# Scientific Notation

-a way to represent large and small numbers

-a way to indicate significant figures

Form:

$a.aaa\ldots \times 10^{a}$

(always ONE nonzero digit before the decimal)

$3.6 \times 10^{4}$

means

$3.6 \times 10 \times 10 \times 10 \times 10$

OR

36000

$6.21 \times 10^{-3}$

means

$6.21 \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$

OR

0.00621

Scientific notation removes the need for placeholder zeros, and that's good when you're dealing with very large and very small numbers!

$4.70 \times 10^{-6} = 0.00000470$

Scientific notation indicates significant figures without extra decimal points or lines. All numbers in front of the power of ten are significant!

$3700 = 3.70 \times 10^{3}$

To write a number in scientific notation, move the decimal point so that it is behind the first nonzero number. The power of ten will be the number of places you moved the decimal. If the number is less than 1, the power of ten is negative. If it's greater than one, the power of ten is positive.

$0.00765$

3

$7.65 \times 10^{-3}$

$14000$

4

$1.400 \times 10^{4}$

$6.38 \times 10^5$

6.3800000

638000

$4.20 \times 10^{-6}$

0.000004.20

0.00000420

Using scientific notation on a calculator:

$6.38 \times 10^5$

on a TI-83:

enter

6.38 [EE] 5

calculator displays:

6.38E5

this E means "x10 raised to"

$4.20 \times 10^{-6}$

enter:

4.20 [EE] [(-)] 6

calculator displays:

4.2E-6

means "$\times 10^{-6}$"

# Matter

- anything that takes up space and can be perceived!

What about the structure of matter? Matter as atoms!

## THE PHASES OF MATTER

### SOLIDS

* Rigid: Fixed shape AND fixed volume
* Dense: contain much mass in a given volume!

### LIQUIDS

* Variable shape ("fluid")
* Fixed volume
* Dense

↑ usually less dense than solid!

exception: water!

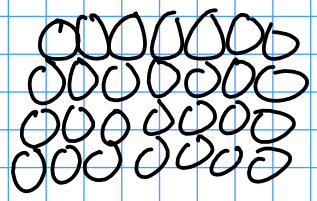
### GASES

* Variable shape ("fluid")
* Variable volume
* Not dense ("diffuse")

An atomic picture of the phases of matter

Solids:

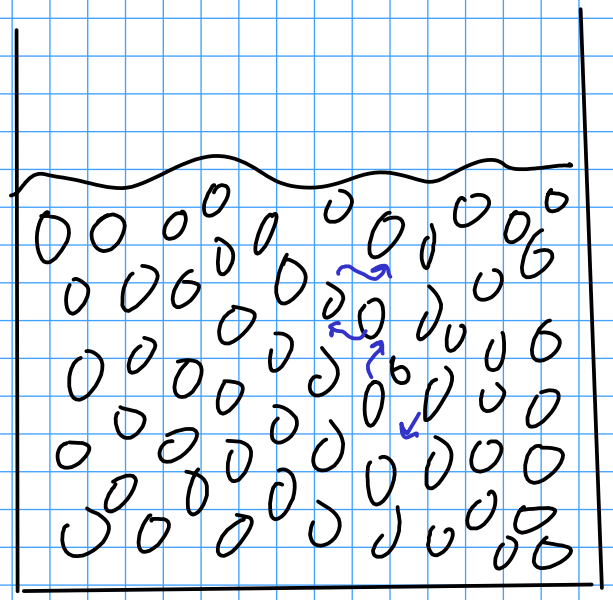
- fixed shape, dense, fixed volume



- Atoms closely packed
- Atoms are arranged in a regular structure (a CRYSTAL), giving the solid rigidity
- Atoms are strongly attracted to each other, keeping the solid together
- Atoms do not move about freely, but there is some vibration

## Liquids:

- variable shape, dense, fixed volume



- Atoms still very close to each other, but usually a little farther apart than in solid phase

An exception: water.

