Periodic Table and Periodicity

- *"Orientation in Time and Space"*

Review

- Bohr Model 2-D
- Nucleus
- Proton
- Neutron
- Electron
- Atomic Number
- Atomic Mass
- Period
- Group

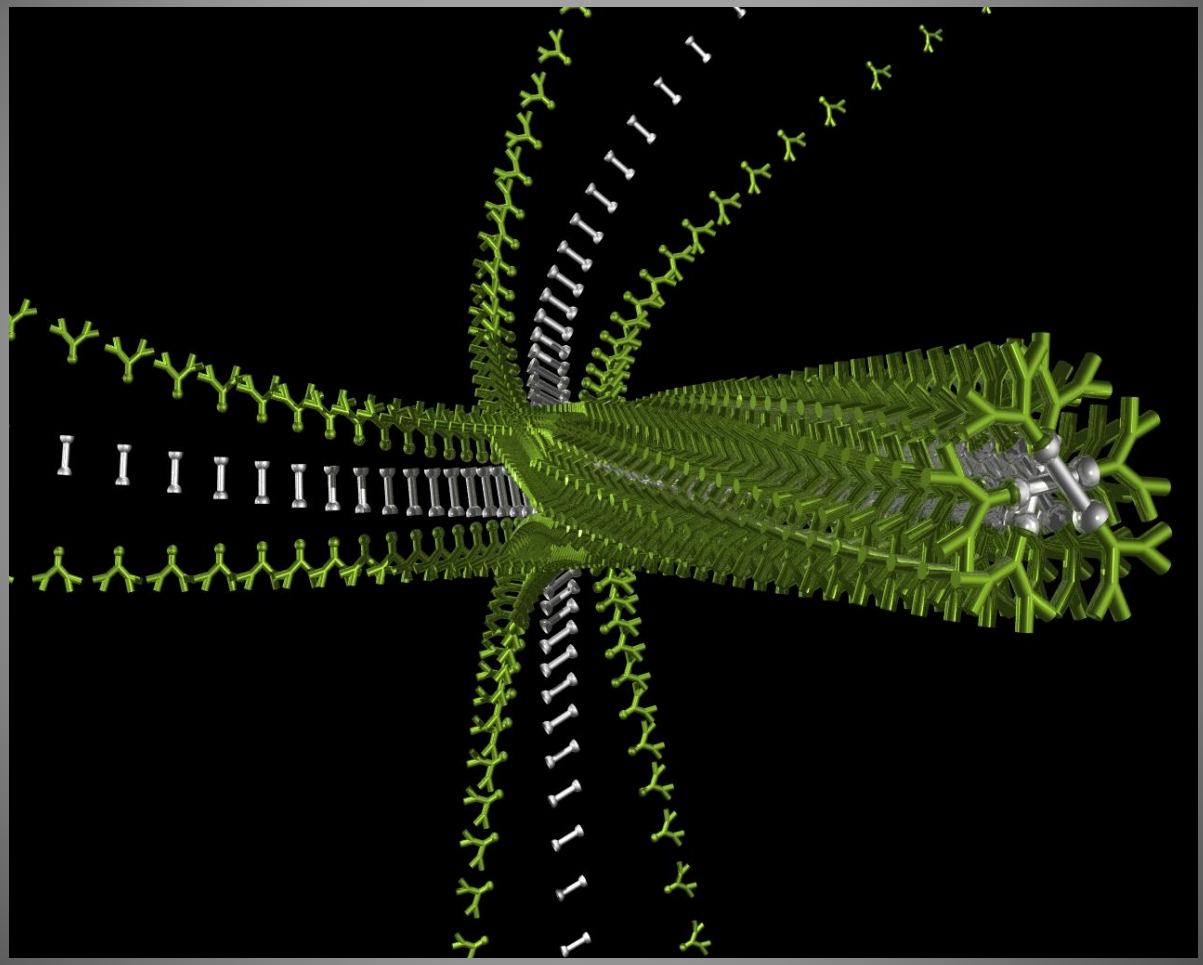
Heisenberg Uncertainty Principle

- It is impossible to measure accurately both the position and energy of an electron at the same time.
- Proposed a cloud model based on the probability of finding an electron in a certain region of space at any given instant

