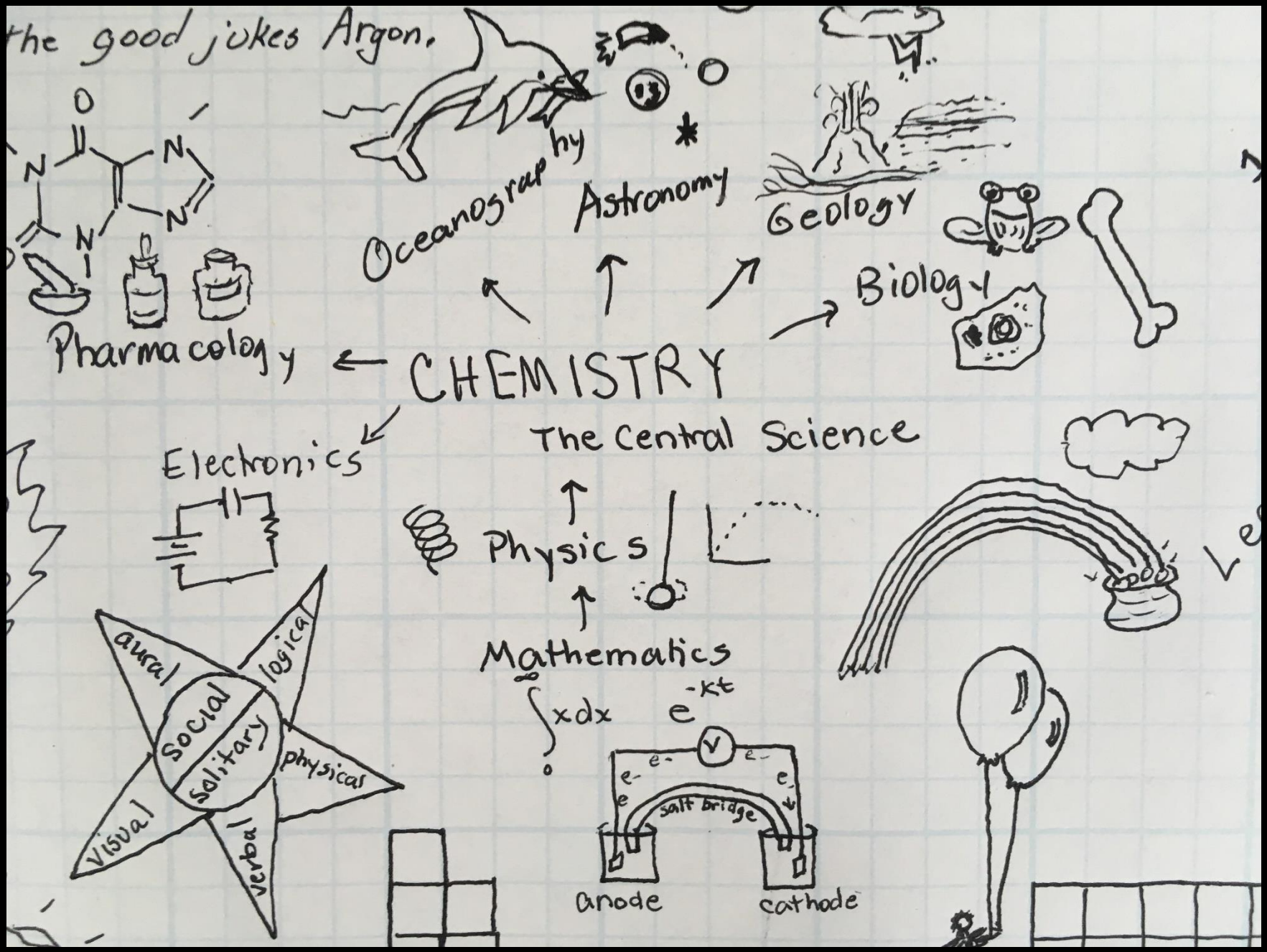
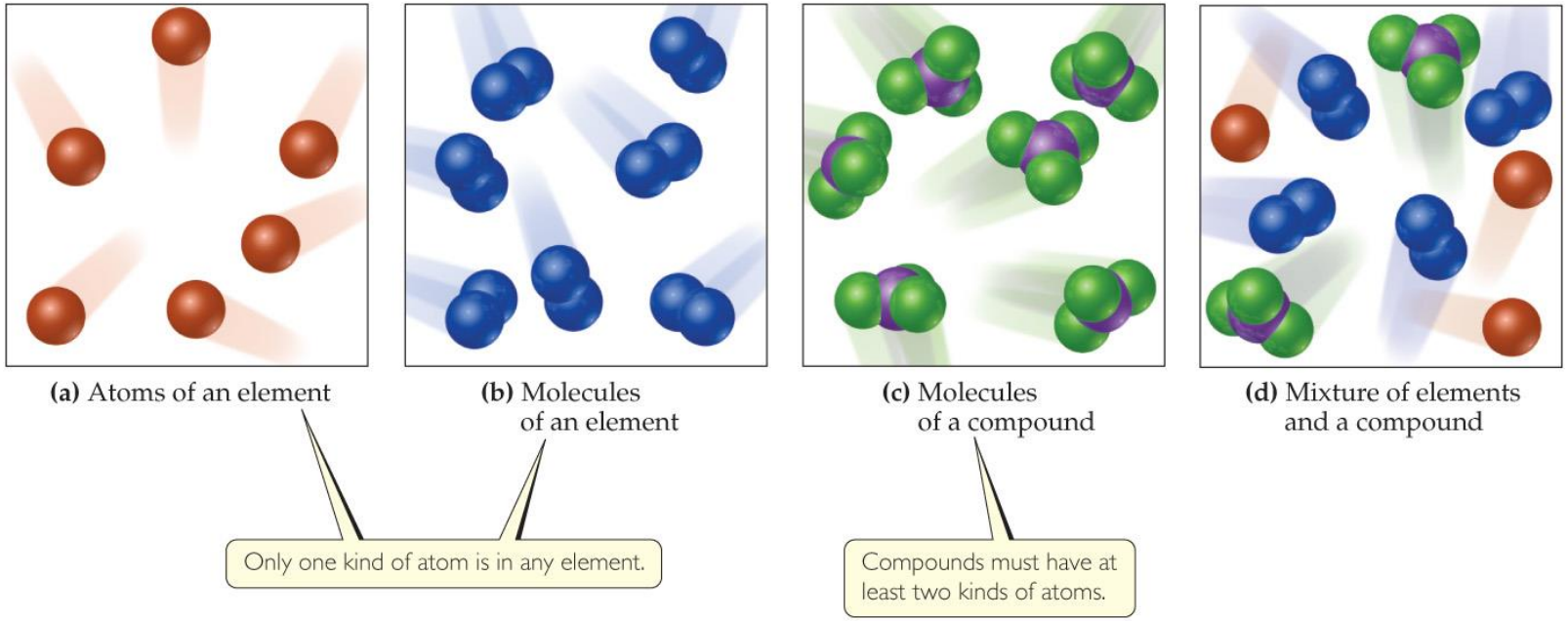
General Chemistry Lecture One

- What is Chemistry
- Definition of Matter
- States of Matter
- Classification of Matter
- Composition of Matter
- Physical Separation of Compounds
- Units of Measurement
- Significant Figures
- Dimensional Analysis

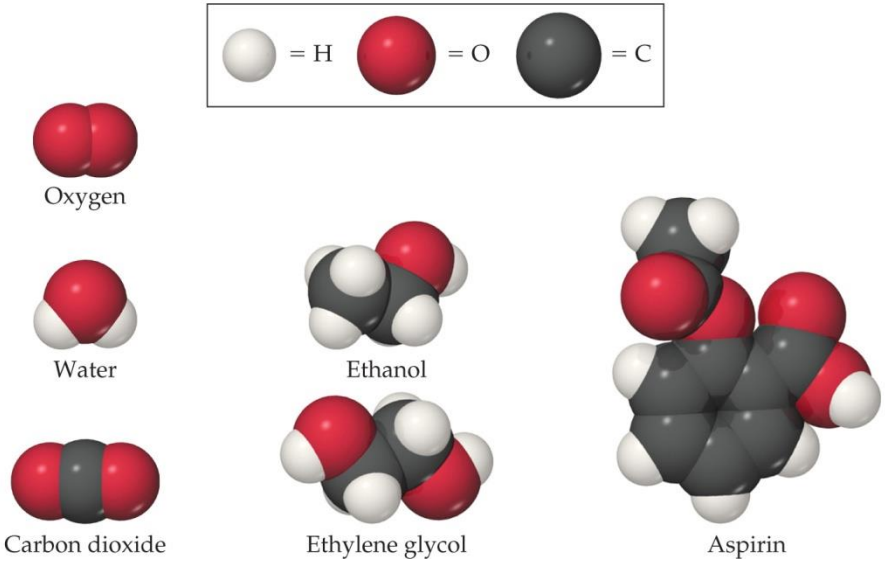

the good jokes Argon.
Oceanography
Astronomy
Geology
Biology
Pharmacology
CHEMISTRY
The Central Science
Electronics
Physics
Mathematics
$\int_0^\infty x\,dx$
e^{-kt}
aural
logical
social
solitary
physical
visual
verbal
V
salt bridge
anode
cathode

Matter

Matter is anything that has mass and takes up space.

