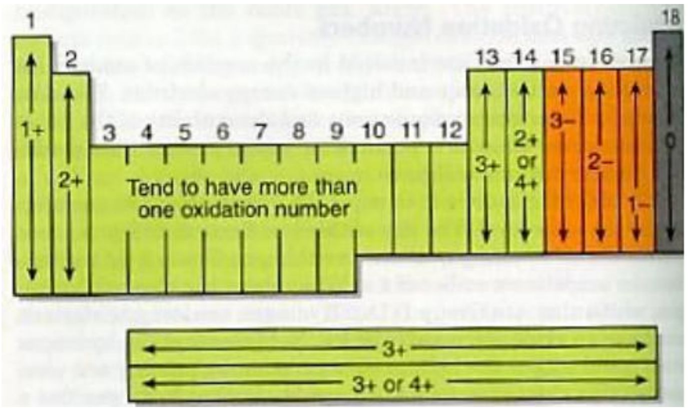
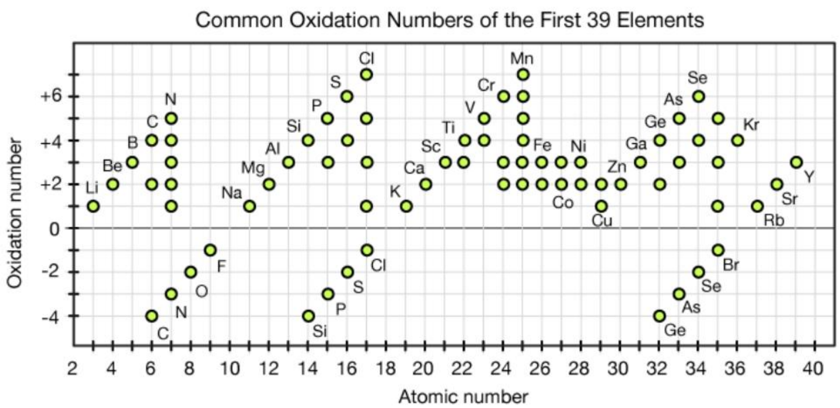
Chemistry In Short

