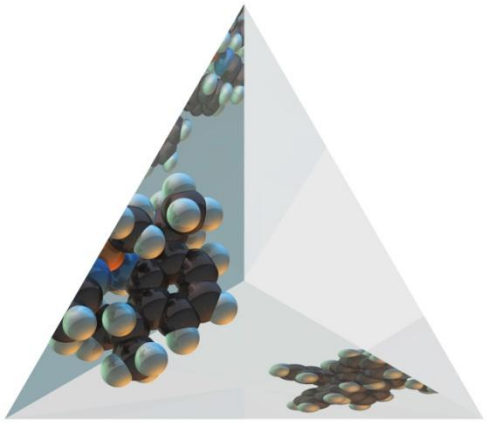


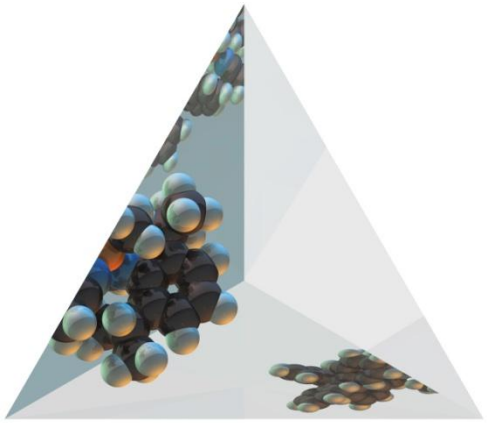
CHEMISTRY

The Central Science

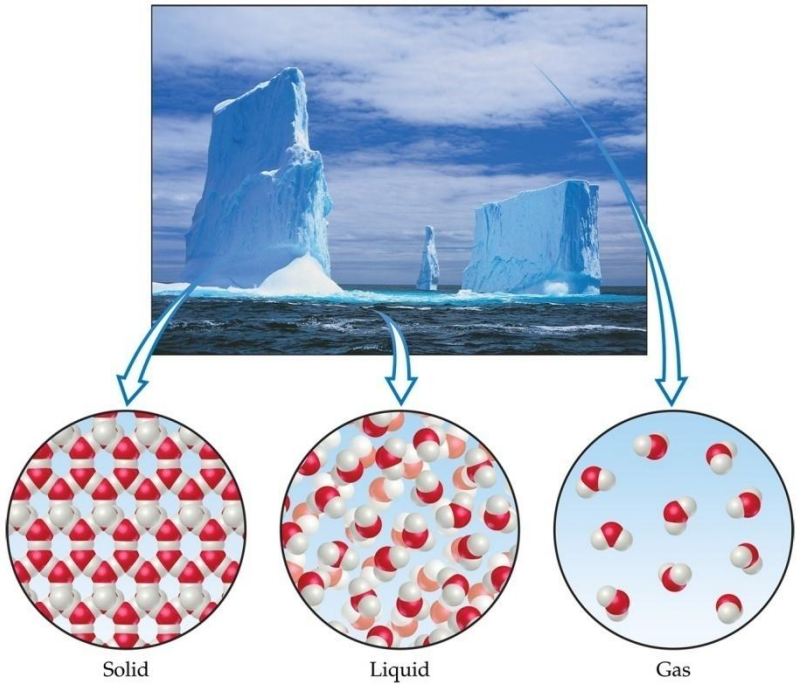
8th Edition

Chapter 1
Introduction
Matter & Measurement

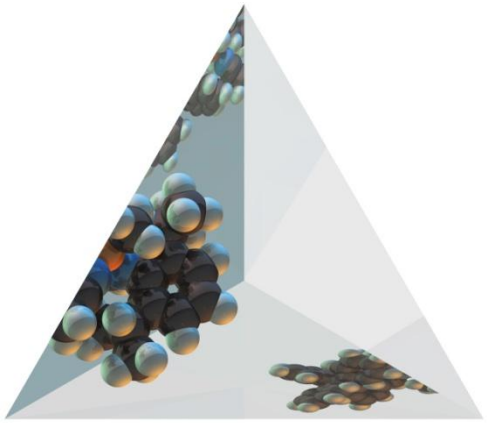
Dr. Kozet YAPSAKLI



Chemistry:

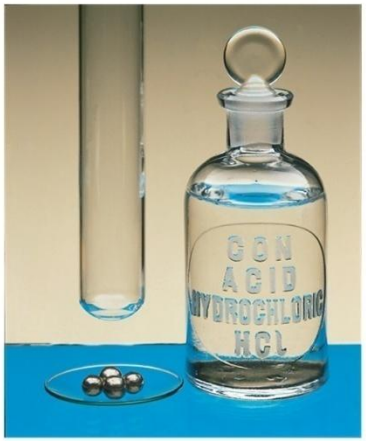


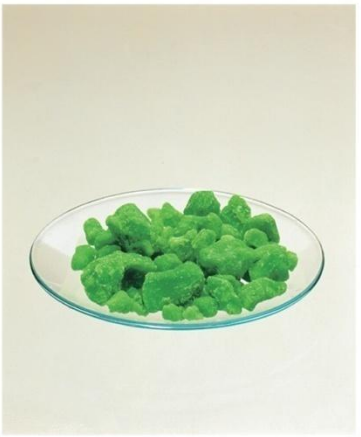
The study of matter and the changes it undergoes.

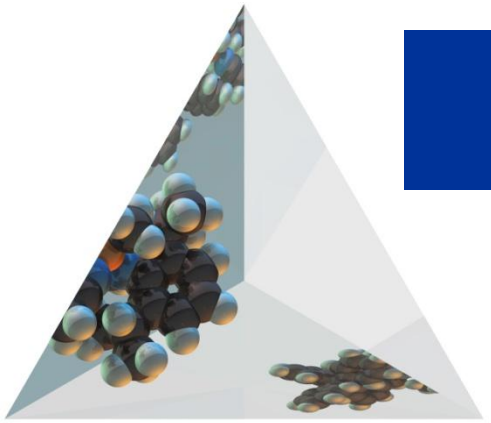


Matter:

Anything that has mass and takes up space.



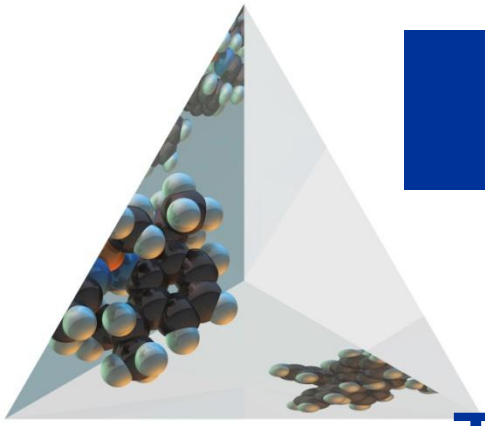




The Study of Chemistry

The Molecular Perspective of Chemistry

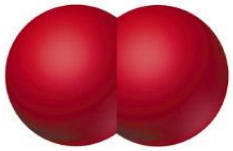
- On the microscopic level, matter consists of atoms and molecules.
- Atoms combine to form molecules.
- Molecules may consist of the same type of atoms or different types of atoms.



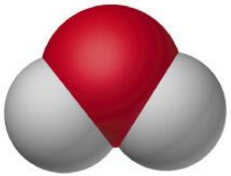
The Study of Chemistry

The Molecular Perspective of Chemistry

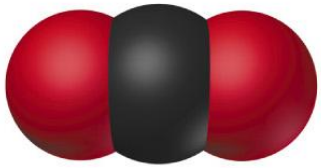
Chemistry also helps to understand the properties of matter in terms of atoms.



