Unit 1
Classification and Properties of Matter

Physical Science

Mrs. Valentine

1.1 Graphing

- Objective:
  - I will be able to identify independent and dependent variables in an experiment. I will be able to create a graph from data.

- Vocabulary:

Data	Independent Variable	Dependent Variable	Graph	Axis
Controlled Experiment	Hypothesis	Best-fit Line	Slope	Y-intercept

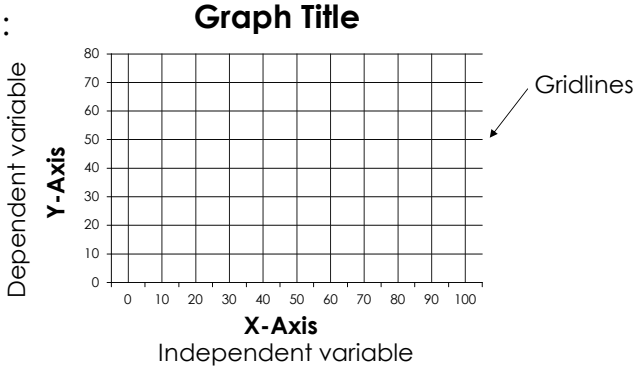
1.1 Graphing

- In a controlled experiment, all variables are held constant except one in order to test a hypothesis.
  - Hypothesis is a proposed explanation for an observation based on limited evidence.
  - Independent Variable
    - The experimental factor that is manipulated
    - The effect of this variable is being studied
    - Used to test the hypothesis
  - Dependent Variable
    - The measurable effect, outcome, or response in which the research is interested.

1.1 Graphing

- Graphs are diagrams that show how two variables, or factors, are related.
  - Can be used to predict what will happen as one variable changes
  - Parts of a Graph:

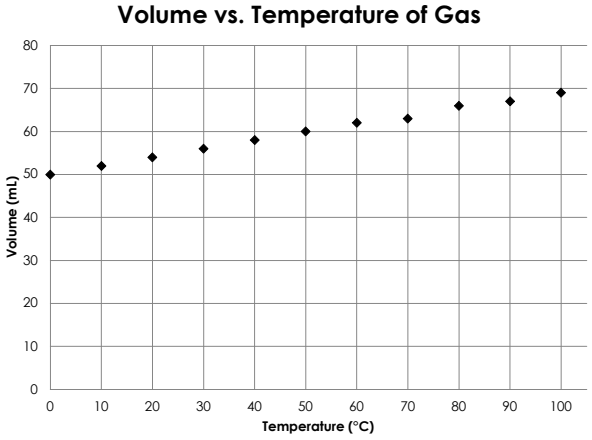
NOTE: Axes are always labeled, including units!



1.1 Graphing

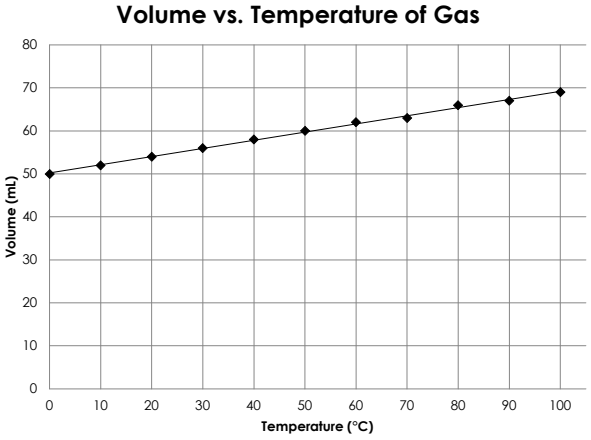
- Practice

Temperature (˚C)	Volume (mL)
0	50
10	52
20	54
30	56
40	58
50	60
60	62
70	63
80	66
90	67
100	69



1.1 Graphing

- Once the data has been plotted, draw a best-fit line
  - A straight line through the center of a group of data points.
  - Note: This line may not pass through all of the data points exactly. This is okay!
  - Used to find the trend in the data



