Atomic Theory

PowerPoint 4.1

What do you remember from Grade 9?

proton

atomic mass

physical change

chemical change

ionic bonding

Bohr diagram

neutron

covalent bonding

ion

valence electrons

nucleus

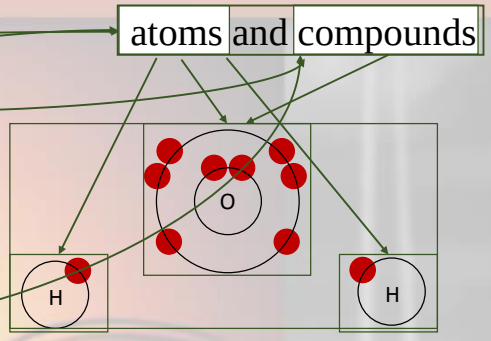
electron

atomic number

Links between Kinetic Molecular Theory and Atomic Theory

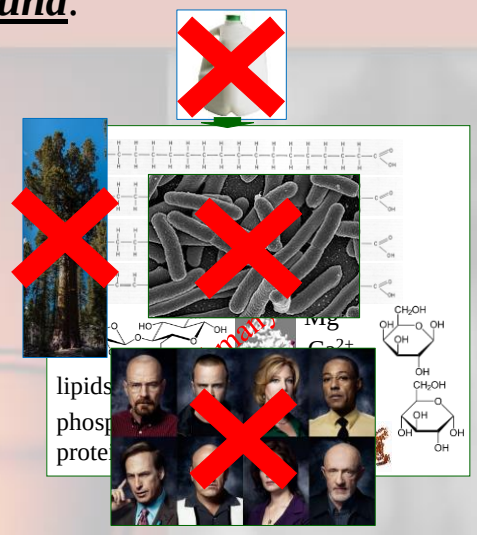
Kinetic molecular theory

1. All matter is made up of very small particles.
2. There is empty space between particles.
3. The particles are constantly moving. These particles are colliding with each other and with the walls of the container.
4. Energy makes particles move. The more energy the particles have, the faster they move and the farther apart they can get.



Pure Substances

A substance composed of only one type of particle.
Classified as either an ***element*** or a ***compound***.



Particules du lait, http://www.ilri.org/InfoServ/Webpub/fulldocs/ilca_manual4/Milkchemistry.htm

The Periodic Table of Elements

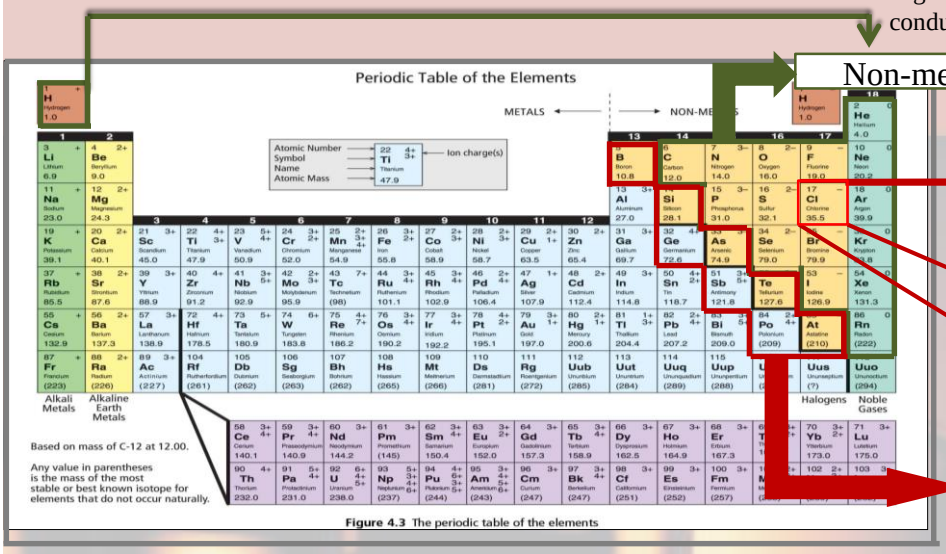


Figure 4.3 The periodic table of the elements

Right side, not shiny, poor conductors, brittle, not ductile

Non-metals

Ionic charge

Atomic number

Element symbol

Element name

Atomic mass

17 -
Cl
chlorine
35.5

Metalloids

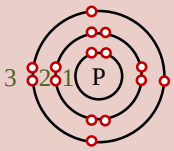
Share some properties with metals and some with nonmetals

The rest are metals → Left side, shiny, conductive, malleable, ductile

Groups and Periods

Rows in the Periodic Table are called periods.

Columns in the Periodic Table are called groups or families.



The number of the period in which an element is located is equal to the number of energy shells in its neutral form.

Elements of the same group or the same period have similar chemical and physical properties.