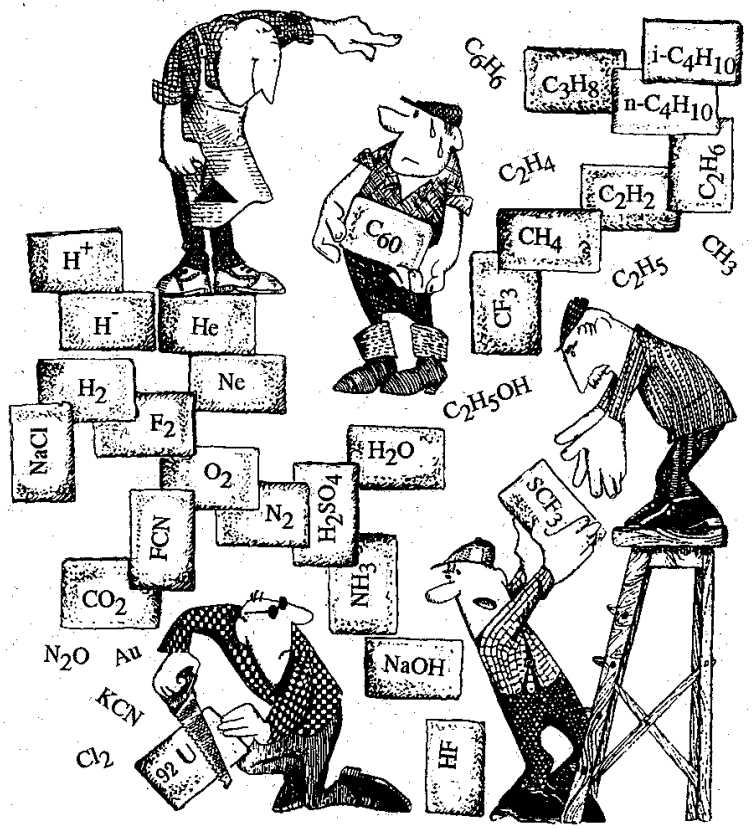
Periodicity

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

Orientation in Time and Space

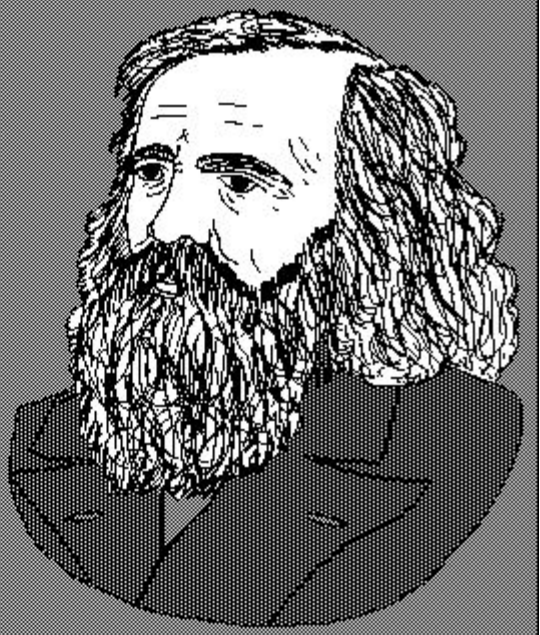


Periodicity



Dmitri Mendeleev
(1834-1907)

In 1869 he published the first successful systematic arrangement of the elements. He discovered that if the elements were arranged in order of increasing atomic weight, there was a periodic repetition of chemical and physical properties.



