

NOTES ON CHAPTER 3: SOLIDS, LIQUIDS, AND GASES

3.2 Changes of State

Particles of a substance at a warmer temperature have more thermal energy than the same substance at a cooler temperature.

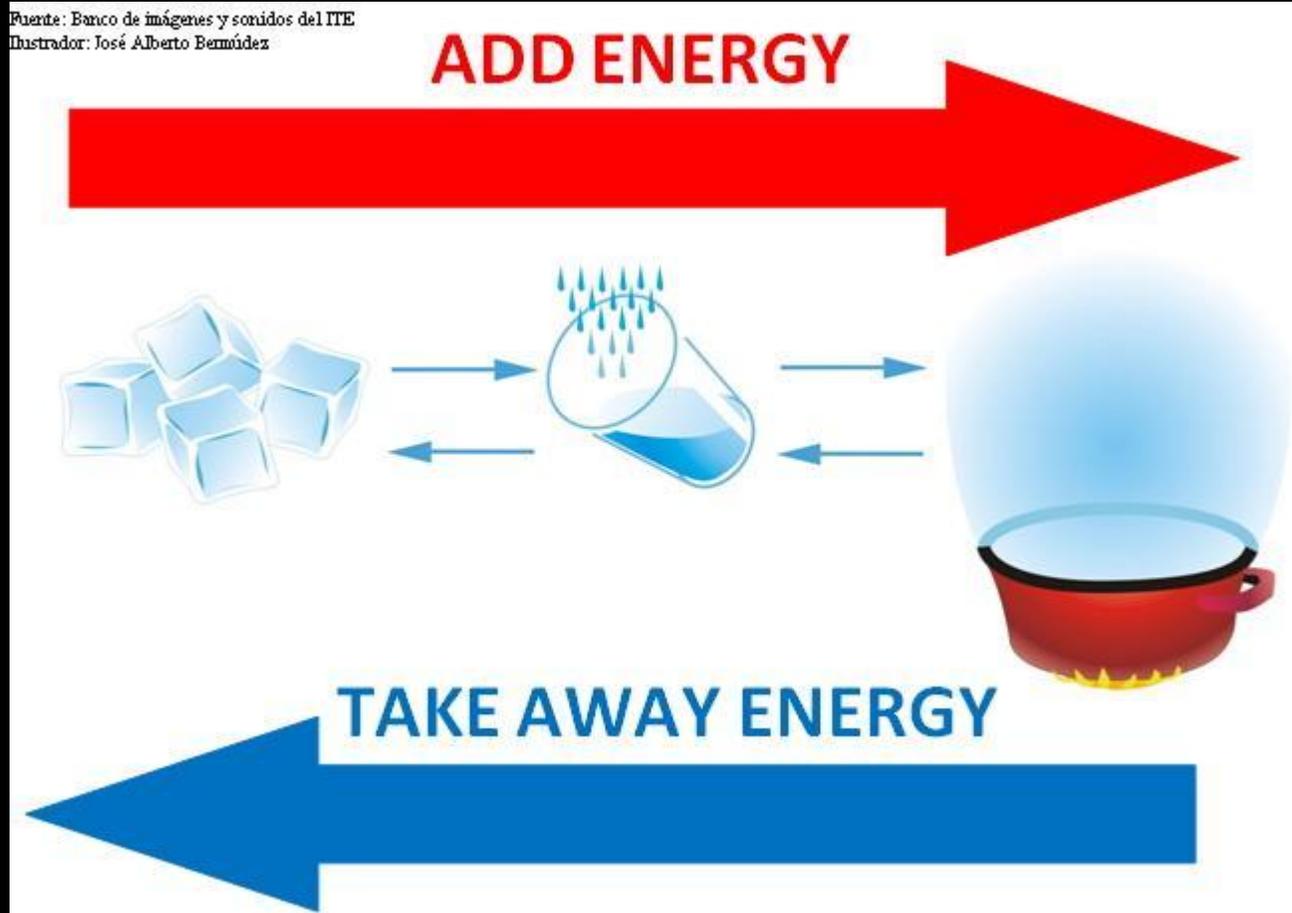
Also, remember that thermal energy always flows as heat from a warmer substance to a cooler one.



