

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 matter, its 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.

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

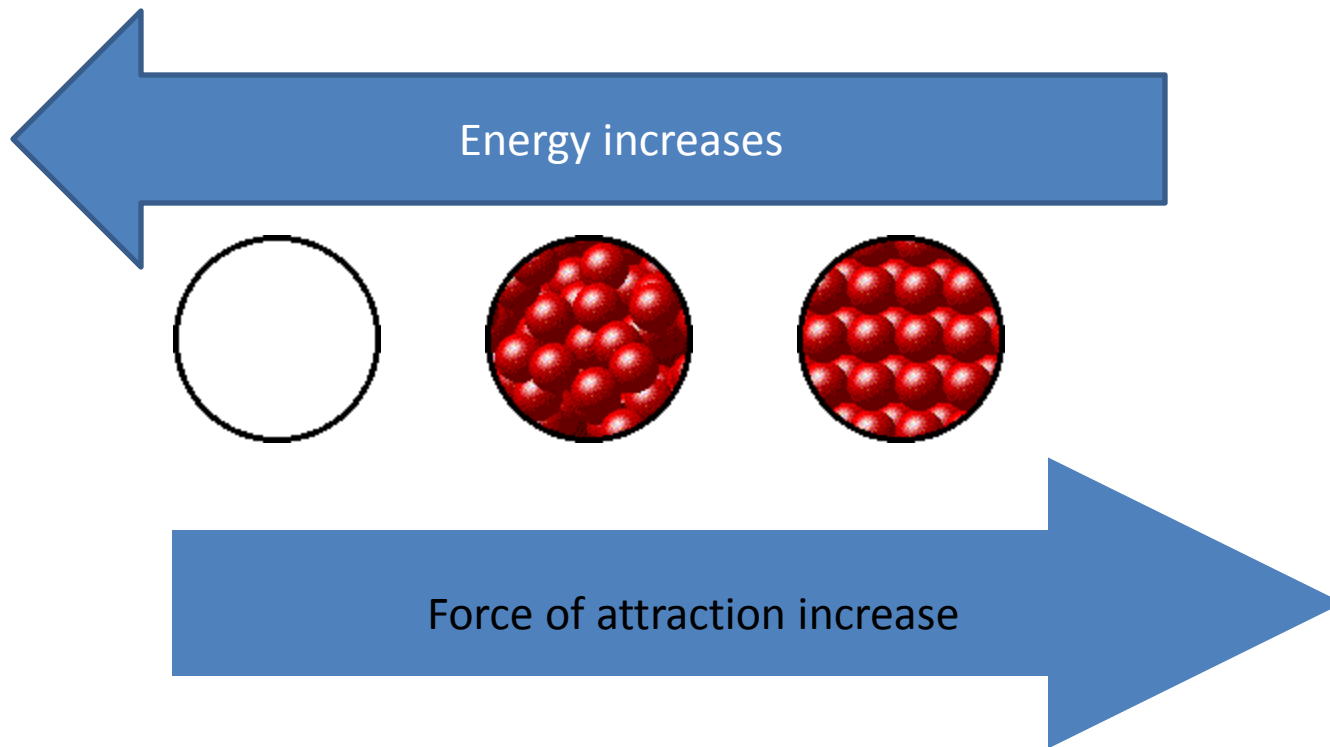
States of Matter

& 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.

