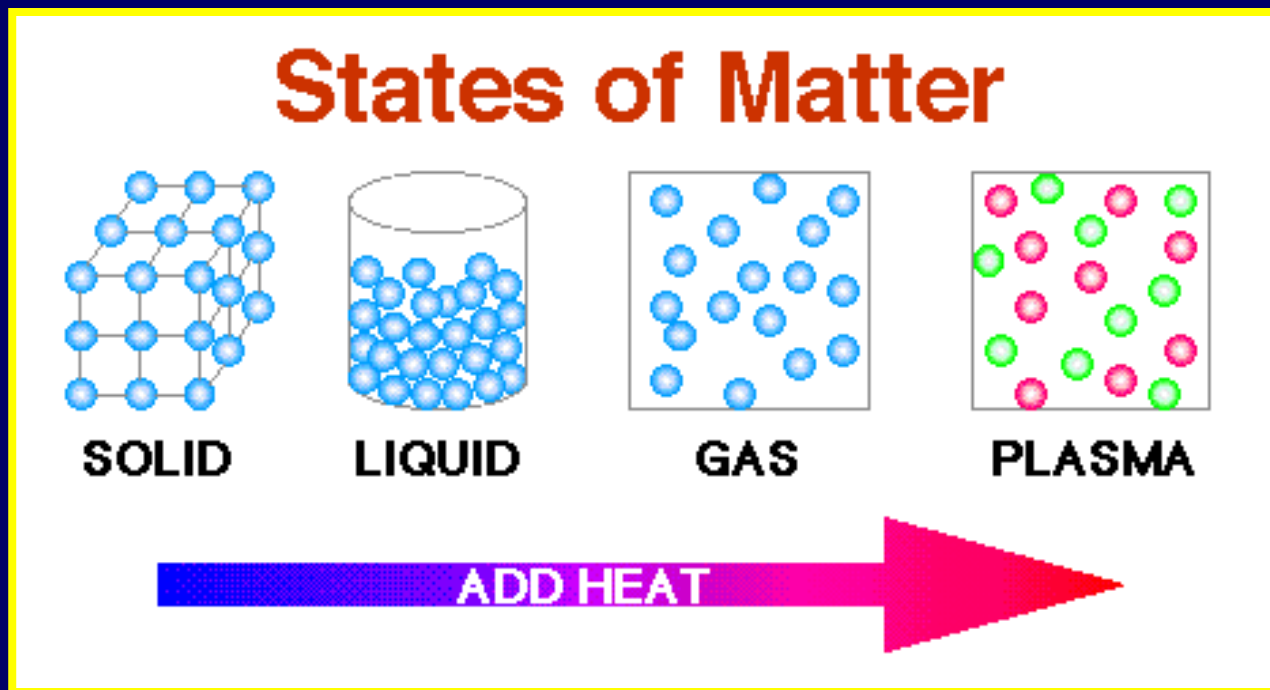


# Changing States of Matter



# Essential Standard 2.1

Understand types, properties,  
and structure of matter.

## Objective 2.1.2

Explain the phases of matter and physical  
changes that matter undergoes.

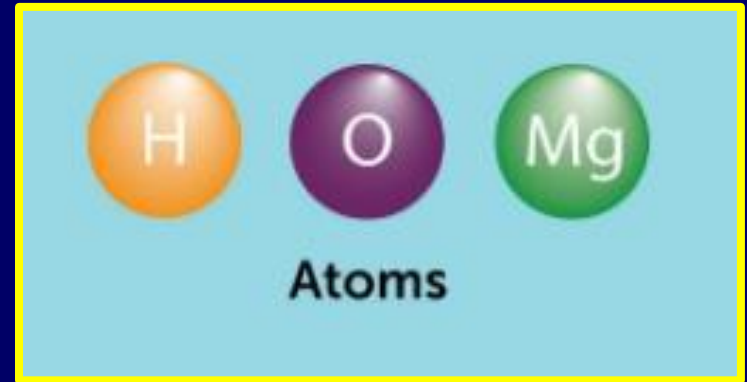
# I Can Statements

At the end of this lesson, you should be able to say, with confidence:

