
Chemistry - 101
Review

What does chemistry study?

In **chemical transformations** (called chemical reactions) substances change into different substances

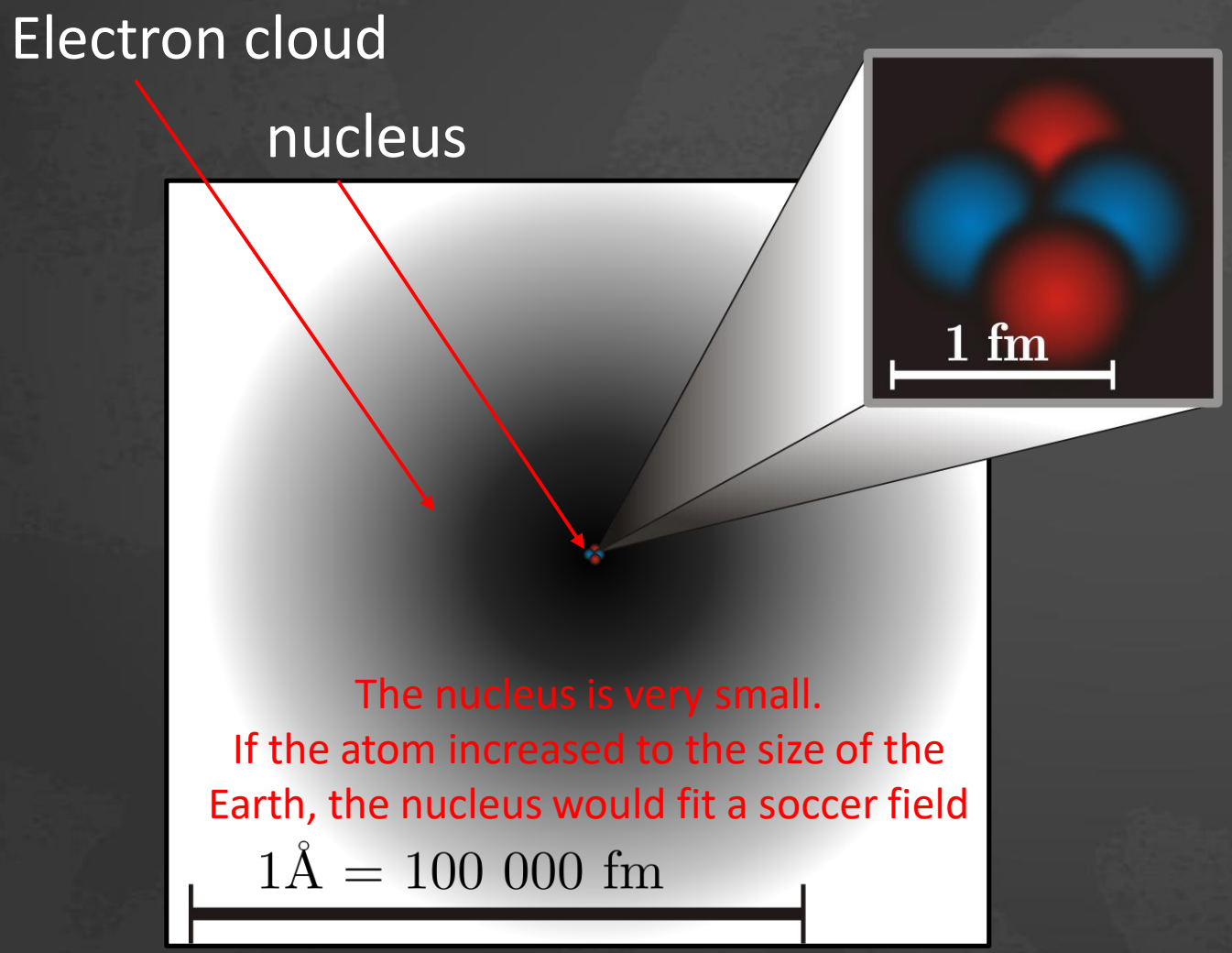
Chemistry is the **study** of matter and the **chemical** reactions between substances. **Chemistry** is also the **study** of matter's composition, structure, and properties.

