Density: Measure of the quantity of mass of a substance that occupies one unit of volume.

- An identifying property of a pure substance. The density of a pure substance never changes at a given temperature.
- Generally, as temperature increases, volume increases as well and density decreases. As temperature decreases, density increases. An exception to this is ice.
- Mass/volume=density
- Density is a physical property because it can be measured, and mass and volume are both physical properties.
- Water freezes at 0DC.
- Volume increases when water freezes.
- Ex. ice floats - ice water has less density than liquid water.
- When metals are heated to high temperatures, they expand and increase in volume.
- Water is the only liquid that expands when frozen.

Matter: Anything that has mass and takes up space (volume)

Law of Conservation of Matter: Matter cannot be created or destroyed by a chemical change, only its form or structure can be altered.

Atom: Smallest possible particle of an element that still retains the properties of the element.

Physical Properties: Quality of a substance that can be observed or measured without changing its chemical composition.

Solid	Liquid	Gas
Particles tightly packed ● Do not flow or float ● particles are in a geometric pattern *Definite shape+volume* ● Don't take the shape of a container *Vibrate in fixed position* ● Incompressible ● Can be measured	● Take shape of container ● They flow *Particles less tightly packed* ● Definite volume ● No definite shape ● Incompressible *Held together by moderate forces of attraction*	*No definite shape or volume* ● Particles spread out *Constant random motion* ● They flow ● Occupy the whole container *Very weak forces of attraction* ● Compressible ● Exerts pressure

Substance: Sample of matter having definite and uniform properties

Mixture: 2 or more substances physically combined. The components of a mixture can be separated by physical methods.

Separation Techniques: Techniques that separate substance through physical means

Methods for Separating Mixtures

1. **Filtration**: separates insoluble components from a solution
2. **Boiling or evaporation**: can reclaim a dissolved salt from salt water
3. **Distillation**: Separates components of a mixture based upon different boiling points.
4. **Decantation**: To pour off the top layer without disturbing the bottom layer
5. **Separatory Funnel**: can be used to separate two immiscible liquids based upon density.

Homogeneous: Sample whose particles are evenly distributed; all parts are the same. 1 part; uniform in composition; the same throughout
Heterogeneous: Sample whose particles are not evenly distributed. Different parts
Compound: 2 or more elements chemically combined (bonded), have definite composition and the same make-up throughout, can be broken down by chemical means. (i.e. NaCl - salt)
Pure Compound: Homogeneous and can be decomposed into simpler substances
Molecule: smallest sample of a compound.
Element: Substance composed of atoms having an identical number of protons in each nucleus and not reducible to a simpler substance; a substance that cannot be broken down by ordinary chemical means.
Alloy: Mixture of two metals

- Elements and Compounds are of definite composition.
- Mixtures are not pure substances because they vary in composition.

Physical Change: A change in a substance that does not alter its composition or chemical properties. It only alters the state of the substance
Chemical Change: A change in a substance and properties of a substance as a result of a chemical reaction; a change in chemical composition. (i.e. oxidation/rust)
Energy: The ability to do work.
Kinetic Energy: energy of motion; increases during phase changes
Potential Energy: stored energy; increases when temperature does not increase. (interphases)

- In a relative position: In an object's mass
- As chemical energy (in gas, batteries, chemical reactions)

Law of Conservation of Energy: Energy cannot be created nor destroyed but can be converted from one form into another.

Temperature: Measure of the average Kinetic energy of a substances particles. Is constant so the heat absorbed is used to break the chemical bonds and make the phase change

Three Scales

- Celsius (ºC)
- Farenheit (ºF)
- Kelvin (K)

K=C+273 C=K-273
C=5/9 x (F-32) C= (F-32)/1.8
F=(9/5 x C)+32 F=1.8(C+32)

Celsius Scale: Freezing point - 0DC	Kelvin Scale (absolute scale)
• Boiling point - 100DC • Divided into 100 equal intervals • DC = K-273	• Freezing point - 273 K • Boiling point - 373 K • K=DC+273.

Chemical Properties: Ability of a substance to react or fail to react with other substances or decompose.

Exothermic: Process where heat is released (feels warm) Release heat **exothermic**
Endothermic:Process where heat is absorbed (feels cold) Heating is **endothermic**
Aqueous (aq): a water solution
Precipitate: An insoluble solid that falls out of a solution.
Specific Heat : The amount of heat required to raise the temperature of one gram of a substance by one degree Celsius.
Heat: The energy produced by the motion of particles.
Calorie: The amount of heat required to raise the temperature of 1g of water by 1 degree Celsius.
Joule: Current heat unit. 1 calorie is equivalent to 4.18 joules.
The **Freezing Point** and **Boiling Point** of a substance is the temperature at which the solid and liquid phases can exist in equilibrium.

