UNIT 1

Matter

OBJECTIVES:

- Define Chemistry
- Apply Steps of Scientific Method
- Be able to classify types matter
- Understand and classify the properties and changes that matter can undergo

WHAT IS CHEMISTRY?

- Known as the *central science*
- Deals with studying and analyzing the materials of the universe and the changes that these materials undergo.
- The study of mater, it's properties and the changes it can undergo

OBSERVATIONS

- Qualitative: descriptive observation that is *not numerical*.
  - Example: This apple is red.

- Quantitative: Numerical observation.
  - Example: The temperature of this room is 23°C.

LAWS, HYPOTHESES, & THEORIES

- Scientific Laws summarize facts, but do not make any attempt to explain the facts.
  - Example: Law of Conservation of Mass states that *matter can neither be created nor destroyed*.
- A Hypothesis is a tentative, reasonable explanation of the facts or the laws.
- Scientific Theory is a hypothesis that has withstood extensive testing and is known to be true.

TWO TYPES OF VARIABLES IN EXPERIMENTS

- **Independent Variable**

  is the variable which is changed or manipulated by the investigator.

- **Dependent Variable**

  is the variable which is influenced by changes in the independent variable.

IDENTIFY THE VARIABLES:

- Cindy wanted to see if a plant grew taller if instead of water she gave it coke.

Independent variable:

Dependent variable:

Control Group:

Shows the normal state of affairs, so as to allow a comparison with the experiment results, and to help ascertain that the results obtained were due to the factor changed not any other reason

- **In the experiment prior what factors should Cindy be sure are the same?**

MATTER

- Anything that has mass and takes up space.
  - Mass = measure of the amount of matter present.
  - Weight = force of gravity upon on object's mass.
    - Even though the definitions are *technically* different, these two terms are used interchangeably.
  - **Units typically used in science are grams and kilograms.**
    - 1 kilogram = 1000 grams
- State – the form of matter in a sample.
- Phase– the number of layers present in a sample

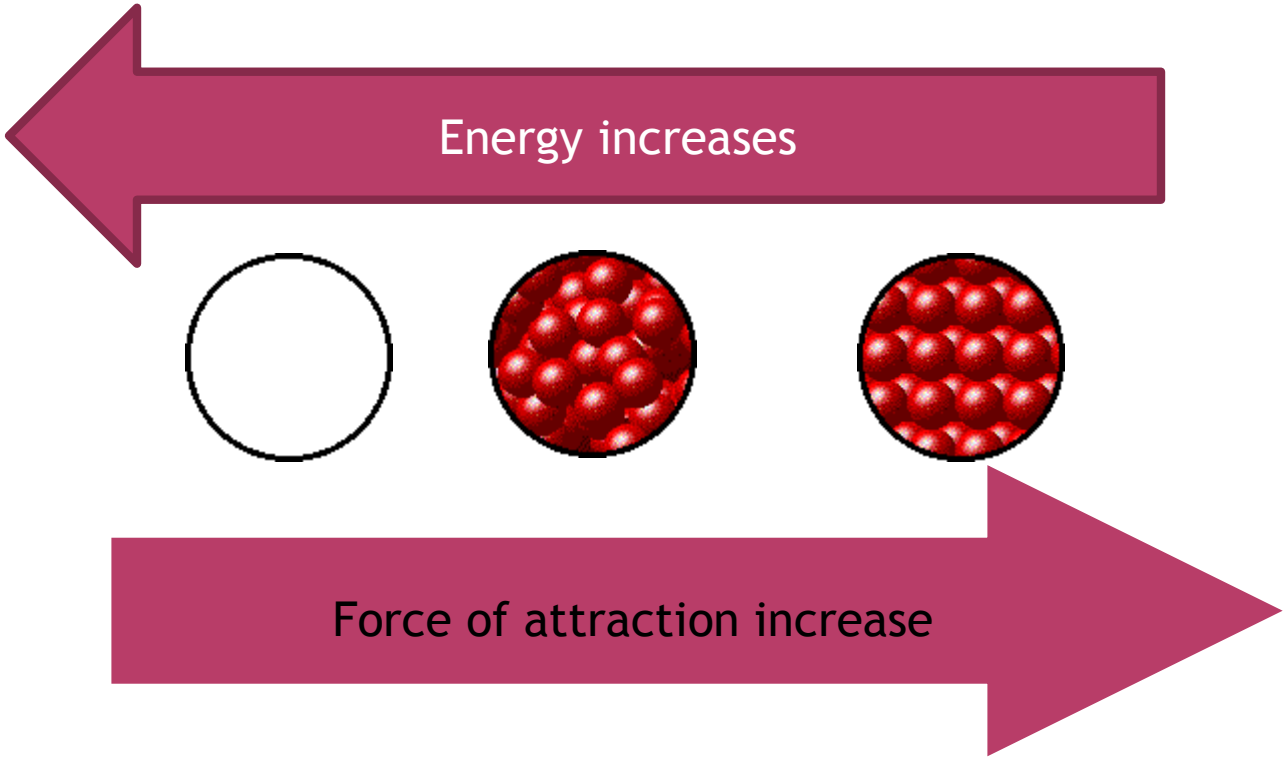
STATES OF MATTER

The **Kinetic Molecular Theory**

- All matter is made of atom and molecules that act as tiny particles
- These particles are always in motion (yes even in solids)
- The higher the temperature the faster the particles move-
- Kinetic energy is directly proportional to Kelvin Temperature (bigger particles move slower)

STATES OF MATTER

- Difference between solids, liquids, & gases are the attractive forces amongst the particles and their energy.



