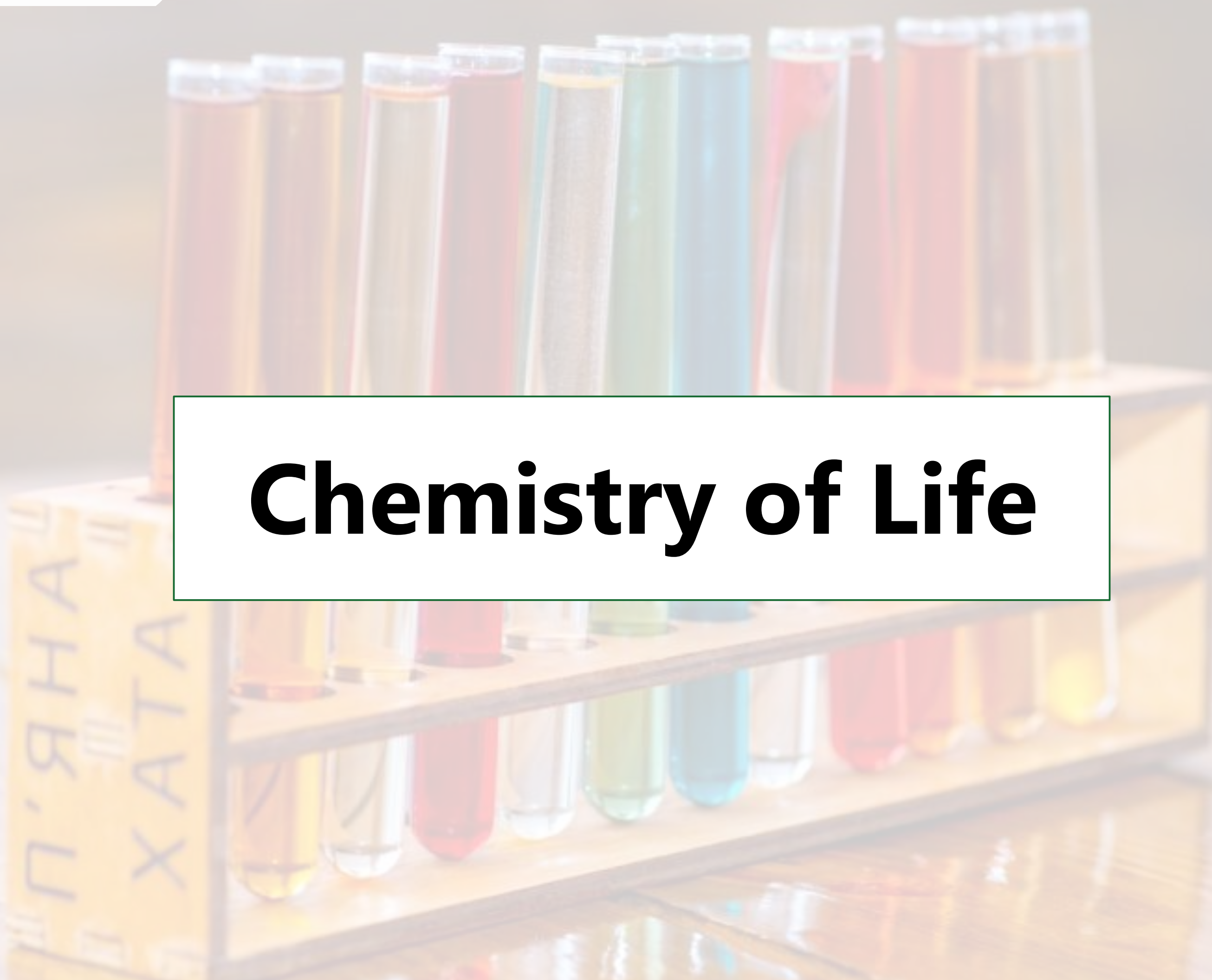


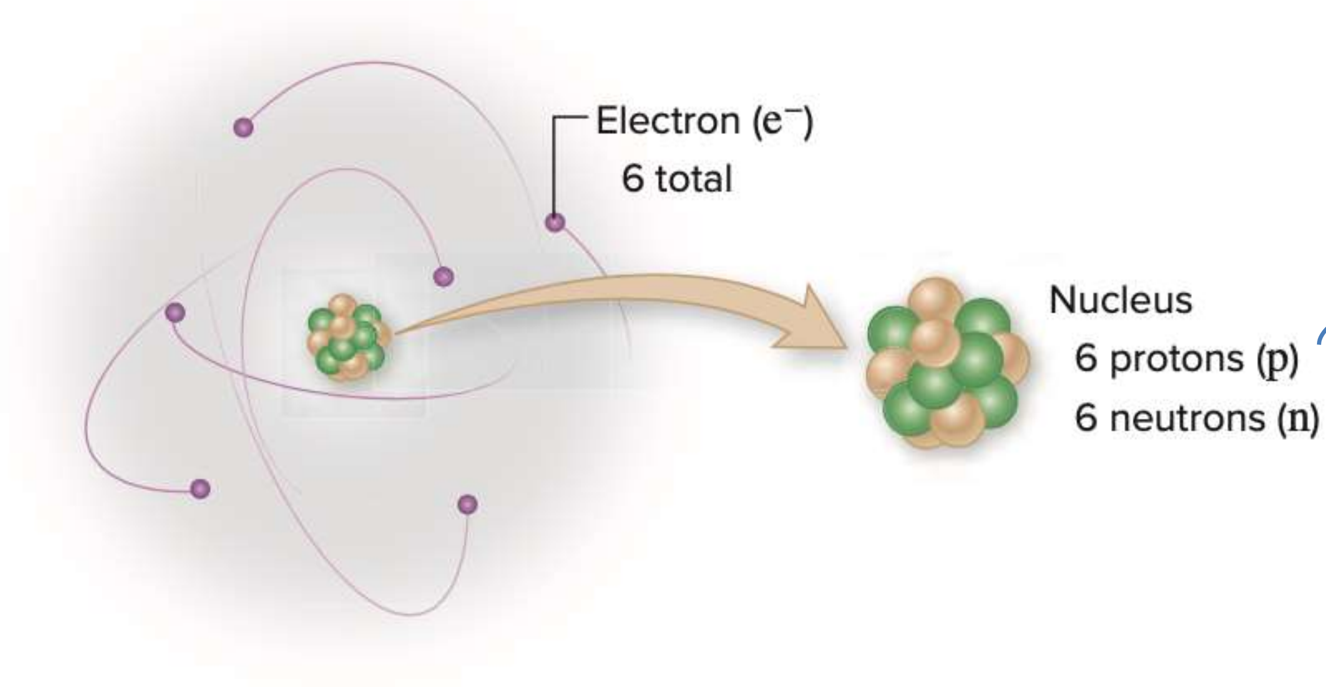
Chemistry of Life

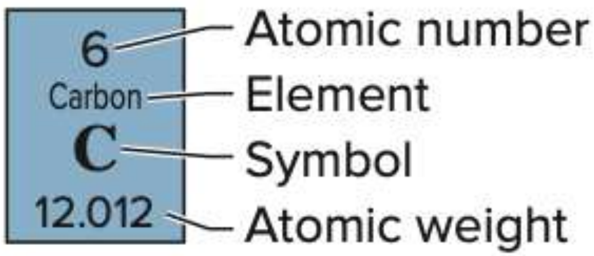
Prof. Dr. Chiara Valsecchi

Class Goals

- Understand how the **atoms** are organize
- Understand the basics of **chemical bond** theory
- Explore the main classes of **biological molecules**