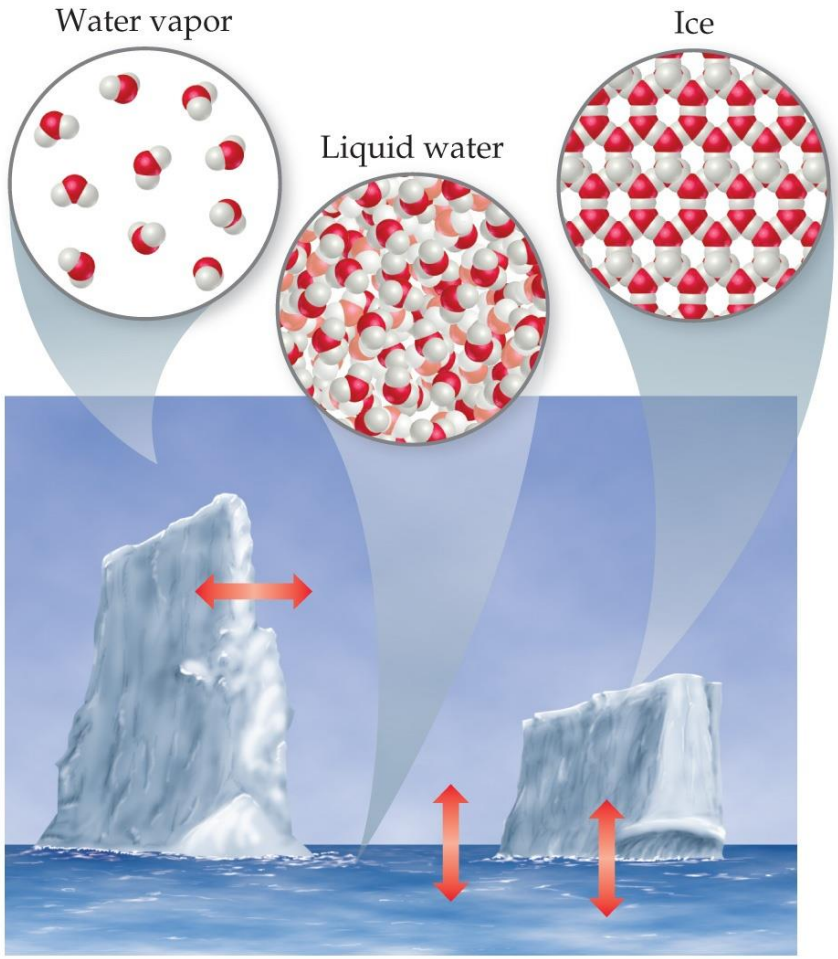


Matter



- **Atoms** are the building blocks of matter.
- Each **element** is made of a unique kind of atom.
- A **compound** is made of two or more different kinds of elements.

