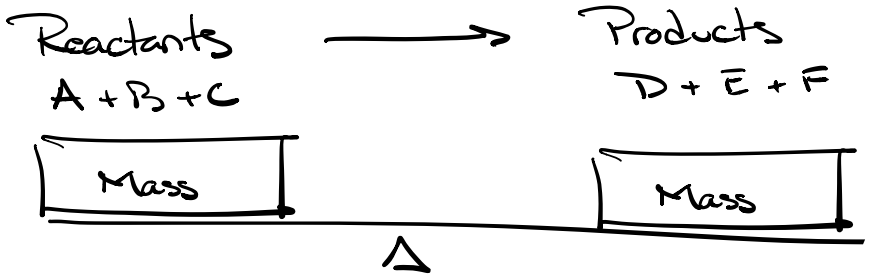
⇒ Law of Conservation of Matter (Mass)

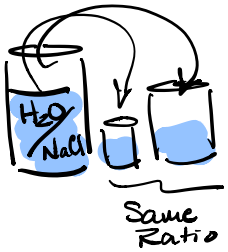
When a chemical or physical change occurs there is no change in the amount of Matter



Classification of Matter

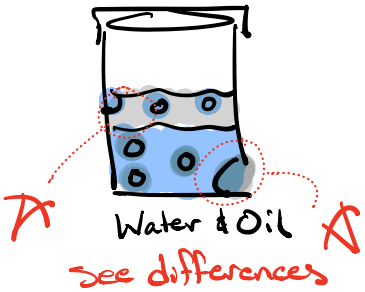
Mixtures
Can be physically separated
filtered or distilled

- **Homogeneous**
  Uniform in Composition
  Regardless of Sample Size



100 H_2O : 1 NaCl

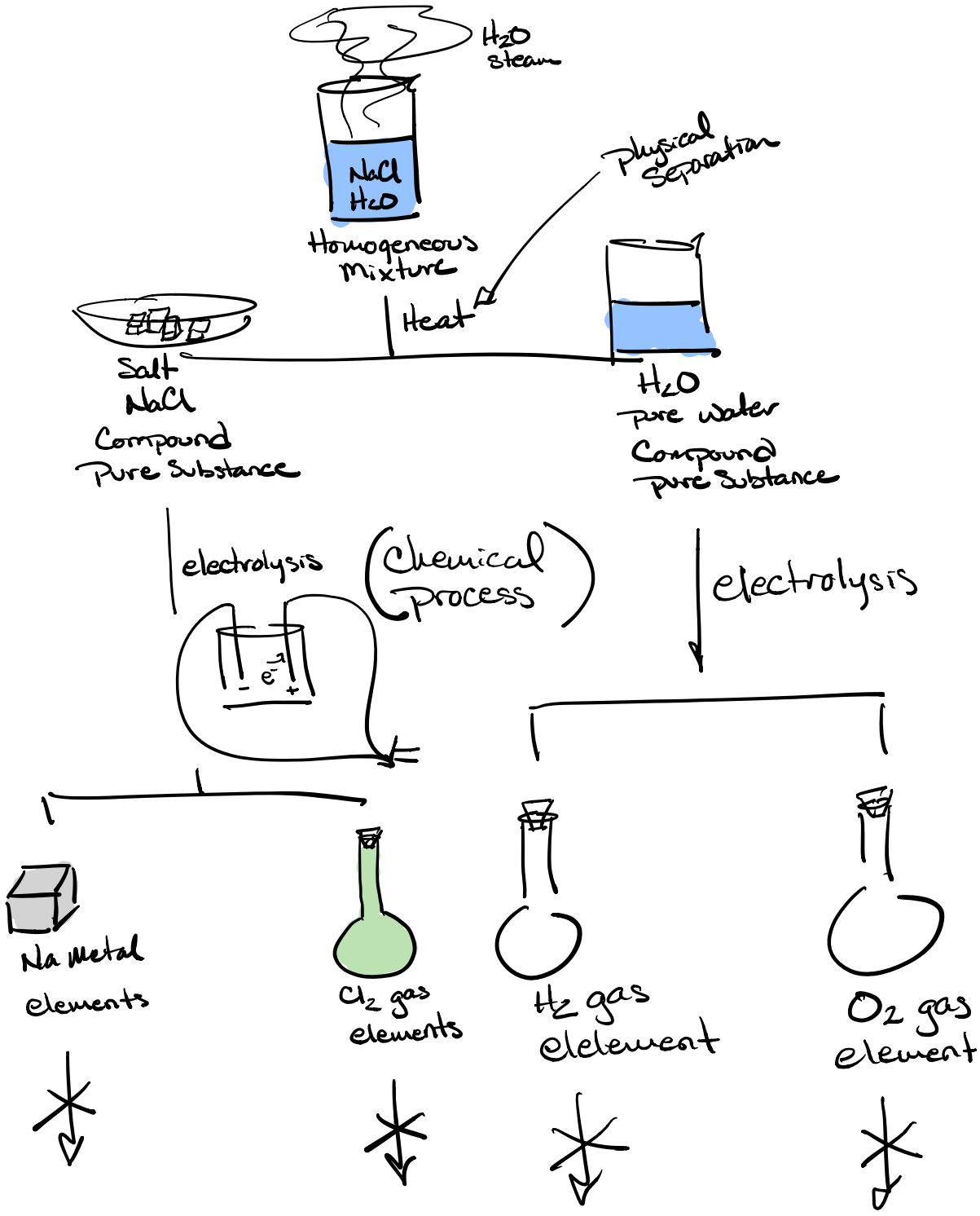
- **Heterogeneous**
  Not uniform
  Differences in Composition observed throughout mixture