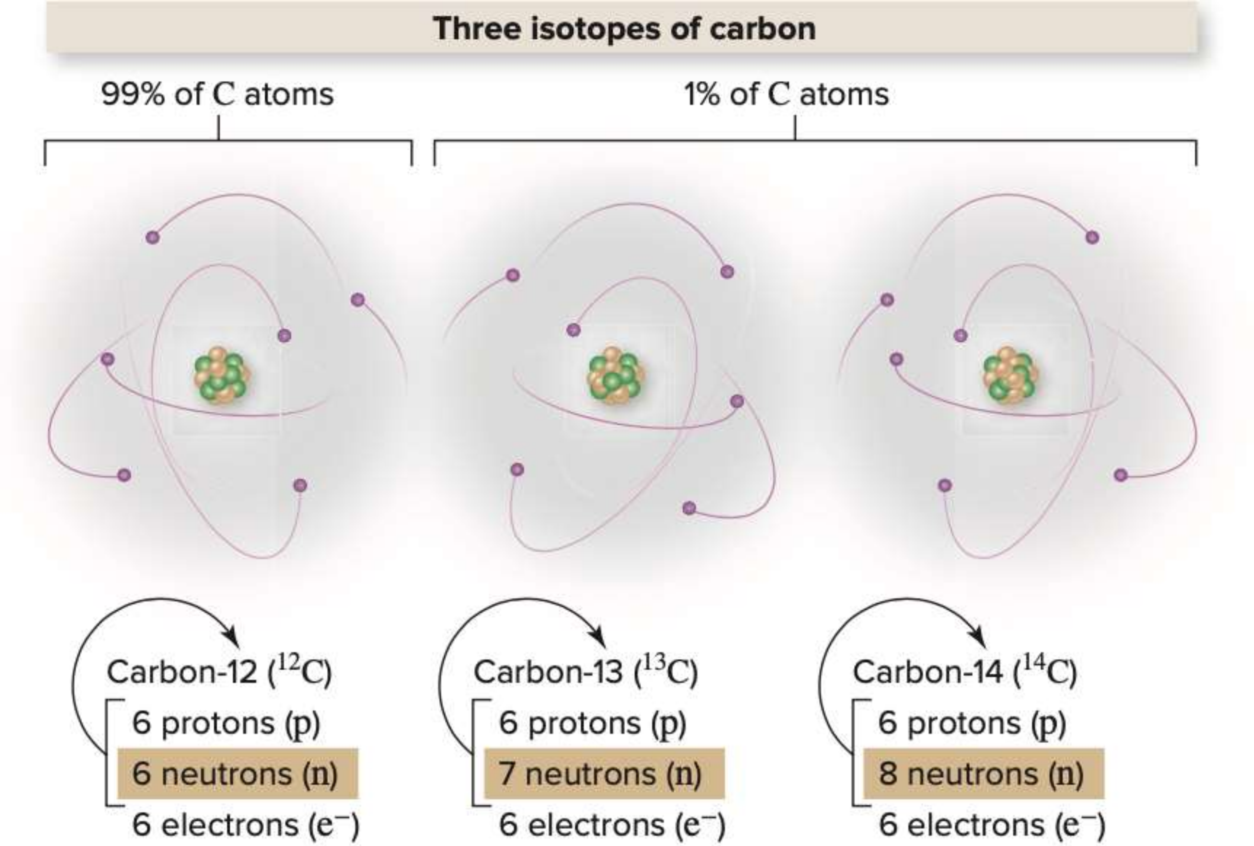
Atomic Structure





The atomic number in the periodic table representes the number of PROTONS

Atomic Isotopes

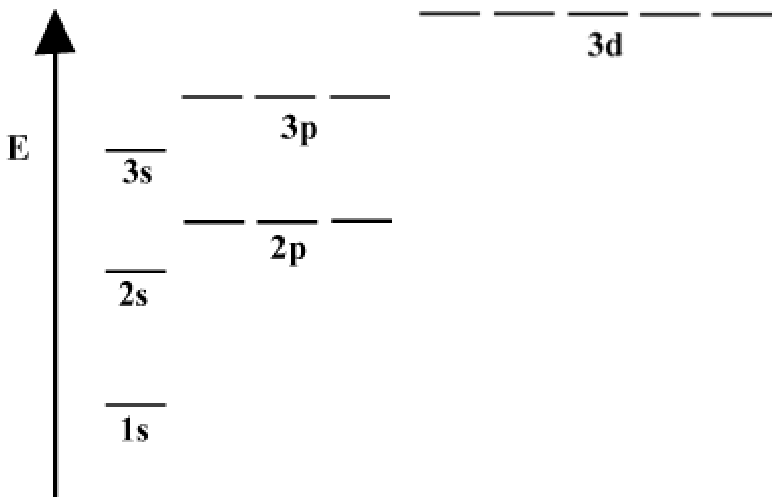


Isotopes changes the number of NEUTRON.

Isotope ^{14}C is used to obtain the date of ancient or historical artifacts

Atomic Orbitals

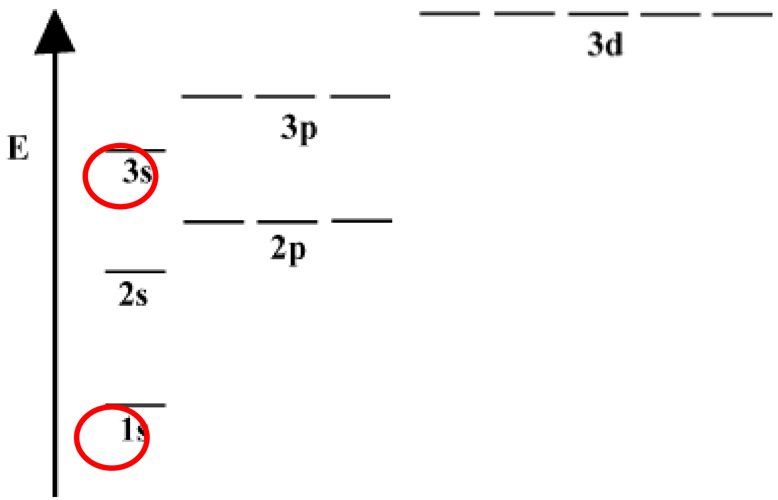
Orbitals have different energy levels, which are associated to a number, called **quantic number n**



Multieletronic Atoms

Atomic Orbitals

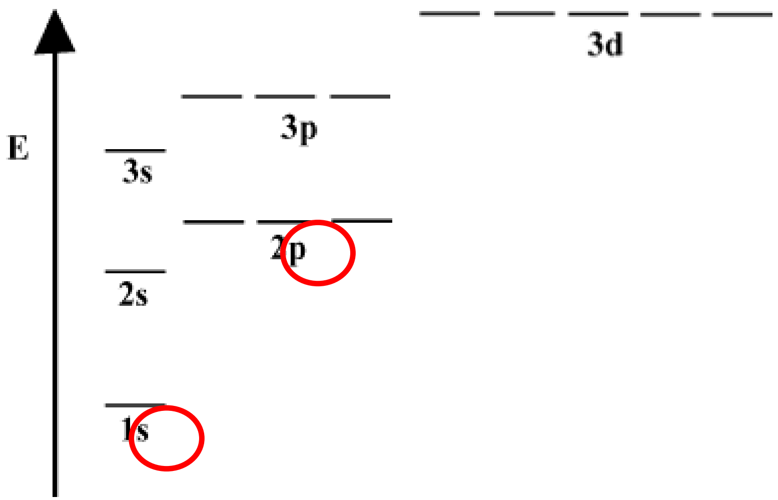
Orbitals have different energy levels, which are associated to a number, called **quantic number n**



Multieletronic Atoms

Atomic Orbitals

The letter indicates the type of orbital, and most important, how many electrons it can contain



Multieletronic Atoms

s = 2 electrons

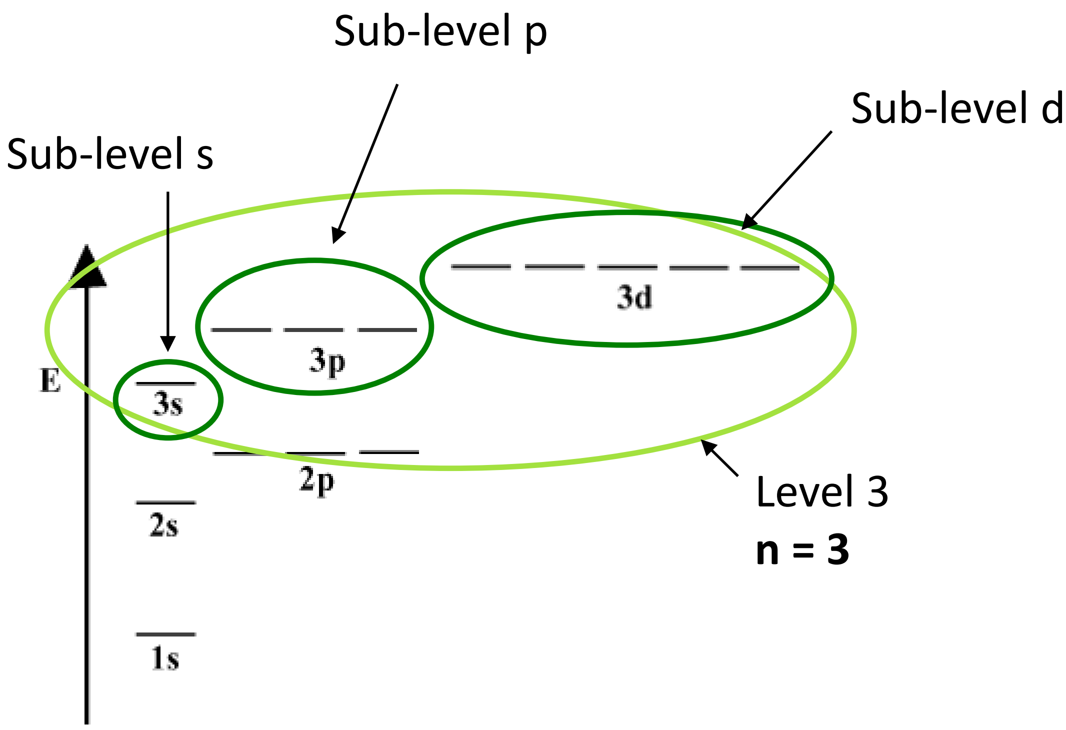
p = 6 electrons

d = 10 electrons

Therefore:

1st level **(n = 1)** can have 2 electrons
2nd level **(n = 2)** can have 8 electr.
3rd level **(n = 3)** can have 18 electr.
….

