AP Chemistry
Chapter 1: Matter & Measurement

The Study of Chemistry

- Matter: has mass and occupies space
- Properties:
  - characteristics of matter
  - allow us to identify and distinguish types of matter
  - Relate to the composition & structure of matter

Matter

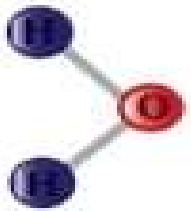
Anything that takes up space and displays the properties of mass and inertia

2 parts/components

Composition

Components of a sample and their relative proportions

Example: Water/H2O
Components: Hydrogen and Oxygen
[2 parts Hydrogen, 1 part Oxygen



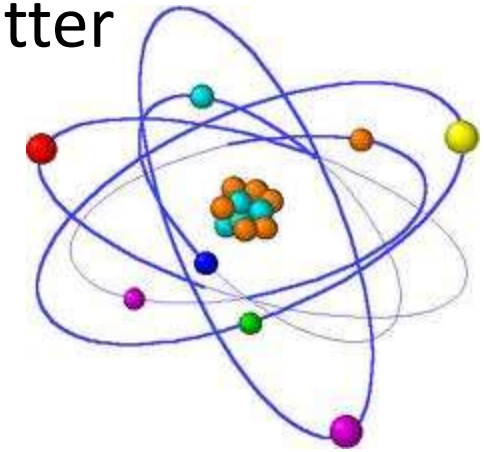
Properties

Distinguishing qualities or attributes of a sample of matter

Example: banana
Color: yellow/green
Texture: squishy/soft
Changes: browning

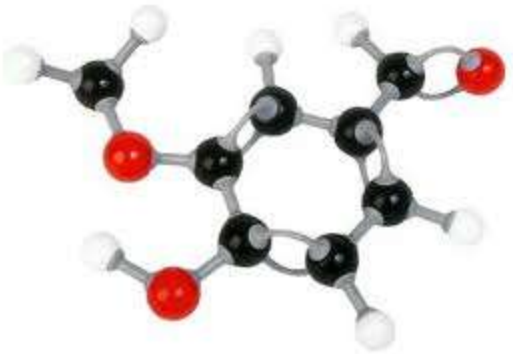
ATOMS

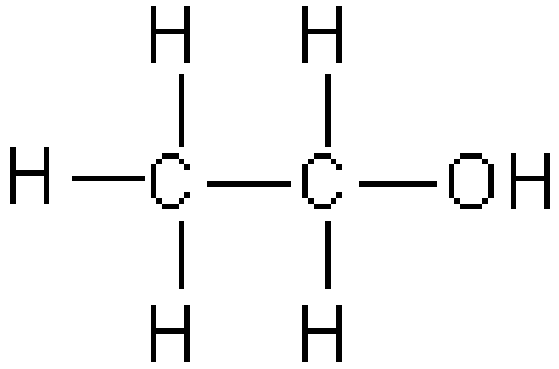
- Elements
  - ~116 known elements
  - Can occur naturally or made in laboratories
  - Composed of one type of atom
- Atoms
  - Submicroscopic building blocks of matter
  - Composed of subatomic particles

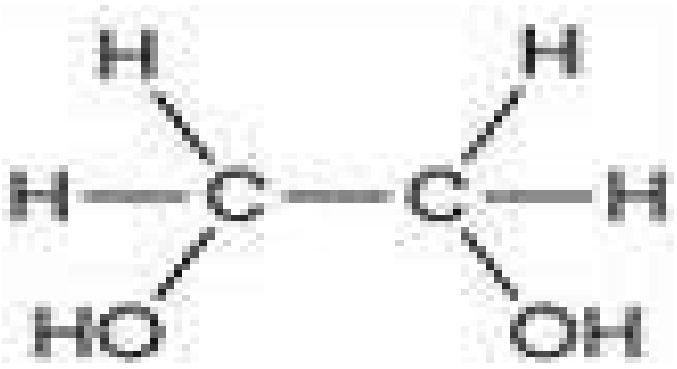


Molecules

- 2 or more atoms joined together by covalent bonds
- Can be the same element (H_2 or O_2) or different elements (H_2O)
- “Minor differences” = Different properties
- Ethanol vs. Ethylene glycol
- Water vs. Hydrogen peroxide




