The Scientific Method

Observations → Hypothesis → Experiment → Conclusions → Theory/Law

Percent Error Equation

$$\%\,error = \frac{|experimental - actual|}{actual} \cdot 100\,\%$$

Experimental Value
The value measured in lab

Actual Value
The correct value based on reliable references

Matter

Matter
Anything that occupies space and has mass

Pure Substances
Anything made of only one kind of matter

Mixtures
Anything made of different kinds of matter

Physical Change

Elements
A pure substance that can't be broken down to a simpler substance

Compounds
A chemical combination of two or more elements joined in fixed properties

Chemical Change

Homogenous
Same throughout
Ex: tea, air

Heterogenous
Varies throughout
Ex: dirt, concrete

Qualitative Results in descriptive non-numerical form. Ex. You feel feverish

Quantitative Results in a definite form, usually as numbers or units. Ex. Your temperature is 39.2°C

Density A measure of how tightly packed and how heavy molecules are in an object; the amount of matter within a certain volume.

Physical Properties describe inherent nature of the material. Ex. Color, state, size, shape, density, boiling point, melting point

Chemical Properties The ability of a substance to react to form a new substance. Ex. Iron reacts with oxygen to form rust, gold does not tarnish

Isotopes Substances that are chemically alike (same #p⁺) but have different #n⁰ and mass #.

Nuclear Decay Changes to the atomic nucleus

- **Radioactive Decay** When naturally unstable nuclei break down into more stable nuclei, emitting high energy radiation in the process.
- **Fission Reaction** Often human induced reactions where nuclei are bombarded with neutrons, causing them to split and create enormous amounts of energy.
- **Fusion Reaction** Where small nuclei are joined together to create a larger nuclei producing energy in the process

Half-Life The time it takes for half of an isotope to decay.

Quantized Energy Electrons can possess only certain discrete energy values; electrons cannot be between energy levels. Evidence: Atoms absorb energy, then it releases as light; only few colors/frequency/energies can be seen; all atoms of the same element have the same spectra; different atoms have different spectral.

The Heisenberg Uncertainty Principle The more precise a particle's position is known, the less precisely its momentum can be known, and vise versa.

$^{A}_{Z}C$

Z = Proton
A = Mass Number = Protons + Neutrons

$^{12}_{5}C$
$carbon - 12$
(98.9%)

$^{13}_{5}C$
$carbon - 13$
(1.1%)

$^{14}_{5}C$
$carbon - 14$
(< 0.1%)

Alpha Decay

$^{4}_{2}He$
$\alpha - particle$

Gamma Decay

$^{0}_{-1}e$
$\beta - particle$

Beta Decay

$^{0}_{0}\gamma$
$\gamma - particle$

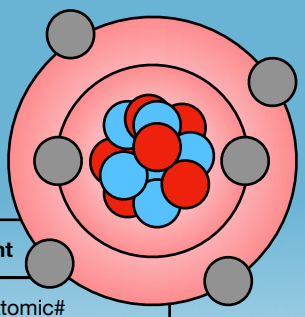
Accuracy vs. Precision

High Accuracy
High Precision

Low Accuracy
High Precision

High Accuracy
Low Precision

Low Accuracy
Low Precision



The Atom

The Atom	Charge	Charge	Location	Amount
Protons (p⁺)	+1	1 amu	Nucleus	#p⁺ = atomic#
Electrons	-1	1/1840 amu	Electron clouds	#e⁻ = #p⁺ (neutral atom)
Neutrons	Neutral	1 amu	Nucleus	#n⁰ can change
Nucleus	+(#p⁺)	#p⁺ + #n⁰	Center of the atom	