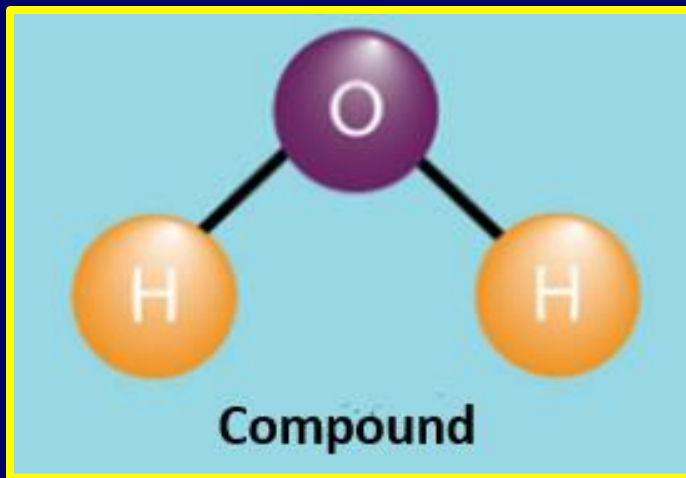
- I can describe the behavior of particles and the breaking or forming of weak bonds as heat is added or removed from a substance.
- I can explain why changing states between a solid, liquid, and a gas is just a physical change.
- I can define the following terms: freezing, melting, boiling, condensation, sublimation, and deposition.

# Atoms and Compounds

Recall that all matter is made up of individual atoms, elements, and compounds.



An element is composed of all the same type of atoms.



Compounds are composed of two or more different elements that are chemically bonded together.

# Chemical Bonds

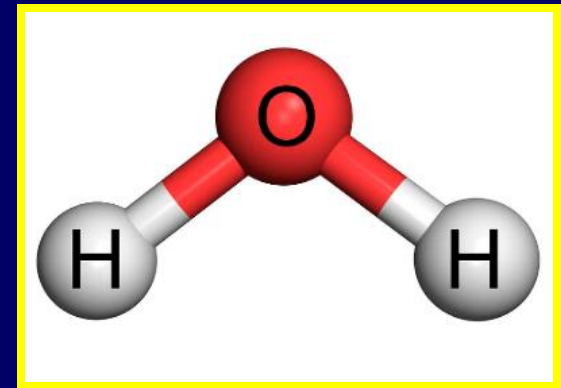
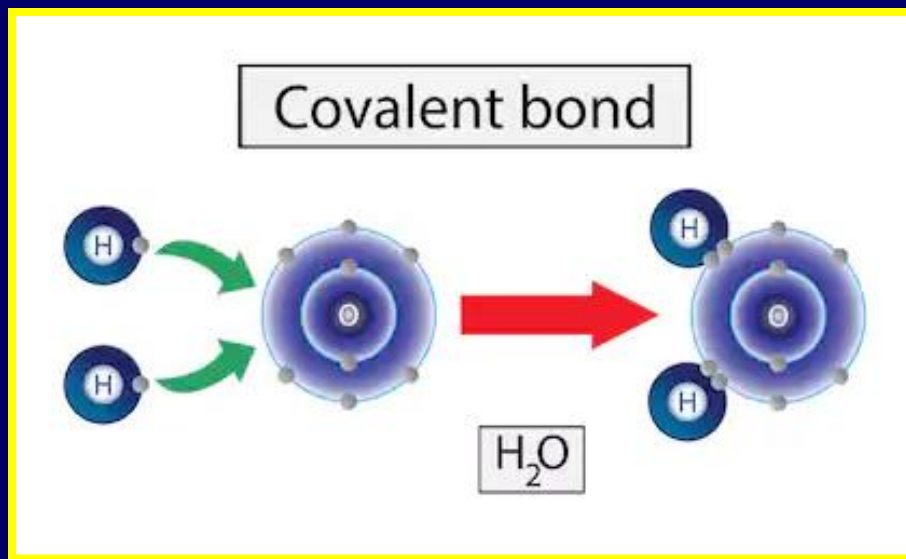
We will go into much further detail in later units about chemical bonds, but for now just remember that chemical bonds are a type of force that holds atoms together.



There are several different types of chemical bonds and some are stronger and some are weaker than others.

