

ATOMS AND ELEMENTS

PERIODIC TABLE CLASSIFICATIONS

Periodic Table of Elements

The Periods represent the horizontal rows of the Periodic Table, while the Groups or Families represent the vertical columns.

Alkali Metals
Alkaline Earth Metals
Noble or Inert Gases
Halogens
Chalcogens
Pnictogens

1 H 1.008	2 He 4.003																
3 Li 6.941	4 Be 9.012																
11 Na 22.990	12 Mg 24.305																
19 K 39.098	20 Ca 40.078	3 Sc 44.956	4 Ti 47.867	5 V 50.942	6 Cr 51.996	7 Mn 54.938	8 Fe 55.845	9 Co 58.933	10 Ni 58.693	11 Cu 63.546	12 Zn 65.38	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc 98.906	44 Ru 101.07	45 Rh 102.905	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.6	53 I 126.905	54 Xe 131.29
55 Cs 132.905	56 Ba 137.327	57-71 Lanthanide Series	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.22	78 Pt 195.084	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89-103 Actinide Series	104 Rf 181	105 Db 185	106 Sg 187	107 Bh 189	108 Hs 191	109 Mt 193	110 Ds 195	111 Rg 197	112 Cn 199	113 Nh 201	114 Fl 203	115 Mc 205	116 Lv 207	117 Ts 209	118 Og 211

Transition Metals

Inner Transition Metals

The 3 major classifications in the periodic table include **metals**, **non-metals** & **metalloids**.

Metals
They have luster (shininess), are good thermal and electrical conductors, malleable, opaque, while having ductility and being solids at room temperature (~25°C).

Non-Metals
They have little to no luster, are poor thermal and electrical conductors, are brittle and transparent, while having no ductility and representing all phases at room temperature (~25°C).

Metalloids
They have characteristics of both metals and non-metals, which explains why they are sometimes called "semi-metals" or "semi-conductors".

PERIODIC TABLE CHARGES

Elements gain or lose electrons in order to be more like the noble gases, which have the optimal number of outer shell electrons.

Metals tend to lose electrons to become positive ions called cations.

Non-metals tend to gain electrons to become negative ions called anions.

Transition metals tend to have varying positive charges.

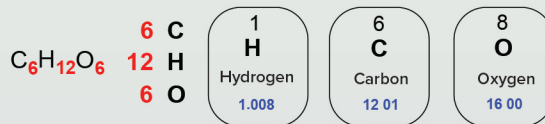
1 H +1	2 He 0																
3 Li +1	4 Be +2																
11 Na +1	12 Mg +2																
19 K +1	20 Ca +2	3 Sc	4 Ti	5 V	6 Cr	7 Mn	8 Fe	9 Co	10 Ni	11 Cu	12 Zn	13 Al +3	14 Si	15 P -3	16 S -2	17 Cl -1	18 Ar
37 Rb +1	38 Sr +2	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag +1	48 Cd +2	49 In	50 Sn +2, +4	51 Sb	52 Te -2	53 I -1	54 Xe
55 Cs +1	56 Ba +2	57-71 Lanthanide Series	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb +2, +4	83 Bi	84 Po	85 At	86 Rn
87 Fr +1	88 Ra +2	89-103 Actinide Series	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

Most main group elements possess a single charge, with notable exceptions of lead (Pb) and tin (Sn), which have charges of +2 and +4.

MOLAR MASS

Molar mass or **molecular weight** is a physical property that represents the mass of a substance divided by the amount of that substance.

- When calculating the molar mass of a compound make sure to count the number of each element and find their atomic masses from the periodic table.



- Add up all the atomic mass totals to determine the molar mass of the compound.

$$C_6H_{12}O_6 \quad 6C \times 12.01 \text{ g/mol} = 72.06 \text{ g/mol}$$

$$12H \times 1.008 \text{ g/mol} = 12.096 \text{ g/mol}$$

$$6O \times 16.00 \text{ g/mol} = 96.00 \text{ g/mol}$$

$$\text{Sum} = 180.156 \text{ g/mol}$$



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ATOMS AND ELEMENTS

MOLE CONCEPT

The mole is the chemical unit for the amount of a substance that connects grams, molecules, atoms, formula units and ions.

