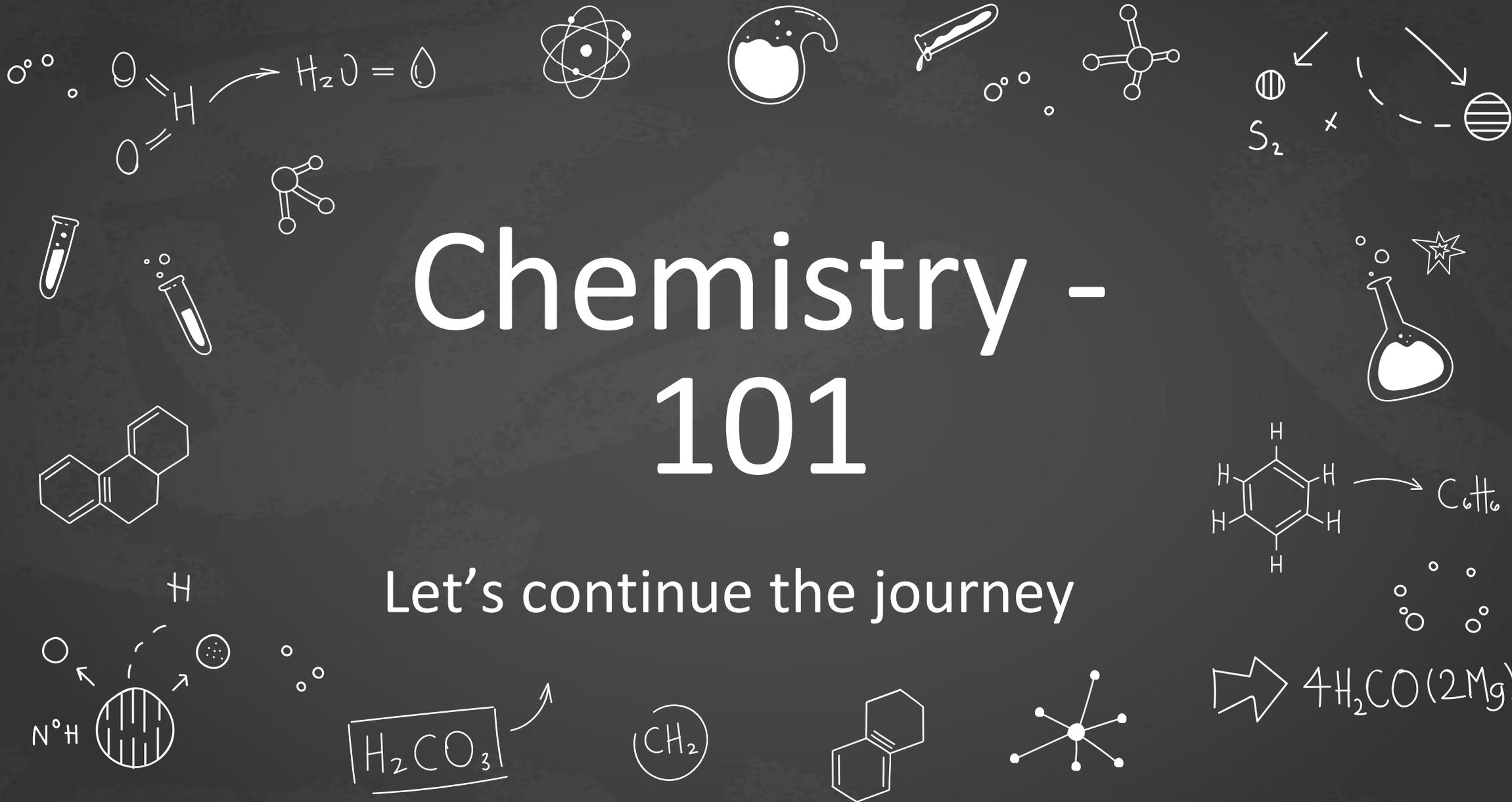


# Chemistry - 101

Let's continue the journey

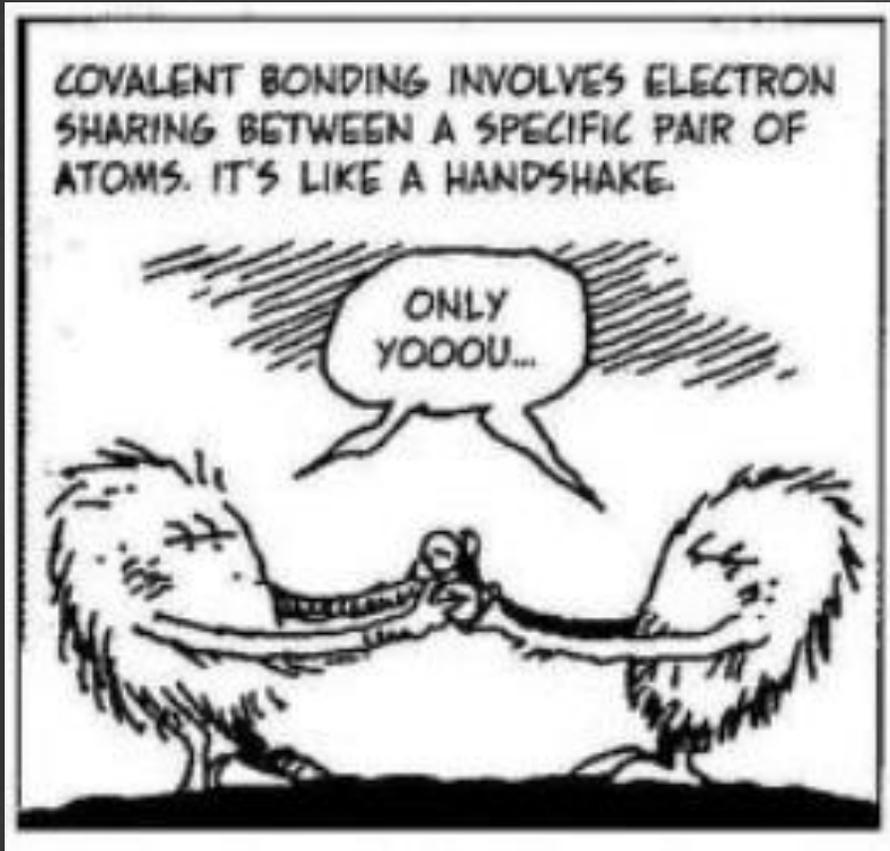


A complete outer shell,  $ns^2np^6$ , is energetically more advantageous than an incomplete one.

We call it the RULE OF EIGHT: an atom tends to pick up or give away just enough electrons to make eight in its outer shell – AN ELECTRON OCTET.