Equations

Photon Energy

$$E = h\nu \quad E = \frac{hc}{\nu}$$

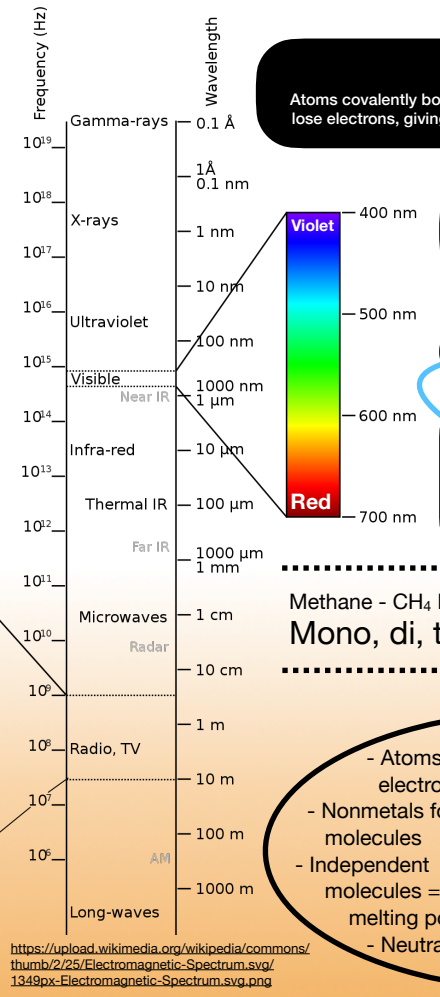
Wavelength/Frequency

$$c = \lambda\nu \quad \nu = \frac{c}{\lambda} \quad \lambda = \frac{c}{\nu}$$

$E = photon\ energy$
$\nu = frequency$
$\lambda = wavelength$

$c = speed\ of\ light = 3.0 \times 10^{8} m/s$

$h = Planck's\ constant = 6.626 \times 10^{-34} Js$



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Ionic Compounds

Polyatomic
Atoms covalently bond and in the process the molecule picks up or lose electrons, giving the molecule a charge. (Ending in -ate or -ite)

Binary
Metal + nonmetal (ending in -ide)

Type I
When the charge of the cation is obvious. Group 1A, 2A, Al^{3+}, Cd^{2+} Zn^{2+} Ag^{+}

Type II
When the charge of the cation is not obvious.

Covalent Compounds

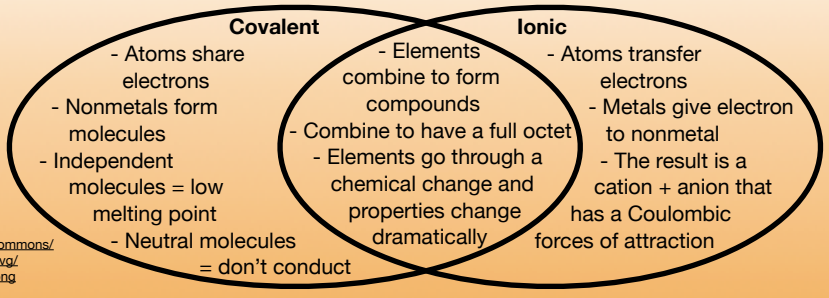
Diatomic
H2, Cl2, F2, Br2, I2 N2, O2 BrINClHOF

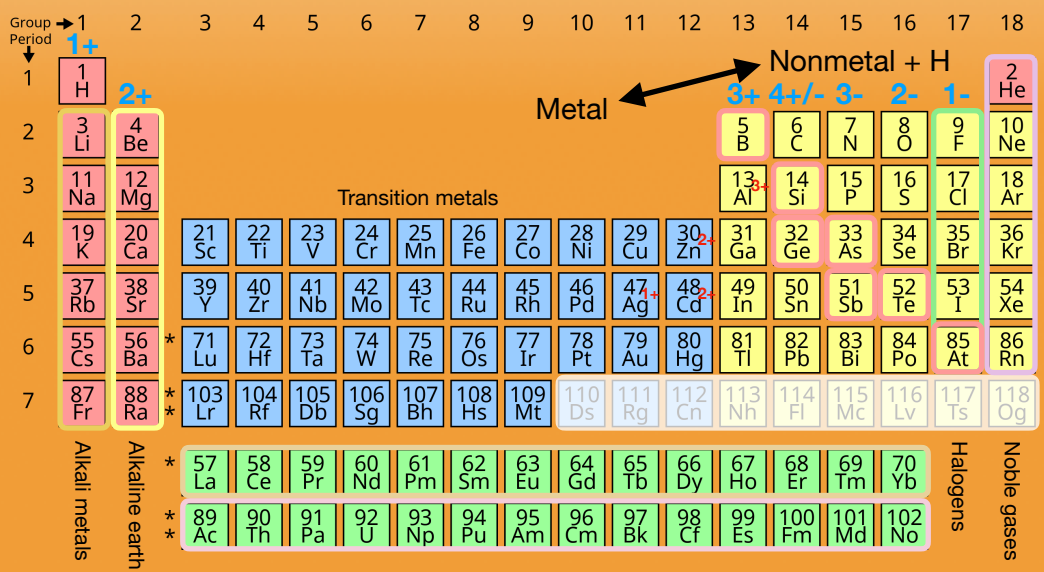
Binary
1st nonmetal + 2nd nonmetal (ending in -ide)