# Strong Chemical Bonds

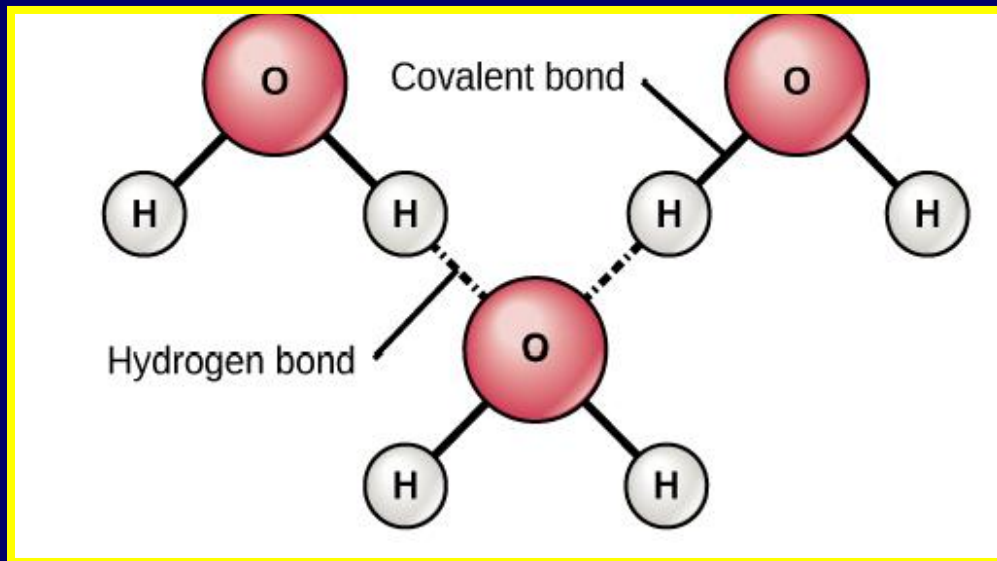
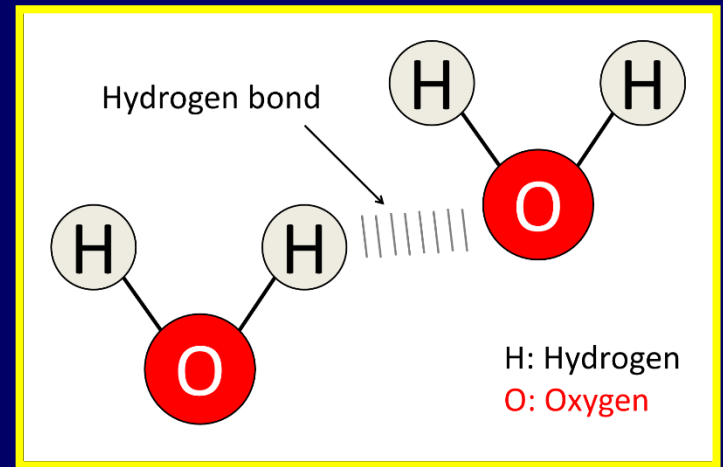
The type of chemical bond that holds a water molecule,  $\text{H}_2\text{O}$ , is called a covalent bond.



Covalent bonds are fairly strong and require chemical reactions to break the bonds, in order to separate the atoms from each other.