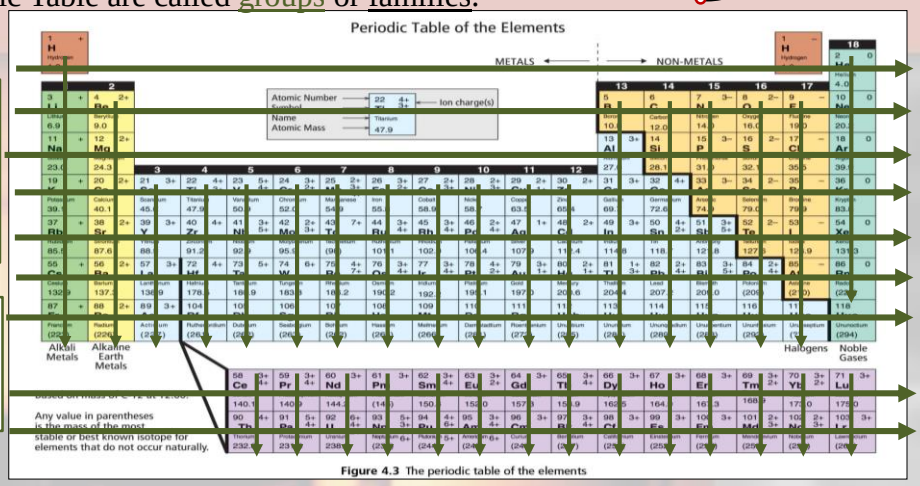
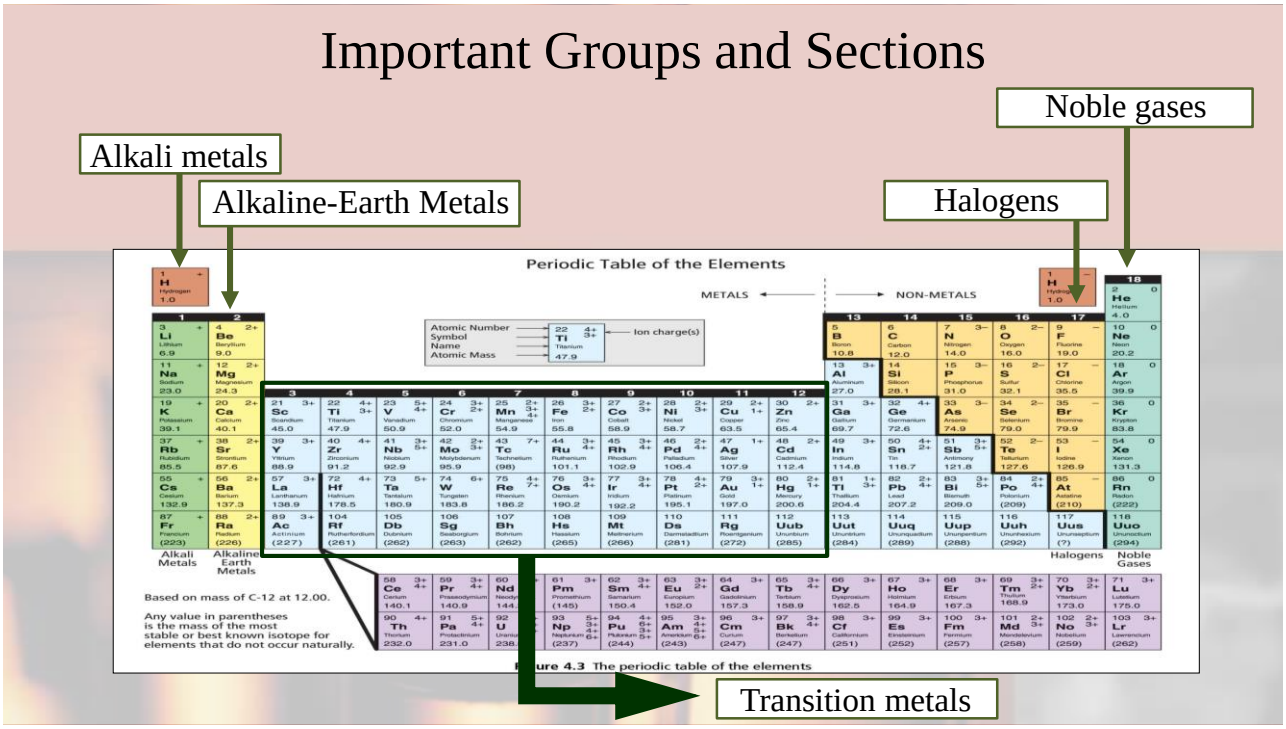
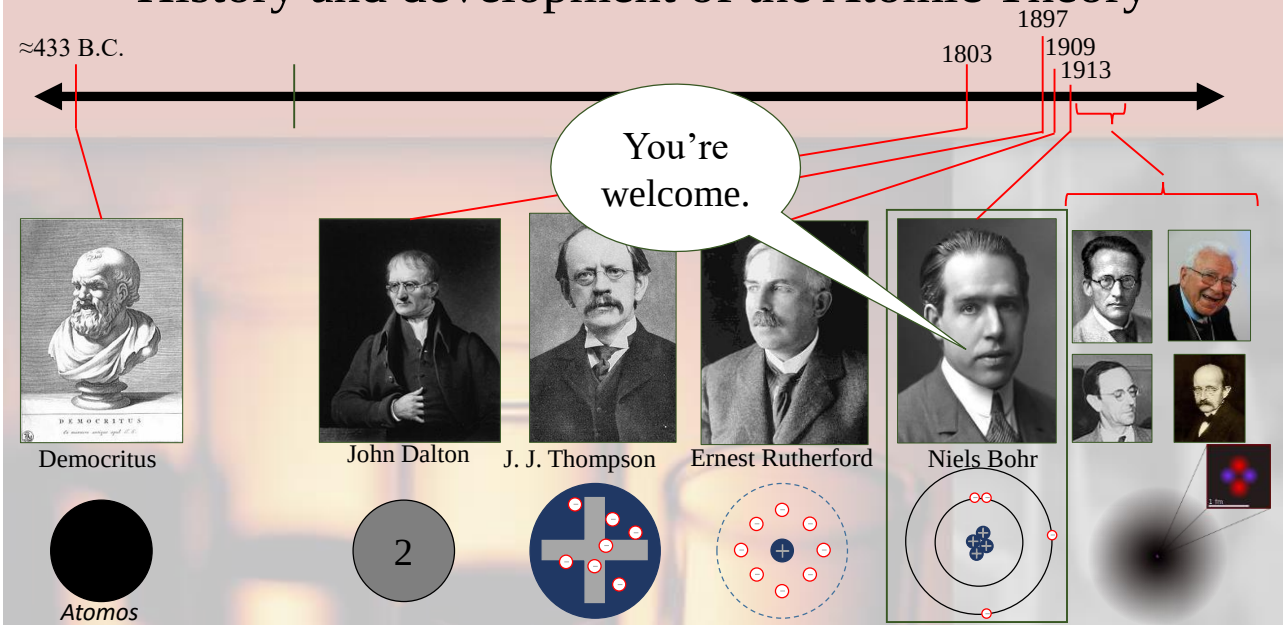