(a) Oxygen

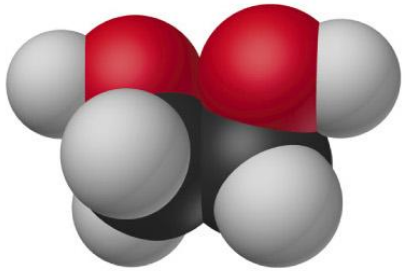


(b) Water

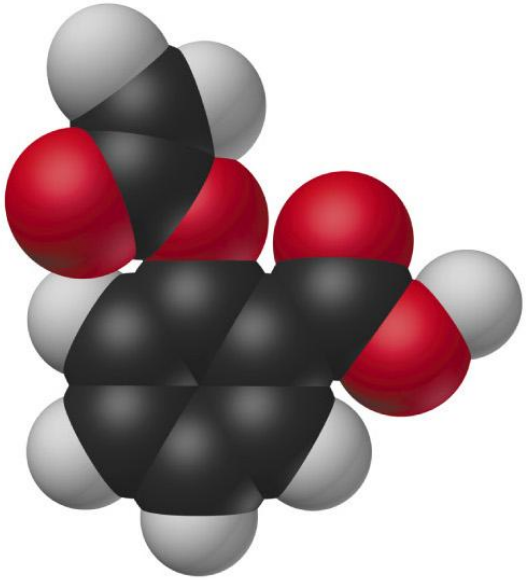


(c) Carbon dioxide

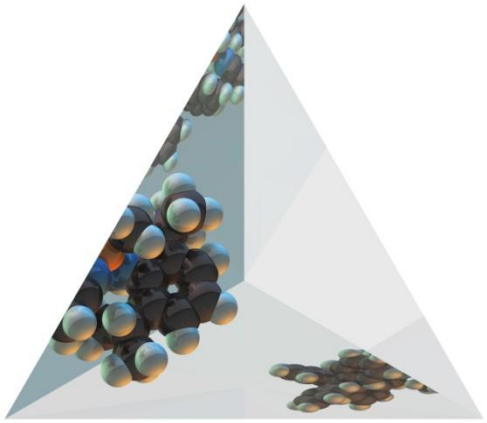
(d) Ethanol



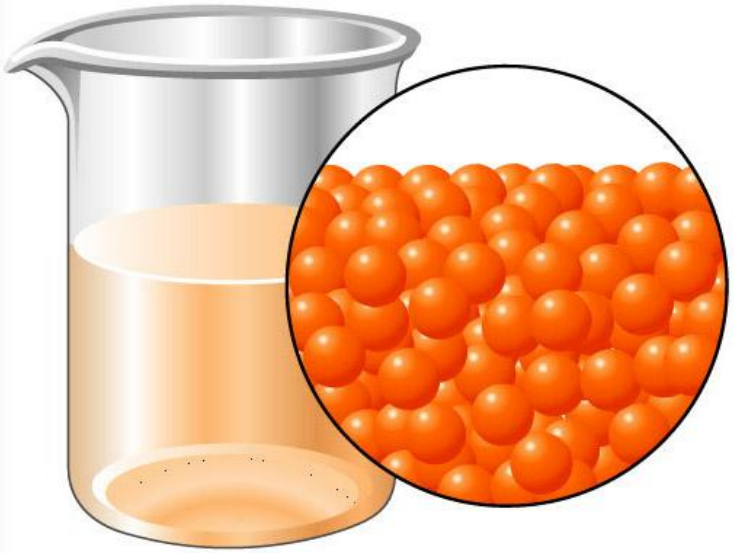
(e) Ethylene glycol



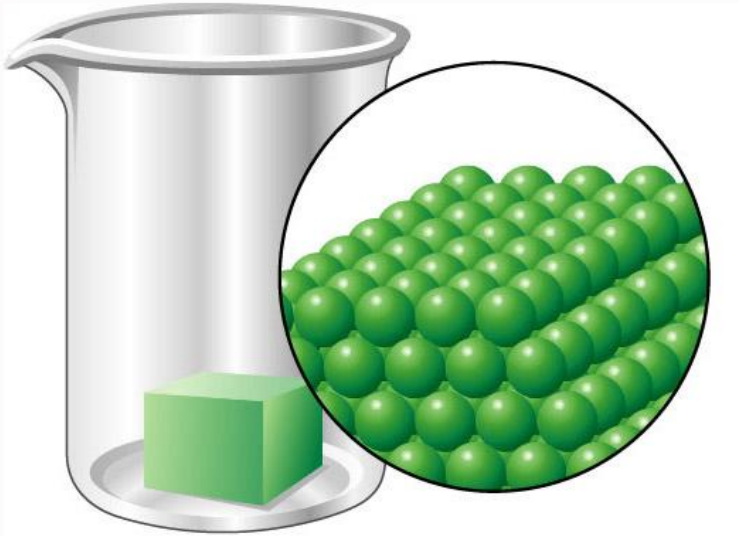
(f) Aspirin



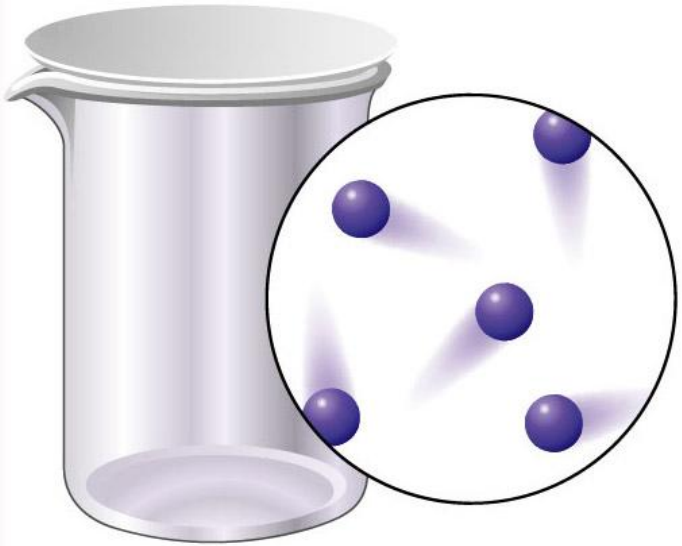
States of Matter



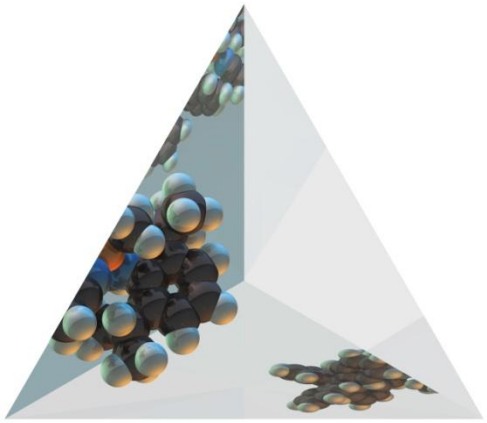
Liquid



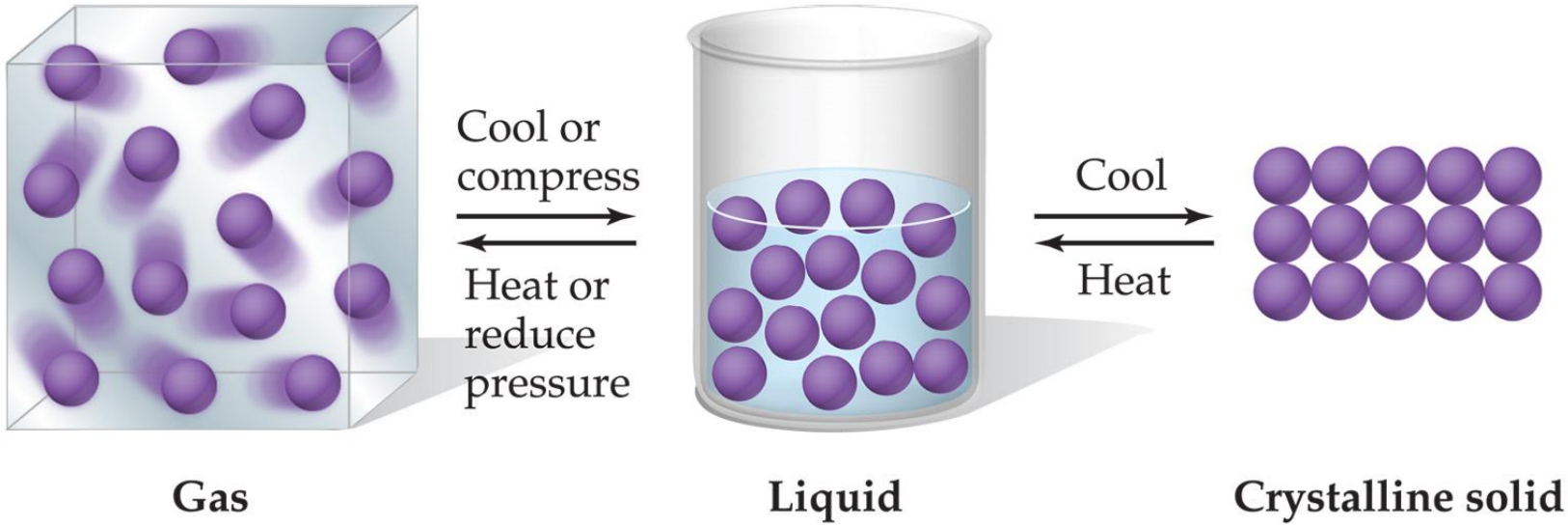
Solid

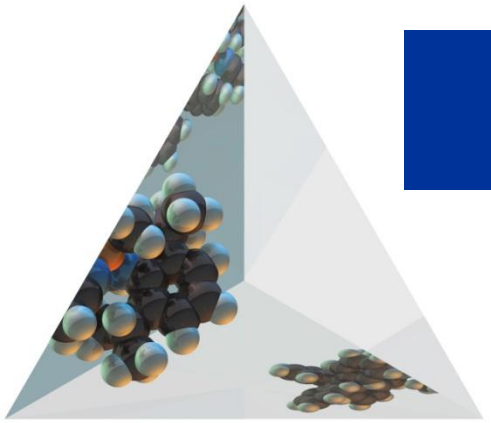


Gas



