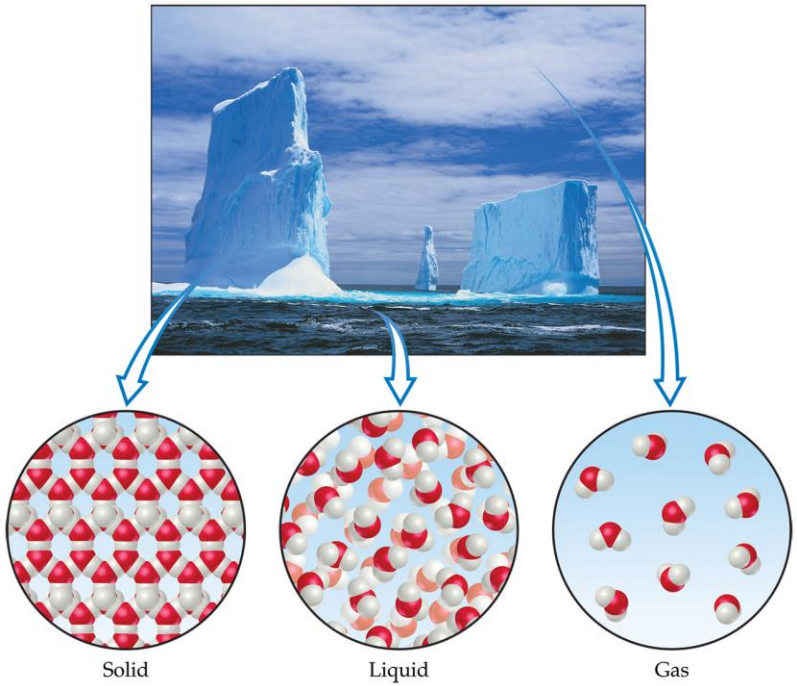
Chemistry, The Central Science, 10th edition
Theodore L. Brown; H. Eugene LeMay, Jr.;
and Bruce E. Bursten

Chapter 1
Introduction:
Matter and Measurement

John D. Bookstaver
St. Charles Community College
St. Peters, MO
© 2006, Prentice Hall

Chemistry:

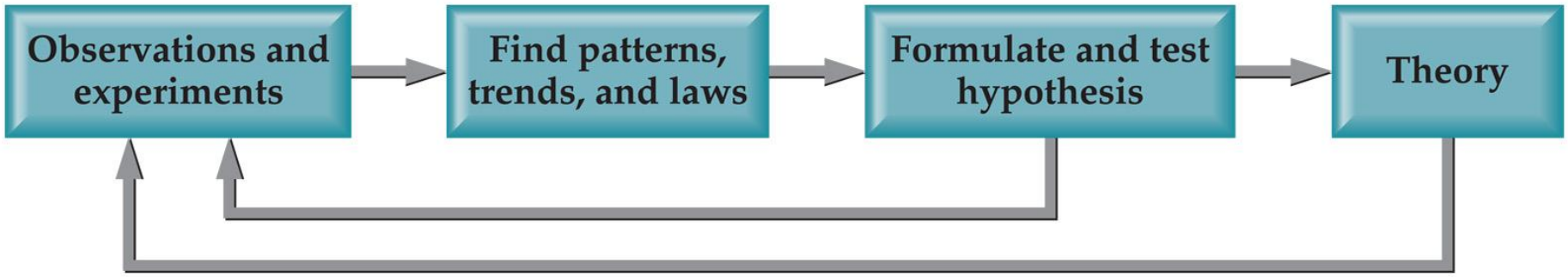


The study of matter and the changes it undergoes.

Matter And Measurement

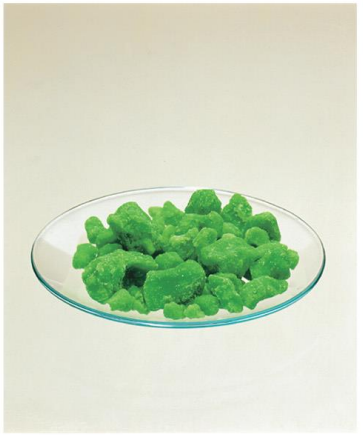
Scientific Method:

A systematic approach to solving problems.



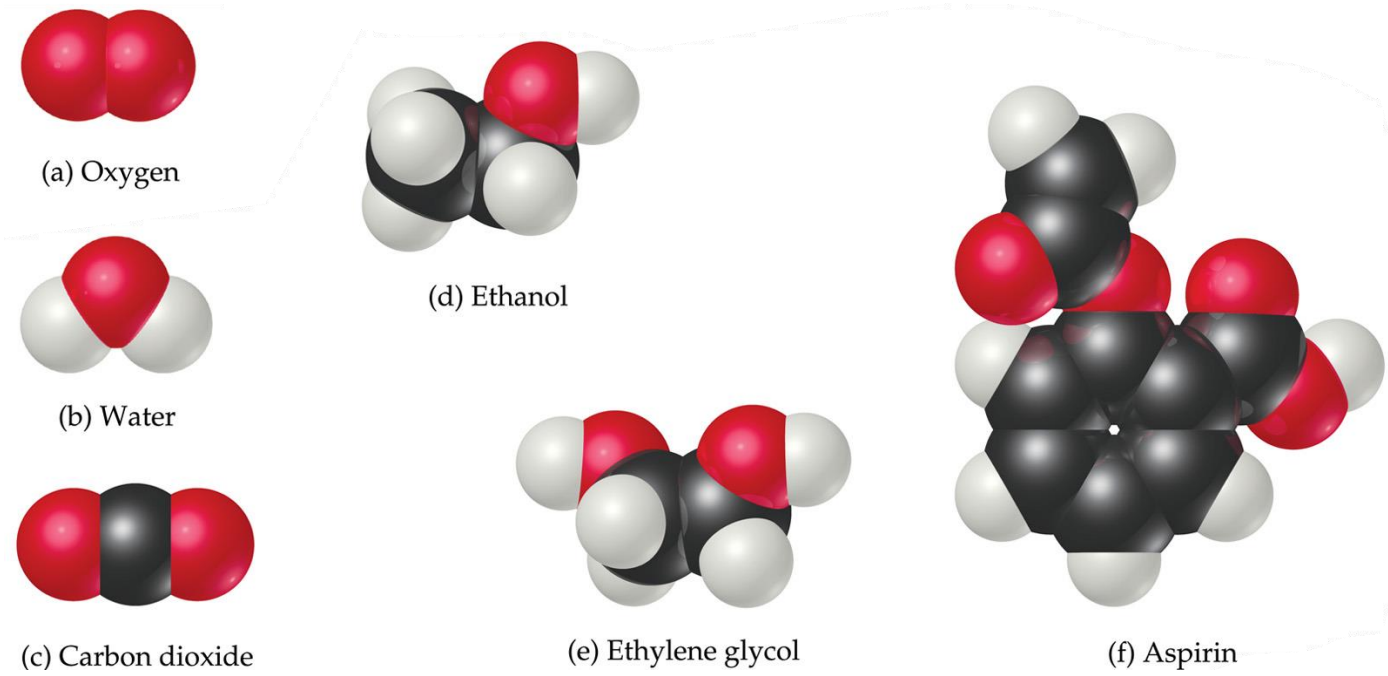
Matter:

Anything that has mass and takes up space.



