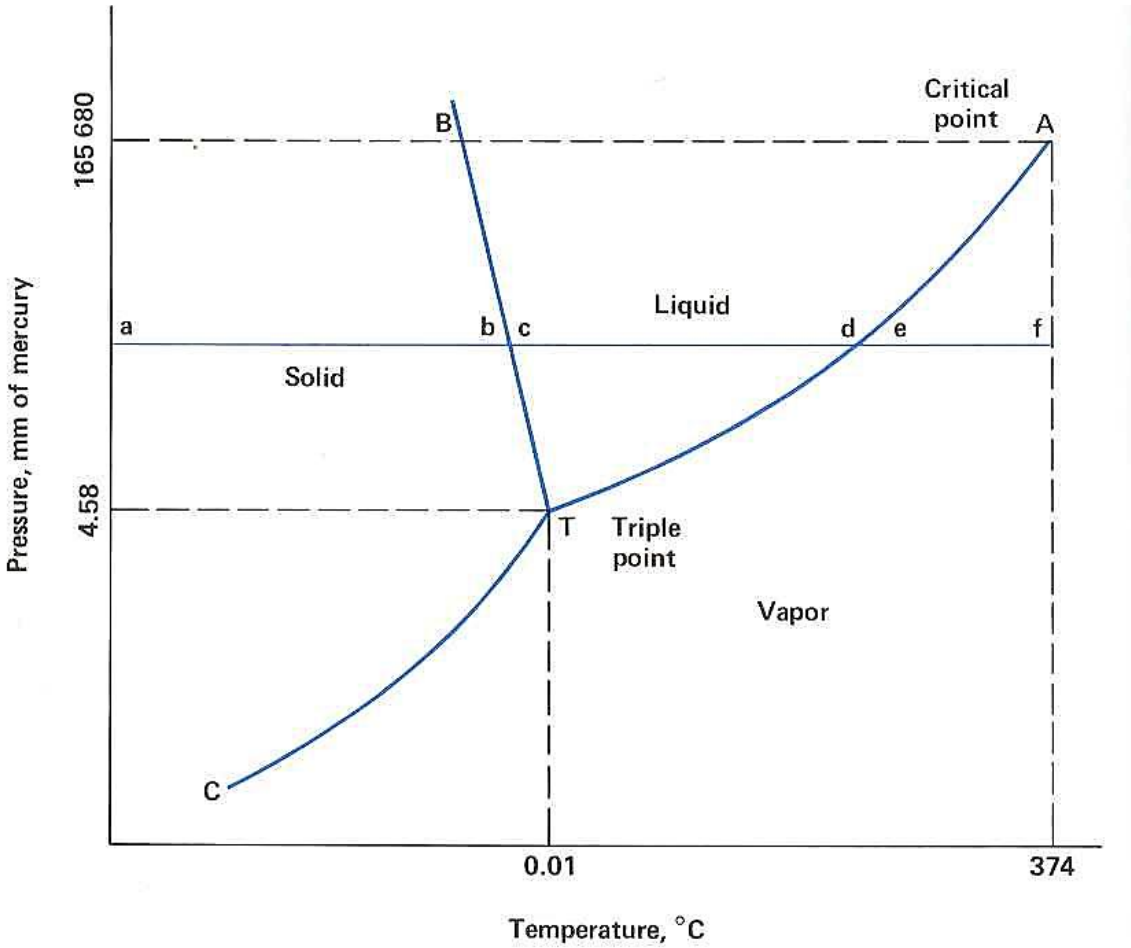
Section 13.3
Phase Changes

Phase Equilibrium

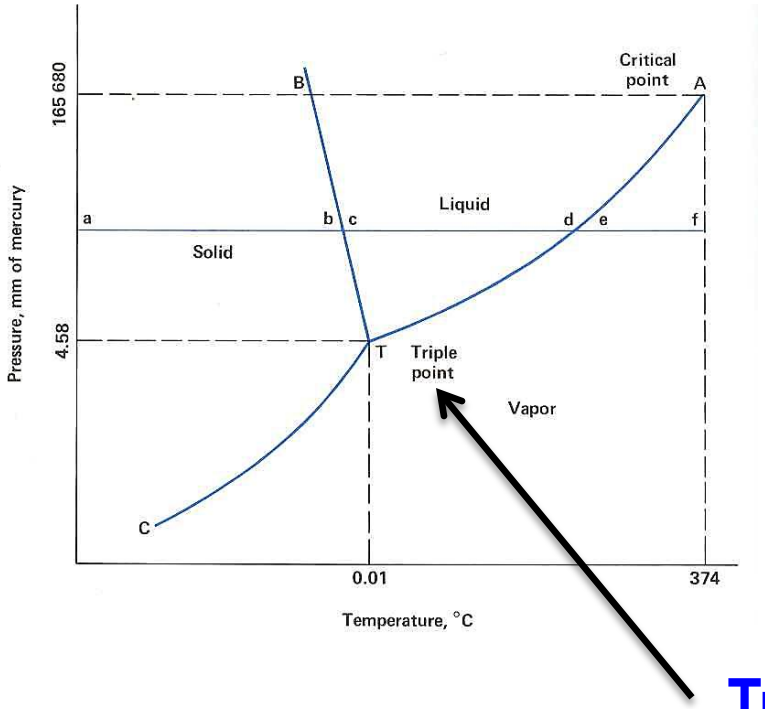
The phase and density of any substance are determined by its temperature and pressure.