# Weak Chemical Bonds

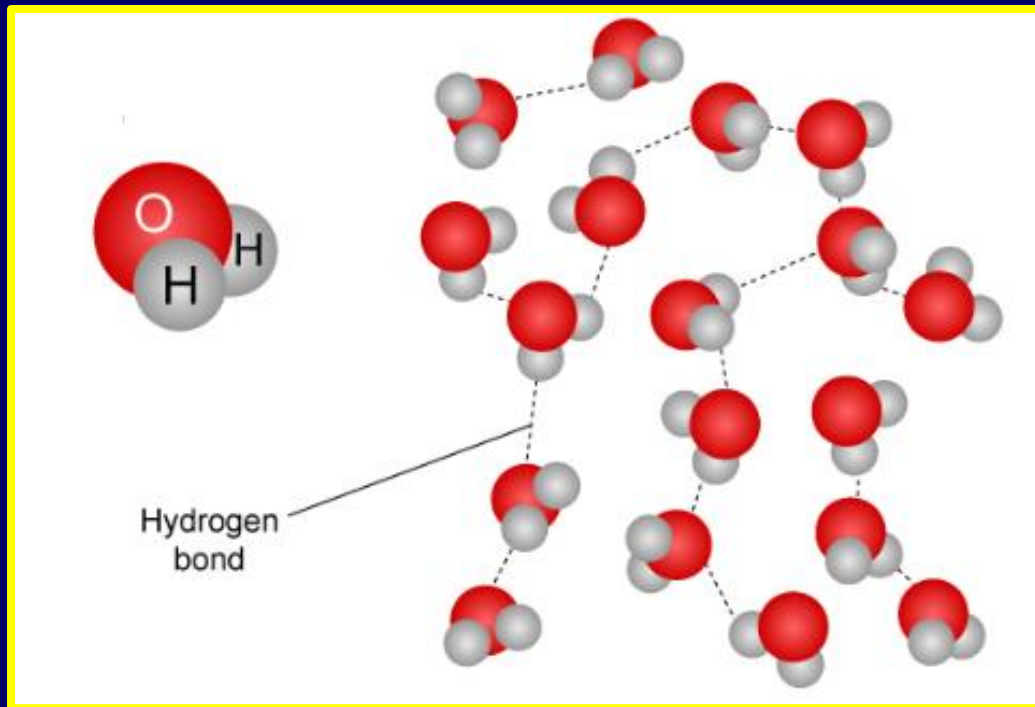
Hydrogen bonds form between the hydrogen atom of one water molecule and the oxygen atom of a different water molecule.



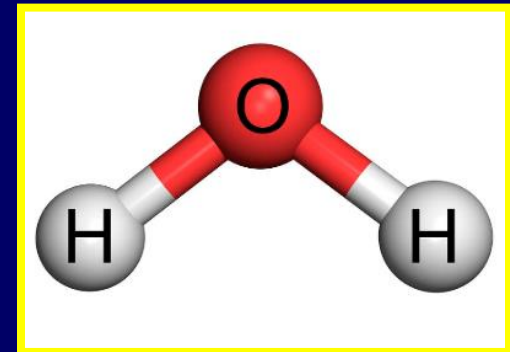
Compared to covalent bonds, hydrogen bonds are fairly weak.

# Adding Heat

When thermal energy from heat is added to water, the water molecules begin vibrating with enough energy to break the hydrogen bonds between the different water molecules.



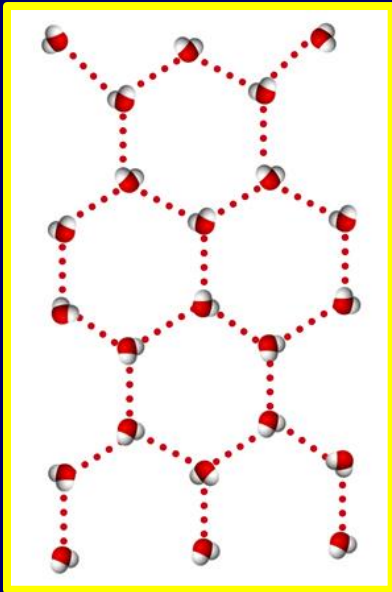
But the actual water molecule,  $H_2O$ , remains intact.





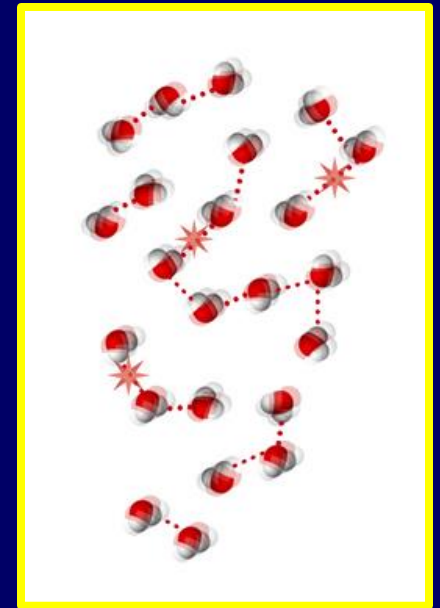
# Solid to Liquid

In solids, the atoms vibrate but are still held tightly together, so they take on a definite shape and volume.