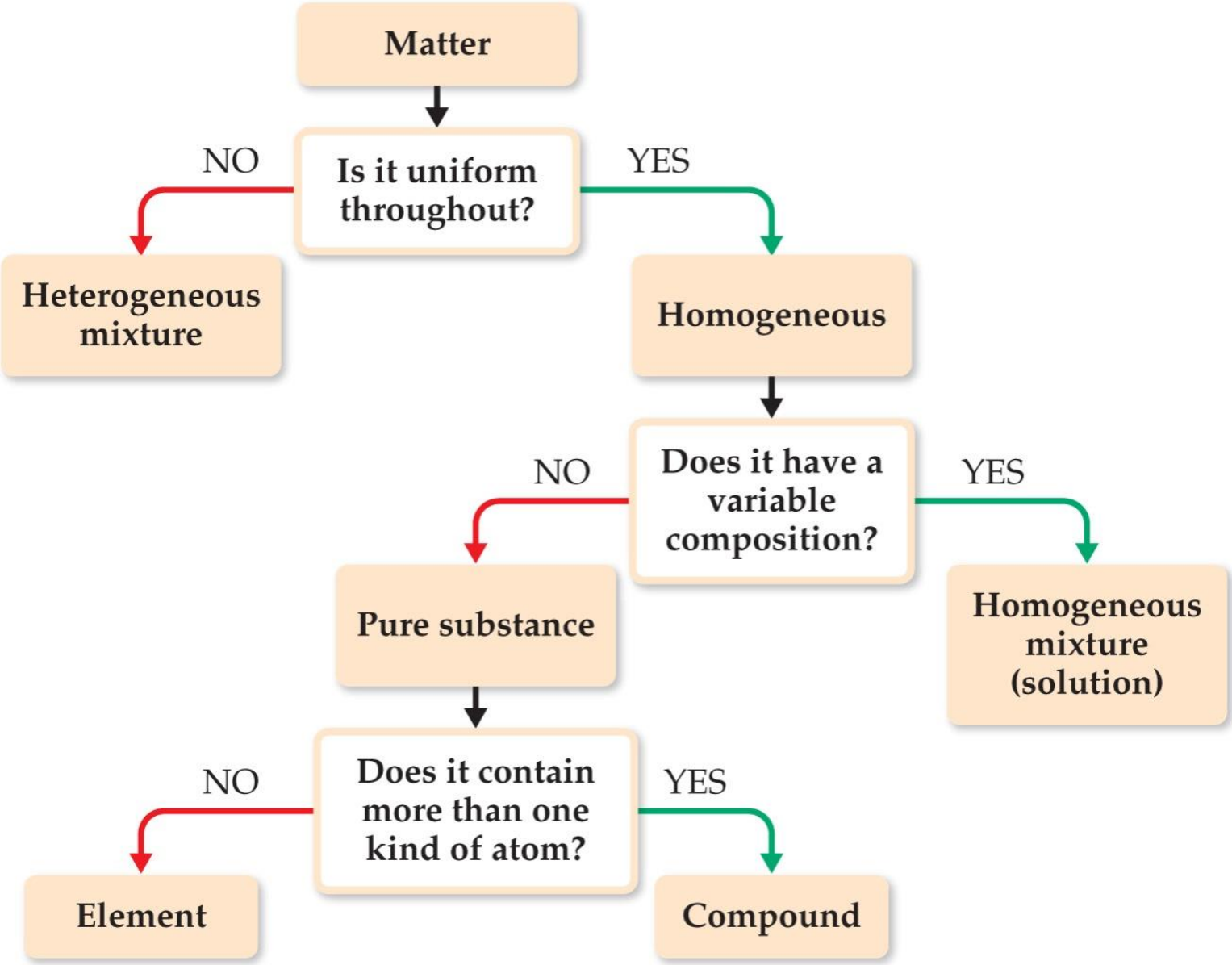
States of Matter

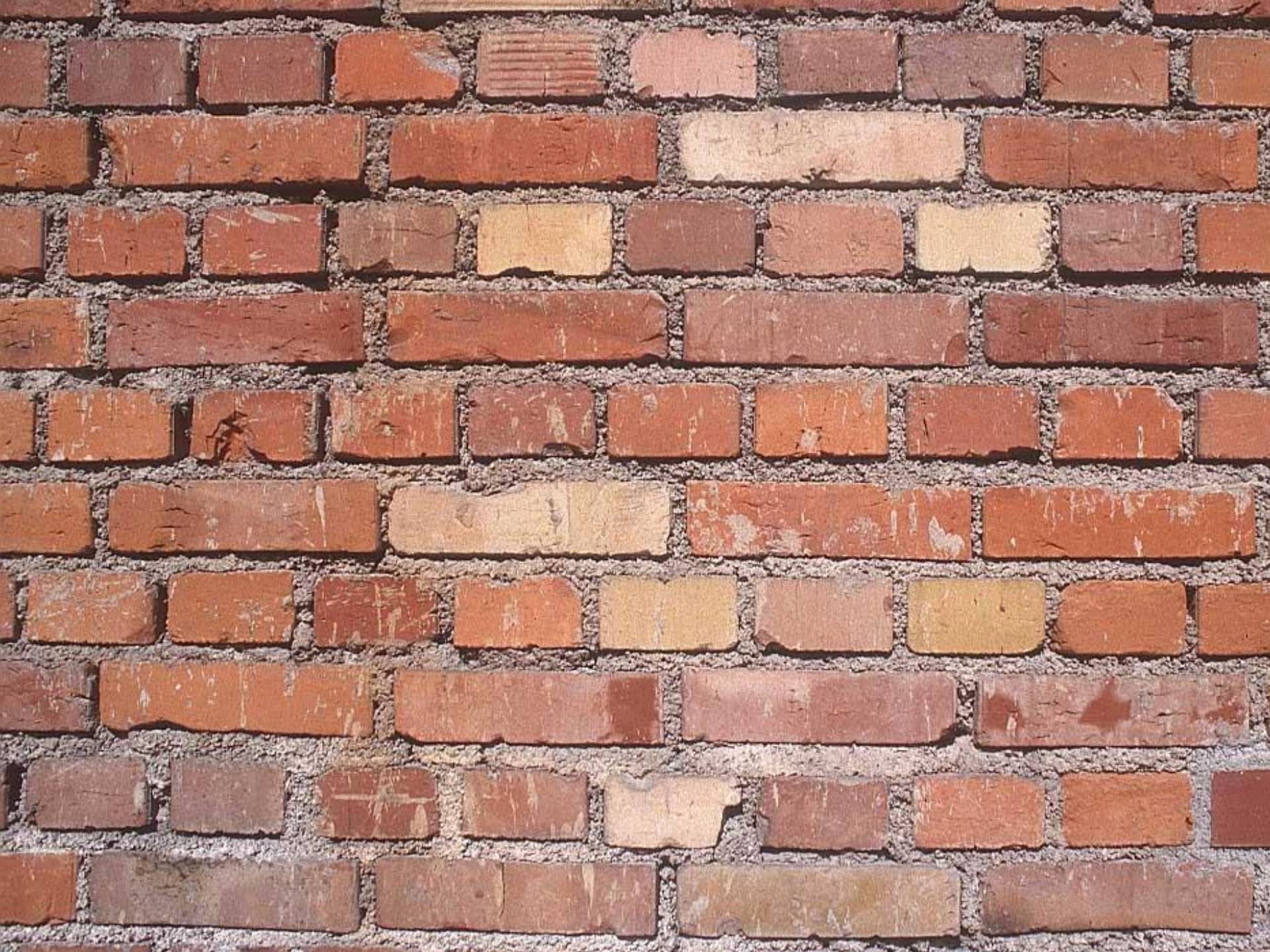


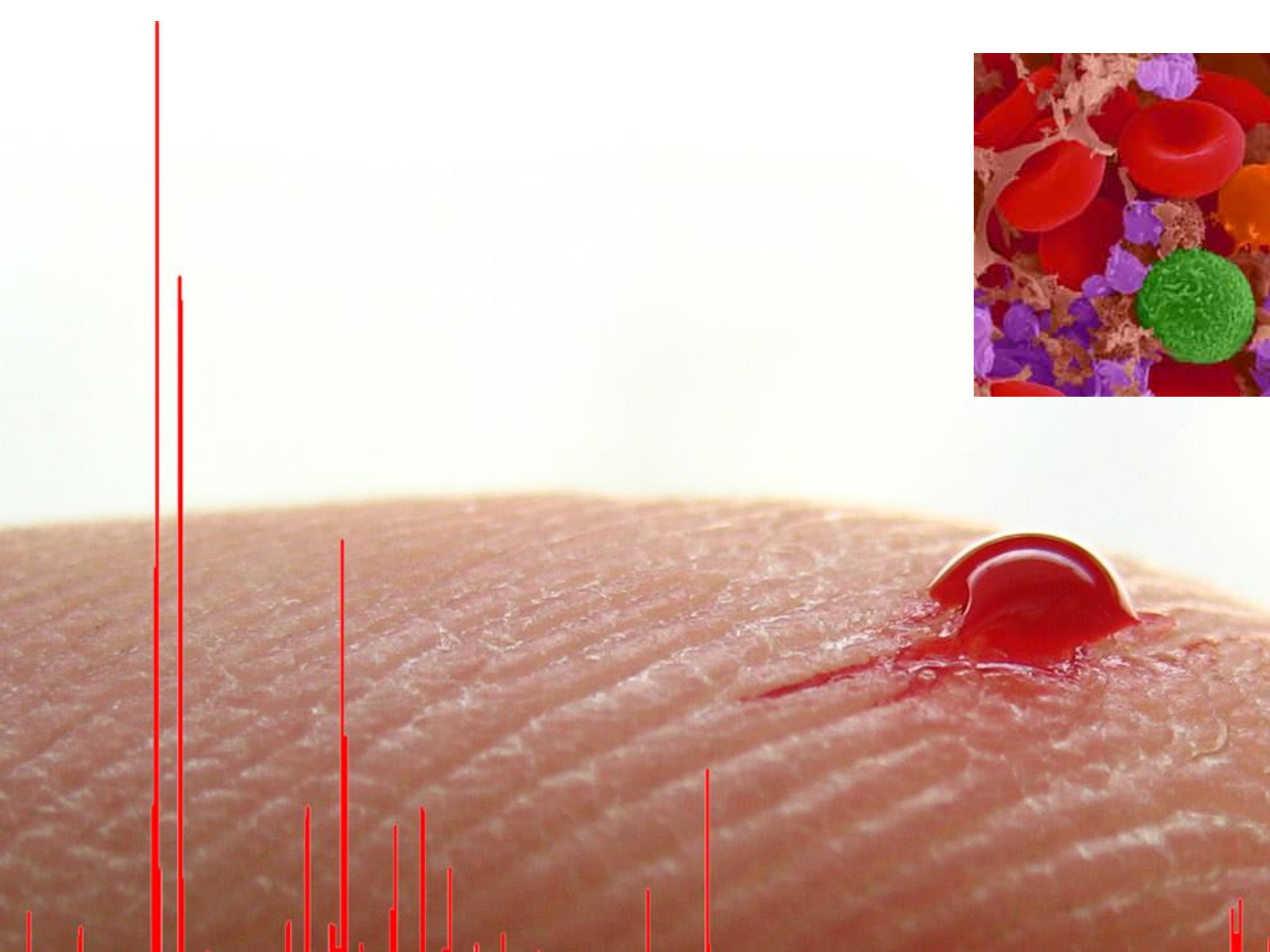
- The four states of matter are
  1) solid.
  2) liquid.
  3) gas.
  4) plasma

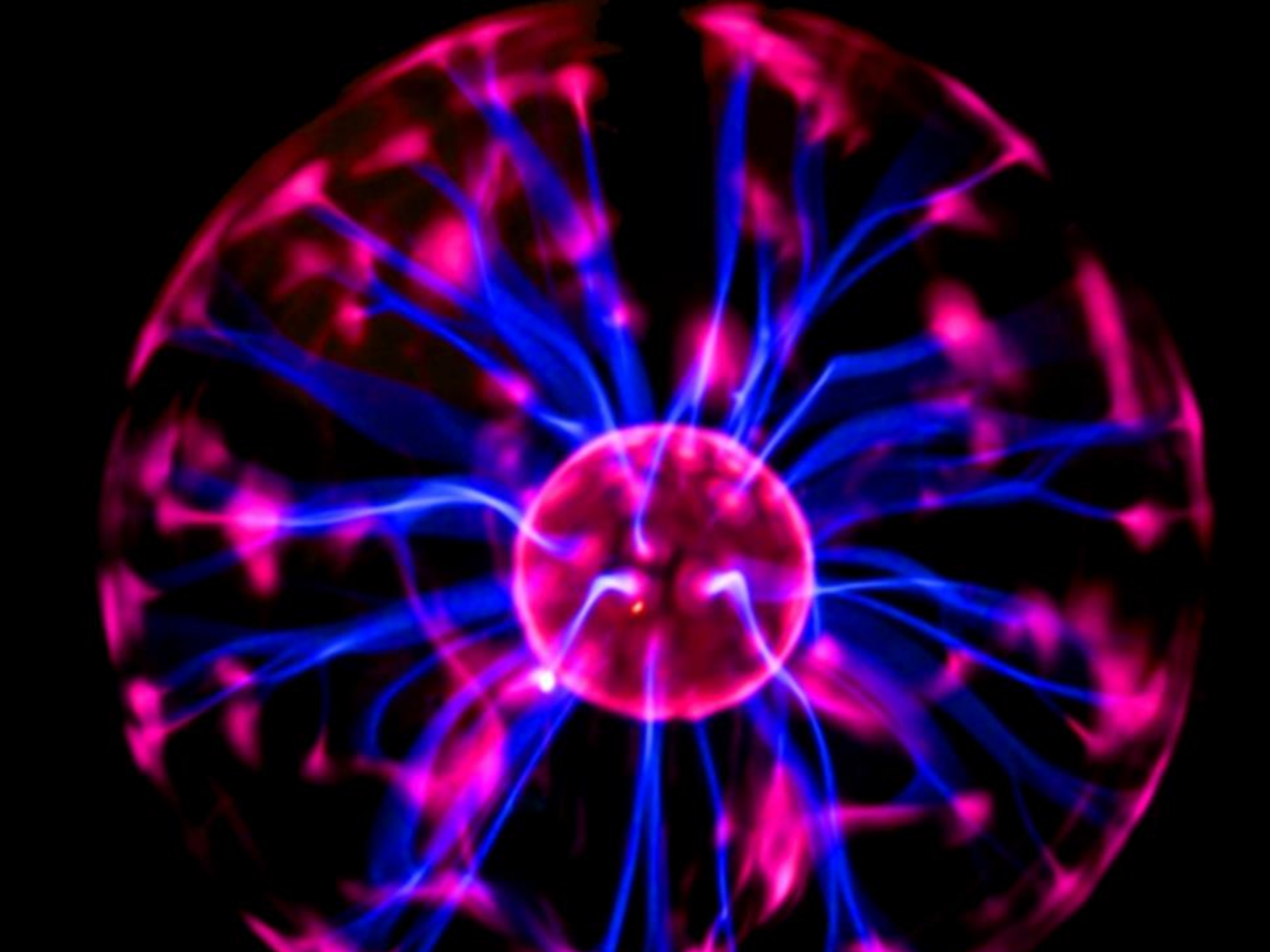
Which one is not shown here?