Solids

- Have a definite shape
- Have a definite volume

Kinetic Molecular Theory

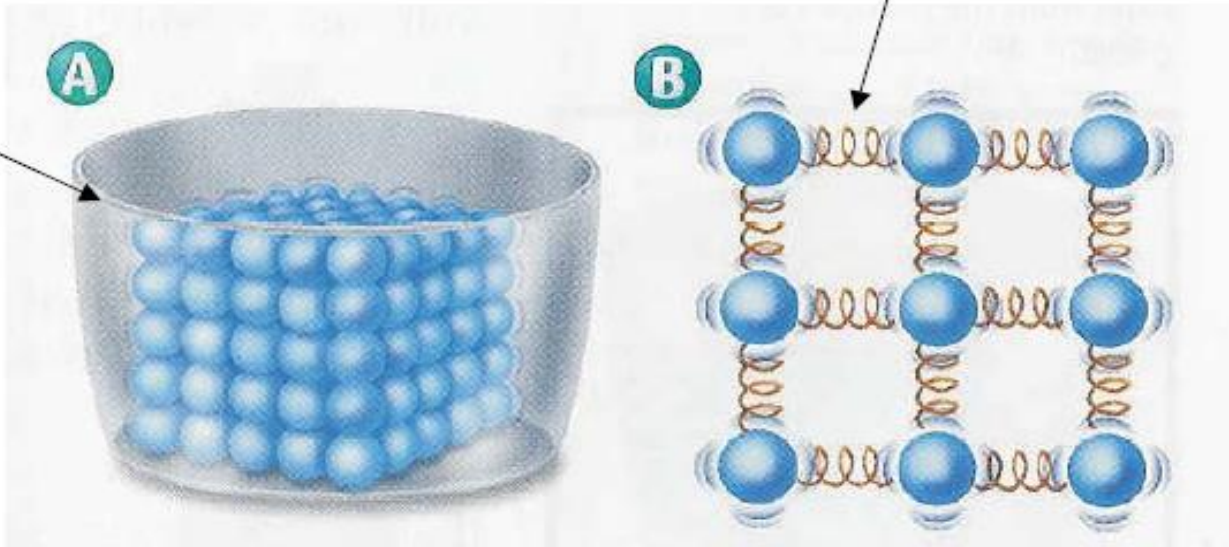
Molecules are held close together and there is very little movement between them. Vibrational motion.
HIGH attraction between particles

The 1st of the 4 States of Matter

Solid- has a definite volume and a definite shape.

A solid does not take the shape of its container.

Particles vibrate back and forth in a solid.



Liquids

- Have an indefinite shape
- Have a definite volume

Kinetic Molecular Theory:

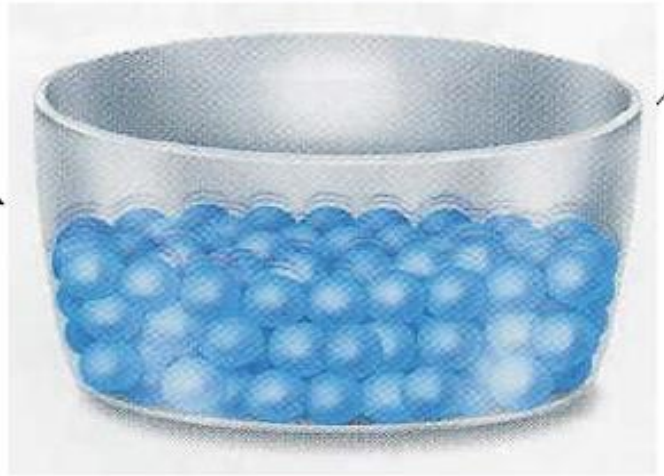
Atoms and molecules have more space between them than a solid does, but less than a gas (ie. It is more "fluid".) Has 2 dimensional motion- can slide past each other- small attraction between particles

The 2nd State of Matter

Liquid- has a definite volume, not a definite shape.

Particles in a liquid move around each other freely.

A liquid takes the shape of its container



Gases

- Have an indefinite shape
- Have an indefinite volume

Kinetic Molecular Theory:

Molecules are moving in random patterns with varying amounts of distance between the particles.

VERY LITTLE attraction between particles

The 3rd State of Matter

Gas- has no definite volume, or a definite shape.