That's why ice cream cones have such a short life in Arizona! They can't handle the extra energy! Such a travesty!

Solids have the least amount of thermal energy. Liquids of the same substance have more than solids, but if that substance is in a gaseous state – it has the most thermal energy!

Fuente: Banco de imágenes y sonidos del ITE
Ilustrador: José Alberto Bermúdez

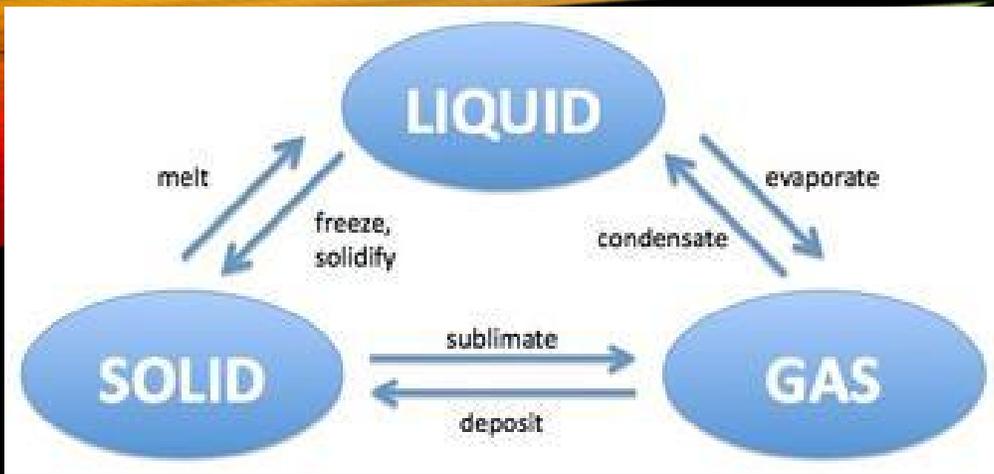


How do the particles in a solid substance change when energy is added?

They vibrate faster.

At what point do the particles of a solid break free from their fixed positions?

At its melting point.



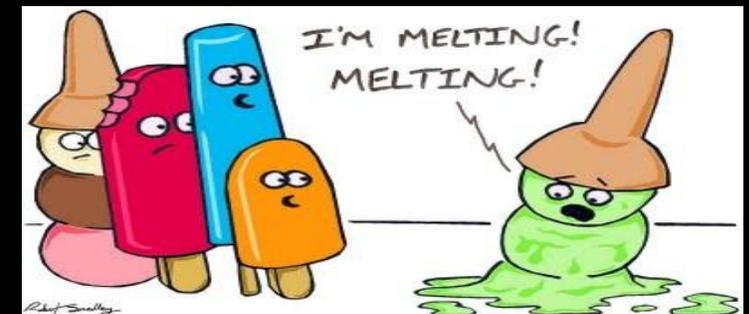
Melting – the change in state from a **solid** to a **liquid** .

In most pure substances, melting occurs at a specific temperature, called the **melting point**.

As thermal energy is added to a solid, it begins to vibrate faster and faster until at last- they break free from their fixed positions and become liquids. The arrangement of the molecules has now changed and it is now in the liquid state.

The melting points of substances can be used to help identify an unknown material. Pure water's melting point is 0°C.

At 0°C, the temperature of the ice stops increasing. Any added energy continues to change the arrangement of the water molecules from ice crystals into liquid water.