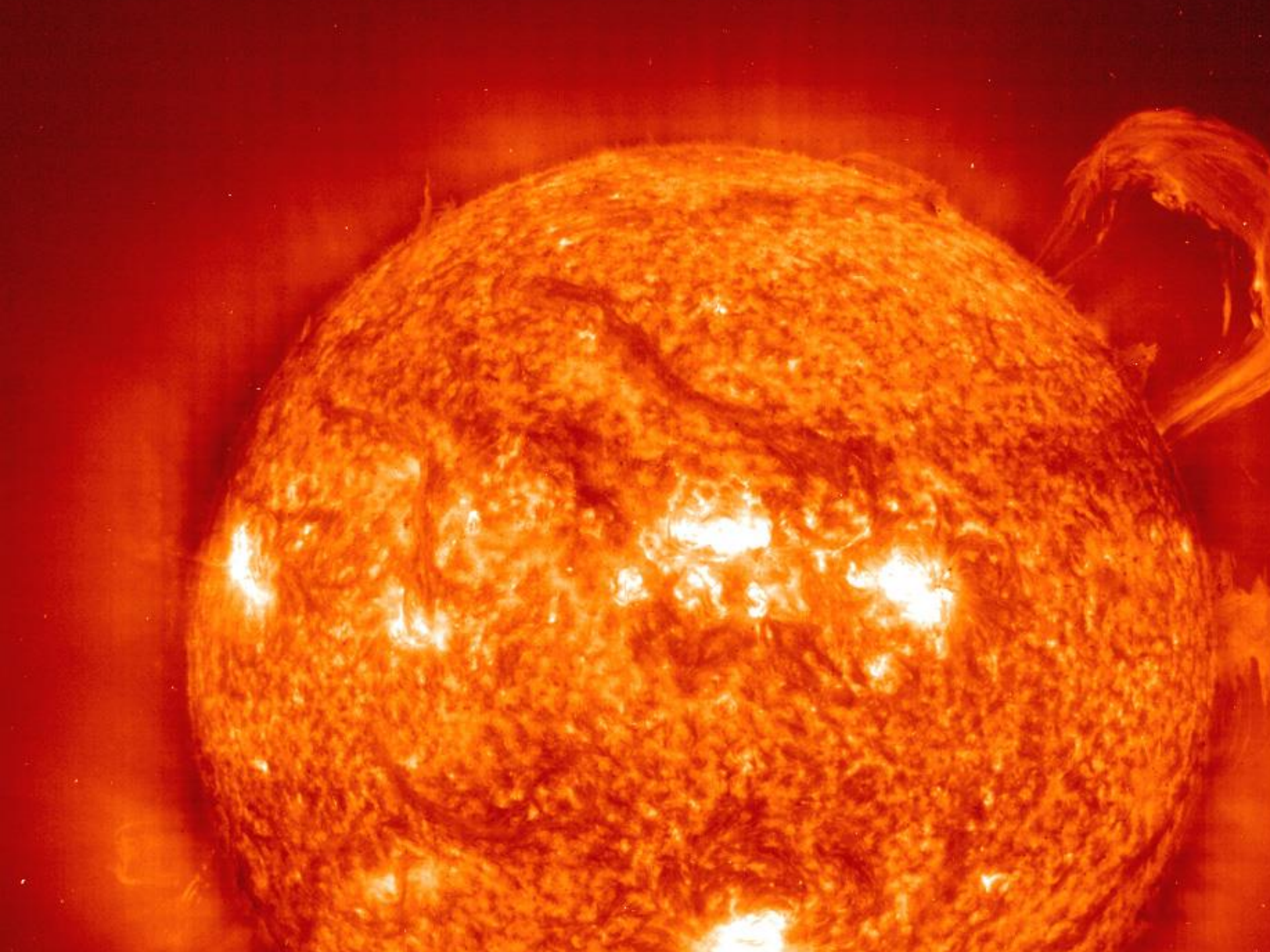
Classification of Matter


Matter
Is it uniform throughout?
NO
YES
Heterogeneous mixture
Homogeneous
Does it have a variable composition?
NO
YES
Pure substance
Homogeneous mixture (solution)
Does it contain more than one kind of atom?
NO
YES
Element
Compound









Solutions, Suspensions, Colloids

A **solution** is a homogeneous mixture of two or more substances,

A **suspension** is a heterogeneous mixture containing particles that will settle out of solution,

A **colloid** is a heterogeneous mixture that contains particles that do not settle out of solution.

Classification of Colloids

Medium / Phases		Dispersed phase		
		Gas	Liquid	Solid
Continuous medium	Gas	**NONE** *(All gases are mutually miscible)*	**Liquid aerosol** *Examples:* fog, mist, hair sprays	**Solid aerosol** *Examples:* smoke, cloud, air particulates
	Liquid	**Foam** *Example:* whipped cream, shaving cream	**Emulsion** *Examples:* milk, mayonnaise, hand cream	**Sol** *Examples:* pigmented ink, blood, paint
	Solid	**Solid foam** *Examples*: aerogel, styrofoam, pumice	**Gel** *Examples*: agar, gelatin, jelly, silicagel, opal	**Solid sol** *Example:* cranberry glass – gold dispersed in glass


Kitc

Compounds and Composition

- Compounds have a definite composition. That means that the relative number of atoms of each element that makes up the compound is the same in any sample.
- This is **The Law of Constant Composition** (or **The Law of Definite Proportions**).

Hydrogen atom (written H)

Oxygen atom (written O)

Water molecule (written H_2O)

Types of Properties

- **Physical Properties** can be observed without changing a substance into another substance.
    - Some examples include boiling point, density, mass, or volume.
- **Chemical Properties** can *only* be observed when a substance is changed into another substance.
    - Some examples include flammability, corrosiveness, or reactivity with acid.

Types of Properties

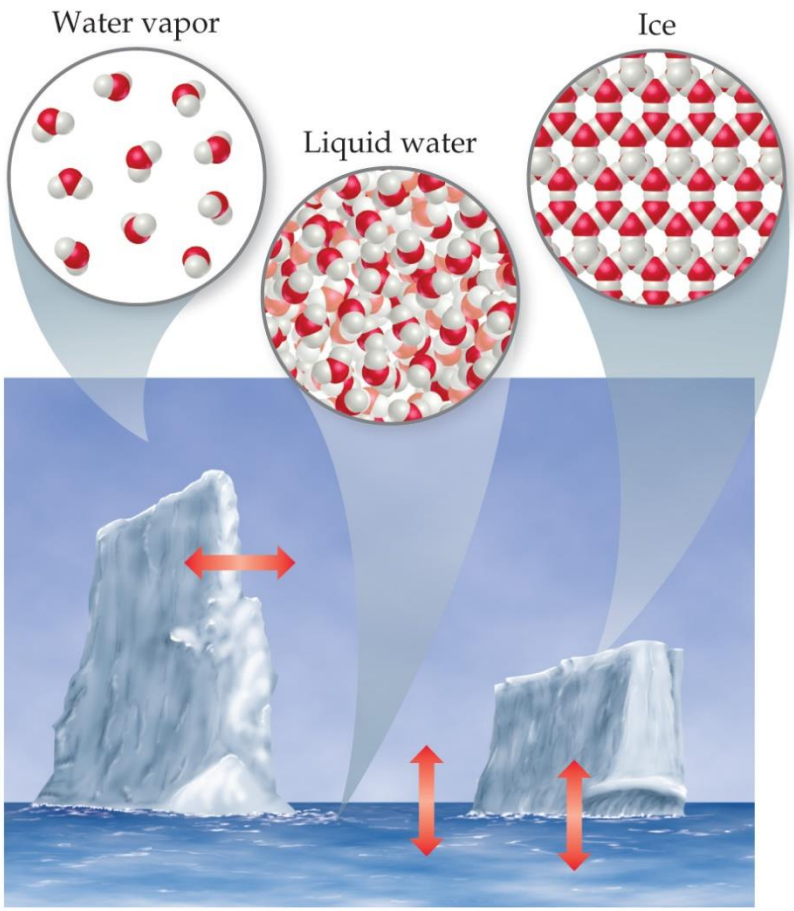
- **Intensive Properties** are independent of the amount of the substance that is present.
  - Examples include density, boiling point, or color.
- **Extensive Properties** depend upon the amount of the substance present.
  - Examples include mass, volume, or energy.