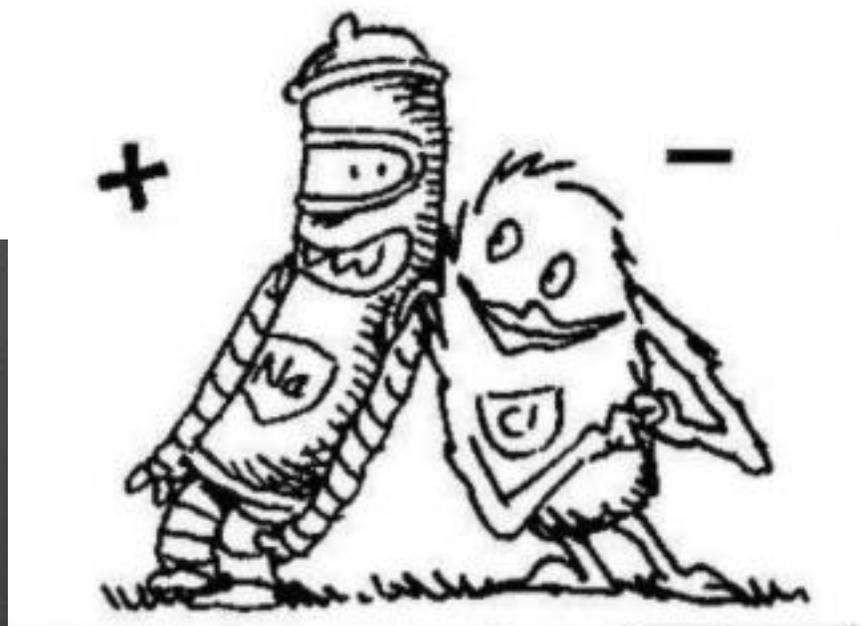
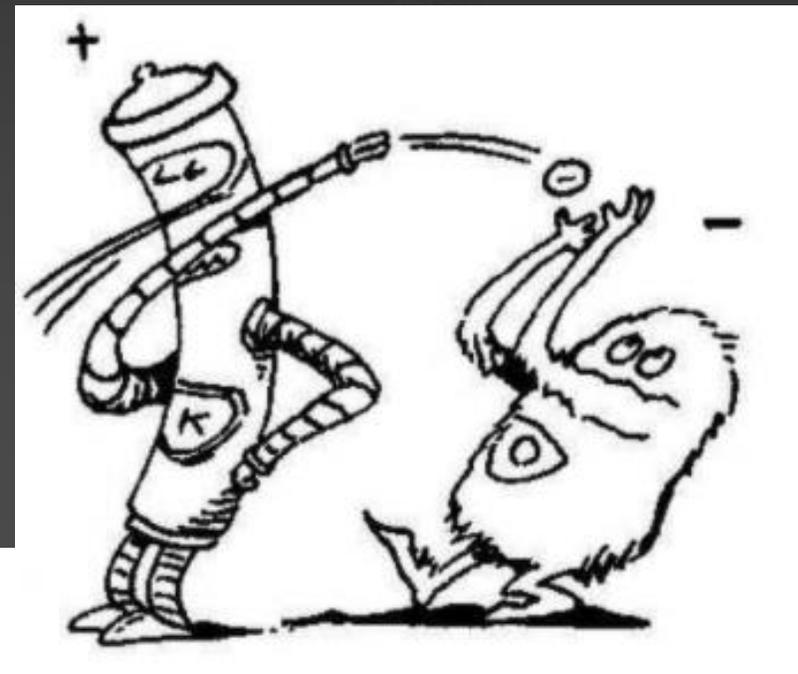


Atoms form chemical bonds by combining such number of electrons that allows them to obtain an electron configuration of noble elements



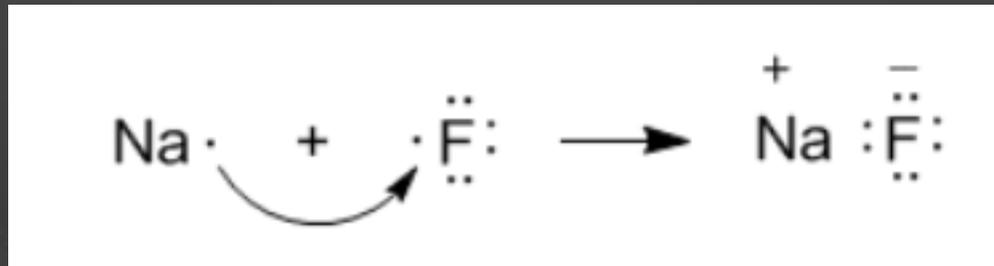
- Hydrogen binds into a molecule resulting in the electron configuration of helium ( $1s^2$ )
- Chlorine combines into a molecule with the electron configuration of argon ( $\dots 3s^2 3p^6$ )