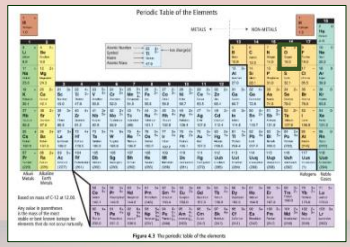
Figure 4.3 The periodic table of the elements

Important Groups and Sections



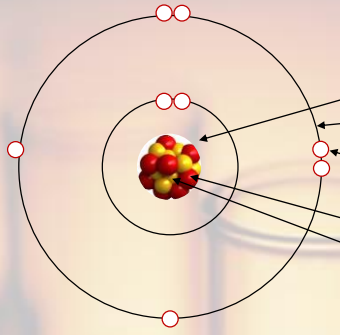
History and development of the Atomic ~~Theory~~ Law





The atom

- The smallest particle of any elements that still retains the properties of that element.



Nucleus

Energy levels
or shells
or orbitals

Particules subatomiques

Electron

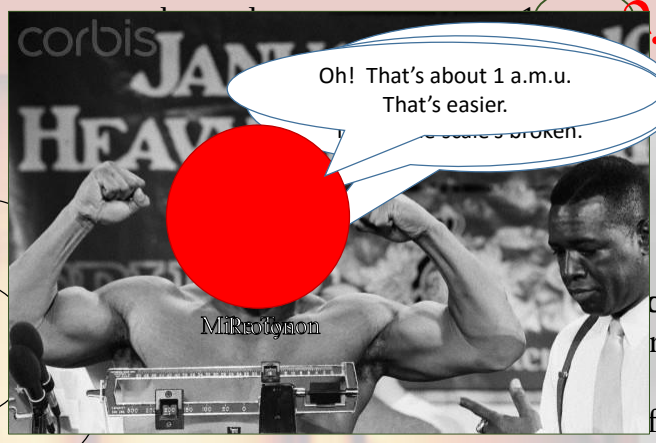
Proton

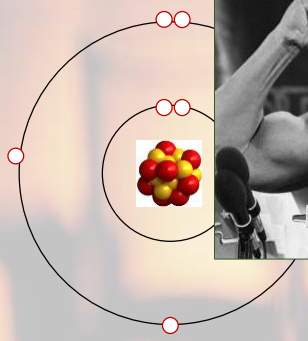
Neutron

Bohr diagram for an atom of oxygen

Subatomic particles

Subatomic particle	Location	Mass	Charge
Proton			1+
Electron		≈ 0 a.m.u.	1-
Neutron			0