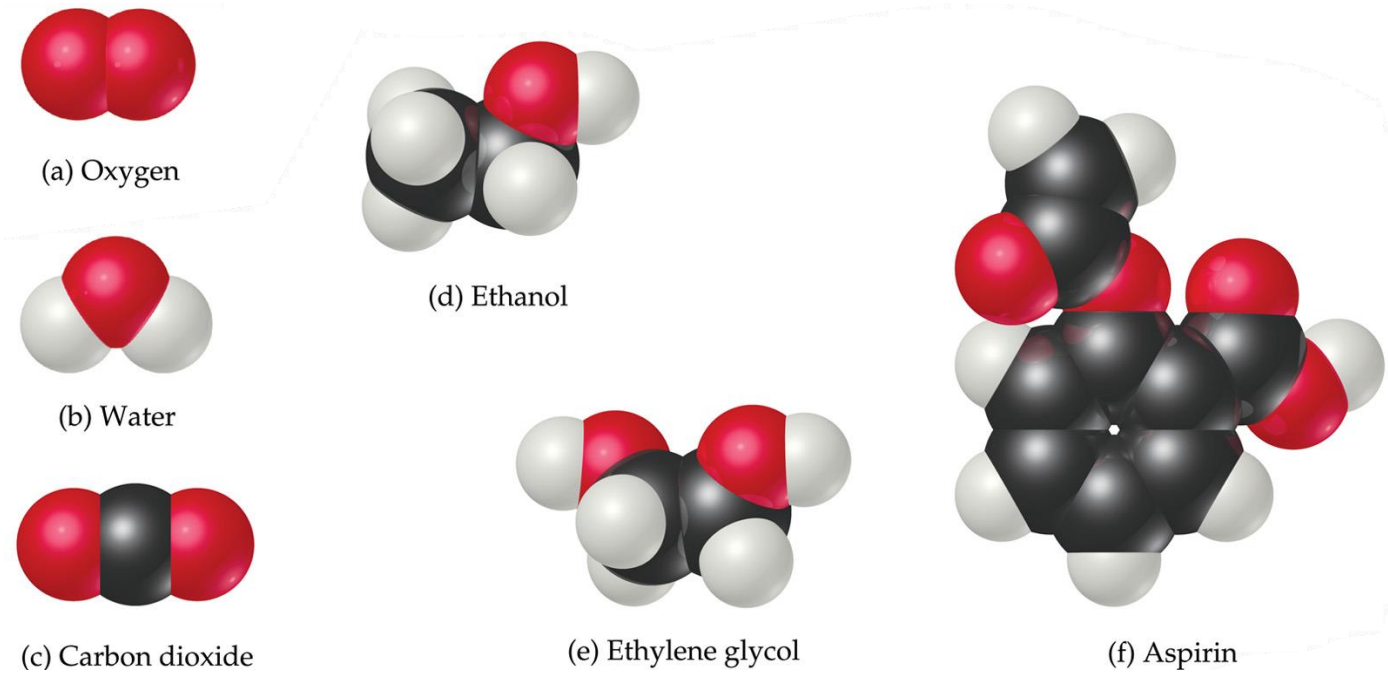
Matter And Measurement

Matter



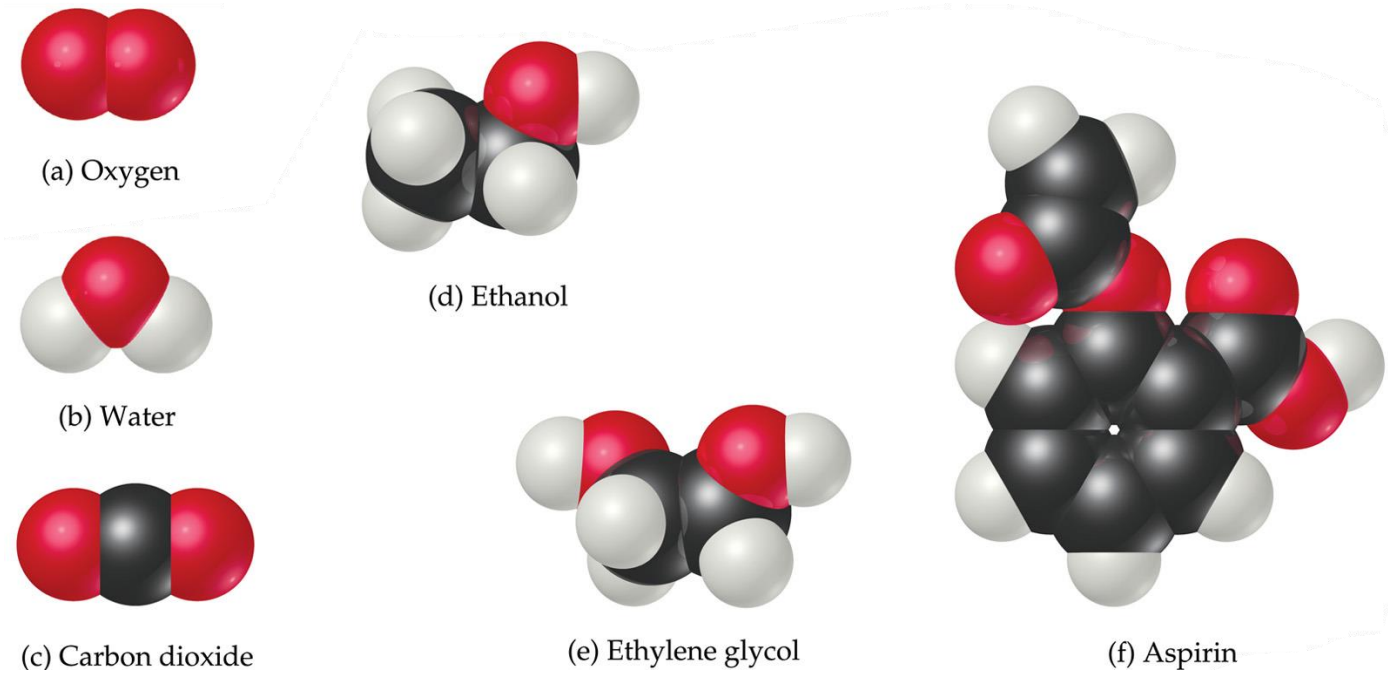
- Atoms are the building blocks of matter.

Matter



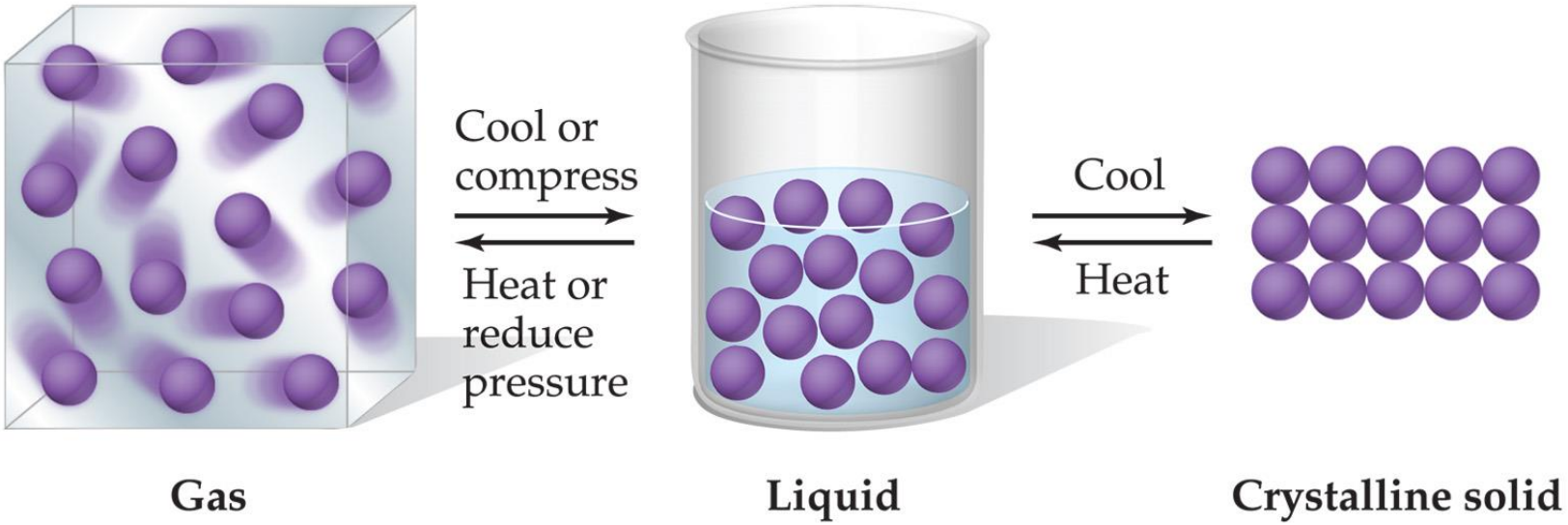
- Atoms are the building blocks of matter.
- Each element is made of the same kind of atom.

Matter



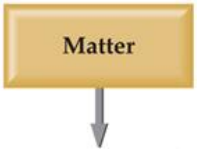
- Atoms are the building blocks of matter.
- Each element is made of the same kind of atom.
- A compound is made of two or more different kinds of elements.