1.1 Graphing

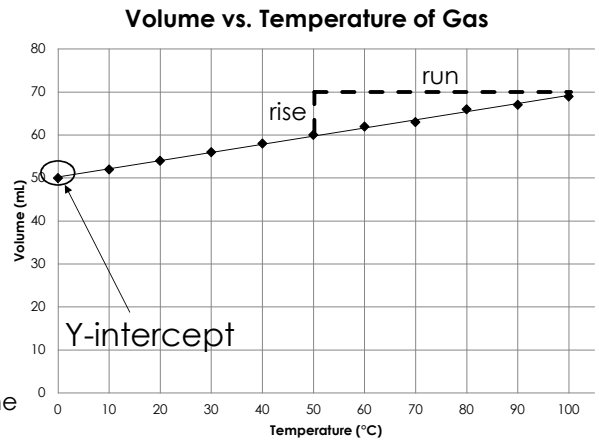
- Finding the equation of the best-fit line.
  - Equation of a line: $y = mx + b$ where
    - m is the slope
    - b is the y-intercept
  - Use points on the line (do not use data points not on the line!)

$$m = \frac{rise}{run}$$

$$m = \frac{10}{50} = \frac{1}{5} \qquad b = 50$$

$$y = \frac{1}{5}x + 50$$

For every milliliter of gas added, the temperature will increase by 5°C.



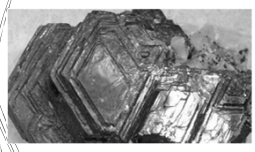
1.2 Physical vs. Chemical Properties

- Objective:
  - I will be able to identify physical and chemical properties of substance, and be able to tell them apart. I will be able to identify physical and chemical changes.
- Vocabulary:

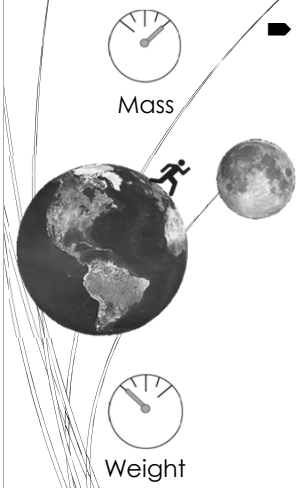
Mass	Volume	Density	Boiling Point	Freezing Point
Physical Property		Chemical Property		
Physical Change		Chemical Change		
Chemical Bond		Chemical Energy		

1.2 Physical vs. Chemical Properties

- Physical Properties of Matter
  - Can be measured without changing the identity of the substance.
  - Examples include:
    - color
    - temperature
    - shape
    - surface area
    - mass
    - volume
    - density
    - boiling point
    - melting point

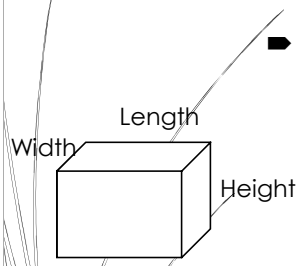


1.2 Physical vs. Chemical Properties



- Mass vs. Weight
  - Mass
    - the amount of matter in a substance
    - Does not change unless the sample changes
    - SI Unit: kg
  - Weight
    - Measure of gravity on an object
    - Changes from planet to planet
    - SI Unit: Newton

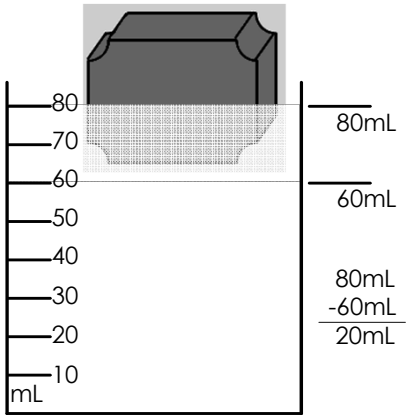
1.2 Physical vs. Chemical Properties



- Volume
  - The amount of space a substance occupies
  - SI Unit: m^3
  - To find the volume of a box:

$$V = length * width * height$$

  - To find the volume of an irregularly-shaped object, measure the volume of some water, submerge the object, and measure the new volume. Take the difference.