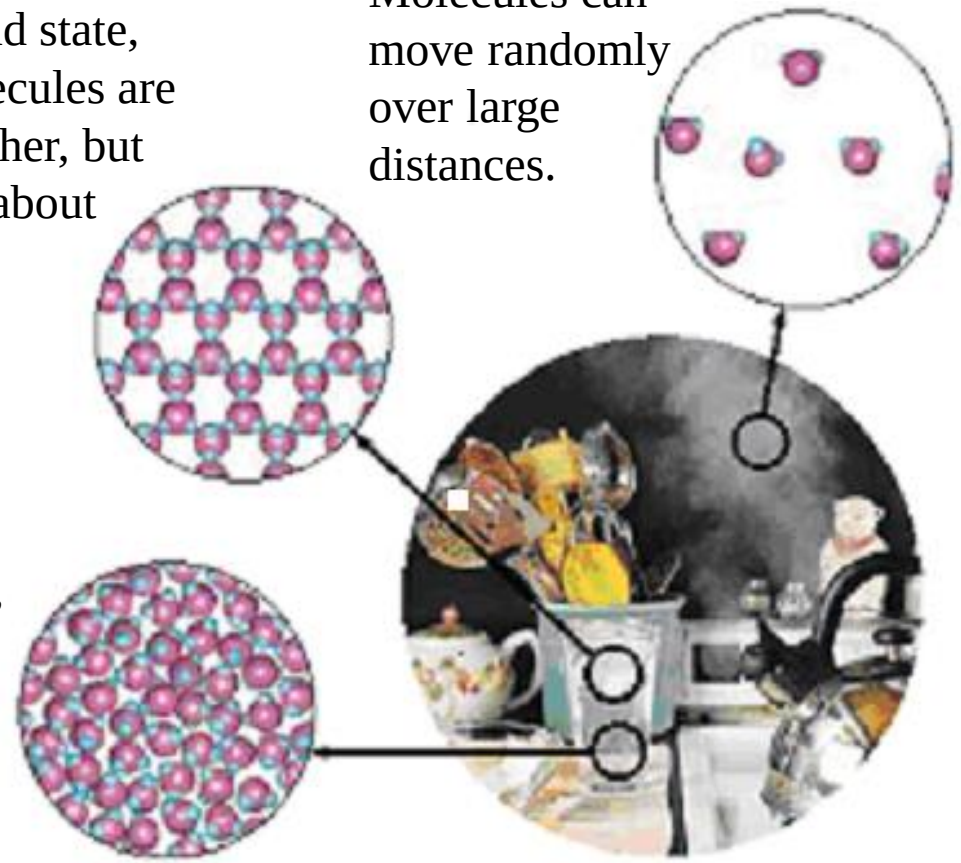
Particles have high energy

The particles in a gas bounce off one another.

Kinetic Molecular Model of Water

At 100°C, water becomes water vapor, a gas. Molecules can move randomly over large distances.

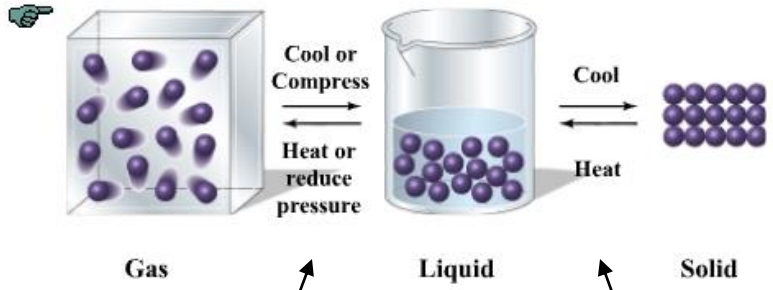
Between 0°C and 100 °C, water is a liquid. In the liquid state, water molecules are close together, but can move about freely.



Below 0°C, water solidifies to become ice. In the solid state, water molecules are held together in a rigid structure.

Changing States

Changing states requires energy in either the form of heat. Changing states may also be due to the change in pressure in a system.



Heat of formation, H_f.

Heat of vaporization, H

Plasma

Plasma is by far the most common form of matter in the universe (not here on Earth). Plasma in the stars and in the tenuous space between them makes up over 99% of the visible universe and perhaps most of that which is not visible. Fluorescent Light Bulbs…