Pure Substances
Cannot be physically separated from one another

- **Compounds**
  Combination of elements bound in whole # Ratios
  H_2O, CO_2
  CO, $C_6H_{12}O_6$
  Fixed Ratios
  H_2O => 2H : 1O always

- **Elements**
  Smallest Component of matter that cannot be broken down into simpler forms.
  H_2, C, O_2,
  N_2, Fe, S_8
  monatomic = 1
  diatomic = 2


H_2O
steam
NaCl
H_2O
Homogeneous
Mixture
Physical
Separation
Heat
Salt
NaCl
Compound
Pure Substance
H_2O
pure water
Compound
pure Substance
electrolysis
Chemical
Process
electrolysis
Na Metal
elements
Cl_2 gas
elements
H_2 gas
element
O_2 gas
element

Atoms are extreemly small

½ kt diamond  c-c-c-c-c - - -

distance would extend to the Sun & back

to small to be visualized with any type of microscope

Also extreemly light 1,000,000,000 Pb (lead) atoms to weigh 3×10^{-13} grams. A paper clip weighs ~ 1 g

3×10^{14} Pb atoms weigh ~ 0.000,000,1 g

Mass of Atoms are measured in Atomic Mass Units (AMU)

1 amu = $\sim 1.66 \times 10^{-23}$ grams

	H	C	N	O	F	Fe
amu	1	12	14	16	19	55

Instrument for measuring elements Mass

Inductively Coupled Plasma Mass Spectrometer

A molecule consists of 2 or more atoms bound in a Chemical bond.

Singles atom

Fe Ne Cu

Just elements

1 Type w/ 2 or more

H_2 O_2 P_4 S_8

elements but also molecules

more than 1 type of atom

H_2O CO_2 $C_{12}H_{24}O_{12}$

Compounds or molecules

Chapter 1.3 Physical Properties & Chemical Properties

Physical Property - Not associated with a change in Chemical Composition.

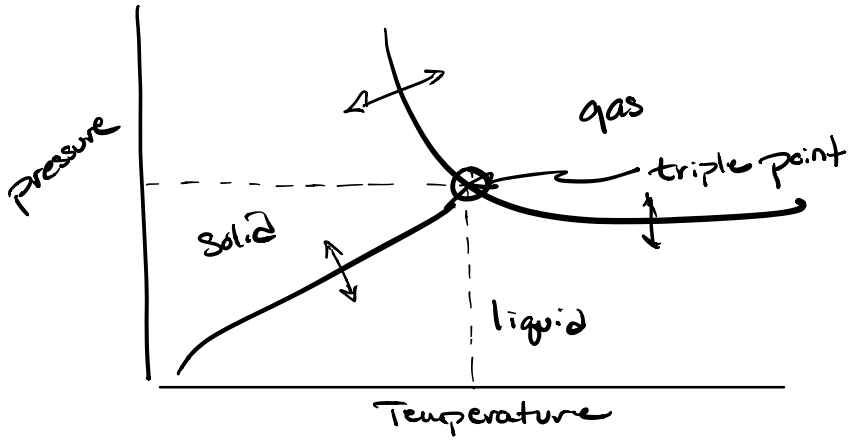
Examples: Density (mass to volume ratio)
- Hardness
- Color
- Boiling point
- Melting point
- Conductivity