Substances are made of **atoms**. Atoms get together to form **molecules**

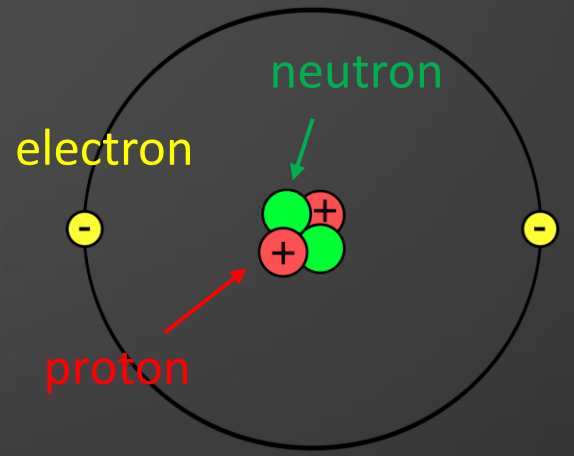
Molecules are building blocks of substances controlling their properties

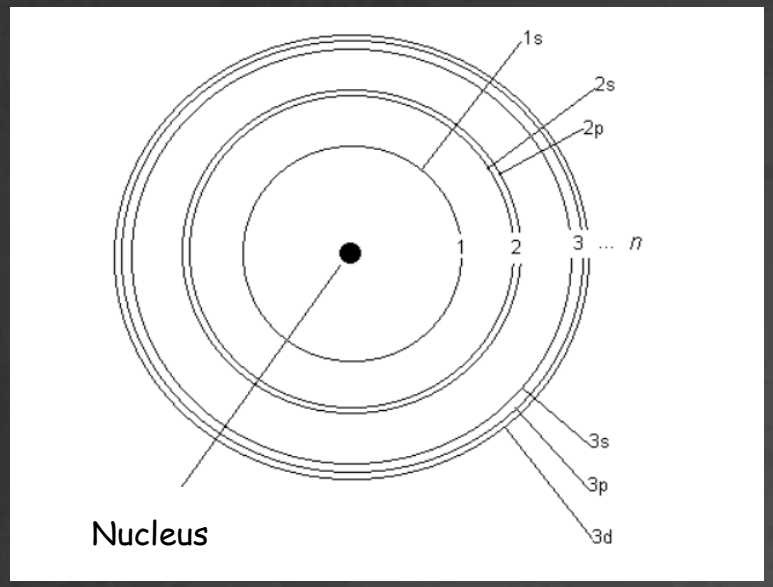
Substance can be broken by breaking molecules, but atoms will not be broken.

Atomic composition

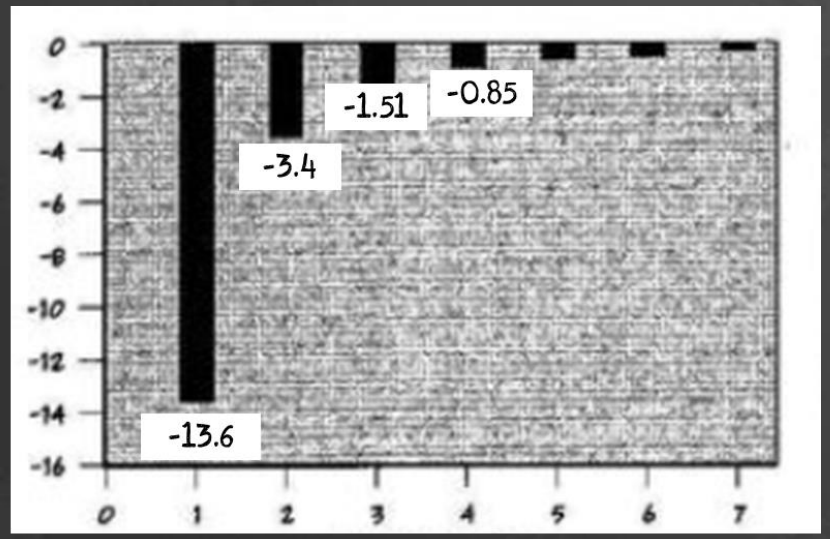


- The number of protons defines the element
- The elements in the periodic table are written in the order of their atomic numbers, which is the number of protons





Atom model by Niels Bohr



In any given atom, the electrons can assume only certain fixed, discrete energy levels (electron's energy quantized)

This energy levels are called shells. The shells further away from a nucleus are more complex and have energy sublevels, orbitals called s (one orbital), p (three orbitals), d (five orbitals), f (seven orbitals).