States of Matter

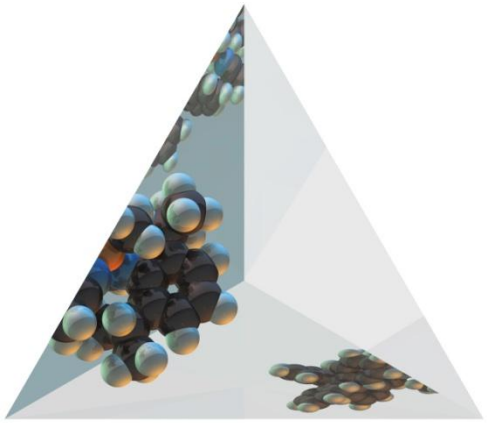




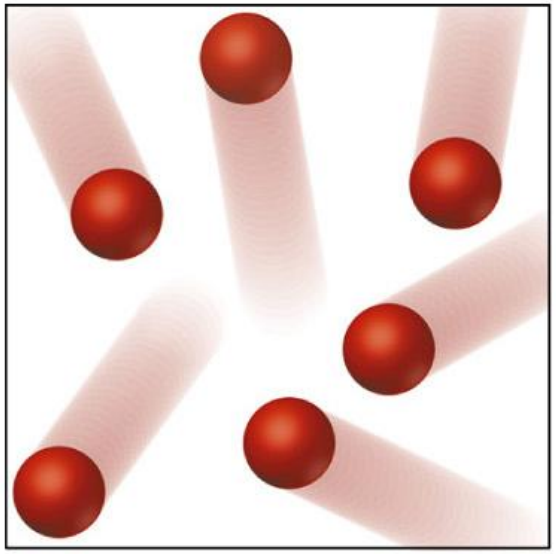
Classification of Matter

Pure Substances and Mixtures

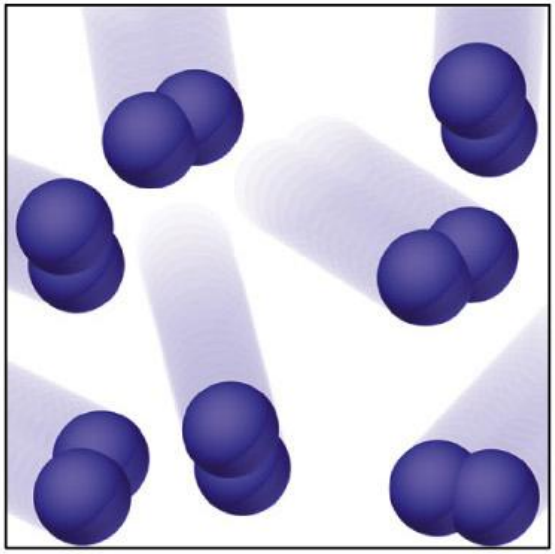
- Atoms consist only of one type of element.
- Molecules can consist of more than one type of element.
  - Molecules can have only one type of atom (an element).
  - Molecules can have more than one type of atom (a compound).
- If more than one atom, element, or compound are found together, then the substance is a mixture.