Ice

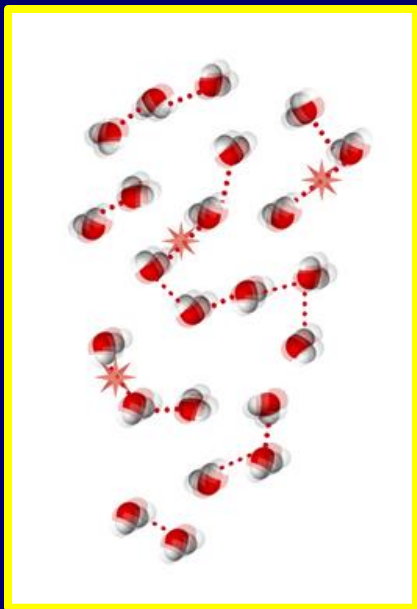
As heat is added, the molecules begin vibrating faster, causing the hydrogen bonds between the water molecules to begin breaking.



Water

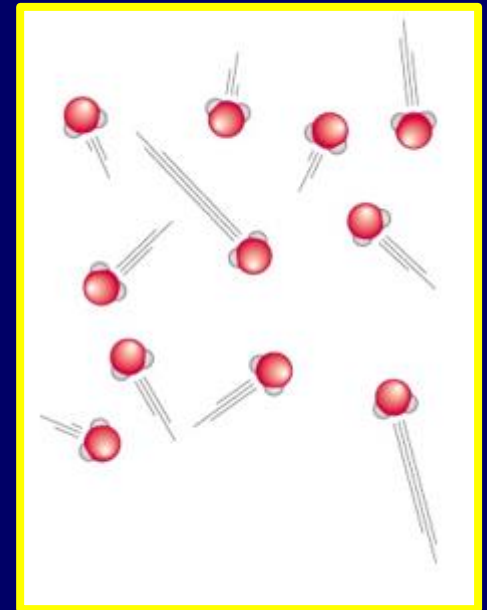
# Liquid to Gas

In liquids, the vibrating atoms break enough of the hydrogen bonds to allow the molecules to be able to slide or flow past each other.



Water

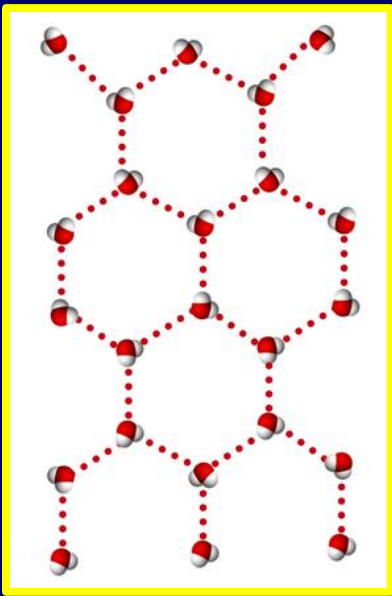
As more heat is added, the molecules begin vibrating with enough energy to break completely free of the hydrogen bonds.