Temperature-Pressure Equilibrium Graph



Graph for Pure Water

Temperature-Pressure Equilibrium Graph



Triple Point

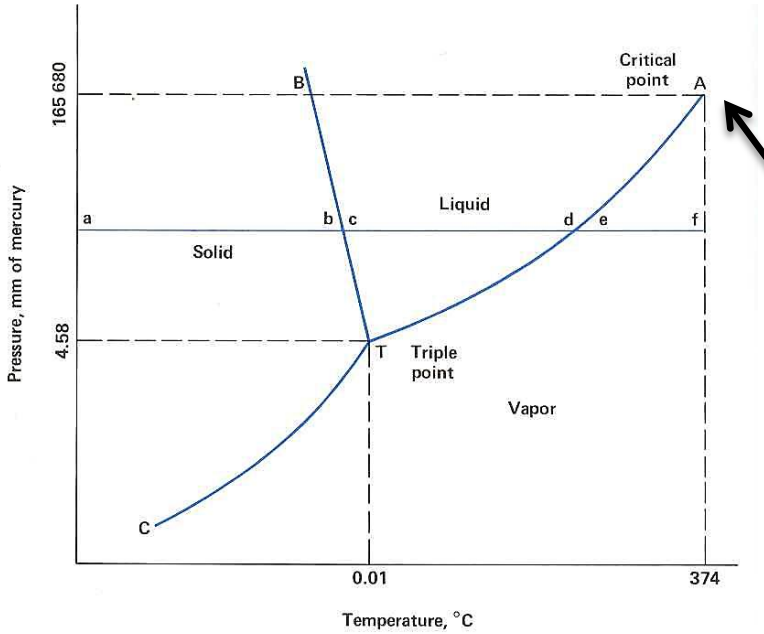
The temperature and pressure at which a substance can co-exist as a solid, liquid, and gas.