Where do we find the trends? Periodic Properties

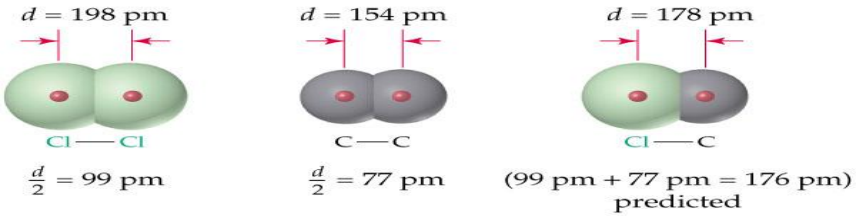
- **Atomic Radius** – half the distance between the centers of two atoms that are touching each other

- **Ionization energy** – energy required to remove an electron from an ion or gaseous atom

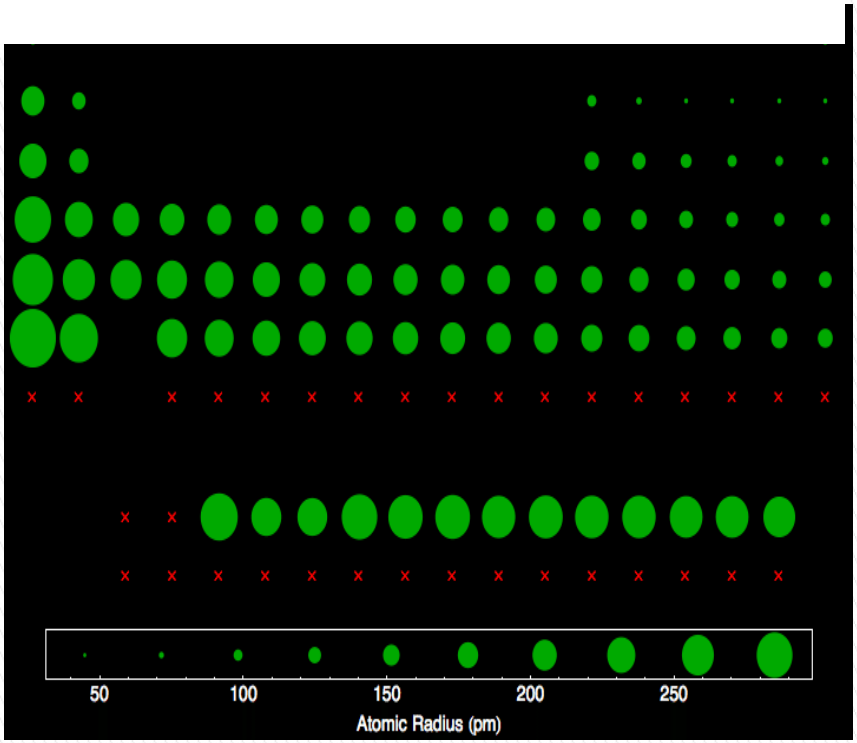
- **Electron Affinity** – ability of an atom to accept an electron

- **Electronegativity** – measure of the ability of an atom to form a chemical bond

Atomic Radius



- The atomic radius of an element is half of the distance between the centers of two atoms of that element that are just touching each other
- Generally, the atomic radius decreases across a period from left to right and increases down a given group
- The atoms with the largest atomic radii are located in Group I and at the bottom of groups