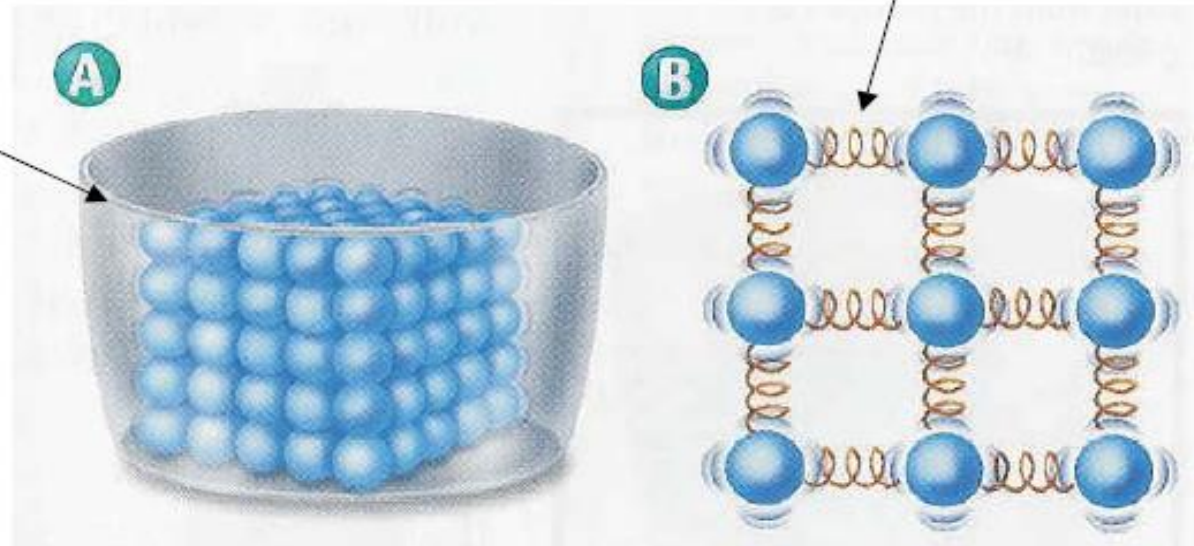


The 1st of the 4 States of Matter

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.

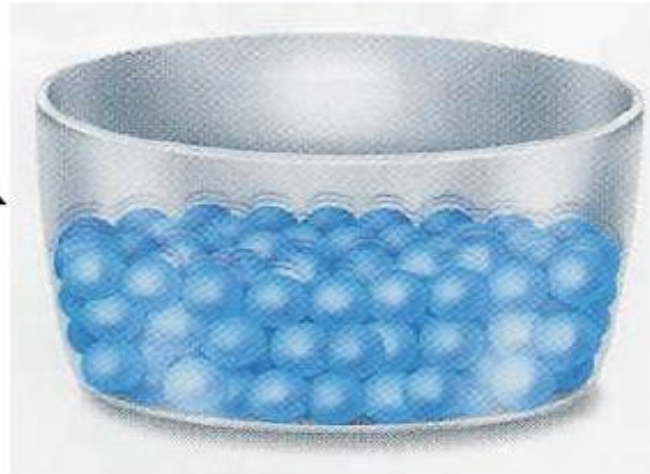


The 2nd State of Matter

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

A liquid takes the shape of its container

Particles in a liquid move around each other freely.



The 3rd State of Matter

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

The particles in a gas
bounce off one
another.