Temperature-Pressure Equilibrium Graph

Triple Point Video

https://www.youtube.com/watch?v=BLRqpJN9zeA

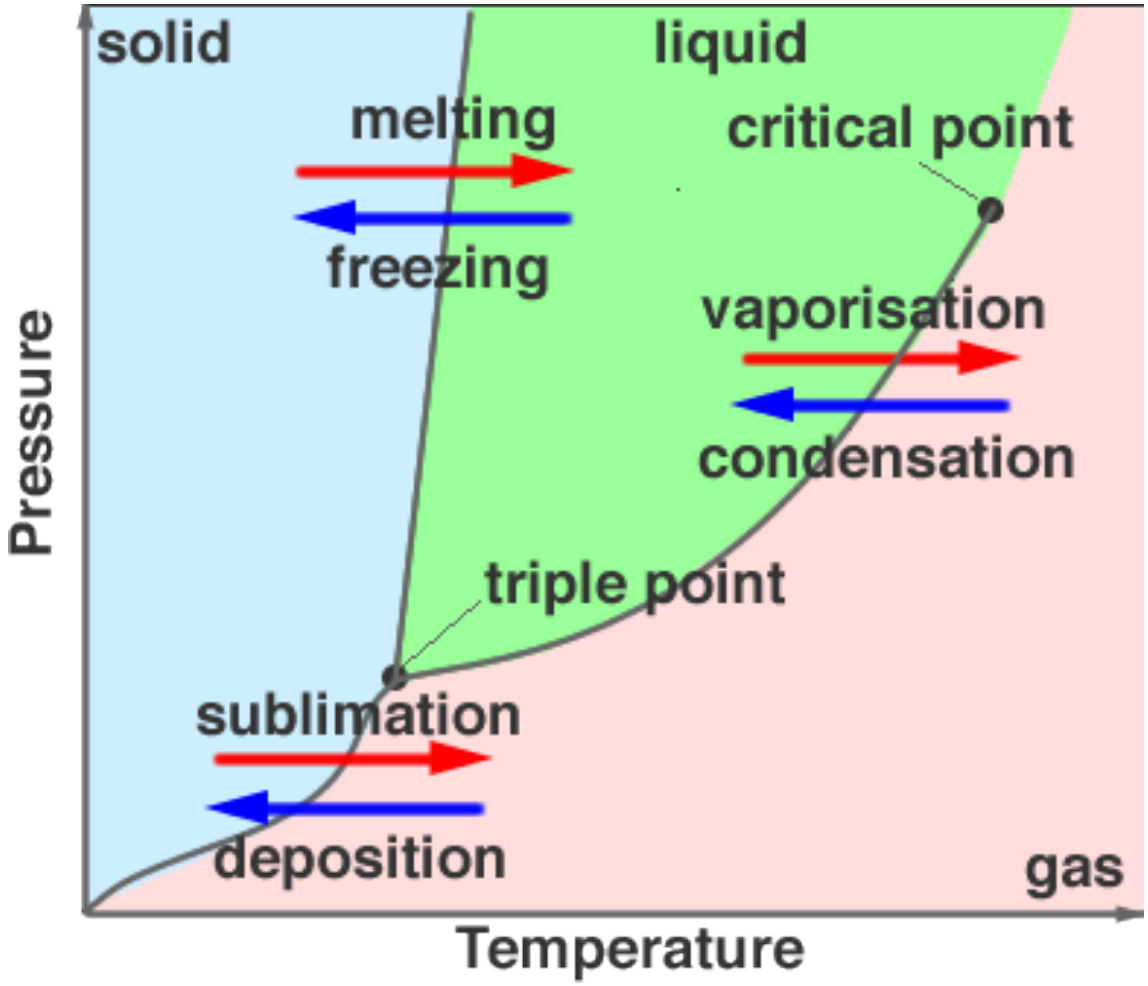
Temperature-Pressure Equilibrium Graph



Critical Point

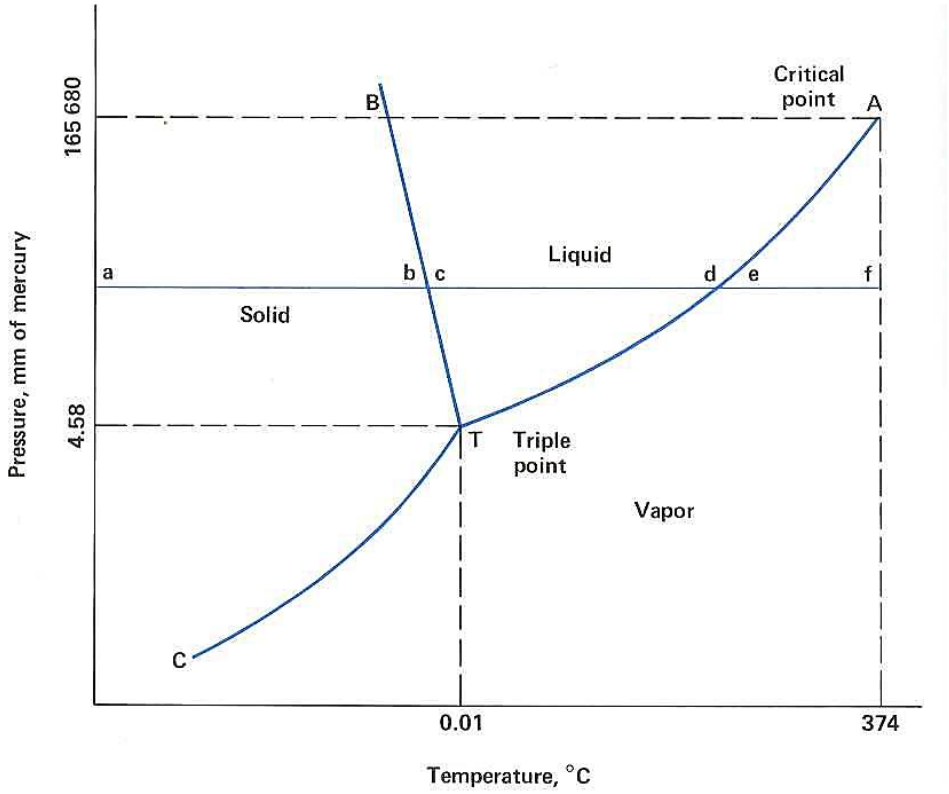
The temperature above which a substance cannot exist as a liquid no matter how great the pressure.

Phase Changes on a Temp. – Pressure Graph



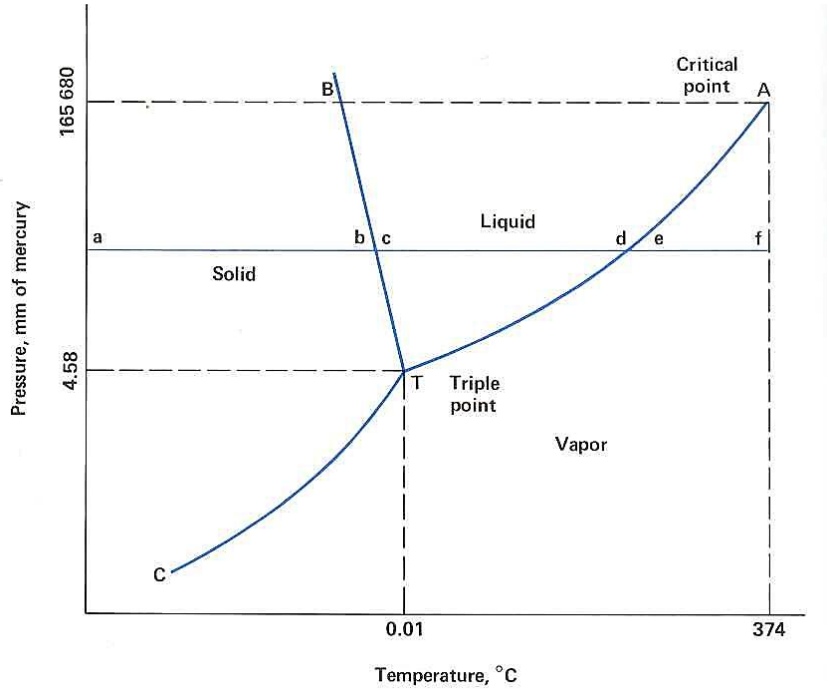
Temperature - Pressure Graph

- If we take a piece of ice (solid), and we apply heat at a uniform rate, the ice will be warmed from its initial temperature to the temperature at point "b".