Atomic Orbitals Levels



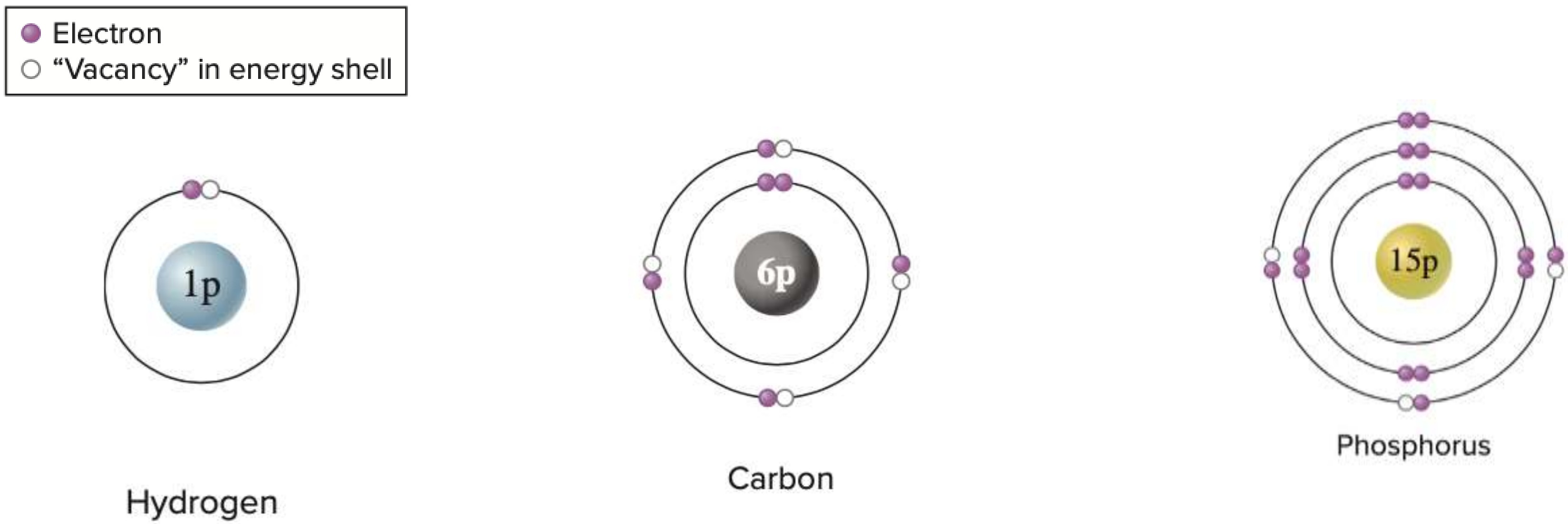
Each level can have sub-levels

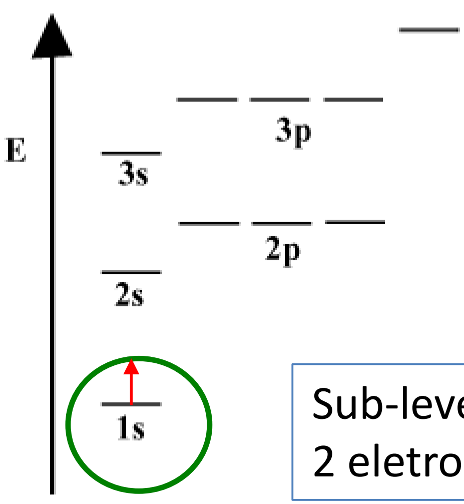
The outmost atomic orbital level is the one that will affect the capacity of the atoms to create bonds