H
H
H
C
C
OH
H
H


H
H
H
C
C
H
HO
OH

- Macroscopic = ordinary sized objects
  - This is where we make our observations

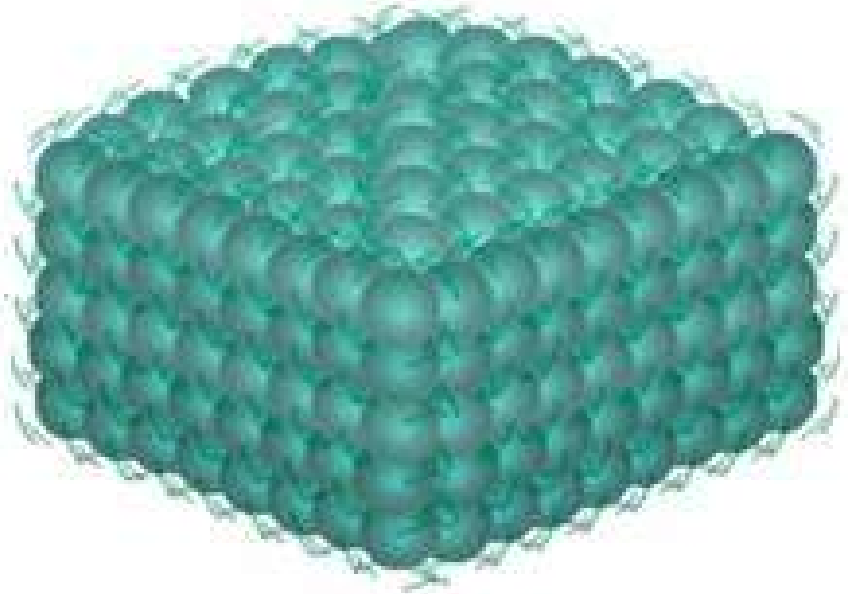
- Submicroscopic = atoms and molecules
  - Changes here cause changes in macroscopic

Classification of Matter

- State
  - Solid
  - Liquid
  - Gas
- Composition
  - Element
  - Compound
  - Mixture

Solids

- Definite shape and volume
- Particles packed tightly
- Vibrate in fixed position

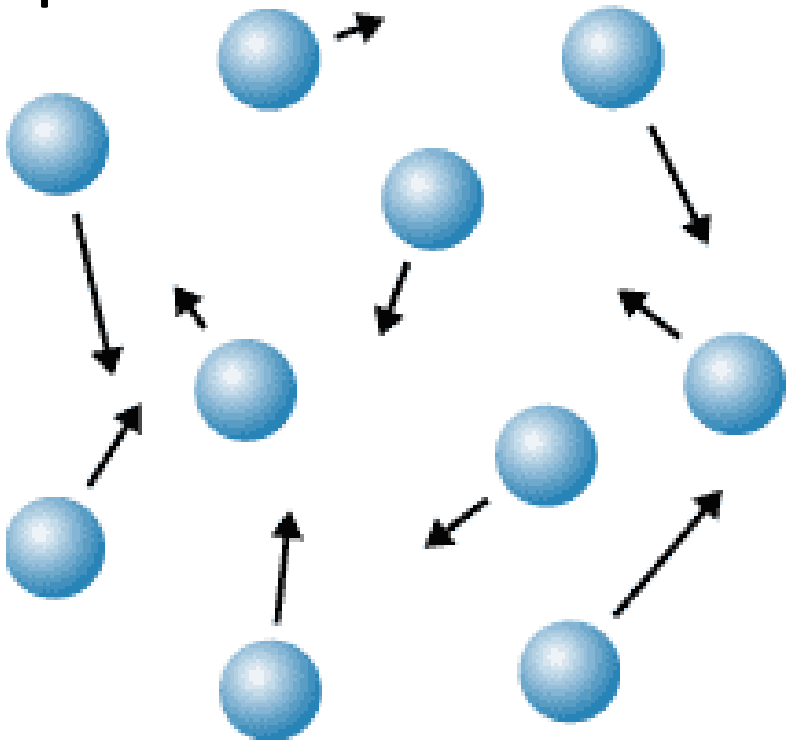


Liquids

- Definite volume
- Takes shape of container
- Particles allowed to move around each other (flow)