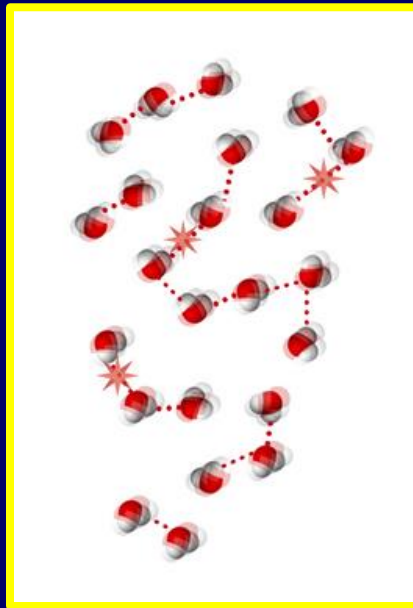
Steam

# Physical Change

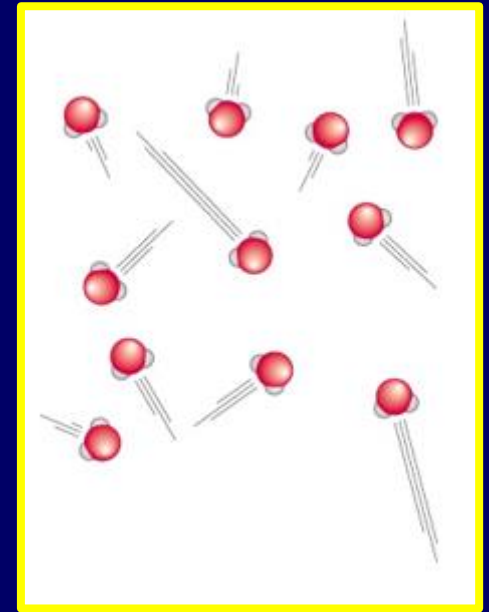
When water changes states, from a solid to a liquid, or a liquid to a gas, the water molecule stays intact.