Particles have high
energy



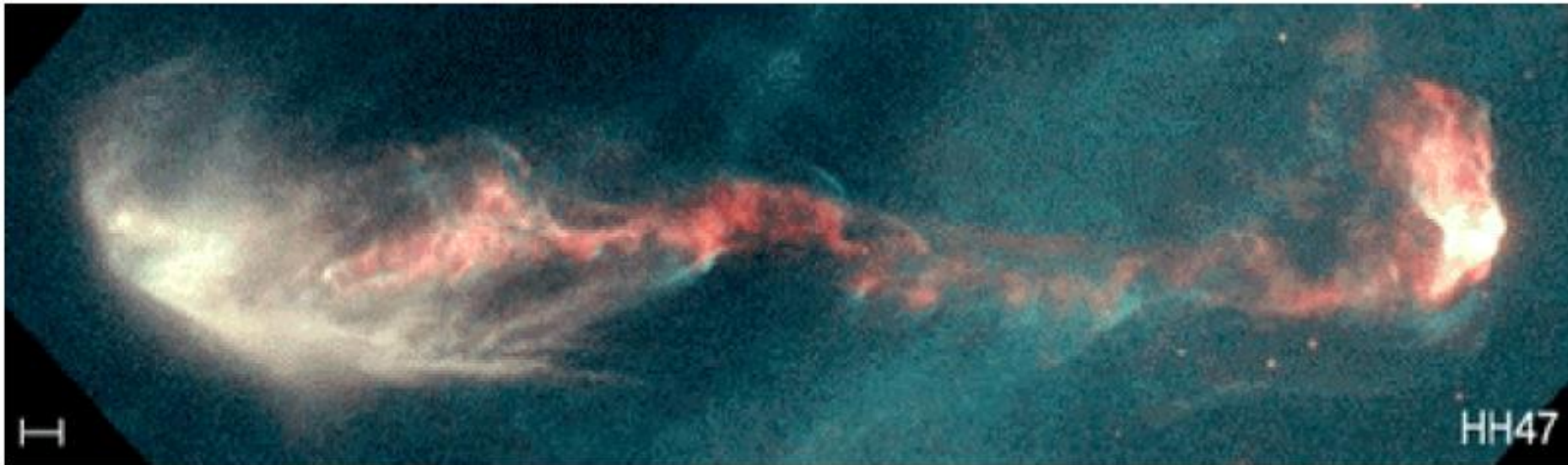
The 4th State of Matter

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



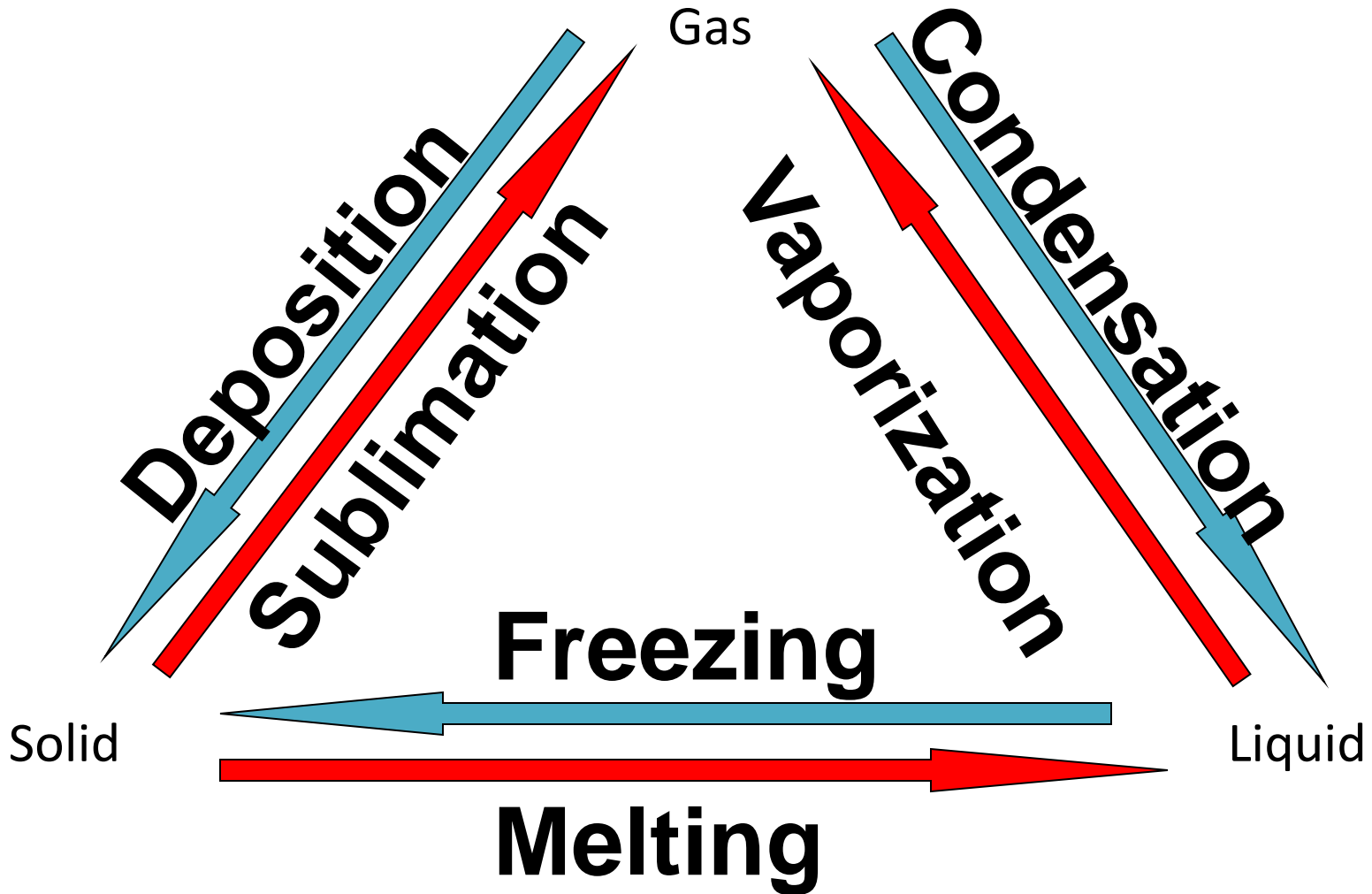
Properties of Solids, Liquids, & Gases

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.