States of Matter

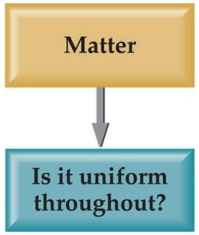


Matter
And
Measurement

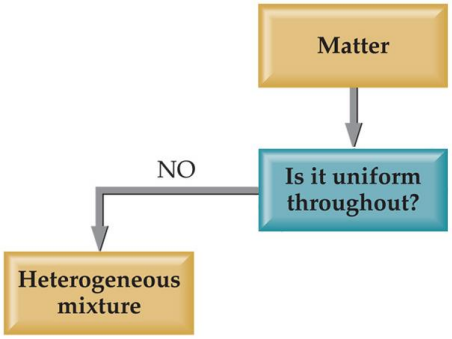
Classification of Matter



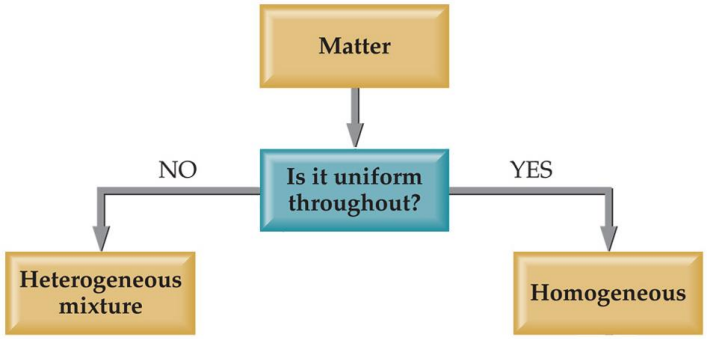
Classification of Matter



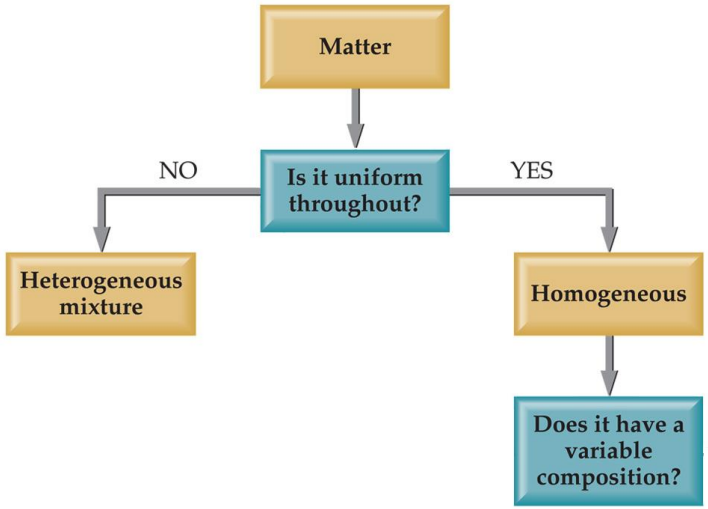
Classification of Matter



Classification of Matter

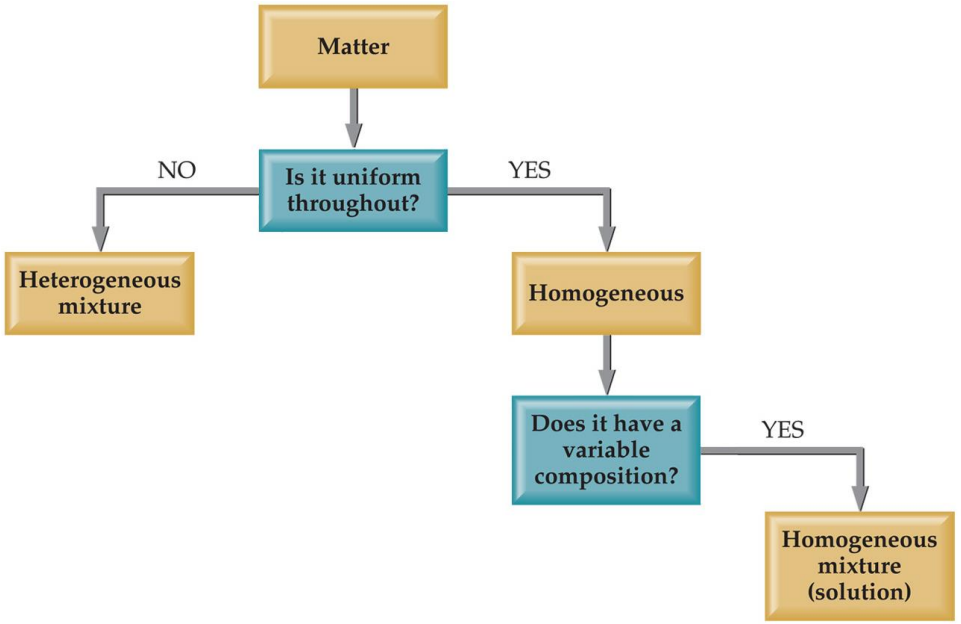


Classification of Matter



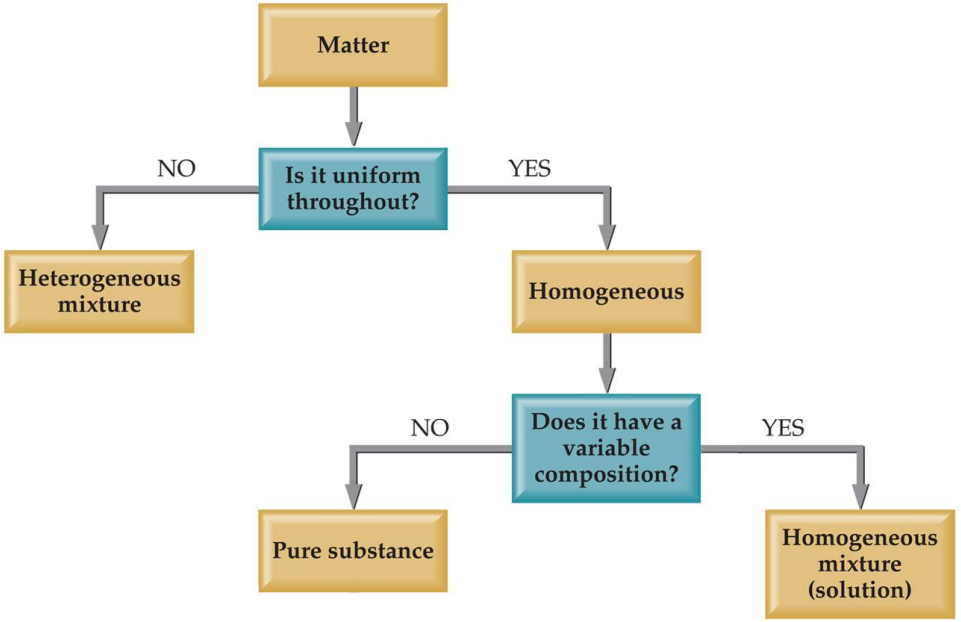
Matter And Measurement

Classification of Matter



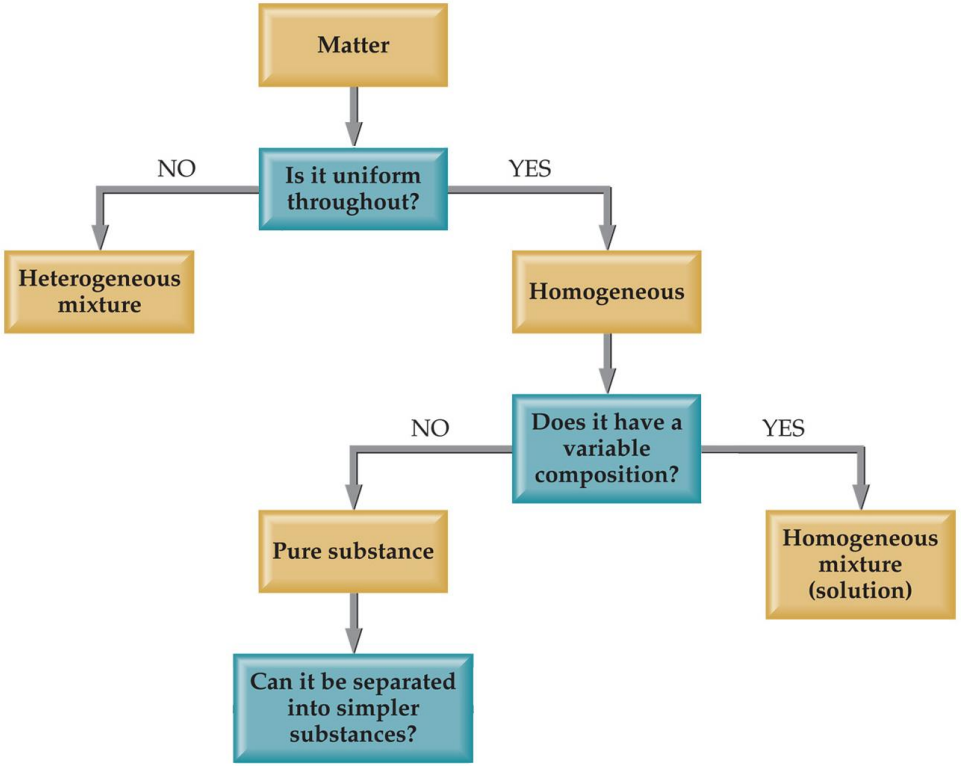
Matter And Measurement

Classification of Matter

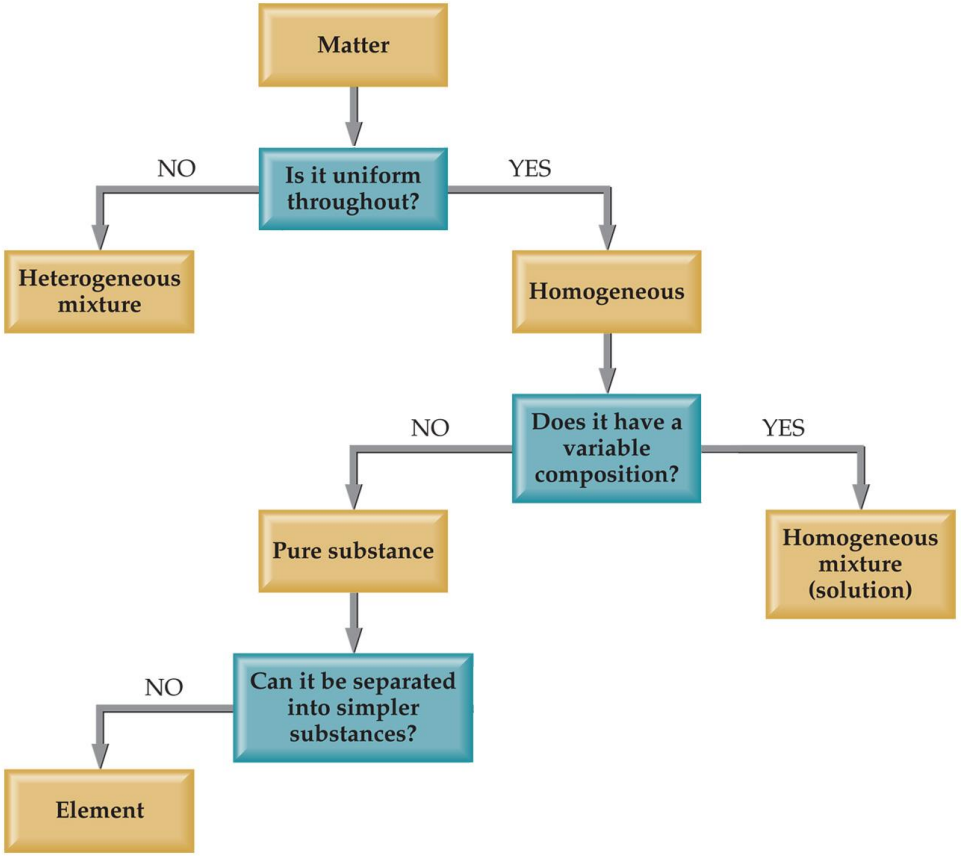


