Periodic table families and valence electrons

Valence electron

- **Valence electrons are the electrons contained in the outermost, or valence, electron shell of an atom**

- **Valence electrons are important in determining how an element reacts chemically with other elements:The fewer valence electrons an atom holds, the less stable it becomes and the more likely it is to react.**

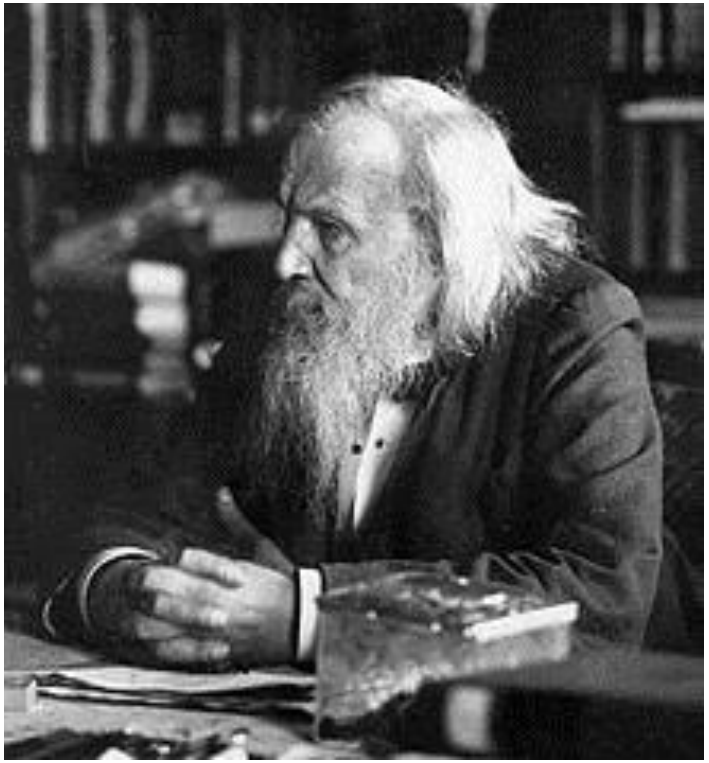
- **The reverse is also true**, the more full/complete the valence shell is with valence electrons, the more inert an atom is and the less likely it is to chemically react with other chemical elements or with chemical elements of its own type.

- **This is because it takes more transfer of energy (photons) to lose or gain an electron from or into a shell when that shell is more complete/full.**