Oxidation States

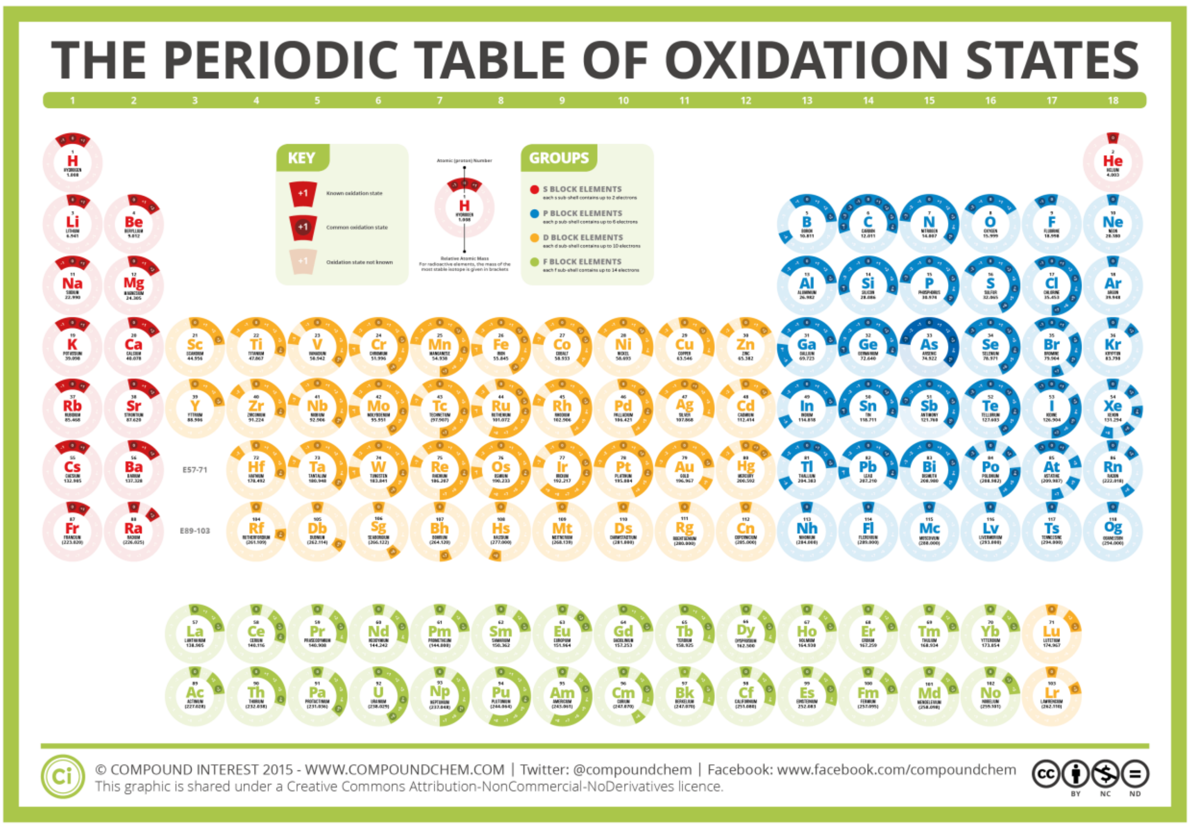


- Group 1 metals: always +1
- Group 2 metals: always +2
- Oxygen: usually -2
  - Except peroxides (-1 since hydrogen peroxide is neutral), superoxides ($-\frac{1}{2}$ – this is an average, meaning that 1 oxygen is -1 and the other is 0) and F_2O (+2 since F is more electronegative than oxygen)
- Hydrogen: usually +1
  - Except in metal hydrides (-1)
- Fluorine: always -1
- Chlorine: usually -1
  - Except compounds with O or F (varies)

- Sulfate ion: SO_4^{2-}
- Nitrate ion: NO_3^-
- Nitrite ion: NO_2^-
- Ammonium ion: NH_4^+
- Carbonate ion: CO_3^{2-}
- Acetate ion: CH_3COO^-
- Phosphate ion: PO_4^{3-}
- Hydrogen sulfate ion: HSO_4^-
- Chromate ion: CrO_4^{2-}
- Chlorate ion: ClO_3^-



Common Oxidation Numbers of the First 39 Elements
Oxidation number
Atomic number
+6
+4
+2
0
-2
-4
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Li
Be
B
C
N
O
F
Na
Mg
Al
Si
P
S
Cl
K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
Ge
As
Se
Br
Kr
Rb
Sr
Y