↓

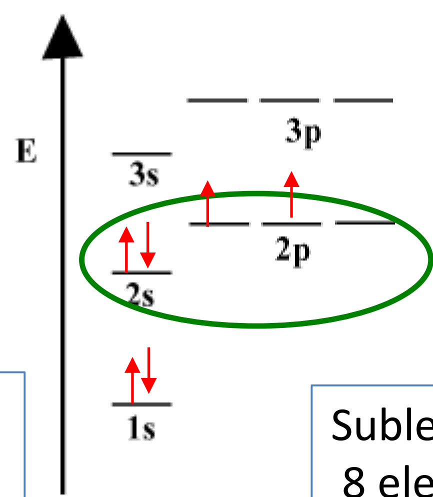
VALENCE SHELL

Valence Shell

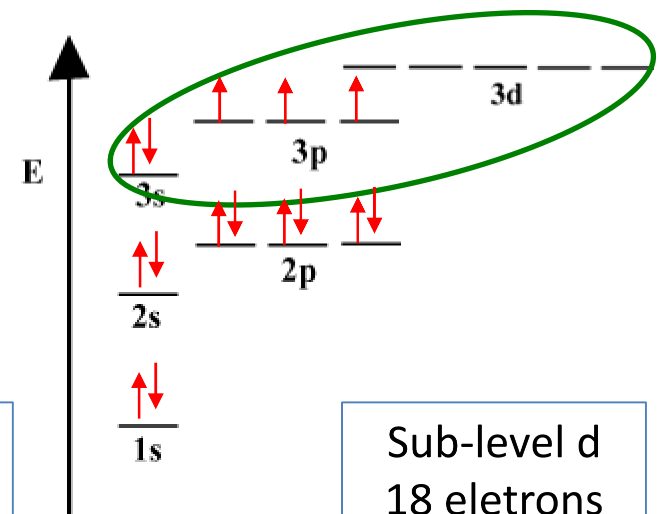




Sub-level s
2 eletrons



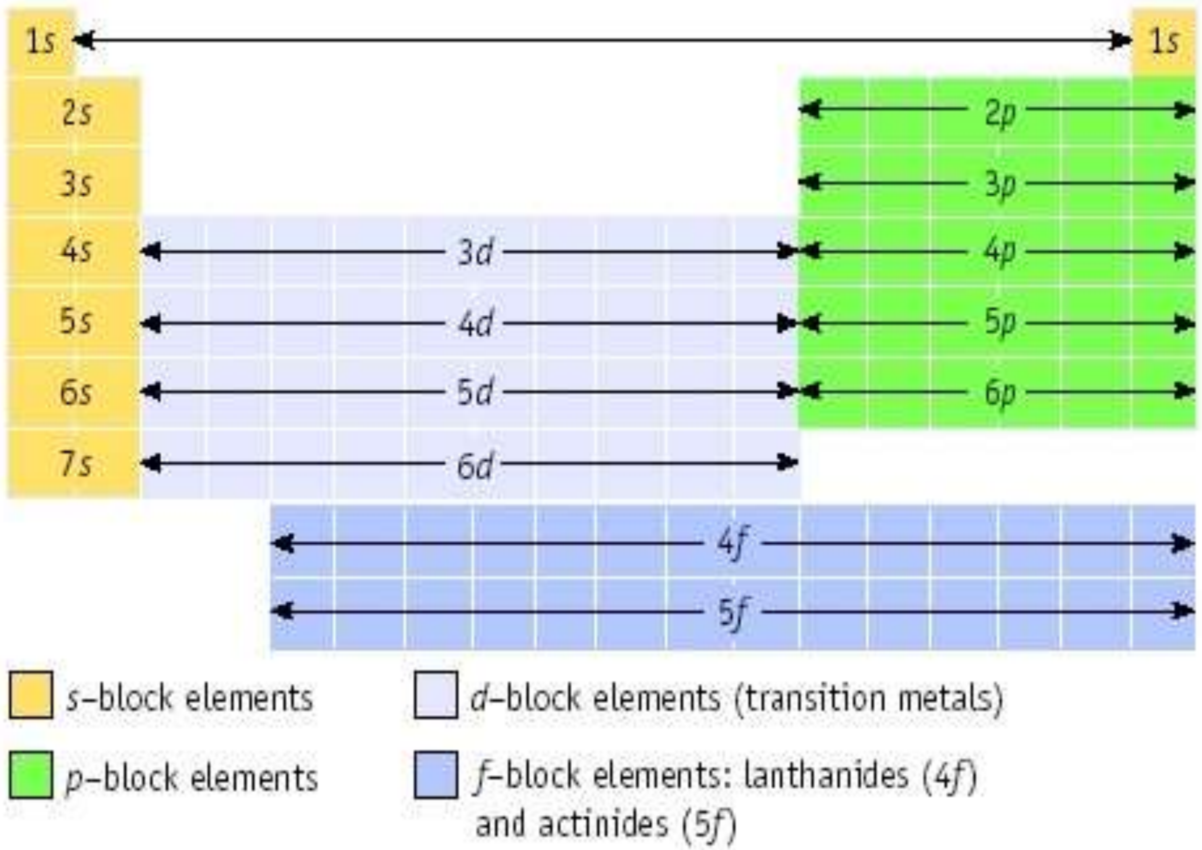
Sublevel p
8 eletrons



Sub-level d
18 eletrons

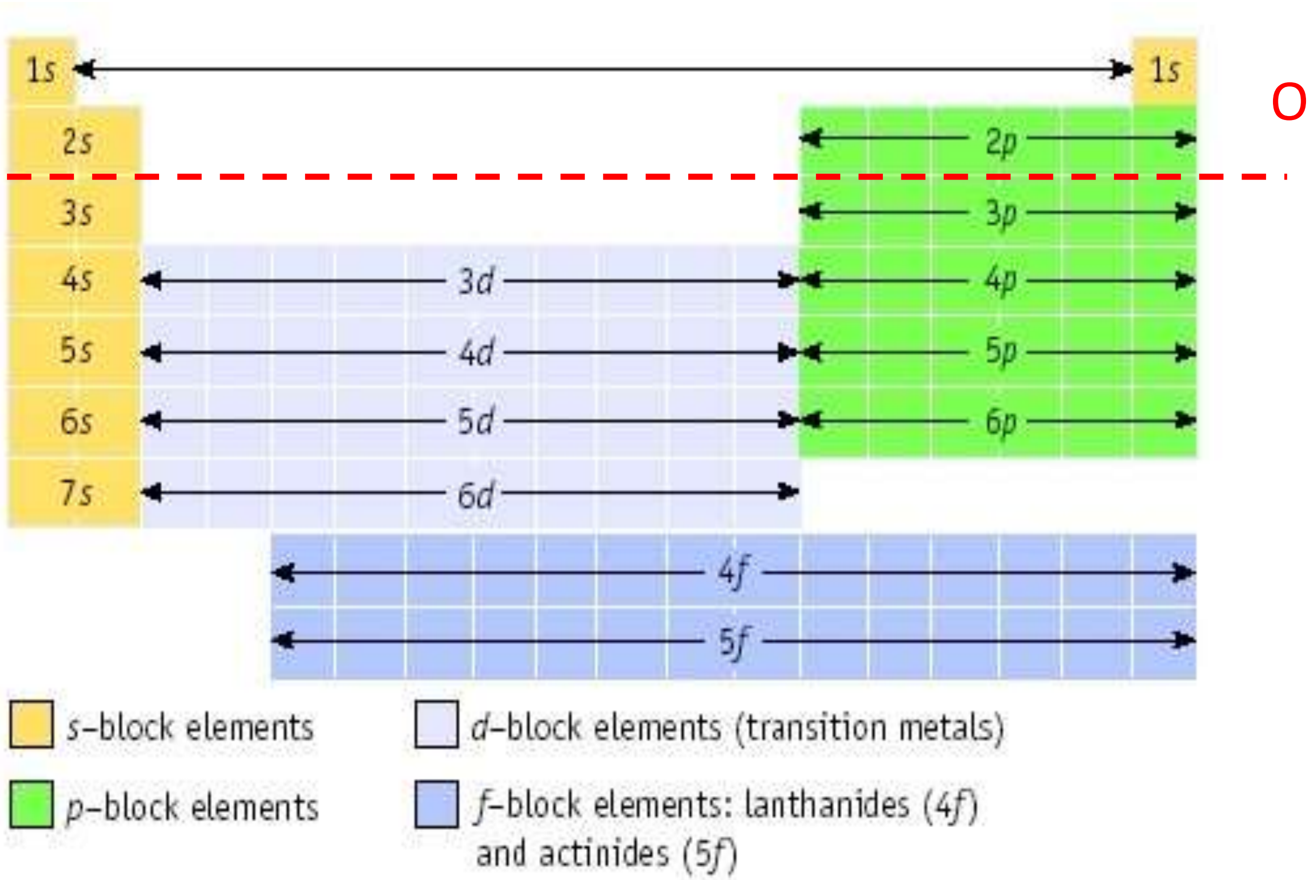
Valence Shell

The valence shell can be easily found in the periodic table



Valence Shell

The valence shell can be easily found in the periodic table



Octect rule

Nobel gas

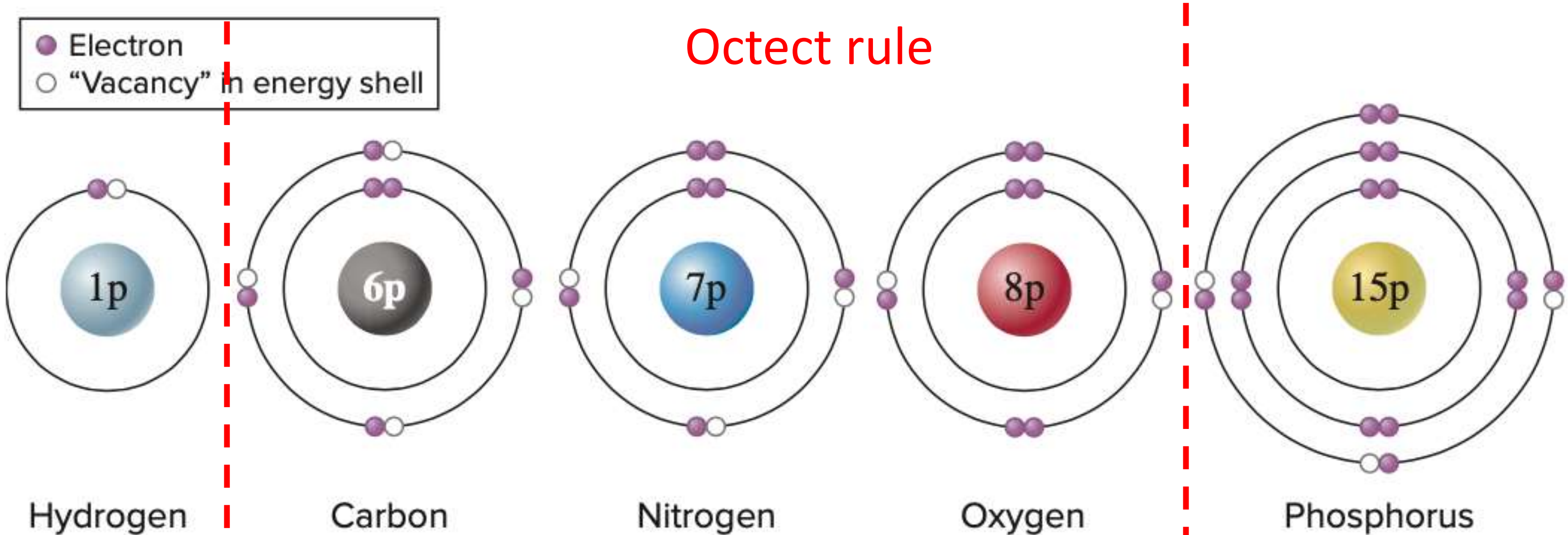
↓

Valence shell **full**

↓

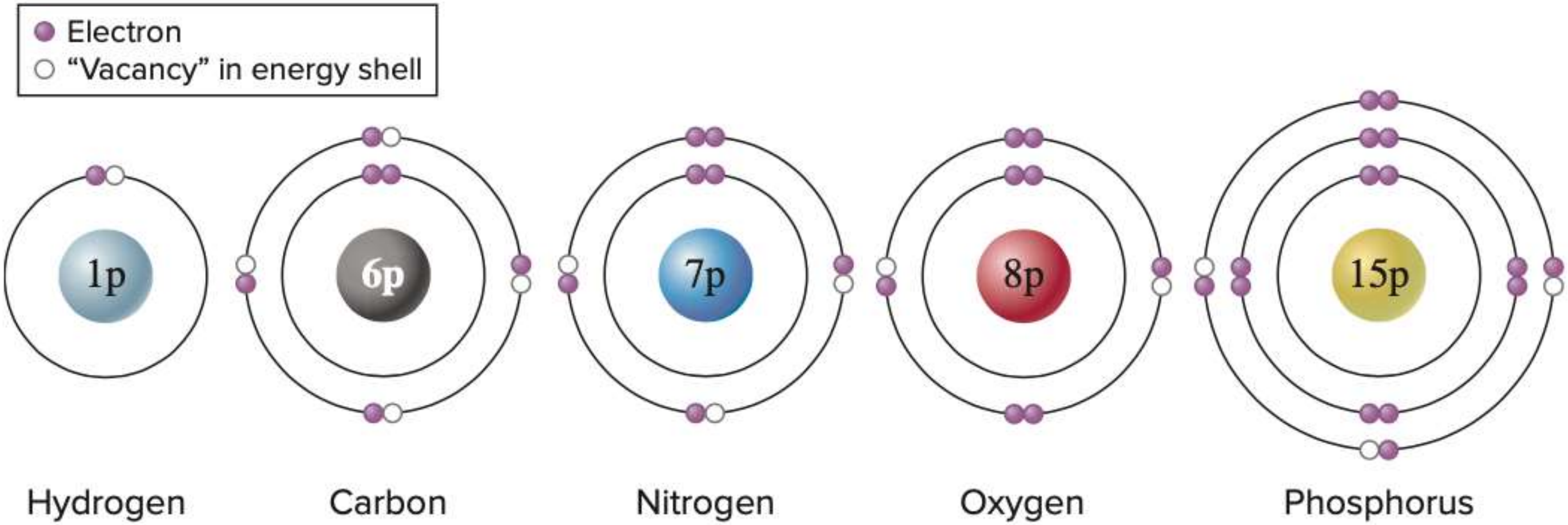
Not reactive

Valence Shell



Hydrogen	Carbon	Nitrogen	Oxygen	Phosphorus
1 e	4 e	5 e	6 e	Up to 5 single bond, it can use the d orbitals
1 vacancy	4 vacancy	3 vacancy	2 vacancy	
1 single bond	4 single Bond or 2 double	3 single, 1 single and 1 double or 1 triple	2 single Bond or 1 double	

Valence Shell



Hydrogen	Carbon	Nitrogen	Oxygen	Phosphorus
1 e^-	4 e^-	5 e^-	6 e^-	Up to 5 single bond, it can use the d orbitals
1 vacancy	4 vacancy	3 vacancy	2 vacancy	
1 single bond	4 single Bond or 2 double	3 single, 1 single and 1 double or 1 triple	2 single Bond or 1 double	

Concepts of chemical bonds

The electronic structure of the elemento determines the bond type: only the elétrons in the valence shell are involved.