# Ionic bonds

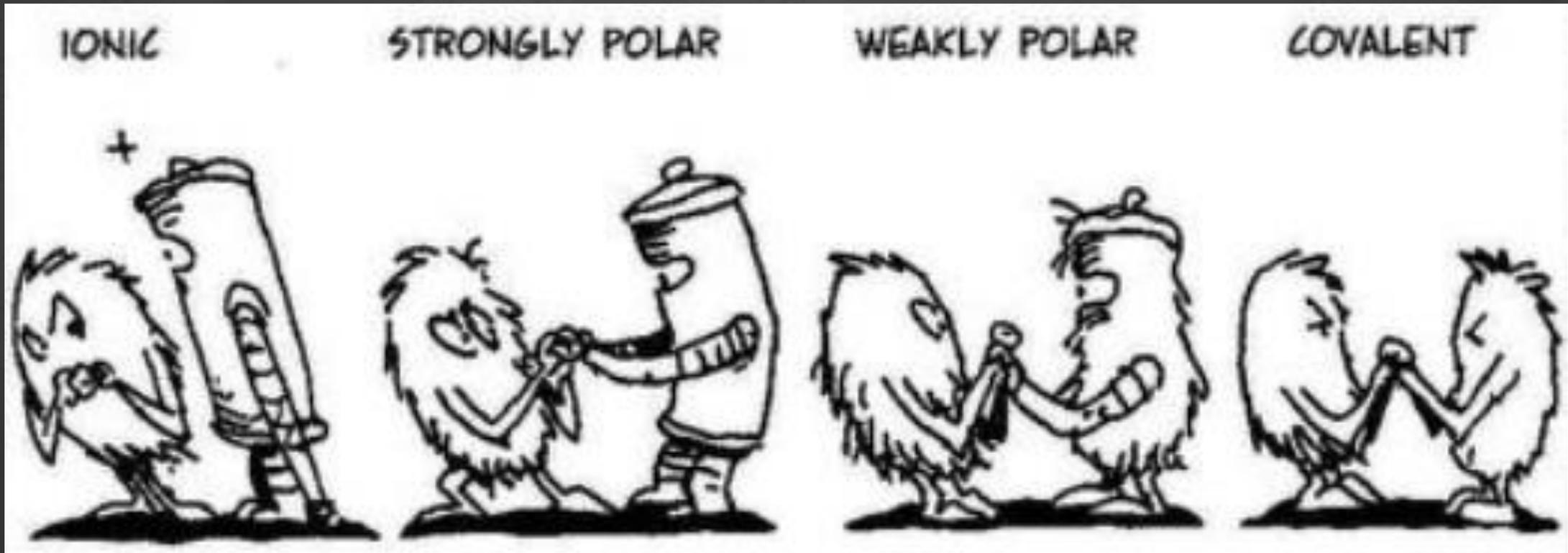


# Ionic bond

- Let's consider interactions between  $_{11}\text{Na}$  and  $_9\text{F}$
- The electron configurations of these elements are:
  - $_{11}\text{Na}: 1s^2 2s^2 2p^6 3s^1$
  - $_9\text{F}: 1s^2 2s^2 2p^5$
- When Na and F bind, they acquire electron configuration of the noble gas Ne
  - The electron configuration of the noble gas  $_{10}\text{Ne}$  is:
    - $\text{Ne}: 1s^2 2s^2 2p^6$
- In the electron formula we need to consider only the outer shells