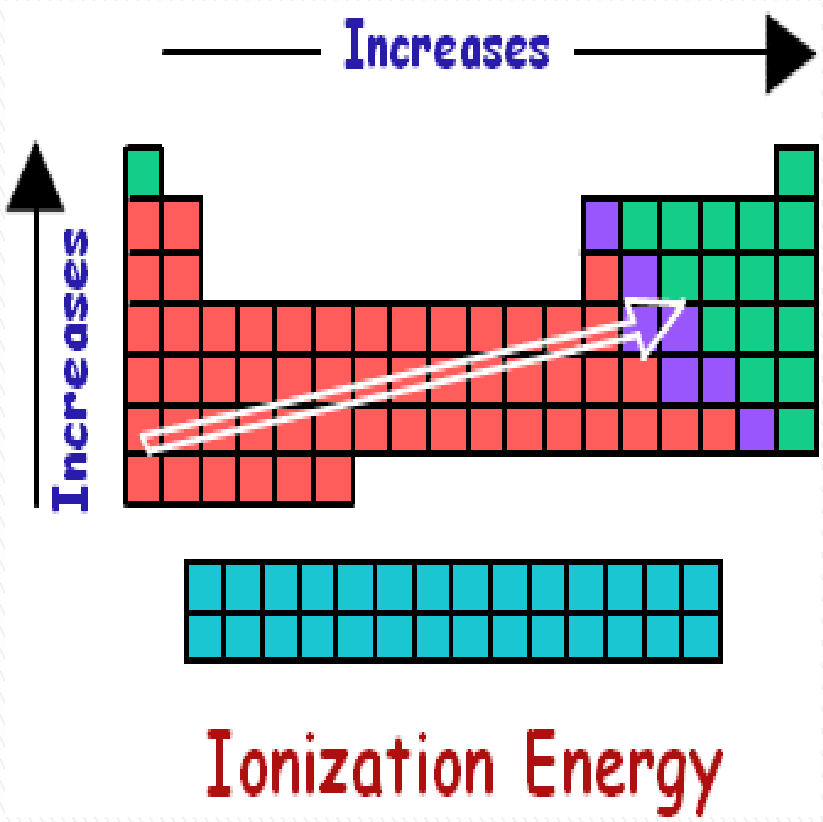


Definition and Characteristics

Periodicity

Ionization Energy

- The energy required to completely remove an electron from a gaseous atom or ion
- The closer and more tightly bound an electron is to the nucleus, the more difficult it will be to remove, and the higher its ionization energy will be
- Ionization energies increase moving from left to right across a period (decreasing atomic radius). Ionization energy decreases moving down a group (increasing atomic radius)
- Group I elements have low ionization energies because the loss of an electron forms a stable octet

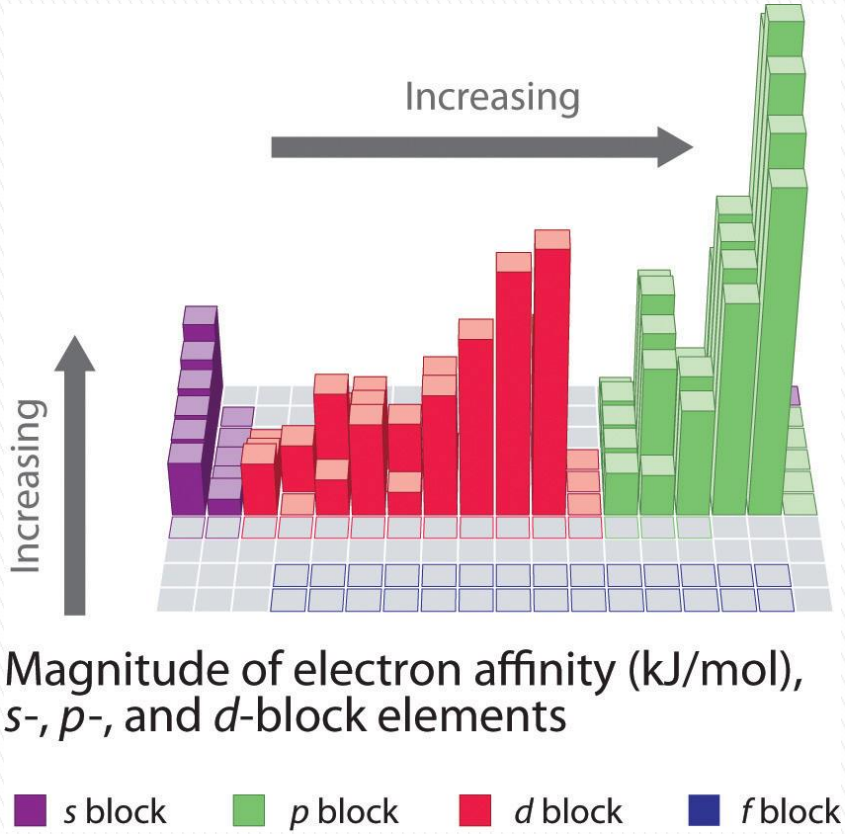


Definition and Characteristic Properties

Periodicity

Electron Affinity

- The ability of an atom to accept an electron
- In a period, the halogen will have the highest electron affinity, while the noble gas will have the lowest electron affinity
- decreases moving down a group because a new electron would be further from the nucleus of a large atom.