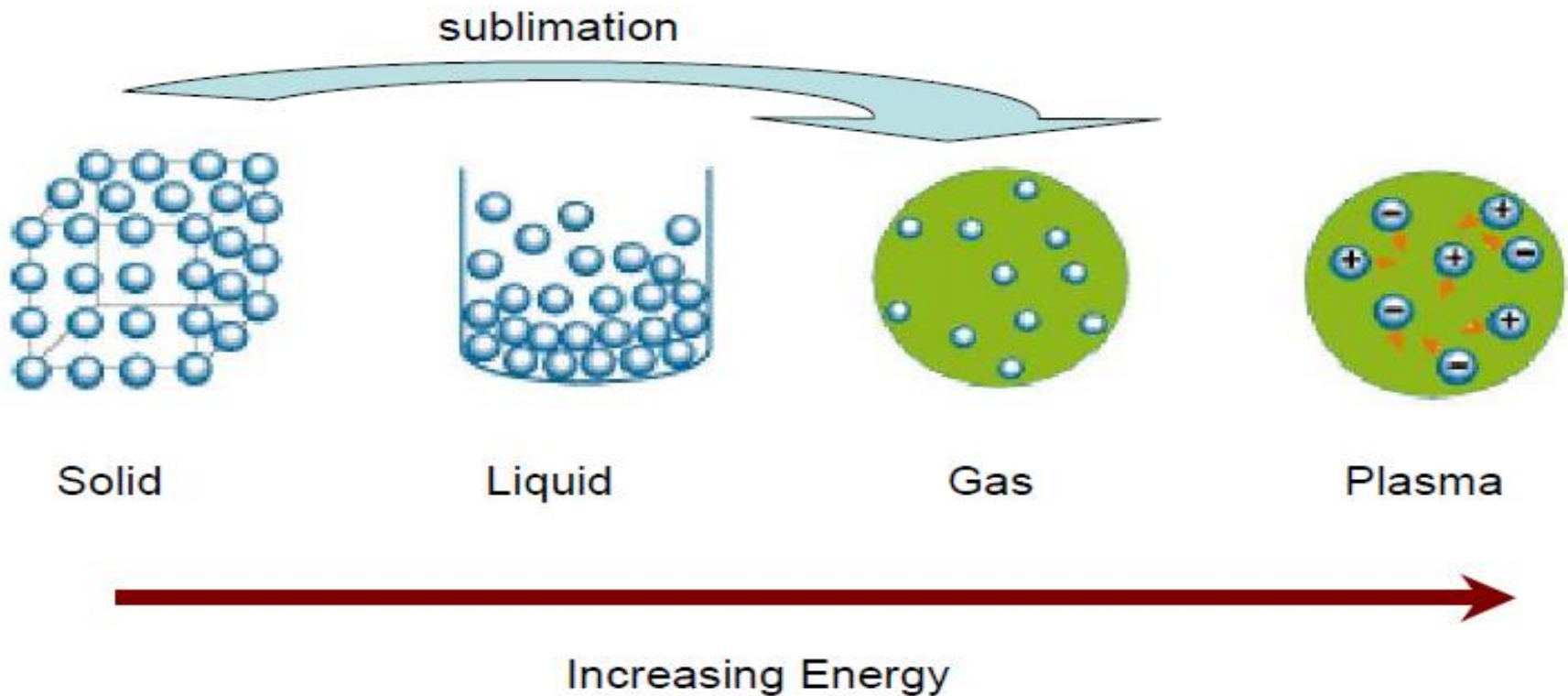
Types of Phase Changes

Red = Endothermic, Take in heat

Blue = Exothermic, Release heat



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.



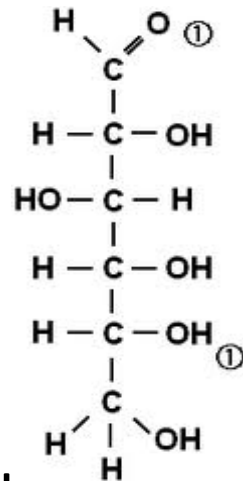
Compounds

- 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)	$\text{C}_2\text{H}_5\text{OH}$	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