- Atoms are not arranged in an overall order and can slide past and around one another

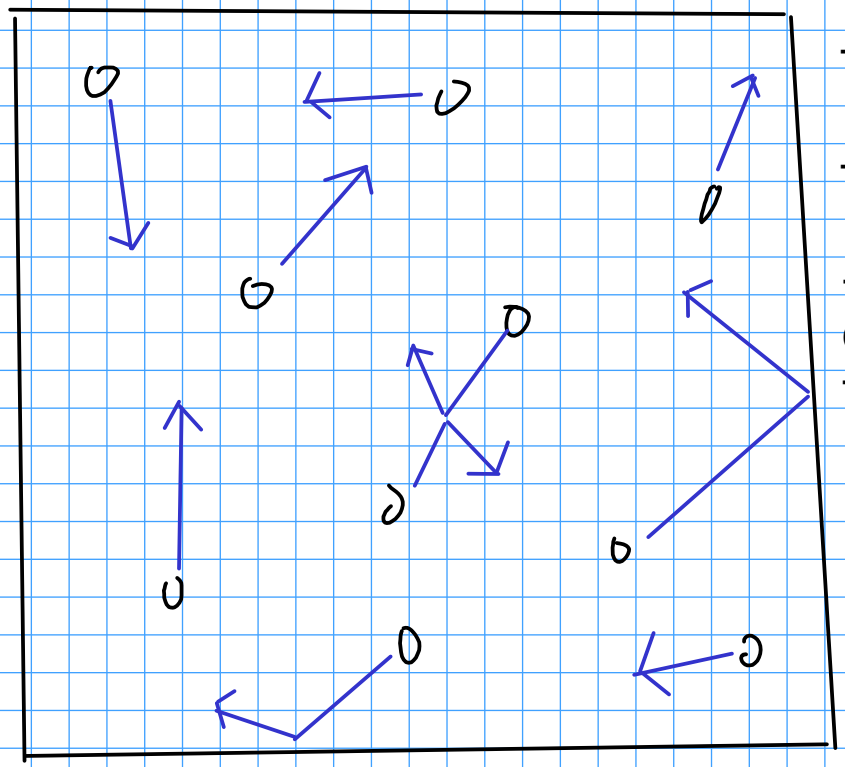
- Atoms are still strongly attracted to each other, keeping the liquid together

- Atoms move around each other constantly

Evidence: DIFFUSION - a drop of food coloring in a glass of water will eventually spread throughout the glass, even if the glass is NOT stirred.

## Gases:

- variable shape, diffuse (not dense), variable volume



- Atoms are spread far apart

- No structure

- Aroms are NOT strongly attracted to each other. They don't interact much at all, unless they happen to collide.

