE'S LAW

$$\text{pressure} \propto \frac{1}{\text{volume}}$$

- Fixed:
  - Amount of gas
  - Temperature
- When you squeeze gas in less space, there's more pressure.
- Imagine a room full of toy cars. Describe the analogy…
- See animation

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- When you squeeze gas in less space, there's more pressure.
- Imagine a room full of toy cars. Describe the analogy…
  - Toy cars kept at same speed (temperature). Pushed together (less volume), there will be more collisions (pressure).
- See animation

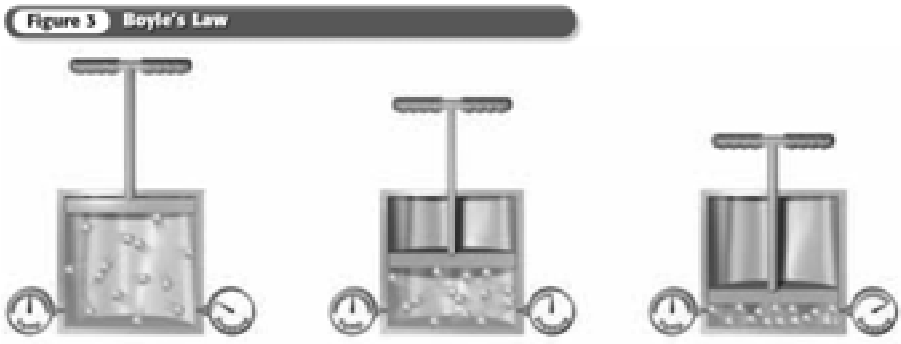


Figure 3 Boyle's Law

Lifting the piston lets the particles of gas spread far apart. The volume of the gas increases as the pressure decreases.

Releasing the piston allows the particles of gas to return to their original volume and pressure.

Pushing the piston forces the gas particles close together. The volume of the gas decreases as the pressure increases.

ANOTHER GAS LAW: CHARLES'S LAW

$$\text{volume} \propto \text{temperature}$$

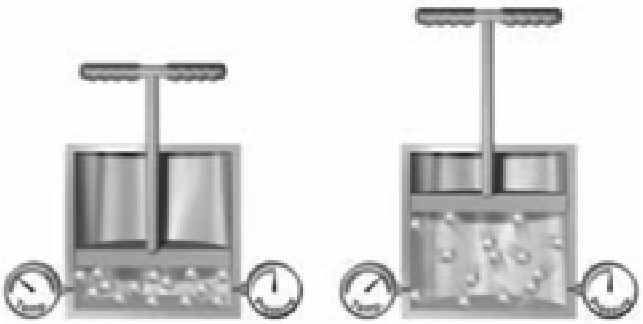
- Fixed:
  - Amount of gas
  - Pressure
- Hotter means gas expands and takes up more space.
- Imagine a room full of toy cars. Describe the analogy…
- See animation

ANOTHER GAS LAW: CHARLES'S LAW

$$\text{volume} \propto \text{temperature}$$

- Fixed:
  - Amount of gas
  - Pressure
- Hotter means gas expands and takes up more space.
- Imagine a room full of toy cars. Describe the analogy…
  - Keep the toy cars from colliding more (constant pressure). If the cars move faster (higher temperature), they must be allowed more space (volume)
- See animation

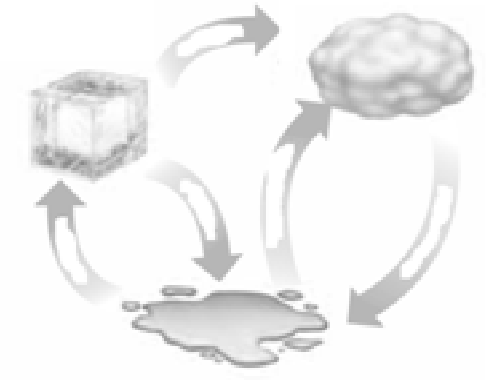
Figure 4 Charles's Law



Decreasing the temperature of the gas causes the particles to move more slowly. The gas particles hit the piston less often and with less force. So, the volume of the gas decreases.