Organic
Hydrocarbons
Organic compounds that involve hydrogen and carbon.

Methane - CH_4 Ethane = C_2H_6 Propane = C_3H_8 Butane = C_4H_{10} Pentane = C_5H_{12}

Mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca





https://commons.wikimedia.org/wiki/File:Simple_Periodic_Table_Chart-blocks.svg

Wavelength The distance between two waves.

Frequency How many waves go by in a second.

Orbitals The region of space around the nucleus where there is a 90% chance of finding an electron.

Aufbau Principle Filling the lowest energy level and building up.

Pauli Exclusion Principle Two electrons can only occupy a lobe if they have opposite "spins".

Hund's Rule (Bus Rule) An electron must enter each lobe of an orbital unit before doubling them up.

D-Block Exception A completely full or half full d sub-level is more stable than a partially filled d sub-level, so an electron from the 4s orbital is excited and rises to a 3d orbital.

Lewis Dot Diagrams Models to show the valence electrons of an atom.

Valence Electrons Electrons in the outer shell.

Mendeleev (1834 - 1907) Organized elements by increasing mass and similar properties were side by side. His arrangement could accurately predict properties of elements that haven't been discovered yet.

The Modern PT is arranged by increasing atomic number and to show similarities in physical and chemical properties

Periodic Law When elements are arranged in order of increasing atomic # there is a periodic repetition of physical and chemical properties.

Metals Substances that tend to be shiny, malleable, ductile, and conduct electricity well. Metals hold their valence electrons loosely in a chemical reaction and give them up to nonmetals.

Nonmetals Substances that tend to be dull, brittle, and don't conduct electricity well. Nonmetals hold valence electrons tightly in chemical reactions and gain electrons from metals or share electrons with other nonmetals.

Metalloids Substances that can sometimes act like a metal and sometimes act like a nonmetal.

Metallic Bonding In pure elements. Electrons have a freedom of movement that makes them malleable and conductive; electrons are delocalized.

Ionization Energy The amount of energy required to remove an electron.

Electronegativity The ability of an atom to attract electrons to itself.

Ionic Bonds Bonds that form from atoms of a metal and atoms of a nonmetal. Ionic Bonds conduct electricity, are generally solids at room temp, and have a high melting point because atoms are locked in place.

SALT Repeating networks of ions called crystals from ionic bonding

Covalent Bonds Bonds formed when atoms of nonmetals share their valence electrons in order to have a full octet. Covalent bonds don't conduct (have no charge), have low melting points, and are often liquid or gases in room temperature.

Ionic Compounds One ration that results in a neutral compound, formula represents the lowest whole number ratio of ions. Metal (cation) first then nonmetal (anion).

Covalent Compounds Different from Ionic and can come together in various ways.

Type I When the charge of the cation is obvious, including Group 1A, 2A, Al^{3+}, Cd^{2+}, Zn^{2+}, and Ag^{+}

Type II When the charge of the cation is not obvious.

- = s-block
- = d-block (transition metals)
- = p-block
- = f-block
- = Metalloid staircase
- = Alkali metals (Group 1)
- = Alkaline earth metals (Group 2)
- = Halogens (Group 17)
- = Noble gases (Group 2)
- = Lanthanides
- = Actinides