Matter And Measurement

Classification of Matter

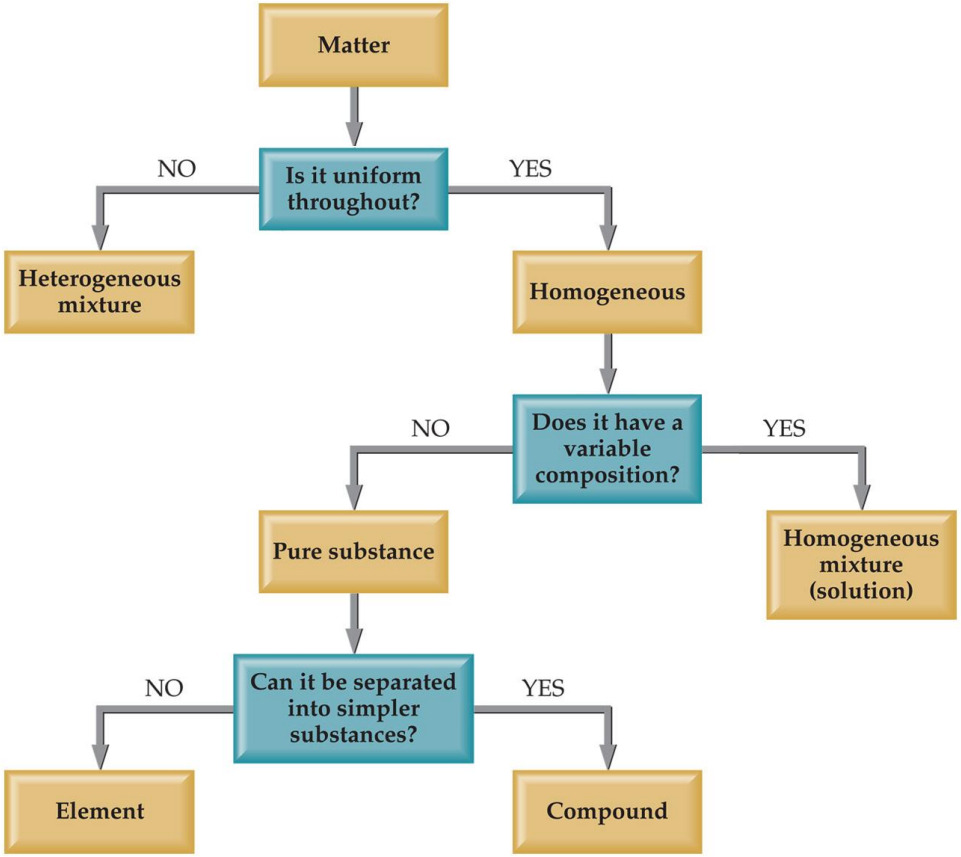


Classification of Matter

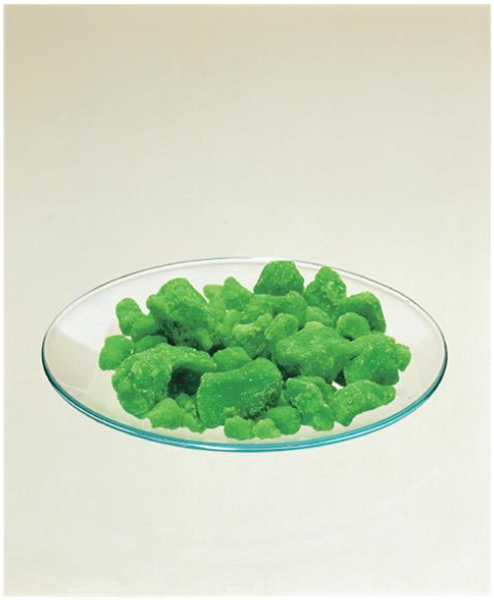


Matter And Measurement

Classification of Matter



Mixtures and Compounds



Matter And Measurement

Properties and Changes of Matter

Properties of Matter

- Physical Properties:
  - Can be observed without changing a substance into another substance.
    - Boiling point, density, mass, volume, etc.
- Chemical Properties:
  - Can *only* be observed when a substance is changed into another substance.
    - Flammability, corrosiveness, reactivity with acid, etc.