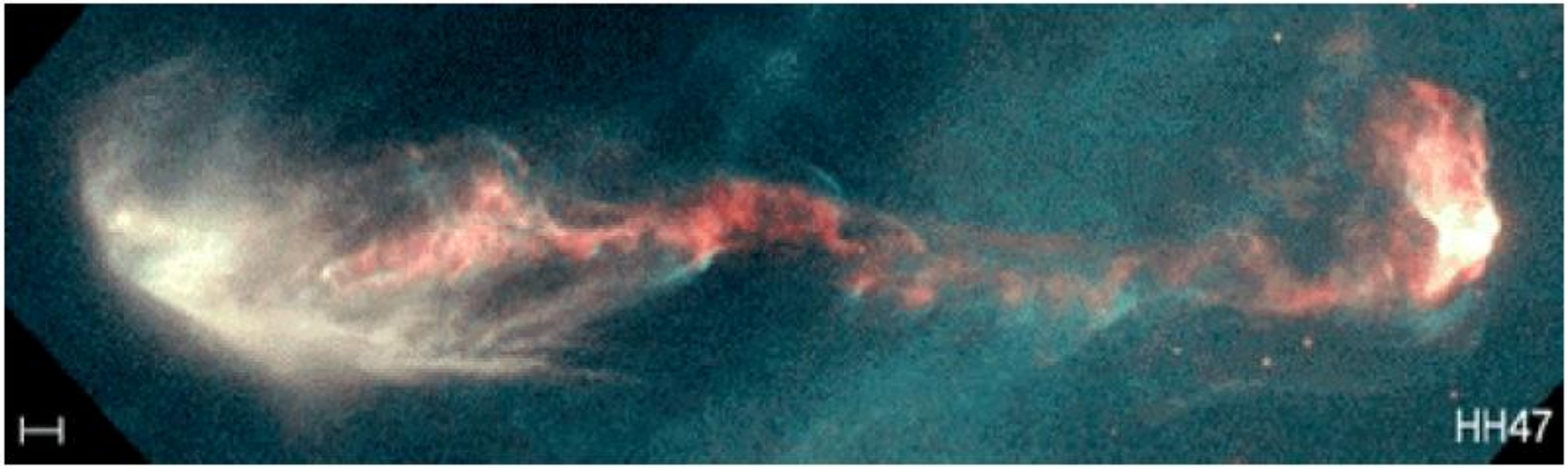
The 4th State of Matter

Plasma- It is estimated that 99% of the matter in the observable universe is plasma.

Plasmas consist of freely moving charged particles.

Formed at high temperatures when electrons are stripped from neutral atoms.

Plasmas are common in nature



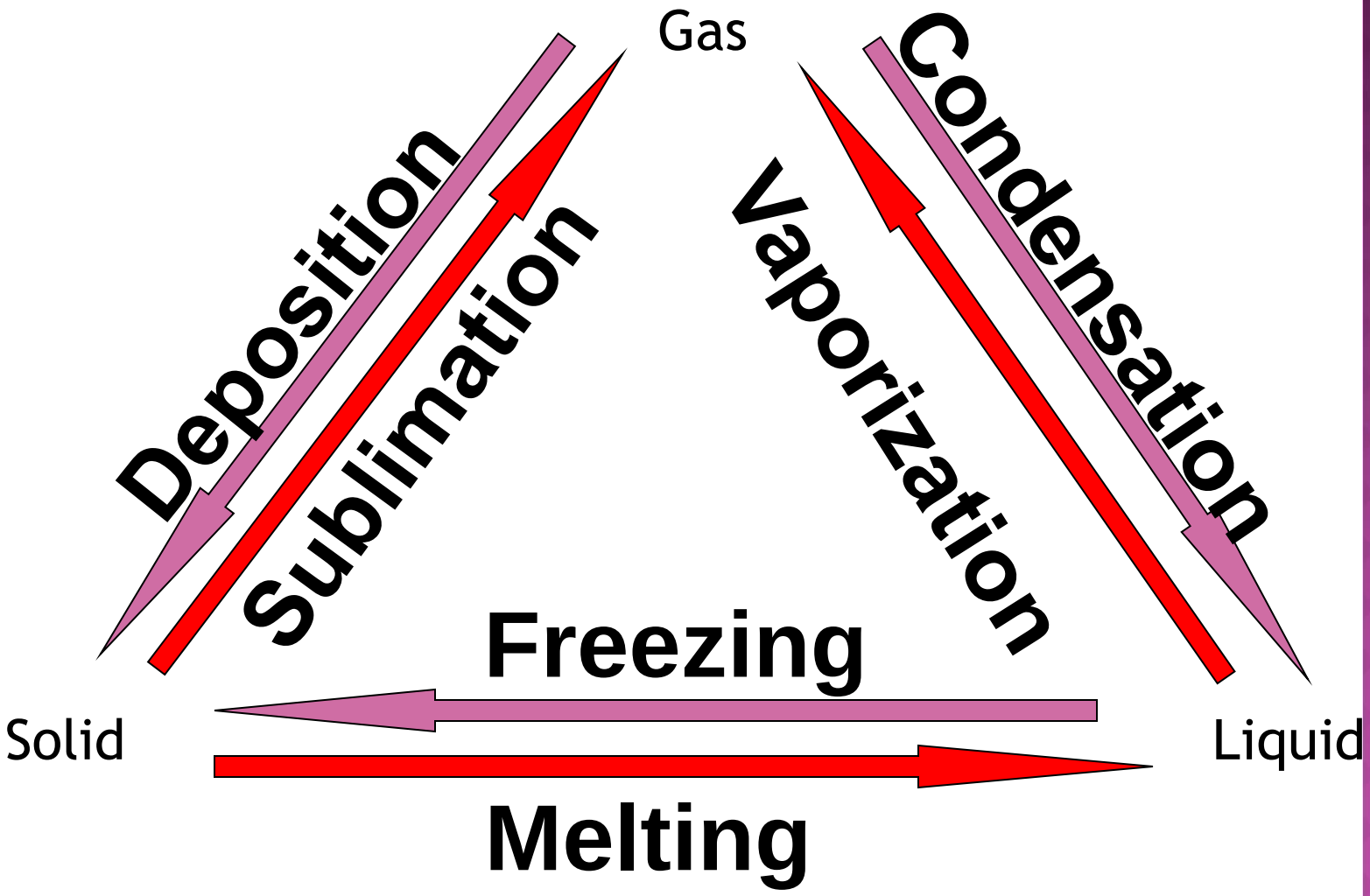
PROPERTIES OF SOLIDS, LIQUIDS, & GASES

State	Shape	Volume	Compressibility	Microscopic Properties
Solid	Definite	Definite	Negligible	Particles touching & tightly packed in rigid arrays.
Liquid	Indefinite	Definite	Very Little	Particles touching but mobile.
Gas	Indefinite	Indefinite	High	Particles far apart and independent of one another.