Atom	a single element with no charge. (Ex: Na)
Ion	a single element with a charge. (Ex: Na ⁺)
Molecule	a compound with 2 or more non-metals together. (C ₆ H ₁₂ O ₆)
Formula Unit	a compound composed of a metal and nonmetal. (Ex: NaCl)



Example

➤ Convert 1.85×10^{21} molecules of C₆H₁₂O₆ to grams.

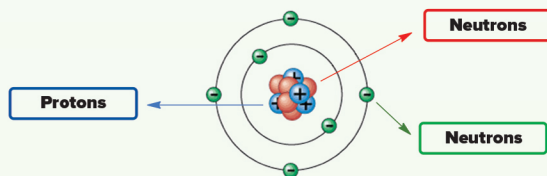
$$1.85 \times 10^{21} \text{ molecules C}_6\text{H}_{12}\text{O}_6 \times \frac{1.0 \text{ mole C}_6\text{H}_{12}\text{O}_6}{6.022 \times 10^{23} \text{ molecules C}_6\text{H}_{12}\text{O}_6} \times \frac{180.156 \text{ g C}_6\text{H}_{12}\text{O}_6}{1.0 \text{ mole C}_6\text{H}_{12}\text{O}_6} = 0.553 \text{ g C}_6\text{H}_{12}\text{O}_6$$

* 6.022×10^{23} is known as Avogadro's number.

SUBATOMIC PARTICLES

The atom is the basic functional unit in chemistry.

- The atom is comprised of three subatomic particles: neutron, proton and electron.



Subatomic Particle	Mass(KG)	Mass(amu)	Relative Charge	Charge (Coulombs)
Neutron	1.67493×10^{-27}	1.00866	0	0
Proton	1.67262×10^{-27}	1.00727	+1	$+1.60218 \times 10^{-19}$
Electron	0.00091×10^{-27}	0.00055	-1	-1.60218×10^{-19}

ATOMIC THEORY

Modern Atomic Theory states that matter is composed of small, indivisible particles called atoms.

Law of Conservation of Mass

states that in a reaction matter is neither created nor destroyed.

Law of Definite Proportions

states that all samples of a compound, no matter on their origin or preparation has the same ratio in terms of their elements.

Law of Multiple Proportions

states that when two elements (A & B) form different compounds, the masses of element B that combine with 1 g of A are a ratio of whole numbers.

EXPERIMENTS (Atomic Theory)

Thomson Cathode Ray Tube Experiment

led to the discovery of the electron and its charge-to-mass ratio as -1.76×10^8 Coulombs per gram.

Rutherford Gold Foil Experiment

led to the discovery of the nucleus through the use of radioactive alpha particles.

Millikan Oil Drop Experiment

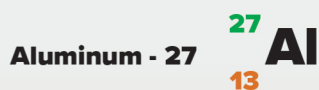
led to the discovery of the nucleus through the use of radioactive alpha particles.

Chadwick Neutron Experiment

led to the discovery of neutron through the use of a proton-rich paraffin substance.

ISOTOPES

Isotopes represent atoms of an element **X** that contain the same **atomic number (Z)**; same number of protons), but different **mass numbers (A)**; different number of neutrons).



Number of neutrons (n⁰) = 27 - 13 = 14

Number of protons (p⁺) = 13

Number of electrons (e⁻) = 13 *

* For a neutral element the number of protons and electrons are equal.

The atomic mass of an element on the periodic table is an average of all its isotopes.

$$\text{Average Mass} = [(\text{Mass Isotope 1}) (\text{Fractional Abundance})] + [(\text{Mass Isotope 2}) (\text{Fractional Abundance})] \dots$$

- Fractional abundance represents the percent abundance of an isotope divided by 100.

The atomic mass of carbon comes from the average masses of its two isotopes, Carbon - 12 and Carbon - 13.

$$\text{Average Mass} = [(12.00 \text{ amu}) \times (\frac{98.93\%}{100})] + [(13.00335 \text{ amu}) \times (\frac{98.93\%}{100})] = 12.01 \text{ amu}$$



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