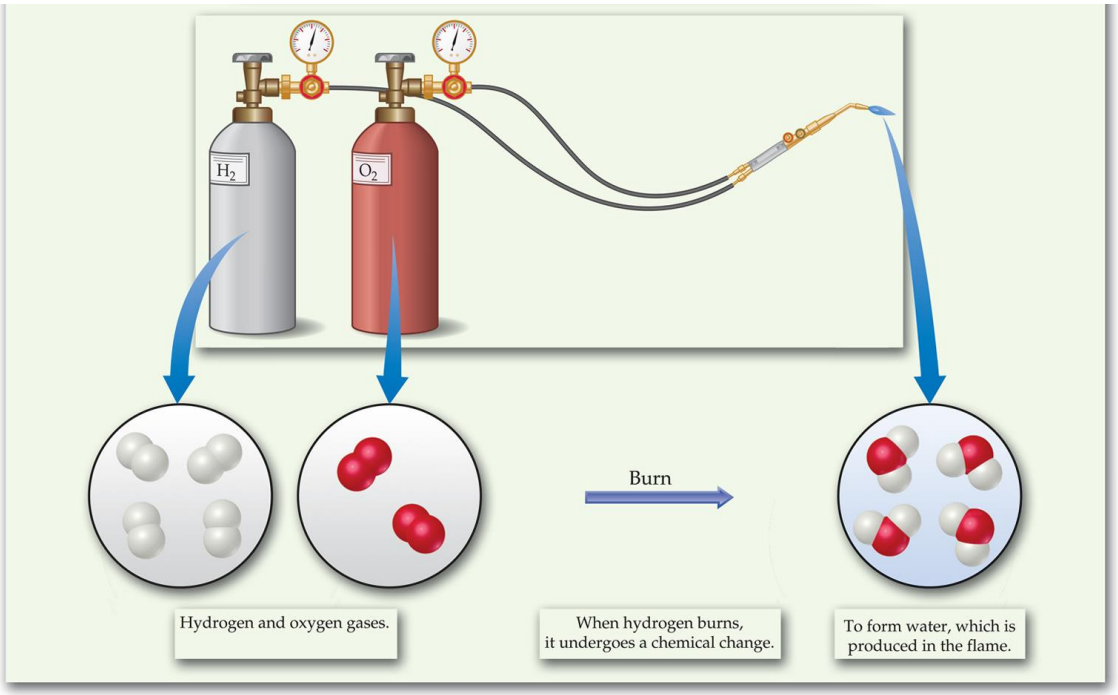
Properties of Matter

- Intensive Properties:
  - Independent of the amount of the substance that is present.
    - Density, boiling point, color, etc.
- Extensive Properties:
  - Dependent upon the amount of the substance present.
    - Mass, volume, energy, etc.

Changes of Matter

- Physical Changes:
  - Changes in matter that do not change the composition of a substance.
    - Changes of state, temperature, volume, etc.
- Chemical Changes:
  - Changes that result in new substances.
    - Combustion, oxidation, decomposition, etc.

Chemical Reactions



In the course of a chemical reaction, the reacting substances are converted to new substances.

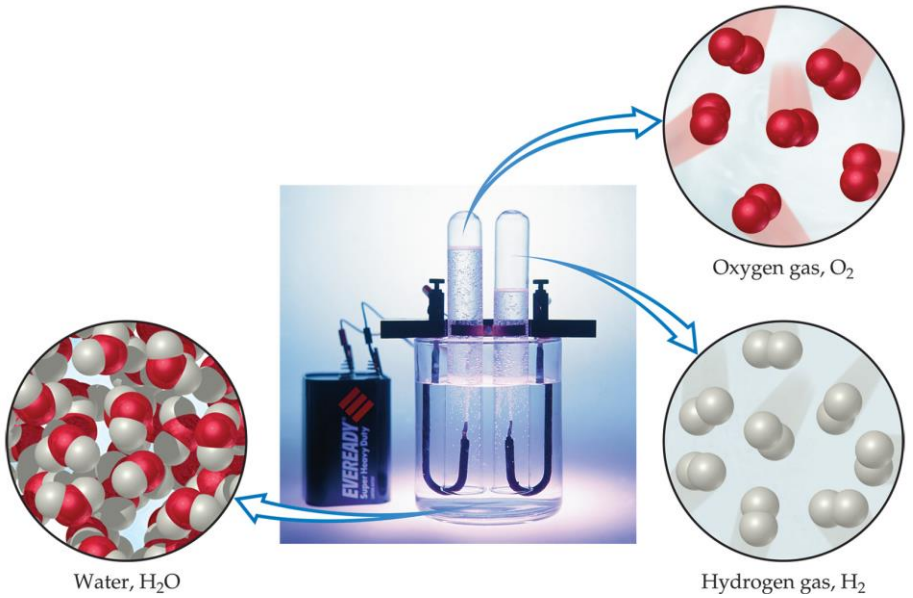
Matter And Measurement

Chemical Reactions

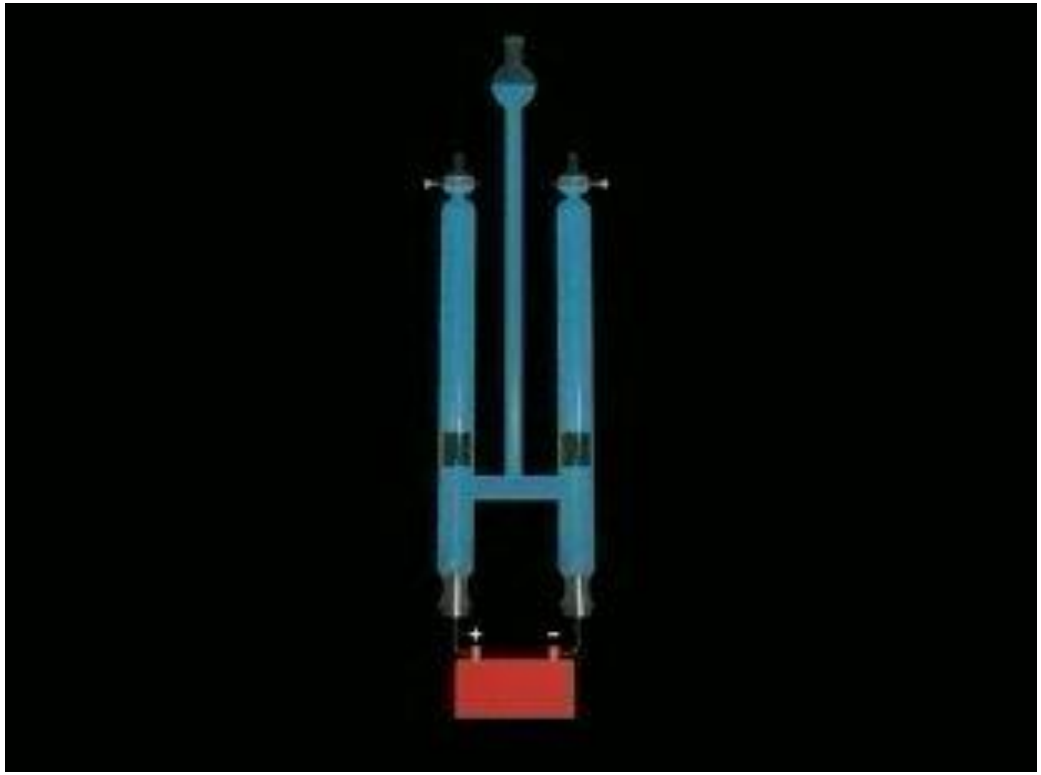
Matter
And
Measurement

Compounds

Compounds can be broken down into more elemental particles.