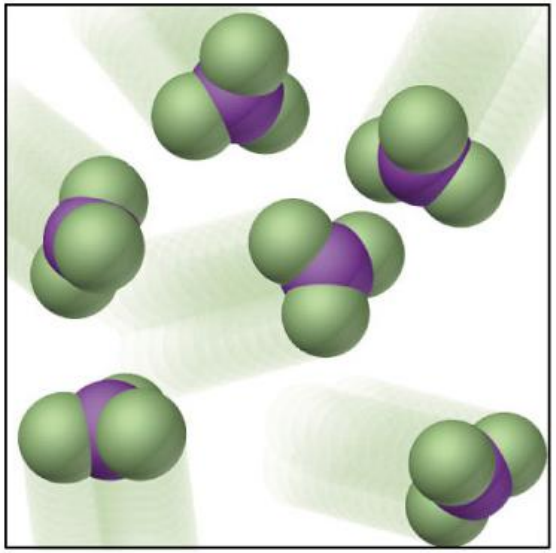
Pure Substances and Mixtures



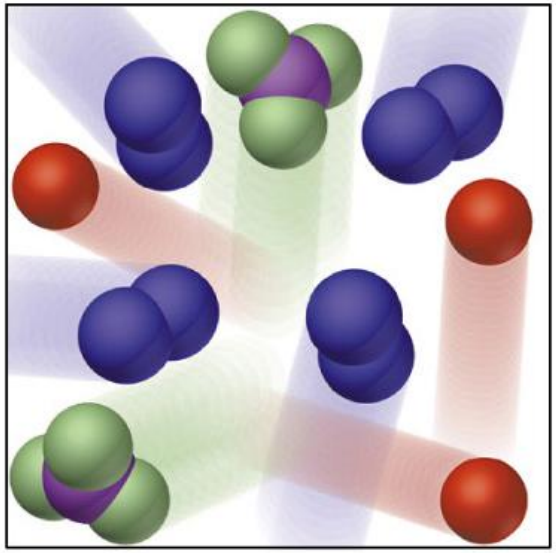
(a) Atoms of an element



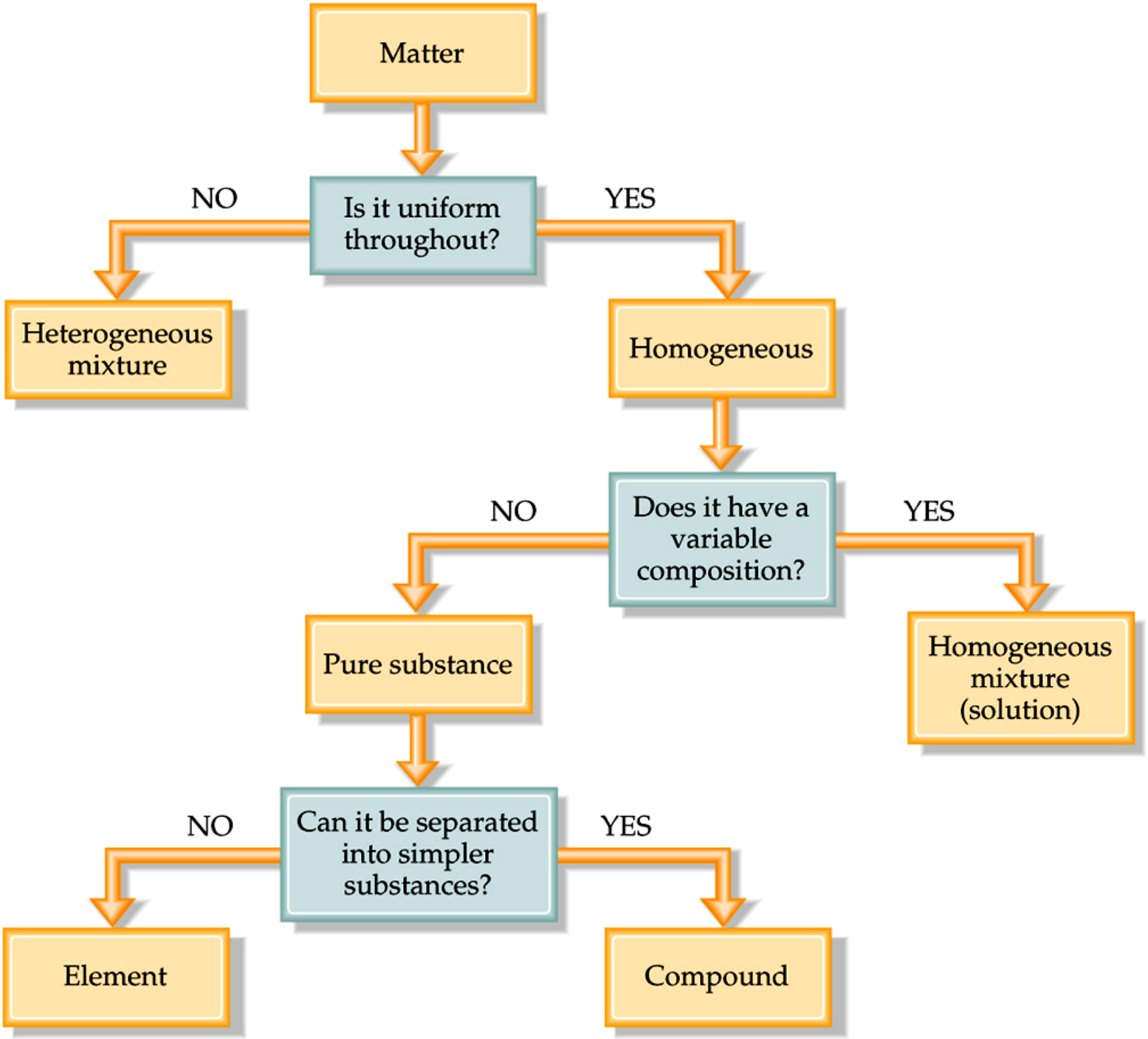
(b) Molecules of an element

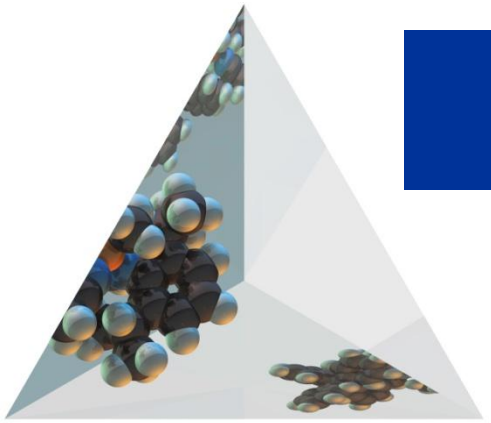


(c) Molecules of a compound



(d) Mixture of elements and a compound

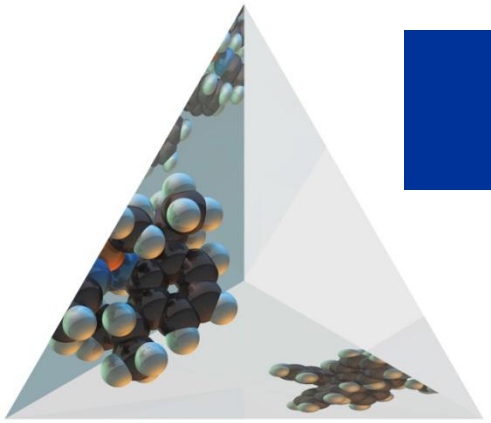

Matter
Is it uniform throughout?
NO
YES
Heterogeneous mixture
Homogeneous
Does it have a variable composition?
NO
YES
Pure substance
Homogeneous mixture (solution)
Can it be separated into simpler substances?
NO
YES
Element
Compound



Classification of Matter

Elements

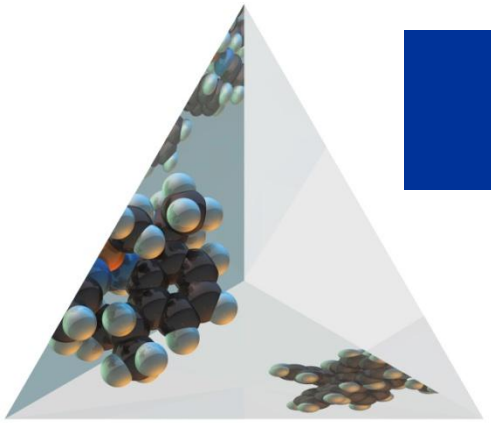
- If a pure substance cannot be decomposed into something else, then the substance is an *element*.
- There are 114 elements known.
- Each element is given a unique chemical symbol (H, Ca)
- Elements are building blocks of matter.
- The earth's crust consists of 5 main elements.
- The human body consists mostly of 3 main elements.