Types of Phase Changes

Red = Endothermic, Take in heat

Purple = Exothermic, Release heat



NAMES OF WATER PHASE CHANGES

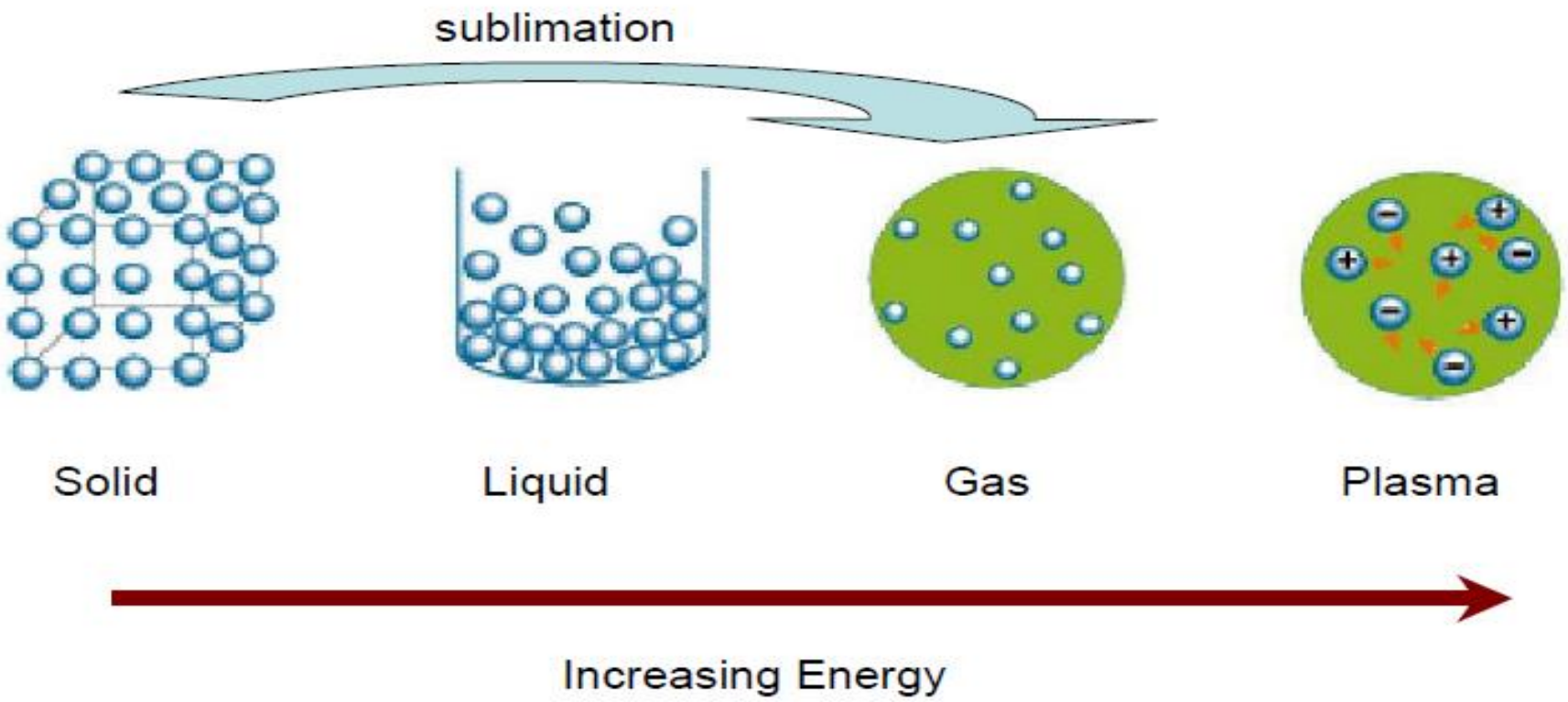
Endothermic Requires Energy to go forward

- Melting: Solid→ Liq
- Boiling (forced) Liquid→ Gas
- Evaporation (spon) Liquid→ Gas
- Sublimation Solid→ Gas

Exothermic Gives energy off

- Condensation Gas→ Liq
- Freezing: Liq→ Solid
- Deposition: Gas→ Solid

Quick Review

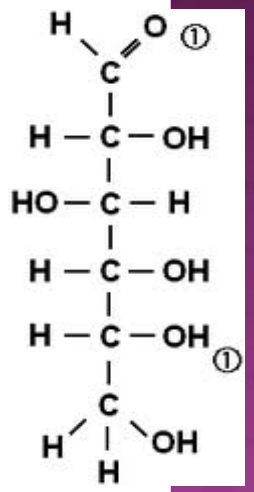


CLASSIFYING MATTER

- Elements: most fundamental substance from which all substances are constructed.
- Elements are pure substances.
- Atoms: smallest particle that retains the properties of the element.
  - Atoms of a particular element cannot be broken into simpler atoms.