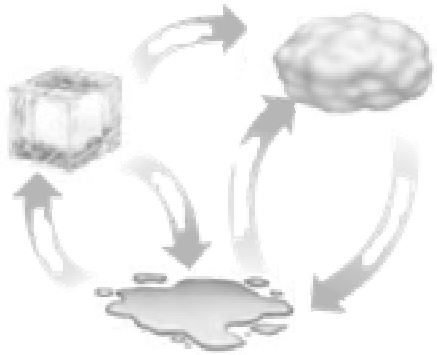
Increasing the temperature of the gas causes the particles to move more quickly. The gas particles hit the piston more often and with greater force. So, the volume of the gas increases.

3.3 Change of State

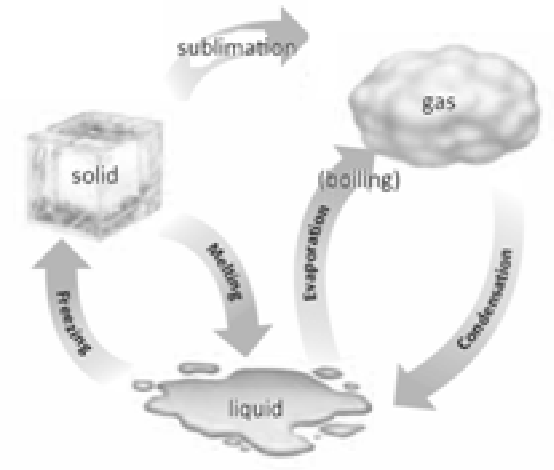


3.3

- Change of State = changing between solid, liquid, or gas.
  - Physical/chemical change?
  - Water vapor and ice is still water H_2O.
- Label the state and the name of the change.



3.3 CHANGE OF STATE



3.3 ENERGY AND STATE

- More energy means lower/higher temperature.
- Particles in liquid moves slower/faster than particles in solid.
- To melt an object, the particles need to lose/gain energy,
- So the partides need to become colder/hotter.

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- To melt an object, the particles need to lose/**gain** energy,
- So the particles need to become colder/**hotter**.
- When a particle gains energy, this is called an endothermic change. (Energy goes in)
- When a particle loses energy, this is called an exothermic change. (Energy is *ex*pelled out)

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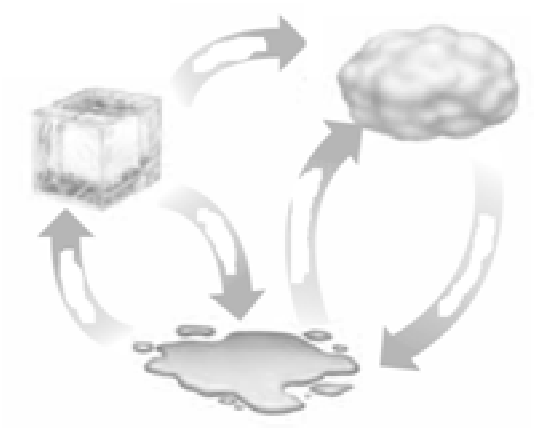
ENDO OR EXO?

Before	After
	
	

3.3 Energy and State

- Label each state as particles moving:
  - fastest, slowest, medium
- Label each change as
  - exo-/lose energy or endo-/gain energy



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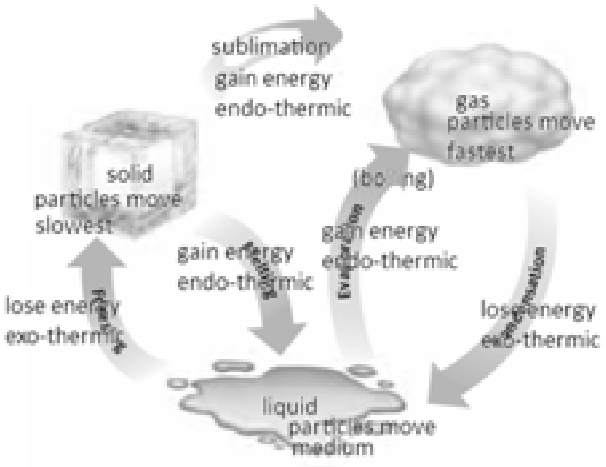