Classification of Matter

Compounds

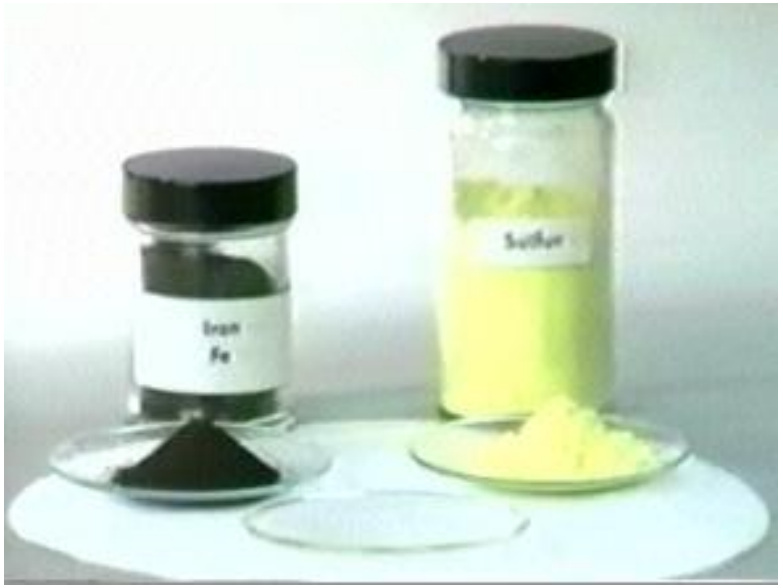
- Most elements interact to form compounds.
- The proportions of elements in compounds are the same irrespective of how the compound was formed.
- The composition of a pure compound is always the same.
- If water is decomposed, then there will always be twice as much hydrogen gas formed as oxygen gas.

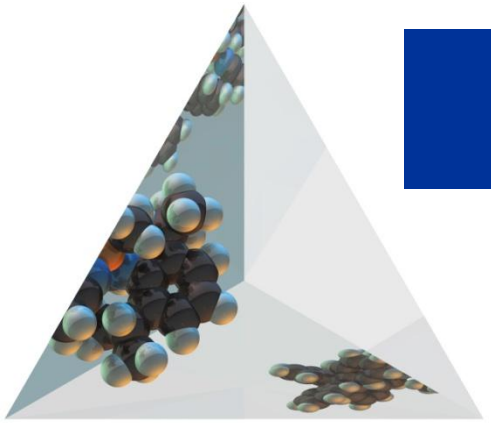


Classification of Matter

Mixtures

- Heterogeneous mixtures are not uniform throughout.
- Homogeneous mixtures are uniform throughout.
- Homogeneous mixtures are called solutions.

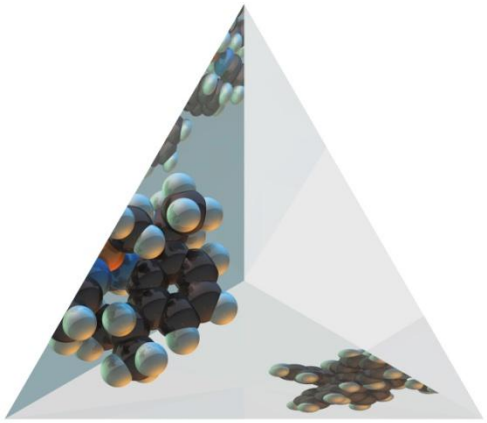




Properties of Matter

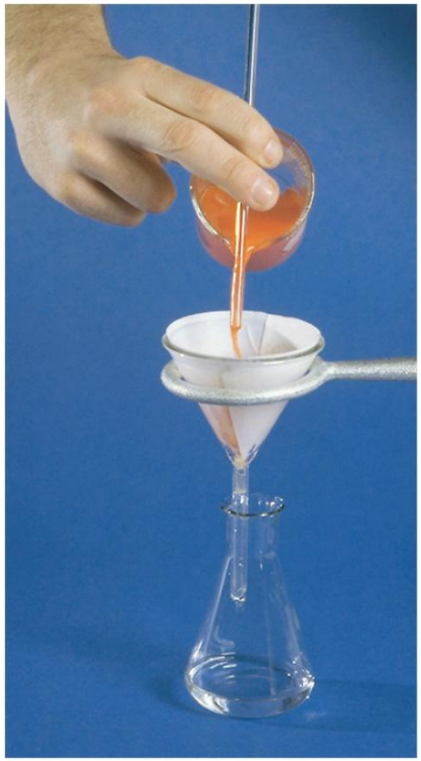
Separation of Mixtures

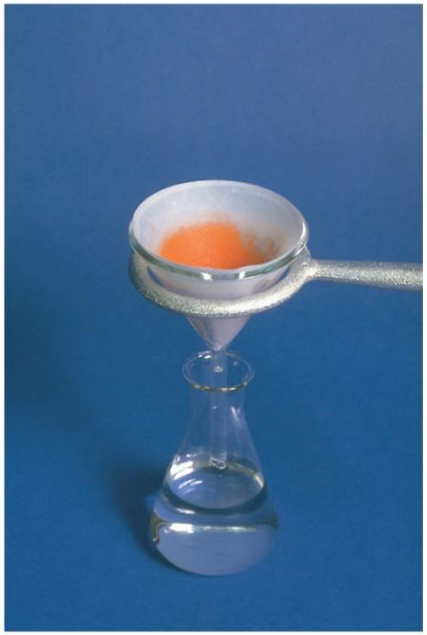
- Mixtures can be separated if their physical properties are different.
- Solids can be separated from liquids by means of *filtration*.
- The solid is collected in filter paper, and the solution, called the filtrate, passes through the filter paper and is collected in a flask.

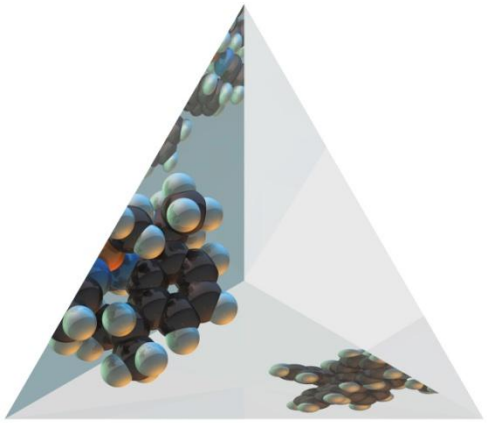


Filtration:

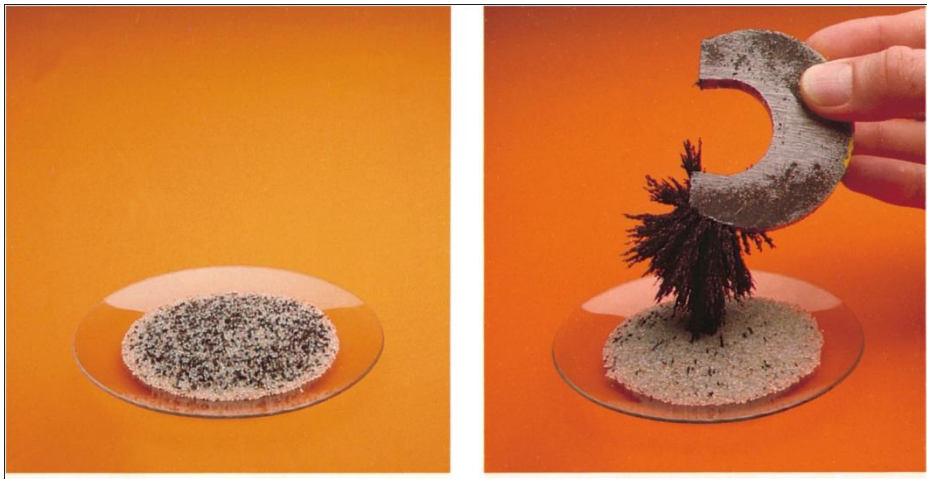
Separates solid substances from liquids and solutions.