Types of Changes

- **Physical Changes** are changes in matter that do *not* change the composition of a substance.
    - Examples include changes of state, temperature, and volume.

- **Chemical Changes** result in new substances.
    - Examples include combustion, oxidation, and decomposition.

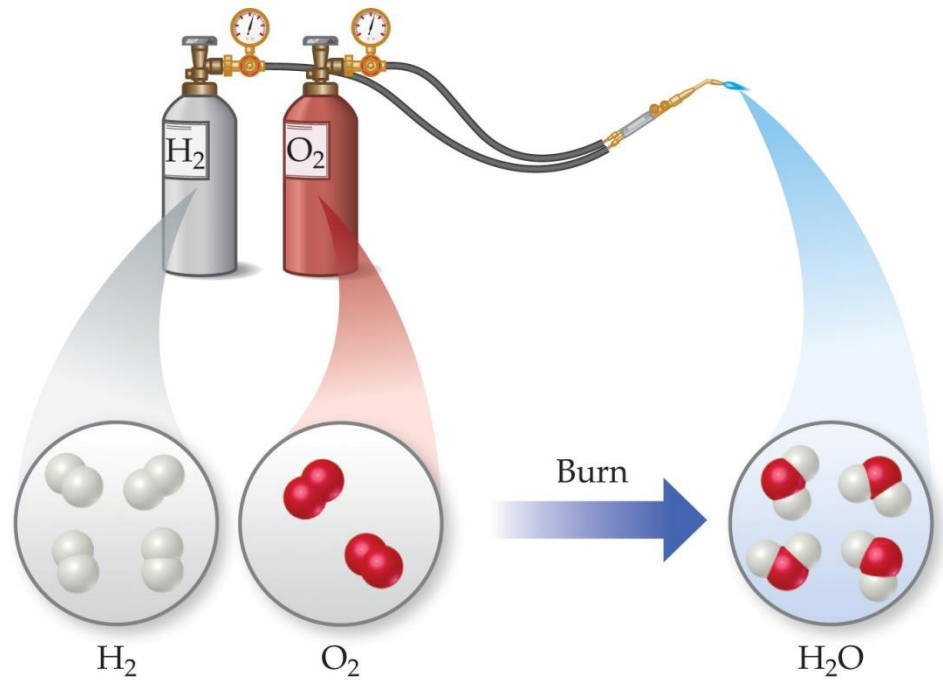
Changes in State of Matter



- Converting between the three states of matter is a **physical change**.

- When ice melts or water evaporates, there are still 2 H atoms and 1 O atom in each molecule.

Chemical Reactions (Chemical Change)



In the course of a chemical reaction, the reacting substances are converted to new substances. Here, the elements hydrogen and oxygen become water.

Separating Mixtures

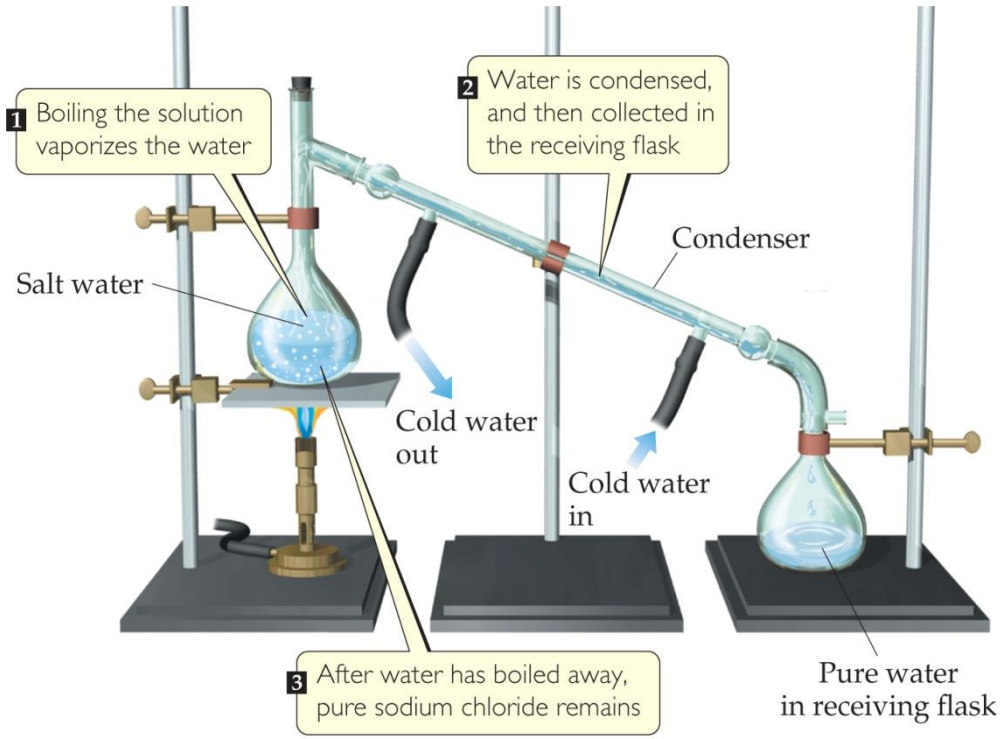
- Mixtures can be separated based on physical properties of the components of the mixture. Some methods used are

  - filtration.
  - distillation.
  - chromatography.

Filtration

- In filtration, solid substances are separated from liquids and solutions.