THE PERIODIC TABLE OF OXIDATION STATES
KEY
GROUPS
S BLOCK ELEMENTS
P BLOCK ELEMENTS
D BLOCK ELEMENTS
F BLOCK ELEMENTS
E57-71
E89-103
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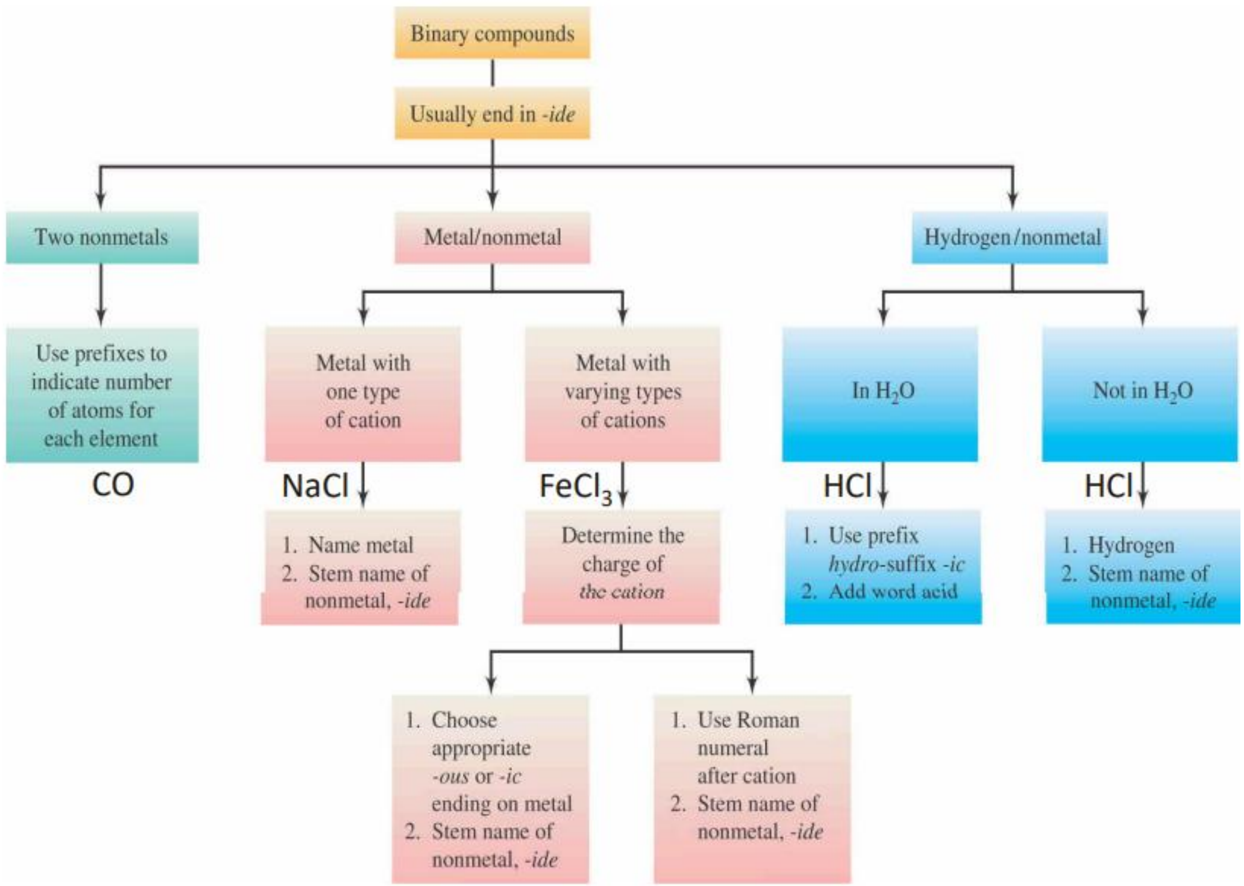
Nomenclature