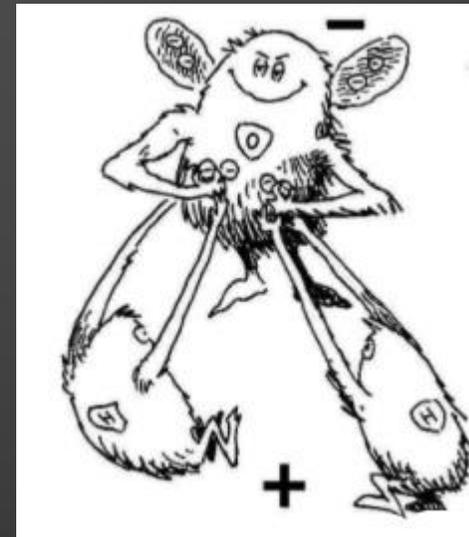
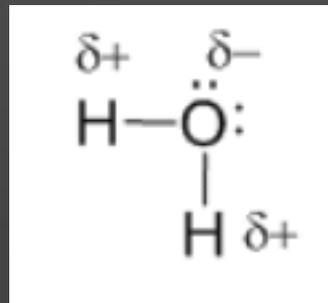
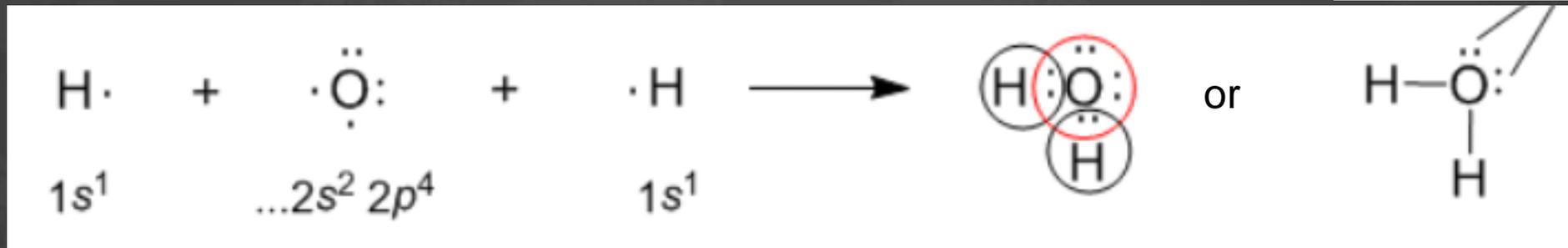


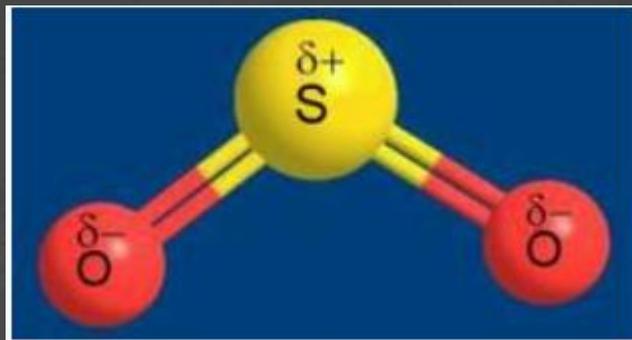
# Different bond types



# Polar covalent bond

- It is an intermediate between covalent and ionic bonds and like for ionic bond it forms between different atoms





SO<sub>2</sub> molecule with polar covalent bond

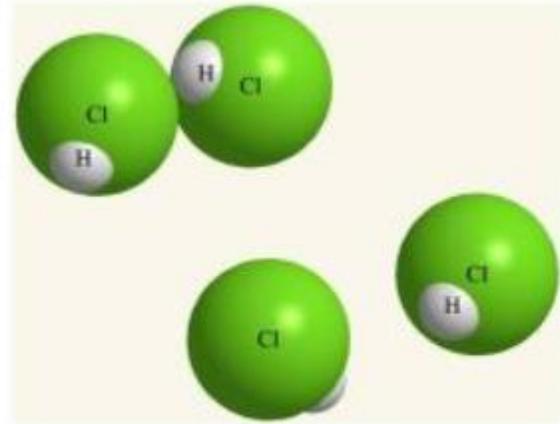
Electronegativity is a relative ability of atoms to attract electrons while binding to other atoms. It is an ability to polarize a covalent bond

Bond's polarity depends on the difference in electronegativity between two atoms. Bigger differences mean more polarity, with a difference of 2 or more being considered ionic