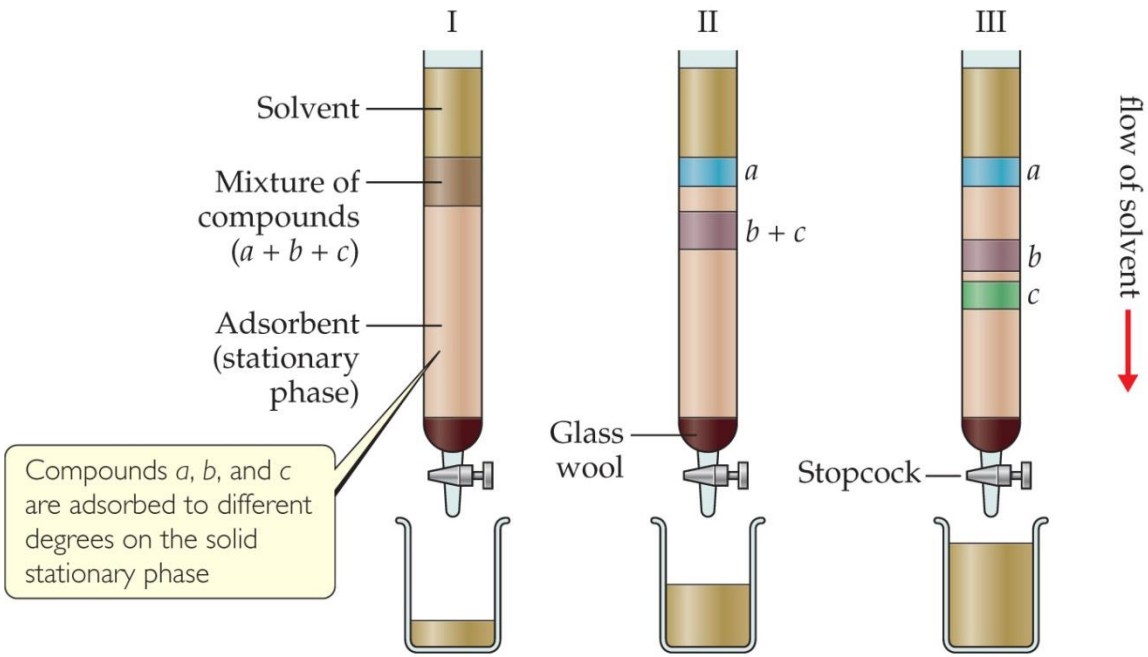
Distillation

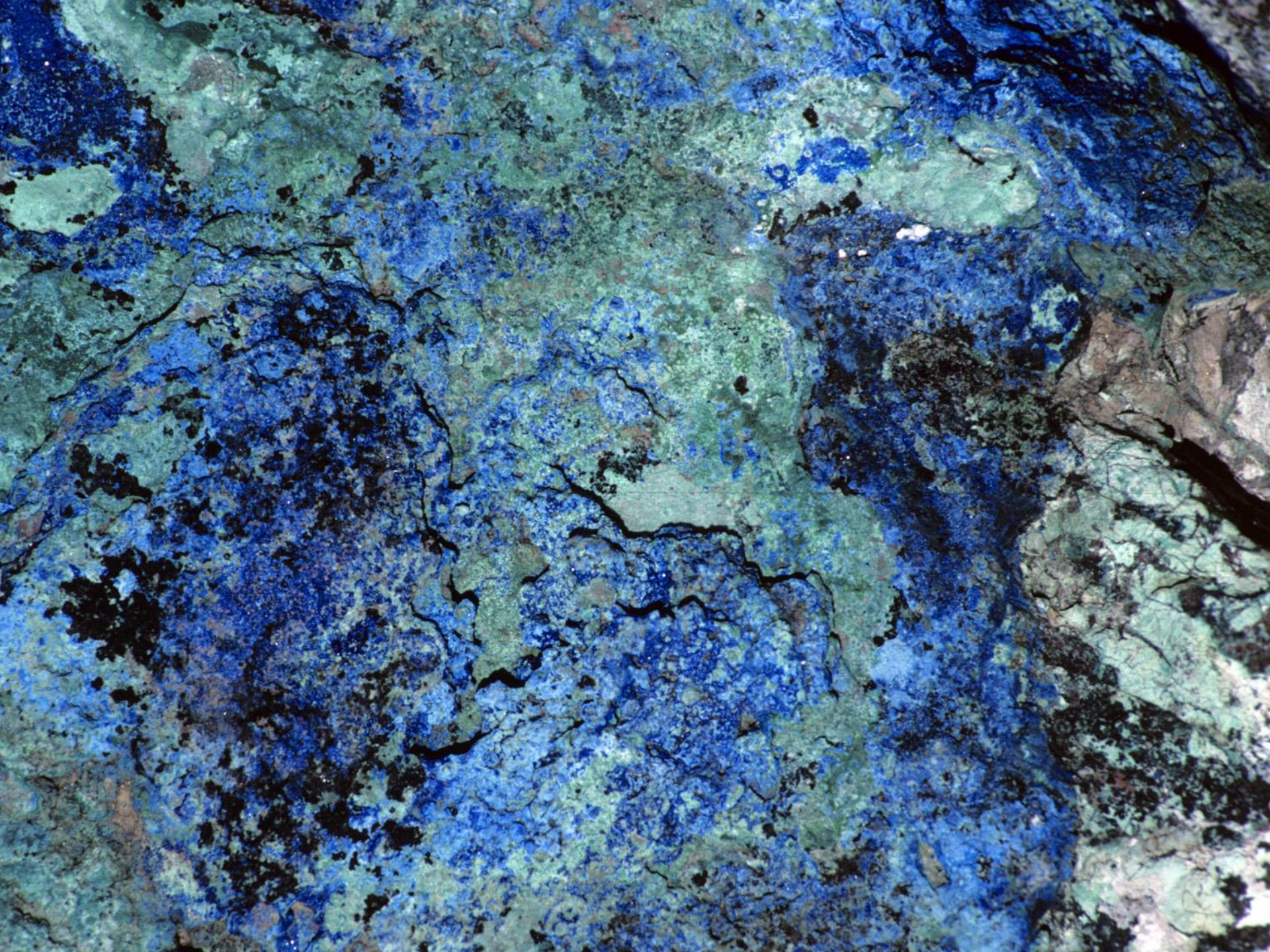


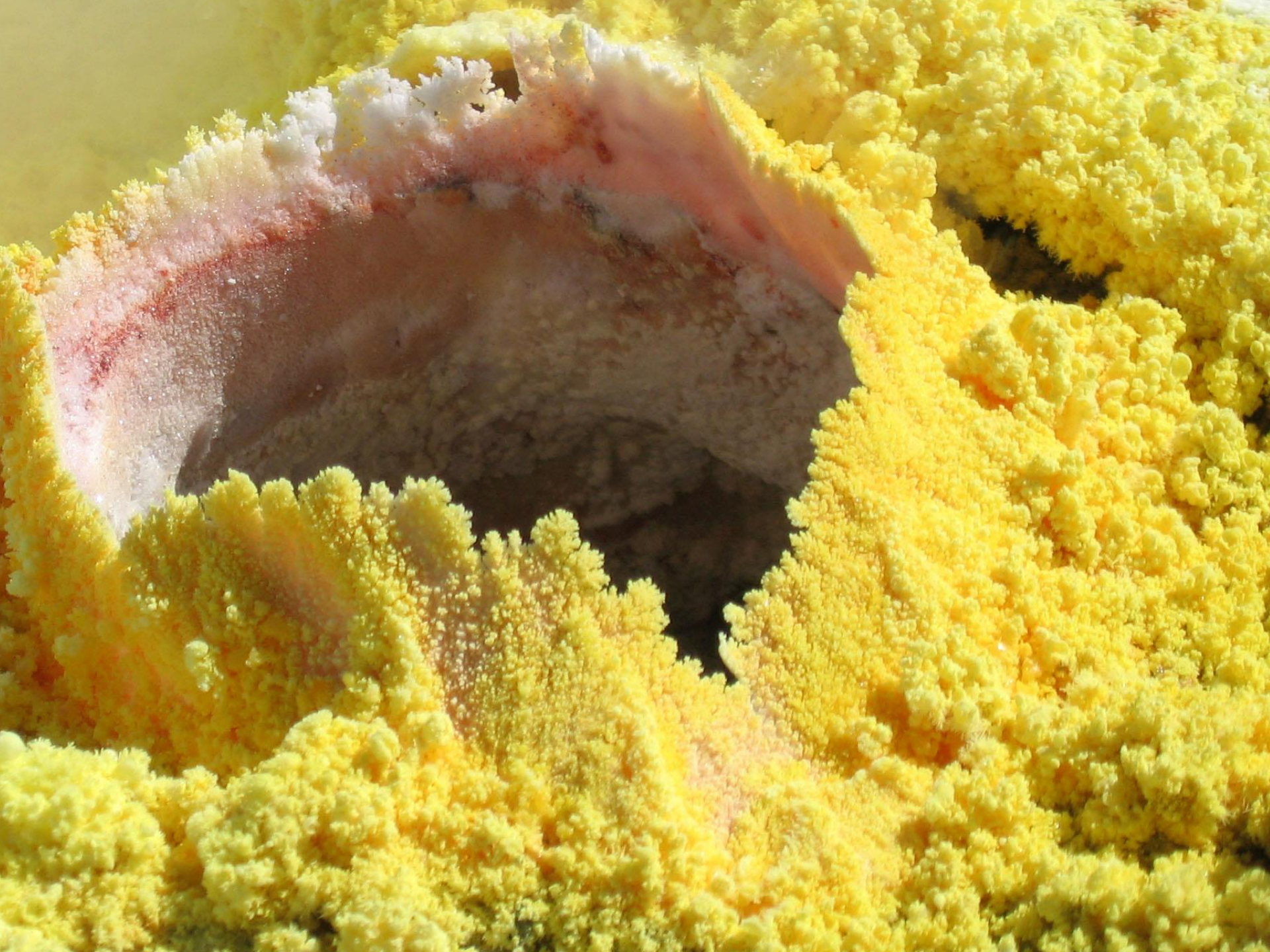
- Distillation uses differences in the boiling points of substances to separate a homogeneous mixture into its components.

