Chemistry - 1

Let’s continue the journey

October 29, 2022

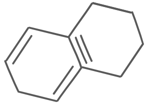
A complete outer shell, ns^2np^6, is energetically more advantageous than an incomplete one.

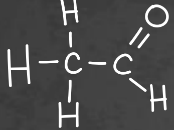
We call it the **RULE OF EIGTH**: at atom tends to pick up or give away just enough electrons to make eight in its outer shell - AN **ELECTRON OCTET**.

Electron donor and electron acceptor properties of atoms are related to the octet rule

The donors tend to achieve the octet by giving up the electrons from their outer shell and the electron acceptors tend to get octet by accepting the electrons to their outer shells

For atoms with similar electron configurations the donor-acceptor properties depend also on how far is the outer shell from the nucleus.





$Ca^2(HO)$

Chemical bonds and chemical reactions - 1

How do atoms bind to each other to form molecules and how do molecules transfer into different molecules in chemical reactions?

$a_{n+1} - a_n = 0_n$

80°C

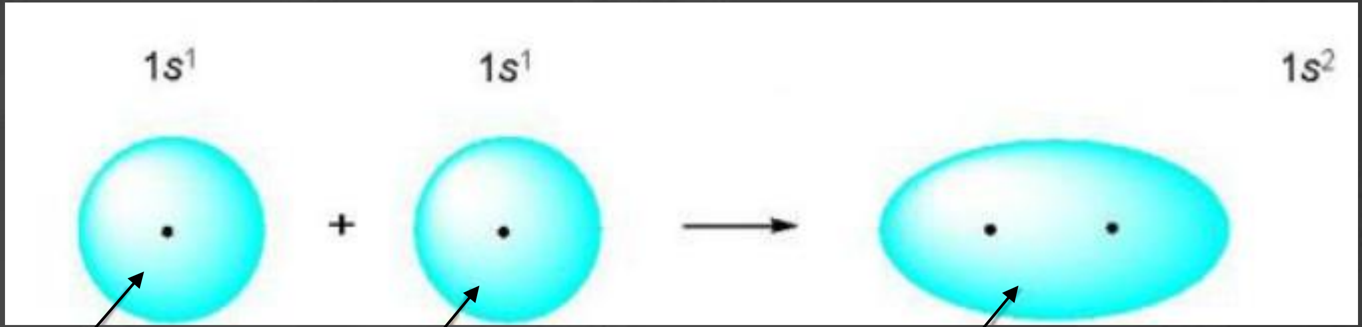
Types of chemical bonds

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

The outer shells of all elements except the noble gases are incomplete

In chemical interactions elements try to complete their outer shells

Covalent bond



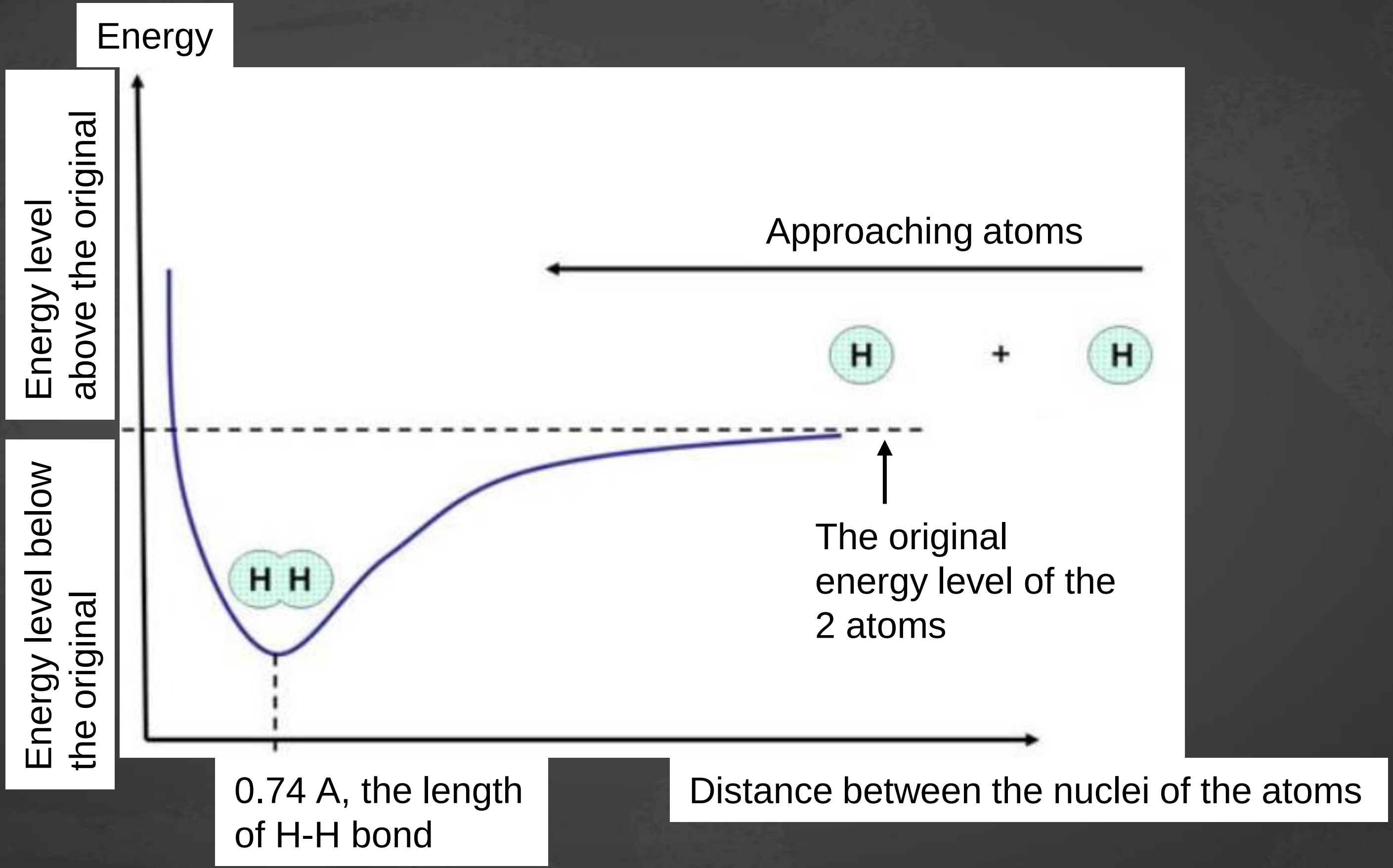
One electron

One electron

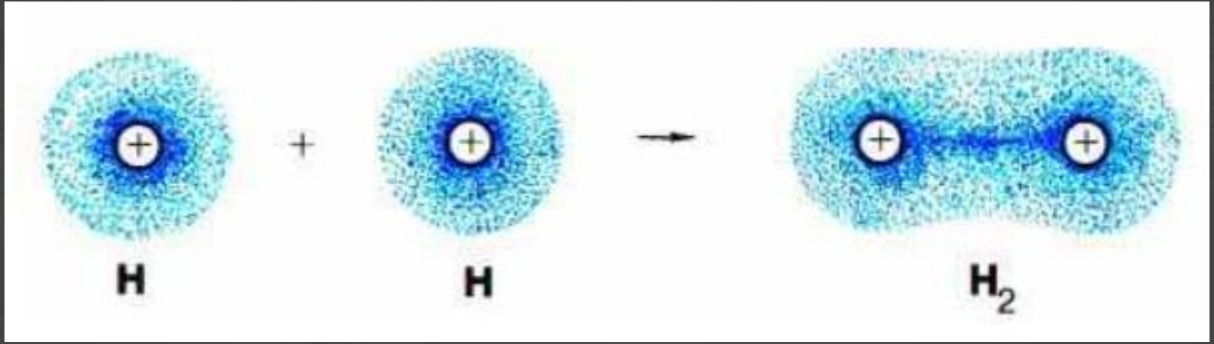
two electron

Alone, hydrogen atom has an unpaired electron. When one hydrogen encounters another, their electrons naturally pair up in a single shared orbital
The pair of electrons pulls on both nuclei, so it holds the atoms together. The bond is called covalent. Because both atoms contribute equally. Each hydrogen got 2 electrons, so the resulting molecule H_2 is stable.