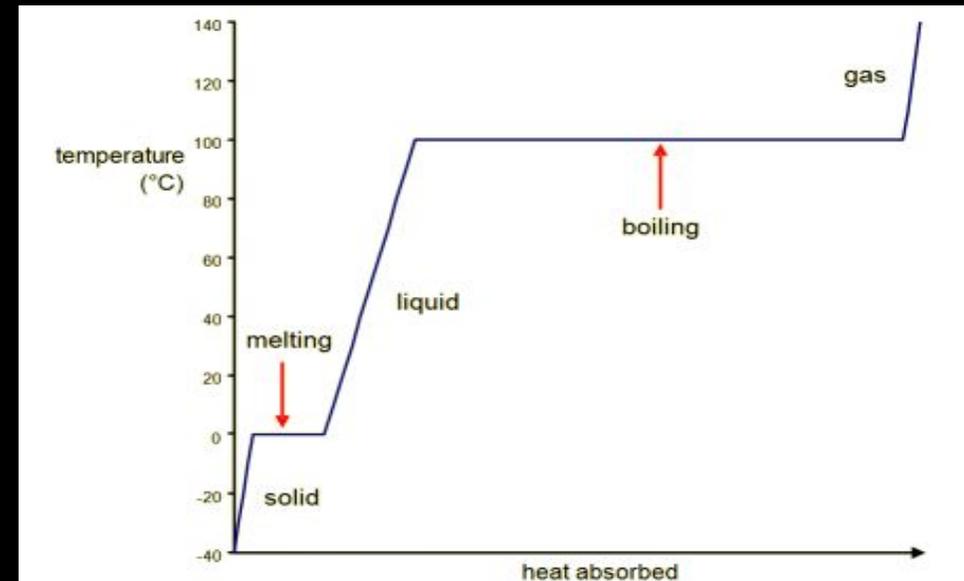
FREEZING IS THE CHANGE OF STATE FROM A LIQUID TO A SOLID.



The thermal energy is being released to the cooler air , causing the molecules to move slower and slower until a solid is formed. These particles begin to form regular patterns.

Does it surprise you to know that 0°C is both water's melting AND freezing point?!

Let's talk about what happens with water. As water's thermal energy drops, the water begins to freeze. Its temperature will remain at 0°C until the freezing is complete.



The change from a liquid to a gas is called vaporization.

This happens when the particles in a liquid gain enough energy to form a gas.

There are two types of vaporization:



1. **EVAPORATION:**

- vaporization that takes place only on the surface of a liquid.
- like a puddle or spilled water that seems to disappear over time.

2. **BOILING:**

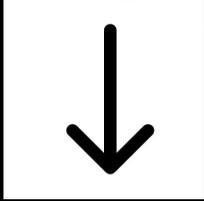
- when a liquid changes to a gas below its surface as well as at the surface.

The temperature at which a liquid boils is known as its **boiling point**. This is also used to identify unknown substances.

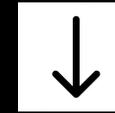


The boiling point depends on the pressure of the air above it.