cleus

rotons and neutrons

f the atom

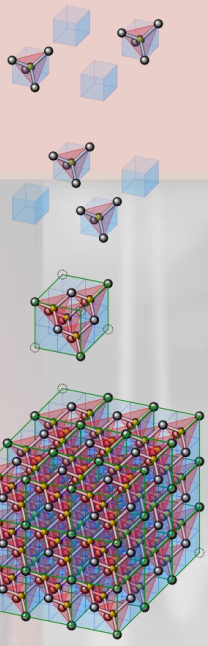
- Extremely small and dense
- Larger nuclei are more unstable due to the repulsion of protons within the nucleus.

Are you kidding me?

=

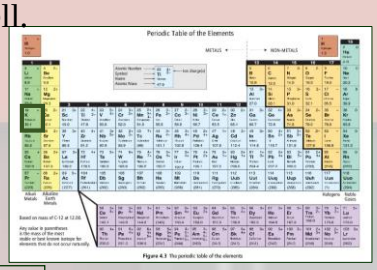
Nothing!?

But…Why?

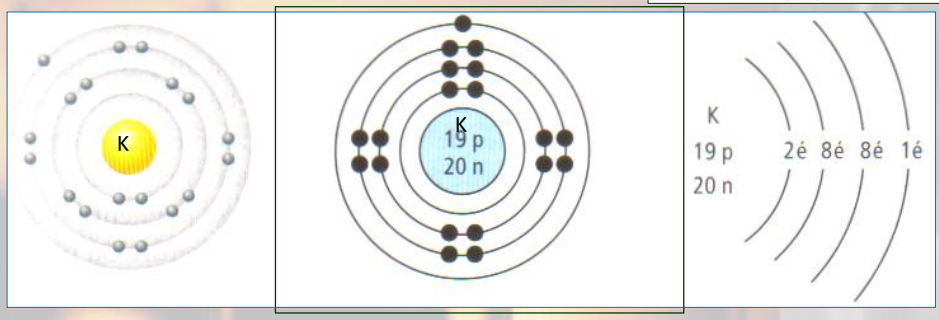


Bohr diagram of the atom

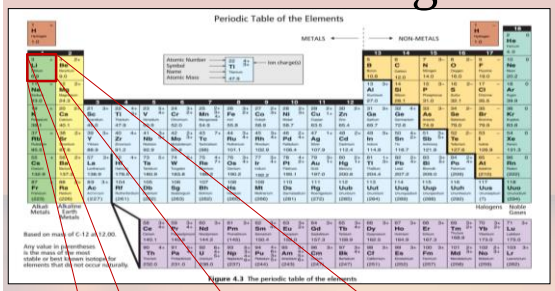
- There are a few variations of Bohr diagrams.
- They each indicate the number of electrons on each shell.

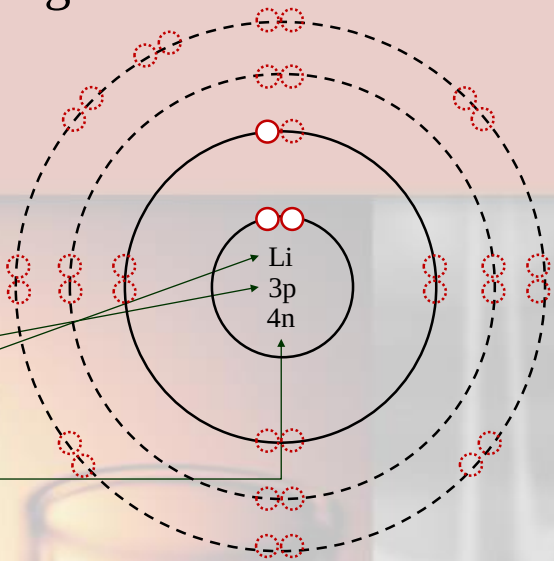


Various Bohr diagrams for the potassium atom, K



Drawing a Bohr Diagram of an atom





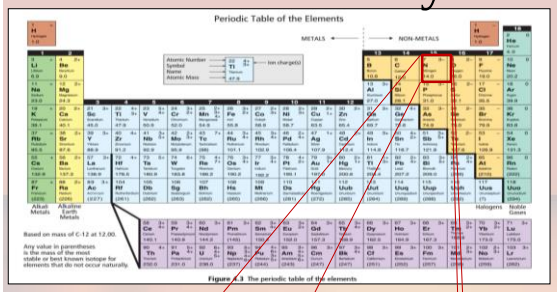
3
Li
Lithium
6.9
+

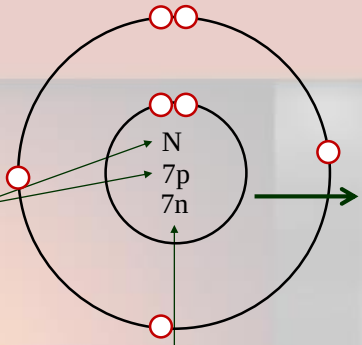
≈ 7 = (#p) + (#n)

