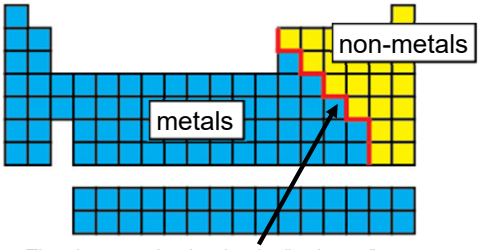
Atoms and Molecules

The Periodic Table

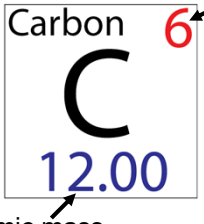
families (groups)

periods



The elements that border the "staircase" are called metalloids. They have properties of both metals and non-metals.

Atomic number
(number of protons)



Atomic mass
(number of protons plus neutrons)

The period number is the number of electron shells.

Groups

- Alkali metals (1)
- Alkaline earth metals (2)
- Chalcogens (16)
- Halogens (17)
- Noble gases (18)

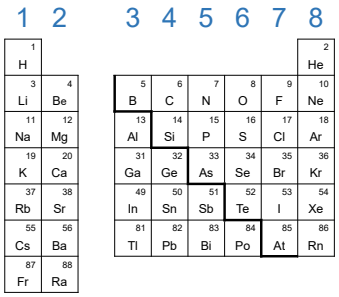
Parts of the Atom

- Atoms have a nucleus (containing protons and neutrons) surrounded by electron clouds
- The atoms of elements in Period 1 have one electron “shell.” This “shell” contains a maximum of 2 electrons.
- Period 2 atoms add a second “shell” which can hold a maximum of 8 electrons.
- Period 3 atoms add a third “shell” which can hold a maximum of 18 electrons.

Valence Shell

- The outermost “shell” of an atom is known as the **valence shell**
- The electrons in the valence “shell” are called **valence electrons**.

Number of Valence Electrons



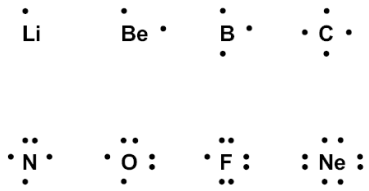
Lewis Dot Diagrams (Electron Dot Diagrams)

- A Lewis dot diagram is a convenient shorthand way to represent an atom and its valence electrons.
- Diagrams in which dots are placed around the chemical symbol of an element to illustrate the valence electrons.

Drawing Lewis Dot Diagrams

- Each dot represents one valence electron.
- In the dot diagram, the chemical symbol represents the core of the atom (nucleus plus the all the inner electrons).
- Atoms in the same family will have similar Lewis dot diagrams, except for helium (He) which has only two valence electrons.

- The Lewis dot diagrams for the elements in the second period are as follows:



Ions

- An atom that loses or gains electrons is called an ion.
- If the atom loses electrons, it becomes positively charged.
- If the atom gains electrons, it becomes negatively charged.
- Atoms gain or lose electrons so that they become like the nearest noble gas.

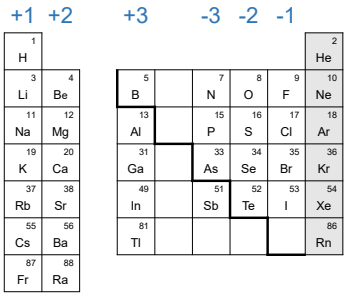
Positive Ions

- Called Cations
- Lose electrons
- Metals usually form cations
- Charge is equal to the number of electrons lost
  - Li^{+} has lost one electron
  - Mg^{2+} has lost two electrons

Negative Ions

- Called Anions
- Gain electrons
- Usually non-metals are anions
- Charge is equal to the number of electrons gained
  - Cl^- has gained one electron
  - O^{2-} has gained two electrons

Ions



Lewis Dot Diagrams for Ions

- Draw the Lewis dot diagram for the atom adding or subtracting valence electrons as needed
- Indicate the charge

Noble Gases

- Noble gases (group 18) have 8 electrons in the valence “shell” (it is full)
  - Helium (He) is an exception (the first shell can only hold 2 electrons)
- Noble gases usually do not form ions

Forming Compounds

- When two atoms collide, valence electrons on each atom interact.
- A chemical bond forms between the atoms if their valence electrons make a new arrangement that has less energy than their previous arrangement.
- Usually that means that the atoms want to be like their nearest noble gas.

Forming Compounds

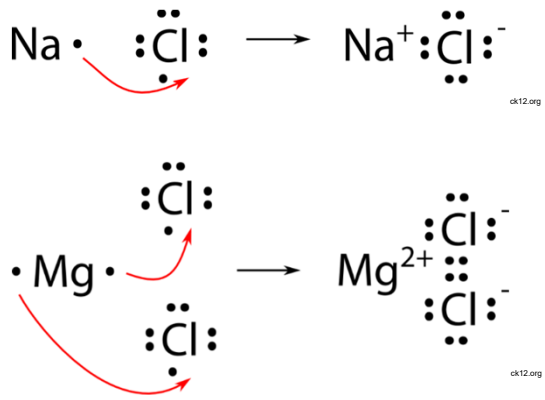
- An atom may acquire a valence “shell” like a noble gas by:
  - Losing electrons (becoming cations)
  - Gaining electrons (becoming anions)
  - Sharing electrons

Bond Types

- There are two types of bonds that are formed between atoms:
  - Ionic
  - Covalent

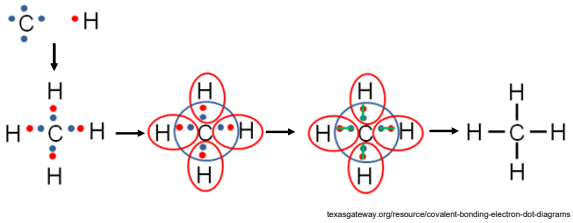
Ionic Bond

- A metal atom loses electrons and becomes a cation
- A non-metal atom takes the electrons and becomes an anion
- The cation (+) is attracted to the anion (-)
- Substances with ionic bonds are known as ionic compounds.

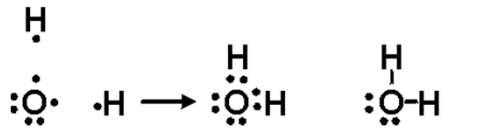


Covalent Bonds

- Two non-metal atoms share some of their valence electrons with each other
- Each pair of shared electrons is referred to as a covalent bond
- Substances with covalent bonds are known as molecular compounds



texasgateway.org/resource/covalent-bonding-electron-dot-diagrams



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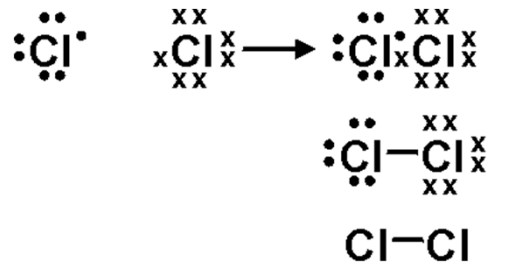
Diatomic Molecules

- A diatomic molecule is a molecule containing two of the same non-metal atoms
- Most elements exist naturally as single atoms
- Seven elements only exist naturally as diatomic molecules
  - N_2, O_2, F_2, Cl_2, Br_2, I_2, H_2



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