1.2 Physical vs. Chemical Properties

- Density
  - How compact a material is
  - $D = \frac{m}{v}$
  - Constant for a solid or a liquid
  - Can be used to help identify a material
  - SI Unit: $\frac{kg}{m^3}$

D = 

1.2 Physical vs. Chemical Properties

- Boiling Point
  - The temperature at which a substance comes to a boil
  - Common Unit: °C
  - Ex: Water boils at 100 °C
- Melting Point
  - The temperature at which a substance melts
  - Common Unit: °C
  - Ex: Ice melts at 0°C

1.2 Physical vs. Chemical Properties

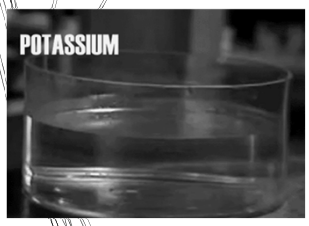
- Chemical Properties of Matter
  - Cannot be measured without changing the substance
  - Examples include:
    - Chemical Energy
    - Flammability
    - Toxicity

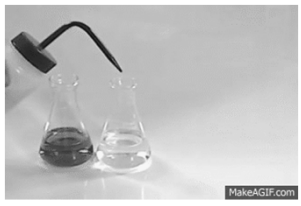
1.2 Physical vs. Chemical Properties

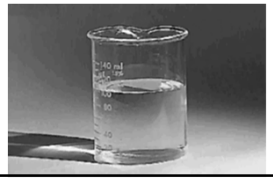
- Physical Changes
  - Changes to a substance that do not change the identity of the substance
  - Examples:
    - Freezing
    - Boiling
    - Ripping Paper

1.2 Physical vs. Chemical Properties

- Chemical Changes
  - Changes to a substance that change its identity
  - Bonds are broken and/or new ones are formed
  - Evidences of Chemical Change:
    - Production of a Gas
    - Exchange of Heat
    - Color Change
    - Precipitation of a New Solid

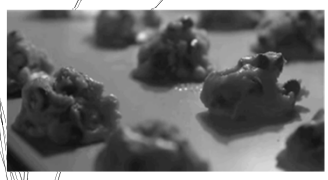






1.2 Physical vs. Chemical Properties

- Examples:
  - Baking Cookies
  - Mixing Baking Soda with Vinegar
  - Burning Wood



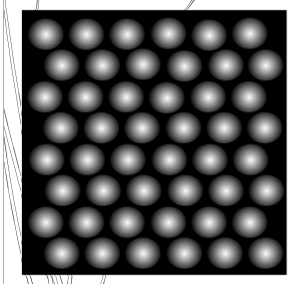
1.3 Phases of Matter

- Objective:
  - I will be able to identify the phases of matter and the changes of state. I will be able to read and/or create a phase diagram.

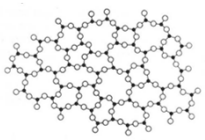
- Vocabulary:

Solid	Liquid	Gas	Plasma	Condensing
Vibration	Viscosity	Freezing	Melting	Deposition
Boiling	Evaporation	Vaporization	Sublimation	
Amorphous Solid	Crystalline Solid	States of Matter	Heating Curve	

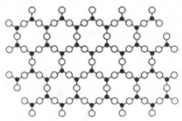
1.3 Phases of Matter



- Four states of matter: solid, liquid, gas, and plasma.
- Solid
  - State of matter with a definite volume and definite shape
  - Particles are tightly packed together and vibrate in place
  - Two types of solids:

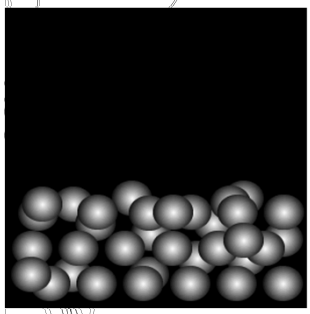


    - Amorphous solid
      - Particles are arranged randomly
      - Examples include rubber, glass, and plastic

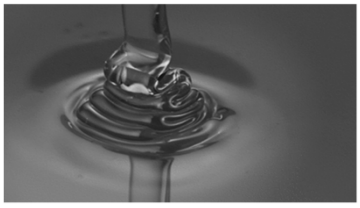


    - Crystalline solid
      - Particles are arranged in an organized pattern
      - Examples include: salt, ice, sugar and sand