- It takes a lot more heat to melt than to boil because more energy is required to leave the system.

During these two phase changes, there is no change in the average motion of the particles; <u>only potential energy increases</u>.

Calorimetry: Measurement of heat
q= mc(Δ)t (Remember this as q= mcAt)

$q = cm\Delta T$

q = amount of heat transfered
c = specific heat of the solution
m = mass of solution
ΔT = temperature change (T_{final} - $T_{initial}$)

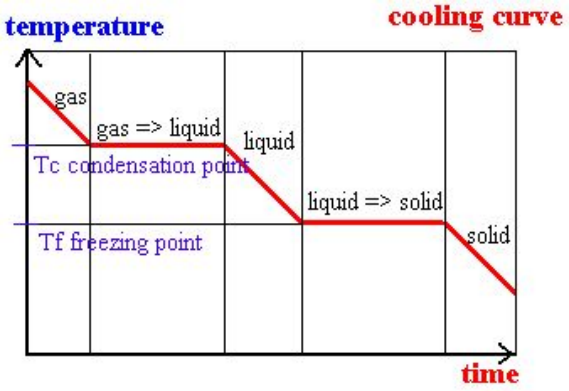
STP - Standard Temperature and Pressure

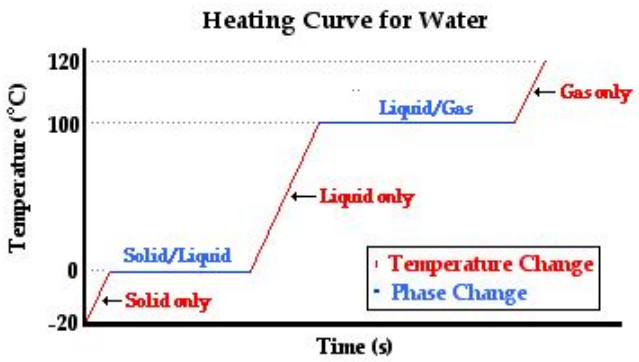
- Standard temperature - 0DC
- Standard pressure - 101.3 kPa

Fusion: Constant temperature process in which particles in the solid phase gain enough energy to break away into the liquid phase; also known as melting
Vaporization: Constant temperature process in which particles in the liquid phase gain enough energy to break away into the gaseous phase. Particles need more energy to leave during vaporization

- 334 J/g to melt ice (Fusion)
- 2260 J/g to evaporate water (Vaporization)
- Heat of vaporization is greater than heat of fusion because particles need more energy to break away from the forces of attraction and leave the system

Sublimation: phase change from solid to gas
Deposition: Phase change from gas to solid



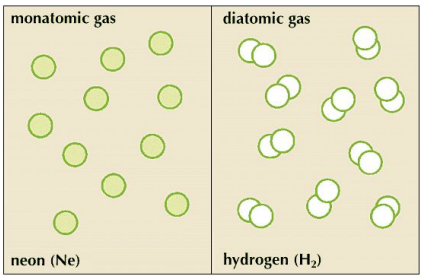


Diatomic : Consisting of 2 atoms

How to Remember the Diatomic Elements: Elements ending with "-gen" including halogens form diatomic molecules.

Diatomic Elements

1. Hydrogen (H2)
2. Nitrogen (N2)
3. Oxygen (O2)
4. Fluorine (F2)
5. Chlorine (Cl2)
6. Iodine (I2)
7. Bromine (Br2)



Monatomic: Consisting of 1 atom

Scientific Method

1. State Problem/Question
2. Develop a hypothesis based upon available information
3. Test hypothesis via experiment
4. Record observations and data
5. Draw a conclusion based upon your observations and data.
6. Record and communicate results. Modify hypothesis and repeat if necessary.

- Logical approach to the solution of a scientific problem.
- Steps:
    - Observations - note and record facts
    - Hypothesis - proposed explanation for an observation
    - Experiment - procedure to test hypothesis
        - Only 2 possibilities - hypothesis is right or hypothesis is wrong
            - If hypothesis is wrong, make corrections and retry experiment
- Once a hypothesis meets a test of repeated experimentation, it becomes a theory.
- Theory is a well-tested explanation for a broad set of observations.
- Theory can never be proved because a new idea could always possibly disprove it.

Scientific Laws

- A scientific law is a concise statement that summarizes the results of many observations and experiments.
- Scientific laws can be expressed by simple mathematical relationships.
- ex. Boyle's law: as pressure increases, volume decreases