Gases

- Take shape and volume of container
- Particles move freely
- Can be compressed and expanded

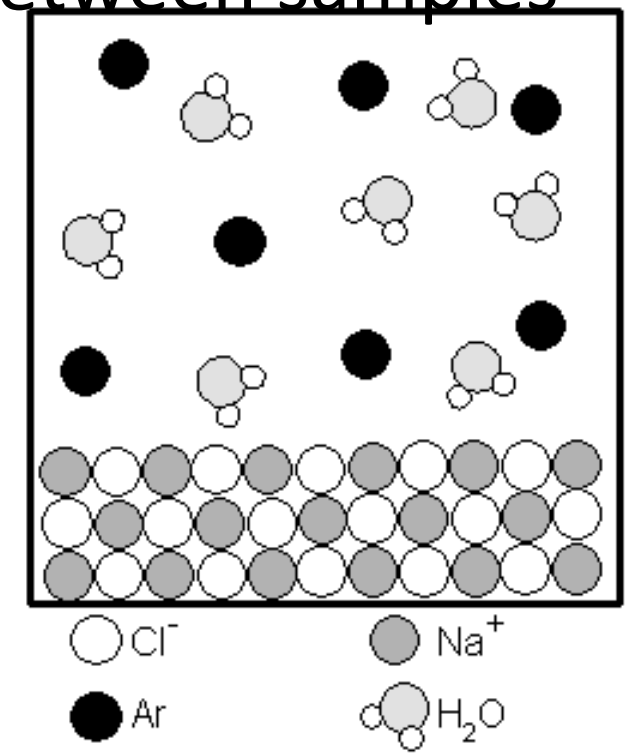


Pure Substances

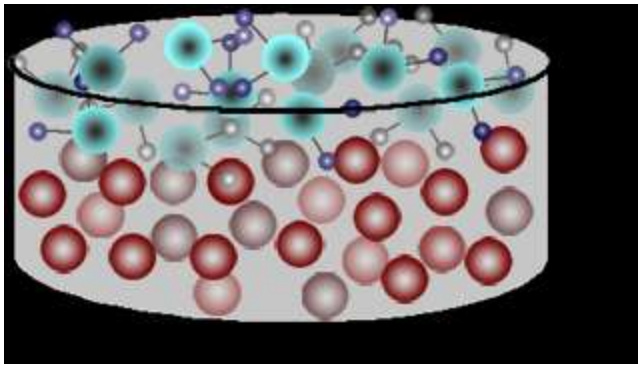
- Have distinct properties
- Composition does not vary from sample to sample
- Includes
  - Elements (one type of atom)
  - Compounds (chemical combination of 2 or more elements)

Mixtures

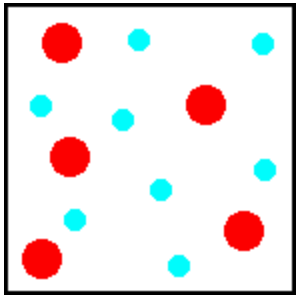
- Combinations of 2 or more substances
- Properties of components are not changed
- Compositions can vary between samples

