



Chapter Eight: Matter and Temperature

- **8.1 The Nature of Matter**
- **8.2 Temperature**
- **8.3 The Phases of Matter**



Chapter 8.3 Learning Goals

- **Identify the phases of matter.**
- **Describe the behavior of atoms and molecules as matter undergoes phase changes.**
- **Describe properties of plasmas.**



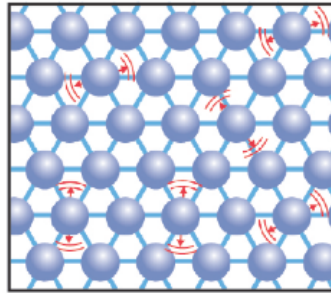
8.3 Phases of Matter

- On Earth, pure substances are usually found as solids, liquids, or gases.
- These are called phases of matter.





8.3 The phases of matter



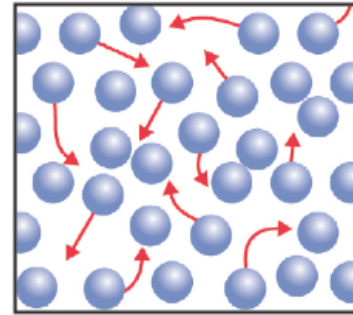
Solid

- A solid holds its shape and does not flow.
- The molecules in a solid vibrate in place, but on average, don't move far from their places.



8.3 The phases of matter

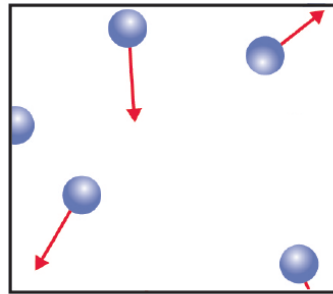
- A liquid holds its volume, but does not hold its shape—it flows.
- Liquids flow because the molecules can move around.



Liquid



8.3 The phases of matter

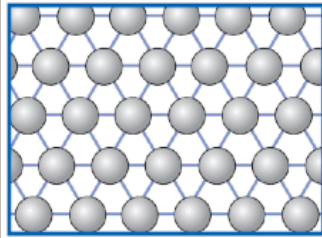


Gas

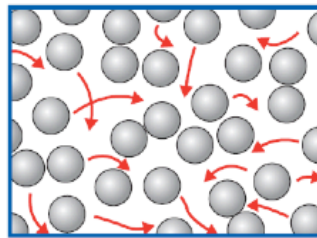
- A gas flows like a liquid, but can also expand or contract to fill a container.
- A gas does not hold its own volume or shape.
- The molecules in a gas have enough energy to completely break away from each other.



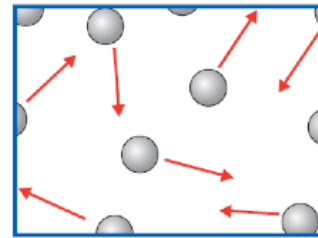
Atoms in a Solid, Liquid, and Gas



Solid



Liquid

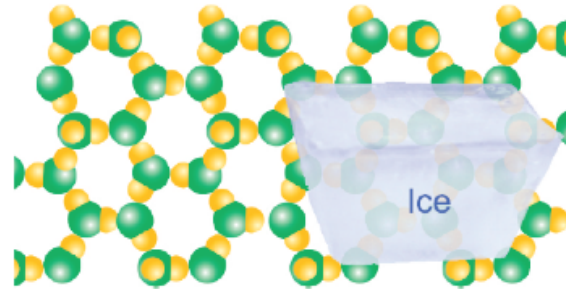


Gas



8.3 The phases of matter

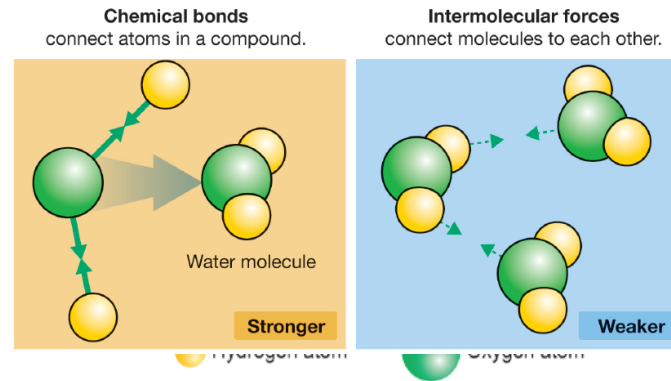
- When they are close together, molecules are attracted through intermolecular forces.