COMPOUNDS

- Compounds: pure substances that are made up of 2 or more different elements; combine in fixed proportions.
  - Example: Glucose = $C_6H_{12}O_6$
  - Sodium chloride = NaCl



  - Each compound has a specific atom ratio and a specific percentage by mass for each element in the compound.
    - Known as the Law of Definite Composition or Law of Definite Proportions.

COMPOSITION OF SOME COMMON COMPOUNDS

Name of Compound	Formula	Comparison of Properties
Ammonia	NH_3	Nitrogen and hydrogen are odorless gases but ammonia has a strong odor.
Ethyl Alcohol (Ethanol)	C_2H_5OH	Carbon can be a black solid and hydrogen and oxygen are colorless gases. Ethyl alcohol is a colorless, flammable liquid.
Hydrogen Sulfide	H_2S	Hydrogen is a colorless, odorless gas. Sulfur is a pale yellow solid. Hydrogen sulfide is a colorless gas that smells like rotten eggs.

MIXTURES

- Combinations of two or more substances that can be varied in proportions but are not combined chemically together.
- Heterogeneous mixtures do not have the same composition or properties throughout.
- Homogeneous mixtures have the same composition and properties throughout.
  - Solutions are homogeneous mixtures.

COMMON SOLUTIONS (HOMOGENEOUS MIXTURES)

Solution	Composition
Gaseous Solutions	
Natural Gas	Methane & small amounts of other gas
Air	78% nitrogen, 20.9% oxygen, 0.9% argon, and traces of carbon dioxide & other gases
Liquid Solutions	
Rubbing Alcohol	70% isopropyl alcohol & 30% water
Solid Solutions	
Brass	70% copper & 30% zinc
Stainless Steel	18% chromium, 8% nickel, 0.2% carbon & 73.8% iron
Sterling Silver	92.5% silver & 7.5% copper
14K Yellow Gold	58% gold, 24% silver, 17% copper & 1% zinc
10K Yellow Gold	42% gold, 12% silver, 40% copper & 6% zinc

EXAMPLE

- Classify the following as heterogeneous or homogeneous.
  a) Gasoline
  b) Wood
  c) Brass
  d) Pizza

ADDING LIQUIDS TOGETHER

- Miscible- will mix- water and alcohol

Homogeneous Mixture

- Immiscible- wont mix

  water and oil

Heterogeneous Mixture

What are solutions?

Solutions are homogenous mixtures that do not scatter light. These mixtures are created when something is completely dissolved in pure water. Therefore, they are easily separated by distillation or evaporation. Appear in one phase of matter

Examples: sugar water, salt water

PARTS OF A SOLUTION

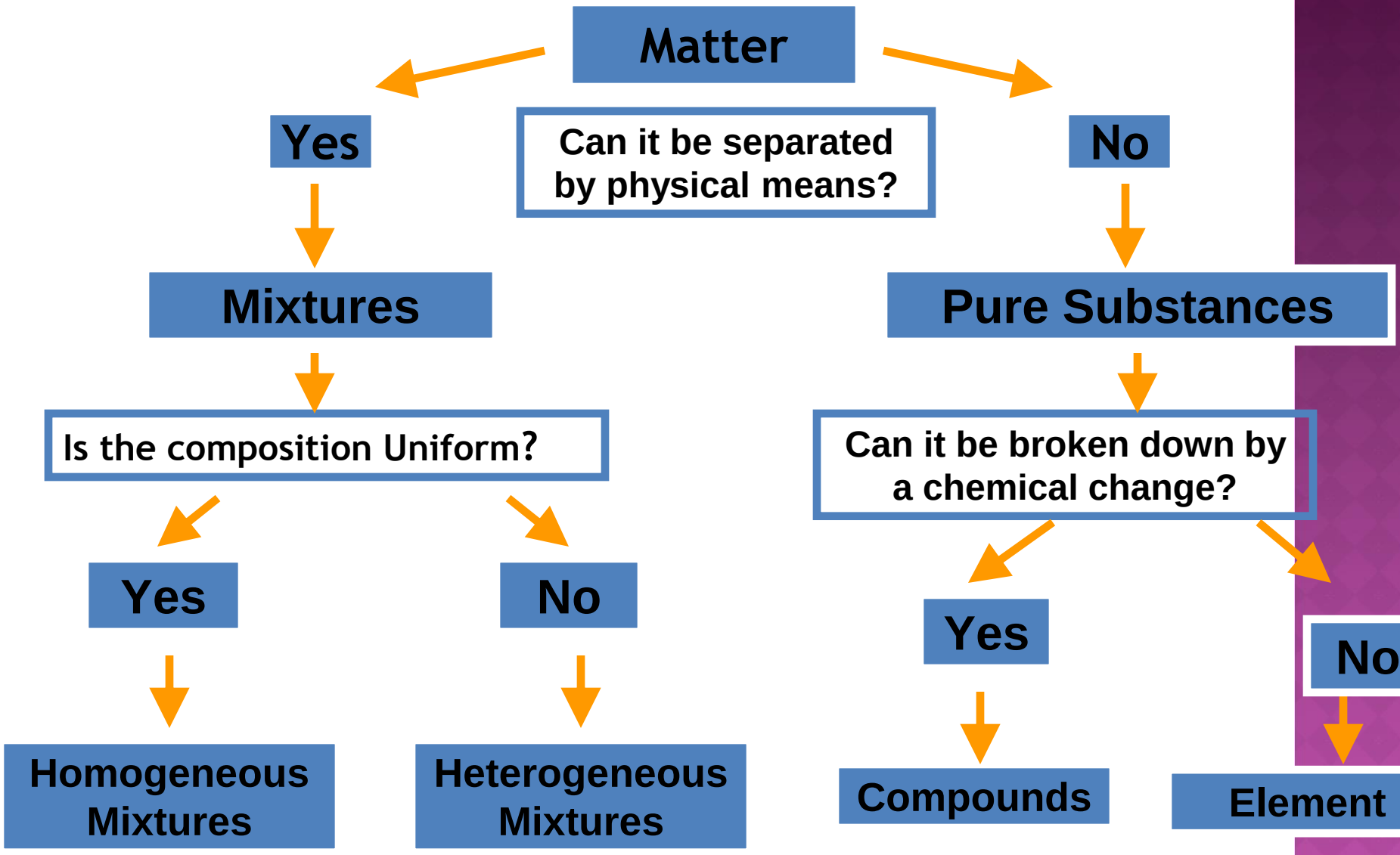
- Solvent- part that does the dissolving- water is our universal solvent
- Solute- part that was dissolved (salt)