Bohr diagram for lithium atom

NEUTRAL atom→ 3#p and #é

Try drawing one yourself





Bohr diagram of a nitrogen atom

7

3-

N

nitrogen

14.007

14 – 7 = 7

≈ 14 = (#p) + (#n)

NEUTRAL atom→ 7p and 7e

Bohr diagrams

Bohr diagrams of the first 18 elements

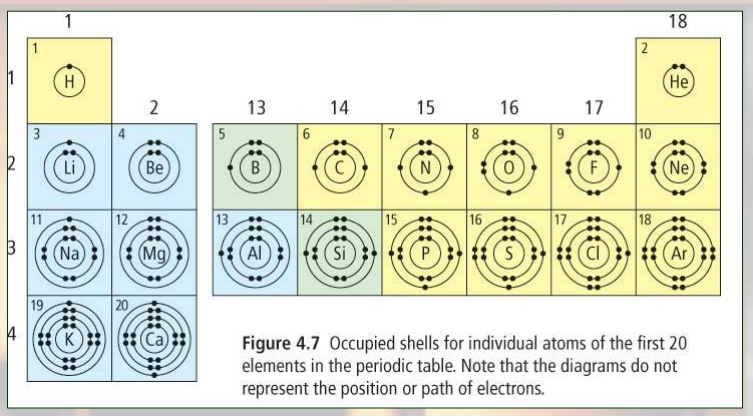
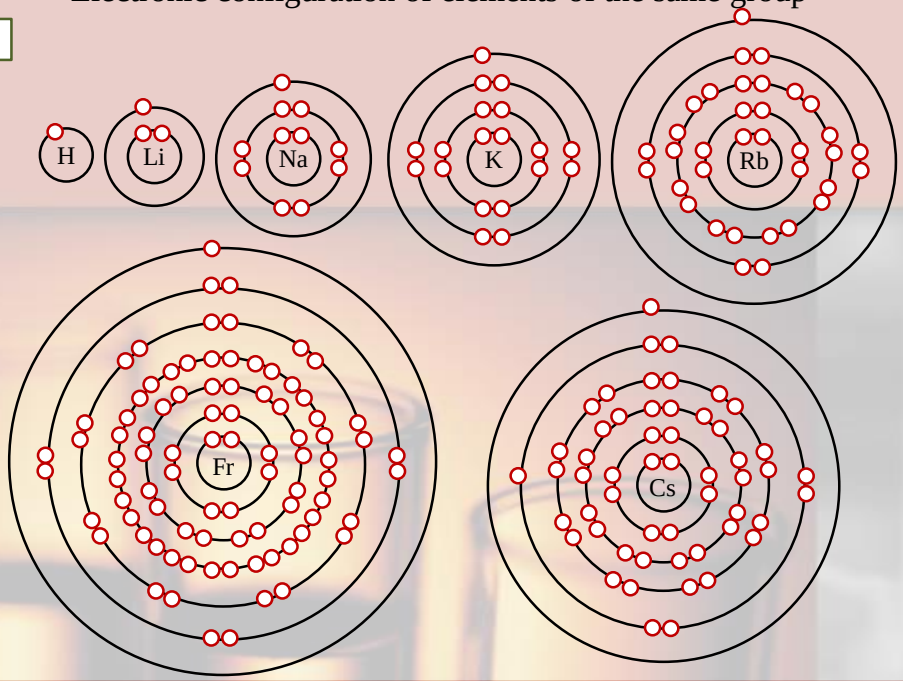


Figure 4.7 Occupied shells for individual atoms of the first 20 elements in the periodic table. Note that the diagrams do not represent the position or path of electrons.