Bond length


Energy
Energy level above the original
Energy level below the original
Approaching atoms
H
+
H
H H
The original energy level of the 2 atoms
0.74 A, the length of H-H bond
Distance between the nuclei of the atoms

Electron density in the molecule



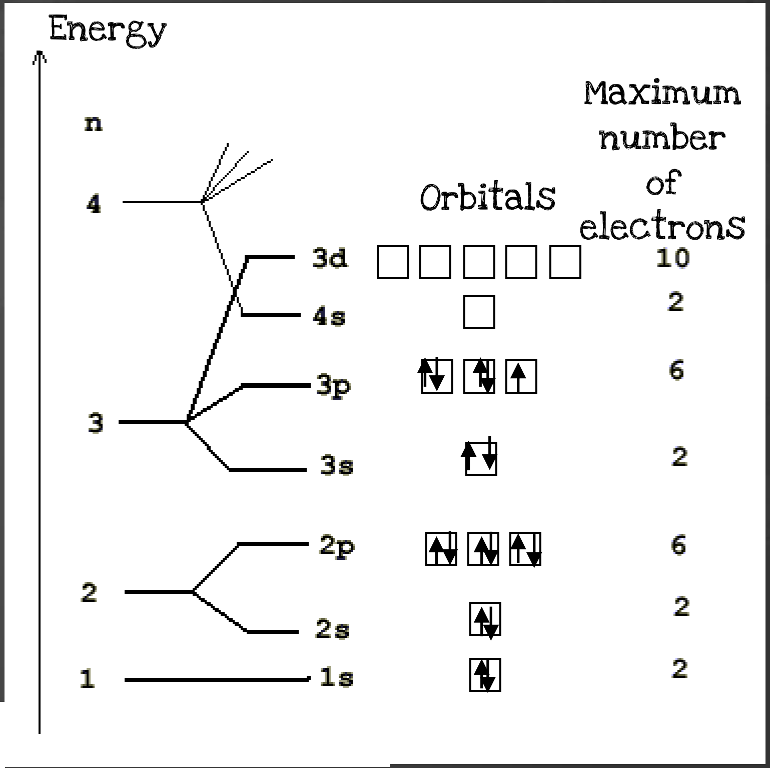
$H\cdot \quad + \quad \cdot H \longrightarrow H:H$

Or H-H

COVALENT BOND is atom bonding by shared pairs of electrons

Binding of chlorine ($_{17}Cl$) atoms

- First, we will write Cl electron configuration
- Then let's write down Cl Lewis structure with the electrons of the outer shell
- Finally, let's write the formation of chlorine molecule from two atoms



Each chlorine atom has 8 electrons

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

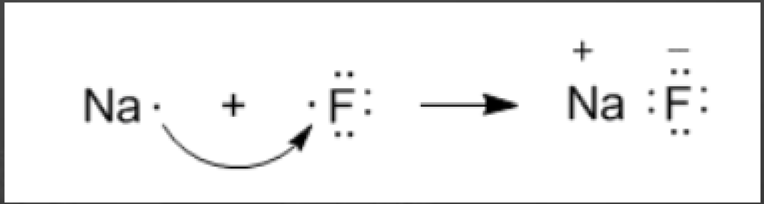
- Hydrogen binds into a molecule resulting in the electron configuration of helium ($1s^2$)
- Chlorine combines into a molecule with the electron configuration of argon ($...3s^2 3p^6$)

Ionic bond

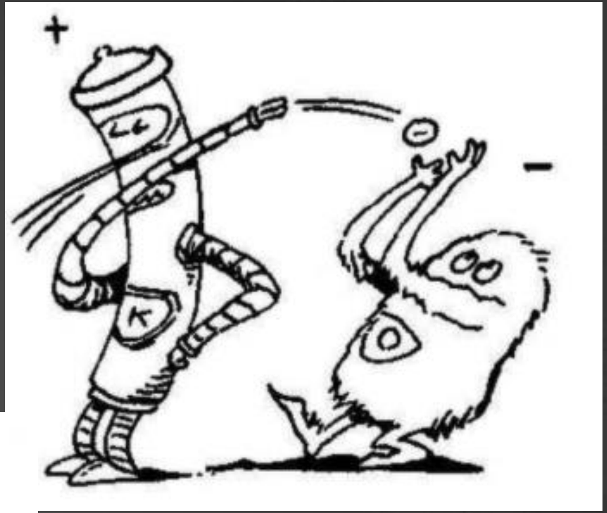
- Let’s consider interactions between $_{11}Na$ and $_{9}F$
- The electron configurations of these elements are:

Na
F

- When Na and F bind they acquire electron configuration of the noble gas Ne
- The electron configuration of the noble gas $_{10}Ne$ is:
- Ne
- In electron formula we need to consider only outer shells

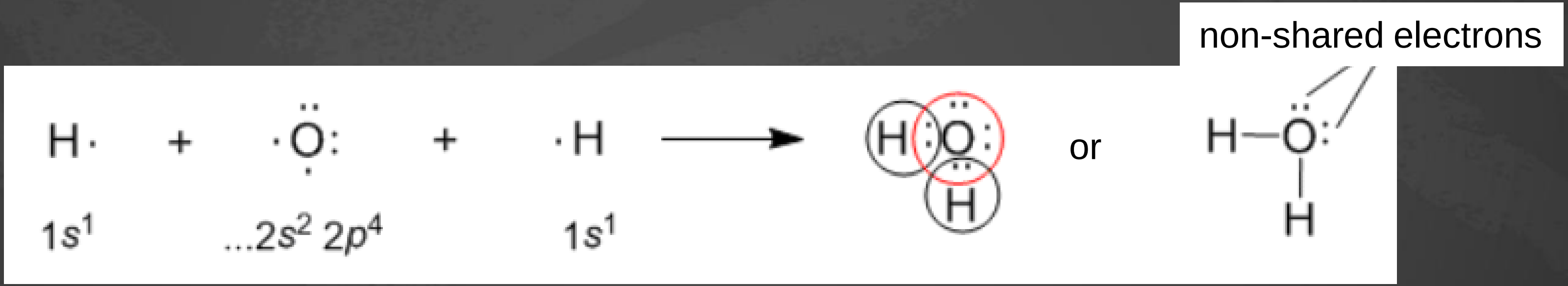


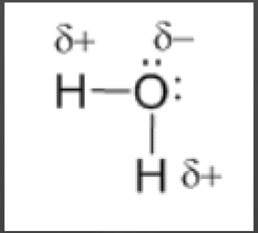
Ionic bonds



Polar covalent bond

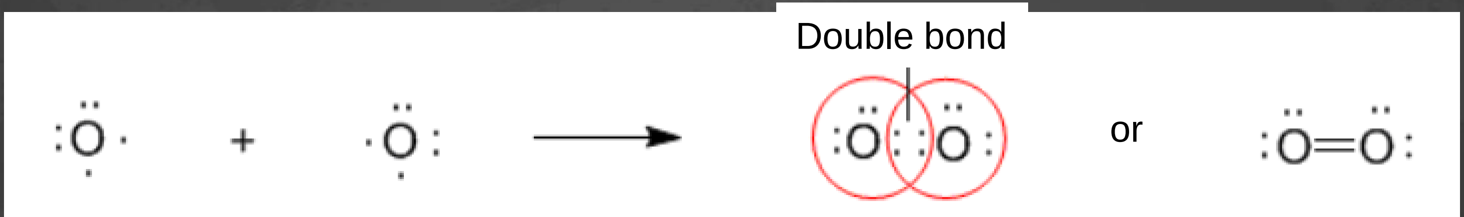
- It is an intermediate between covalent and ionic bonds and like for ionic bond it forms between different atoms





Multiple bonds

- If the octet rules requires multiple bonds can form between two atoms (each bond is two shared electrons)
  - These bonds are cold 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.

Multiple bonds

Bond	Bond length (A=10^{-8} cm)	Bond strength, kJ
Single (N-N)	1.45	58.5
Double (N=N)	1.25	456
Triple (N≡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.