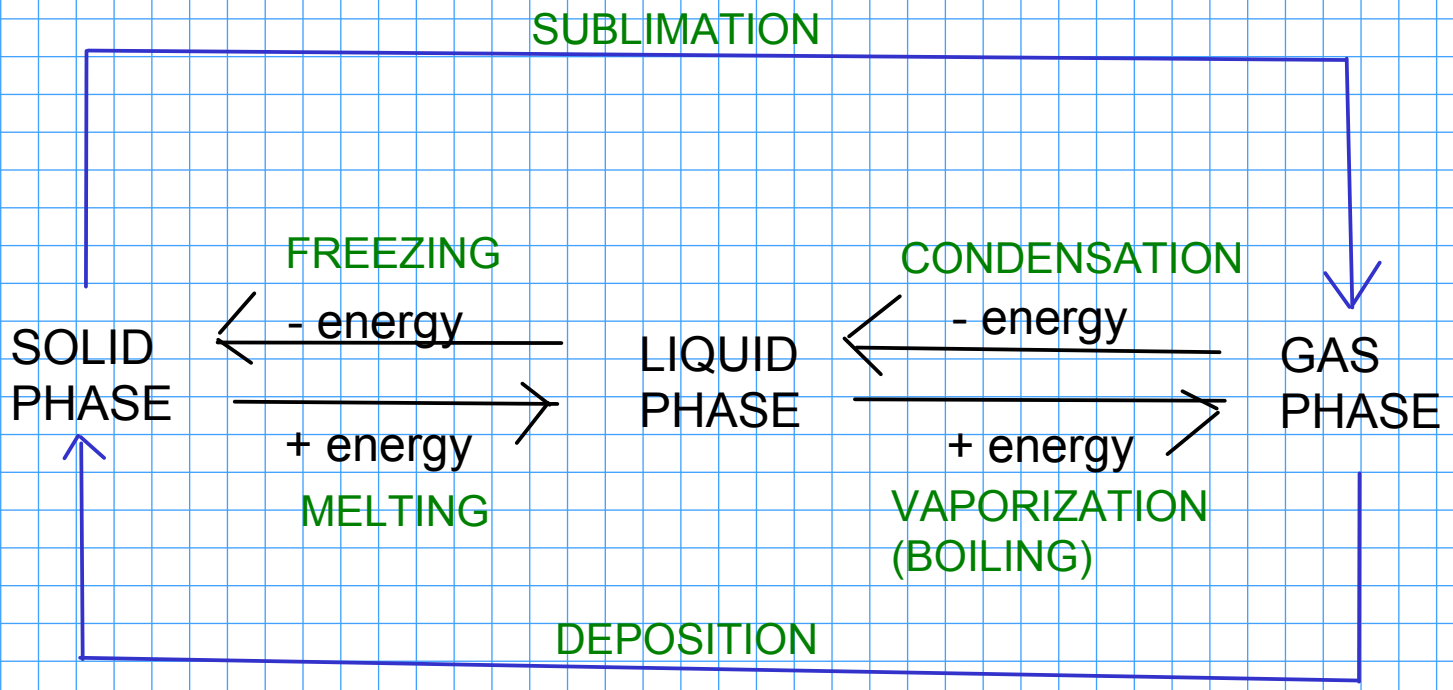
- Atoms in constant, rapid motion. The speed of the atoms increases as temperature increases.

Gases take the shape of their containers. Collision of atoms/molecule of gas with the walls of their containers create the effect we call PRESSURE.

Kinetic theory

- describes matter in terms of atomic/molecular MOTION

- the energy of the molecules relates to atomic/molecular motion, and temperature




You can speed up the molecules (add energy) by heating!
You can slow down the molecules (remove energy) by cooling!

# Physical and Chemical

- We classify changes in matter according to whether the identity of matter changes during the process.

## PHYSICAL CHANGE

- A change in the form or appearance of matter WITHOUT a change in identity

Examples:

- Melting, freezing (all phase changes) are physical; changes
- Breaking, cutting, etc. are also physical changes

## CHEMICAL CHANGE

- A change in the identity of matter
- also called "chemical reactions"

Examples:

- Burning, rusting, metabolism

We classify PROPERTIES of substances by whether or not you must change the identity of a substance to obtain information about the property

## PHYSICAL PROPERTIES

- can be determined without changing the identity of matter

Examples:

- size, shape, color, mass, hardness
- melting point, boiling point, density, etc.

## CHEMICAL PROPERTIES

- can only be determined by changing the identity of matter

Examples:

- flammability, reactivity with acids, temperature at which thermal decomposition occurs

# Classification of matter

- We can broadly classify matter by how difficult it is to separate

## PURE SUBSTANCES

- CANNOT be separated into different materials by PHYSICAL PROCESSES

Examples:

Table salt, gold, silver, nitrogen, oxygen, carbon, hydrochloric acid, carbon dioxide, ethanol (grain alcohol), water, silicon dioxide

## MIXTURES

- CAN be separated into other materials by PHYSICAL PROCESSES

Examples:

salt water, vodka, air, toilet bowl cleaner, beef, macaroni and cheese, dirt

# More on PURE SUBSTANCES

- Pure substances can be further classified, depending on how easy it is to separate them by CHEMICAL PROCESSES

## ELEMENTS

- Cannot be broken down into simpler substances using physical or chemical means

- Elements are the building blocks of chemistry! They are the simple things from which all other things are formed!

- Listed on the PERIODIC TABLE OF THE ELEMENTS

Examples:

gold, silver, carbon, nitrogen, oxygen

## COMPOUNDS

-Can be broken down into simpler substances using chemical means

- Are made of ELEMENTS combined in simple, fixed ratios

- A compound, no matter how it was made, has a definite ratio of one atom to another (LAW OF CONSTANT COMPOSITION)

$H_2O$: 2 parts hydrogen to one part oxygen!