Where the element is in the *Periodic Table*

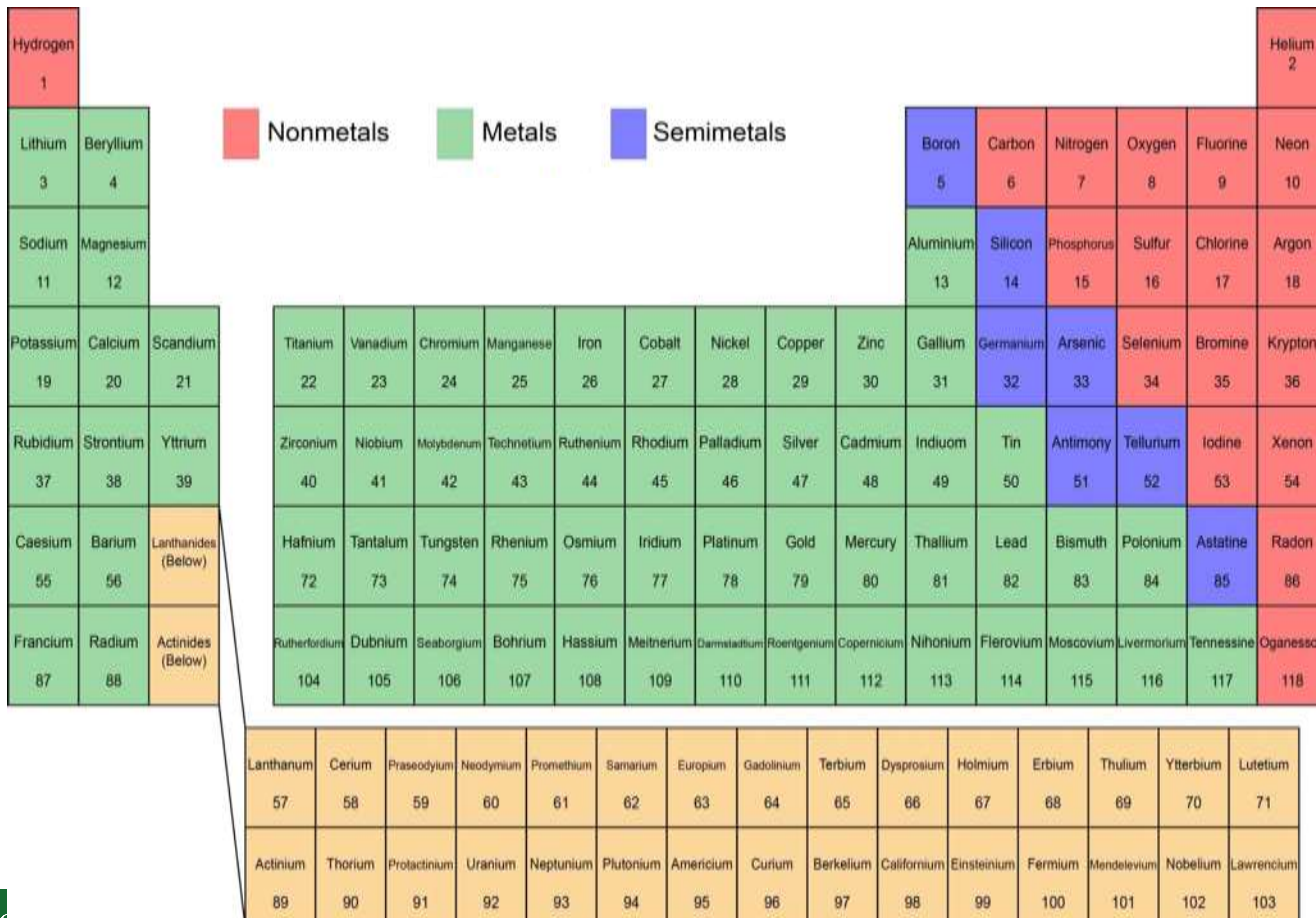
Column and Period

Bond type

Number of bonds

Concepts of chemical bonds

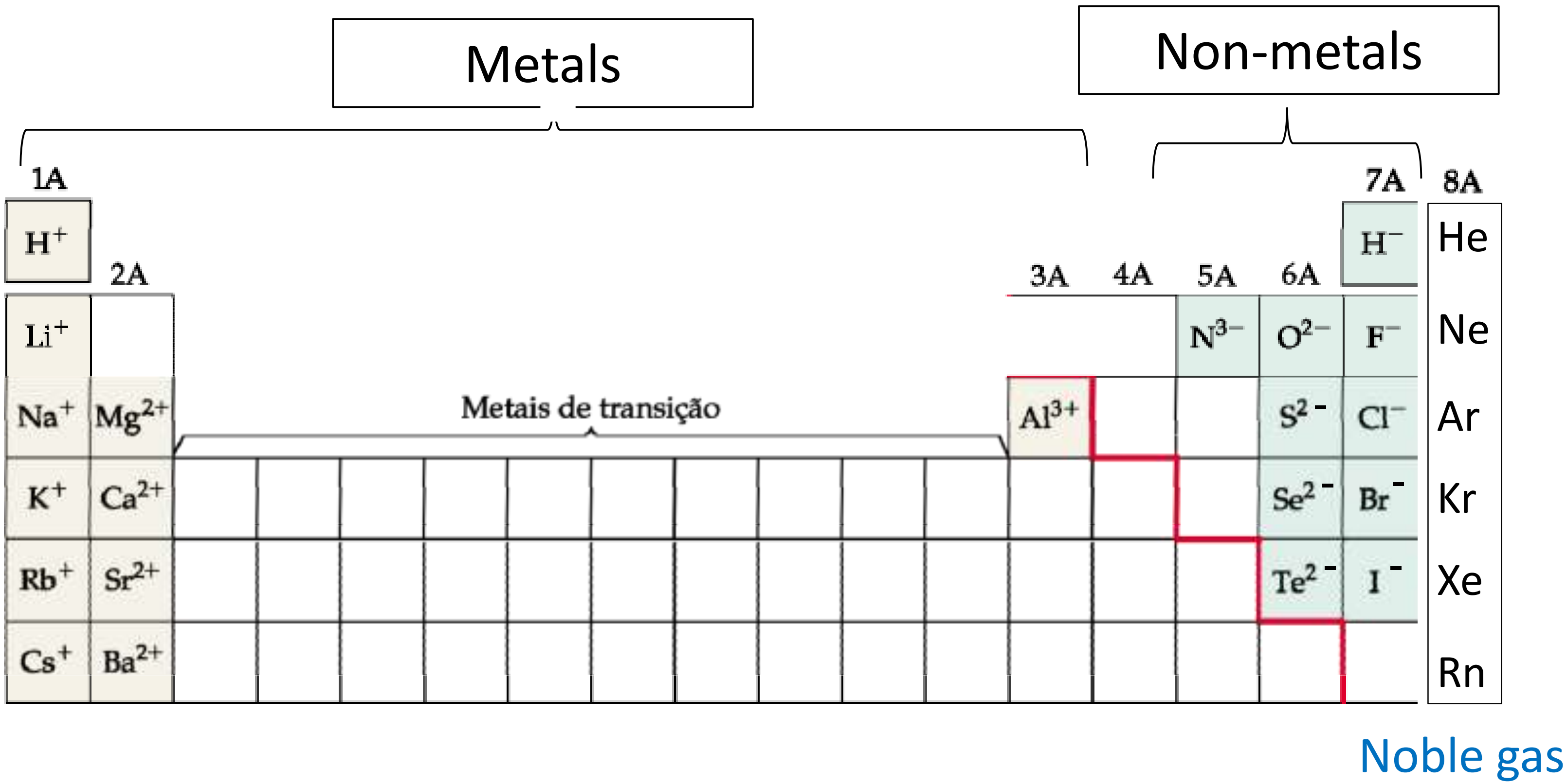
Ionic	→	**Metal + Non-metal**	Electron transfer
Covalent	→	**Non-Metal + Non-Metal**	Electron sharing



Ionic bond

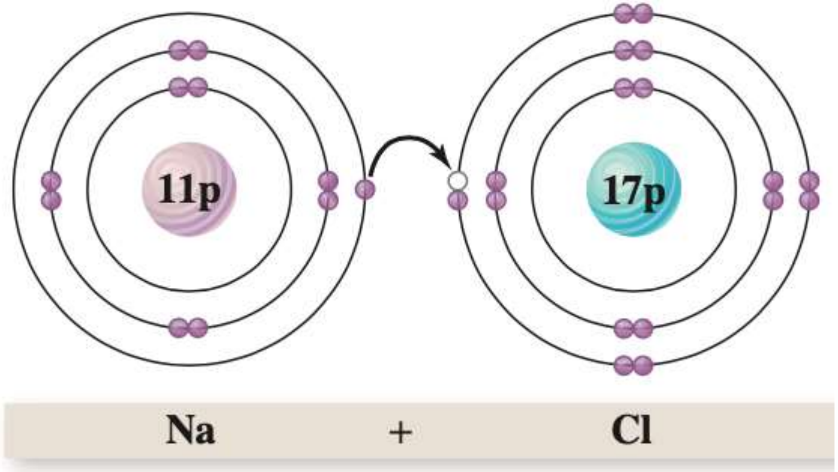
Metal, column 1A, 2A and 3A → lose electrons = CATION (+)

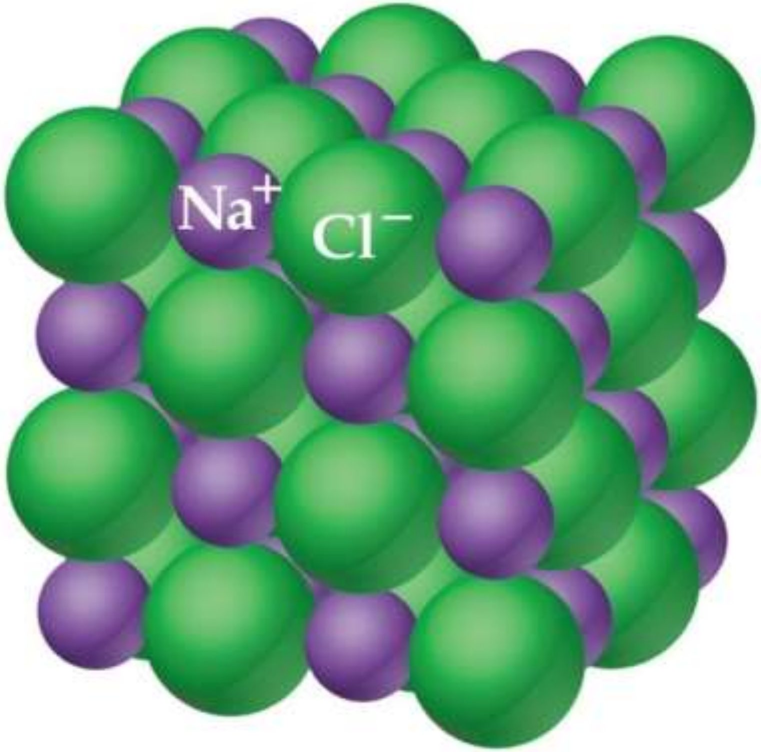
Non-metal, column 5A, 6A and 7A → gain electrons = ANION (-)