Chromatography

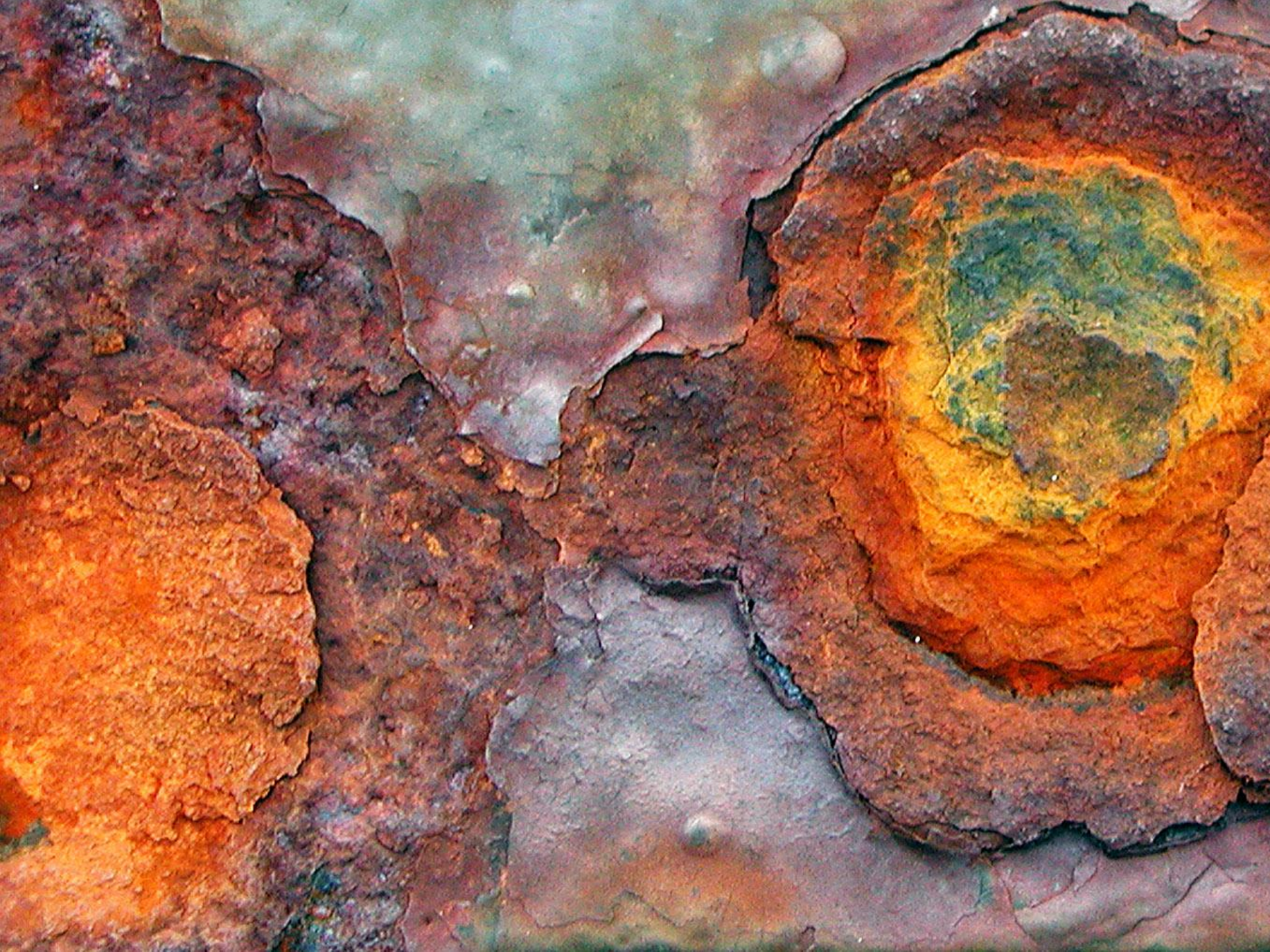
- This technique separates substances on the basis of differences in the ability of substances to adhere to the solid surface, in this case, dyes to paper.








www.mchs.gov.ru



Numbers and Chemistry

- Units of measurement
- Quantities that are measured and calculated
- Uncertainty in measurement
- Significant figures
- Dimensional analysis

Units of Measurements—SI Units

Table 1.4 SI Base Units

Physical Quantity	Name of Unit	Abbreviation
Mass	Kilogram	kg
Length	Meter	m
Time	Second	s or sec
Temperature	Kelvin	K
Amount of substance	Mole	mol
Electric current	Ampere	A or amp
Luminous intensity	Candela	cd

- *Système International d'Unités* ("The International System of Units")
- A different base unit is used for each quantity.

Units of Measurement—Metric System

❖The base units used in the metric system

- Mass: gram (g)
- Length: meter (m)
- Time: second (s or sec)
- Temperature: degrees Celsius (^{o}C) *or* Kelvins (K)
- Amount of a substance: mole (mol)
- Volume: cubic centimeter (cc or cm^3) *or* liter (l or L)

Units of Measurement—Metric System Prefixes

Table 1.5 Prefixes Used in the Metric System and with SI Units

Prefix	Abbreviation	Meaning	Example	
Peta	P	10^{15}	1 petawatt (PW)	$= 1 \times 10^{15}$ watts[a]
Tera	T	10^{12}	1 terawatt (TW)	$= 1 \times 10^{12}$ watts
Giga	G	10^{9}	1 gigawatt (GW)	$= 1 \times 10^{9}$ watts
Mega	M	10^{6}	1 megawatt (MW)	$= 1 \times 10^{6}$ watts
Kilo	k	10^{3}	1 kilowatt (kW)	$= 1 \times 10^{3}$ watts
Deci	d	10^{-1}	1 deciwatt (dW)	$= 1 \times 10^{-1}$ watt
Centi	c	10^{-2}	1 centiwatt (cW)	$= 1 \times 10^{-2}$ watt
Milli	m	10^{-3}	1 milliwatt (mW)	$= 1 \times 10^{-3}$ watt
Micro	μ[b]	10^{-6}	1 microwatt (μW)	$= 1 \times 10^{-6}$ watt
Nano	n	10^{-9}	1 nanowatt (nW)	$= 1 \times 10^{-9}$ watt
Pico	p	10^{-12}	1 picowatt (pW)	$= 1 \times 10^{-12}$ watt
Femto	f	10^{-15}	1 femtowatt (fW)	$= 1 \times 10^{-15}$ watt
Atto	a	10^{-18}	1 attowatt (aW)	$= 1 \times 10^{-18}$ watt
Zepto	z	10^{-21}	1 zeptowatt (zW)	$= 1 \times 10^{-21}$ watt

[a]The watt (W) is the SI unit of power, which is the rate at which energy is either generated or consumed. The SI unit of energy is the joule (J); $1\ J = 1\ kg \cdot m^2/s^2$ and $1\ W = 1\ J/s$.
[b]Greek letter mu, pronounced "mew."

- Prefixes convert the base units into units that are appropriate for common usage or appropriate measure.

Mass and Length

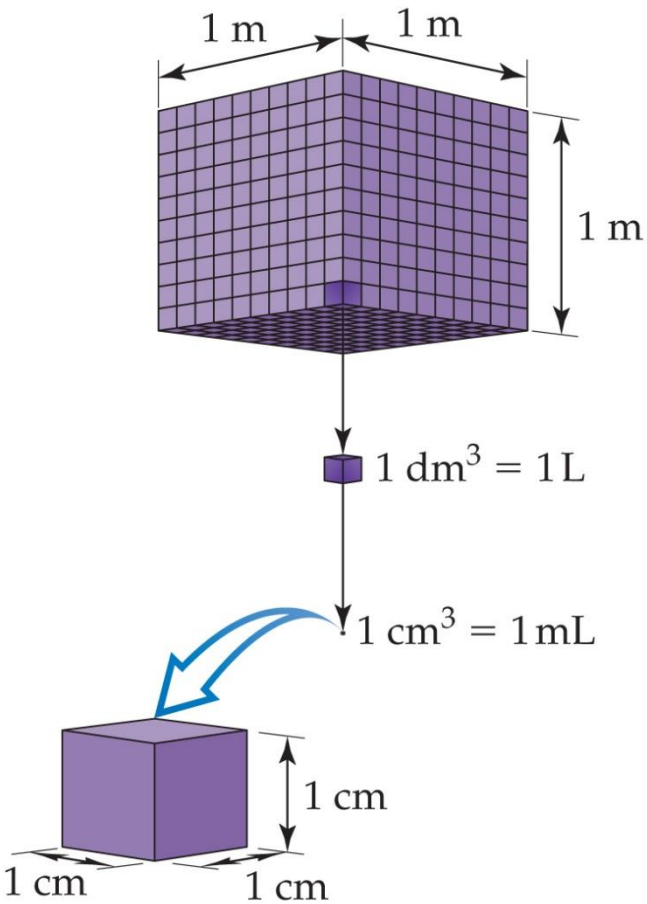
- These are basic units we measure in science.
- **Mass** is a measure of the amount of material in an object. SI uses the kilogram as the base unit. The metric system uses the gram as the base unit.
- **Length** is a measure of distance. The meter is the base unit.