Periodic table

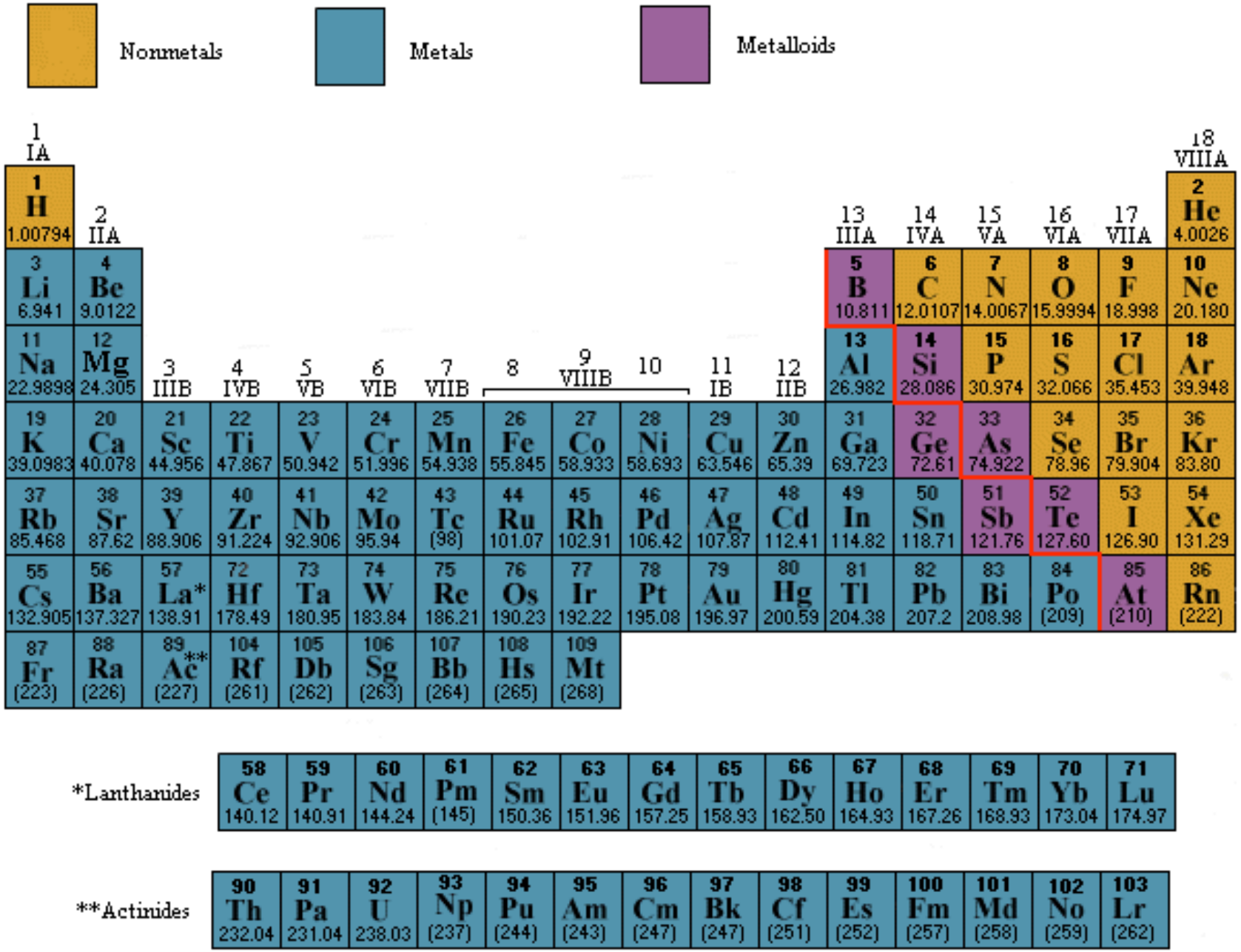
- Grouping of the known elements based on their chemical properties.

- Initially created by Dimitri Mendeleev



Groups and Periods

- Groups: Elements in the same group have the same number of valence electrons*
- Periods: Elements in the same period have the same number of electron shells (orbits)
- Increasing periods = increasing # of shells


Nonmetals
Metals
Metalloids
1 IA
2 IIA
3 IIIB
4 IVB
5 VB
6 VIB
7 VIIB
8
9 VIIIB
10
11 IB
12 IIB
13 IIIA
14 IVA
15 VA
16 VIA
17 VIIA
18 VIIIA
1 H 1.00794
2 He 4.0026
3 Li 6.941
4 Be 9.0122
5 B 10.811
6 C 12.0107
7 N 14.0067
8 O 15.9994
9 F 18.998
10 Ne 20.180
11 Na 22.9898
12 Mg 24.305
13 Al 26.982
14 Si 28.086
15 P 30.974
16 S 32.066
17 Cl 35.453
18 Ar 39.948
19 K 39.0983
20 Ca 40.078
21 Sc 44.956
22 Ti 47.867
23 V 50.942
24 Cr 51.996
25 Mn 54.938
26 Fe 55.845
27 Co 58.933
28 Ni 58.693
29 Cu 63.546
30 Zn 65.39
31 Ga 69.723
32 Ge 72.61
33 As 74.922
34 Se 78.96
35 Br 79.904
36 Kr 83.80
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)
44 Ru 101.07
45 Rh 102.91
46 Pd 106.42
47 Ag 107.87
48 Cd 112.41
49 In 114.82
50 Sn 118.71
51 Sb 121.76
52 Te 127.60
53 I 126.90
54 Xe 131.29
55 Cs 132.905
56 Ba 137.327
57 La* 138.91
72 Hf 178.49
73 Ta 180.95
74 W 183.84
75 Re 186.21
76 Os 190.23
77 Ir 192.22
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104 Rf (261)
105 Db (262)
106 Sg (263)
107 Bb (264)
108 Hs (265)
109 Mt (268)
*Lanthanides
58 Ce 140.12
59 Pr 140.91
60 Nd 144.24
61 Pm (145)
62 Sm 150.36
63 Eu 151.96
64 Gd 157.25
65 Tb 158.93
66 Dy 162.50
67 Ho 164.93
68 Er 167.26
69 Tm 168.93
70 Yb 173.04
71 Lu 174.97
**Actinides
90 Th 232.04
91 Pa 231.04
92 U 238.03
93 Np (237)
94 Pu (244)
95 Am (243)
96 Cm (247)
97 Bk (247)
98 Cf (251)
99 Es (252)
100 Fm (257)
101 Md (258)
102 No (259)
103 Lr (262)