Ionic bond

Ordered solids = ionic compounds or SALTS or Crystals

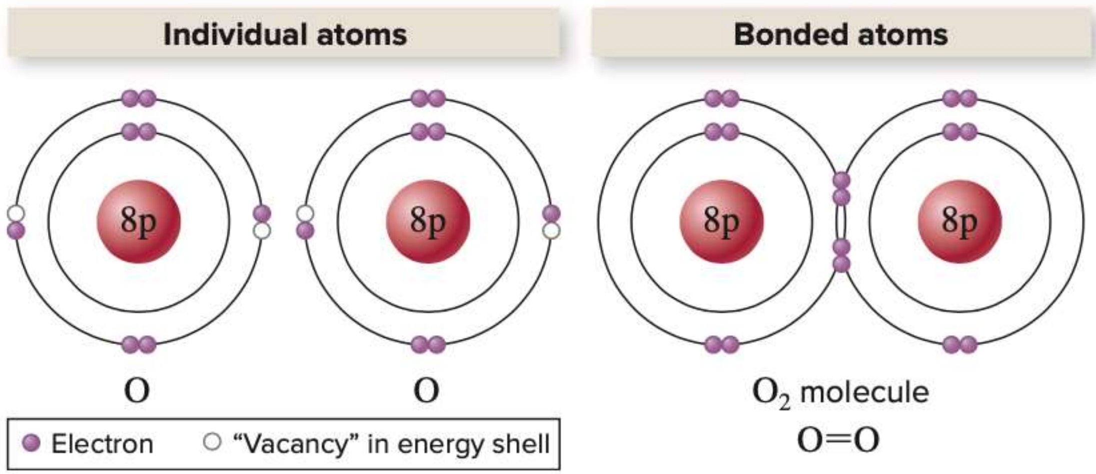




Ionic bond

Ionic solids typically have high melting temperature, but they are fragile

Covalent bond

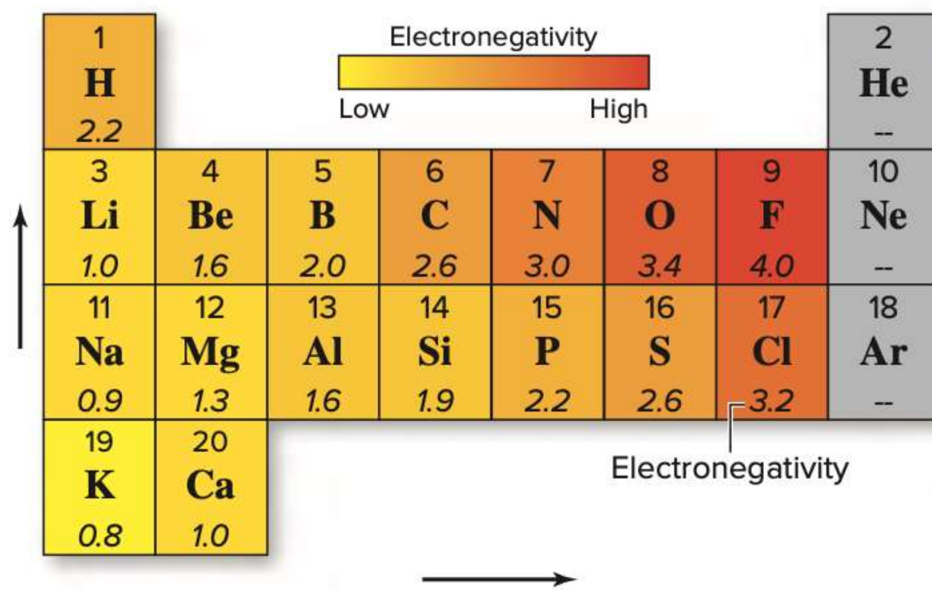


Electrons are shared

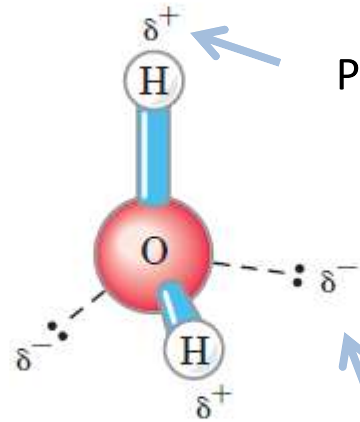
However, this is NOT na equal sharing

Atoms that are more electronegative (like O, F and Cl) keep the electron more close

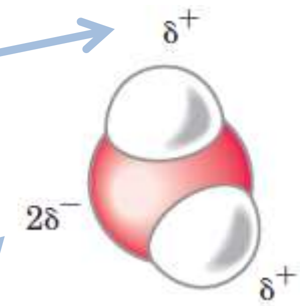
They have a partial negative charge
The others, a partial positive charge



Water Molecule Structure



Partial positive charges



Ball and stick model

Partial positive charges

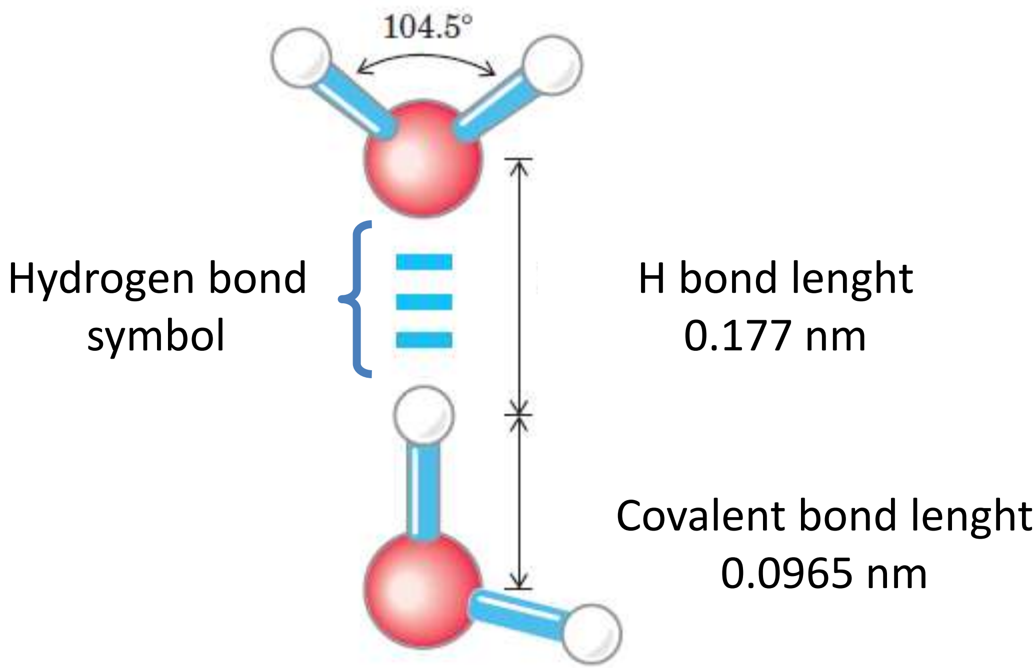
Spatial sphere model

Oxigen is more electronegative than hydrogen and attracts more the shared electrons to itself. This uneven distribution creates partial charges

↓

The molecule is **POLAR**

Hydrogen Bond



Atoms are further apart than in a covalente bond, so hydrogen bond is weaker.

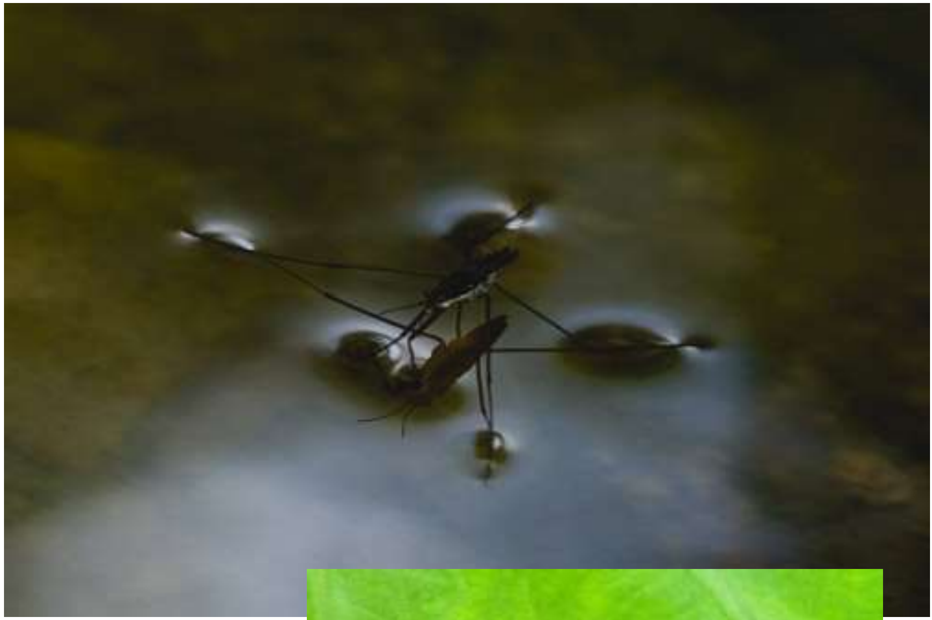
However, the hydrogen bond allows all the special properties of water.