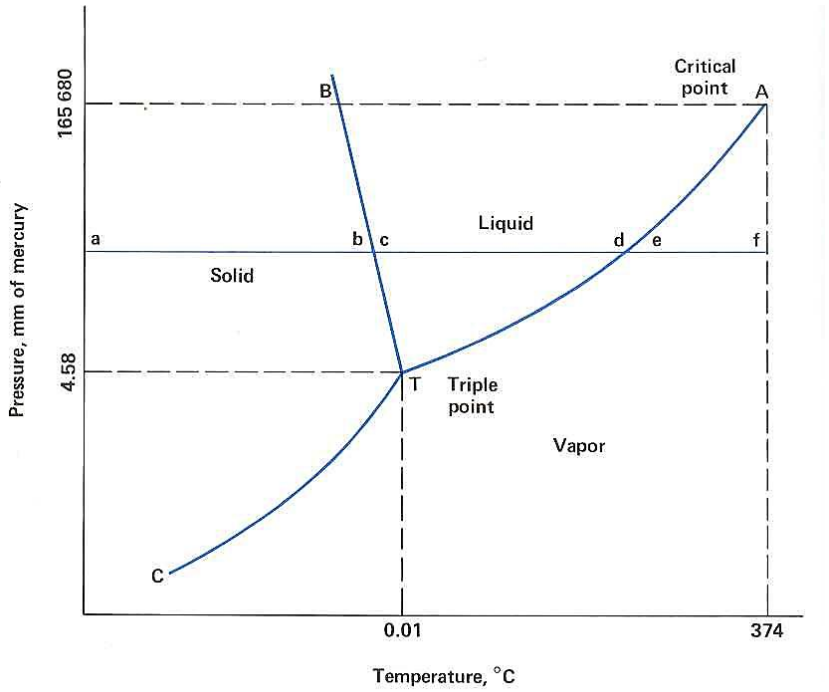
Temperature - Pressure Graph

- At this temperature the will begin to melt.
- The application of more heat will melt more ice but the temperature will not rise until all the ice is melted.



Temperature - Pressure Graph

- Following this change of phase, the horizontal line “abcdef” shows the temperature values as heat is applied first to ice, then to water, and finally to a vapor while the pressure is held constant.