How do we increase solubility of a solid into a liquid

- Heat it- more collisions between solute and solvent
- Mix- Fresh solvent to solute
- Crush- more surface area- more contact

INCREASE SOLUBILITY OF A GAS IN A LIQUID

- Henrys Law- solubility of the gasis directly proportional to the pressure above the liquid-
- Effervescence- rapid escape of gas from liquid
- Decrease temperature- slows down diffusion


Matter
Can it be separated by physical means?
Yes
No
Mixtures
Pure Substances
Is the composition Uniform?
Can it be broken down by a chemical change?
Yes
No
Yes
No
Homogeneous Mixtures
Heterogeneous Mixtures
Compounds
Element

PHYSICAL & CHEMICAL PROPERTIES

- Characteristic properties can be used to identify or characterize a substance – and distinguish that substance from other substances.
  - **Physical Properties**: identify the substance without causing a change in the composition of the substance.
    - Color, odor, density, melting/boiling points, hardness, luster, ductility, malleability, and viscosity.
  - **Chemical Properties**: properties that relate to the change in the composition a substance to how it reacts with other substances.
    - Tendency to react with other substances, to tarnish, to corrode, to explode, or act as a poison.

MORE ON PROPERTIES

- **Intensive Properties** *are not* dependent on the amount of matter present.
- Depend on what is **In**side
  - Density, boiling point, color
- **Extensive Properties** *are* dependent on the amount of matter present.
- Depend on how far they **EX**tend
  - Mass, volume, length

PHYSICAL & CHEMICAL CHANGES

- **Physical changes** *do not* change to the composition of the substance.
  - Typically involve phase changes.
- In any **Chemical change**, one or more substances are used up while one or more new substances are formed. This means that the composition of the original substance has changed.
  - Chemical reactions are chemical changes.

INDICATIONS OF A CHEMICAL REACTION

- Bubbles- gas given off
- Change in energy-
  - becomes warm- exothermic
  - becomes cool- endothermic
  - light is given off
- A precipitate (solid) forms
- Sometimes a change in color

EXAMPLE

- Classify the following as a physical property, chemical property, physical change, or chemical change.
  a) Alcohol is flammable.
  b) Alcohol is volatile; it evaporates readily.
  c) A sample of table salt dissolves in a glass of water.
  d) Over time, a flashlight battery loses its charge.

CHARACTERISTICS OF CHEMICAL CHANGES

- Reaction with acids
- Reaction with bases (alkalis)
- Reaction with oxygen (combustion)
- Ability to act as oxidizing agent
- Ability to act as reducing agent
- Reaction with other elements
- Decomposition into simpler substances
- Corrosion