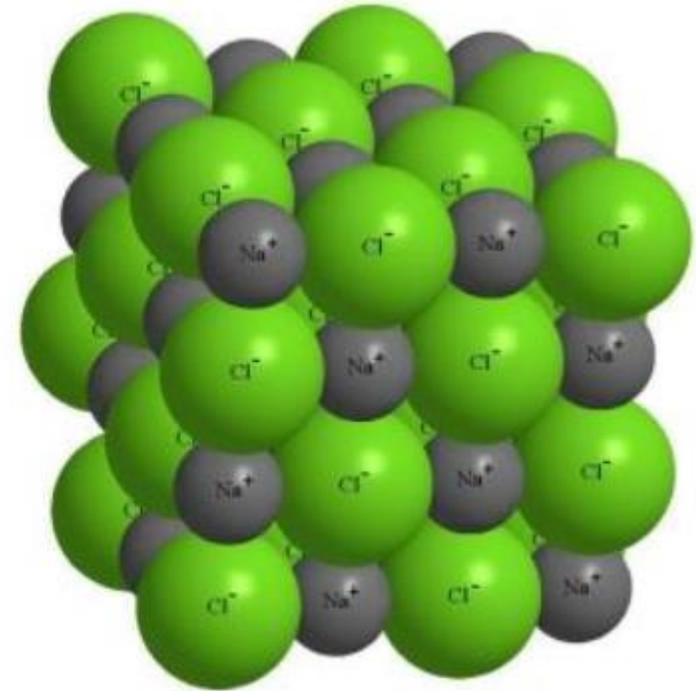
H	2.1	Na	0.9
Li	1.0	Mg	1.2
C	2.5	S	2.5
N	3.0	Cl	3.0
O	3.5	K	0.8
F	4.0	Ca	1.0



H : H  
Cl : Cl  
H : Cl  
Na<sup>+</sup>Cl<sup>-</sup>



HCl

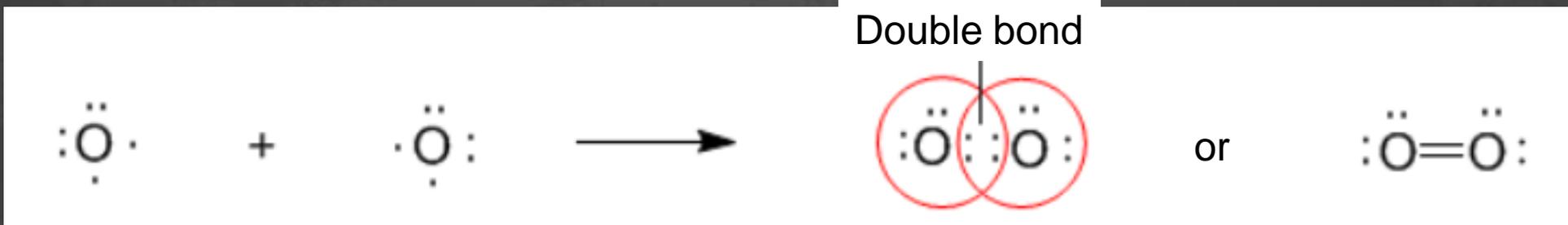


NaCl

- Increased bond polarity results in different properties of the substance - hydrogen chloride (polar covalent bond) is a gas at room temperature while sodium chloride(ionic bond between the atoms) is a solid crystalline substance

# Multiple bonds

- If the octet rule requires multiple bonds can form between two atoms (each bond is two shared electrons)
  - These bonds are called double or triple bonds
- E.g. oxygen can form a molecule from two oxygen atoms only when there are two shared electron pairs between the atoms:



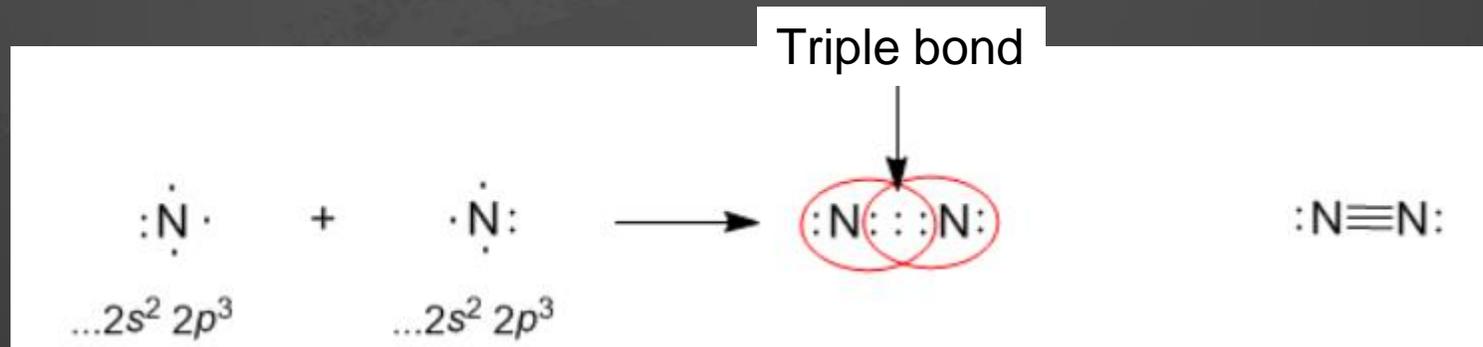
Each oxygen atom has 6 electrons

Each oxygen atom has 8 electrons

**Structural formulas** identify the location of **chemical** bonds between the atoms of a **molecule**.  
A **structural formula** consists of symbols for the atoms connected by short lines that represent **chemical** bonds — one, two, or three lines standing for single, double, or triple bonds, respectively.

How many electron pairs do atoms of nitrogen need to get the octet?

${}_7\text{N}$  electron configuration:



## Multiple bonds

Bond	Bond length ( $\text{\AA}=10^{-8} \text{ cm}$ )	Bond strength, kJ
Single (N-N)	1.45	58.5
Double (N=N)	1.25	456
Triple (N $\equiv$ N)	1.098	945

**Bond order is the number of chemical bonds (shared electron pairs) between a pair of atoms and the bond stability. The highest bond order is 3.**

