Welcome to the World of Chemistry

The Language of Chemistry

- **CHEMICAL ELEMENTS** -
  - pure substances that cannot be decomposed by ordinary means to other substances.

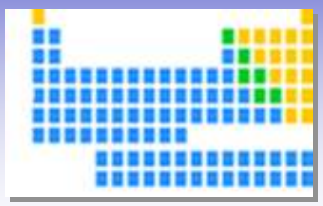
Sodium

Aluminum

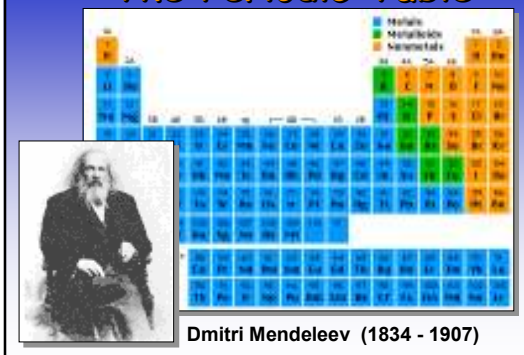
Bromine

The Language of Chemistry

- The elements, their names, and symbols are given on the **PERIODIC TABLE**
- How many elements are there?

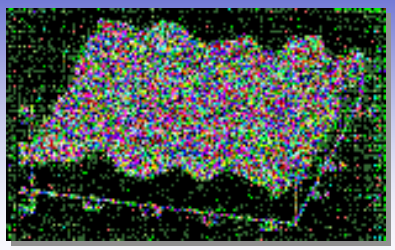


The Periodic Table



Dmitri Mendeleev (1834 - 1907)

- An **atom** is the smallest particle of an element that has the chemical properties of the element.



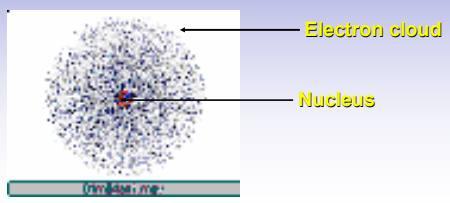
Copper atoms on silica surface.

Distance across = 1.8 nanometer (1.8 x 10^{-9} m)

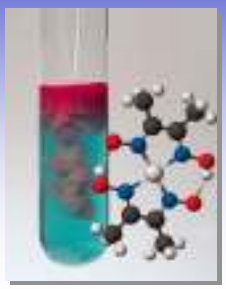
The Atom

An atom consists of a

- **nucleus**
  - –(of **protons** and **neutrons**)
- **electrons** in space about the nucleus.



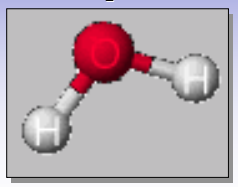
CHEMICAL COMPOUNDS are composed of atoms and so can be decomposed to those atoms.



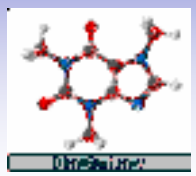
The red compound is composed of
- nickel (Ni) (silver)
- carbon (C) (black)
- hydrogen (H) (white)
- oxygen (O) (red)
- nitrogen (N) (blue)

A **MOLECULE** is the smallest unit of a compound that retains the chemical characteristics of the compound.
Composition of molecules is given by a
MOLECULAR FORMULA

H_2O

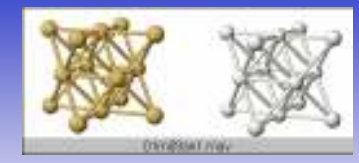


$C_8H_{10}N_4O_2$ - caffeine



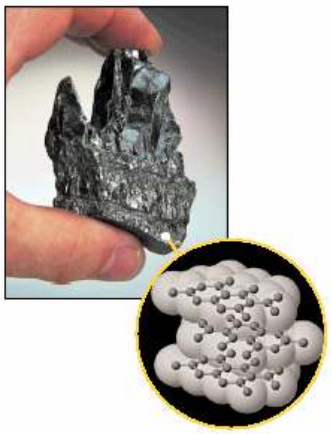
The Nature of Matter

Gold



Mercury

Chemists are interested in the nature of matter and how this is related to its atoms and molecules.



Graphite — layer structure of carbon atoms reflects physical properties.

Chemistry & Matter

- **MACROSCOPIC** world
- **PARTICULATE** worlds we cannot see
- **SYMBOLS** to describe these worlds.