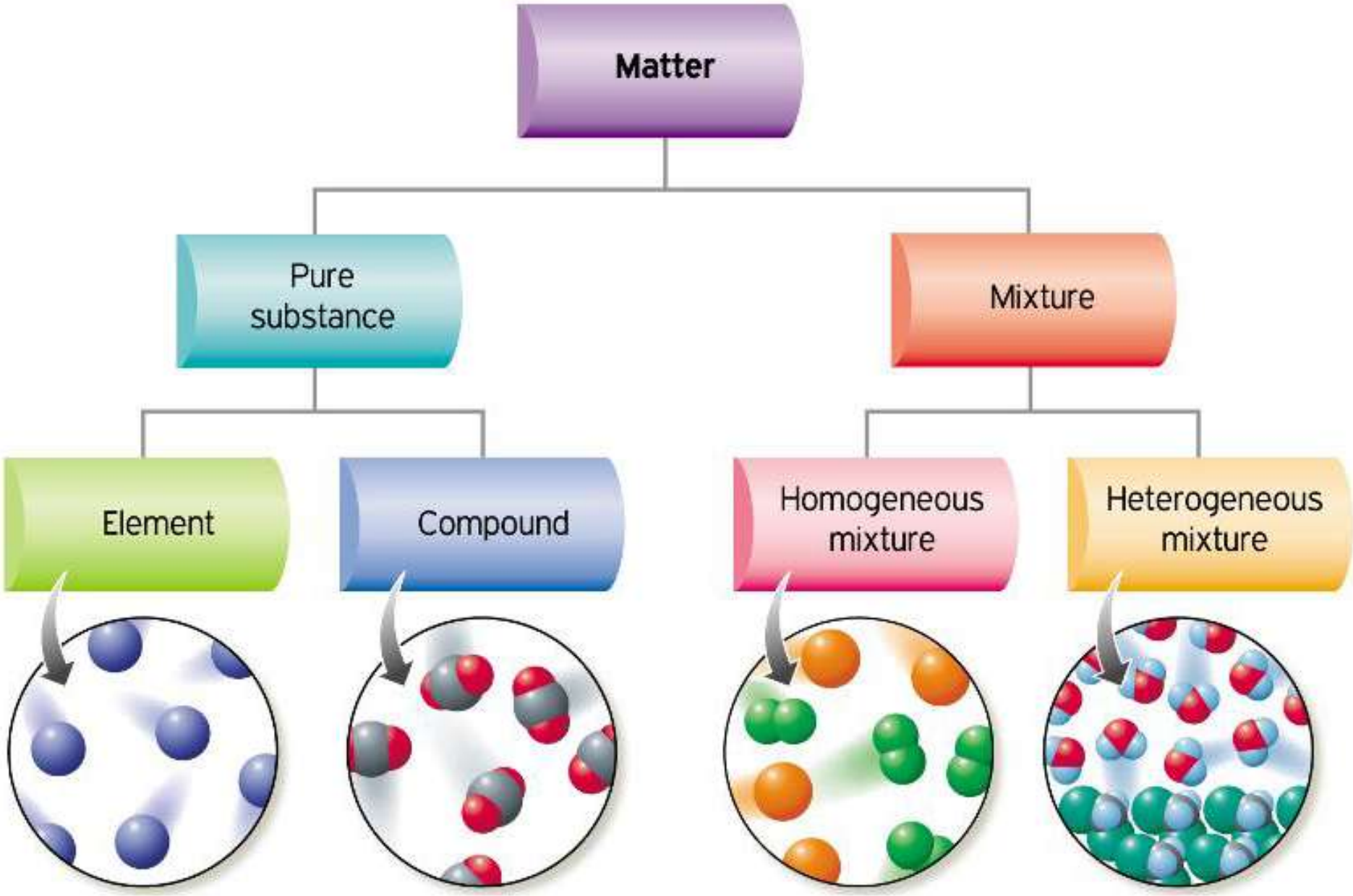


Types of Mixtures



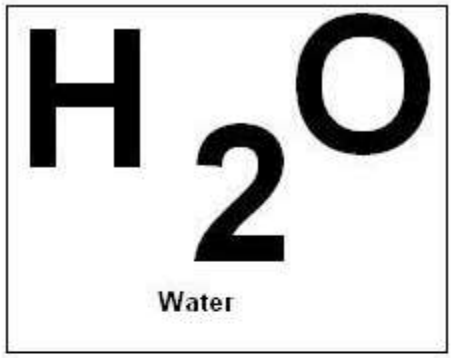
- Heterogeneous
  - Material varies throughout
- Homogeneous
  - Material is uniform throughout
  - Also called solutions
  - Can be solid, liquid, or gas