Volume

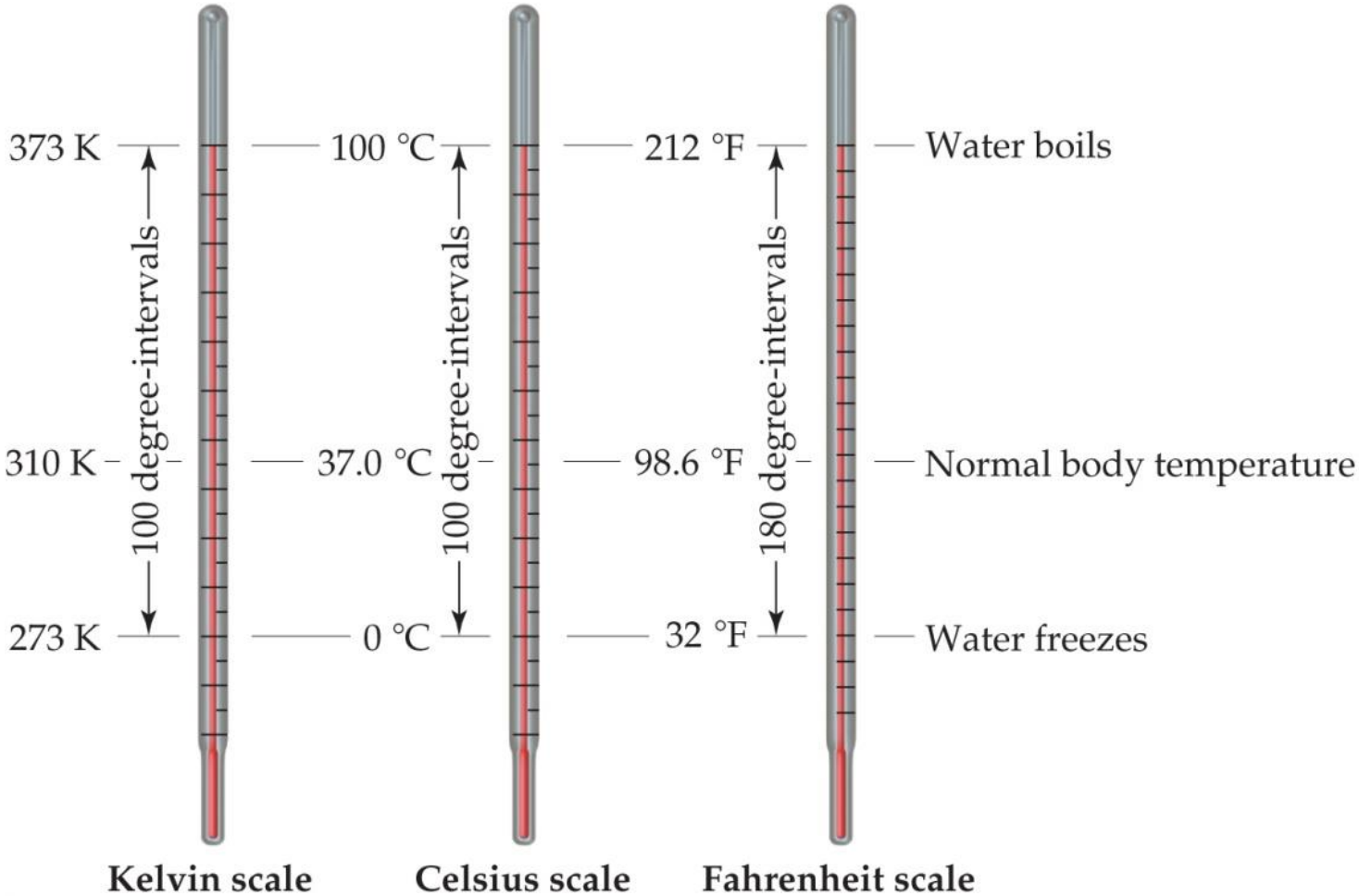
- Note that volume is not a base unit for SI; it is derived from length (m × m × m = m^3).
- The most commonly used metric units for volume are the liter (L) and the milliliter (mL).

✓A liter is a cube 1 decimeter (dm) long on each side.

✓A milliliter is a cube 1 centimeter (cm) long on each side, also called 1 cubic centimeter (cm × cm × cm = cm^3).



Temperature



Temperature

- In scientific measurements, the Celsius and Kelvin scales are most often used.
- The Celsius scale is based on the properties of water.
  - 0 °C is the freezing point of water.
  - 100 °C is the boiling point of water.
- The kelvin is the SI unit of temperature.
  - It is based on the properties of gases.
  - There are no negative Kelvin temperatures.
  - The lowest possible temperature is called absolute zero (0 K).
- K = °C + 273.15

Temperature

- The Fahrenheit scale is not used in scientific measurements, but you hear about it in weather reports!

- The equations below allow for conversion between the Fahrenheit and Celsius scales:

  $°F = 9/5(°C) + 32$

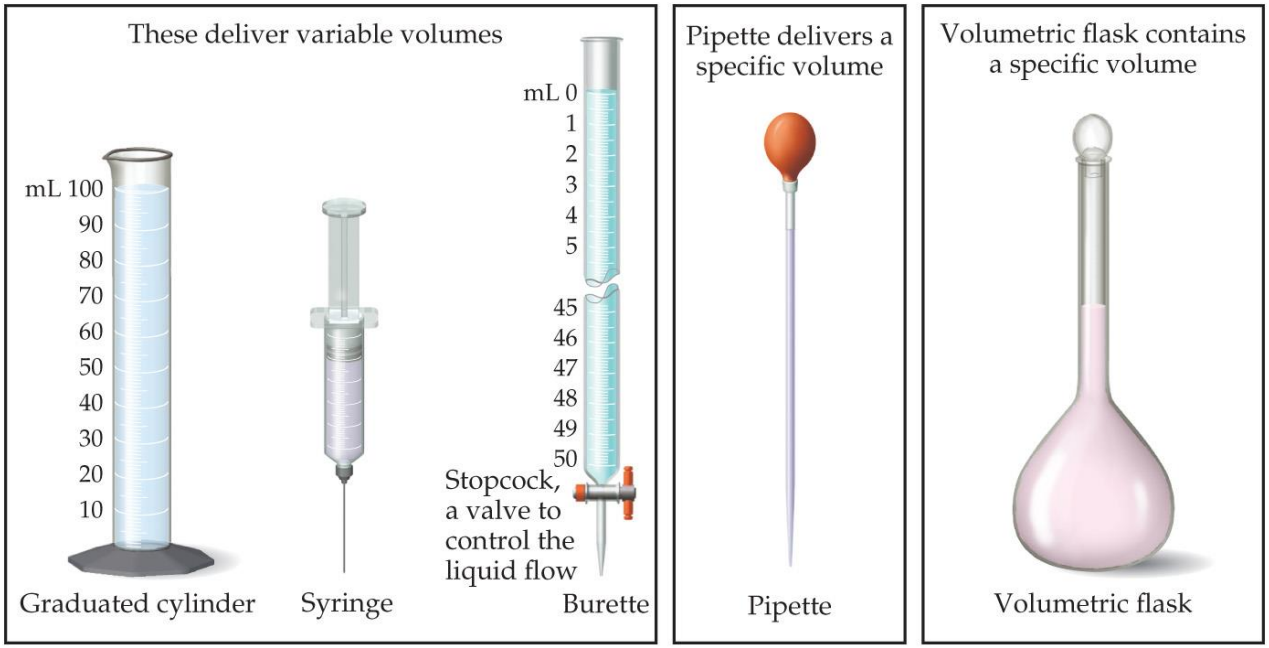
  $°C = 5/9(°F - 32)$

Numbers Encountered in Science

- **Exact** numbers are counted or given by definition. For example, there are 12 eggs in 1 dozen.
- **Inexact** (or **measured**) numbers depend on how they were determined. Scientific instruments have limitations. Some balances measure to ±0.01 g; others measure to ±0.0001g.

Uncertainty in Measurements

- Different measuring devices have different uses and different degrees of accuracy.
- All measured numbers have some degree of inaccuracy.



Accuracy versus Precision

- **Accuracy** refers to the proximity of a measurement to the true value of a quantity.

- **Precision** refers to the proximity of several measurements to each other.

Good accuracy
Good precision

Poor accuracy
Good precision

Poor accuracy
Poor precision

Significant Figures

Why do we care about significant figures?

Counting Significant Figures

1. All nonzero digits are significant.
2. Zeroes between two significant figures are themselves significant.
3. Zeroes at the beginning of a number (leading zeros) are never significant.
4. Zeroes at the end of a number (trailing zeros) are significant only if a decimal point is written in the number.

Significant Figures

- When addition or subtraction is performed, answers are rounded to the least significant **decimal place**.

- When multiplication or division is performed, answers are rounded to the number of digits that corresponds to the ***least*** **number of significant figures** in any of the inexact numbers used in the calculation.

Dimensional Analysis

- We use **dimensional analysis** to convert one quantity to another.
- Most commonly, dimensional analysis utilizes **conversion factors** (e.g., 1 in. = 2.54 cm).
- We can set up a ratio of comparison for the equality either 1 in/2.54 cm *or* 2.54 cm/1 in.
- We use the ratio which allows us to change units (puts the units we have in the denominator to cancel).