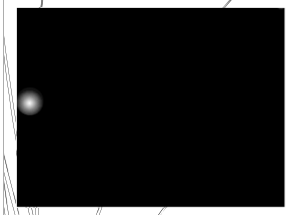
1.3 Phases of Matter



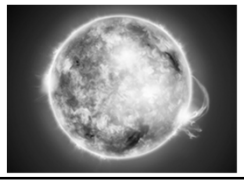
- Liquid
  - A state of matter with a definite volume but an indefinite shape
  - Particles are only slightly less tightly packed than in a solid and can move around each other, hence lack of definite shape
  - Weaker particle attractions than in solids
  - Viscosity
    - Resistance of liquid to flowing
    - High viscosity = slow flow



1.3 Phases of Matter

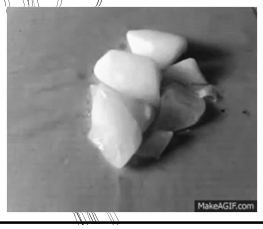


- Gas
  - State of matter with indefinite shape and indefinite volume
  - Particles are very far apart from each other and much weaker attractions
  - Spread out to fill all available space
- Plasma
  - High temperature state of matter wherein atoms lose their electrons.
  - Does not exist naturally on Earth.
  - The sun is made of plasma.



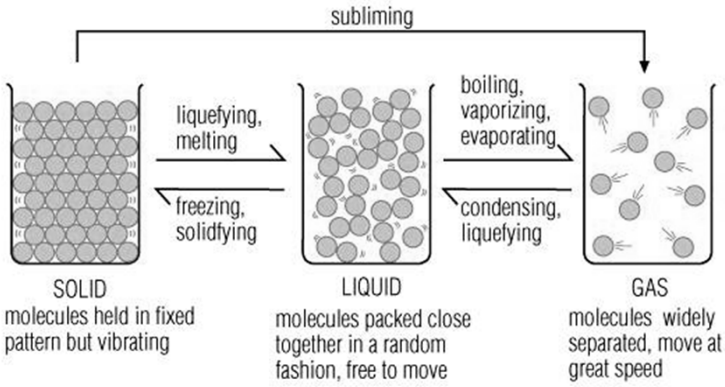
1.3 Phases of Matter

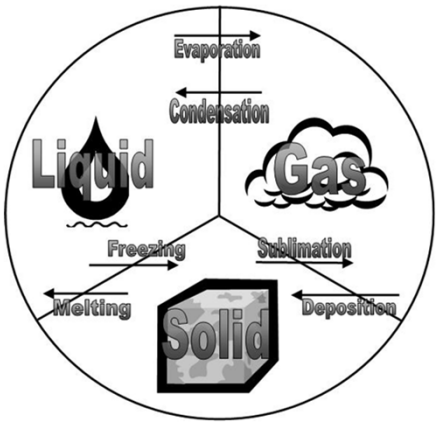
- Changes of State
  - Between Solid and Liquid
    - Melting - solid changes to a liquid
    - Freezing – liquid changes to a solid
  - Between Liquid and Gas
    - Vaporization – liquid changes to a gas
      - Evaporation – on the surface only
      - Boiling – inside and on the surface (bubbles)
    - Condensation – gas changes to a liquid
  - Between Solid and Gas
    - Sublimation – solid changes directly to a gas
    - Deposition – gas changes to a solid