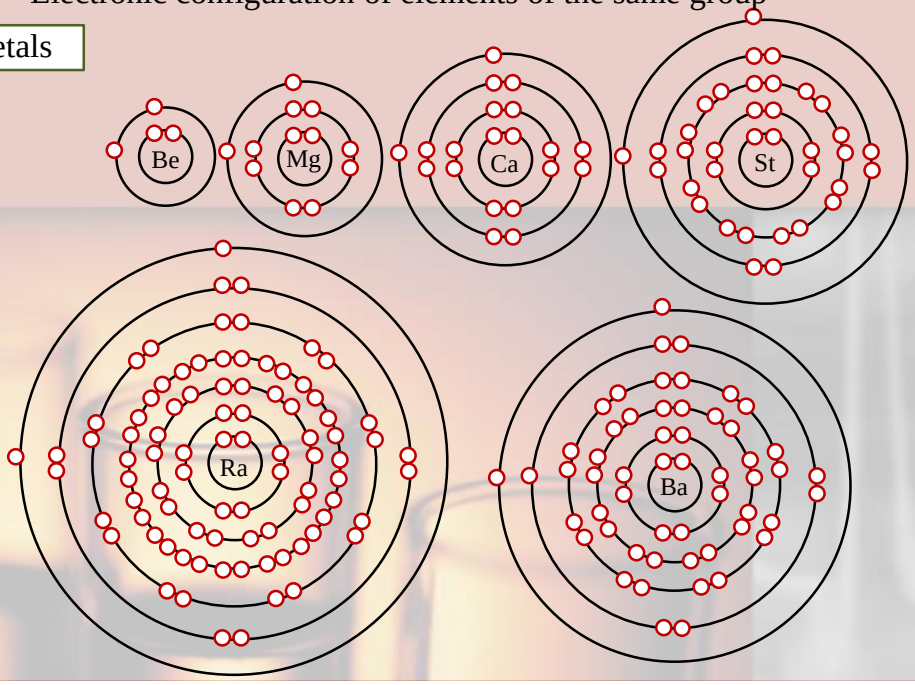
Electronic configuration of elements of the same group

Alkali metals

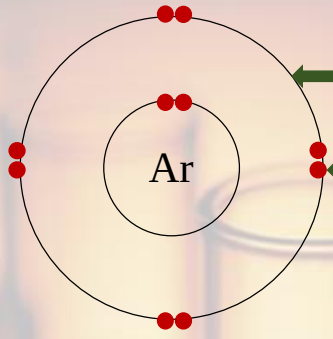


Electronic configuration of elements of the same group

Alkaline-Earth metals



More Atomic Terminology



Valence shell

- Outermost shell containing electrons

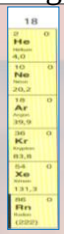
Valence electrons

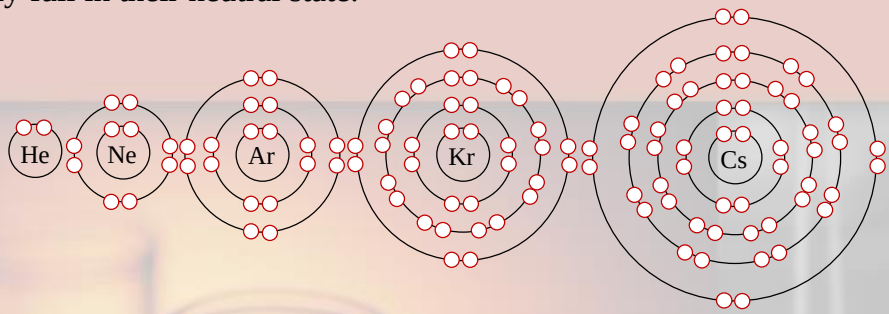
- Electrons in the valence shell
- Electrons that interact during chemical reactions and that participate in chemical bonds.

Stable Octet

Noble gases are particularly non-reactive, or stable, because their atoms have valence shells that are already full in their neutral state.

Noble gases





Octet rule

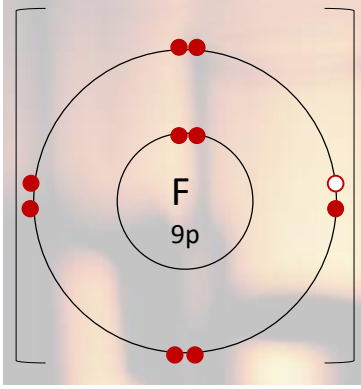
- Atoms « like » having a full valence shell, often containing 8 electrons.
- Atoms of non-noble gas elements must add or remove electrons in order to have a full valence shell, thereby becoming ions.

Ions

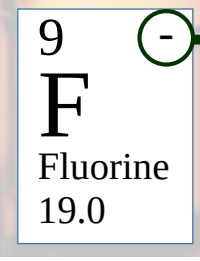
Atoms that gain or lose one or more electrons are called ***ions***.

- The number of protons in the nucleus is not equal to the number of electrons surrounding the nucleus
- Ions carry a positive charge (cations) or a negative charge (anions).

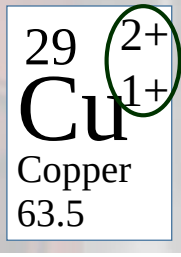
Fluorine is often found in its ionic state, the ***fluoride ion***.



\- ← Fluorine adds an electron in order to fill its valence shell thereby becoming an anion.



The charge of the ion commonly formed for each element is indicated in the top right-hand corner of the element's box.



Elements with more that one possible ionic charge are called ***multivalent*** elements.

Compounds

A compound is formed when two or more atoms connect together via an exchange or sharing of electrons.

- Two main types of compounds,
  1. Ionic compounds
  2. Covalent compounds or molecules

Ionic Compound Formation

In order to fill their valence shell, atoms will exchange one or more electrons.