8.3 The phases of matter

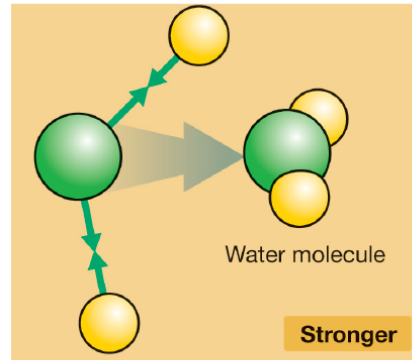
- The forces in chemical bonds are stronger than intermolecular forces.



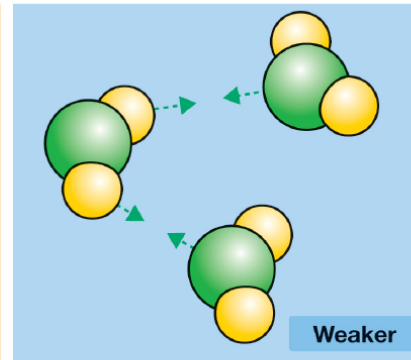


8.3 Intermolecular forces

Chemical bonds
connect atoms in a compound.



Intermolecular forces
connect molecules to each other.



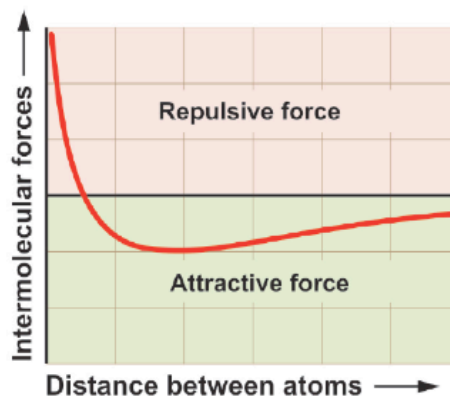
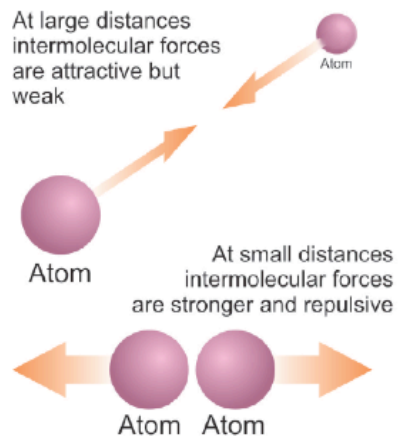
● Hydrogen atom ● Oxygen atom



8.3 Intermolecular forces

- **Within all matter, there is a constant competition between temperature and intermolecular forces.**
- **When temperature wins the competition, molecules fly apart and you have a gas.**
- **When intermolecular forces win the competition, molecules clump tightly**

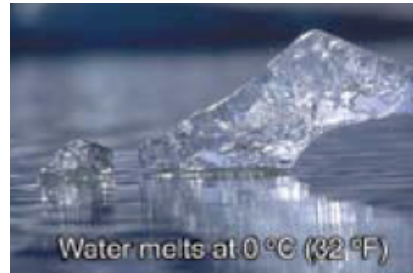
Intermolecular Forces





8.3 Melting and boiling

- **The melting point is the temperature at which a substance changes from a solid to a liquid.**



Water melts at 0 °C (32 °F)