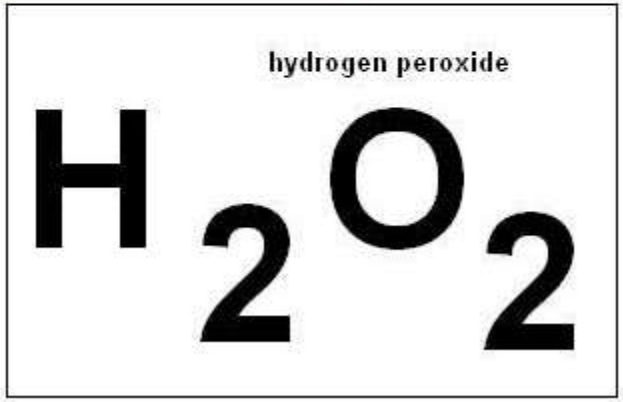

Matter
Pure substance
Mixture
Element
Compound
Homogeneous mixture
Heterogeneous mixture

Law of Constant Composition

- The elemental composition of a pure compound is always the same.



Difference? ONE ATOM



Properties of Matter

- Physical Properties
  - Determined without changing identity of substance
  - Can be measured or described with senses
- Chemical Properties
  - Describe how substances can react to form new substances

Properties of Matter

- Intensive Properties
  - DO NOT depend on the amount of substance
    - Boiling point, density, color
  - Can be used to identify substances
- Extensive Properties
  - Depend on the amount (quantity) of substance
    - Mass, volume, length

Physical Changes

- Substance changes its appearance but not its composition
- All PHase changes are PHysical!

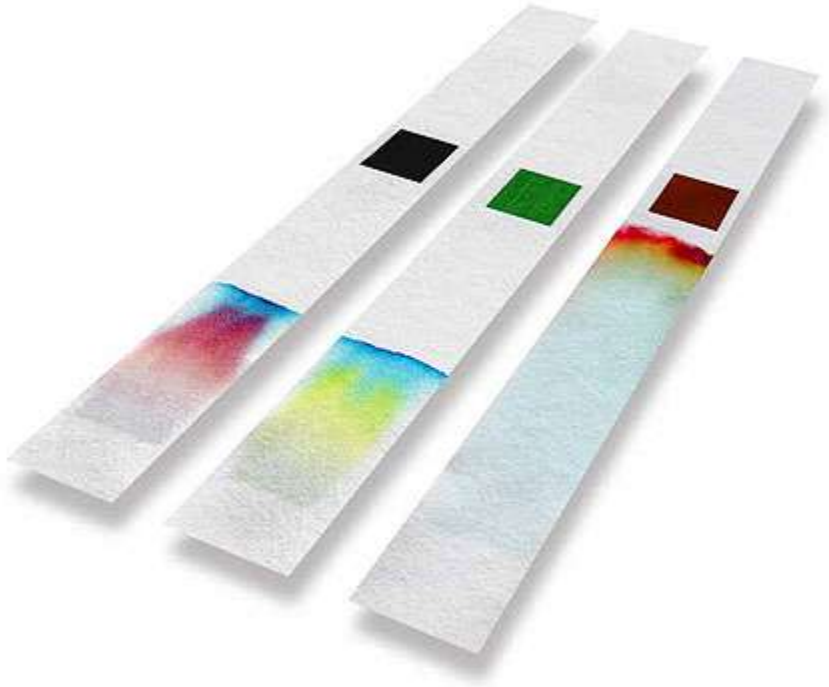
Chemical Changes

- Substance is transformed into a different substance
- Chemical reactions

- Copper + Nitric Acid (story)

Separation of Mixtures

- Filtration
- Distillation
- Chromatography
- Decantation



Units of Measurement

- SI Base Units (Table 1.4 page 14)