The periodic table cannot only be divided into families, but it can also be organized into four groupings. As the table illustrates, members of the groupings share many properties.

Grouping	Examples	Location	Physical Properties	Chemical Properties
Metals	*Alkali metals, alkaline earth metals, transition metals (Sc,Ti, V etc)*	With exception of H and metalloids, all elements to the LEFT of "staircase". (step-like boundary on top of elements with atomic numbers 13,32,51 and 84.)	good conductors of electricity and heat; shiny, malleable, usually high density and high melting,, except for alkalis;	React with nonmetals and form (+) ions. many react with acid
Metalloids	*B, Si, Ge, As, Sb, Te, Po:*	With exception of Al, elements that border the staircase (jagged line in periodic table)	semi-conductors; some shiny; not malleable	React with nonmetals. don't react with acid;
Nonmetals	*N, O, S, P, Cl, Br, Se etc*	With exception of metalloids and noble gases, elements to the right of the staircase.	poor conductors of heat and electricity; low-melting;	React with metals and nonmetals. When reacting with metals, nonmetals form (-) ions.
Noble Gases	*He, Ne, Ar, Kr, Xe, Rn*	Last column of the periodic family	All gases at room temperature; poor conductors of heat and electricity	Generally unreactive

Periodic families and their physical/chemical properties

- Alkali metals:

- 1 valence electron
- Common ion formed +1
- Physical properties: Soft, low melting, shiny metals: conduct heat and electricity
- Chemical properties: React vigorously with acids, water, oxygen and halogens. The reaction with water generates hydrogen gas and a base.

Periodic families and their physical/chemical properties

- Alkaline earth metals:

- 2 valence electron
- Common ion formed +2

- **Physical properties**: Harder, higher-melting metals: conduct heat and electricity

- **Chemical properties:** React with acids, water, oxygen and halogens, but not always as violently as alkali metals. The reaction with water also generates hydrogen gas and a base, but unlike the alkali metal bases, these are not too soluble in water, just like mud or "earth", hence their name