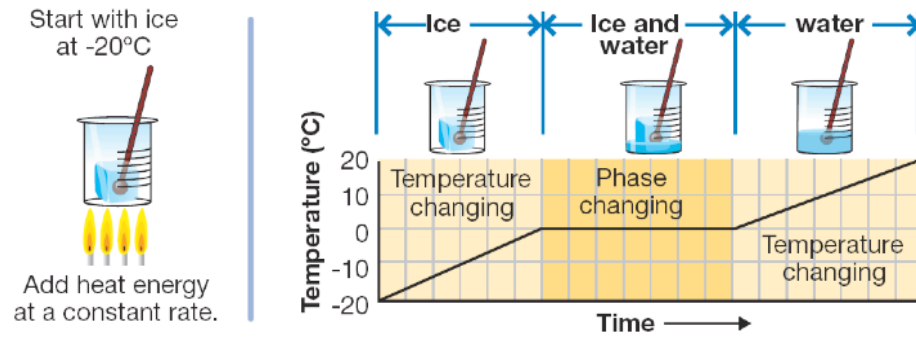


8.3 Melting and boiling

- The temperature at which a liquid becomes a gas is called the **boiling point**.



Temperature and Time Graph



Notice temperature is constant while ice melts!

As heat energy is added to ice, the temperature increases until it reaches 0°C .

Then *the temperature stops increasing*.

As you add more heat, more ice becomes liquid water but the temperature stays the same.

This is because the added energy is being used to break the intermolecular forces and change solid into liquid.

Once all the ice has become liquid, the temperature starts to rise again if more energy is added.



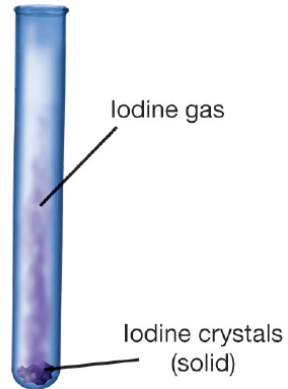
8.3 Melting and boiling points of common substances

- Materials have a wide range of melting and boiling points.

Substance	Melting point	Boiling point
helium	-272°C	-269°C
oxygen	-218°C	-183°C
mercury	-39°C	357°C
water	0°C	100°C
lead	327°C	1749°C
aluminum	660°C	2519°C



8.3 Sublimation



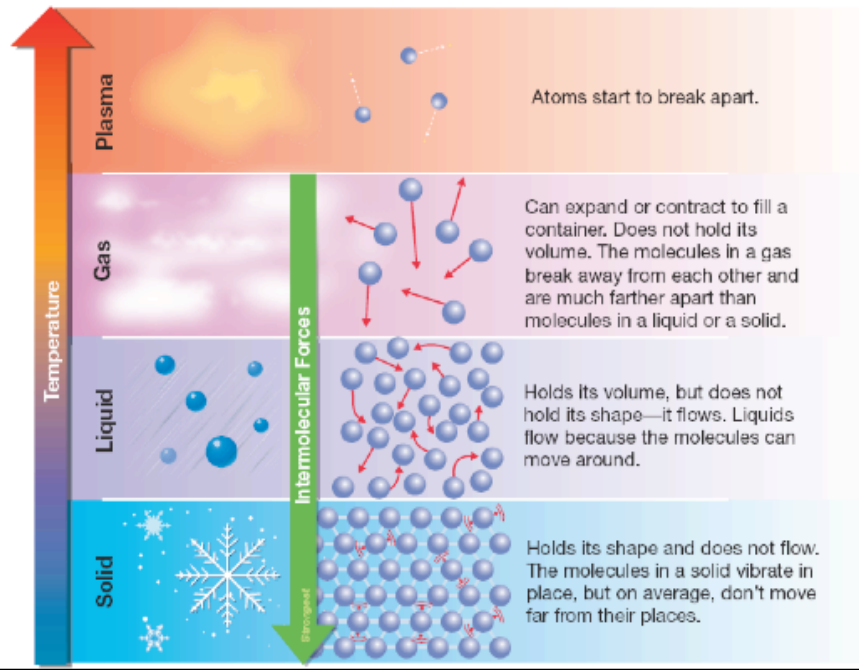
- Sometimes a solid can change directly to a gas when heat energy is added.
- This process is called **sublimation**.

8.3 Plasma

- In the plasma phase, matter becomes ionized as electrons are broken loose from atoms.
- The Sun is made of plasma, as is most of the universe, including the Orion nebula.



Summary of the Phases of Matter





Phases of Water on Mars?

- Scientists know that water exists as solid and gas on Mars.
- On September 29, 2008, the meteorological station detected snow falling from Martian clouds.