ELEMENTS

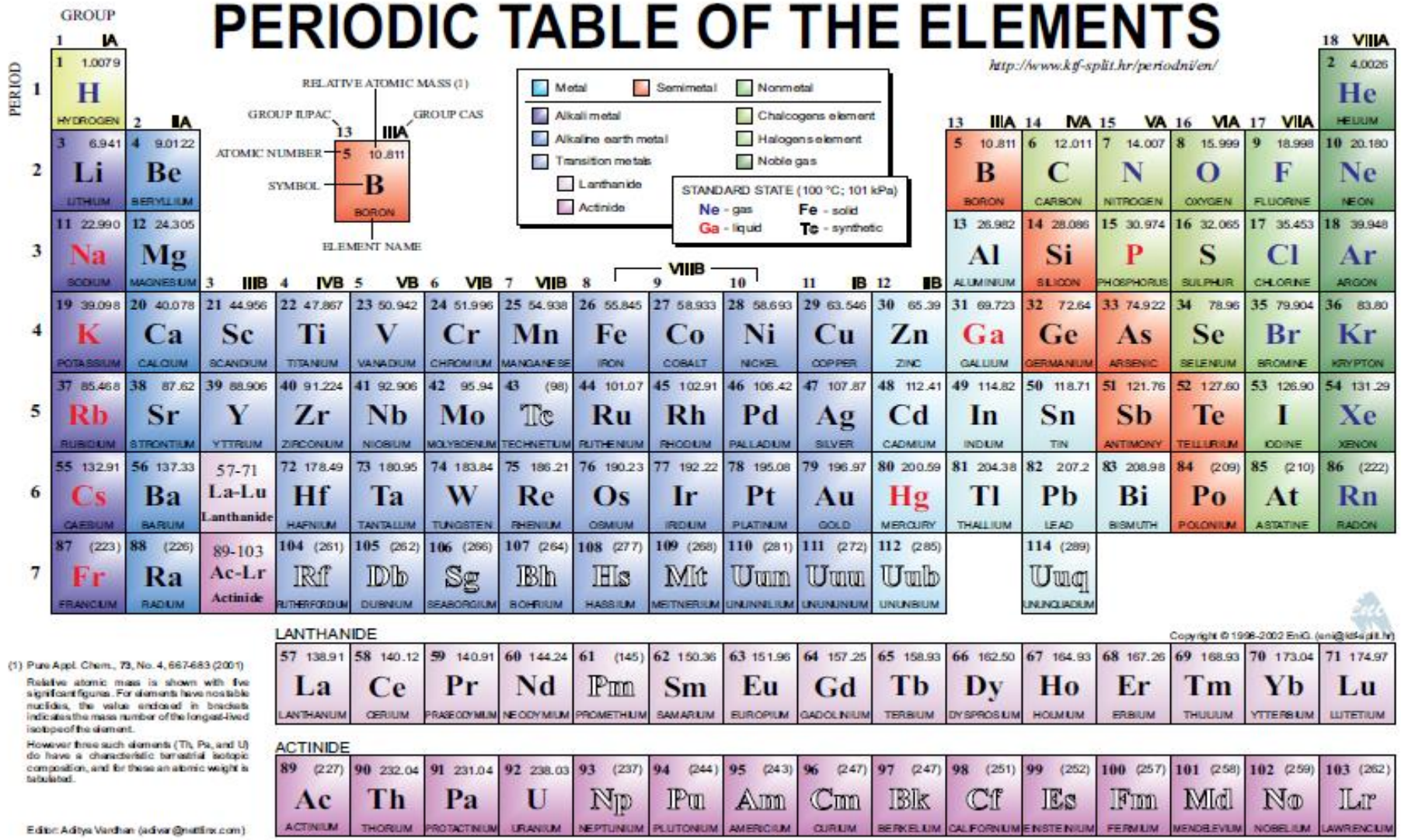
- Give name of elements given their chemical symbols.
- Be able to write the symbols given an elements name.
- Describe the Class arrangements of the periodic table.
- List characteristics/properties that distinguish, metals, nonmetals and metalloids.

ELEMENTS

- Elements: are pure substances that cannot be decomposed by chemical changes.
- *Building blocks of all matter.*

- Each element has characteristic properties.

- Scientist came up with a way to organize the elements based on these characteristics.
- *The Periodic Table*


PERIODIC TABLE OF THE ELEMENTS
http://www.kgf-split.hr/periodni/en/
GROUP
PERIOD
RELATIVE ATOMIC MASS (1)
GROUP IUPAC
GROUP CAS
ATOMIC NUMBER
SYMBOL
ELEMENT NAME
Metal
Semimetal
Nonmetal
Alkali metal
Alkaline earth metal
Transition metals
Lanthanide
Actinide
Chalcogens element
Halogens element
Noble gas
STANDARD STATE (100 °C; 101 kPa)
Ne - gas
Ga - liquid
Fe - solid
Tc - synthetic
LANTHANIDE
ACTINIDE
(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)
Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.
However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.
Editor: Aditya Vardhan (adivar@netflirx.com)
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PERIODIC TABLE

- Groups: Vertical columns all have similar chemical properties.
- Periods: Horizontal rows properties change regularly across periods.

- **Elements that are close together in a period tend to be more similar than one that are far apart.**

METALS VS. NONMETALS

- **Metals:** Good conductors of heat and electricity. Malleable, Ductile, and have a metallic luster

  Tend to be Solids at room temperatures.

- **Nonmetals:** Poor conductors of heat and electricity.

  Many nonmetals are Gases

- **Metalloids:** Share characteristics from both metals and non-metals.

  All Metalloids are solids at room temp.

  They are semiconductors many uses in electronics.