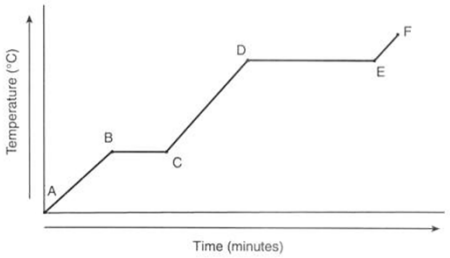
1.3 Phases of Matter

- Changes of State



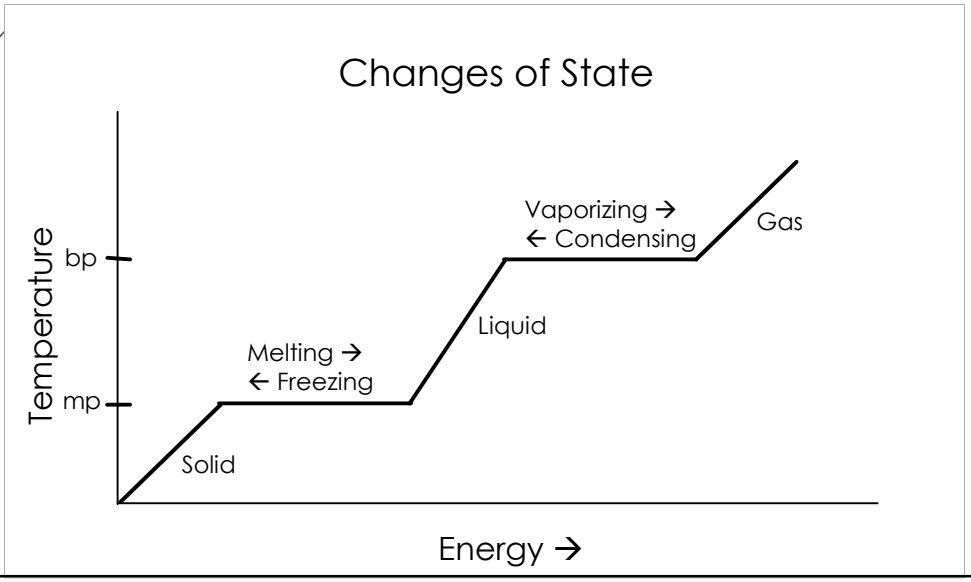


1.3 Phases of Matter



- Heating Curves
  - Temp vs. Energy Graphs
  - Diagonal Segments
    - Each segment represents a state of matter
    - The lower the temperature, the more structured the state
  - Horizontal Segments
    - Changes of state between the connecting states of matter
    - Note that while a substance is changing its state of matter, the temperature does not change!

1.3 Phases of Matter



1.4 Classifying Matter I

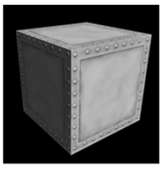
- Objective:
  - I will be able to classify matter as a pure substance, mixture, element, and/or compound. I will be able to identify heterogeneous and homogeneous mixtures.

- Vocabulary:

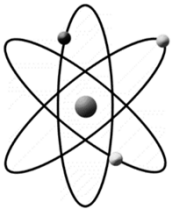
Matter	Pure Substance	Mixture	Element	Atom
Compound	Molecule	Homogeneous	Heterogeneous	Formula

1.4 Classifying Matter I

- Matter is anything that has mass and takes up space.
- Each specific substance has its own combinations of properties that can be used to identify the substance.
- Types of matter:
  - Element
  - Compound
  - Pure Substance
  - Mixture



1.4 Classifying Matter I



- An element is a substance that cannot be broken down into any substances by chemical or physical means.
  - Building blocks of matter
  - Atoms are the smallest particle of an element.
  - Some elements exist in molecules (two or more bonded atoms).
  - Each element has its own symbol (one or two letters).

He	Be	O
Helium	Beryllium	Oxygen

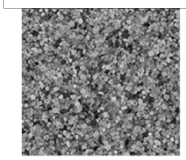
1.4 Classifying Matter I

- A compound is a substance made of two or more elements chemically bonded in a specific ratio.
  - Represented by a formula, which shows the ratio of elements in the compound.
  - Smallest unit of a compound is a molecule
  - Do not necessarily have the same properties as the elements that are bonded.