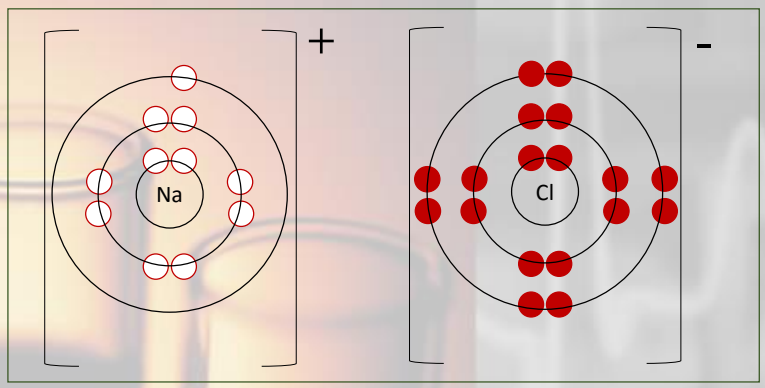
Sodium — Chlorine

Sodium ion — Chloride

Sodium chloride

Notice that,

- metals will typically lose electrons, becoming cations,
- non-metals typically add electrons to be come anions,
- ionic compounds typically contain a metal and a non-metal.

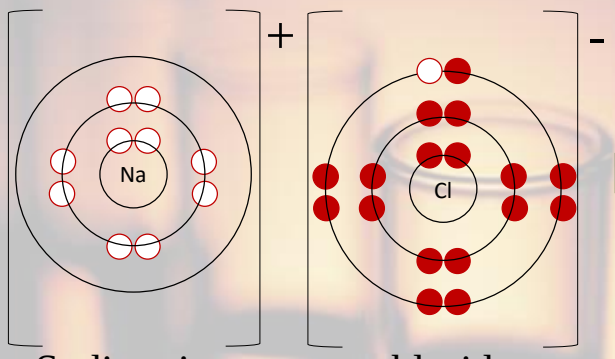


Ionic Compounds

Formed by the attraction between oppositely charged ions.

- Opposite charges attract and like charges repel one another

Bohr diagram of the ionic compound NaCl



Sodium ion chloride

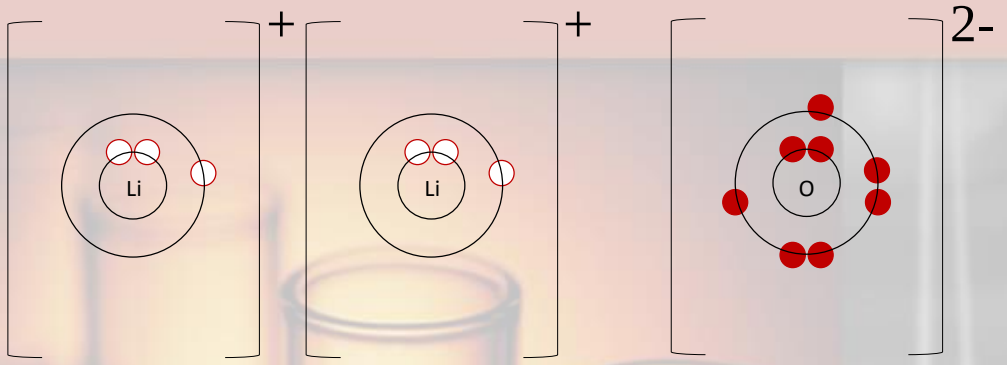
Chemical formula, NaCl

Chemical name, sodium chloride

Chemical equation, $Na^+ + Cl^- \rightarrow NaCl$

Try drawing the ionic compound with the following chemical formula

Li_2O



Try writing the chemical equation for the formation of this compound,

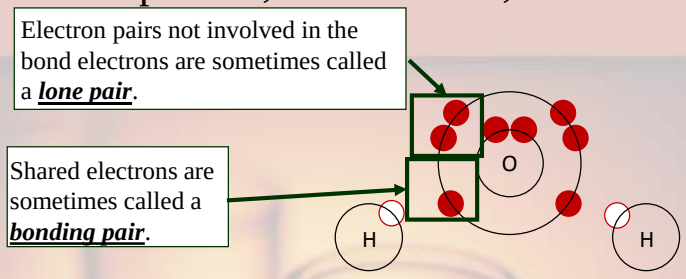
$2Li^+ + O^{2-} \rightarrow Li_2O$

Try writing the chemical name for this compound,

Lithium oxide

Covalent compounds or Molecules

Covalent compounds, or molecules, involve a sharing of electrons.