Periodic families and their physical/chemical properties

- Halogens

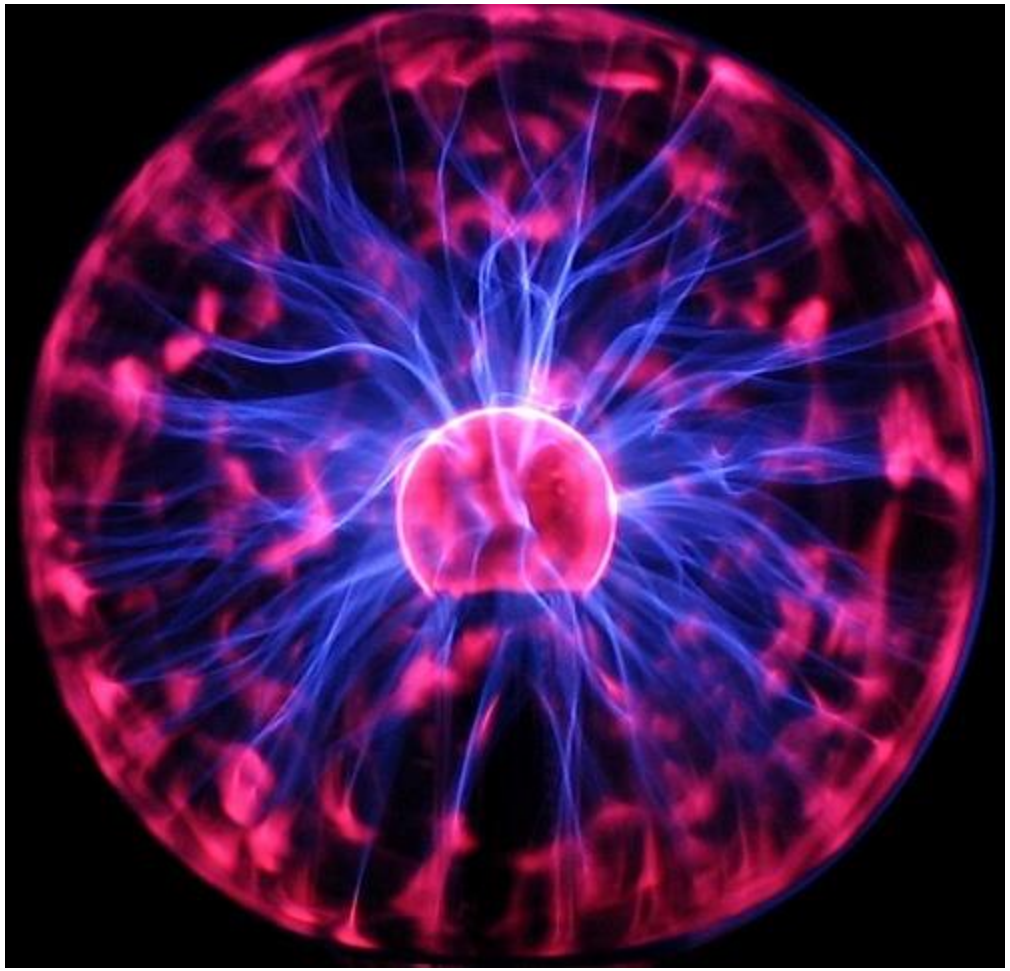
- 7 valence electron
- Common ion formed -1

- **Physical properties**: Some are liquid, solid and gas at room temperature. Poor conductors.

- **Chemical properties:** React with most metals, and form diatomic molecules

Periodic families and their physical/chemical properties

- Noble (inert) gases



- 8 valence electron
- Common ion formed 0
- **Physical properties**: All gases at room temperature. Poor conductors
- **Chemical properties:** Generally, not chemically active. None of the noble gases are flammable

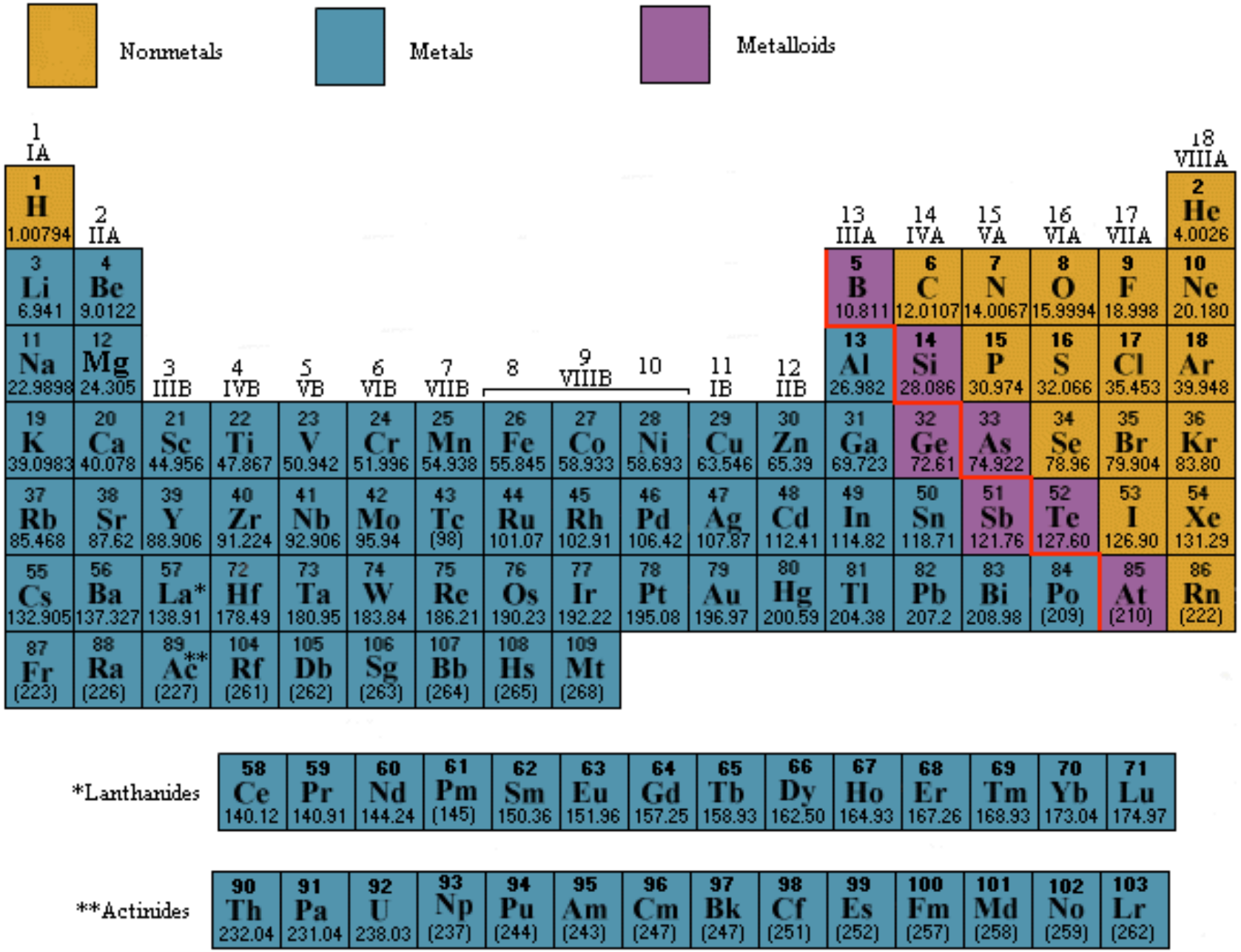
WHAT IS PERIODICITY?