Silicon

Oxygen

Silicon dioxide



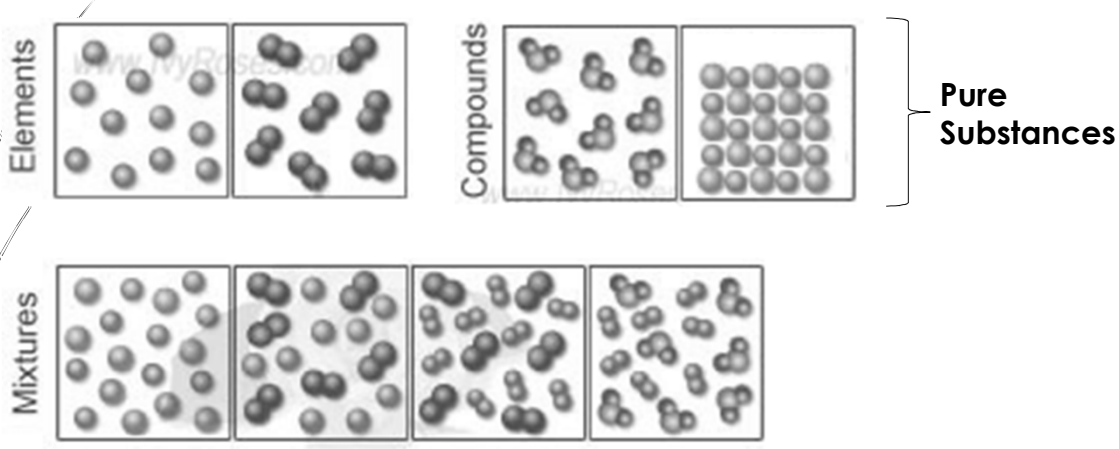
1.4 Classifying Matter I

- A pure substance is a substance made of only one kind of matter and having definite properties.
  - A single element is a pure substance
  - A single compound is also a pure substance because the atoms are bonded together.

- A mixture is made from two or more substance that are together in the same place but are not chemically combined into a new substance.
  - Homogeneous mixture is a well-blended mixture. Every sample is the same.
  - Heterogeneous mixture is not a well-blended mixture. Samples may vary.

1.4 Classifying Matter I

- Particle Diagrams of Matter



1.5 Classifying Matter II

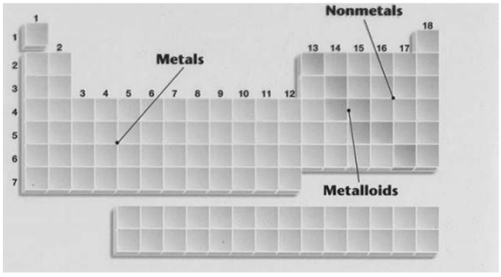
- Objective:
  - I will be able to identify a substance as a metal, nonmetal, or metalloid based on its properties.

- Vocabulary:

Metal	Nonmetal	Metalloid	Conductor	Luster
Malleable	Ductile	Brittle	Semiconductor	Corrosion
Alloy	Diatomic Molecules			

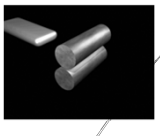
1.5 Classifying Matter II

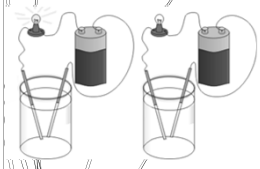
- Elements are classified as metals, metalloids, and nonmetals.



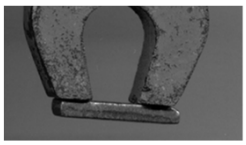
- Most elements are metals.
- Metals are good conductors of heat and electricity.
- Other properties:
  - Malleability
  - Ductility
  - Luster
  - Conductivity
  - Magnetism
  - High Melting Points

1.5 Classifying Matter II



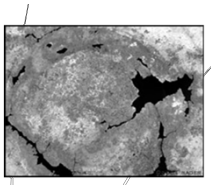


- Malleability is the ability to be pounded into shapes.
- Ductility is the ability to be pulled out, or drawn, into a wire.
- Luster is shininess. 
- Most metals are good conductors, as they transmit heat and electricity easily.
- Many metals, though not all, are magnetic. Iron is an example of a magnetic metal.