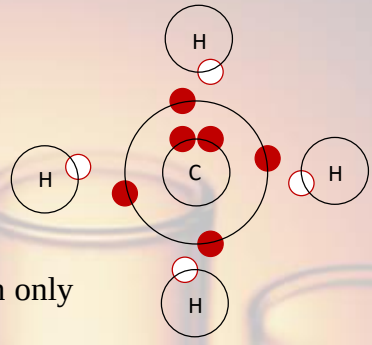


Atoms in a water molecule are covalently bonded

Chemical equation, $2H + O \rightarrow H_2O$

Try drawing the molecule with the following chemical formula,

CH_4



Ensure that you indicate that electrons that are shared between atoms are placed on the valence shells of the atoms involved.

- they should overlap

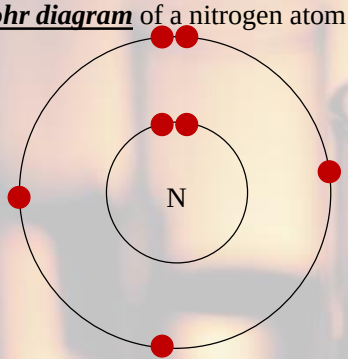
- Notice that covalent compounds often contain only non-metals.

Chemical equation for the formation of this compound is $C + 4H \rightarrow CH_4$

Lewis Diagrams

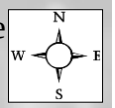
A ***Lewis diagram*** (or a ***Lewis structure*** or an ***electron dot diagram***) is a diagram that illusrates chemical bonding by showing only an atom's valence electrons (lone pairs and bonding pairs) and the chemical symbol.

Bohr diagram of a nitrogen atom



Lewis diagram of a nitrogen atom

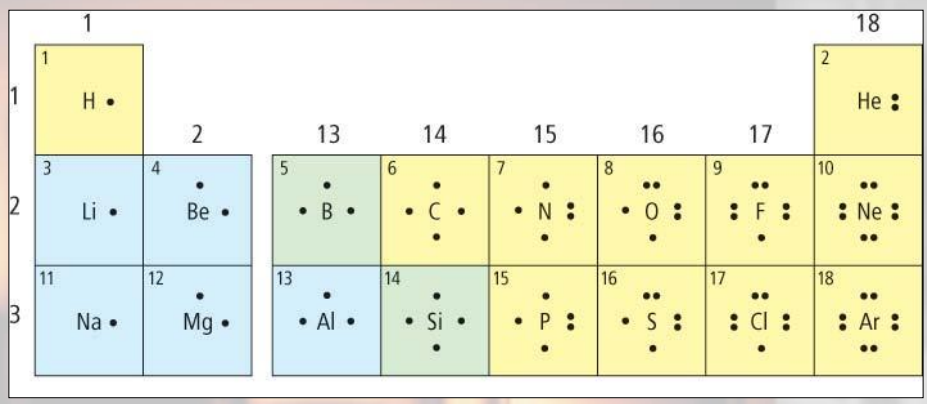
- Dots represent electrons and are placed around the chemical symbol at the points of a compass.



- Electron dots are placed singly until the fifth electron is reached, then they are paired
- Helium is a bit of an exception

Lewis diagrams

Lewis diagrams of the first 18 elements



Lewis Diagrams for Atoms, Ions, and Compounds

Atoms

Sodium Na

Oxygen O

Ions

Sodium ion [Na]+

Oxide ion [O]2-

Ionic compounds

Sodium oxide, Na_2O

[Na]+ [Na]+ [O]2-

Covalent compounds (molecules)

Water, H_2O

H O H

or

H—O
|
H

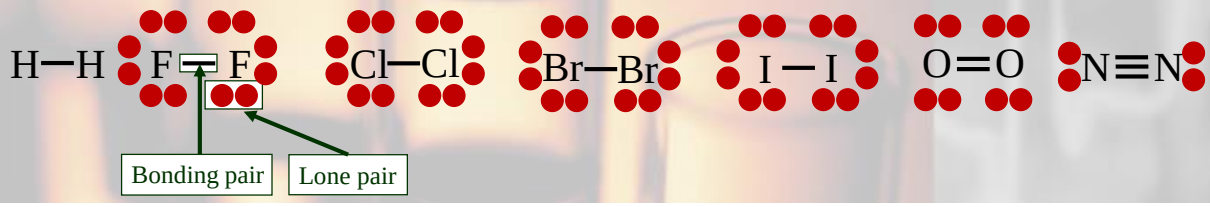
Each line represents two shared electrons

Lewis Diagrams of Diatomic Molecules

Some elements exist naturally as ***diatomic molecules*** because they are more stable together than as individuals.

A pair of atoms joined by a covalent bond

Hydrogen	Fluorine	Chlorine	Bromine	Iodine	Oxygen	Nitrogen
H_2	F_2	Cl_2	Br_2	I_2	O_2	N_2



Summary

Subatomic Particle	Location	Mass	Charge
Proton	nucleus	1 amu	1+
Electron	shells	≈ 0 amu	1-
Neutron	nucleus	1 amu	0