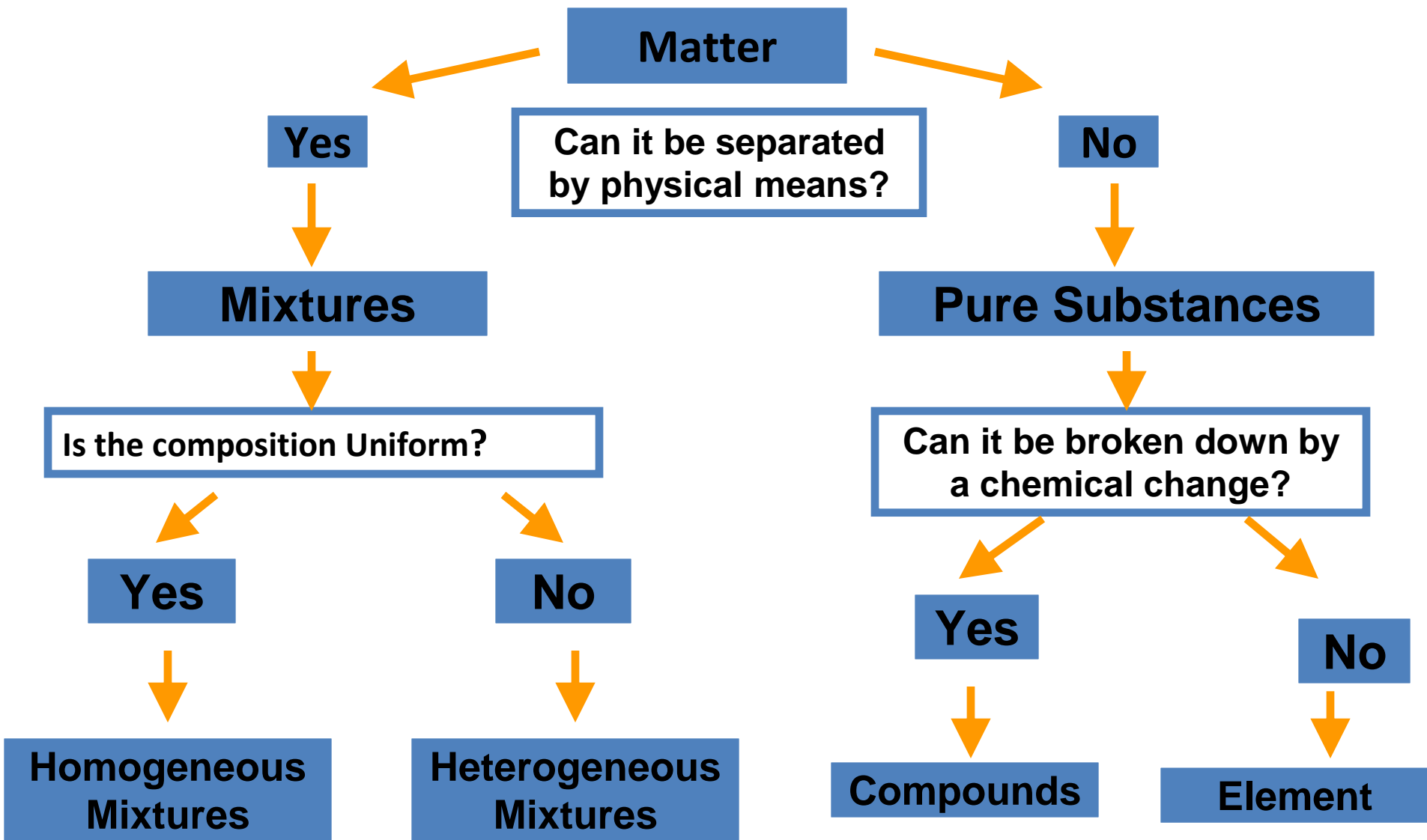
- Combinations of two or more substances that can be varied in proportions but are not combined chemically together.
- Heterogeneous mixtures do not have the same composition or properties throughout.
- Homogeneous mixtures have the same composition and properties throughout.
 - Solutions are homogeneous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