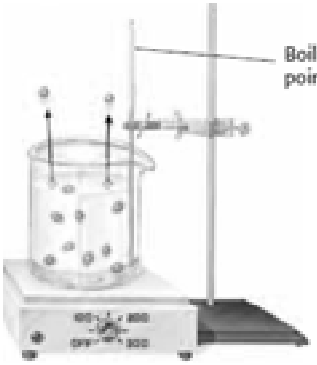
3.3 MELTING

- Solid → Liquid = melting
- Liquid → Solid = freezing
- Melting point: Melting and freezing occur at the same temperature. (0°C for water.)

Figure 3 *Liquid water freezes at the same temperature at which ice melts–0°C.*

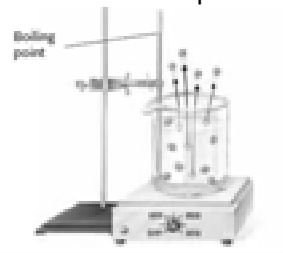
3.3 LIQUID → GAS

- Evaporation: liquid → gas (surface)
  - Can occur when surface molecules gain energy from air and escape. (below boiling point)



3.3 LIQUID → GAS

- Boiling: liquid → gas (throughout. Bubbles)
  - The whole liquid is very hot, molecules moving very fast, gas bubbles form and rise and escape into air.
  - When vapor pressure = atmospheric pressure.
  - Boiling point: 100°C on Earth's surface.
  - Is boiling point <u>higher or lower</u> on a mountain?
  - Can you boil 5 mL at a lower temperature than 5 L?



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  - The whole liquid is very hot, molecules moving very fast, gas bubbles form and rise and escape into air.
  - When vapor pressure = atmospheric pressure.
  - Boiling point: 100°C on Earth's surface (sea level)
  - Is boiling point <u>higher or lower</u> on a mountain?
  - Lower, 95°C in Denver because the atmosphere is thinner.

3.3 CONDENSATION: GAS → LIQUID

- How does dew form?

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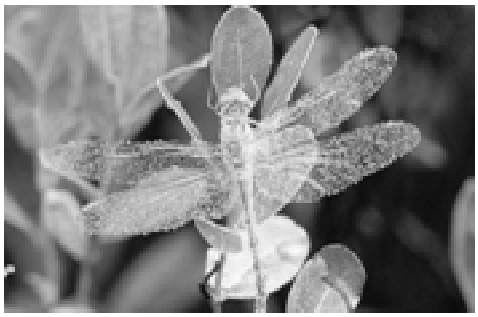
- How does dew form?

When the wings are colder than the air,

water vapor gives its energy to the wings, so water vapor loses energy and goes from gas to liquid.



3.3

- How does sweating help people cool down?

- Why is your breath foggy on a cold day?

Solid ↔ liquid ↔ gas?

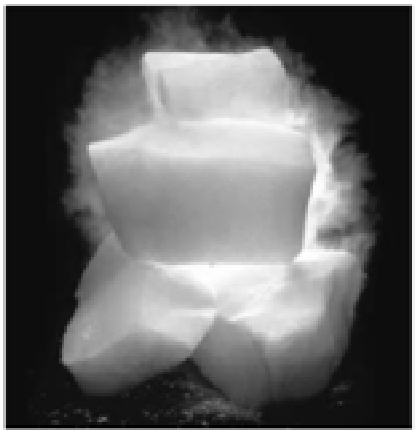
3.3

- How does sweating help people cool down?

Water gains energy from the person and escapes into the air (becomes vapor) taking the energy with it. So the person loses energy through water and gets cooler.

- Why is your breath foggy on a cold day?

Hot breath is made of hot vapor which gives its energy to the cold air around it, so the hot vapor turns into liquid droplets that you can see.



- Is sublimation an endothermic or exothermic change? Physical or chemical?

- Carbon dioxide in solid form is much colder than water as ice.

3.3 A SUBSTANCE EITHER CHANGES TEMPERATURE OR STATE (NOT BOTH AT SAME TIME)