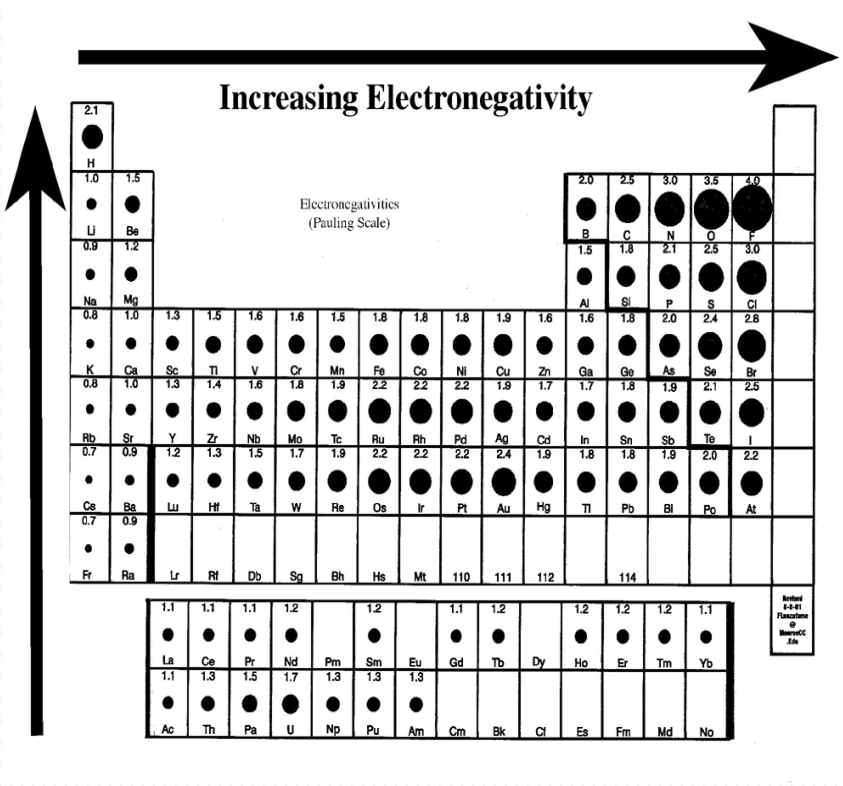


Definition and Characteristics

Periodicity

Electronegativity

- A measure of the attraction of an atom for the electrons in a chemical bond
- The higher the electronegativity of an atom, the greater its attraction for bonding electrons
- Electronegativity is related to ionization energy. Electrons with low ionization energies have low electronegativity because their nuclei do not exert a strong attractive force on electrons and vice versa