Ice



Water

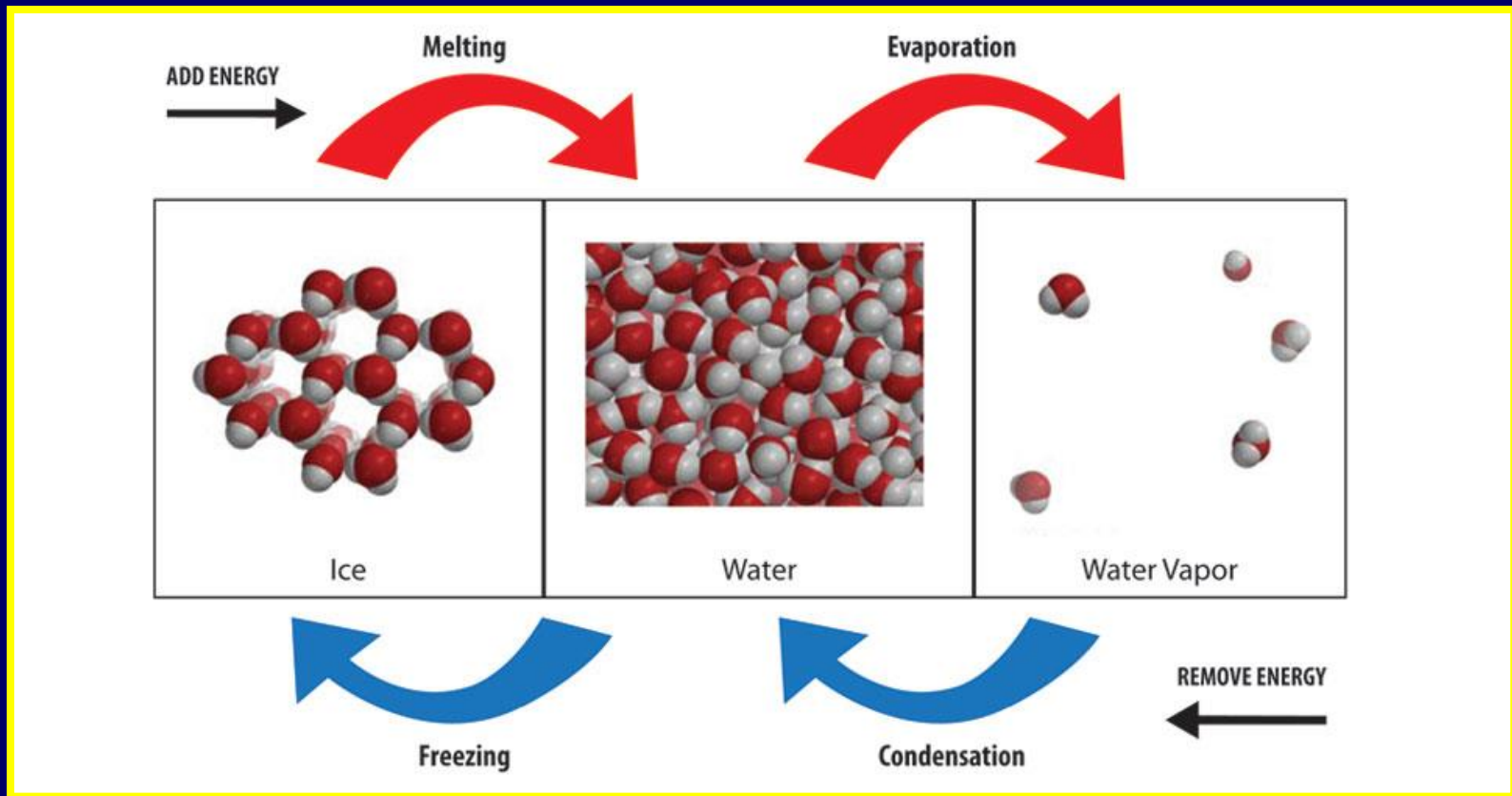


Steam

Because no new substances are formed, changing states of matter is just a physical change.

# Changing States of Matter

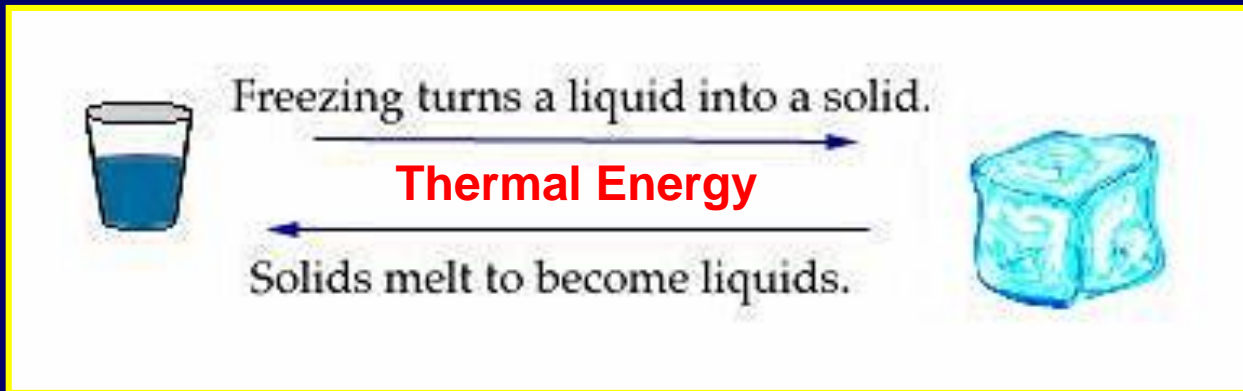
Matter can change states with the addition or removal of thermal energy (heat).



# Freezing and Melting Point

The temperature at which a substance changes from a liquid into a solid is called its freezing point.

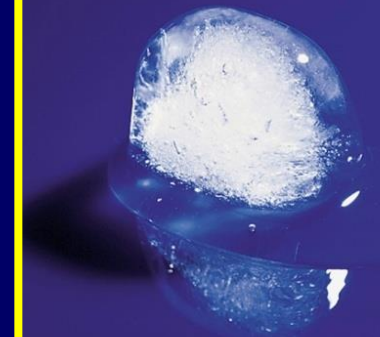
## Freezing



The temperature at which a substance changes from a solid into a liquid is called its melting point.

## Melting

Water 0 °C



The melting and freezing point occur at the same temperature.

# Lowering the Freezing Point

Adding substances, such as anti-freeze or salt, keeps the water molecules from being able to form hydrogen bonds to solidify.



The water molecules can still freeze, but it has to be a lot colder for them to do so. As a result, the freezing point of water is lowered.

# Vaporization

Vaporization is when substances change from a liquid state into a gas state.

Evaporation occurs at the surface of a liquid and the temperature doesn't have to be as high.



Evaporation



Boiling occurs lower within the body of the liquid and the temperature needs to be much higher.

# Boiling Point

The temperature at which a substance changes from a liquid into a gas is called its boiling point.



Water 100 °C



# Condensation and Evaporation

Vapor, or gas, changing into a liquid is called condensation.



## Condensation



Condensation is a gas changing into a liquid.



Liquids evaporate into gases.

Liquids changing to vapor is called evaporation.



## Evaporation

# Sublimation

Sublimation occurs when a substance moves directly from a solid state into a gas state without going through a liquid state.