Examples:

carbon dioxide, hydrochloric acid, ethanol, water

# More on MIXTURES

- Mixtures can be further classified based on uniformity

## HOMOGENEOUS MIXTURES

- uniform in composition and properties throughout

- physical properties the same at any point in the mixture

Examples:

salt water, toilet bowl cleaner, vodka

"solutions"

## HETEROGENEOUS MIXTURES

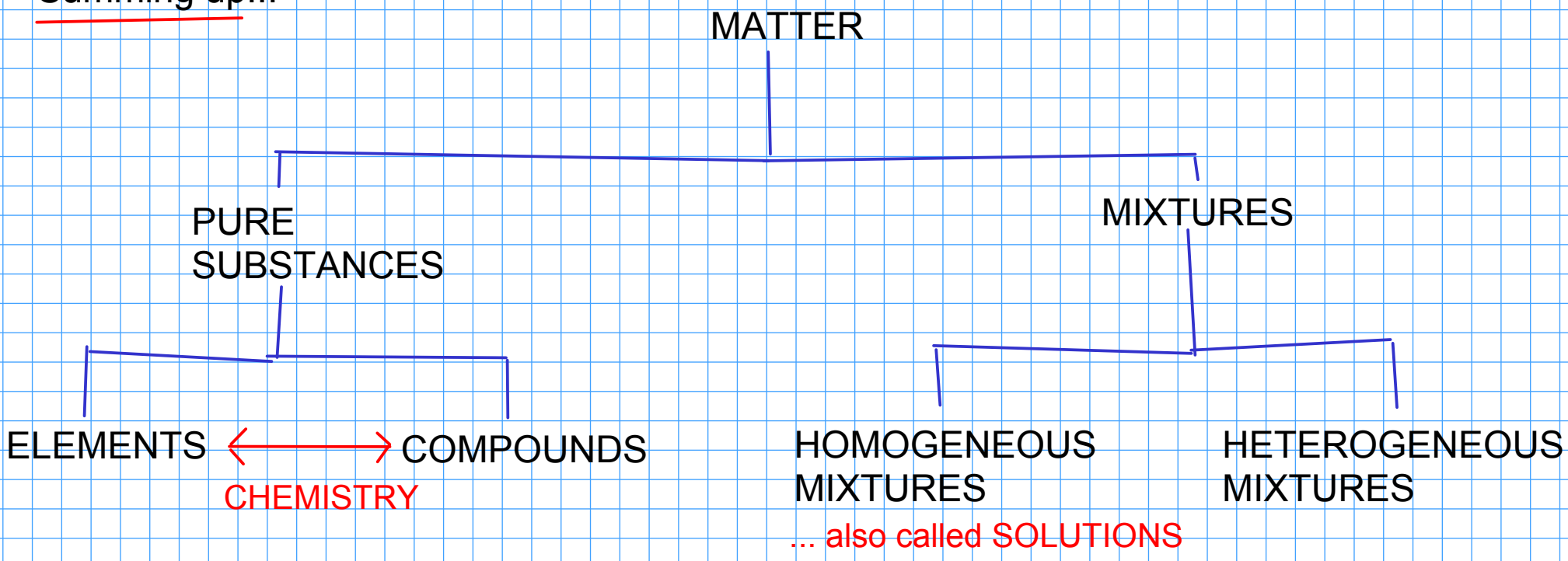
- nonuniform

- physical properties may differ (sometimes dramatically) at different points in the mixture

Examples:

beef, dirt, macaroni and cheese

Summing up...


MATTER
PURE SUBSTANCES
MIXTURES
ELEMENTS
COMPOUNDS
CHEMISTRY
HOMOGENEOUS MIXTURES
... also called SOLUTIONS
HETEROGENEOUS MIXTURES

# Conservation of mass

- During any chemical or physical process, the overall amount of mass remains constant, even if the chemical identity or physical state of the matter involved changes

* Total mass remains constant from (1) to (2), even though the mass of the GAS decreases and the mass of the SOLID increases after combustion!