- Periodicity refers to the recurring trends that are seen in the element properties.

WHAT ARE THE PERIODIC PROPERTIES?

The periodic properties are:

1. **ionization energy** - energy required to remove an electron from an ion or gaseous atom
2. **atomic radius** - half the distance between the centers of two atoms that are touching each other
3. **electronegativity** - measure of the ability of an atom to form a chemical bond
4. **electron affinity** - ability of an atom to accept an electron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TRENDS OR PERIODICITY

The periodicity of these properties follows trends as you move across a row or period of the periodic table or down a column or group:

Moving Left → Right

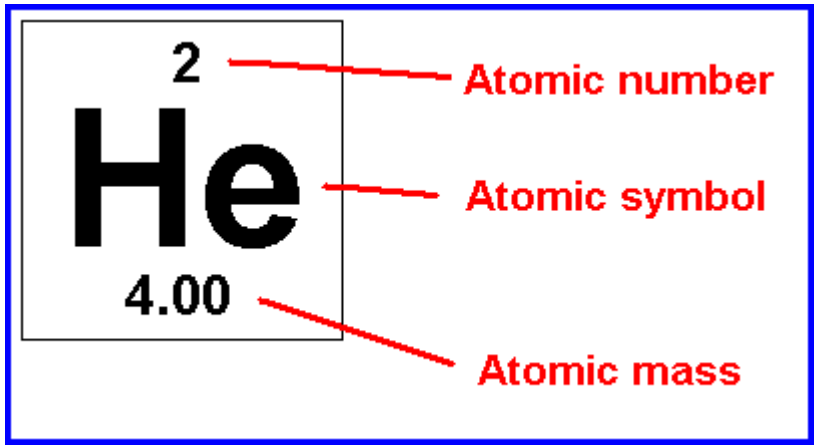
- Ionization Energy Increases
- Electronegativity Increases
- Atomic Radius Decreases

Moving Top → Bottom

- Ionization Energy Decreases
- Electronegativity Decreases
- Atomic Radius Increases