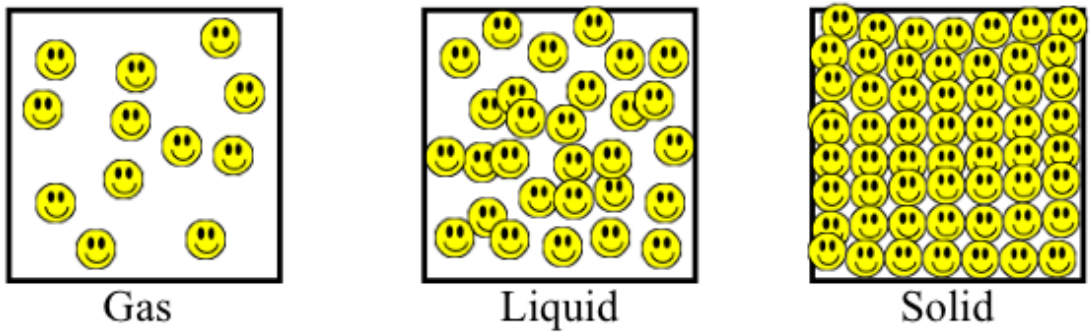
3 Phases of Matter

- Solid
- Liquid
- Gas

Density of Matter

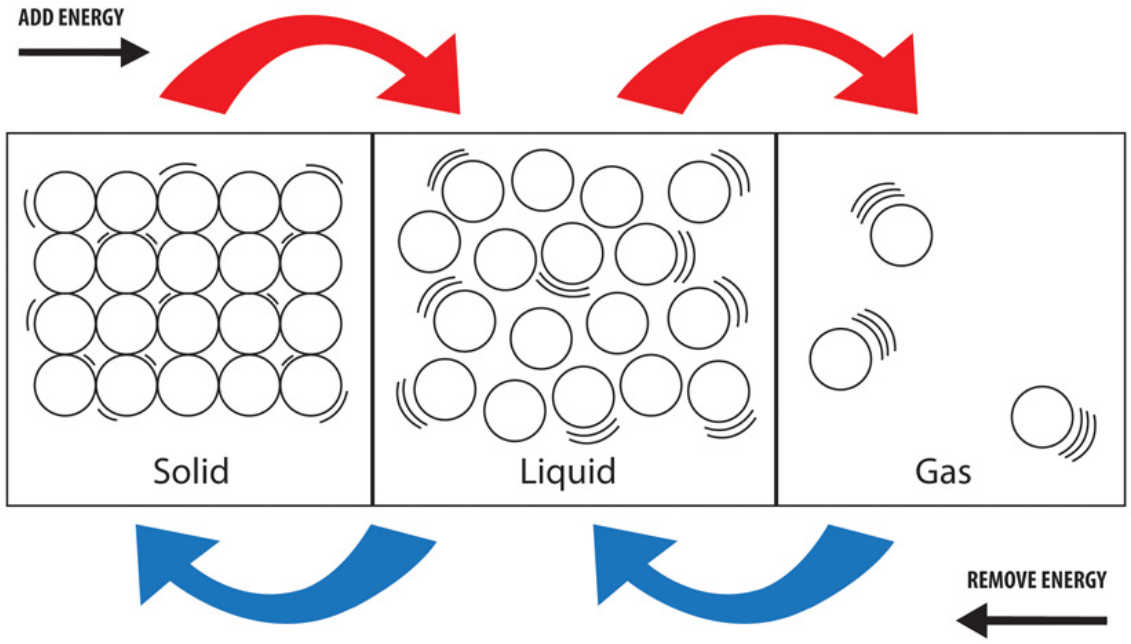
How packed matter is (The amount of matter in a given space)

- **Solid:** **High Density**
- **Liquid:** **Medium Density**
- **Gas:** **Low Density**



Energy

- **Solid:** **Low Energy**
- **Liquid:** **Medium Energy**
- **Gas:** **High Energy**



Phases of Matter

Solids

- Molecules are tightly packed together
- High potential energy – more bonds
- Low Kinetic Energy – Not moving very fast
- Particles vibrate in place
- Very dense
- Not easily compressed

Solid

Liquids

- Particles are not so tightly packed (liquids flow and can be poured)
- Medium potential and kinetic energy
- Less dense than solids

Liquid

Gases

- Particles spread out as the container will allow
- Low potential energy – less bonds
- High kinetic energy, particles are moving very quickly *(1,000,000 m/s)*
- Low density, can be compressed, very fluid.

Gas

What is a Phase Change?

- **Is a change from one state of matter (solid, liquid, gas) to another.**
- **Phase changes are physical changes because:**
  - ✓ *It only affects physical appearance, not chemical make-up*
  - ✓ *Reversible*

Energy Required for a Phase Change

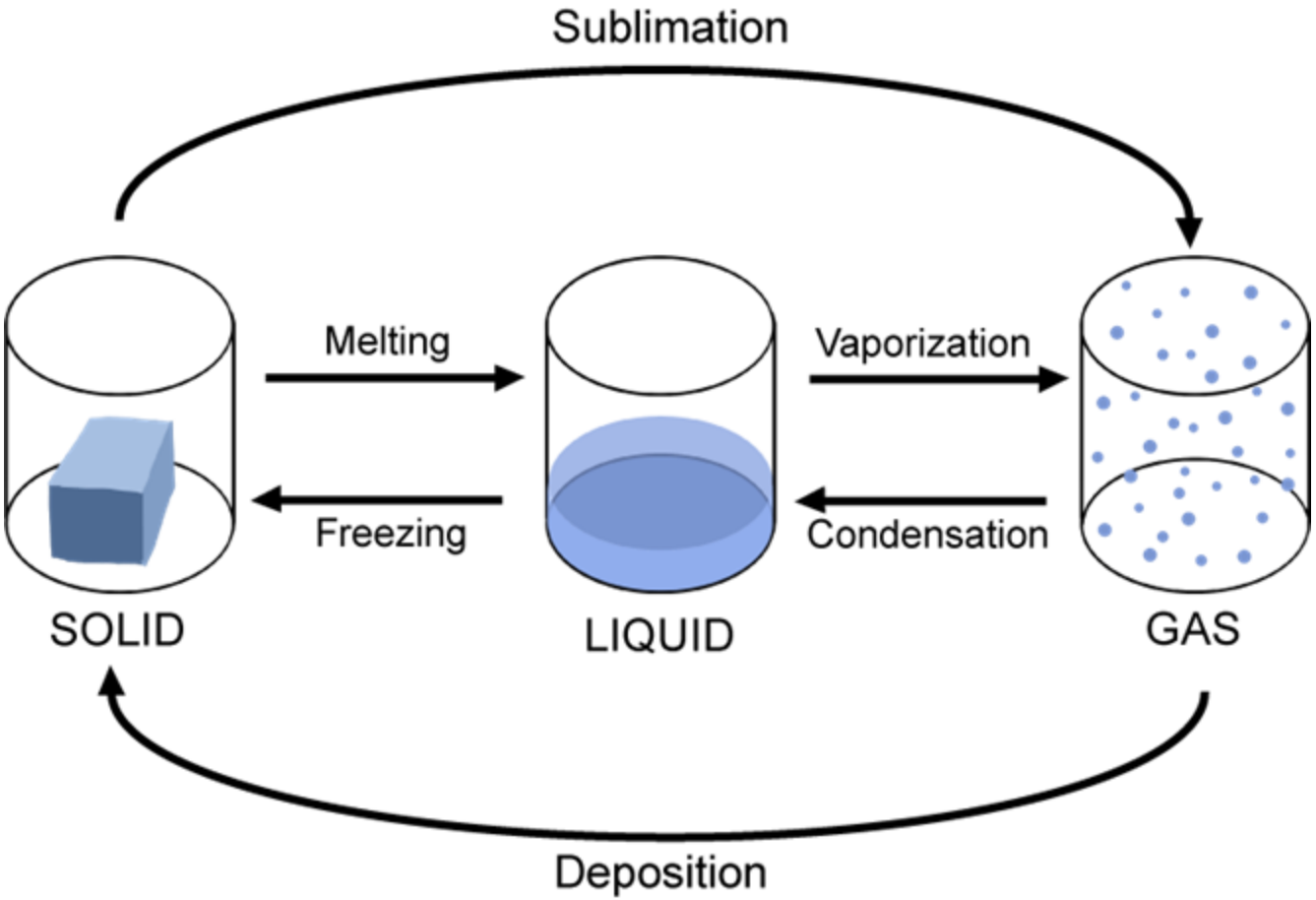
Just like specific heat is a set amount of energy for each substance – the amount of energy required for a phase change is also substance specific.