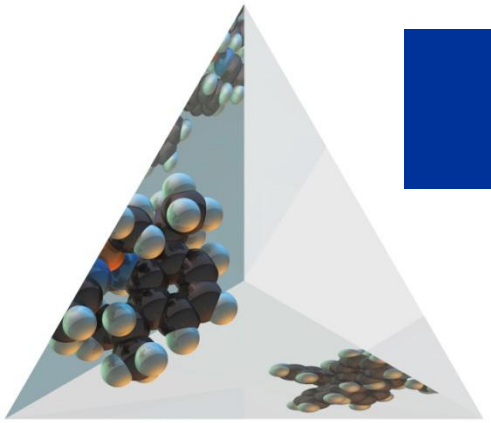




Physical Separation



magnet

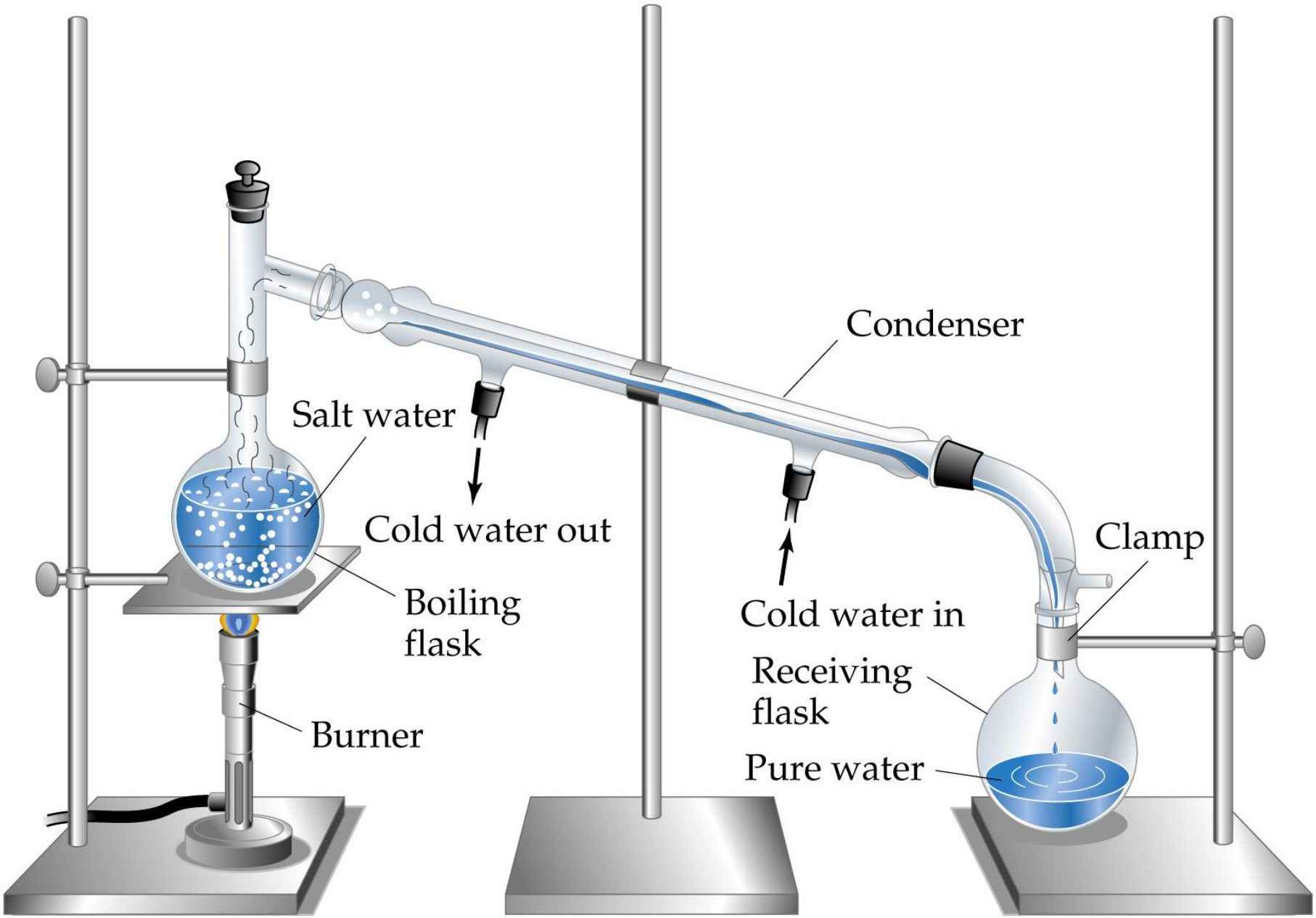


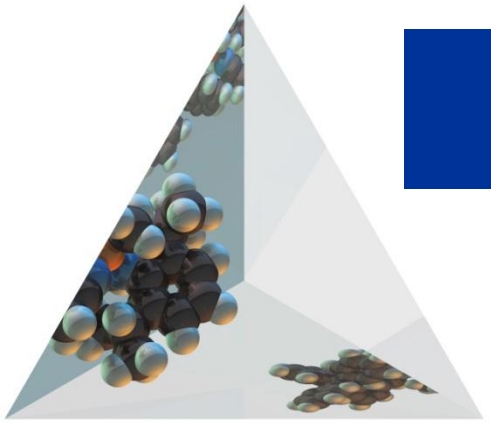
Properties of Matter

Separation of Mixtures

- Homogeneous liquid mixtures can be separated by *distillation*.
- Distillation requires the different liquids to have different boiling points.
- In essence, each component of the mixture is boiled and collected.
- The lowest boiling fraction is collected first.

Separation of Mixtures

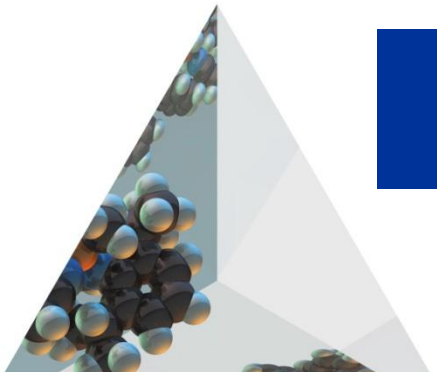




Units of Measurement

SI Units

- There are two types of units:
  - fundamental (or base) units;
  - derived units.
- There are 7 base units in the SI system.

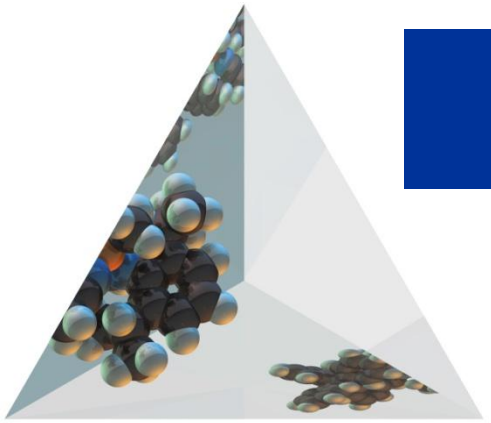


Units of Measurement

TABLE 1.4 SI Base Units

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

[a] The abbreviation sec is frequently used.