Dimension	Unit	Abbreviation
Mass	kilogram	kg
Length	meter	m
Time	second	s
Temperature	Kelvin	K
Amount of substance	mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

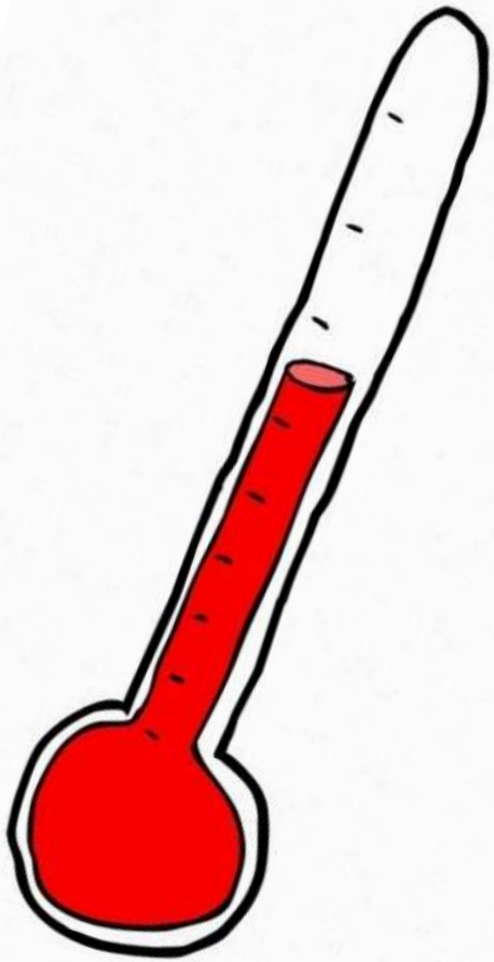
Selected Metric Prefixes

Prefix	Abbreviation	Meaning
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

See Table 1.5 page 14

Temperature Conversions

- $K = {}^{o}C + 273.15$
- ${}^{o}C = 5/9\ ({}^{o}F - 32)$
- ${}^{o}F = 9/5\ {}^{o}C + 32$



Sample Exercise 1.3 pg 16

Converting units of temperature

If a weather forecaster predicts that the temperature for the day will reach 31°C, what is the predicted temperature (a) in K, (b) in °F