The amount of energy that must be added or removed when a substance is changing from one phase to the next at a constant temperature is called it's Latent Heat.

What happens during a phase change?

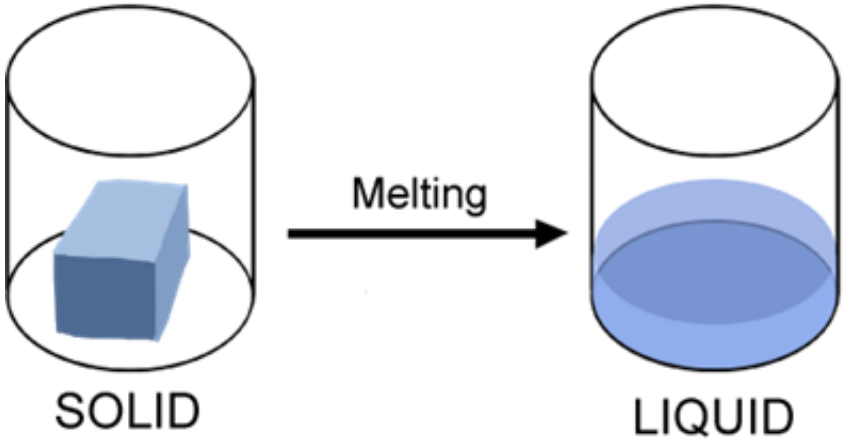
- During a phase change, heat energy is either absorbed or released.
- Heat energy is released as molecules slow down and move closer together (exothermic)
- Heat energy is absorbed as molecules speed up and expand (endothermic)

Types of Phase Changes



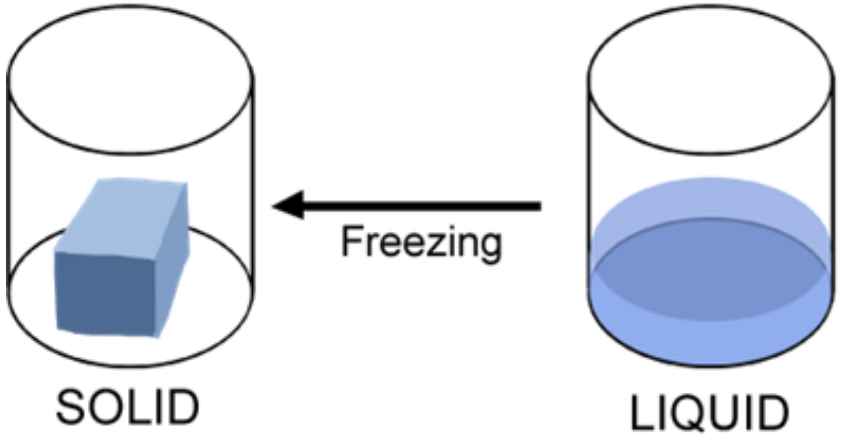
Melting

- Phase change from a solid to a liquid
- Molecules speed up, move farther apart, and absorb heat energy (endothermic)



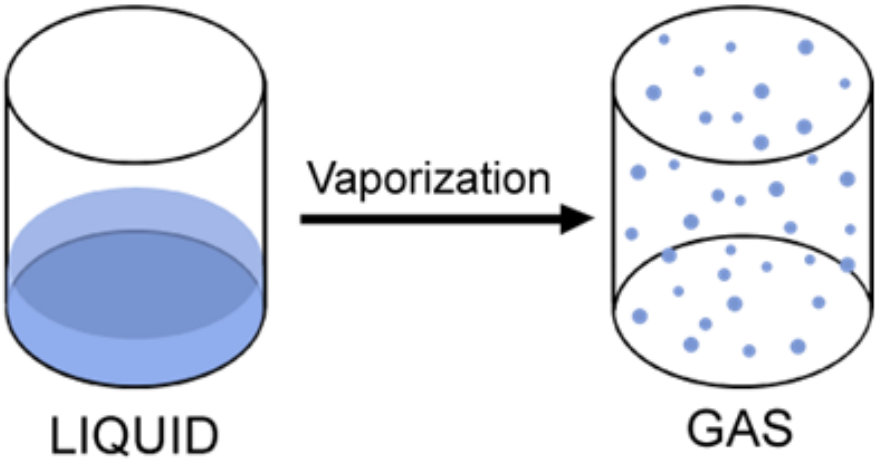
Freezing

- Phase Change from a liquid to a solid
- Molecules slow down, move closer together and release heat energy (exothermic)