Common Solutions (Homogeneous Mixtures)

Solution	Composition
<i>Gaseous Solutions</i>	
Natural Gas	Methane & small amounts of other gas
Air	78% nitrogen, 20.9% oxygen, 0.9% argon, and traces of carbon dioxide & other gases
<i>Liquid Solutions</i>	
Rubbing Alcohol	70% isopropyl alcohol & 30% water
<i>Solid Solutions</i>	
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



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 **Inside**
 - 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.

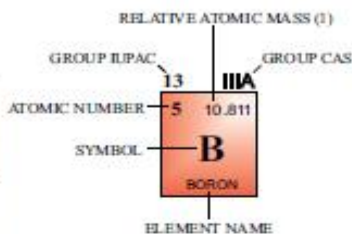
Elements

- 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.kg-split.hr/periodni/en/>

PERIOD	GROUP																		
	1 IA	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA	
1	1 1.0079 H HYDROGEN																	2 4.0026 He HELIUM	
2	3 6.941 Li LITHIUM	4 9.0122 Be BERYLLIUM																10 20.180 Ne NEON	
3	11 22.990 Na SODIUM	12 24.305 Mg MAGNESIUM																18 39.948 Ar ARGON	
4	19 39.098 K POTASSIUM	20 40.078 Ca CALCIUM	21 44.956 Sc SCANDIUM	22 47.867 Ti TITANIUM	23 50.942 V VANADIUM	24 51.996 Cr CHROMIUM	25 54.938 Mn MANGANESE	26 55.845 Fe IRON	27 58.933 Co COBALT	28 58.693 Ni NICKEL	29 63.546 Cu COPPER	30 65.39 Zn ZINC	31 69.723 Ga GALLIUM	32 72.64 Ge GERMANIUM	33 74.922 As ARSENIC	34 78.96 Se SELENIUM	35 79.904 Br BROMINE	36 83.80 Kr KRYPTON	
5	37 85.468 Rb RUBIDIUM	38 87.62 Sr STRONTIUM	39 88.906 Y YTTRIUM	40 91.224 Zr ZIRCONIUM	41 92.906 Nb NIOBIUM	42 95.94 Mo MOLYBDENUM	43 (98) Tc TECHNETIUM	44 101.07 Ru RUTHENIUM	45 102.91 Rh RHODIUM	46 106.42 Pd PALLADIUM	47 107.87 Ag SILVER	48 112.41 Cd CADMIUM	49 114.82 In INDIUM	50 118.71 Sn TIN	51 121.76 Sb ANTIMONY	52 127.60 Te TELLURIUM	53 126.90 I IODINE	54 131.29 Xe XENON	
6	55 132.91 Cs CAESIUM	56 137.33 Ba BARIUM	57-71 La-Lu Lanthanide	72 178.49 Hf HAFNIUM	73 180.95 Ta TANTALUM	74 183.84 W TUNGSTEN	75 186.21 Re RHENIUM	76 190.23 Os OSMIUM	77 192.22 Ir IRIDIUM	78 195.08 Pt PLATINUM	79 196.97 Au GOLD	80 200.59 Hg MERCURY	81 204.38 Tl THALLIUM	82 207.2 Pb LEAD	83 208.98 Bi BISMUTH	84 (209) Po POLONIUM	85 (210) At ASTATINE	86 (222) Rn RADON	
7	87 (223) Fr FRANCIUM	88 (226) Ra RADIUM	89-103 Ac-Lr Actinide	104 (261) Rf RUTHERFORDIUM	105 (262) Db DUBNIUM	106 (266) Sg SEABORGIUM	107 (264) Bh BOHRNIUM	108 (277) Hs HASSIUM	109 (268) Mt MEITNERIUM	110 (281) Uu UNUNNIUM	111 (272) Uub UNUNBIUM	112 (285) Uuq UNUNQUADIUM		114 (289) Uuq UNUNQUADIUM					