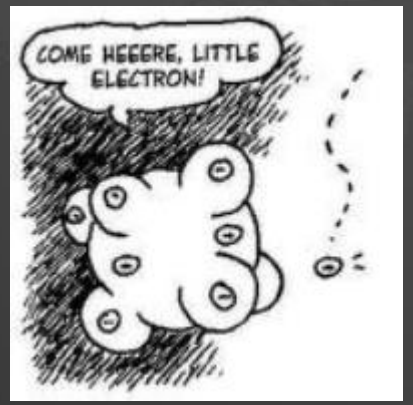
Rules of filling electrons' shells

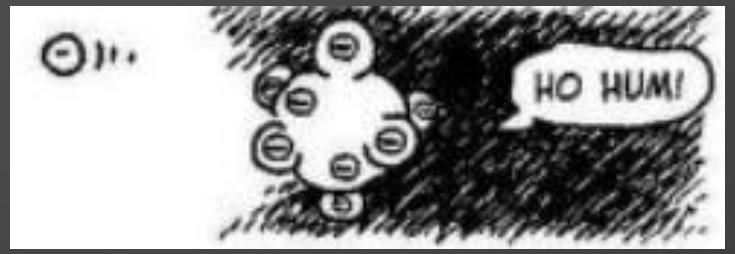
1. Decide the total number of electrons to be placed (it should be equal to the number of protons, which is its atomic number)
2. Add electrons to each orbital starting with that of the lowest energy level and keeping in mind that we cannot place more than 2 electrons on each orbital
3. According to Hund's rule, all orbitals will be singly occupied before any is doubly occupied.

A complete outer shell, ns^2np^6, is energetically more advantageous than an incomplete one. We call it the rule of 8 (an electron **octet**)

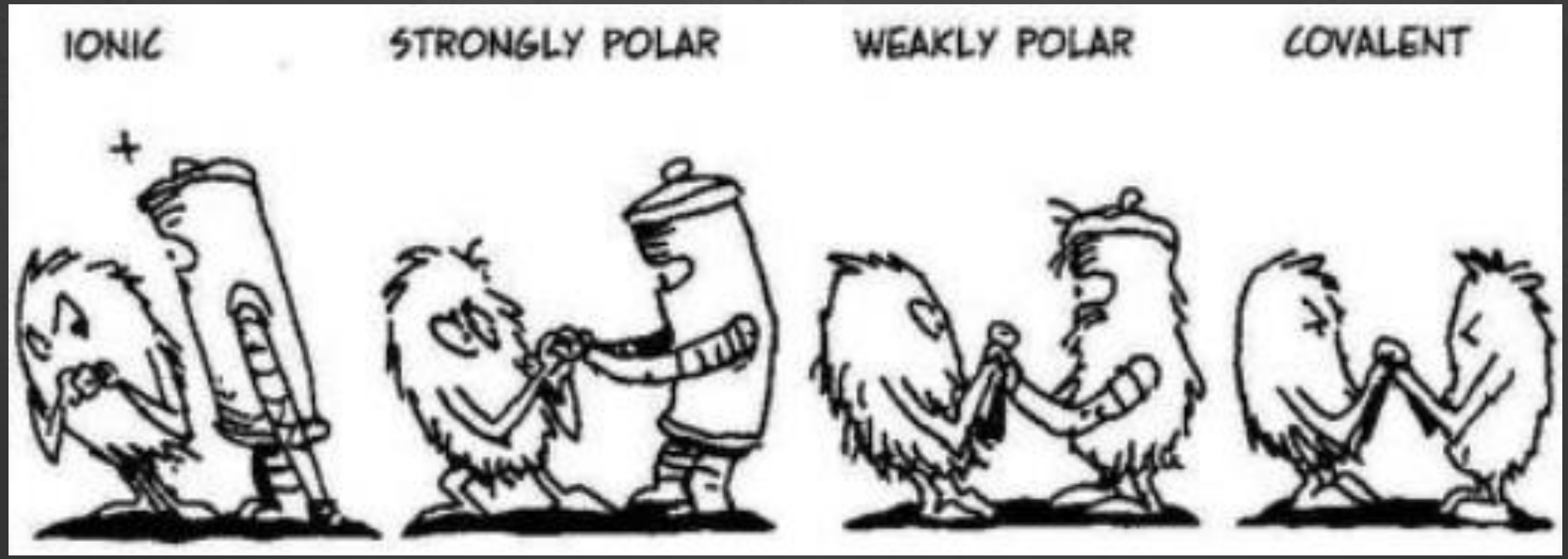
To achieve an electron octet atoms either give up or accept electrons.

The **electron 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.





Moving electrons around results in formation of chemical bonds that can be covalent, ionic, polar covalent (and some other types that we have not talked about yet).



The oxidation state, which may be positive, negative or zero, is the hypothetical charge that an atom would have if all bonds to atoms of different elements were 100% ionic, with no covalent component.