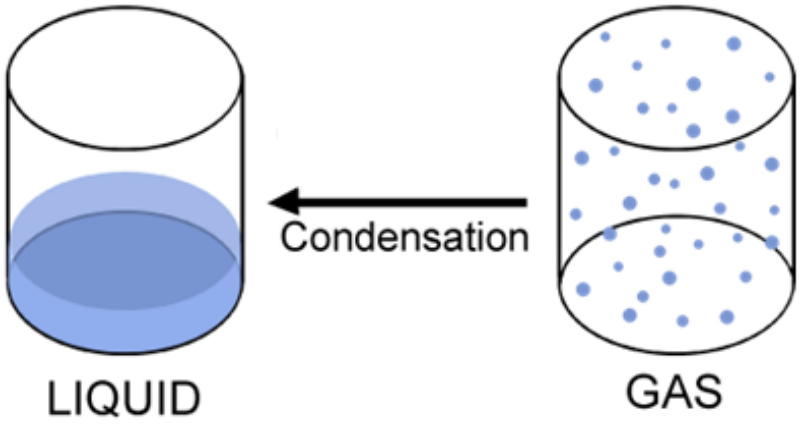
Vaporization (Boiling)

- Phase change from a liquid to gas. It occurs at the boiling point of matter
- Molecules speed up, move farther apart, and absorb heat energy (endothermic)



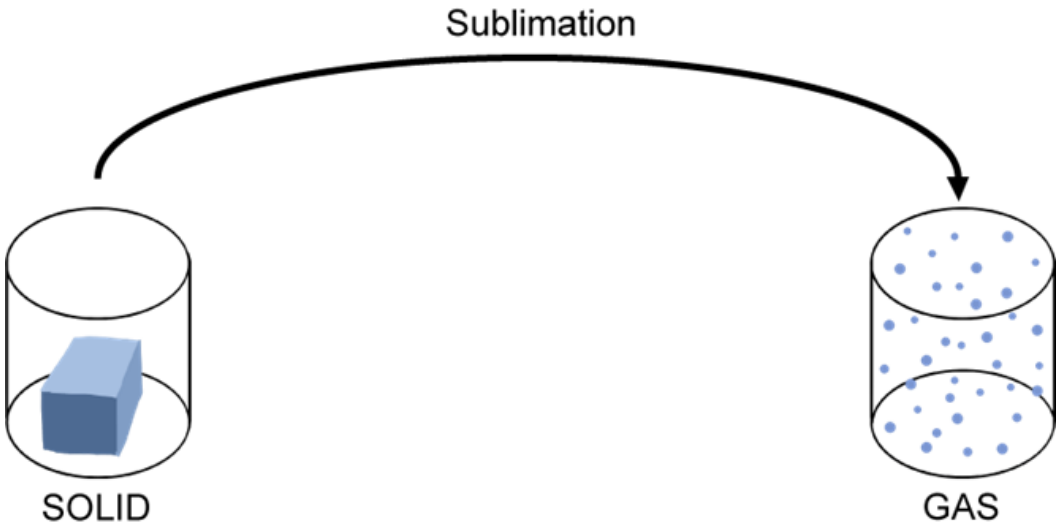
Condensation

- Phase change from a gas to a liquid
- Molecules slow down, move closer together and release heat energy (exothermic)



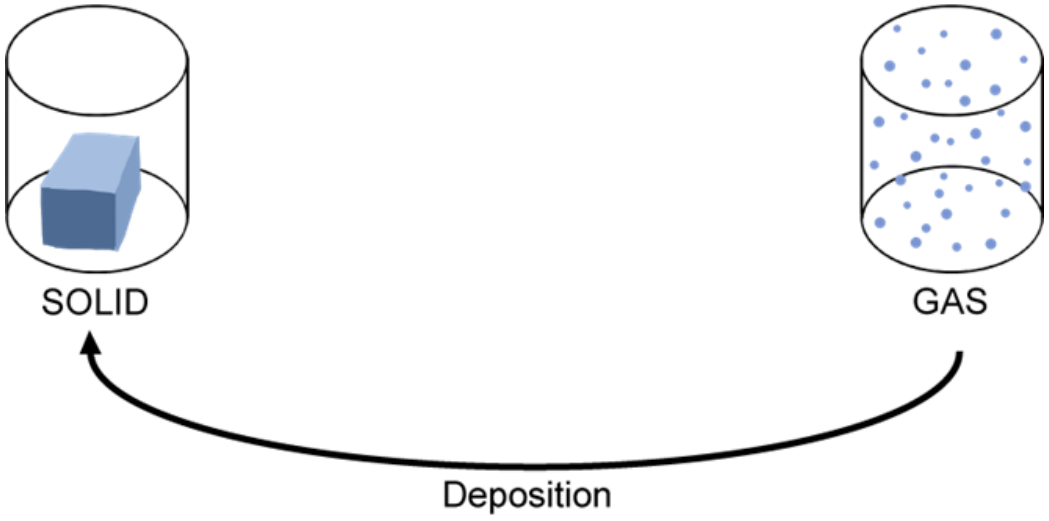
Sublimation

- Phase change from a solid to a gas
- Molecules speed up, move farther apart, and absorb heat energy (endothermic)