- Most metals are solid at room temperature, and require very high temperatures to melt

1.5 Classifying Matter II



- Some metals are highly reactive, like sodium, while others do not react easily, like gold.
- When exposed to oxygen, some metals form metal oxides. These can flake off the metal in a process called corrosion.
- Mixtures of metals are called alloys. Some useful alloys include:
  - Steel (iron, carbon, chromium, and vanadium)
  - Bronze (copper and tin)
  - Brass (copper and zinc

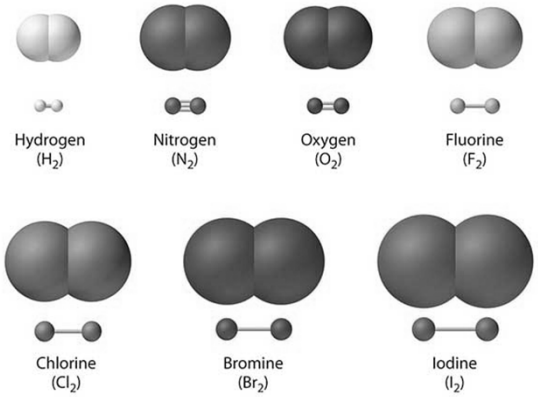
1.5 Classifying Matter II

- Nonmetals have the opposite properties of metals.
  - Most are dull

  - Solid nonmetals are brittle, meaning they break easily on impact
  - Lower densities
  - Poor conductors of heat an electricity
  - Some nonmetals do not react at all, while others form compounds.
  - Many nonmetals are gasses are room temperature

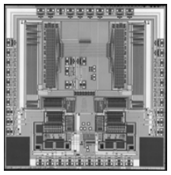
1.5 Classifying Matter II

- Seven of the nonmetals exist as diatomic molecules in nature (two atoms bonded in a molecule)



1.5 Classifying Matter II

- Metalloids have some characteristics of metals and some of nonmetals.
  - The most common metalloid is silicon
  - Metalloids are often semiconductors, meaning that they may or may not conduct electricity based on environment
    - Most useful property!!
    - Good for computer chips and lasers.



1.6 Classifying Matter III

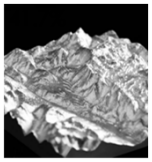
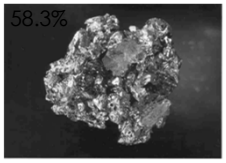
- Objective:
  - I will be able to be able to identify a mixture as a solution, colloid, or suspension. I will understand how solutions are made and how mixtures are separated.

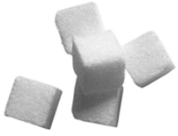
- Vocabulary:

Solution	Colloid	Suspension	Solute	Solvent
Solubility	Solubility Curve	Diffusion	Decanting	Precipitation
Diluted	Concentrated	Tyndall Effect		

1.6 Classifying Matter III

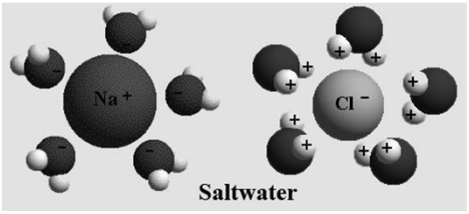
- A solution is a homogeneous mixture with particles between 0.01-1nm.
  - The particles in a solution do not precipitate or filter out.
  - Composed of two parts:
    - Solvent – substance present in the solution in the largest amount
    - Solute(s) – substance present in solution in smaller amount; dissolved by the solvent



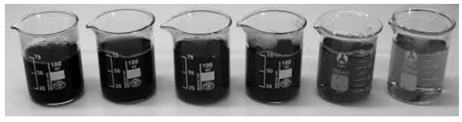
1.6 Classifying Matter III

- The particles of the solute become surrounded by the particles of the solvent in solution.
- Water is a very common solvent; it is sometimes referred to as the "universal solvent."
- There are many solutions made without using water.
  - Ex: Air, dental filling, brass
- Dissolving a substance can increase its conductivity, such as for table salt.