Order of oxidation state naming

1. Hypo-…-ous – Lowest OS
2. …-ous
3. …-ic
4. Per-…-ic – Highest OS

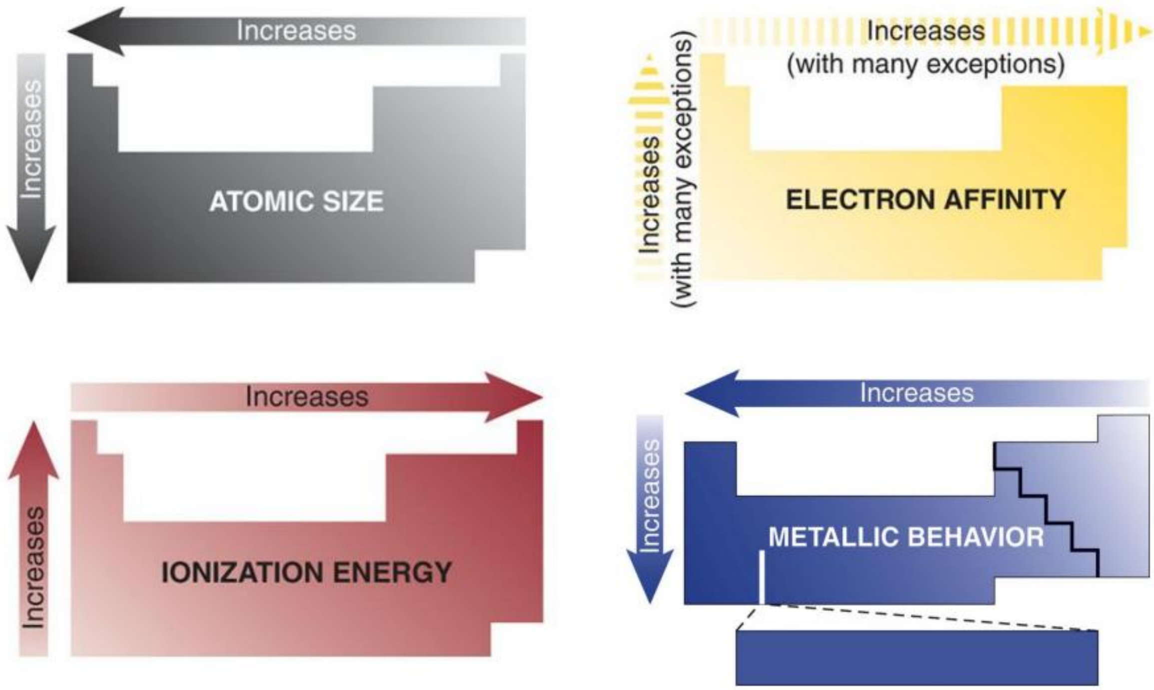


Superoxide is O_2^- ion, while peroxide is R-O-O-R structure

Orbitals

- Orbital numbers are n, l, m.
- $n \in \mathbb{Z}^+$ is the principal quantum number
  - Relates to Bohr's energy levels
  - Higher n means higher energy
  - For higher n values, the difference between energy levels decreases
- $l \in \mathbb{Z} \cap [0, n-1]$ is the angular momentum quantum number
  - Determines the shape of the orbital
  - Different values have different letters assigned:
    - $l = 0$: s orbital – sphere
    - $l = 1$: p orbital – 2 balloons pointing towards each other, tied at the knot
    - $l = 2$: d orbital – mainly 4 balloons pointing towards each other, tied at the knot
    - $l = 3$: f orbital – mainly 8 balloons pointing towards each other, tied at the knot
- $m \in \mathbb{Z} \cap [-l, l]$ is the magnetic momentum number
  - Determines the orientation of the orbital
- Electrons can have spin
  - $m_s \in \left\{-\frac{1}{2}, \frac{1}{2}\right\}$
- Max number of electrons in an energy level n is $2n^2$
  - $n = 1 \rightarrow 2$
  - $n = 2 \rightarrow 4$
  - $n = 3 \rightarrow 16$
  - $n = 4 \rightarrow 32$

- $Z_{EFF} = Z - S$
  - Effective nuclear charge = atomic number – shield constant


Increases
Increases
ATOMIC SIZE
Increases
(with many exceptions)
Increases
(with many exceptions)
ELECTRON AFFINITY
Increases
Increases
IONIZATION ENERGY
Increases
Increases
METALLIC BEHAVIOR

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Lewis Theory

- $Formal\ Charge = Valence\ e^{-}\ count - Lone\ Pair\ Count - \frac{Bonding\ Electron\ Count}{2}$
- The greater the difference in electronegativity, the greater the polarity
  - The element with the greatest electronegativity gets the partial negative charge
  - $\Delta EN = 0$
    - Pure covalent bond
  - $0.1 \leq \Delta EN \leq 0.4$
    - Nonpolar covalent
  - $0.5 \leq \Delta EN \leq 1.9$
    - Polar covalent bond
  - $\Delta EN \geq 2.0$
    - Ionic bond
- Dipole moment (m) is a measure of bond polarity measured in Debyes (D)
  - $m = q \times r$
  - q is the magnitude of partial charges
  - r is the distance
  - The percent ionic character is the percentage of a bond's measured dipole moment to what it would be if full ions
- $Bond\ Order\ (B.O) = \frac{1}{2}(Electrons\ in\ bonding\ molecular\ orbitals) - Electrons\ in\ antibonding\ molecular\ orbitals$
  - BO>0: Molecule is more stable compared to single atoms
  - BO=0: Molecule is not formed
  - The higher BO, the stronger the bond

Gases

- $1atm = 14.7psi = 760mmHg = 101\ 325Pa$
- $1Pa = 1kgm^{-1}s^2 = 1Nm^{-2}$
- $1bar = 10^5 Pa$
- Ideal gas is a simplified real gas
  - $pV = nRT$
  - $R = 8.20574 \times 10^{-2} L\ atmK^{-1}mol^{-1} = 8.31446JK^{-1}mol^{-1}$
- Boyle's Law
  - $V \propto \frac{1}{p}$
- Charles' Law
  - $V \propto T$
- Avogadro's Law
  - $V \propto n$
- Gay-Lussac's Law
  - $p \propto T$
- $\frac{P_i V_i}{n_i T_i} = \frac{P_f V_f}{n_f T_f}$
  - $\therefore M_M = \frac{mRT}{PV}$
  - $\rho = \frac{m}{V} = \frac{M_M P}{RT}$