Deposition

- Phase change from a gas to a solid
- Molecules slow down, move closer together and release heat energy (exothermic)



Phase Change Points

Melting Point

The temperature at which a solid changes into a liquid

Boiling Point

The temperature at which a liquid changes into a gas

Freezing Point

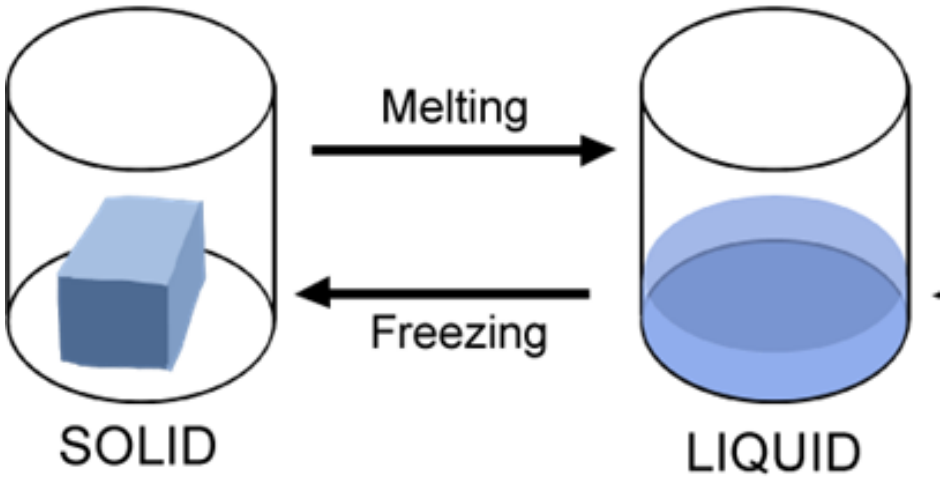
The temperature at which a liquid changes into a solid

Condensation Point

The temperature at which a gas changes into a liquid

Phase Change Info

- **Melting point and freezing point are the same thing. It just depends if the substance is getting hotter or colder.**

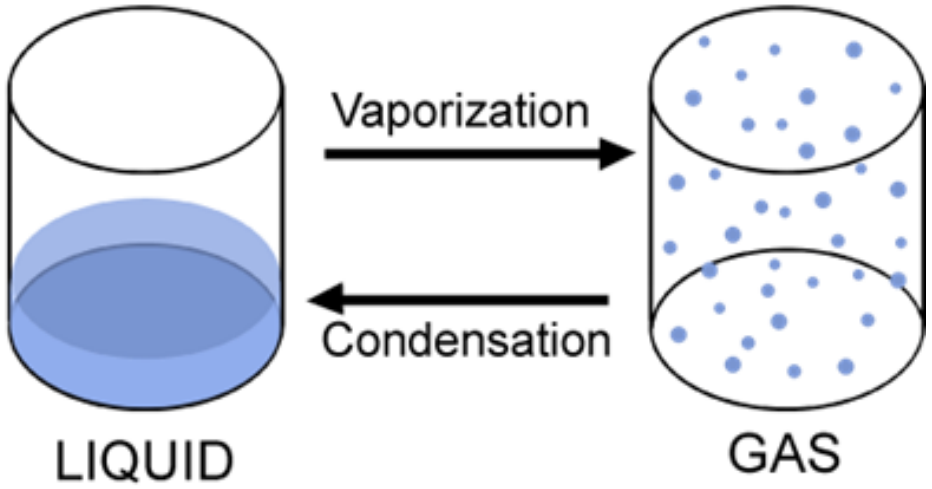


What temperature does melting and freezing occur in water?

0ºC or 32º F

Phase Change Info

- **Vaporization (boiling) point and condensation point are the same thing. It just depends if the substance is getting hotter or colder**



What temperature does vaporization and condensation occur in water?

100ºC or 212ºF

Energy During a Phase Change

- Requires the adding or the removal of energy
- During a phase change temperature does not change, but the amount of heat (energy) does
- Since temperature doesn't change, the energy goes toward breaking up weak intermolecular forces between the particles

Potential and Kinetic Energy during a Phase Change

Changing Temperature (warming up or cooling down):

- **Kinetic Energy:** increases or decreases
- **Potential Energy:** stays the same

During a Phase Change:

- **Kinetic Energy:** stays the same
- **Potential Energy:** increases or decreases