Atomic number

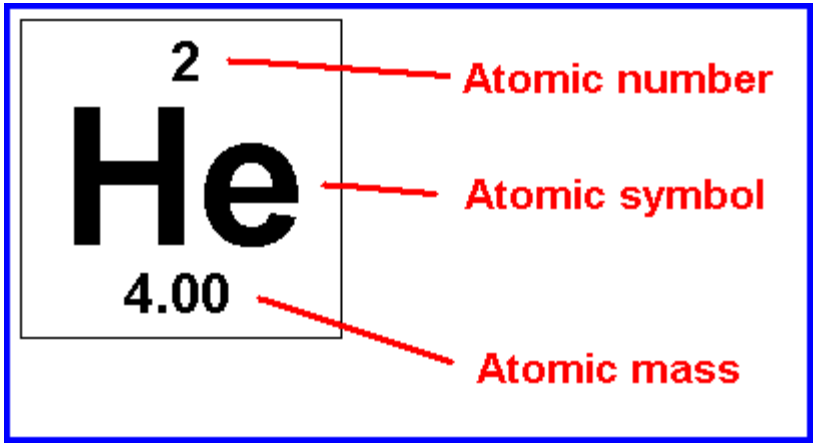
- Atomic number = number of protons in the nucleus of the atom. Distinguishes one element from another



Relative atomic mass

- Relative atomic mass = mass of an atom measured by comparison with a reference element, carbon-12

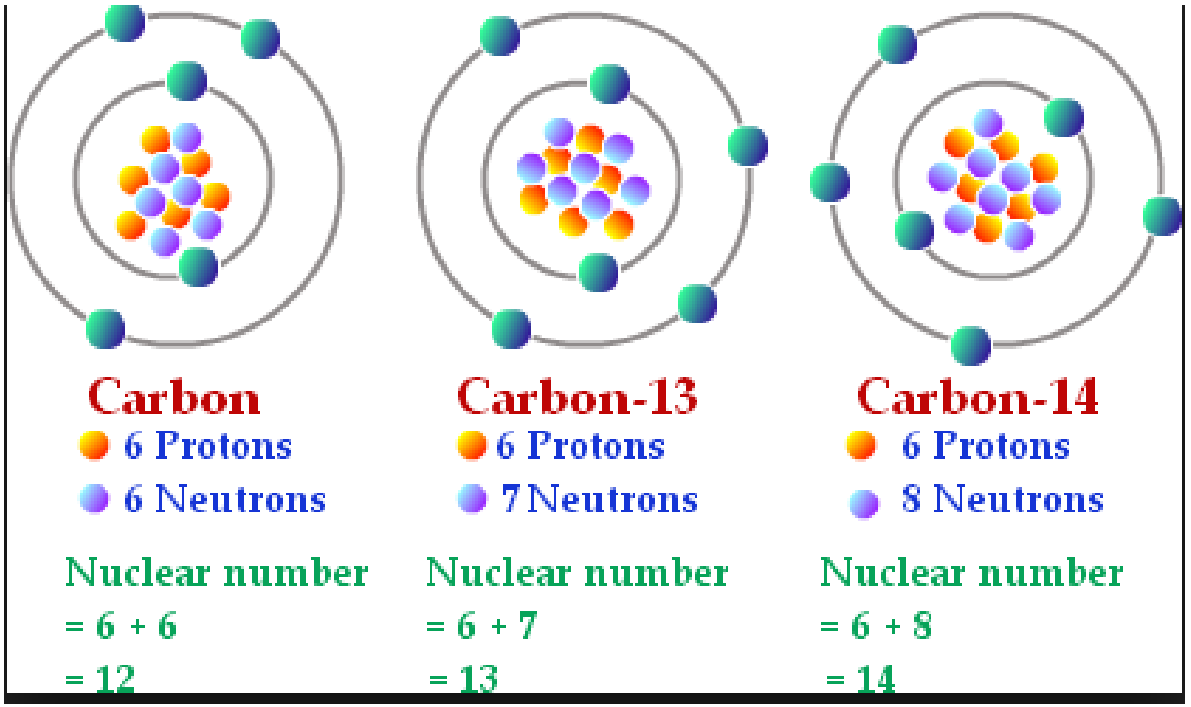
- Mass number



- One atomic unit = $1.660539040(20)\times10^{-27}$ Kg

Isotopes

- An isotope is an atom of an element with the same number of protons as another atom of the same element, but with a different number of neutrons



Lewis Notation

- Lewis notation is a simplified representation of the atom, in which only the valence electrons are illustrated.