Derived Units

- Volume: cm^3 = mL
- Density: g/cm^3
- Speed: m/s

Sample Exercise 1.4 pg 20

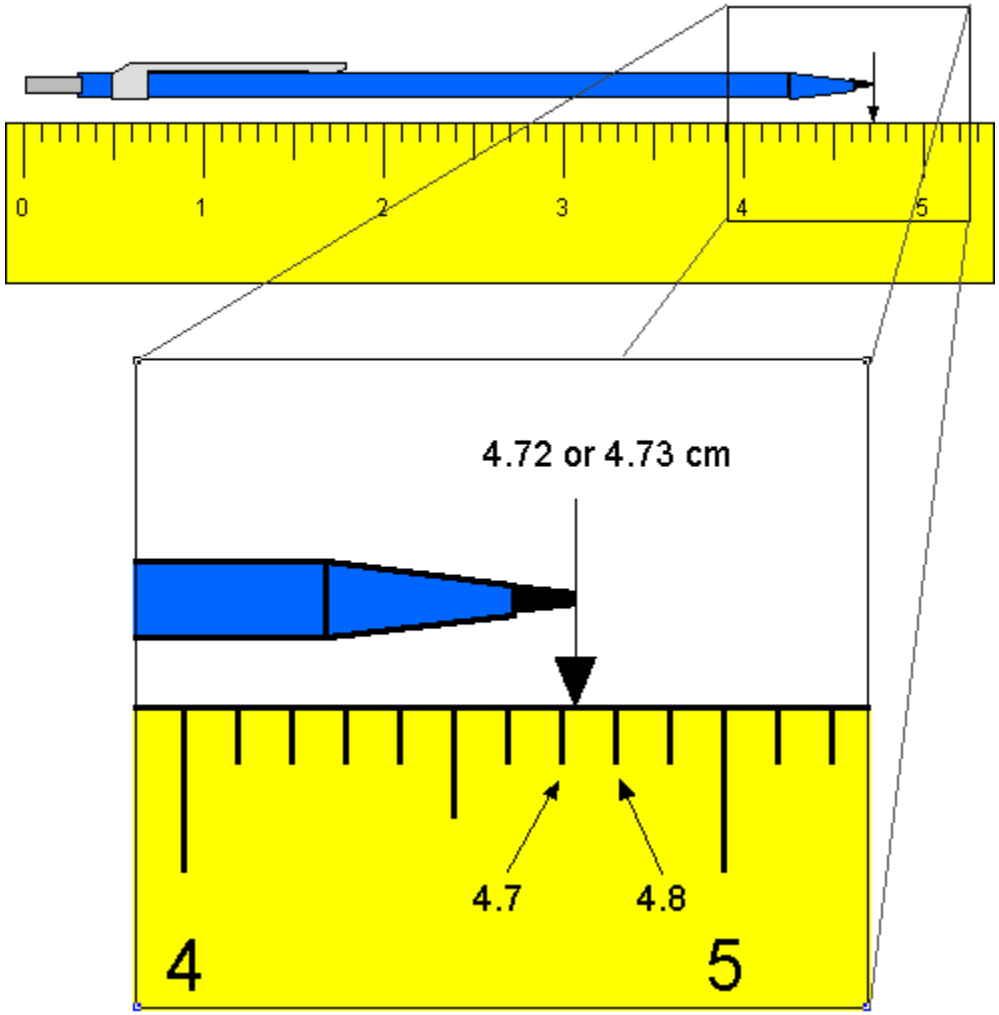
Determining density and using density to determine volume or mass

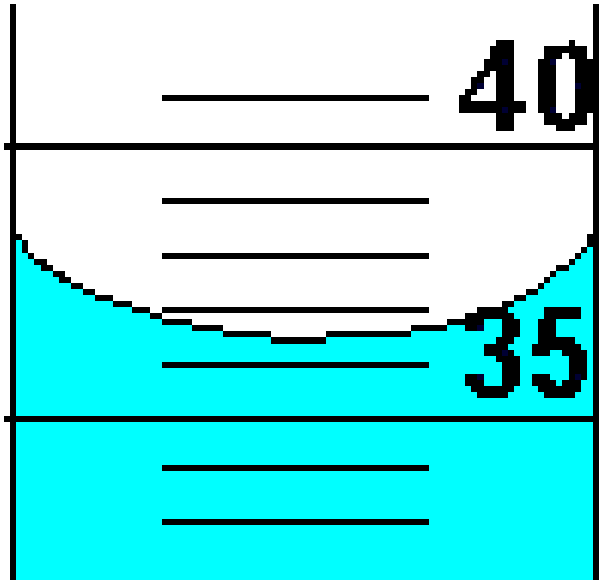
(a)Calculate the density of mercury if 1.00×10^2 g occupies a volume of 7.36 cm^3.

(b)Calculate the volume of 65.0 g of the liquid methanol (wood alcohol) if its density is 0.791 g/mL.

(c)What is the mass in grams of a cube of gold (density = 19.32 g/cm^3) if the length of the cube is 2.00 cm?