Physical Change - A change of State of matter

State of matter = Solid, liquid, gas

Examples of Changes of state

Solid ⇌ liquid	melting
liquid ⇌ gas	boiling
Solid ⇌ gas	Sublimation



Chemical Change - Results in a change in the composition of matter

Examples: Combustion (burning)
Oxidation (Rusting)
Reduction
decomposition (Explosions)
Combination
Replacement (Single or double)

Combustion

$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$

butane — oxygen gas — Carbon dioxide — water

Change in Composition

8C, 20H, 26O = 8C, 20H, 26O

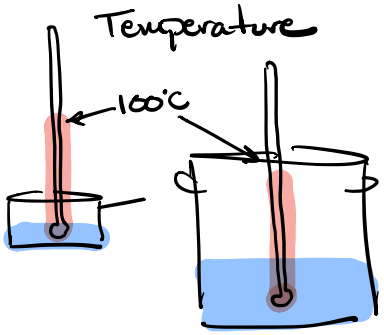
Δ

Conservation of Matter!

Properties of Matter

Intensive

Does not depent on the amount of matter measured



Density = $\frac{\text{mass}}{\text{Volume}}$ Ratio

Density does not Change given the amount of Material measured

Extensive

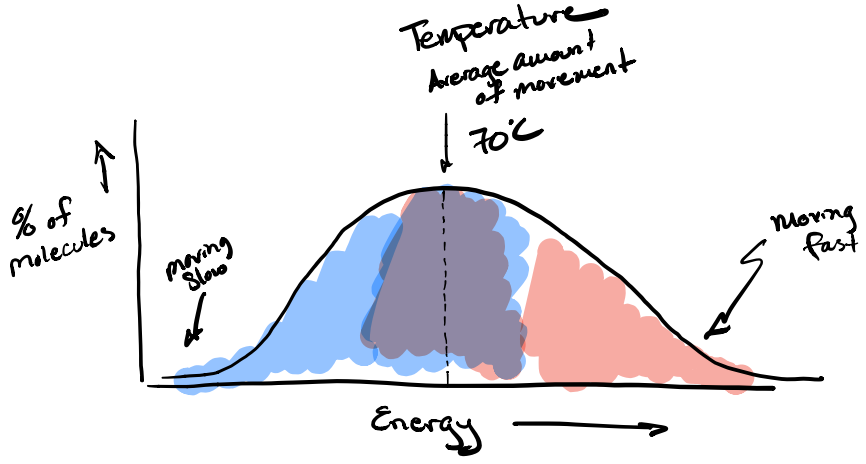
Do depend on the amount of matter measured

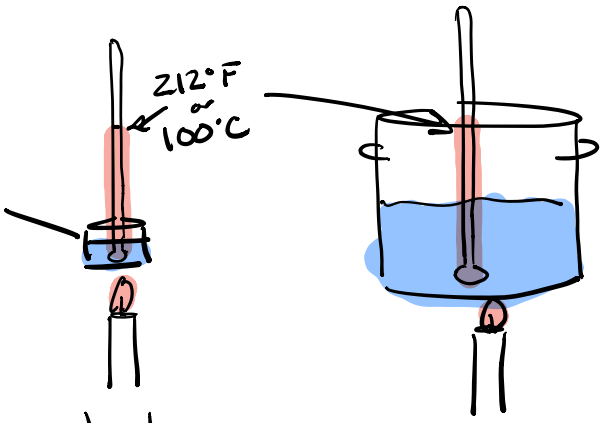
mass
Volume
Heat

mass	10 g	100 g
Volume	1 cm^3	1,000 cm^3

Heat = Sum of all motion

Temp = Ave of all motion





Heat in inorder to boil

Boil First

Takes a lot more heat (energy) inorder to boil

Periodic Table of Elements

1 1A																	18 8A
1 H Hydrogen 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.41	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3		72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)		104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (289)	117 Ts Tennessine	118 Og Oganesson

Lanthanides	57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinides	89 Ac Actinium (227)	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

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Values rounded to four significant figures