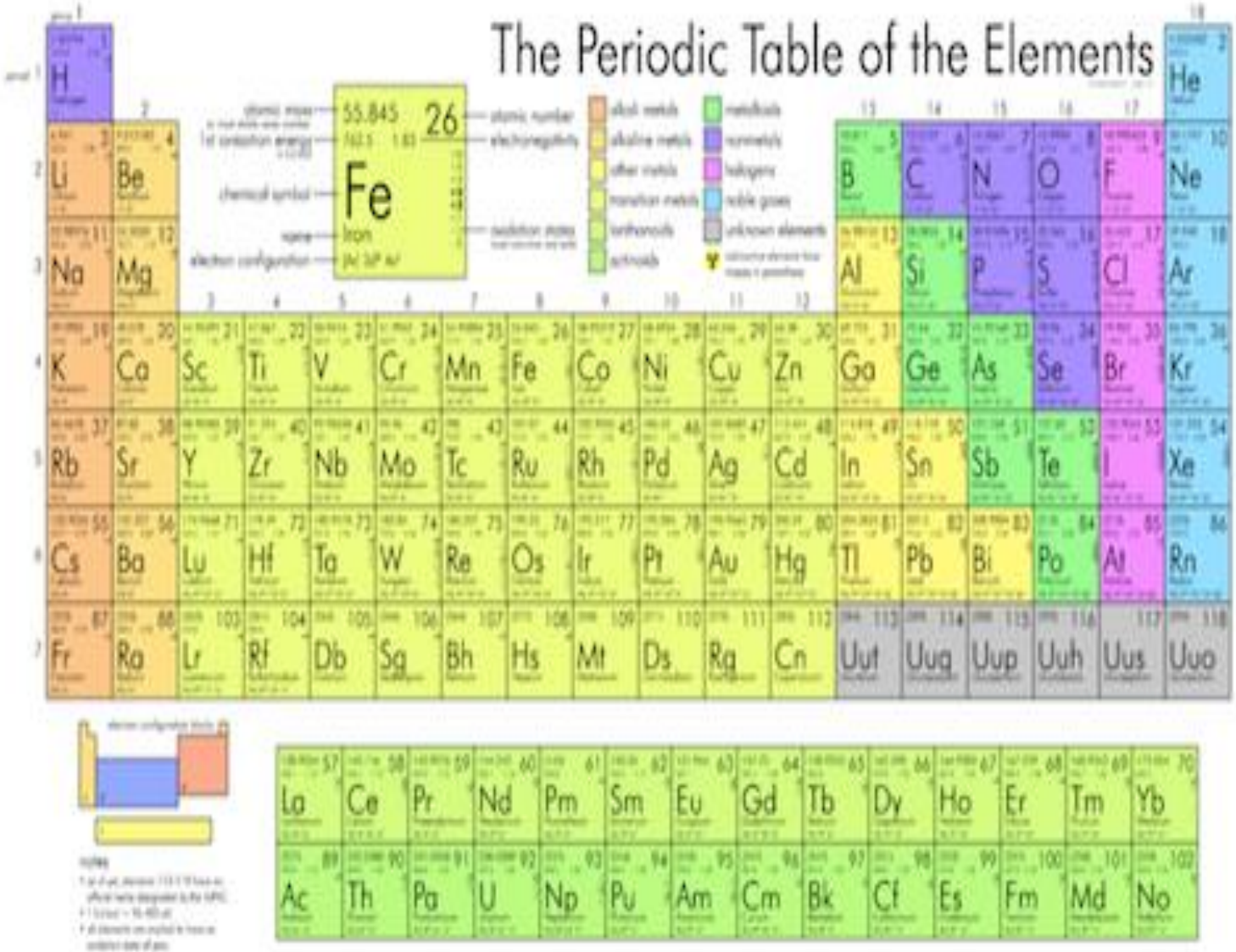


Definition and Characteristics

Periodicity

Periodic Table Groups

- **A closer look at**:
  *Alkali Metals
  *Alkaline Earth Metals
  *Transition Metals
  *Metalloids
  *Halogens
  *Noble Gases


The Periodic Table of the Elements
55.845
26
Fe
Iron
H
He
Li
Be
B
C
N
O
F
Ne
Na
Mg
Al
Si
P
S
Cl
Ar
K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
Ge
As
Se
Br
Kr
Rb
Sr
Y
Zr
Nb
Mo
Tc
Ru
Rh
Pd
Ag
Cd
In
Sn
Sb
Te
I
Xe
Cs
Ba
Lu
Hf
Ta
W
Re
Os
Ir
Pt
Au
Hg
Tl
Pb
Bi
Po
At
Rn
Fr
Ra
Lr
Rf
Db
Sg
Bh
Hs
Mt
Ds
Rg
Cn
Uut
Uuq
Uup
Uuh
Uus
Uuo
La
Ce
Pr
Nd
Pm
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Ac
Th
Pa
U
Np
Pu
Am
Cm
Bk
Cf
Es
Fm
Md
No

Group 1A: Alkali Metals

- Lower densities than other metals (d=m/v)
- One loosely bound valence electron
- Highly reactive
- Form salts with other elements (mostly 7A Halogens)

Characteristic Properties

Metallic Lithium (Li)

Group 2A: Alkaline Earth Metals

- Two valence electrons in the outer shell
- Readily form divalent cations
- Di = 2, Valent = outer shell/orbital Cation = positive charge

Characteristic Properties

Metallic Magnesium (Mg)and Barium (Ba)

Group 3B to 12B:Transition Metals

- Positive Oxidation states (charges – cations)
- Very hard metals
- High melting points
- Low boiling points
- High electrical conductivity
- Malleable
- Five *d orbitals* become more filled, from left to right on periodic table