1.6 Classifying Matter III

- Solutions have strengths
  - Dilute solution is a mixture that has only a little solute dissolved in it.
  - Concentrated solution is a mixture that has a lot of solute dissolved in it



- Concentration can be altered by adding more solute or solvent to a solution.
  - More solvent dilutes the solution
  - More solute concentrates the solution

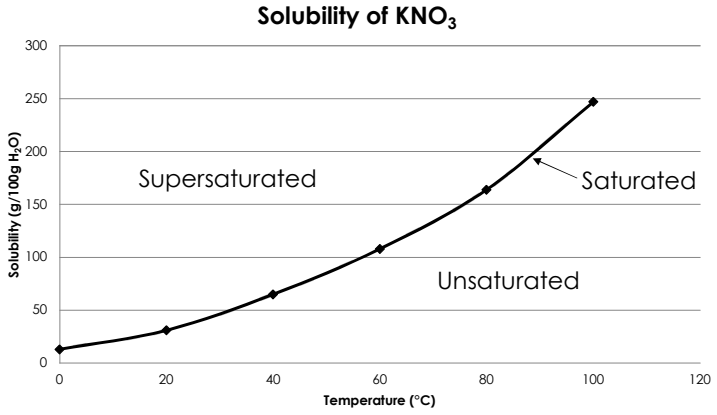
1.6 Classifying Matter III

- Solubility is how much of a solute can be dissolved in a certain amount of solvent at a given temperature
  - Unsaturated solution has less solute than it can dissolve at a given temperature
  - Saturated solution has as much solute as it can dissolve at a given temperature
  - Supersaturated solution has more solute than is predicted by its solubility at the given temperature
- Do not confuse this with concentration!

1.6 Classifying Matter III

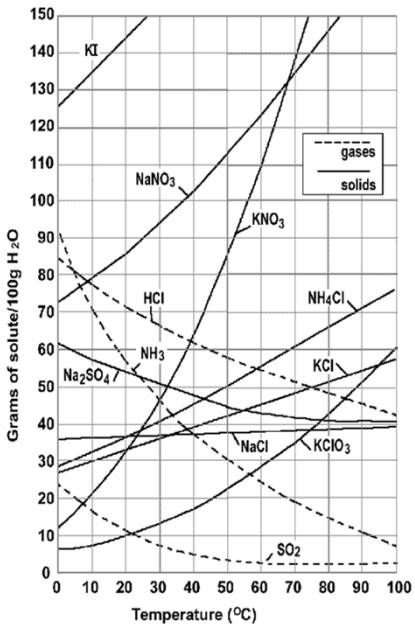
- For a solution, a solubility curve shows how much solute can be dissolved in a given amount of solvent at a specific temperature.

Temperature (°C)	Solubility (g/100g water)
0	13
20	31
40	65
60	108
80	164
100	247



1.6 Classifying Matter III

- Practice
  - What is the general trend for the solubility of solids as temperature increases?
  - What is the solubility of $KClO_3$ at 20°C in 100g of water?
  - At what temperature will 85g of $NaNO_3$ dissolve in 100g of water?



1.6 Classifying Matter III

- Colloids
  - Mixture with small, undissolved particles that do not settle out
  - Heterogeneous mixture; particle size 1nm-1000nm
  - Examples: Jell-o, whipped cream, mayonnaise, shaving cream
  - Cannot be separated by filtration
  - Particles scatter light (ex: headlight in fog) – called the Tyndall effect

1.6 Classifying Matter III

- Suspensions
  - Mixture in which particles can be seen and easily separated by settling or filtration
  - Heterogeneous; particle size over 1000nm
  - Can be separated by filtration
  - May scatter light or be opaque
  - Examples: mud, pepper in water

1.6 Classifying Matter III

- Quick Comparison

Properties of Solutions, Colloids, and Suspensions

Solutions	Colloids	Suspensions
Homogeneous	Heterogeneous	Heterogeneous
Particle size: 0.01-1 nm; atoms, ions, or molecules	Particle size: 1-1000 nm, dispersed; large molecules or aggregates	Particle size: over 1000 nm, suspended; large particles or aggregates
Do not separate on standing	Do not separate on standing	Particles settle out
Cannot be separated by filtration	Cannot be separated by filtration	Can be separated by filtration
Do not scatter light	Scatter light (Tyndall effect)	May either scatter light or be opaque