■ Metal	■ Semimetal	■ Nonmetal
■ Alkali metal	■ Chalcogens element	
■ Alkaline earth metal	■ Halogens element	
■ Transition metals	■ Noble gas	
■ Lanthanide		
■ Actinide		

STANDARD STATE (100 °C; 101 kPa)
Ne - gas Fe - solid
Ga - liquid Te - synthetic

LANTHANIDE

57 138.91 La LANTHANUM	58 140.12 Ce CERIUM	59 140.91 Pr PRASEODYMIUM	60 144.24 Nd NEODYMIUM	61 (145) Pm PROMETHIUM	62 150.36 Sm SAMARIUM	63 151.96 Eu EUROPIUM	64 157.25 Gd GADOLINIUM	65 158.93 Tb TERBIUM	66 162.50 Dy DYSPROSIUM	67 164.93 Ho HOLMIUM	68 167.26 Er ERBIUM	69 168.93 Tm THULIUM	70 173.04 Yb YTTERIUM	71 174.97 Lu LUTETIUM
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ACTINIDE

89 (227) Ac ACTINIUM	90 232.04 Th THORIUM	91 231.04 Pa PROTACTINIUM	92 238.03 U URANIUM	93 (237) Np NEPTUNIUM	94 (244) Pu PLUTONIUM	95 (243) Am AMERICIUM	96 (247) Cm CURIUM	97 (247) Bk BERKELIUM	98 (251) Cf CALIFORNIUM	99 (252) Es EINSTEINIUM	100 (257) Fm FERMIUM	101 (258) Md MENDELEVIUM	102 (259) No NOBELIUM	103 (262) Lr LAWRENCIUM
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(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)

Relative atomic mass is shown with few significant figures. For elements having 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 (advr@netflix.com)

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.

Quiz #1

Hydrogen	H
Boron	B
Carbon	C
Nitrogen	N
Oxygen	O
Fluorine	F
Phosphorous	P
Sulfur	S
Vanadium	V
Iodine	I
Uranium	U

Helium	He
Lithium	Li
Beryllium	Be
Neon	Ne
Aluminum	Al
Silicon	Si
Argon	Ar
Calcium	Ca
Scandium	Sc
Titanium	Ti
Cobalt	Co
Nickel	Ni
Selenium	Se
Bromine	Br
Xenon	Xe
Barium	Ba

Quiz #2

Chromium	Cr
Magnesium	Mg
Manganese	Mn
Zinc	Zn
Arsenic	As
Rubidium	Rb
Strontium	Sr
Zirconium	Zr
Cadmium	Cd
Cesium	Cs
Platinum	Pt
Radon	Rn

Sodium	Na
Potassium	K
Iron	Fe
Copper	Cu
Silver	Ag
Tin	Sn
Antimony	Sb
Gold	Au
Mercury	Hg
Lead	Pb