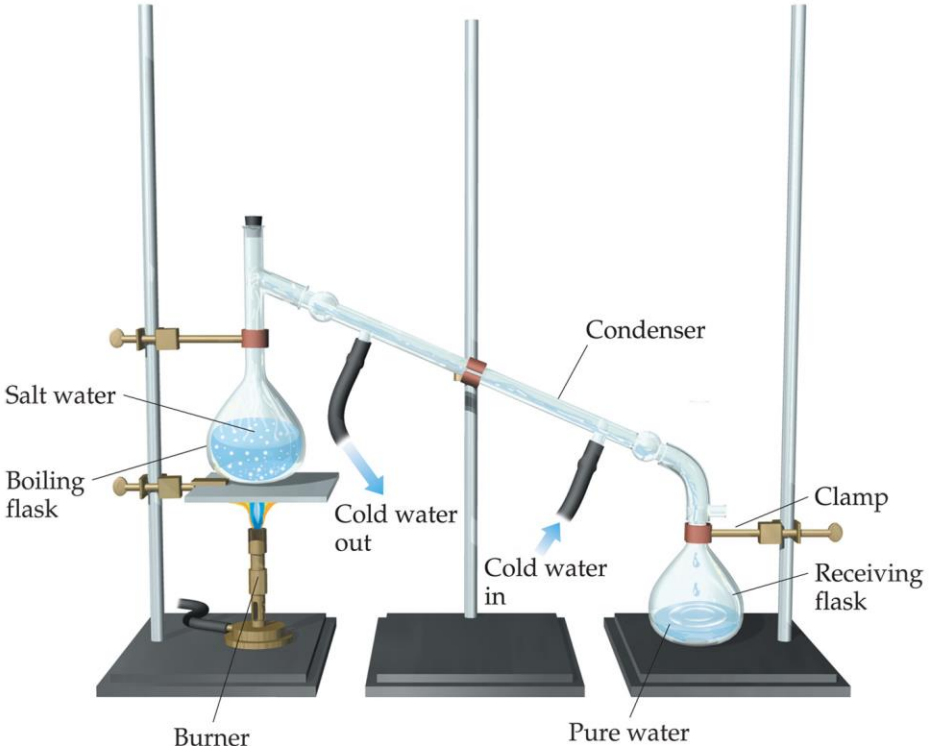
Electrolysis of Water



Matter
And
Measurement

Separation of Mixtures

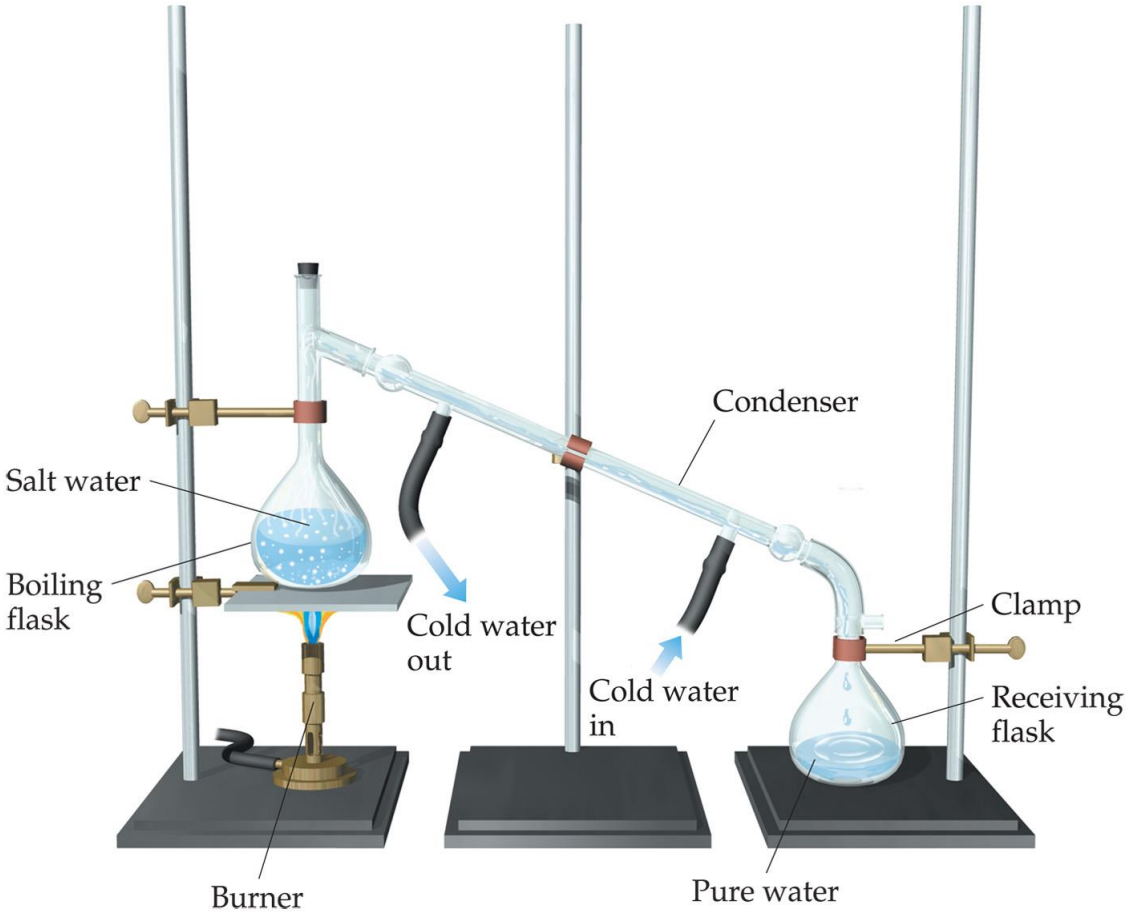
Distillation:



Separates homogeneous mixture on the basis of differences in boiling point.

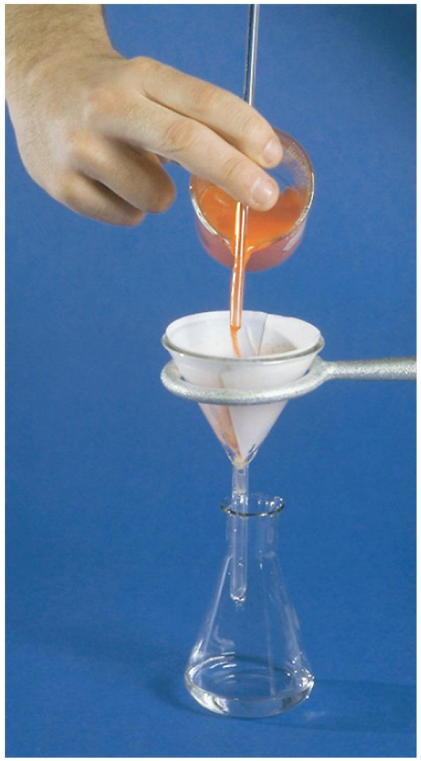
Matter And Measurement

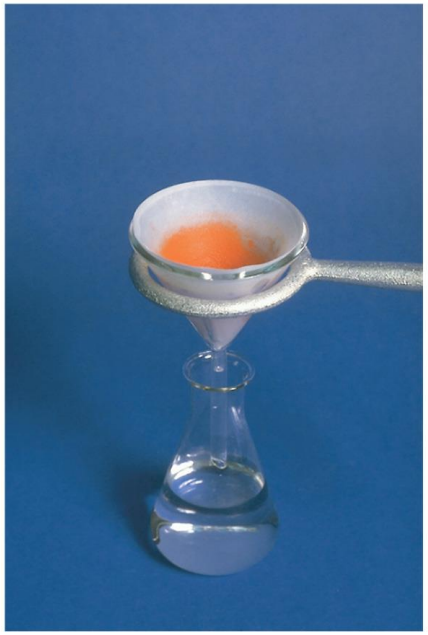
Distillation



Matter And Measurement

Filtration:





Separates solid substances from liquids and solutions.

Matter And Measurement

Chromatography:

Separates substances on the basis of differences in solubility in a solvent.

Units of Measurement

SI 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.

- *Système International d'Unités*
- Uses a different base unit for each quantity

Metric System

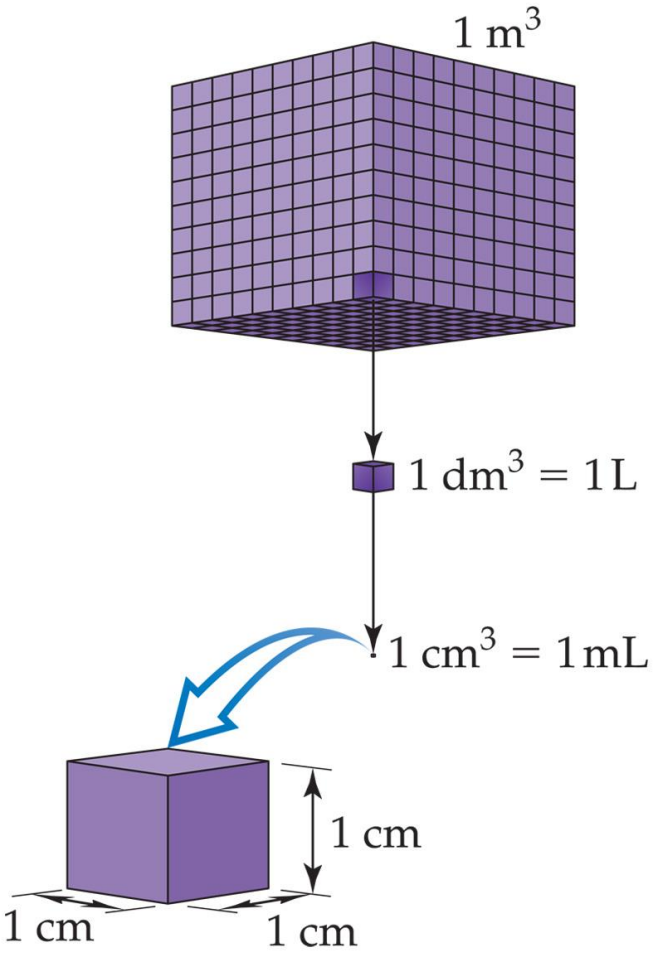
Prefixes convert the base units into units that are appropriate for the item being measured.