Water Properties

1. Cohesive force
2. Adhesive force
3. High boiling point
4. Lower solid density
5. Solvation power

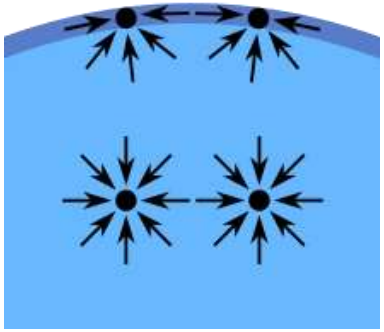
Water Properties

1. Cohesive force
2. Adhesive force

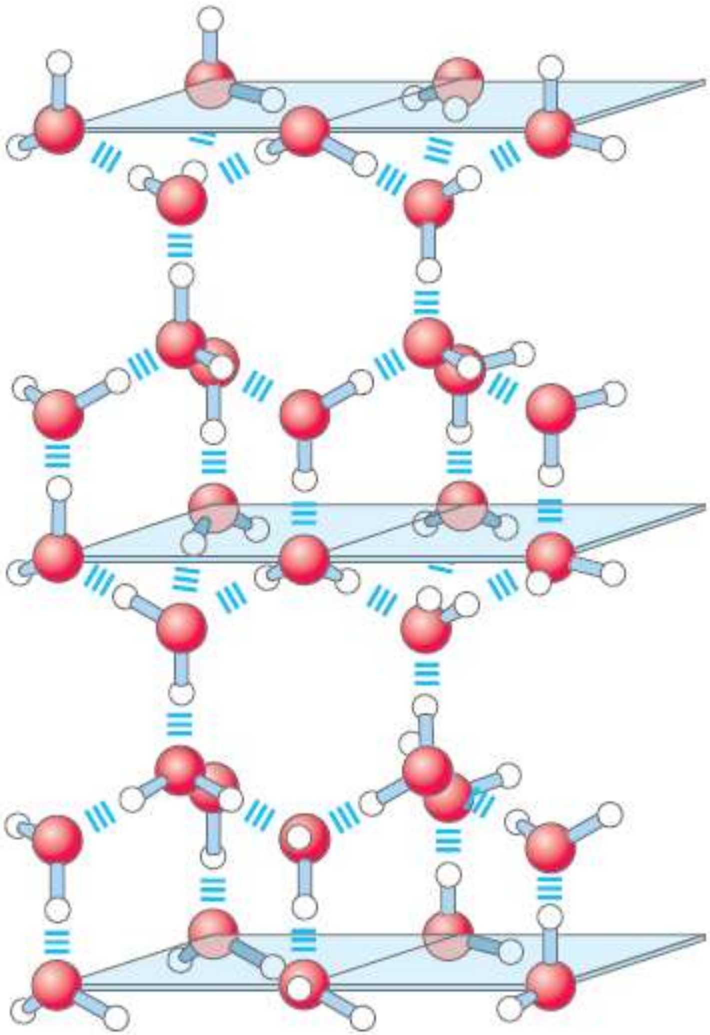


Outside molecules stick together, give highersurface resistance

Surface Tension



Water Properties

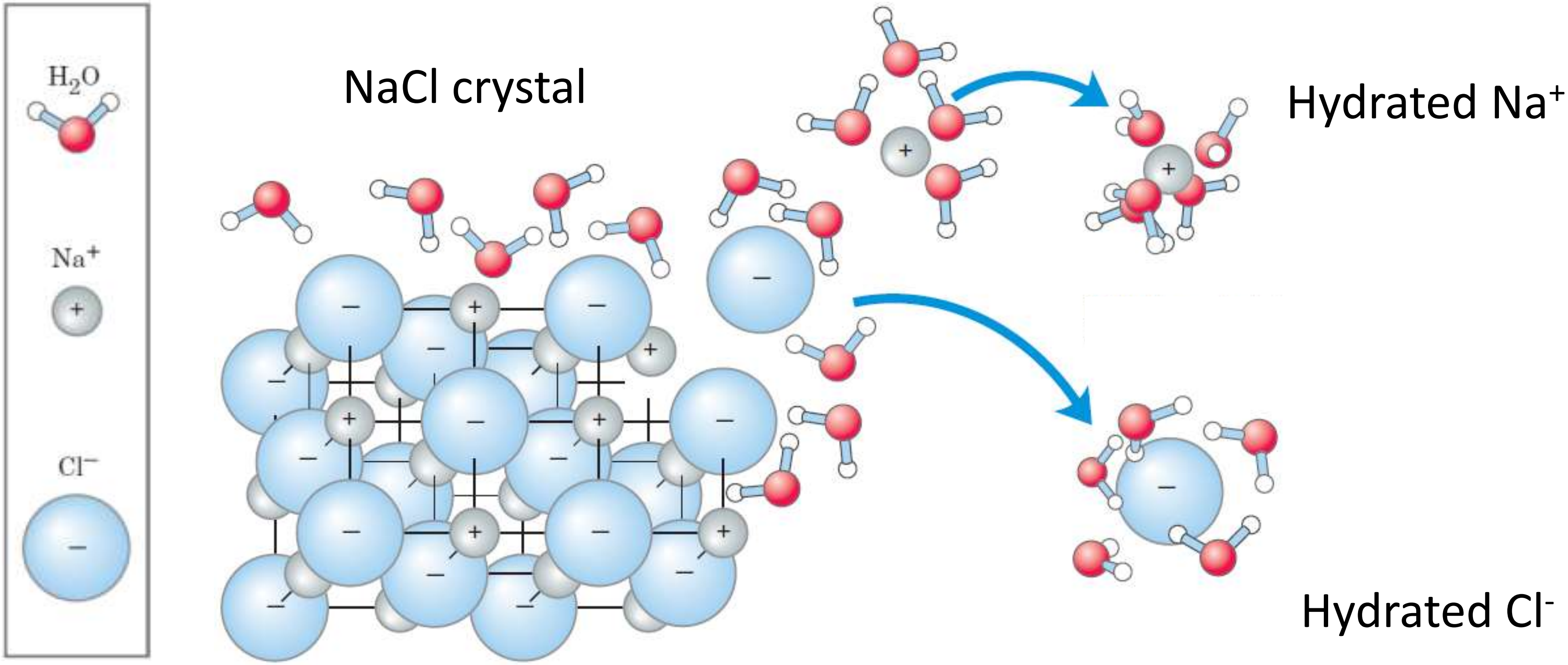


3. Lower solid density

Water molecules in ICE have 4 hyrogen bonds, organized in a tetrahydral formation

Ice expands → less dense than liquid water

Water Properties



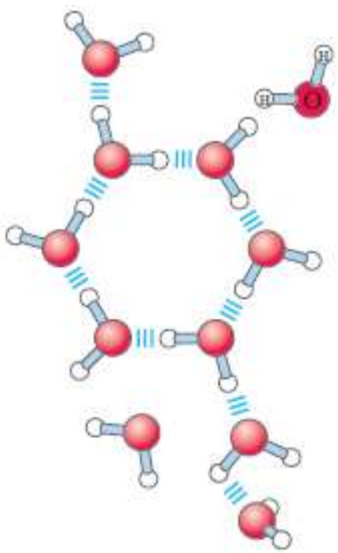
5. Solvation power:

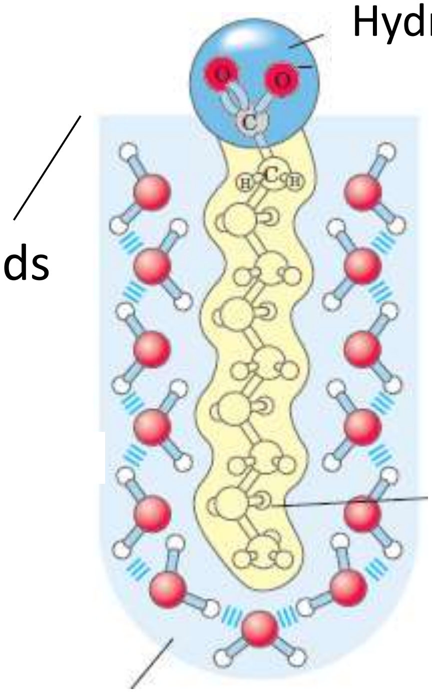
A lot of water molecules can overcame the ionic bond and dissolve salts

Polar or Apolar ?

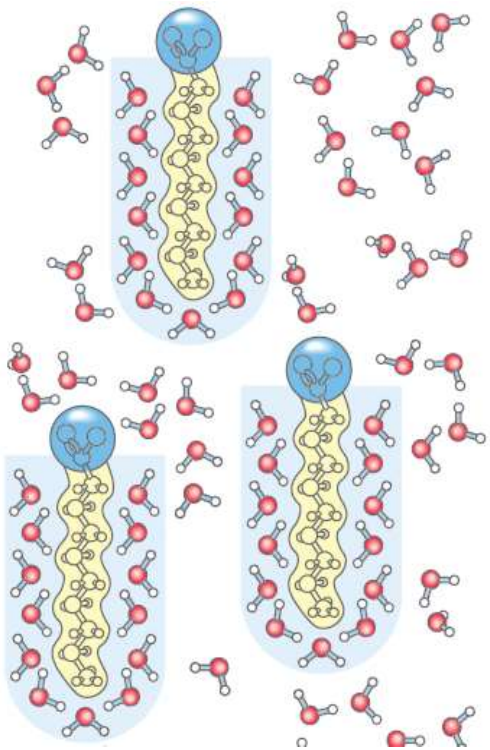
Polar molecules interact between themselves and with water. They are called **HYDROPHILIC**.

Apolar molecules tend to separate from water (like oil): they are called **HYDROPHOBIC**.