Characteristic Properties

Metallic Zirconium (Zr) and Cadmium (Cd)

Group 7A: Halogens

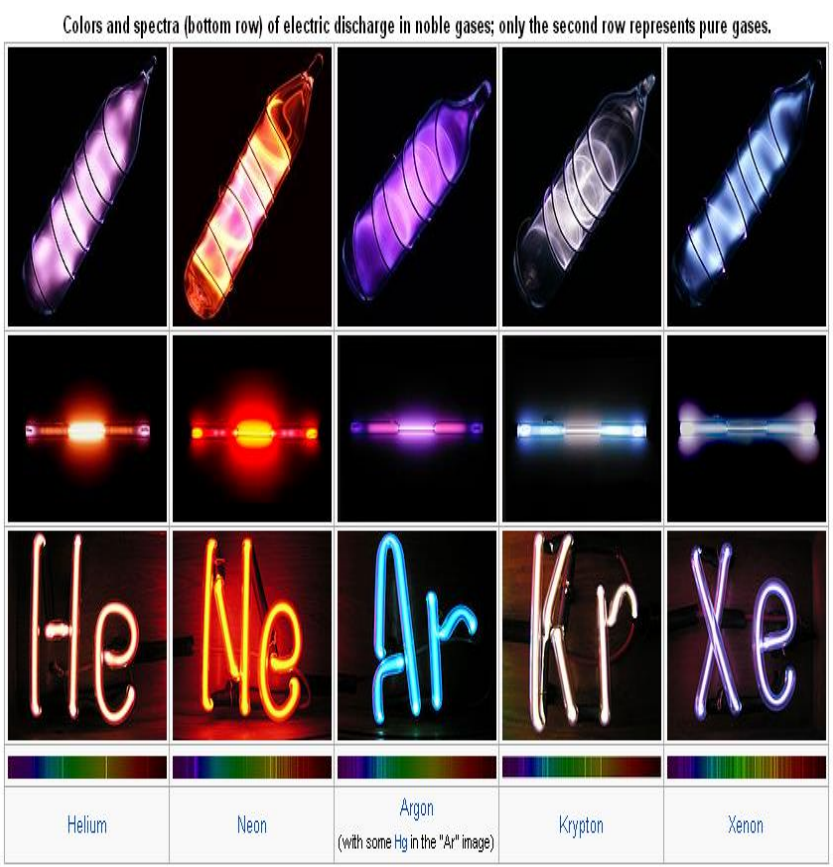
- Seven valence electrons (one short of a stable octet – octet rule)
- Highly reactive, especially with the Group 1A Alkali Metals and Group 2A Alkaline Earth Metals

Characteristic Properties

Metallic Fluorine (F) and Iodine (I)

Group 8A: Noble Gases

- Fairly nonreactive
- Complete valence shell
- Low boiling points (all gases at room temperature)



Characteristic Properties

Lanthanides

- Silvery-white metals that tarnish when exposed to air
- Relatively soft metals
- High melting and boiling points
- Very reactive
- Commonly bind to water
- React with H^+ to release H_2
- Exothermic reaction with Hydrogen
- Burn easily in air

Actinides

- All are radioactive
- Highly electropositive
- Tarnish readily in air
- React with boiling water or dilute acid to release hydrogen gas
- React with most nonmetals

Is It a Metal, Non-Metal, or Metalloid?

Metal Properties

- Lustrous (shiny)
- Malleable (can be hammered)
- Good conductors of heat and electricity
- These properties result from the ability to easily move the electrons in the outer shells of metal atoms.

Non-Metal Properties

- The nonmetals are poor conductors of heat and electricity
- Solid nonmetals are brittle and lack metallic luster
- Most nonmetals gain electrons easily
- The nonmetals are located on the upper right side of the periodic table, separated from metals by a line that cuts diagonally through the periodic table
- The nonmetals can be divided into classes of elements that have similar properties. The halogens and the noble gases are two groups of nonmetals.

Metalloid Properties

- Elements that have some properties of metals and some properties of nonmetals are called metalloids
- Good semiconductors
- The metalloids are located along the diagonal line between the metals and nonmetals in the periodic table.