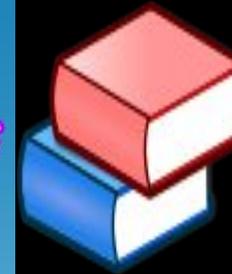
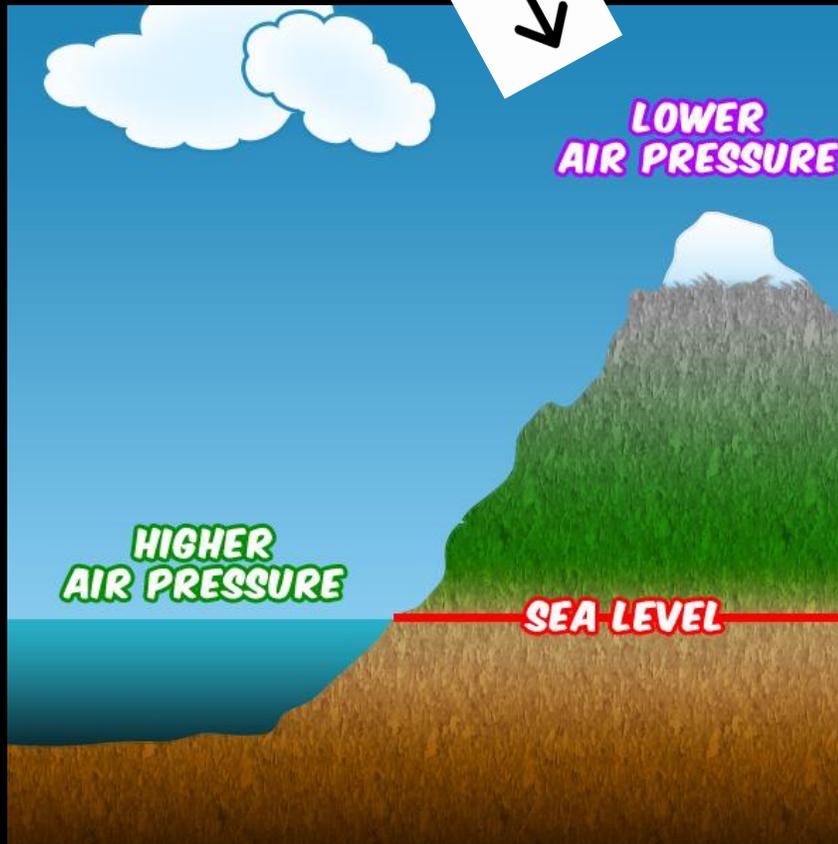
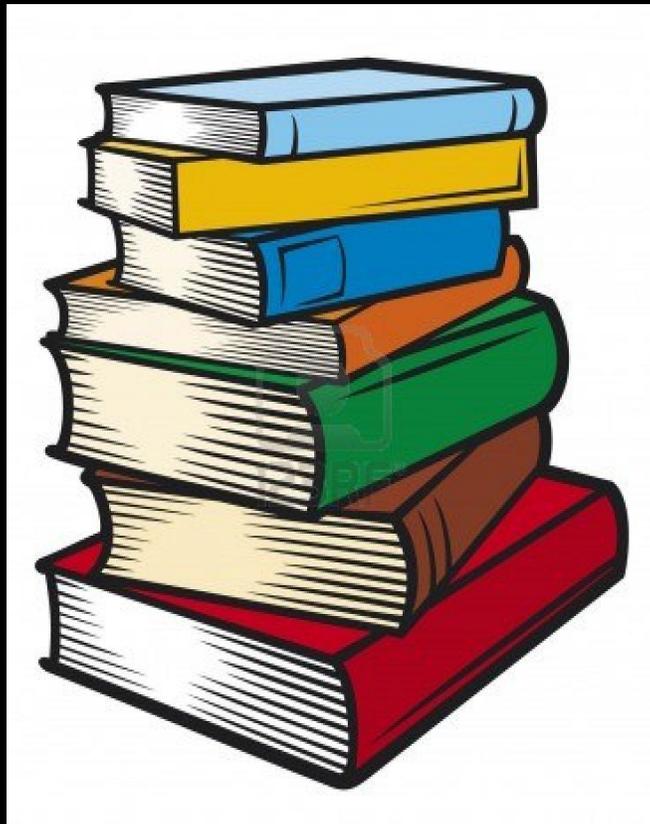
Think of air pressure like books stacked up in a pile. The lower the elevation, the higher the air pressure.