Units of Measurement

SI Units

TABLE 1.5 Selected Prefixes Used in the Metric System

Prefix	Abbreviation	Meaning	Example
Giga	G	10^{9}	1 gigameter (Gm) $= 1 \times 10^{9}$ m
Mega	M	10^{6}	1 megameter (Mm) $= 1 \times 10^{6}$ m
Kilo	k	10^{3}	1 kilometer (km) $= 1 \times 10^{3}$ m
Deci	d	10^{-1}	1 decimeter (dm) $= 0.1$ m
Centi	c	10^{-2}	1 centimeter (cm) $= 0.01$ m
Milli	m	10^{-3}	1 millimeter (mm) $= 0.001$ m
Micro	μ[a]	10^{-6}	1 micrometer (μm) $= 1 \times 10^{-6}$ m
Nano	n	10^{-9}	1 nanometer (nm) $= 1 \times 10^{-9}$ m
Pico	p	10^{-12}	1 picometer (pm) $= 1 \times 10^{-12}$ m
Femto	f	10^{-15}	1 femtometer (fm) $= 1 \times 10^{-15}$ m

[a] This is the Greek letter mu (pronounced "mew").

Units of Measurement

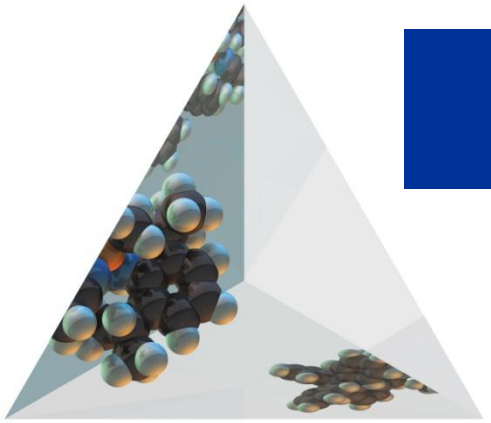
SI Units

- Note the SI unit for length is the meter (m) whereas the SI unit for mass is the kilogram (kg).
  - 1 kg weighs 2.2046 lb.

Temperature

There are three temperature scales:

- Kelvin Scale
  - Used in science.
  - Same temperature increment as Celsius scale.
  - Lowest temperature possible (absolute zero) is zero Kelvin.
  - Absolute zero: 0 K = –273.15 ^{o}C.

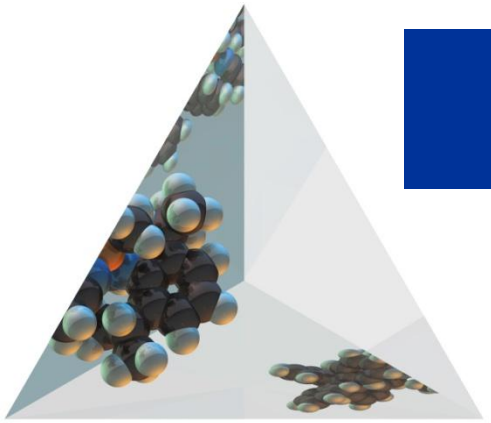


Units of Measurement

Temperature

- Celsius Scale
  - Also used in science.
  - Water freezes at 0 ^{o}C and boils at 100 ^{o}C.
  - To convert: K = ^{o}C + 273.15.
- Fahrenheit Scale
  - Not generally used in science.
  - Water freezes at 32 ^{o}F and boils at 212 ^{o}F.
  - To convert:

$$°C = \frac{5}{9}(°F - 32) \qquad °F = \frac{9}{5}(°C) + 32$$

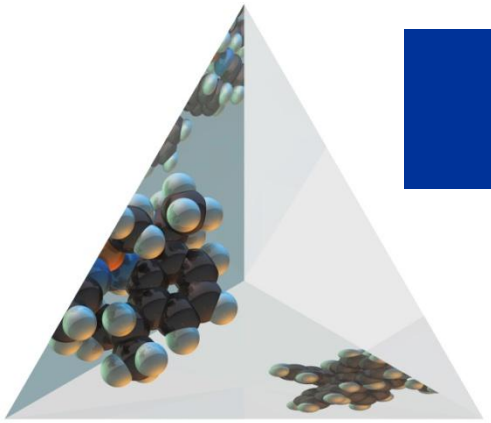


Units of Measurement

Derived Units

- Derived units are obtained from the 7 base SI units.
- Example:

$$\text{Units of velocity} = \frac{\text{units of distance}}{\text{units of time}} = \frac{\text{meters}}{\text{seconds}} = \text{m/s}$$



Units of Measurement

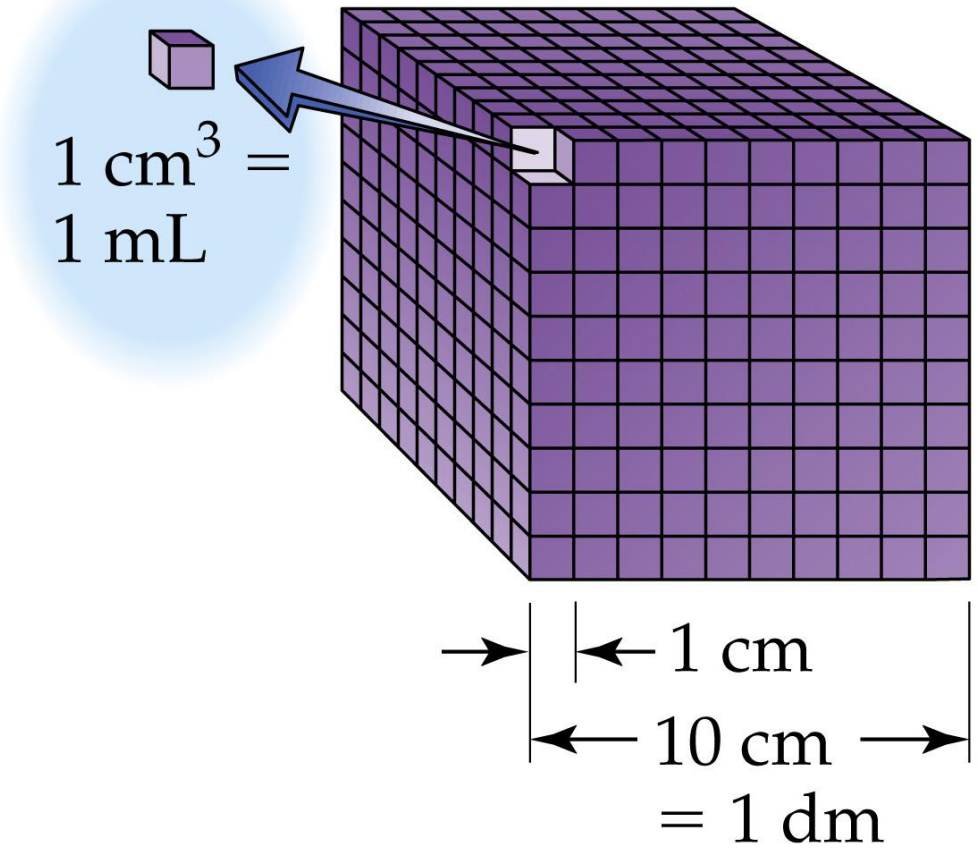
Volume

$$1\,\text{L} = 1\,\text{dm}^3 = 1000\,\text{cm}^3$$

- The units for volume are given by

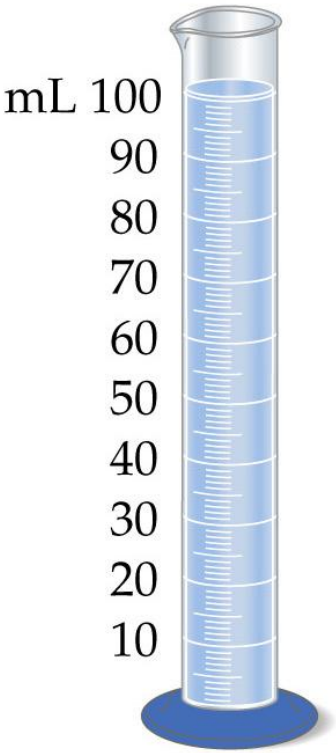
  (units of length)^3.