Prefix	Abbreviation	Meaning	Example
Giga	G	10^9	1 gigameter (Gm) = 1×10^9 m
Mega	M	10^6	1 megameter (Mm) = 1×10^6 m
Kilo	k	10^3	1 kilometer (km) = 1×10^3 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) = 1×10^{-6} m
Nano	n	10^{-9}	1 nanometer (nm) = 1×10^{-9} m
Pico	p	10^{-12}	1 picometer (pm) = 1×10^{-12} m
Femto	f	10^{-15}	1 femtometer (fm) = 1×10^{-15} m

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

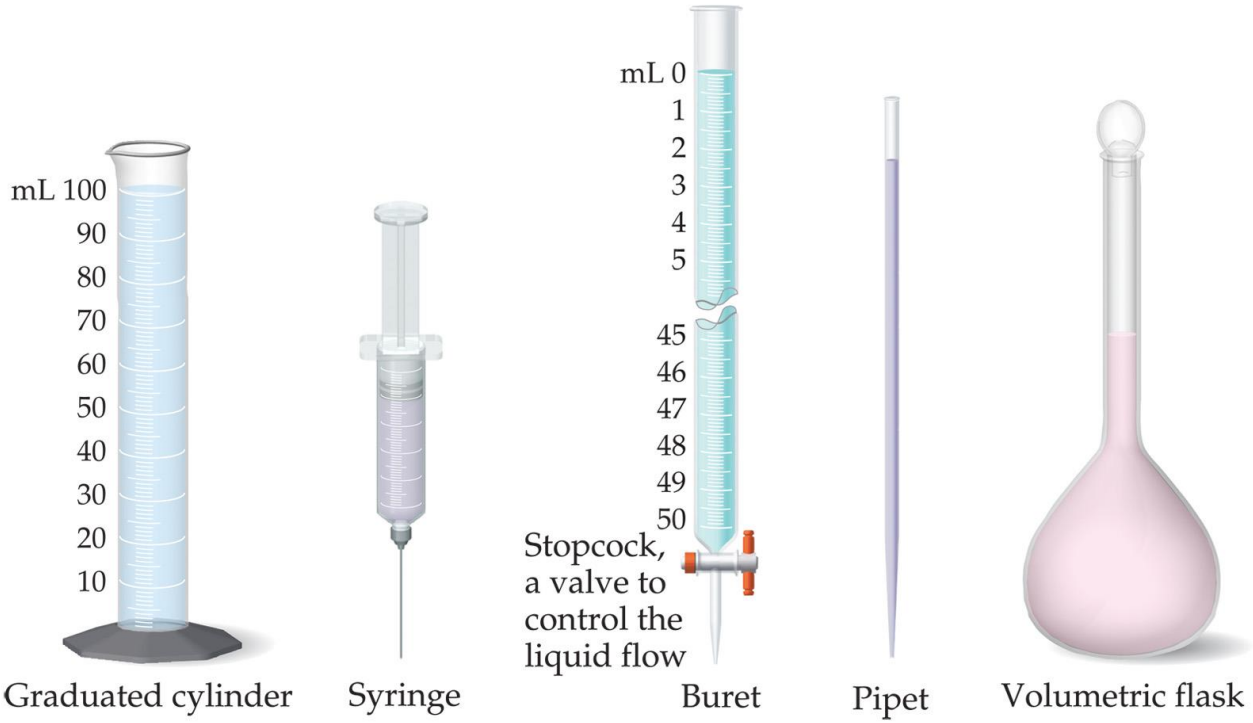
Volume

- The most commonly used metric units for volume are the liter (L) and the milliliter (mL).
  - A liter is a cube 1 dm long on each side.
  - A milliliter is a cube 1 cm long on each side.



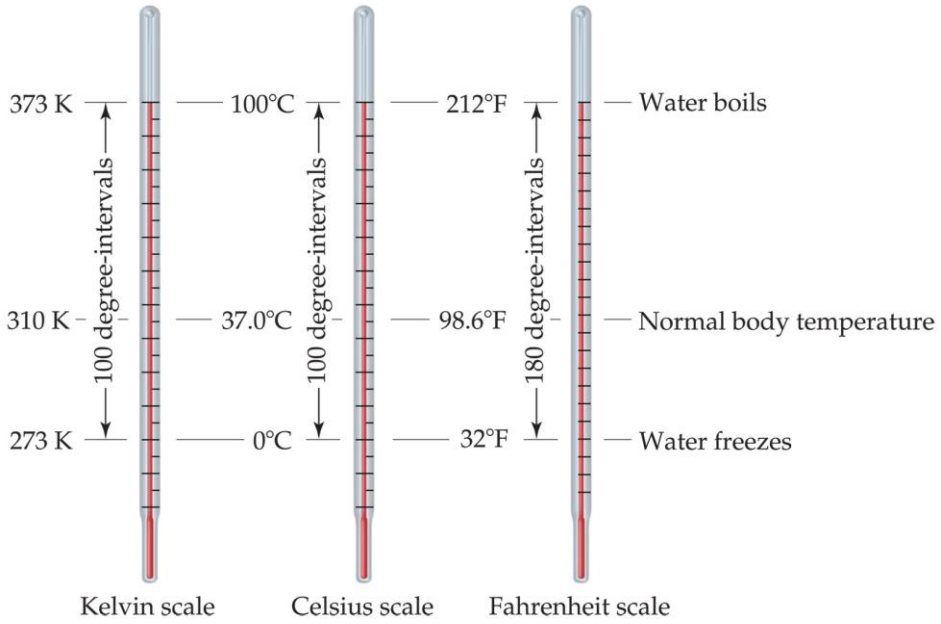
Uncertainty in Measurements

Different measuring devices have different uses and different degrees of accuracy.



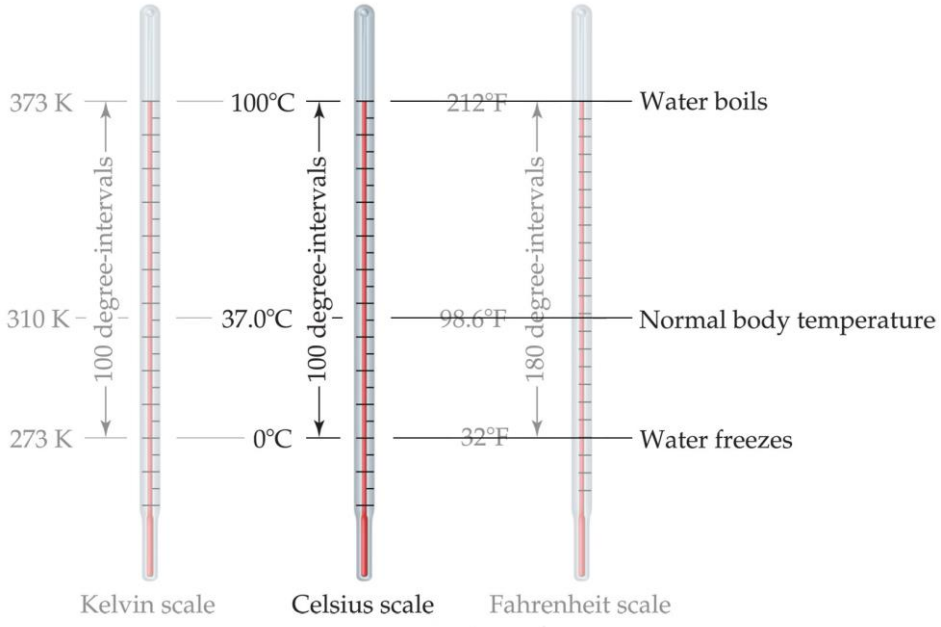
Matter And Measurement

Temperature:



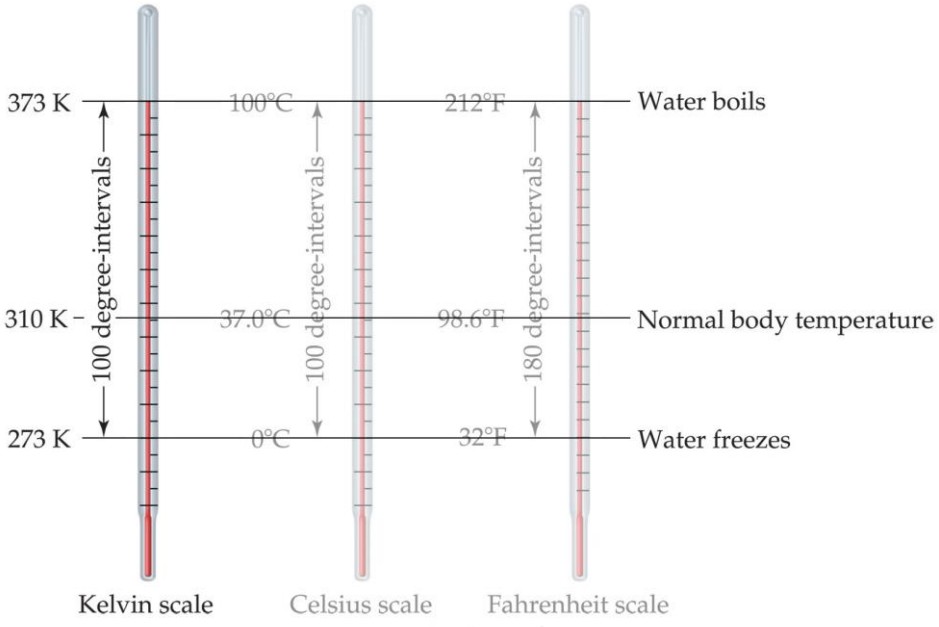
A measure of the average kinetic energy of the particles in a sample.

Temperature



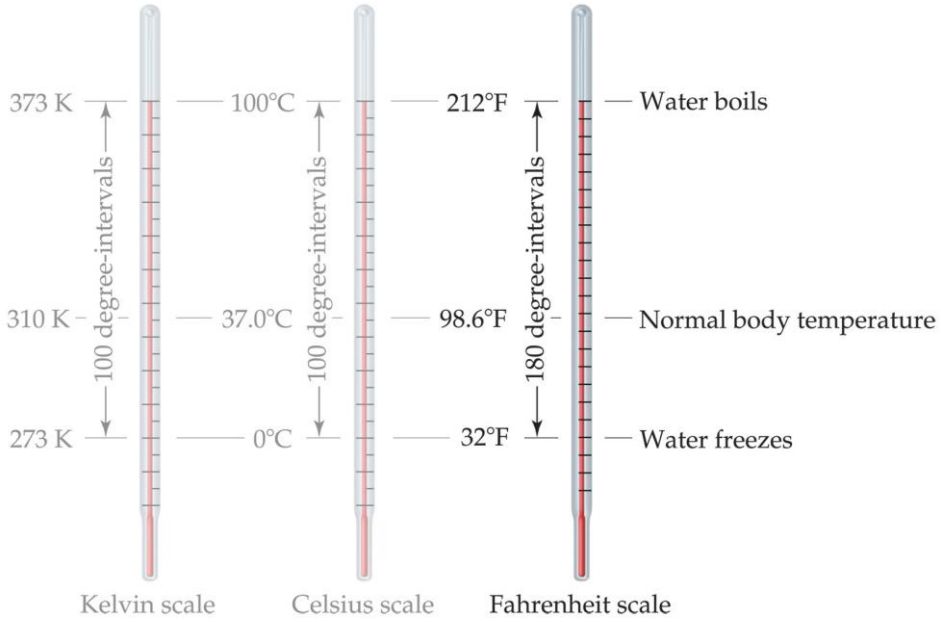
- In scientific measurements, the Celsius and Kelvin scales are most often used.
- The Celsius scale is based on the properties of water.
  - 0°C is the freezing point of water.
  - 100°C is the boiling point of water.

Temperature



- The Kelvin is the SI unit of temperature.
- It is based on the properties of gases.
- There are no negative Kelvin temperatures.
- K = °C + 273.15

Temperature



- The Fahrenheit scale is not used in scientific measurements.
- °F = 9/5(°C) + 32
- °C = 5/9(°F − 32)

Density:

Physical property of a substance

$$d = \frac{m}{V}$$

Matter And Measurement

Uncertainty in Measurement

Significant Figures

- The term significant figures refers to digits that were measured.
- When rounding calculated numbers, we pay attention to significant figures so we do not overstate the accuracy of our answers.

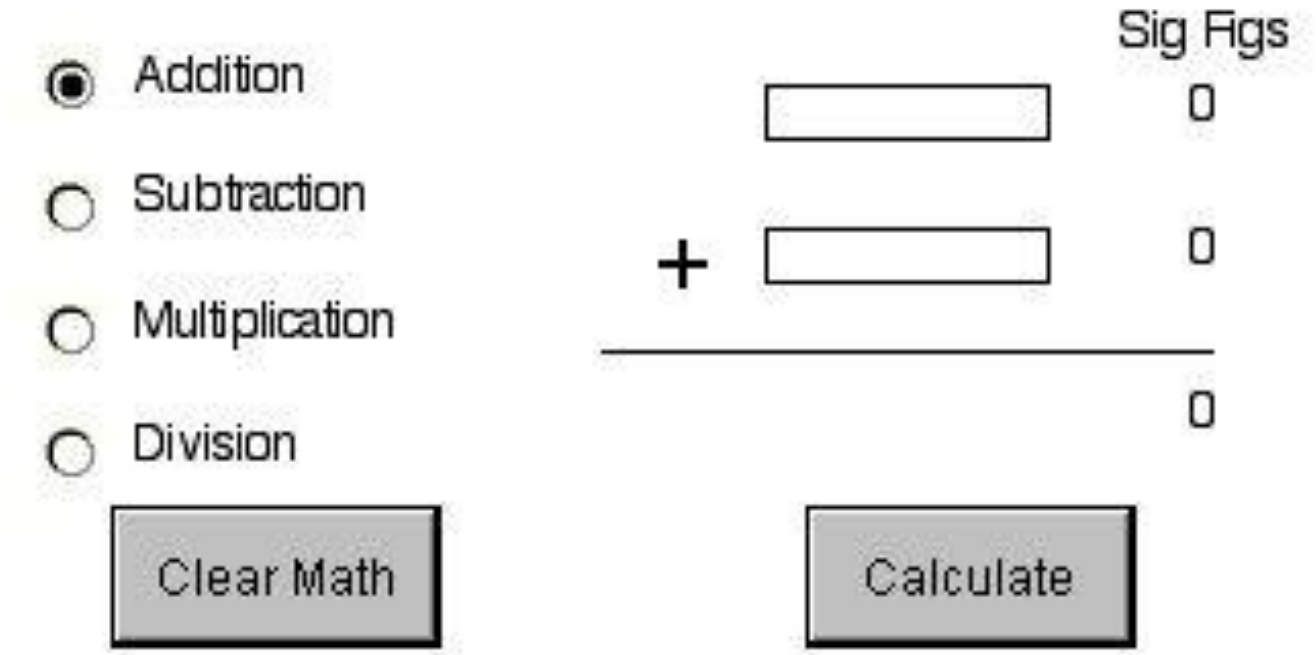
Significant Figures

1. All nonzero digits are significant.
2. Zeroes between two significant figures are themselves significant.
3. Zeroes at the beginning of a number are never significant.
4. Zeroes at the end of a number are significant 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 numbers used in the calculation.

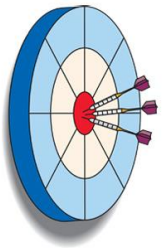
Significant Digit Calculations



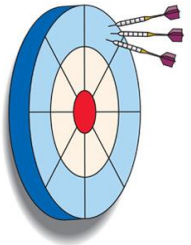
Matter And Measurement

Accuracy versus Precision

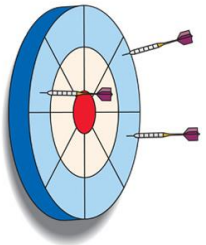
- Accuracy refers to the proximity of a measurement to the true value of a quantity.
- Precision refers to the proximity of several measurements to each other.



Good accuracy
Good precision



Poor accuracy
Good precision



Poor accuracy
Poor precision