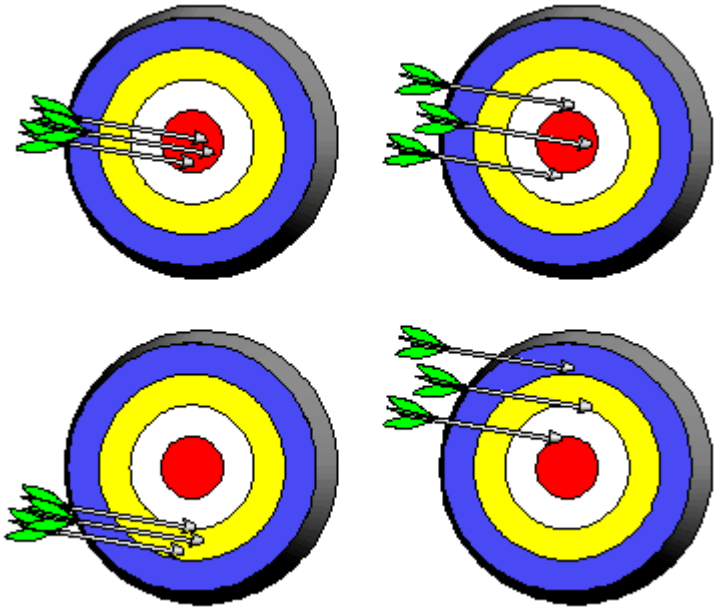
Uncertainty in Measurement





Precision vs Accuracy

- Precision
  - Degree of closeness of several measurements to each other
- Accuracy
  - Degree of closeness of a single measurement to the “true” or accepted value



Significant Figures

- Measured quantities are reported in a way that only the last digit is uncertain

Which digits are significant?

Digits	When to Count	Example
Nonzero	Always	2.514 = 4 sig figs
Leading zeroes	Never	0.025 = 2 sig figs
Trailing zeroes	After a decimal	250 = 2 sig figs 2.50 = 3 sig figs
Captive zeroes	Always	200.5 = 4 sig figs 200.0 = 4 sig figs

Sample Exercise 1.6 pg 23

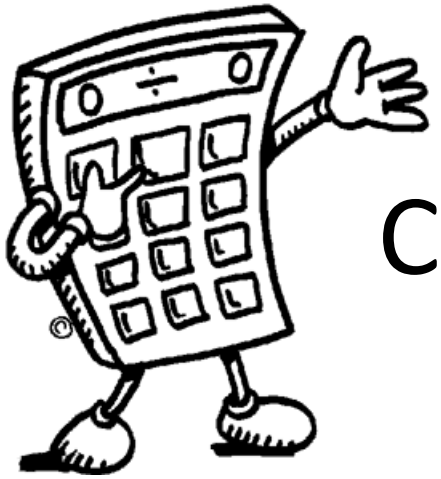
Determining the number of significant figures in a measurement

How many significant figures are in each of the following numbers (assume that each number is a measured quantity):

(a)4.003

(b)6.023×10^{23}

(c)5000



Calculating with Sig Figs:

- Adding or Subtracting:
  - Report answer with the same number of decimal places as the least precise number in the calculation
- Multiplying or Dividing:
  - Report answer with the same number of significant digits as the least precise number in the calculation

Sample Exercise 1.7 pg 24

Determining the number of significant figures in a calculated quantity

The width, length, and height of a small box are 15.5 cm, 27.3 cm, and 5.4 cm, respectively. Calculate the volume of the box, using the correct number of significant figures in your answer.

Sample Exercise 1.8 pg 25

Determining the number of significant figures in a calculated quantity

A gas at 25°C fills a container whose volume is 1.05×10^3 cm^3. The container plus gas have a mass of 837.6 g. The container, when emptied of all gas, has a mass of 835.2 g. What is the density of the gas at 25°C?

Dimensional Analysis

- A method used to solve numerical problems and check solutions for possible errors
- Units are important!
- Often uses conversion factors:
  - fractions that have the same quantity with different units in the numerator and denominator

Sample Exercise 1.9 pg 26

Converting units

If a woman has a mass of 115 lbs, what is her mass in grams?

Sample Exercise 1.10 pg 27

Converting units using two or more conversion factors

The average speed of a nitrogen molecule in air at 25^{o}C is 515 m/s. Convert this speed to miles per hour.

Sample Exercise 1.11 pg 28

Converting volume units

Earth's oceans contain approximately 1.36×10^9 km^3 of water. Calculate the volume in liters.

Sample Exercise 1.12 pg 29

Conversions involving density

What is the mass in grams of 1.00 gal of water? The density of water is 1.00 g/mL.