Element	Electronegativity	Element	Electronegativity
Cs	0.79	H	2.20
K	0.82	C	2.55
Na	0.93	S	2.58
Li	0.98	I	2.66
Ca	1.00	Br	2.96
Mg	1.31	N	3.04
Be	1.57	Cl	3.16
Si	1.90	O	3.44
B	2.04	F	3.98
P	2.19		

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

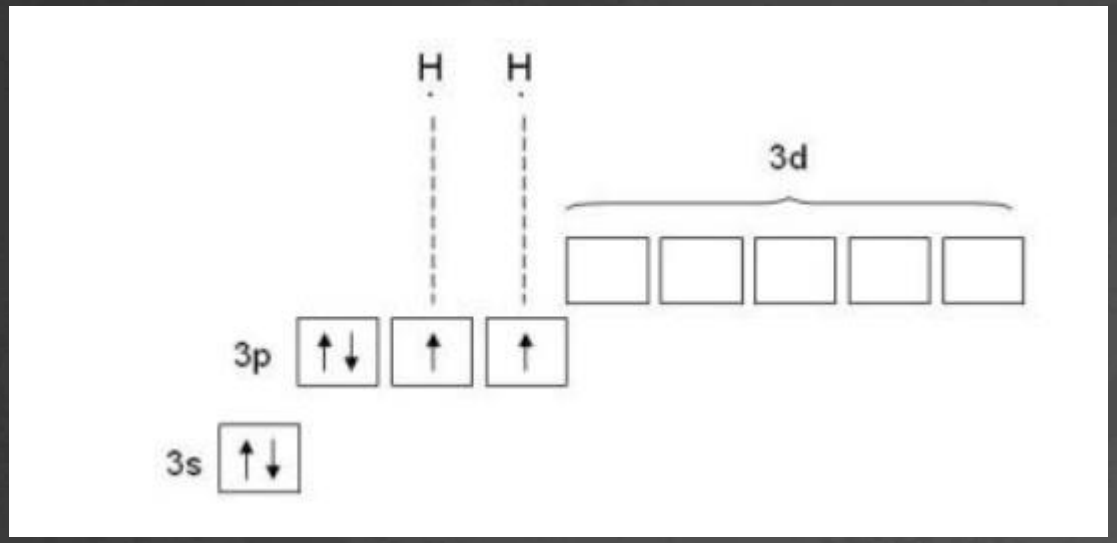
Element	Valence	Element	Valence
H	I	Ba	II
Na	I	O	II
K	I	Zn	II
Ag	I	Sn	II (IV)
F	I	Pb	II (IV)
Cl	I (III, V, VII)	Fe	II, III
Br	I (III, V, VII)	Cr	III, VI
I	I (III, V, VII)	S	II, IV, VI
Hg	I, II	Al	III
Cu	I, II	N	III (IV)
Be	II	P	III, V
Mg	II	C	IV
Ca	II	Si	IV (II)

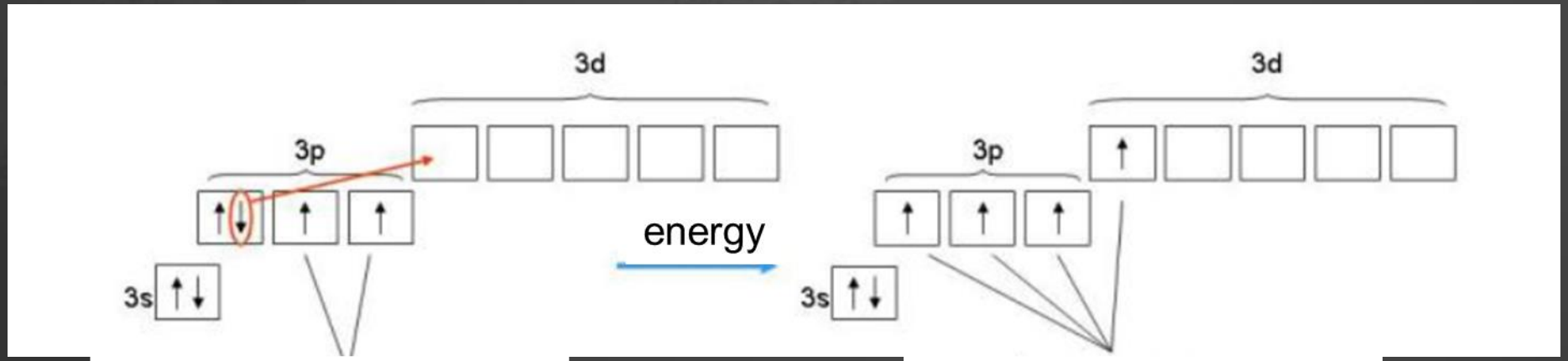
Let’s consider $_{16}S$

$2H + S = H_2S$

$2O + S = SO_2$

$3O + S = SO_3$





2 unpaired electrons
(valence II)

4 unpaired electrons
(valence IV)

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”