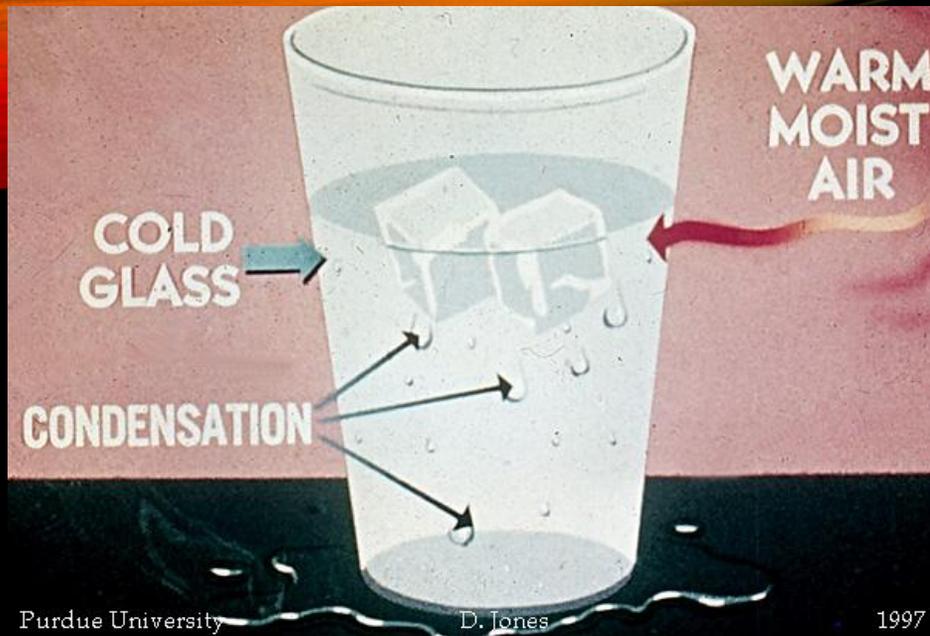
Whereas in Denver, water boils at 95°C



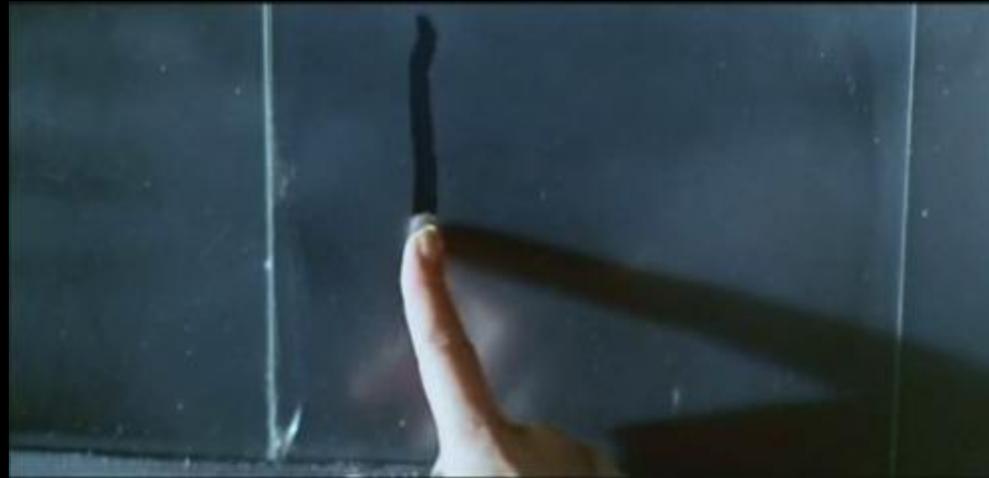
The lower the pressure, the less energy needed for the particles of the liquid to escape into the air. The boiling point is lowered.



At sea level the boiling point of water is 100°C.



Condensation occurs when particles in a gas lose enough thermal energy to form a liquid.



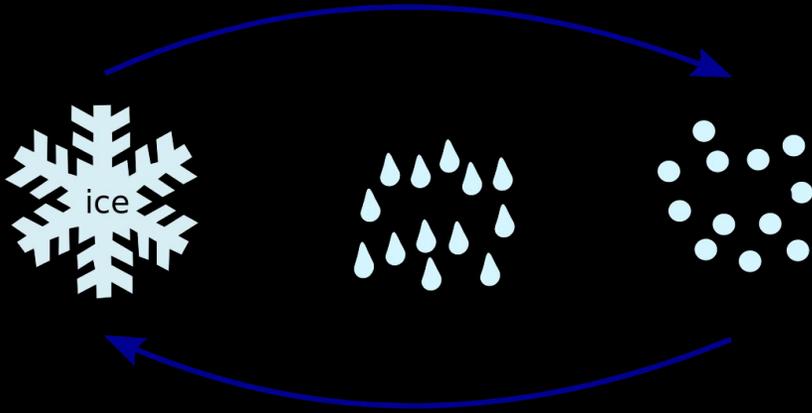
We must “clear up” something here. Water vapor is a colorless gas that is impossible to see.

Steam is **NOT** water vapor – neither are clouds or fog. These are actually tiny droplets of liquid water suspended in the air.



SUBLIMATION:

when particles of a solid do not pass through the liquid state as they form a gas.



Sublimation is caused when the surface particles of a solid gain enough energy to form a gas.

You could see this if you live where the temperature is well below freezing. The snow seems to disappear, but it doesn't melt!

Dry ice is actually **solid carbon dioxide**. Under normal circumstances, carbon dioxide **cannot exist as a liquid**. So, when dry ice absorbs thermal energy, it turns into a gas. In the process, it keeps the area around it ice cold and dry. The **water vapor** in the surrounding air is cooled as well, condensing into a liquid. This **creates the fog** around the dry ice.