A Chemist's View of Water

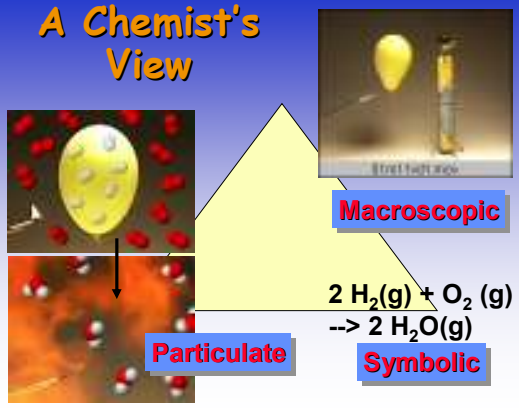
Macroscopic

H_2O
(gas, liquid, solid)

Particulate

Symbolic

A Chemist's View



Macroscopic

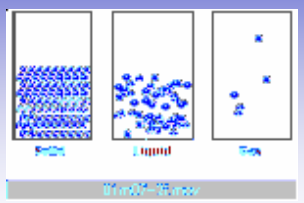
$2\ H_2(g) + O_2\ (g) \rightarrow 2\ H_2O(g)$

Particulate

Symbolic

Kinetic Nature of Matter

Matter consists of atoms and molecules in motion.



STATES OF MATTER

- **SOLIDS** — have rigid shape, fixed volume. External shape can reflect the atomic and molecular arrangement.
  - –Reasonably well understood.
- **LIQUIDS** — have no fixed shape and may not fill a container completely.
  - –Not well understood.
- **GASES** — expand to fill their container.
  - –Good theoretical understanding.

Physical Properties

- color
- melting and boiling point
- odor

Physical Changes

physical changes

- boiling of a liquid
- melting of a solid
- dissolving a solid in a liquid to give a homogeneous mixture — a SOLUTION.

Movie

Chemical Properties and Chemical Change

•Burning hydrogen (H_2) in oxygen (O_2) gives H_2O.

Chemical Properties and Chemical Change

•Burning hydrogen (H_2) in oxygen (O_2) gives H_2O.

- Chemical change or *chemical reaction* — transformation of one or more atoms or molecules into one or more different molecules.

Movie #1 Movie #2 Movie #3

Types of Observations and Measurements

- QUALITATIVE observations of reactions — changes in color and physical state.
- QUANTITATIVE MEASUREMENTS, - involve numbers.
- SI units — based on the metric system

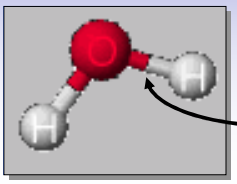
UNITS OF MEASUREMENT

Use SI units — based on the metric system

Length	Meter, m
Mass	Kilogram, kg
Time	Seconds, s
Temperature	Celsius degrees, ˚C kelvins, K

Units of Length

- 1 kilometer (km) = ? meters (m)
- 1 meter (m) = ? centimeters (cm)
- 1 centimeter (cm) = ? millimeter (mm)
- 1 nanometer (nm) = 1.0 x 10^{-9} meter

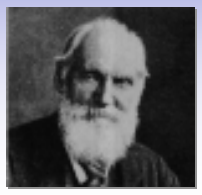


O—H distance =
9.4 x 10^{-11} m
9.4 x 10^{-9} cm
0.094 nm

Temperature Scales

- Fahrenheit
- Celsius
- Kelvin

Anders Celsius
1701-1744

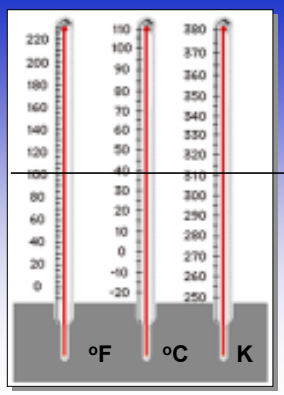


Lord Kelvin
(William Thomson)
1824-1907

Temperature Scales

	Fahrenheit	Celsius	Kelvin
Boiling point of water	212 ˚F	100 ˚C	373 K
	180˚F	100˚C	100 K
Freezing point of water	32 ˚F	0 ˚C	273 K

Notice that 1 kelvin degree = 1 degree Celsius



Temperature Scales

100 °F
38 °C
311 K

Calculations Using Temperature

- Generally require temp's in kelvins
- T (K) = T °(C) + 273.15
- Body temp = 37 °C + 273 = 310 K
- Liquid nitrogen = -196 °C + 273 = 77 K