# Valence

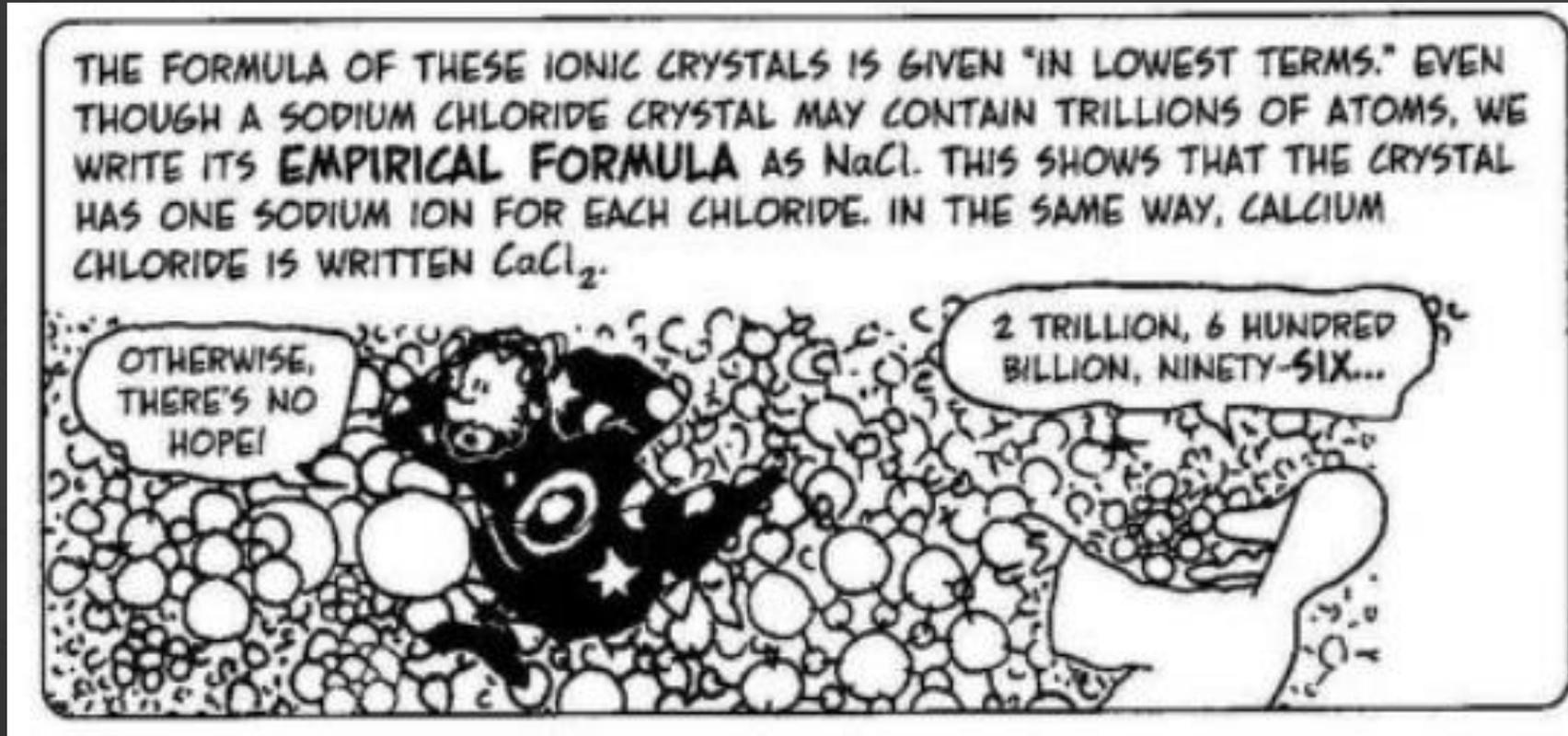
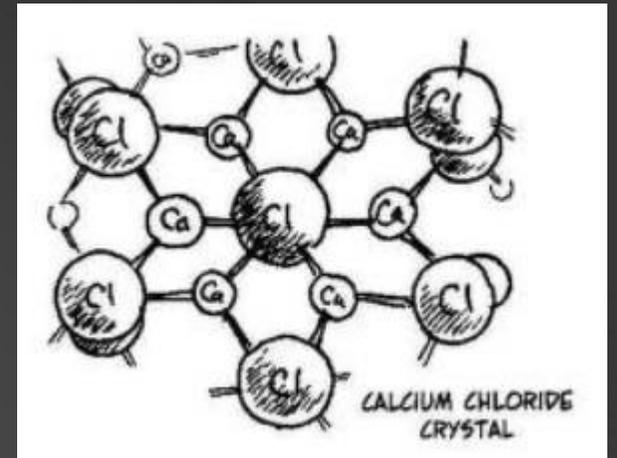
*The valence or valency* of an element is a measure of its combining power with other atoms when it forms molecules

Or

*The valence* is the number of electron pairs that binds the atom with other atoms



# Consider crystals of calcium chloride – $\text{CaCl}_2$



Some substances do not form separate molecules but make a continuous network of repeating atoms (metals) or units (e.g. quartz). In this case the formulas of such matter are those of the repeating units – Cu, or  $\text{SiO}_2$

This class uses the materials from the following books:

Larry Gonick and Graig Criddle “The cartoon guide to chemistry”

Manyuilov and Rodionov “Chemistry for children and adults”

Kuzmenko, Eremin, Popkov “Beginnings of chemistry”