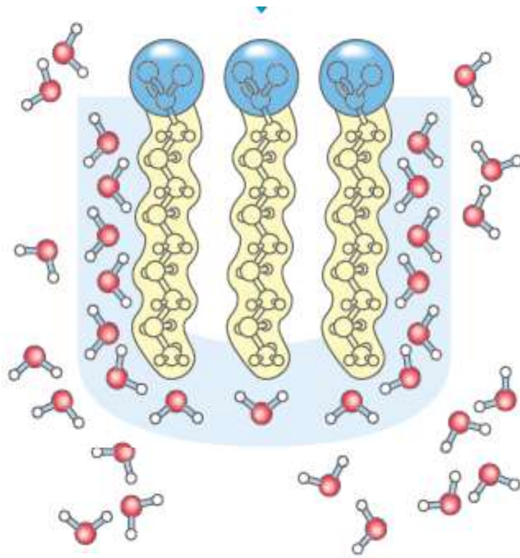




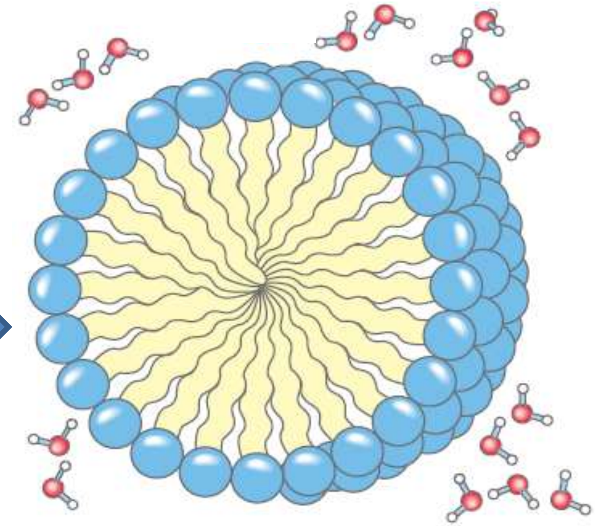
Polar or Apolar ?



Phospholipids in water



Small aggregate



Mycel

Phospholipids tends to aggregate in order to ”escape” from water → membranes and mycelles are formed

pH Scale

Concentration of H^+ ions in water

To avois scientific notation, due to small number, the pH Scale is actually a logaritmic scale

p : means: “minus logarithm of... ”

Ex.:

$[H^+] = 1{,}0 \times 10^{-5}$

pH= **-log** $[H^+] = -\log [10^{-5}] = +5$

pH is negative logarithm of H^+ concentration

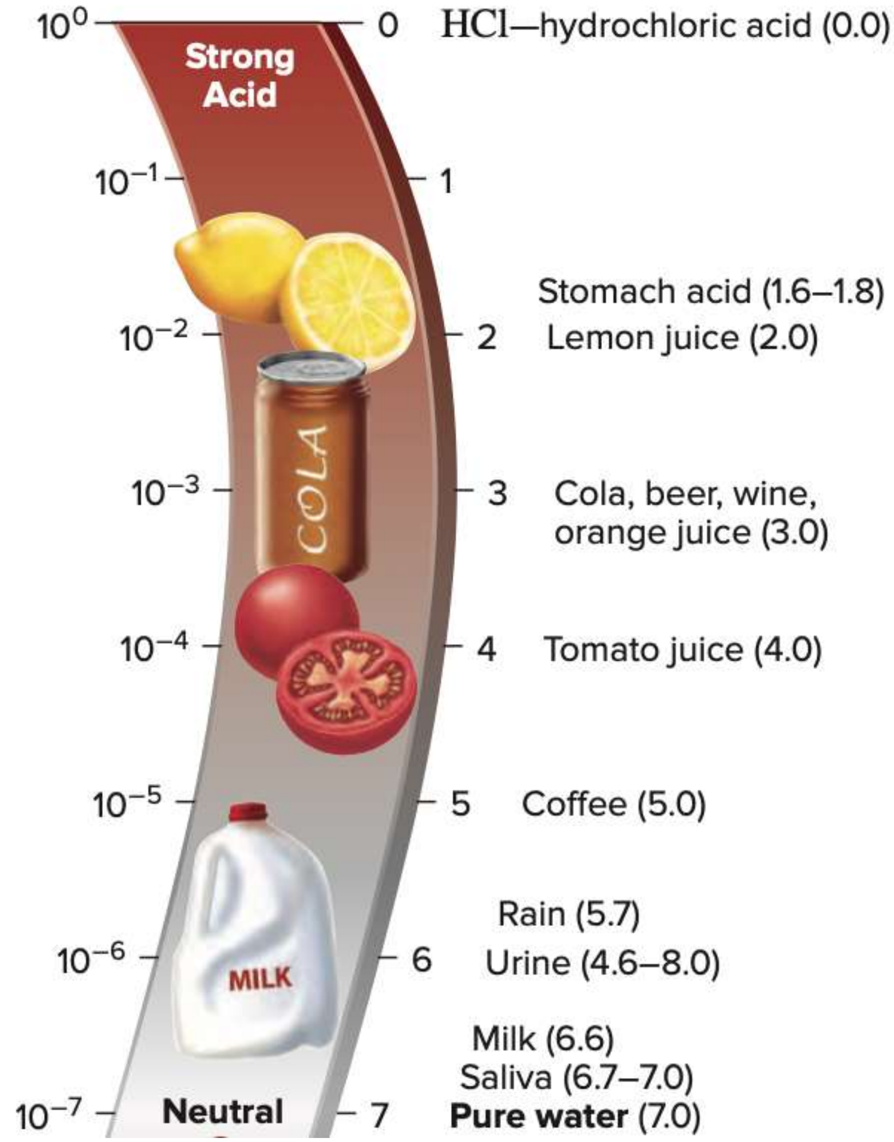
pH Scale

Acidic solution:

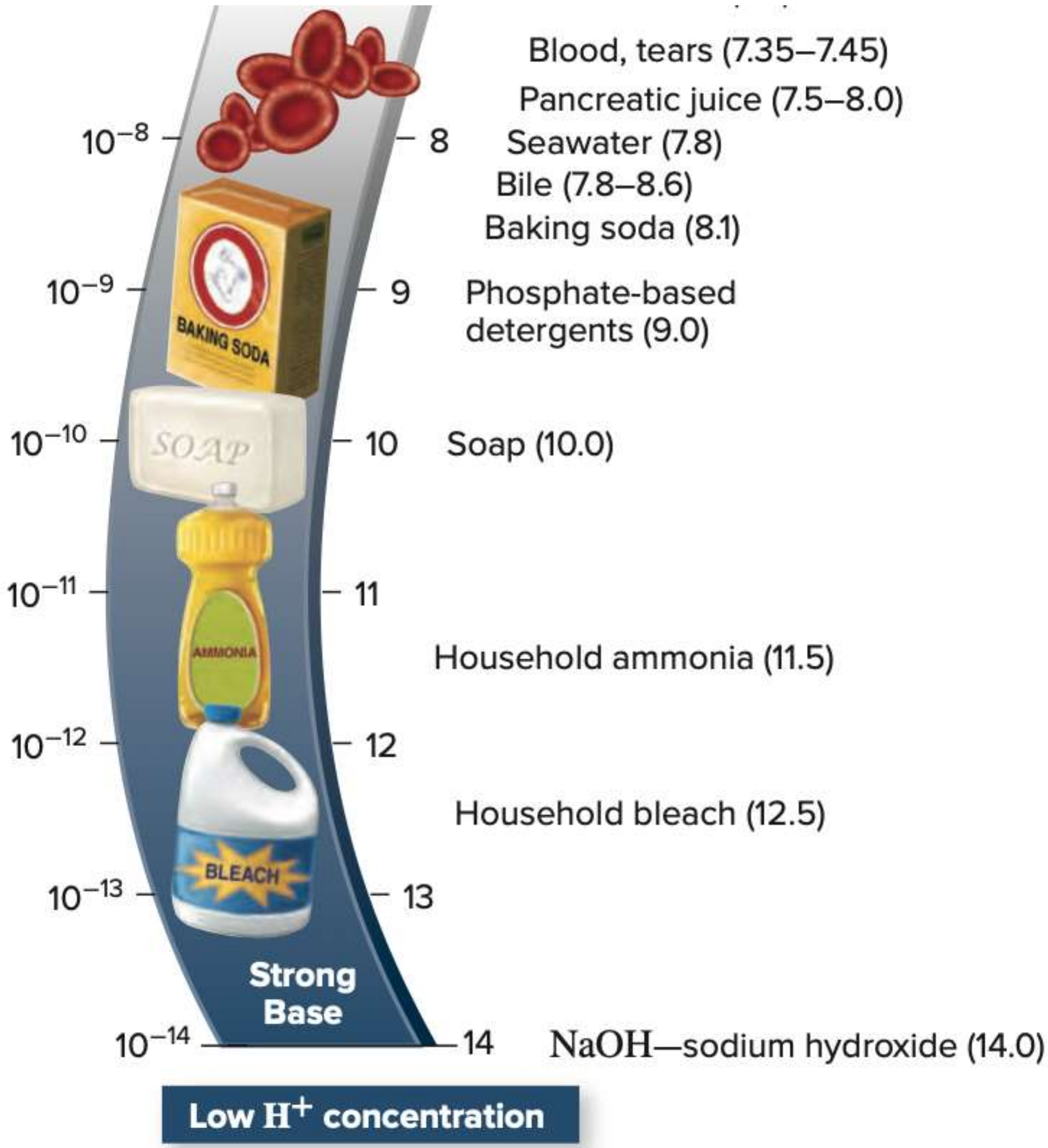
$0 < pH < 7$

An acid molecule generate H^+ ions, like HCl

$HCl \rightarrow H^+ + Cl^-$



pH Scale



Basic solution:

$7 < pH < 14$

A basic molecule generate OH^- ions, like NaOH

$NaOH \rightarrow Na^+ + OH^-$

pH Scale

Neutral solution: pH = 7

Pure water is neutral

$$[\,H^+\,] = [\,OH^-\,]$$

pH Scale

Neutral solution:

pH = 7

Pure water is neutral

$[H^+] = [OH^-]$

OBSERVATIONS

✓[H+] x [OH-] is always equal to 10^{-14}

✓**pH + pOH is always equal to 14**