Carbon Dioxide is called dry ice because it does not melt into a liquid.



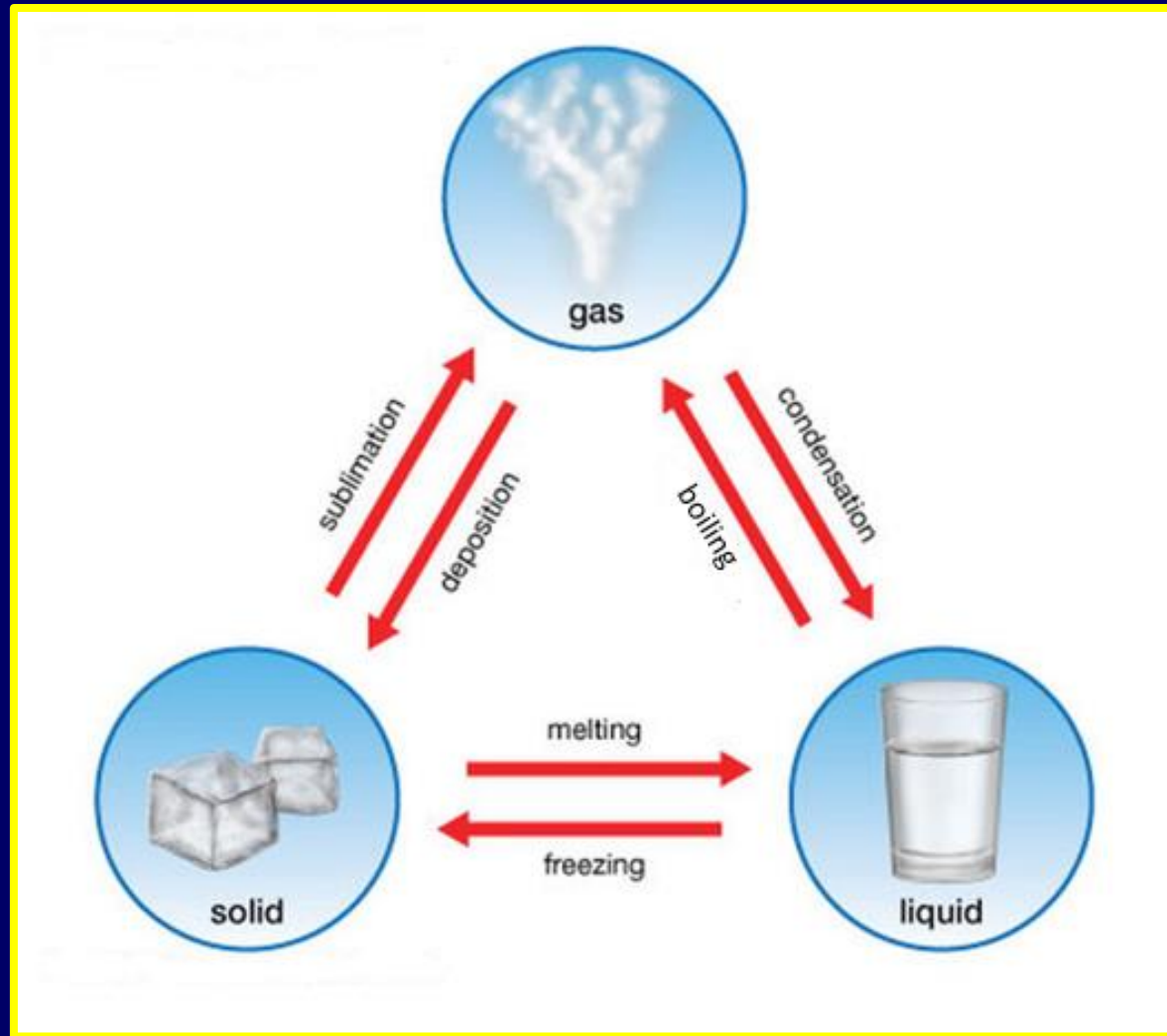
# Deposition

Deposition occurs when water moves directly from a gas state into a solid state without going through a liquid state.



When the humidity in the air is high on cold nights, water vapor will freeze on windshields through deposition.

# Changing States



# The End