  - SI unit for vol. is 1 m^3.
- usually use 1 mL=1 cm^3



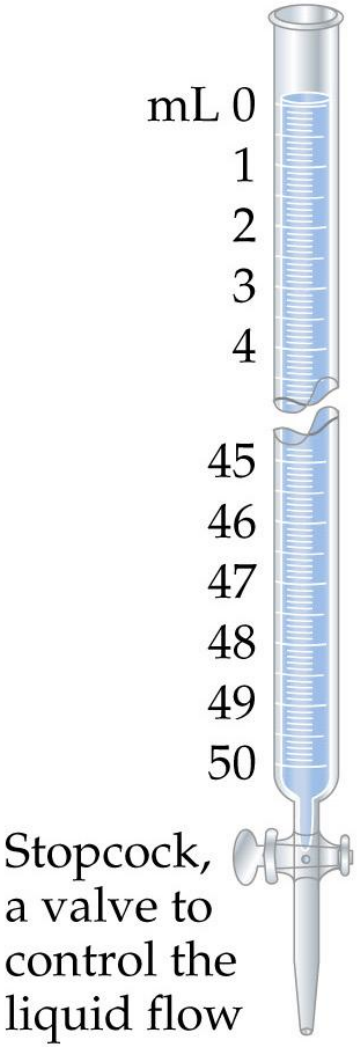
Units of Measurement

Volume



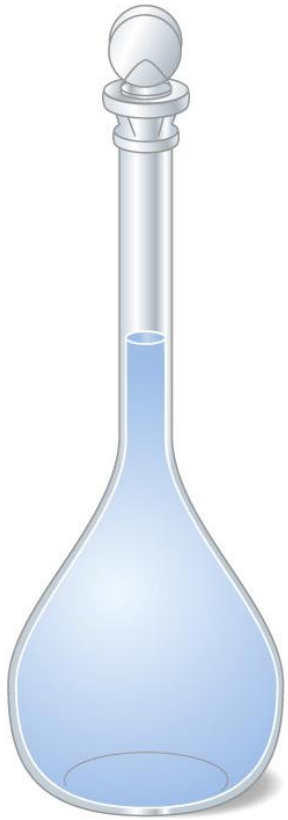
Graduated cylinder

Syringe

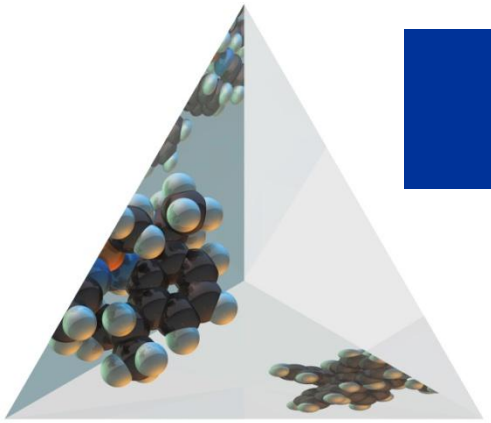


Buret

Pipet



Volumetric flask



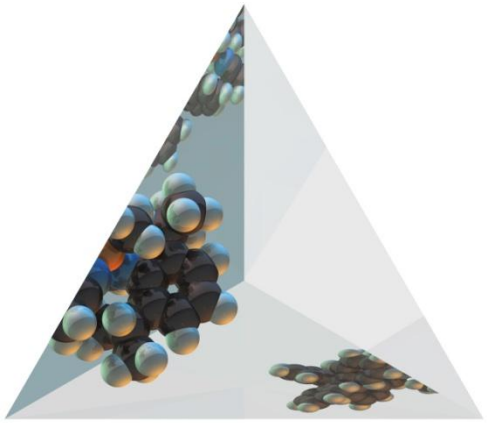
Units of Measurement

Density

- Used to characterize substances.
- Defined as mass divided by volume:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

- Units: g/cm^3.
- Originally based on mass (the density was defined as the mass of 1.00 g of pure water).



- In chemistry there are two types of numbers:
  - Exact numbers (precisely fixed values)
  - Inexact numbers

  Every measurement other than that of counting gives inexact number

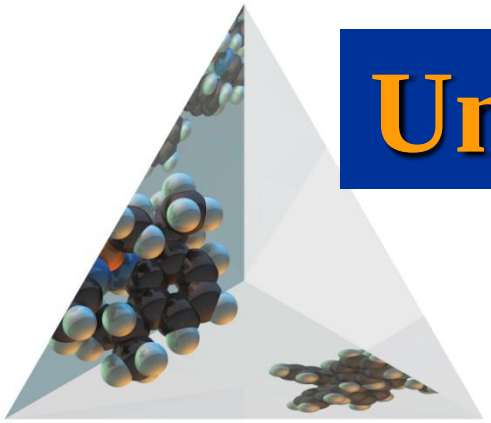
Uncertainty in Measurement

Uncertainty in Measurement

- All scientific measures are subject to error.
- These errors are reflected in the **number of significant figures** reported for the measurement.
- These errors are also reflected in the observation that two successive measures of the same quantity are different.

Precision and Accuracy

- Measurements that are close to the "correct" value are *accurate*.
- Measurements that are close to each other are *precise*.



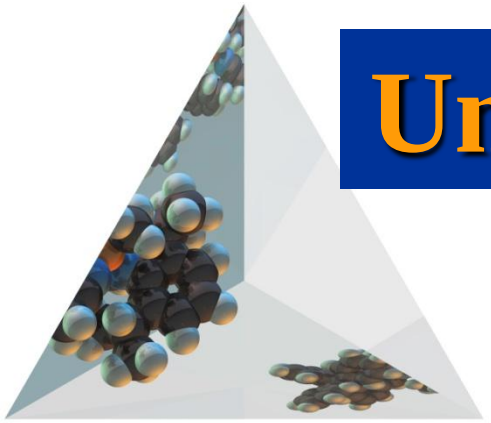
Uncertainty in Measurement

Precision and Accuracy

Good accuracy
Good precision

Poor accuracy
Good precision

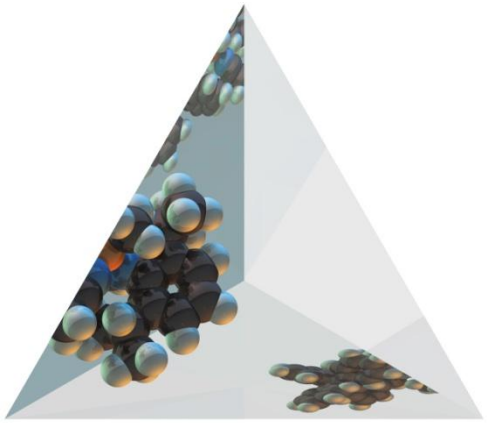
Poor accuracy
Poor precision



Uncertainty in Measurement

Significant Figures

- All the figures known with certainty plus one extra figure are called significant figures.
- Significant figures indicate the margin of error in a measurement.
- When significant figures are used the last digit is understood to be uncertain.



Dimensional Analysis

Dimensional Analysis

- Method of calculation utilizing a knowledge of units.
- Given units can be multiplied or divided to give the desired units.
- Conversion factors are used to manipulate units:
- Desired unit = given unit × (conversion factor)
- The conversion factors are simple ratios:

$$\text{Conversion factor} = \frac{\text{desired unit}}{\text{given unit}}$$