CHEMISTRY
The Central Science

The Study of the composition, structure, and properties of matter and of the reactions by which one form of matter may be produced from or converted into other forms.

The Elements: A fundamental substance which cannot be chemically changed nor broken down.

- 92 naturally occurring
- 24 produced artificially by nuclear chemists
- The atom is the basic stable elemental particle
- Arranged in the modern **Periodic Table** according to atomic number (number of protons)
  - Periods - horizontal rows
  - Groups(families) - vertical columns
  - Elements within a given group have similar chemical properties
  - Main groups
  - Transition metals
  - Inner transition metals

Chemical Properties of the elements

Extensive properties: Possess values dependent on amount of sample

Physical Properties: Characteristics that do not involve a change in the chemical identity of the matter.

- color
- hardness
- melting point
- boiling point
- physical state
- electrical conductivity

Chemical Properties: Characteristics involving the way one kind of matter is transformed into

another kind of matter.

- Heat of combustion (Enthalphy)
- oxidation
- reduction
- chemical activity
- pH (acid or base)

MATTER: Anything occupying space and having mass

Law of Conservation of Matter: During a physical or chemical change, there is no detectable increase or decrease in the total quantity of matter from that initially present.

Mass: The amount of matter in an object.

Physical States of Matter

Solid-- Possesses a definite shape and has a volume nearly independent of changes in temperature and pressure

Liquid-- Possess an indefinite shape and is only slightly compressible

Gas-- Very fluid; possesses both an indefinite shape and indefinite volume resulting in gases being readily compressible and capable of infinite expansion

Plasma-- Extremely high energy state consisting of a mixture of free electrons and highly ionized nuclei

Le Système International d'Unités
International System of Units
(SI System)

Developed in France in 1791
Used in the US since 1964
A decimal measurement system
Seven fundamental units

TABLE 0.1 The Seven Fundamental SI Units of Measure

Physical Quantity	Name of Unit	Abbreviation
Mass	kilogram	kg
Length	meter	m
Temperature	kelvin	K
Amount of substance	mole	mol
Time	second	s
Electric current	ampere	A
Luminous intensity	candela	cd

TABLE 0.2 Some Prefixes for Multiples of SI Units

Factor	Prefix	Symbol	Example
$1{,}000{,}000{,}000{,}000 = 10^{12}$	tera	T	1 teragram (Tg) $= 10^{12}$ g
$1{,}000{,}000{,}000 = 10^{9}$	giga	G	1 gigameter (Gm) $= 10^{9}$ m
$1{,}000{,}000 = 10^{6}$	mega	M	1 megameter (Mm) $= 10^{6}$ m
$1{,}000 = 10^{3}$	kilo	k	1 kilogram (kg) $= 10^{3}$ g
$100 = 10^{2}$	hecto	h	1 hectogram (hg) $= 100$ g
$10 = 10^{1}$	deka	da	1 dekagram (dag) $= 10$ g
$0.1 = 10^{-1}$	deci	d	1 decimeter (dm) $= 0.1$ m
$0.01 = 10^{-2}$	centi	c	1 centimeter (cm) $= 0.01$ m
$0.001 = 10^{-3}$	milli	m	1 milligram (mg) $= 0.001$ g
$*0.000\,001 = 10^{-6}$	micro	μ	1 micrometer (μm) $= 10^{-6}$ m
$*0.000\,000\,001 = 10^{-9}$	nano	n	1 nanosecond (ns) $= 10^{-9}$ s
$*0.000\,000\,000\,001 = 10^{-12}$	pico	p	1 picosecond (ps) $= 10^{-12}$ s
$*0.000\,000\,000\,000\,001 = 10^{-15}$	femto	f	1 femtomole (fmol) $= 10^{-15}$ mol

*It is becoming common in scientific work to leave a thin space every three digits to the right of the decimal point in very small numbers, analogous to the comma placed every three digits to the left of the decimal point in large numbers.

Experimentation and Measurement in Chemistry

Temperature
Three distinct scales

Celsius $\frac{^oC}{100} = \frac{^oF-32}{180}$

Fahrenheit

Kelvin $K = 273 + {}^oC$

Units are Important: Never use a number representing a measurement without including the corresponding measurement units

TABLE 0.3 Some Derived Units and the Quantities They Measure

Quantity	Definition	Derived Unit (Name)
Area	Length times length	m^2
Volume	Area times length	m^3
Density	Mass per unit volume	kg/m^3
Speed	Distance per unit time	m/s
Acceleration	Change in speed per unit time	m/s^2
Force	Mass times acceleration	$(kg \cdot m)/s^2$ (newton, N)
Pressure	Force per unit area	$kg/(m \cdot s^2)$ (pascal, Pa)
Energy	Force times distance	$(kg \cdot m^2)/s^2$ (joule, J)

Derived Units: Measuring Volume

The Liter
Volume is cubic length
V = l X w X h
1L = 1 dm^3
1mL = 1 cm^3 or cc

Derived Units: Measuring Volume

Mass & Force (weight)
Mass is measured in kg in the SI system
Weight is a force
Force is a derived unit; F = m X a
Force is measured in newtons (N)
The acceleration of gravity on a body's mass

Balance: Instrument used to compare the mass of an object with other objects of known mass
Tribeam balance
Electronic balance

Density: The mass of a unit volume of substance $D = m/V$

ENERGY: The Capacity for doing work

Types of Energy
Potential Energy (V): Possesses the potential to do work based on position, condition, or composition.
Kinetic Energy(E_k): Energy due to the motion of a body.

Forms of Energy

Electromagnetic
Chemical
Mechanical
Nuclear
Thermal

Law of conservation of energy: During a physical or chemical change, energy can be neither created nor destroyed; it only changes form.

Accuracy, Precision, and Significant Figures in Measurement

RULES FOR SIGNIFICANT FIGURES (Review and understand how to use)

All nonzero digits <u>are</u> significant
All zeros between two nonzero digits <u>are</u> significant
Zeros to the right of a nonzero digit, but to the left of an understood decimal, <u>are not</u> significant. (unless specifically indicated)
All zeros to the right of a decimal, but to the left of a nonzero digit <u>are not</u> significant.
All zeros to the right of a decimal and to the right of a significant digit <u>are</u> significant.

Operations with Significant Digits (Review and understand how to use)

Addition & Subtraction
Multiplication & Division

Dimensional Analysis & Exponential Notation (Review and understand how to use)

Exponential Notation (Review and understand how to use)